2. SITE 442, SHIKOKU BASIN, DEEP SEA DRILLING PROJECT LEG 58

The Shipboard Scientific Party[1]

HOLES 442 AND 442A

Date occupied: 12 December 1977

Date departed: 20 December 1977

Time on hole: 7 days, 11 hours

Position: 28°59.00′N; 136°03.43′E

Water depth (sea level; corrected m, echo sounding): 4639.0

Water depth (rig floor; corrected m, echo sounding): 4649.0

Bottom felt (m, drill pipe): 4649.0

Penetration (m): 0.5 (Hole 442); 313.5 (Hole 442A)

Number of cores: 1 (Hole 442); 34 (Hole 442A)

Total length of cored section (m): 0.5 (Hole 442); 313.5 (Hole 442A)

Total core recovered (m): 0.10 (Hole 442); 154.26 (Hole 442A)

Core recovery (%): 20 (Hole 442); 49 (Hole 442A)

Oldest sediment cored:
Depth sub-bottom (m): 286.1
Nature: limestone
Age: early Miocene (18–21 m.y.)
Measured velocity (km/s): 3.75

Basement:
Depth sub-bottom (m): 313.5
Nature: basalt
Velocity range (km/s): 3.98–4.66

Principal results: Site 442 is in the west-central part of the Shikoku Basin, on magnetic anomaly 6. The stratigraphic section consists of 164 meters of Pleistocene and Pliocene mud and clay, 45 meters of Pliocene and late-Miocene mud, 68 meters of late- and middle-Miocene mud and volcanic ash, 8.6 meters of middle- and early-Miocene zeolitic clay and claystone, 0.4 meters of early-Miocene limestone, 66 meters of massive basalt flows with normal magnetic polarity, and 92 meters of pillow basalt flows with normal polarity in the upper part and reverse polarity in the lower part. Continuous sedimentation started with pelagic limestone and clay; dominantly hemipelagic sediments were subsequently deposited at or near the CCD. The basement age (early Miocene, 18;–21 m.y.) agrees with the magnetic-anomaly age for anomaly 6. The basalt basement shows higher-than-normal vesicularity and is characterized by the absence of olivine.

HOLE 442B

Date occupied: 20 December 1977

Date departed: 27 December 1977

Time on hole: 6 days, 12 hours

Position: 28°59.04′N; 136°03.43′E

Water depth (sea level; corrected m, echo sounding): 4634.5

Water depth (rig floor; corrected m, echo sounding): 4644.5

Bottom felt (m, drill pipe): 4644.5

Penetration (m): 455.0

Number of cores: 20

Total length of cored section (m): 187.5

Total core recovered (m): 50.99

Core recovery (%): 27

Oldest sediment cored:
Depth sub-bottom (m): 353.0
Nature: clayey nannofossil ooze
Age: early Miocene (18–21 m.y.)
Measured velocity (km/s): 1.57

Basement:
Depth sub-bottom (m): 455.0
Nature: basalt
Velocity range (km/s): 3.85–5.25

Principal results: See principal results for Holes 442, 442A.

BACKGROUND AND OBJECTIVES

Background

The marginal basins of the western Pacific owe their origin either to a rifting process analogous to sea-floor spreading (Karig, 1970, 1971; Hayes and Ringis, 1973; among others), to a process analogous to crustal development along a transform fault (Hawkins, 1977), or to entrapment of older oceanic crust through subsequent development of a younger trench (Uyeda and Miyashiro, 1974); Cooper et al., 1976). The north Philippine Sea provides a unique opportunity to test some of these

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ideas about modes of origin of marginal basins, the Shikoku Basin providing an unparalleled testing ground for the rifting model, and the Daito Ridge and Basin region for the crustal-entrapment model.

The marine geology of the Shikoku Basin is summarized best in Karig, Ingle, et al. (1975); Tomoda et al. (1975); Kobayashi and Isezaki (1976); and Watts and Weissel (1975). Tomoda et al. (1975) demonstrated that the magnetic-anomaly pattern of the Shikoku Basin is linear. Later, Watts and Weissel (1975) and Kobayashi and Isezaki (1976) identified the ages of these magnetic anomalies and suggested a symmetrical-spreading history for the Shikoku Basin. This spreading began at a now-extinct spreading center about 28 Ma and ceased about 18 Ma. Watts and Weissel (1975) proposed two episodes of spreading with changing spreading rates, whereas Kobayashi and Isezaki (1976) suggested that spreading was a continuous episode. More recently, a more-detailed map of Shikoku Basin magnetic anomalies was compiled by Kobayashi and Nakata (1977). Deep drilling in the Shikoku Basin, recommended by the Active Margin Panel of JOIDES, provided an unusual opportunity to test the spreading hypothesis and to determine more precisely the magnetic ages suggested by geophysical surveys.

Basement-age determination was attempted during DSDP Leg 31 (Karig, Ingle, et al., 1975) when Site 297 was drilled; however, drilling at that site failed to reach basement. The drilling results did demonstrate that, during the earlier history of rifting, turbidites were deposited in the basin; this was followed by pelagic sedimentation. Presumably, the Nankai Trough, developed later to the northeast, acted as a sediment trap for turbidites derived from the Japanese Islands, although derivation of these turbidites from active and extinct island arcs such as the Kyushu–Palau Ridge and the Iwo Jima Ridge must also be considered.

The nature of the crust underlying marginal basins has also been of interest. Several investigators have demonstrated that marginal basins are floored by oceanic crust (Fischer, Heezen, et al., 1971; Andrews, Packham, et al., 1975). Detailed petrographic and geochemical study of basement rocks from Site 54 in the Parece Vela Basin indicated that these rocks are similar to abyssal tholeiites originating from mid-ocean ridges (Ridley et al., 1974).

Site 442 is on a prominent positive magnetic anomaly, tentatively identified as anomaly 6, on the west side of a hypothetical extinct spreading center in the Shikoku Basin. This site was located along a seismic profile surveyed by the R/V *Kaiyo-Maru* of Japex (IPOD–Japan, 1977) and shown in Figure 1. The seismic-survey line obtained by the D/V *Glomar Challenger* is shown in Figure 2.

Objectives

The primary drilling objectives at Site 442 were twofold. Of prime importance was paleontological determination of the age of the basalt basement, so as to calibrate the magnetic-anomaly age determinations of previous studies and provide the basis for testing the spreading model proposed for the origin of the Shikoku Basin by concomitant drilling of Site 443. A second major objective was determination of the mineralogy, petrology, and chemical composition of the basalt floor of the back-arc Shikoku Basin, and comparison of these properties with those of oceanic basalts from other marine tectonic domains. In addition, paleomagnetic ages of the basaltic section were to be determined, so as to understand the crustal evolution of the Shikoku Basin in particular and back-arc basins in general.

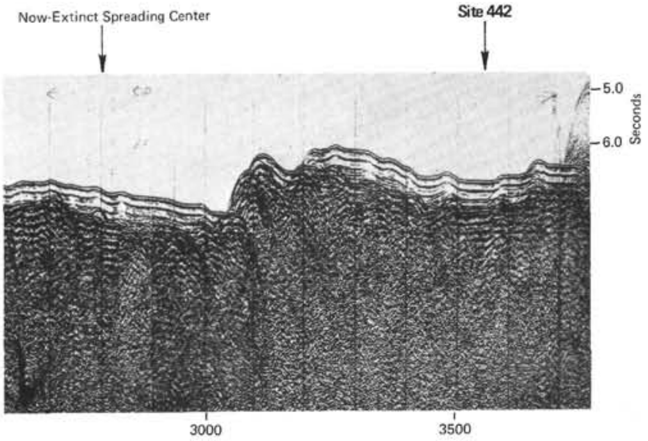


Figure 1. *Seismic-survey line through Shikoku Basin by R/V* Kaiyo-Maru *(JAPEX).*

Additional objectives at Site 442 included determination of changing patterns of sedimentation during the evolution of the Shikoku Basin, and, last, determination of paleocirculation patterns within the basin during its rifting history.

OPERATIONS

Site 442 was approached along a course of 199°, which was established on 11 December 1977 and continued until 1018 hours, 12 December. The course was changed then to 252° to follow a seismic-refraction profile obtained by the R/V *Kaiyo-Maru* (IPOD–Japan, 1977), to reach Site 442 (Figure 2). The ship's speed before the course change was 9 knots, and after the speed was reduced to 6 knots, to obtain a clearer seismic-reflection profile along a line from proposed Site 443 to Site 442 (Figure 3). A standard seismic array of 40- and 80-cubic-inch air guns was towed along with a magnetometer.

On 12 December, at 2116 hours, the 16-kHz beacon was dropped at Site 442, and the site was occupied following a Williamson turn by the ship. Once on site, the crew began a running-in of drill pipe, because it was necessary to remove down-graded drill-pipe on rackers and replace it with aluminum pipe from the hold. This operation was completed at 2145 hours, 16 December, prior to actual spudding-in for a wash-down to determine casing depth.

After the replacement of drill pipe, scientific drilling operations at Site 442 were scheduled according to the following plan:

1. Drilling of Hole 442. Operations included the construction of a bottom-hole assembly and drill string,

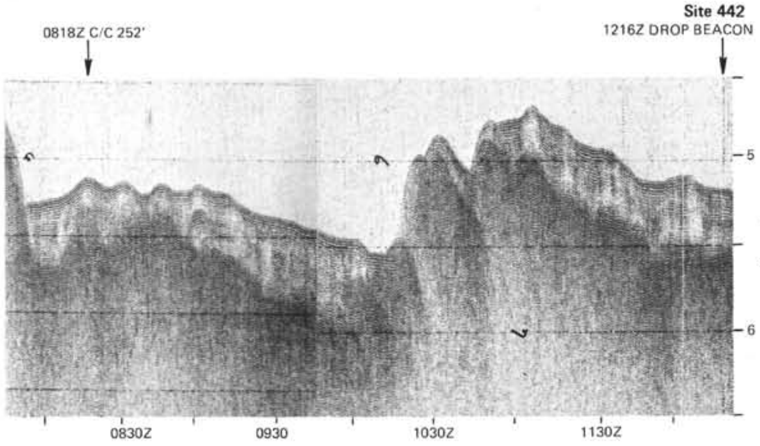


Figure 2. Glomar Challenger *reflection profile approaching Site 442.*

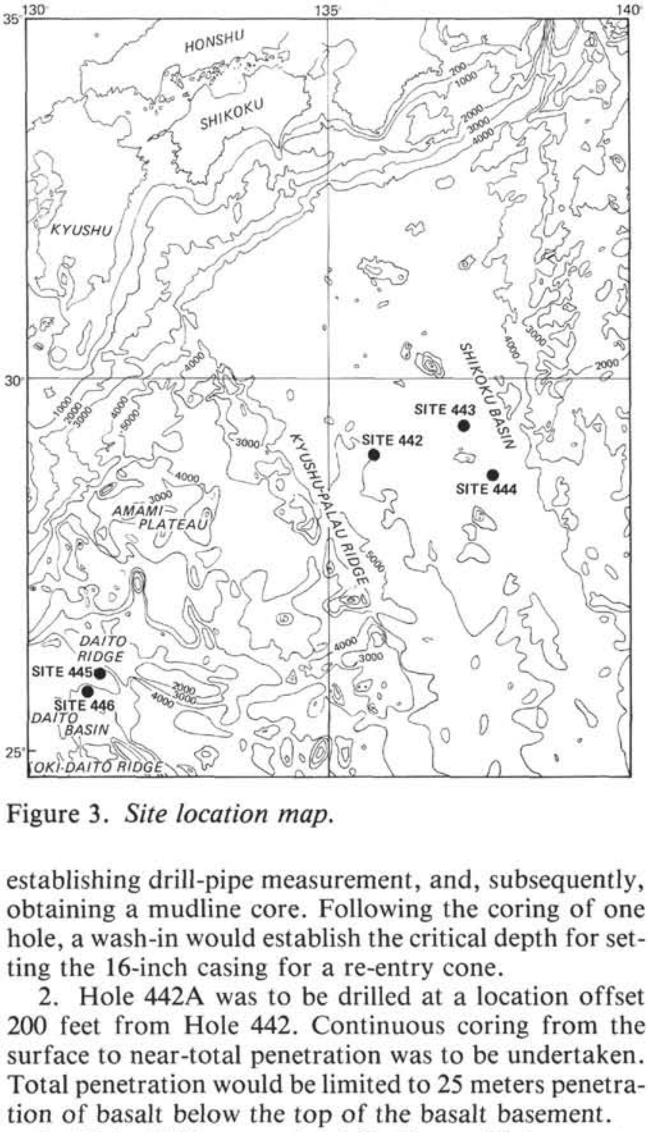


Figure 3. *Site location map.*

establishing drill-pipe measurement, and, subsequently, obtaining a mudline core. Following the coring of one hole, a wash-in would establish the critical depth for setting the 16-inch casing for a re-entry cone.

2. Hole 442A was to be drilled at a location offset 200 feet from Hole 442. Continuous coring from the surface to near-total penetration was to be undertaken. Total penetration would be limited to 25 meters penetration of basalt below the top of the basalt basement.

3. Hole 442B was to be drilled by multiple re-entry at an offset location of 200 feet from 442A. A re-entry cone would be assembled, keel-hauled and set. Hole 442B would be washed and drilled; spot coring was to cover missing intervals or intervals of low recovery in 442A until reaching the sediment/basement interface established in 442A, when continuous coring would be undertaken.

Drilling operations at Hole 442A began at 2145 hours, 16 December 1977. The drill-pipe measurement was established at 4649.5 meters. At 2130 hours, 17 December, a mudline core was retrieved (Table 1). The wash-in depth for the 16-inch casing was established subsequently at 66 meters (below sea floor). At 0115 hours, 18 December, continuous coring began at Hole 442A (Table 1). Continuous coring proceeded without interruption until 2000 hours, 19 December, when the Bowen power sub leaked oil. Down time for repairs (replacement of a bolt) was 1 hour 30 minutes, and at 2145 hours drilling operations resumed. On December 20, basalt basement was penetrated at 287 meters below sea floor. At 0815 hours, 20 December, the Bowen power sub leaked oil again, and a motor was replaced to prevent further oil leakage. Down time was 2 hours. Drilling resumed at 1015 hours, and two cores of basalt were recovered. At 1500 hours, 20 December, drilling operations at Hole 442A ceased, the drill string was pulled, and assembly of the re-entry cone for Hole 442B was started.

A re-entry cone and 66 meters of casing were assembled prior to coring at Site 442B. The re-entry cone and casing were run into Hole 442B around noon on 21 December. Hole 442B was spudded in on 21 December, at 2310 hours, the drill pipe measurement reaching 4644.5 meters at the sea floor. A hole was washed-in to 267.5 meters below sea floor and continuous coring started around 0800 hours on 22 December at a depth of 267.5 meters below sea floor. Coring was stopped at 1945 hours on 23 December, after nearly 120 meters of penetration, because of torquing on the drill pipe. The drill string was pulled out at 2030 hours. Re-entry was undertaken on 24 December and achieved at 2058 hours. Coring resumed at 0215 hours on 25 December, and four cores were recovered. Because of deteriorating weather and high winds, the drill string was set back in-

TABLE 1
Coring Summary, Site 442

Cores	Date (Dec., 1977)	Time	Depth From Drill Floor (m) Top Bottom	Depth Below Sea Floor (m) Top Bottom	Length Cored (m)	Recovery (m)	Recovery (%)
442-1	17	2246	4649.0–4649.5	0.0–0.5	0.5	0.10	20
				Totals	0.5	0.10	20
442A-1	18	0530	4649.5–4659.0	0.0–9.5	9.5	0.00	0
2	18	0720	4659.0–4668.5	9.5–19.0	9.5	9.15	96
3	18	0845	4668.5–4678.0	19.0–28.5	9.5	8.91	94
4	18	1012	4678.0–4687.5	28.5–38.0	9.5	6.75	71
5	18	1130	4687.5–4697.0	38.0–47.5	9.5	7.94	84
6	18	1315	4697.0–4706.5	47.5–57.0	9.5	8.30	87
7	18	1443	4706.6–4716.0	57.0–66.5	9.5	7.54	79
8	18	1612	4716.0–1725.5	66.5–76.0	9.5	7.51	79
9	18	1746	4725.5–4735.0	76.0–85.5	9.5	3.57	38
10	18	1917	4735.0–4744.5	85.5–95.0	9.5	5.22	55
11	18	2040	4744.5–4754.0	95.0–104.5	9.5	3.40	36
12	18	2223	4754.0–4763.5	104.5–114.0	9.5	3.28	35
13	18	2355	4763.5–4773.0	114.0–123.5	9.5	3.41	36
14	19	0129	4773.0–4782.5	123.5–133.0	9.5	4.27	45
15	19	0257	4782.5–4792.0	133.0–142.5	9.5	5.06	53
16	19	0426	4792.0–4801.5	142.5–152.0	9.5	3.30	35
17	19	0554	4801.5–4811.0	152.0–161.5	9.5	2.78	29
18	19	0719	4811.0–1820.5	161.5–171.0	9.5	3.95	42
19	19	0844	4820.5–4830.0	171.0–180.5	9.5	4.72	50
20	19	1009	4830.0–4839.5	180.5–190.0	9.5	1.55	16
21	19	1146	4839.5–4849.0	190.0–199.5	9.5	5.41	57
22	19	1311	4849.0–4858.5	199.5–209.0	9.5	0.73	8
23	19	1443	4858.5–4868.0	209.0–218.5	9.5	6.43	68
24	19	1629	4868.0–4877.5	218.5–228.0	9.5	6.56	69
25	19	1756	4877.5–4887.0	228.0–237.5	9.5	5.96	63
26	19	1958	4887.0–4896.5	237.5–247.0	9.5	3.10	33
27	19	2308	4896.5–4906.0	247.0–256.5	9.5	3.08	32
28	20	0046	4906.0–4915.5	256.5–266.0	9.5	4.80	51
29	20	0213	4915.5–4925.0	266.0–275.5	9.5	4.65	49
30	20	0358	4925.0–4934.5	275.5–285.0	9.5	4.48	47
31	20	0546	4934.5–4939.5	285.0–290.0	5.0	1.18	24
32	20	0747	4939.5–4944.0	290.0–294.5	4.5	2.16	48
33	20	1217	4944.0–4953.5	294.5–304.0	9.5	3.99	42
34	20	1458	4953.5–4963.0	304.0–313.5	9.5	1.12	12
				Totals	313.5	154.26	49
WASH/DRILL	22		4644.5–4912.0	0.0–267.5			
442B-1	22	0911	4912.0–4921.5	267.5–277.0	9.5	3.97	42
2	22	1056	4921.5–4931.0	277.0–286.5	9.5	7.28	77
3	22	1255	4931.0–4940.5	286.5–296.0	9.5	4.67	49
4	22	1457	4940.5–4950.0	296.0–305.5	9.5	2.32	24
5	22	1702	4950.0–4959.5	305.5–315.0	9.5	4.35	46
6	22	2013	4959.5–4969.0	315.0–324.5	9.5	2.14	23
7	23	0029	4969.0–4978.5	324.5–334.0	9.5	0.98	10
8	23	0458	4978.5–4988.0	334.0–343.5	9.5	8.83	93
9	23	0715	4988.0–4997.5	343.5–353.0	9.5	3.37	35
10	23	0921	4997.5–5007.0	353.0–362.5	9.5	1.00	11
11	23	1133	5007.0–5016.5	362.5–372.0	9.5	2.27	24
12	23	1347	5016.5–5026.0	372.0–381.5	9.5	0.88	9
13	23	1544	5026.0–5035.5	381.5–391.0	9.5	2.21	23
14	23	1726	5035.5–5045.0	391.0–400.5	9.5	1.04	11
15	23	1932	5045.0–5054.5	400.5–410.0	9.5	0.57	6
	24	First re-entry					
16	25	0420	5054.5–5061.5	410.0–417.0	7.0	1.70	24
17	25	0631	5061.5–5071.0	417.0–426.5	9.5	0.94	10
18	25	0823	5071.0–5080.5	426.5–436.0	9.5	0.35	4
19	25	1024	5080.5–5090.0	436.0–445.5	9.5	1.40	15
	27	Second re-entry					
20	27	1205	5090.0–5099.5	445.5–455.0	9.5	0.72	8
				Totals	187.5	50.99	27

to sediment to wait out the storm. This operation started at 1130 hours and was completed at 1230 hours, 25 December. Around 0420 hours, 26 December, the drill string was removed entirely from the hole. The storm abated during the afternoon of 26 December, and preparations were started for a re-entry attempt around 1830 hours. Re-entry operations began at 0000 hours, 27 December, and were completed successfully at 0445 hours. Coring resumed at 0955 hours, 27 December, but because of bottom hole instability and extreme torquing on the drill string, the drill string was pulled, starting at 1300 hours. Departure from Hole 442B took place at 2242 hours on 27 December.

SEDIMENT LITHOLOGY

Introduction

Three holes were drilled at Site 442. Hole 442 was a pilot hole in which a mudline core was taken, recovering 10 to 15 cm of siliceous silty clay. Hole 442A penetrated 313.5 meters, of which 286.1 meters were sediment, ranging in age from late Pleistocene to early Miocene. Hole 442B was a re-entry hole for deep basalt penetration. Three sediment cores were taken, starting from a sub-bottom depth of 268.5 meters. Basalt was first encountered in Core 442B-3, at a sub-bottom depth of 289.7 meters. Table 2 summarizes the stratigraphy of Site 442.

Unit Descriptions

The descriptions for units I through V (Table 2, Figure 4) are based primarily on analyses of sediments from Hole 442A. Additional descriptions for sub-unit IIIB and unit IV are based on results from Hole 442B.

Unit I

Unit I, present in Cores 442A-1 through 442A-18-2, 100 cm, approximately 164 meters thick, is dominantly dark-greenish-gray mud (silty clay) with some clay. The relative homogeneity of the unit precludes further subdivisions into sub-units; however, the following distinctive characteristics are observed:

1. The radiolarian content generally exceeds 5 per cent (to a high of 30%) for Cores 442A-1 through 442A-4. Cores 442A-5 through Section 442A-18-2, 100 cm, are barren of radiolarians.
2. The silt content is (with exceptions) greater than 35 per cent for Cores 442A-1 through Section 442-A-18-2. The clay content generally exceeds 50 per cent for Core 442A-1 through Section 442A-18-2.
3. The quartz-feldspar content is (with exceptions) greater than 10 per cent in sediments of Cores 442A-1 through 442A-10, and does not exceed 5 per cent in Core 442A-11 through Section 442A-18-2, 100 cm.
4. Volcanic glass and ash observed in smear slides appear to be present persistently in Core 442A-2 through Section 442A-18-2. Ashy units and (or) pumice fragments generally are present consistently in Cores 442A-2 through 442A-7, 442A-10, 442A-12, 442A-13, 442A-16, and 442A-18.
5. Shear-vane studies indicate that a physical difference exists between sediments of Cores 442A-1 through 442A-9 and those of Cores 442A-10 through 442A-18.

Unit II

Unit II is distinguished from Unit I by a change from dark-greenish-gray (5GY 4/1) mud and clay to yellow-brown (10YR 5/4) mud and clay. The unit is 45 meters

TABLE 2
Lithologic Units at Site 442

Interval	Lithologic Unit	Depth and Thickness (m)	General Description	Age
442-1; 442A-1 to 442A-18-2, 100 cm	I	0.0–164.0 (164)	Dark- greenish-gray mud, clay	Quaternary and Pliocene
442A-18-2, 100 cm to 442A-22	II	164.0–209.0 (45)	Yellow-brown mud (164–180.5 m) to brown, dark-brown mud (180.5–209 m)	Pliocene and possibly late Miocene
442A-23 to 442A-30-2, 13 cm	IIIa IIIb	209.0–~277.0 (68.1)	Sub-unit IIIA: yellow-brown mud with siliceous fossils Sub-unit IIIB: gray, dark-greenish intermixed ash, mud (start 259.6 m, Core 28-3, 100 cm)	Pliocene or late Miocene to middle Miocene
442A-30-2, 13 cm to 442A-31-1, 70 cm	IV	277.1–285.7 (8.6)	Dark-brown clay, claystone with bioturbation, zeolites	Middle to early Miocene
442A-31-1, 70 cm to 442A-31-1, 107 cm	V	285.7–286.1 (0.4)	Hard, fine-grained, pink limestone	Early Miocene
Basalt at 286.1 meters sub-bottom				
442B-1-1 to 442B-1, CC	IIIb	267.5–277.1 (9.6)	Grayish, olive, greenish-gray clayey ash, clay	Middle Miocene
442B-2 to 442B-3-1, 20 cm	IV	277.1–289.7 (12.6)	Dark-brown zeolitic clays, bioturbated claystones, Mn nodules. Altered ash beds (w/nannofossils in Core 2-1)*	Middle to early Miocene
Basalt at 289.7 meters sub-bottom				

thick and present in Section 442A-18-2, 100 cm, through Core 442A-22. It passes into Unit III at 209 meters (Section 442A-23-1) with a change from dark-grayish-brown mud with trace amounts of radiolarians to yellowish-brown (10YR 6/4) sediments with common radiolarians beginning in Core 24 (218.5 m). Foraminifers are generally rare or absent in Unit II, becoming common to abundant in Unit III.

Other lithologic characteristics of the sediments of unit II are: a clay (size) content of 60% per cent or more, a general absence of siliceous fossils, and a volcanic glass content generally less than 3 per cent, but as high as 95 per cent in ash layers.

Unit III

Unit III is 68.1 meters thick and present in Core 442A-23 through Section 442A-30-2, 13 cm. The unit is divided into two sub-units. Sub-unit IIIa (50.6 meters thick) contains yellowish-brown mud and clay with radiolarians and is present in Core 442A-23 through Section 442A-28-3, 105 cm. Sub-unit IIIb consists of dark-greenish-gray intermixed volcanic ash, mud, and clay and is present in Sections 442A-28-3, 105 cm, through 442A-30-1, 13 cm. The siliceous-fossil content is considerably lower (trace to 1%) in sub-unit IIIb than in Sub-unit IIIa.

Sub-unit IIIb, in Hole 442A, was cored beginning at 259.6 meters and is 17.5 meters thick. Coring in Hole 442B began at 267.5 meters in sub-unit IIIb, and sediment of the sub-unit continued to a depth of 277 meters. The sub-unit is similar in both holes, consisting of intermixed clay and volcanic ash. However, the lower boundary of the dark-brown, zeolitic clay or claystone of unit IV differs in the two holes. In Hole 442A, the contact with the underlying dark-brown, zeolitic clays or claystones in Section 442A-30-2, 13 cm is clear. However, in Hole 442B the contact is represented by 15 cm of fragments of brecciated, light-gray (5Y7/1) clay within a matrix of nannofossil-bearing clay. Probably this sediment unit was present in Hole 442A, but was washed out during coring and core recovery. Its presence in Hole 442B marks the first significant appearance of carbonate sediments in the upper 275 meters of the sedimentary section.

Unit IV

Unit IV is present in Sections 442A-30-2, 13 cm through 442A-31-1, 70 cm, and consists of yellow-brown and dark-brown, firm to hard, zeolitic clay and claystone. The sediments are characterized by evidence of extensive bioturbation and clay-size-material and clay-mineral contents greater than 75 per cent (with ex-

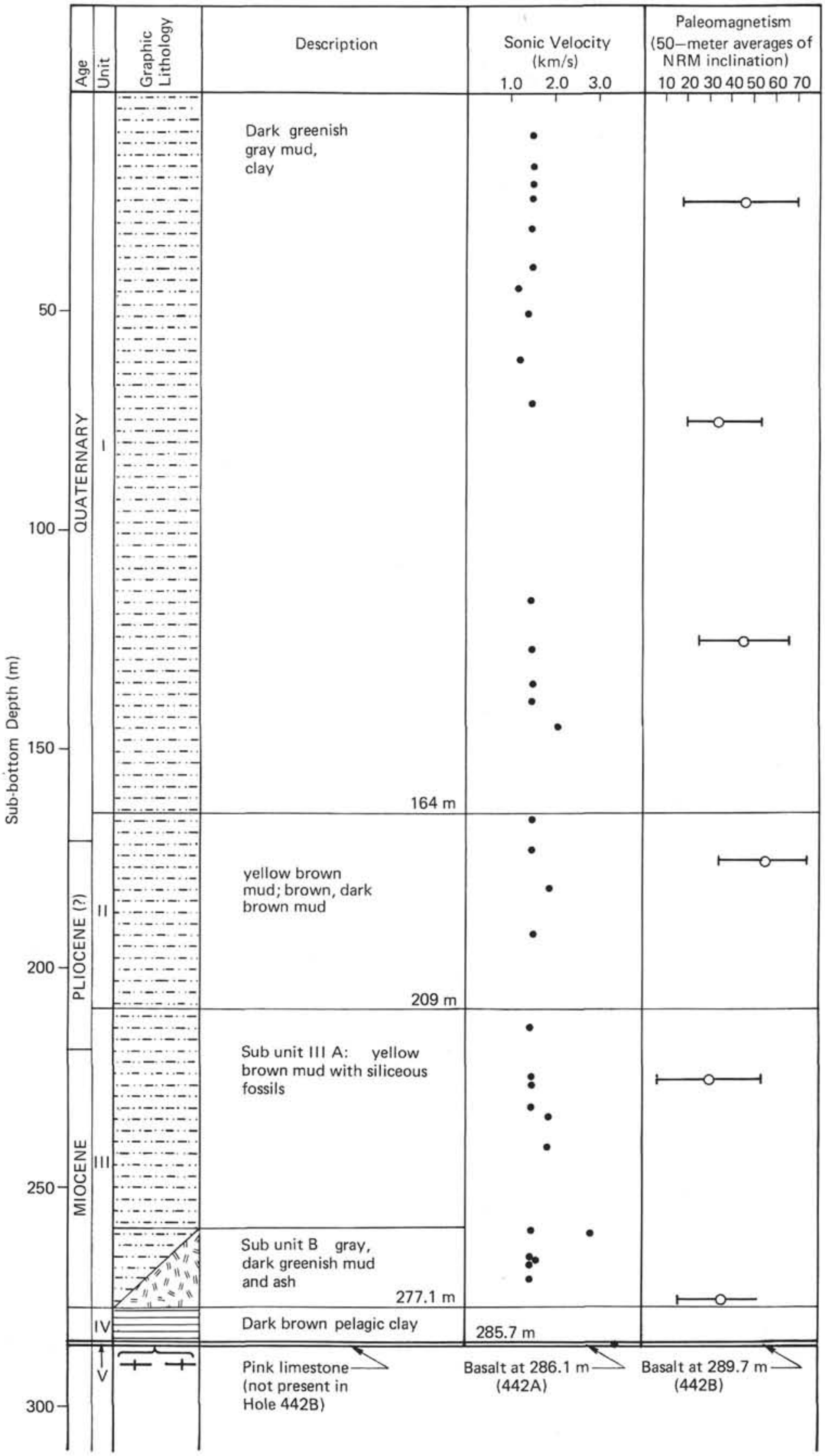


Figure 4. *Lithology, sonic velocity, and magnetics of sediments from Holes 442A and 442B.*

ceptions). In Section 442A-30-3, phillipsite becomes common (20–25%). Micronodules(?) of iron or manganese are common in Sections 442A-30-2 and 442A-30-3.

The darker brown colors appear to be due to oxidation of disseminated manganese and (or) iron. The mottled appearance of the yellow-brown and dark-brown clays is a result of bioturbation. A pink altered-ash zone occurs in Section 442A-30-2.

Sediments of Unit IV were recovered in Hole 442B from 277.1 meters (Core 442B-2) to the top of basalt at 289.7 meters (Core 442B-3). Excellent recovery of the cored section permits good characterization of the unit. In Hole 442B also, the unit contained a brecciated zone consisting of lighter-colored claystone (altered ash) fragments within a matrix of dark-brown, zeolitic clay. It is presumed that the breccia is a drilling artifact, because the general lithologic characteristics do not differ from those of unbrecciated portions of Unit IV.

The unit is a firm, stiff, zeolitic (phillipsite?), dark brown (2.5YR3/3 to 5YR4/4) clay and claystone. Bioturbated, mottled sediment in the upper portion of the unit includes a dark-yellowish-brown (10YR4/4) clay. In general, the unit takes on lighter hues the more extensive the bioturbation; however, bioturbation is present in the lower portions of the unit also, and lighter hues are not evident there.

In many cases, the extensive bioturbation creates a "near breccia" appearance. However, bioturbation evidence does include burrow patterns, such as excellently developed *Zoophycos.*

The upper portion of the unit (Section 442B-2-1 through Core 442B-3) does not contain zeolites; however, it does contain manganese micronodules, evidence of manganese streaking and bioturbation. Zeolites first appear in Section 442B-2-4 and show a maximum content of 30 per cent in the sediment.

Manganese micronodules are ubiquitous, and occasional zones of micronodule concentrations (parallel to bedding) are noted. In the interval, 442B-2-1, 55-57 cm, a nodule-like spheroid, was encountered; it has a diameter of about 2 cm and is composed of altered ash and clay coated with a 0.5- to 2-mm manganese crust. The clay is similar to the surrounding sediment.

The unit also contains several zones, 10- to 20-cm thick, of lighter-colored [pinkish-gray (7.5YR7/2), light-yellowish-brown (2.5Y6/4), pale-yellow (2.5Y7/4)] altered ash. The ash, now almost completely altered to a clay, contains manganese micronodules and displays bioturbation, particularly at the upper boundary with the dark-brown, zeolitic clay.

Unit V

Unit V consists of a 0.4-meter section of hard, dense, fine-grained, pinkish-gray limestones with manganese(?) and smaller-foraminifer tests scattered throughout. This unit overlies basalt in Hole 442A.

The limestone matrix is a fine micrite, with sparite as vein or cavity filling and as a replacement of foraminifer tests. The limestone may be recrystallized nannofossil ooze; however, there is no evidence to support this. Grain size of the micrite appears to decrease up-section from the basalt contact. Other notable characteristics of the limestone include:

1. Evidence of bioturbation. The burrows are filled with micrite which is slightly finer grained than the limestone matrix.
2. The presence of rare iron–manganese minerals; partly replaced (by sparite, Fe–Mn oxides, or other carbonates) foraminifer tests; volcanic-glass spherules; and basalt fragments.
3. Black opaque minerals (Fe or Mn ozides) as vein or cavity fillings; cavity filling by volcanic glass or silica; filling of foraminifer tests by sparry calcite (the tests themselves replaced by micrite).

Sediments of Unit V were not recovered from Hole 442B. it appears that the sediment unit overlying basalt in Hole 442B is the dark-brown, zeolitic clay of unit IV.

ORGANIC GEOCHEMISTRY

Four gas samples were taken from cores of Hole 442A which showed some signs of gas, but light hydrocarbons were found to be absent in all four samples.

Twenty-one samples were analyzed for organic-carbon and nitrogen contents. The data and results are reported elsewhere (Waples and Sloan, this volume). Organic-carbon contents are uniformly low, ranging from about 0.5 per cent near the sediment/water interface to about 0.05 per cent near basalt basement.

A black, granular material was found in several cores and analyzed to determine whether it was organic. It reacted rapidly with H_2O_2, suggesting that it might be organic, but element analysis and pyrolysis both showed that it consisted of less than 0.1 per cent organic carbon. It was concluded that the material probably represented manganese micronodules.

INORGANIC GEOCHEMISTRY

Seven interstitial-water samples were taken for inorganic geochemical measurements. The data are listed in Table 3 and presented on Figure 5. Six samples were taken in the sedimentary section of Hole 442A, within units I, II, III, and IV. One sample from Hole 442B is representative of unit IV.

The *p*H averages 7.71 and ranges from 8.19 to 7.46. Except for an increase in Sample 2 relative to Sample 1, *p*H tends to decrease with increasing depth. All sediment *p*H values are below those values for the IAPSO standard and surface sea water at the site.

Alkalinity averages 4.70 meq/kg for the seven samples, all values exceeding the IAPSO standard and surface sea water values of 2.39 and 2.32, respectively. Alkalinity decreases regularly with increasing depth, and no deviations from this trend were observed. The range of values is 9.74 to 2.97 meq/kg.

Salinity averages 35.3 per mill and chlorinity 19.29 per mill for the seven samples. Only one deviation exists in the expected matching trends for the two variables. For Samples 3 and 4, salinity remains constant at 35.2 per mill; however, the chlorinity drops from 19.38 to 18.67 per mill. However, this may be a result of laboratory error in the chlorinity and (or) salinity measurements.

TABLE 3
Summary of Shipboard Geochemical Data for Holes 442A and 442B

Sample (interval in cm)	Sample Number	Sub-Bottom Depth (m)	*p*H	Alkalinity (meq/kg)	Salinity (°/oo)	Ca^{++} mmol/l	Mg^{++} mmol/l	Cl^- (°/oo)
	IAPSO	–	8.05	2.39	35.2	10.55	53.99	19.375
	SSW	–	8.27	2.32	35.2	10.38	53.81	19.14
442A-2-3, 143–150	1	13.93–14.00	7.78	9.74	35.5	10.68	50.26	19.41
7-4, 140–150	2	62.90–63.00	8.19	5.65	35.2	12.52	46.29	19.34
13-2, 143–150	3	116.93–117.00	7.87	4.66	35.2	13.64	44.70	19.38
19-3, 0–10	4	174.00–174.10	7.59	3.75	35.2	14.80	45.13	18.67
23-2, 93–100	5	211.43–211.50	7.52	3.12	36.0	14.41	47.53	19.79
27-3, 0–8	6	250.00–250.08	7.57	2.97	35.5	12.65	48.29	19.51
442B-2-4, 140–150	7	282.90–283.00	7.46	2.99	34.4	11.45	51.38	18.94

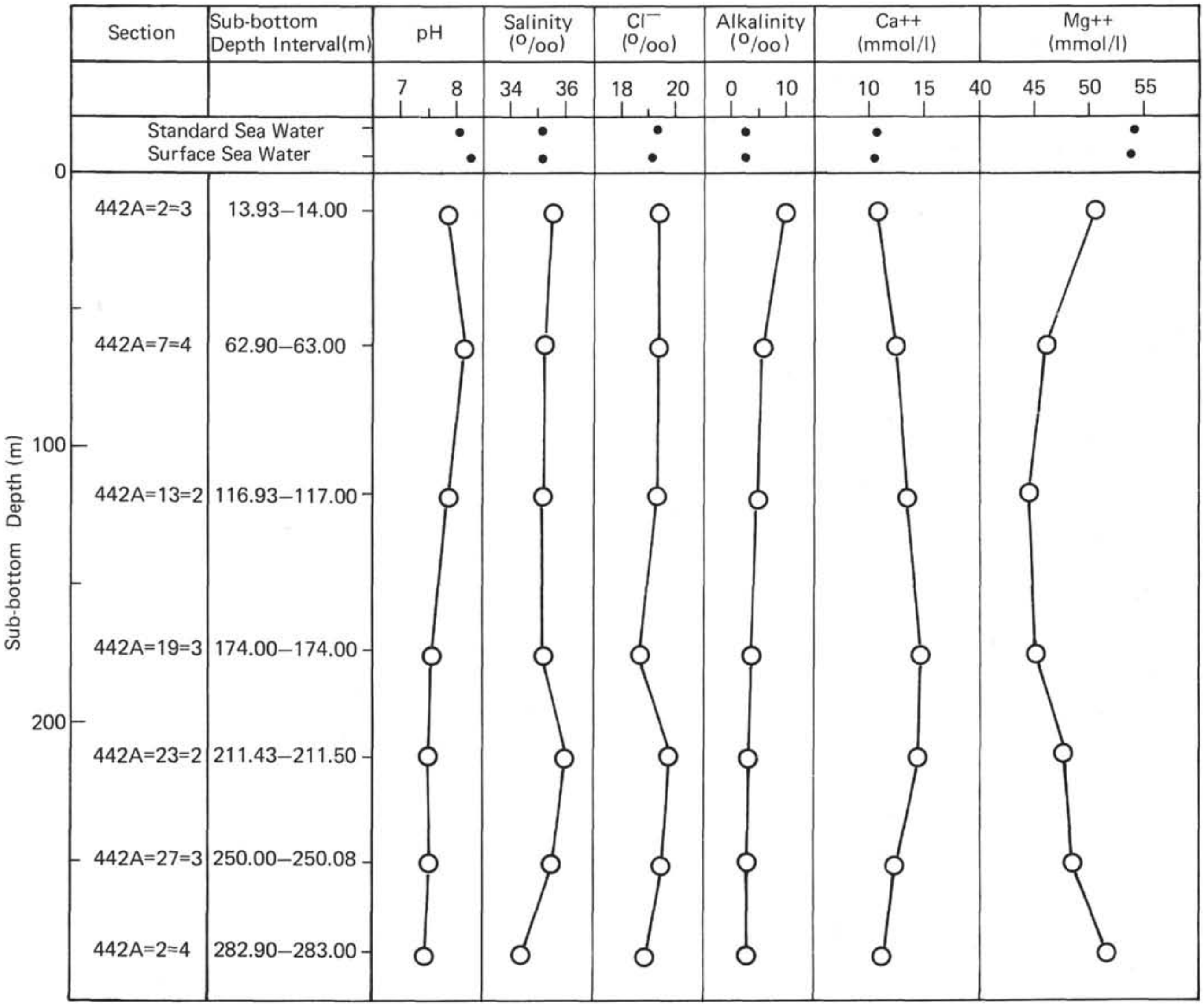


Figure 5. *Interstitial-water geochemistry, Hole 442A.*

Ca^{++} averages 12.88 mmol/l and Mg^{++} 47.64 mmol/l for the seven samples. Ca^{++} values are higher than those recorded for the IAPSO and surface sea water standards, whereas Mg^{++} values are lower compared to values for the same standards.

Ca^{+} increases regularly to Section 442A-9-3 (unit II) decreasing thereafter. Mg^{++} decreases to Section 442A-13-2 (unit I), increasing thereafter.

BIOSTRATIGRAPHY

Overview

Holes 442, 442A, and 442B are in the Shikoku Basin, approximately 50 km west of a supposedly extinct spreading center. The objectives at this site were to determine the age of basement basalt which is considered to be on magnetic anomaly 6 (~19–20 m.y.), and to obtain a complete record of the sedimentary history of Shikoku Basin.

Core 442–1 recovered only the length of the core catcher of the surface sediment. Although the water depth at this site, 4639 meters, is considered to be slightly below the present CCD, this sample contained late-Quaternary foraminifers, nannofossils, and radiolarians.

Hole 442A was continuously cored through the 286-meter sedimentary sequence and approximately 30 meters of basalt. Calcareous nannofossils are the most significant microfossils for age determination, although their occurrence is sporadic in the lower portion of the sedimentary sequence of this hole (Table 4).

Cores 442A-1 to 442A-3 contain rich faunal and floral assemblages of foraminifers, nannofossils and radiolarians. All of these three microfossil groups indicate the age of late Quaternary with mixed tropical and temperate water facies. Due to the closeness to the CCD, calcareous nannofossils suffered slight to moderate dissolution. The foraminifers are fragmented and poorly preserved.

Core 442A-4 yielded well-preserved nannofossils and radiolarians. Both fossil groups indicate an age of middle Pleistocene.

Between Cores 442A-5 and 442A-13, nannofossils are the only significant microfossils preserved; below Core 442A-7, the assemblages indicate an early-Pleistocene age.

Cores 442A-14 through 442A-23 are barren, except for Section 442A-19, CC, which yielded a moderately well-preserved assemblage of Pliocene radiolarians.Cores 442A-21 to 442A-27 contain many pseudomorphs which are casts of foraminifers having no significance for age determination.

Cores 442A-24 and 442A-25 contain only radiolarians; the assemblages indicate ages of late and middle Miocene for these two cores, respectively.

Cores 442A-26 and 442A-27 contain nannofossils and radiolarians. The assemblages of both fossil groups indicate an age of middle Miocene.

In Section 442A-31-1, a dark-brown clay overlies approximately 30 cm of limestone, which in turn directly overlies basalt. Nannofossils in this clay indicate an age of late early Miocene. There was no sign of this limestone being formed under shallow-water conditions.

Limestone directly above basalt was also observed at Site 53, on the western flank of the Iwo Jima Ridge, approximately 700 km south of Site 442. The origin of this limestone was thought to be either inorganic precipitation or recrystallization of nannofossil ooze due either to low-temperature diagenetic reactions or thermal metamorphism associated with igneous activity (Fischer, Heezen, et al., 1971).

At Hole 442B, 22 meters of sediments were cored directly above the basement basalt. Section 442B-1,CC contains poorly preserved radiolarians, whereas Section 442B-2-1 contains a thin layer of calcareous sediment. Nannofossils and foraminifers indicate ages of late early to early middle Miocene for these cores, as does the sediment directly above the limestone at Hole 442A.

Approximately 2 meters of soft sediment (recognized by the drilling rate) were encountered in Core 442B-9, which was drilled through the basalt layers. Although none of this sediment was recovered in the core barrel proper, a small piece of light-yellowish-brown and dark-brown mud was found in the core catcher. The light-colored material consists almost entirely of nannofossils, with some foraminifers, whereas the dark material contains the same fossil assemblage diluted by non-biogenic material. Both foraminifers and nannofossil assemblages show the age of this sediment to be early early Miocene (17–121 m.y.). This age is near that predicted by magnetic-anomaly study at this site. Although Core 442B-13 contained another fragment of sediment, it does not contain any microfossils.

Although this hole was offset by only 70 meters from Hole 442A, no limestone was recovered; this could be attributed to either patchy distribution of limestone or failure of recovery because of brecciation and subsequent washout of the material by drilling.

The presevation of calcareous microfossils shows the depth of water at this site in relation to the CCD as follows:

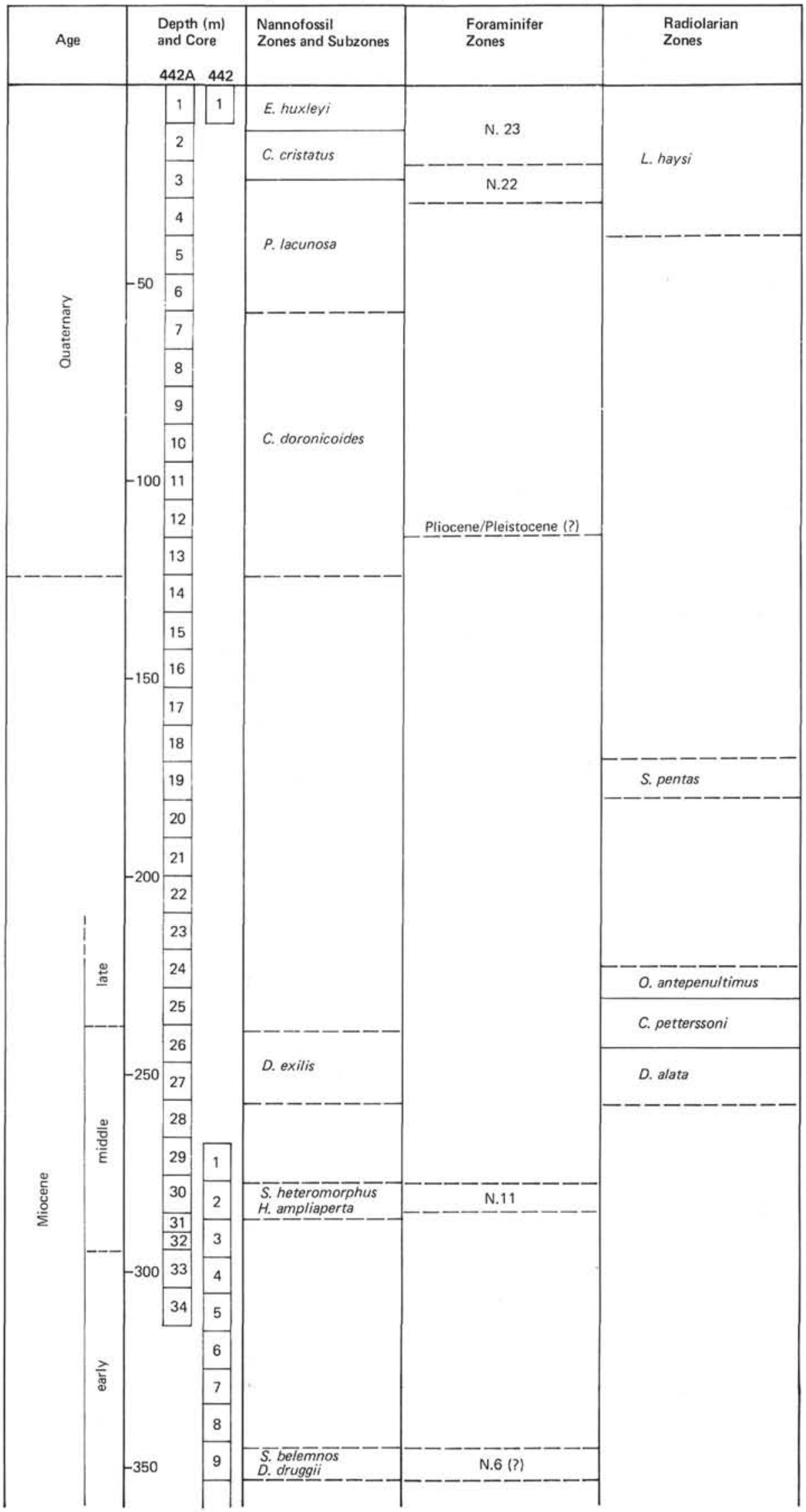
1. Slightly above the CCD during the late Quaternary, as indicated by both foraminifers and nannofossils.
2. At about the depth of the CCD during the middle and early Quaternary.
3. Well below the CCD during the Pliocene and late Miocene.
4. Slightly below the CCD during the early and middle Miocene, except during a few short periods slightly above the CCD.

Foraminifers

The summary for Holes 442, 442A, and 442B is based essentially on core-catcher samples, plus four section samples which were used for controls. The time scale used is that of Berggren and Van Couvering (1974) and Saito (1977).

Foraminifers encountered in Holes 442, 442A, and 442B were sporadic and, where present in some sections, rare and poorly preserved. Therefore, a continuous biostratigraphic study of the sequences is not possible.

TABLE 4
Biostratigraphic Zones, Site 442 (Holes 442, 442A, 442B)



The only time intervals for which foraminifers could be used with some confidence were the Pleistocene and early Miocene, and even for these intervals foraminifers were rare and showed evidence of dissolution.

The paucity of this group is attributed to the depth of the CCD. Planktonic foraminifers are readily fragmented and dissolved between the lysocline and the carbonate-compensation depth. In samples deposited in this zone, only the most robust and heavily calcified forms survive, and these may be reduced in size because of dissolution of outer shell material. Although benthic foraminifers are usually better preserved, because of more-rapid burial and retention of their protective organic sheath, they too show varying degrees of dissolution.

In summary, deposition throughout the sections penetrated in Holes 442, 442A, and 442B was either very close to or below the CCD.

Hole 442

One core was taken at Hole 442. The core penetrated Holocene to uppermost-Pleistocene sediments. Dissolution and fragmentation of the planktonic foraminifers indicate deposition close to the CCD during that time. Identifiable planktonic forms were *Globorotalia inflata*, *G. truncatulinoides*, and *Globigerina*; the deep-water benthic assemblage contained *Melonis pompilioides, Eponides, Dorothia,* and *Lagena.*

Hole 442A

Section 442A-2,CC, at a depth of 4668 meters yielded the first material from Hole 442A. The material examined contained a sparse and poorly preserved planktonic and benthic fauna of Pleistocene (N.23) age. There is a possibility of reworking in this sample.

In Core 442A-3, there is an increase in numbers and diversity of the identifiable planktonic and benthic foraminifers. However, the abundance of fragmented tests indicates dissolution and deposition close to the CCD. The assemblage of planktonic forms includes *Globorotalia inflata, G. truncatulinoides, G. tosaensis, Globigerina bulloides, Globigerinoides ruber, G. diminutus, Neogloboquadrina dutertrei, Pulleniatina finalis*; this assemblage indicates a Pleistocene (N.22) age for the core. The benthic assemblage contains species of *Uvigerina, Cibicides,* and *Globocassidulina.*

Cores 442A-4 through 442A-20 are considered barren of foraminifers, for in all samples only one or two specimens and fragmented chambers were recovered.

In the washed residue of Core 442A-21 is the first appearance of completely replaced casts of foraminifers. It appears that the test of the foraminifer was not replaced, but dissolved after the infilling was diagnetically altered. The crystalline replacement material, identified by X-ray diffraction and atomic absorption, is the rhodochrosite.

In Core 442A-22, there is an increase in the amount of this material, and in Core 442A-23 there is a flood of these completely replaced questionable foraminifers. In this core, the shapes are more diverse and definitive. Down-hole, the last significant occurrence of these forms is in Core 442A-27.

Cores 442A-28 through 442A-30 lacked all traces of foraminifers. The brown, silty clay and brecciated material in Core 442A-31 was also devoid of foraminifers, but a thin section of the limestone immediately overlying the basalt did have outlines of recrystallized planktonic forms.

Hole 442B

Cores 442B-1 through 442B-3 are barren of foraminifers, except for Section 442B-2-1, 7–9 cm, in which partially dissolved *Sphaeroidinellopsis subdehiscens* or *Prosphaeroidinella* were found. The preservation is so poor that identification is questionable.

S. subdehiscens does not appear in the geologic record until N.13—approximately 12 m.y.—and the 12-m.y. age is at least 2 m.y. less than the nannofossil age, which seems to be more reliable. *Prosphaeroidinella* occurs from 14 to 15 m.y.

Core 442B-9 recovered basalt, but the core catcher contained approximately 20 cm^3 of brown, silty clay with some calcium carbonate. Planktonic and benthic foraminifers were found in this material, and the index species *Catapsydrax dissimilis*, although partially dissolved, was recognized.

Based on this species, the age of the sediment, is estimated to be early Miocene (N.6 or below; 17.5–19 m.y.).

Nannofossils

Well- to moderately well-preserved Pleistocene and poorly preserved Miocene nannofossil assemblages were observed at this site. The Zonation of cores is summarized in Table 4.

Pleistocene

Only one core was recovered in Hole 442. Sample 442-1, CC contains a subtropical assemblage of the *Emiliania huxleyi* Zone (late Pleistocene or Holocene). The preservation of nannofossils is good; they show only slight effects of etching.

Sample 442A-2-1, 50 cm contains a well-diversified assemblage of the *E. huxleyi* Zone, with occasional reworked Pliocene and Miocene forms. The interval between Samples 442A-2-3, 52 cm and 442A-3-2, 105 cm belongs to the *Ceratolithus cristatus* Subzone; the nannofossils, affected by slight etching, are well- to moderately well-preserved, and reworking is moderate. The *Pseudoemiliania lacunosa* Subzone was identified in Samples 442A-3-5, 75 cm to 442A-5, CC; reworking is extensive in the upper part and becomes slight in the lower portion of this zone. The interval between Samples 442A-7-1, 80 cm and 442A-13, CC represents the *Crenalithus dolonicoides* Zone (early Pleistocene). Rare occurrences of Pliocene and Miocene forms are also recognized.

Miocene

Nannofossils are rare and badly dissolved in Samples 442A-26-2, 80 cm and 442A-28-1, 95 cm. The coexistence of *Discoaster bollii* and *exilis* suggests middle Miocene (*Discoaster exilis* Zone?). Rare and poorly preserved nannofossils also occur in Sample 442A-31-1, 4 cm. Although *Sphenolithus heteromorphus* is absent, abundant *Discoaster deflandrei, Cyclicargolithus floridanus*, and common *Discoaster variabilis* suggest an age of late early Miocene (*S. heteromorphus* or *Helicosphaera ampliaperta* Zones).

Sample 442B-2-1, 10 cm contains an abundant and moderately well-preserved assemblage of either the *S. heteromorphus* Zone or the *H. ampliaperta* Zone. A piece of sediment recovered in the core catcher of Core 442B-9 contains abundant but poorly preserved nannofossils. Occurrences of *Discoaster druggii, Sphenolithus dissimilis, Triquetrorhabdulus carinatus* and *T. milowii* indicate middle early Miocene (*Sphenolithus belemnos* or *Discoaster druggii* Zones).

Radiolarians

Of the three holes drilled at this site, only Hole 442A yielded a significant radiolarian fauna.

Preservation

There were four preservation zones encountered in Hole 442A. The first four cores contain abundant, well-preserved radiolarians. Cores 442A-5 to 442A-24 (with the exception of Core 442A-19, which contains a few moderately well-preserved Pliocene radiolarians) are barren. The third zone, from Cores 442A-25 to 442A-27, contains radiolarians which are common and moderately well-preserved. From Cores 442A-28 to 442A-31, the sequence is essentially barren.

Biostratigraphy

Preservation zone 1 (Cores 442A-1 through 442A-4) is Quaternary to Holocene (*Lamprocyrtis haysi* Zone). Species found in these cores include *L. haysi, Spongaster tetra, Ommatartus tetrathalamus, Theocorythium trachelium*, and *Spongopyle osculosa*.

The large section barren of radiolarians in preservation zone 2 has no biostratigraphic indicator fossils, with the exception of Core 442A-19, which is lower Pliocene.

Preservation zone 3 contains Miocene forms. Because of the presence of common *Ommatartus antepenultimus* and associated species, Section 442A-24, CC is placed in the late-Miocene *Ommatartus antepenultimus* Zone. Core Section 442B-25, CC is in the middle-Miocene *Cannartus petterssoni* Zone, with *Cannartus laticonus, Lithopera bacca, Cyrtocapsella japonica*, and *Stichocorys wolffii*. The first appearance of *Cyrtocapsella tetrapera* is in Section 442A-26, CC, with common *Cannartus laticonus* and *Cyrtocapsella japonica*; these species suggest the early middle Miocene (*Dorcadospyris alata* Zone). The bottom of the preservation zone 3 and the last core to which an age can be given using radiolarians is Core 442A-27. This core is also early middle Miocene, in the *Dorcadospyris alata* Zone. It contains the same species as Section 442A-26, CC, and also *Stichocorys delmontensis*.

SEDIMENTATION RATE

An age-depth plot is shown in Figure 6. The ages of the sediment were obtained from the time scale of Berggren (1972), Berggren and Van Couvering (1974), Bukry (1975), and modifications of the Miocene proposed by Saito (1977). Table 5 shows sediment-accumulation rates for each stratigraphic unit, which also are plotted on Figure 6.

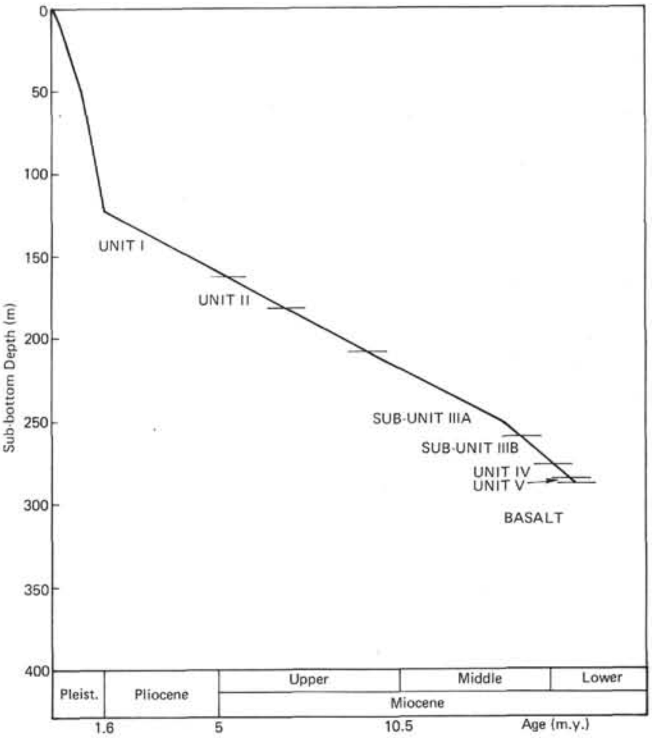


Figure 6. *Sediment-accumulation-rate curve for Site 442, based on biostratigraphic age determinations.*

The sediment-accumulation curve shows an upward increase of sediment-accumulation rates; unit V shows the lowest rate of 2.4 m/m.y., and the rate increase to 19.4 m/m.y. and 9.4 m/m.y. for unit IV and unit III respectively. Units IV and V appear to be dominantly pelagic, and low rates are to be expected, whereas unit III appears to represent the first phase of hemipelagic sedimentation, which can show both low and intermediate rates (Klein, 1975). With the increase in hemipelagic deposition of unit II, rates of sediment accumulation increase again, to an average of 10.7 m/m.y.

TABLE 5
Sedimentation Rates, Site 442 (Hole 442A)

Unit	Depth (m)	Interval Thickness (m)	Sedimentation Rate (m/m.y.)
I	0.0–164.0	164.0	30.9
II	164.0–209.0	45.0	10.5
III	209.0–277.1	68.1	12.6
IIIa	209.0–259.6	50.6	11.2
IIIb	259.6–277.1	17.5	17.5
IV	277.1–285.7	8.6	17.2
V*	285.7–286.1	0.4	0.8

*Not recovered in Hole 442B.

Unit I, which is Quaternary and Pliocene age,is characterized by higher rates of sediment accumulation with an average rate of 30.9 m/m.y. Initially, resedimentation of this unit was suspected as a cause for these high rates, but the complete biostratigraphic continuity, lack of evidence of abraded faunal remains, and lack of turbidites clearly point to other causes. An increase in regional volcanism is a second possibility, particularly with the known increase of volcanic ash and glass reported in Quaternary sediments at Site 296 (Donnelly, 1975), and in the circum-Pacific (Kennett et al., 1977). However, the general ratio of volcanic debris to a higher volume of terrigenous sedimentary components in unit I and the older units of Site 442 indicates that, although volcanism may play an important part, it can only explain the high sediment accumulation rate in unit I if combined with an additional sedimentary process. That third process may well be Quaternary fluctuations in sea level over adjoining land areas. In some areas, such as the eastern U.S., rates of sediment supply and accumulation are low in marine-slope settings during high stands of sea level, but increase with a lowering of sea level, when turbidite sedimentation and hemipelagic deposition become dominant (Doyle et al., 1976). The consequence of lowered sea level is to increase the area of erosion on land, thus increasing the volume of sediment supplied to oceanic settings. The distance of lateral transport from shore regions to deeper basins also decreases under such conditions because of shoreline progradation towards the basin center. Under such conditions, it would be expected that high accumulation rates would be dominant. It is suggested that the combination of sea-level fluctuations and the high rate of volcanism during the Quaternary in the region would account for the high sediment accumulation rates in unit I.

IGNEOUS PETROLOGY

Hole 442A

Lithology

At Hole 442A, basalt was encountered at 285.7 meters sub-bottom, and was cored continuously to 313.5 meters sub-bottom. Of the 27.8 meters of basalt cored, 8.5 meters were recovered. The entire section consists of aphyric, fine- to medium-grained basalt, with only slight variations in texture, degree of alteration, and vesicularity. Given the short interval cored, and its uniformity, these basalts are treated as a single lithologic unit.

The most remarkable feature of the basalts is their high vesicularity, which averages between 20 and 30 per cent by volume. All the basalts contain from 10 to 30 per cent fine vesicles (<1.0 mm), and many have a second distinct population of 1 to 5 per cent medium-sized vesicles (1.0–5.0 mm) as well.

Based on sometimes subtle differences in the degree of alteration, vesicularity, and texture, the basalts were divided into six sub-units. Despite the lack of intervening glass or chill zones, we feel that each of these sub-units represents a separate cooling unit. These units are similar to those found in the upper 30 meters of basement cored nearby at Hole 442B where intervening glass and chill zones are present. Sub-units 1C and 1F differ from the other sub-units in that the basalt has a variolitic texture. Sub-units A and B, and D and E, differ from each other principally in degree of vesicularity and alteration.

Petrography

The basalts from Hole 442A are fine- to medium-grained, and, with the exception of a few scattered plagioclase microphenocrysts, are entirely aphyric. Generally, they consist of randomly oriented plagioclase laths and pyroxene granules in an intersertal groundmass of pyroxene and plagioclase microlites, magnetite, what appears to be devitrified glass, and alteration products, chiefly clays. The intersertal basalts grade into intergranular varieties made up of randomly oriented plagioclase and subophitic pyroxene with intra- and intergranular magnetite. Chromite is a common accessory mineral. No olivine, or evidence of it, was seen in any thin section. Sample 442A-34-1 (Piece 9) differs from the rest of the basalts in that pyroxene is present only as microlites between plagioclase laths, and a variolitic texture is readily discernible in thin section.

Plagioclase is the most abundant constituent of these rocks, amounting to 10 to 30 per cent of the basalt. It is frequently twinned, and carlsbad and pericline twins are present in addition to abundant albite twins. The plagioclase is fairly calcic, generally exceeding An_{70}, and larger grains are often zoned, with substantially more-calcic cores.

Pyroxene also occurs in large amounts, generally from 5 to 30 per cent, excluding microlites. It is augite, with a light-brown color, a positive optic sign, and a moderate $2v$ around 45 to 60°. It ranges from groundmass microlites to granules and subophitic masses around plagioclase and stubby subhedral grains. The pyroxene in Sample 442A-33-4 (Piece 7) differs in that it often occurs as laths intergrown with plagioclase. Hourglass zoning of the pyroxene was observed in a number of thin sections.

Magnetite ranges from less than 1 to 5 per cent of the basalt. It is commonly euhedral and may be enclosed in plagioclase and pyroxene grains; it also occurs intergranularly in the groundmass.

Small chromian-spinel octahedra (~ 0.01 mm) were found in eight of the nine thin sections examined. Unlike many oceanic basalts, spinel is often found as an inclusion in pyroxene grains as well as in plagioclase. It is rare in the groundmass. The spinel has a deep rust-red color and is commonly barely transparent. Spinel was present in very small amounts, and commonly only a few grains could be found in an entire thin section.

With the exception of Sample 442A-34-1 (Piece 9), the order of crystallization of the minerals was difficult to determine. Plagioclase, pyroxene, and spinel appear to have crystallized early, and magnetite late. The crystallization of magnetite clearly overlapped that of pyroxene and plagioclase, but may not have overlapped that of spinel. The rarity of chromian spinel in the groundmass probably reflects very early crystallization and a tendency to act as a nucleus for silicate crystallization.

Alteration

All basalts from Hole 442A apparently have undergone some alteration. The principal evidence of alteration is numerous calcite amygdules (1–5%) and veins. There is a light-brown to yellow discoloration of the basalt, although much of it has little discoloration. In thin section, many basalts are seen to contain small amounts of clay.

Hole 442B

Introduction

Basalt was encountered at approximately 292 meters sub-bottom, and was cored continuously to 455.0 meters. 39.5 meters of basalt was recovered from the 163 meters of basement drilled. A sub-basement lithologic column is shown in Figure 7. Recoveries and intervals have been adjusted for the plastic spacers added to split cores during processing. This changes the recovery from the 39.5 meters actually recovered, to the 51.6 meters shown in Figure 7, but allows ready cross-reference between the present positions of rocks in the core liners to their positions in the column.

The upper 59 meters, designated unit 1, consists of aphyric, vesicular cooling units similar to those described for Hole 442A. Beneath unit 1, unusually high drilling rates, similar to those for mud, were encountered for 2 meters. The core catcher contained nannofossil- and foraminifer-bearing mud, containing *Discoaster druggii* (18–21 m.y.), which is of greater age than fossils found in the mud overlying unit 1. Paleontologic evidence suggests an age gap of 1 to 5 m.y. Beneath this horizon, at 353 meters sub-bottom, a sequence of aphyric vesicular pillow basalt, unit 2, was encountered and drilled to the bottom of the hole at 455.0 meters sub-bottom. The lower third of unit 2 is brecciated and contains two short intervals of massive, aphyric basalt intercalated with the pillows.

As at Hole 442A, the most unusual feature of these basalts is their high vesicularity, averaging about 25 per cent by volume.

We believe that the mud found in Section 9, CC represents about a 2-meter-thick horizon at about 351 meters sub-bottom, rather than slumping of mud from higher in the hole. We base this belief on (1) the high drilling rates, (2) the presence of mud in the core catcher with fossils older than those in the sediments overlying basement, (3) the location at the major lithologic break in the basalt sequence, and (4) the absence of any similar recoveries elsewhere in the sub-basement cores.

Unit 1, Massive Basalts

Unit 1 consists of highly vesicular, massive basalts, similar in most respects to that recovered at Hole 442A. As at Hole 442A, the unit 1 basalts at Hole 442B have been divided into sub-units which we feel represent separate cooling units. The lithologic differences among these sub-units, as at Hole 442A, are subtle, and include variability in texture, vesicularity, and alteration. Unlike Hole 442A, however, eleven separate chill zones were found, and these separated most of the designated lithologic sub-units shown in Figure 7.

The sub-units in the upper 30 meters of Holes 442A and 442B correlate well, with the exception of the very minor sub-unit 1F at Hole 442B. If 1F at 442B is ignored, there are the same number of sub-units, with similar variations in vesicularity, and the last one at each hole is variolitic.

No actual contacts between subunits were recovered. At some locations adjoining fragments have opposing chill zones, but are not physically connected. Unlike the glass-rich pillow rinds found in unit 2, glass was missing in most of the chill zones and was found only at two locations in Core 442B-6; the largest glass zone was only 3 mm thick. In most cases, chill zones are marked by a sudden large decrease in grain size, discoloration of the rock, pipe vesicles, and, in some instances, a variolitic zone. Where the original orientation was preserved, the chill zones appeared to be nearly horizontal.

As at Hole 442A, all basalts contain 10 to 30 per cent fine vesicles (<1.0 mm) by volume. Many also have a second distinct population of 1 to 5 per cent medium-sized vesicles (1.0 to 5.0 mm). Pipe vesicles are common near chilled margins.

The basalts range from aphanitic to medium grained and have a variety of textures. The majority of the thin sections examined consist of intergrown, fine- to medium-grained augite and plagioclase, with a texture ranging from intersertal through intergranular to diabasic. In a few cases, the intersertal basalts have a groundmass consisting of intergrown plagioclase and clinopyroxene microlites and titanomagnetite grains; in most cases, however, the groundmass consists almost entirely of alteration products, chiefly smectites, but in some cases zeolites, chlorite, and possibly talc. The intergranular basalts grade into the intersertal basalts, consist of fine- to medium-grained plagioclase and augite, and are either diabasic (roughly equigranular) or glomeroporphyritic, with a groundmass of finer-grained plagioclase, clinopyroxene, titanomagnetite. Chromite, as in Hole 442A, is found in many of these rocks as an accessory phase, principally enclosed in plagioclase, occasionally in pyroxene, and rarely in the groundmass. The augite is also similar to that in the Hole 442A basalts, but is strongly zoned in the coarser-grained rocks and grades from a pale olive green at the center to brown at the rims. Plagioclase is generally calcic, usually around An_{80} or higher.

Variolitic textures were found in sub-units 1G and 1H. These rocks consist of randomly oriented and radiating spherulites of plagioclase in a cryptocrystalline groundmass consisting of feathery plagioclase and clinopyroxene microlites.

Sub-units 1B and 1C contain sparsely phyric basalt with close to 1 per cent plagioclase phenocrysts (0.5–1.0 mm) and very rare clinopyroxene phenocrysts in an intergranular groundmass of 0.1-mm pyroxene granules,

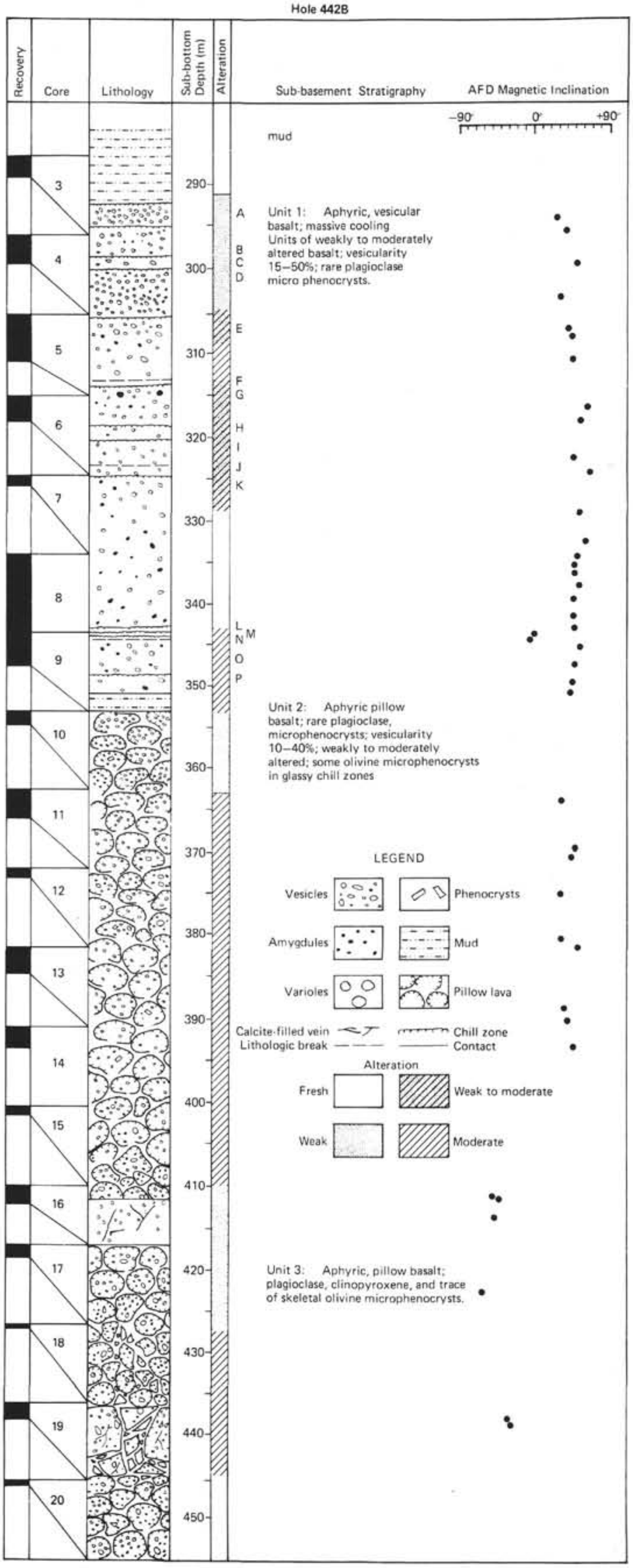


Figure 7. *Recovery, lithology, and characteristics of basalts, Hole 442B.*

0.1–0.2-mm plagioclase laths, titanomagnetite, and smectite.

Sub-units 1I and 1O are fine-grained, intersertal basalts consisting of plagioclase needles from 0.2 to 3.0 mm long, in a very fine-grained mass of quench plagioclase and pyroxene microlites, and smectites.

Sulfide droplets occur in five out of nine coarsest-grained basalts. These droplets appear to be primarily pyrite and pyrrhotite.

The unit 1 basalts are generally only slightly to very very moderately altered. In a third of the thin sections, however, smectite and other clays are abundant, replacing the groundmass minerals. Alteration is present in a number of the sub-units, notably sub-units 1E and 1K. In these, a green, low-relief mica appears to replace the groundmass, along with a clear, high-birefringence, mica-like mineral (clay or talc?) and a brown, pleochroic, low-relief, high-birefringence, biotite-like mineral which has bird's-eye extinction (talc?). The cavities in the locks where this mineral is found yield a soft, talc-like mineral, which we have also tentatively identified as talc. Also present in the same unit are zeolite-filled amygdules. The other principal forms of alteration are nearly ubiquitous calcite-filled amygdules, which may amount to as much as 5 per cent by volume, and numerous calcite-filled veins. Pyrite crystals were also observed, with calcite, in vugs in sub-unit 1K.

Unit II, Pillow Lavas

Pillow lavas were recovered only in the bottom 100 meters of Hole 442B, and are interrupted by two massive units consisting of coarser-grained material (Figure 7). Twenty per cent of the many basalt fragments recovered in the core have glassy chill margins. The basalts are again very vesicular (30–50%). The vesicles are usually 1 mm or less in size, but can reach 5 to 7 mm. Pipe vesicles are also found, oriented at right angles to the chill zone.

The pillow basalts grade inward from a glass zone, through variolitic basalt, into fine-grained, relatively crystalline, intergranular or intersertal basalt.

In thin section, the glass zones may contain plagioclase, clinopyroxene, or olivine microphenocrysts, although olivine microphenocrysts were found ony in glass from the lower half of the pillow-basalt section (Cores 442B-14 to 442B-20). Olivine generally appears to be absent in the relatively crystalline interiors of the pillows, which consist of plagioclase and clinopyroxene with accessory magnetite. The plagioclase appears to be fairly calcic ($\sim$ An_{80}), and the clinopyroxene appears to be augite.

There is little alteration of the pillow lavas. Only a few vesicles contain clay or calcite. In a few intervals, there are caps of limestone on the pillow fragments.

Geochemistry of Site 442 Basalts

The geochemistry of these basalts is discussed in detail elsewhere in this volume. Major- and trace-element analyses from the shipboard XRF sampling program indicate that these basalts are tholeiites, generally lying within the compositional limits of abyssal tholeiites from both mid-ocean ridges and marginal basins. The aphyric pillow basalts in the lower section of Hole 442B, unit 2, which contain minor olivine microphenocrysts, have anomalously low Cr contents (35–64 ppm). These Cr contents are similar to those of island-arc tholeiites, but other island-arc tholeiite features, such as low Ni contents, extensive range of Fe/Mg ratios, and low abundances of incompatible trace elements, combined with evolved major-element contents, are not present.

Interpretation

The massive cooling units drilled at Hole 442A and above the pillow basalts at Hole 442B are something of an enigma. The correlation of the massive basalts at the two holes suggests that they are laterally continuous. It is evident from the lack of pillow rinds, the relatively coarse textures, and the nearly-continuous recovery of a single unit in Cores 442A-7 and 442A-8 that these units are not pillow lavas. Even where recovery during drilling of pillow lavas has been poor on previous DSDP legs, glassy margins and pillow rinds have been well represented in the recovery. The presence of glassy margins and fine-grained to aphanitic textures in Core 442A-6 suggests that there may be some intercalated pillows. It is clear, however, that these units must be largely shallow intrusives, or surface flows which for some reason did not develop pillow structures. One possibility is that the basalt was intruded under a sediment cover, some of the sub-units representing sills intruded contemporaneously into the others. This would help explain the paucity of glass in the recovered material (longer cooling intervals).

Chromian spinel is commonly found in oceanic basalts as an inclusion in olivine and plagioclase, and only rarely in pyroxene. Dick (1975) has suggested that this is a result of early crystallization of spinel and the late appearance of pyroxene on the liquidus of most oceanic basalts, and the high solubility of Cr_2O_3 in pyroxene. Thus, spinel is likely to precipitate with pyroxene only where the pyroxene is close to saturation with respect to Cr_2O_3. Accordingly, one might assume that pyroxene appears on the liquidus of some of the 442A basalts earlier than it does in most abyssal tholeiites.

Vesicular basalts are not unusual in mid-ocean-ridge basalt suites, however, at depths greater than 1000 to 2000 meters, they are rare. Studies of vesicularity of basalts along the Reykjanes Ridge suggest a strong correlation between decreasing vesicularity and increasing water depth. Shipboard studies of the sediment immediately overlying the basalts indicate a water depth near the CCD ($\sim$ 4000 m). Accordingly, unless precipitous and extraordinary subsidence occurred after eruption of the basalts, it is probable that these basalts contained volatiles in excess of those normally found in mid-ocean-ridge basalts.

Compared to basalts of layer 2A drilled on previous DSDP legs, and dredged from many localities throughout the world, the Site 442 basalts are extraordinarily vesicular. In addition, these basalts generally lack phenocrysts. Such basalts are not unusual in other oceanic regions, but these features are noteworthy. The frequency with which chromian spinel occurs as an inclusion in pyroxene is also unusual, as are the low Cr contents of some of the 442B pillow basalts. It is fair to say, then, that these basalts are not entirely typical of what is commonly perceived to be mid-ocean-ridge abyssal tholeiite.

PALEOMAGNETISM

Sedimentary Layers

Paleomagnetism samples for sedimentary cores of Holes 442A and 442B were taken on the average every 1.5 meters in the recovered cores. The positions of samples are listed in Table 6. All samples were cut into cylinders and put in a plastic vial (2.3-cm diameter, 2.3-cm length). Measurements of the natural remanent magnetization (NRM) and the remanent magnetism after alternating-field demagnetization (AFD) were carried out by means of a shipboard flux-gate-type spinner magnetometer (Balanced Fluxgate Rock Magnetometer, Digico Limited).

After measurement of natural remanent magnetization, all the samples were washed magnetically in a unitaxial AF demagnetizer (AC Geophysical Specimen Demagnetizer, Schonstedt) with a peak AF of 200 oe, decreasing to zero at a constant rate of 20 milligauss/cycle. The cylindrical axis of the specimen was aligned paralled to the demagnetizing axis of the demagnetizer. Stationary DC magnetic field, mixture of the geomagnetic field and ship-induced magnetic field, were eliminated by a three-layered, highly permeable metal shield surrounding the AF demagnetizer.

Results of the measurements are listed in Table 6, and a schematic diagram of normal and reversed remanent magnetization of the sedimentary cores is given in Figure 8. Inclination of the original NRM of both the 442A and 442B samples in relation to sub-bottom depth is shown in Figure 9. There is a large scatter in the inclination values which might have been caused by mechanical disturbances of the drill bit. Therefore, a statistical treatment is applied to cores every 50 meters sub-bottom depth. The results of the statistical calculation are listed in Table 7 and are also plotted in Figure 9, with the standard deviation around mean values.

Basaltic Layers

Eight cylindrical core samples from Hole 442A, and 42 samples from Hole 442B, were taken for study of paleomagnetism. Of the 50 samples, 42 were AF demagnetized in a stepwise manner (up to maximum 600 oe, with 50 oe step) to find the stability of the NRM. Measurements of remanent magnetizations were carried out on six spinning axes. Demagnetization was made along three mutually perpendicular orientations of each sample. Sampling depths in the cores and the results of measurements are listed in Table 8. Inclination of NRM versus core-section number of basaltic layers for both 442A and 442B are plotted in Figure 10. Maximum demagnetizing field varies from specimen to specimen, depending on their magnetic hardness, as shown in Figure 11. Therefore, the inclination values after AFD were taken at the nearest higher value of MDF. Inclination values of remanent magnetization after AFD are also plotted in Figure 10. Statistical analysis of NRM intensities and AFD inclinations were carried out. Specimens were divided into three groups: (1) all samples of Hole 442A, (2) normally magnetized layer of Hole 442B, and (3) reversely magnetized layer of Hole 442B. Statistical results are given in Table 9.

Interpretations

The results of paleomagnetism measurements are summarized as follows:

1. Average intensity of NRM is around 3×10^{-5} gauss/cm^3, in good agreement with values for typical oceanic basalts.
2. Stability of NRM in both sediments and basalts is sufficiently high to provide data about the paleomagnetic-field direction.
3. Sequences of normal and reversed polarity in the lowermost portion of the sedimentary layers from both Hole 442A and Hole 442B are identical. The bottom of the sedimentary layers has a normal polarity of NRM, which continues to the top of the underlying basaltic layers.
4. Means of the NRM inclination of sediments are close to the mean inclination of the recent geomagnetic dipole field (estimated: 47.9°) around Site 442, although the scatter of inclinations of samples is large (~ 20°).
5. NRM inclinations of sediments and basalts are nearly identical.
6. AFD inclinations of the basalts of Hole 442A and the Hole 442B normal group differ by about 9 degrees, and their standard deviations overlap little.
7. AFD inclinations of the Hole 442B normal group and reversed group seem to align in antipodal directions.

Taking into account these facts, we can conclude that:

1. High stability and high Q_n' values (often exceeding 500) imply that contribution of an induced magnetization to the magnetic anomalies is negligible in the uppermost part of layer 2A of the oceanic crust at this site.
2. The top of the basalts and the lowermost part of the sediments seem to be of the same age. According to shipboard paleontological study of Section 442A-30-3, this age is about 16 to 18 m.y., which includes normal polarity periods with anomaly numbers 5D and 5E.
3. Site 442 has remained at almost the same latitude during the last 17 m.y.
4. Basalts of Holes 442A and 442B were formed at different times, or one of them was relatively tilted by more than 9 degrees. If they were formed at different times, and if the present rate of the secular variation of the geomagnetic field has held for the last 17 m.y., the interval of formation of basalts of Holes 442A and 442B was at least about 1000 years.
5. The time interval of the formation of normal and reversed groups of basalts of Hole 442B was not shorter than 5000 years as indicated by switching time of geomagnetic polarities.

TABLE 6
Paleomagnetism Measurements of Sedimentary Cores from Holes 442A and 442B[a]

Sample (interval in cm)	Sub-Bottom Depth (m)	J_{NRM} (10^{-5} gauss)	Susceptibility (10^{-5} gauss/oe)	Inclination		Polarity	Age
				NRM	AFD		
442A-2-1, 91–93	10.42	2.09	–	10.2	39.5	+	
2-2	–	1.57	–	5.0	3.6	+	
2-4, 71–73	14.72	0.54	–	-5.2	0.0	-	
2-5, 13–15	15.64	2.75	–	-77.6	-43.1	-	
2-6, 36–38	17.37	0.04	–	-68.3	-75.2	-	
3-2, 30–32	20.81	1.76	–	-77.5	-32.0	-	0.3 m.y.
3-3, 46–48	22.47	1.00	–	71.4	70.9	+	
3-4, 53–55	24.04	2.41	–	66.1	32.6	+	
3-5, 100–102	26.01	0.72	–	-60.4	-4.9	-	
3-6, 127–129	27.78	0.37	–	37.0	34.3	+	
3-7, 68–70	28.69	0.45	–	-75.0	-7.5	-	
4-2	–	2.00	–	69.8	37.0	+	
4-3, 20–22	31.71	25.3	–	-10.0	-15.0	-	
4-4, 35–37	33.36	1.64	–	45.7	24.5	+	0.9 m.y.
4-5, 7–9	34.58	0.21	–	-65.4	-2.8	-	
5-1, 111–113	39.12	4.00	–	41.9	24.6	+	
5-2, 106–108	40.57	0.90	–	58.8	18.9	+	
5-3, 73–75	41.74	8.05	–	-0.4	+0.5	±	
5-4, 131–133	43.82	1.29	–	19.3	10.3	+	
5-5, 118–120	45.19	0.12	–	15.3	0.4	+	
6-1, 121–123	48.72	0.07	–	52.2	9.1	+	
6-2, 10–12	49.11	0.68	0.45	71.1	15.4	+	
6-3, 108–110	51.59	0.97	0.49	-37.6	-16.7	-	
6-4, 45–47	52.46	0.57	0.58	-57.4	-9.8	-	
6-5, 10–12	53.61	0.37	0.59	-28.7	-5.3	-	
6-6, 5–7	55.06	0.58	0.55	-16.8	-3.3	-	
7-1, 129–131	58.30	0.07	0.51	-12.1	+1.4	±?	
7-2, 34–36	58.85	0.97	0.51	-39.9	-11.3	-	
7-3, 34–36	60.35	0.50	0.51	-14.2	-1.8	-	
7-4, 34–36	61.85	0.88	0.54	-62.7	-18.8	-	
7-5, 34–36	63.35	1.16	0.49	-22.3	-9.0	-	
8-4, 45–47	71.46	0.87	0.41	-53.7	-21.9	-	
8-5, 45–47	72.96	0.86	0.52	-37.3	-6.1	-	
10-3, 11–13	88.62	0.69	0.71	-64.0	-24.4	-	
10-4, 11–13	90.12	0.34	0.77	-43.4	-10.3	-	
11-3, 6–8	98.07	1.01	0.69	41.4	25.7	+	
13-2, 100–102	116.51	1.59	0.74	71.0	58.3	+	
14-3, 99–101	127.50	0.54	0.84	-38.1	-2.2	-	
15-2, 69–71	135.20	0.18	0.80	-21.4	-2.7	-	
15-3, 44–46	136.45	0.83	0.75	-58.6	-17.9	-	
15-4, 9–11	137.60	1.29	0.86	-60.9	-17.1	-	
16-1, 93–95	143.44	1.81	0.67	44.4	48.8	+	
16-2, 33–35	144.34	0.22	0.67	12.9	2.0	+	
17-2, 84–86	154.35	2.23	0.73	-42.1	-25.4	-	
18-2, 135–137	164.36	1.88	0.78	3.3	4.8	+	
18-3, 7–9	164.59	0.86	0.78	-57.8	-13.5	-	1.6 m.y.
19-1, 130–132	172.31	2.95	0.55	38.1	24.4	+	
19-2, 60–62	173.11	0.13	0.51	47.9	2.5	+	
19-3, 88–90	174.89	2.70	0.59	53.4	36.2	+	
20-1, 100–102	181.51	0.55	0.66	-85.7	-10.6	-	
21-1, 16–18	190.17	0.36	0.69	-45.9	-4.5	-	
21-2, 16–18	191.67	0.39	0.82	-37.1	-2.3	-	
21-3, 16–18	193.17	2.22	0.66	-34.1	-13.5	-	
21-4, 16–18	194.67	1.36	0.54	88.3	87.5	+	
21-4, 20–22	194.71	2.14	0.53	46.3	32.2	+	
23-1, 28–30	209.29	2.40	0.62	21.8	27.3	+	
23-3, 57–59	212.56	3.26	0.69	3.5	6.0	+	
23-4, 143–145	214.94	2.70	0.71	0.6	0.9	±	
23-5, 16–18	215.17	3.19	0.75	-42.0	-41.2	-	
24-1, 128–130	219.79	1.42	0.65	-40.1	-32.8	-	
24-2, 140–142	221.41	1.16	0.77	-14.9	-15.2	-	
24-3, 50–52	222.01	0.66	1.02	-75.8	-85.8	-	
24-4, 50–52	223.51	0.22	0.72	-22.0	-24.6	-	
24-5, 50–52	225.01	3.29	1.20	-74.8	-76.1	-	
25-2, 111–113	230.52	0.26	0.92	23.8	38.4	+	
25-3, 126–128	232.27	1.74	1.13	-6.3	-16.1	-	
25-4, 126–128	233.77	2.66	1.30	-39.5	-35.8	-	
26-2, 100–102	240.01	4.80	0.92	36.8	39.9	+	13 m.y. ?
27-2, 100–102	249.51	88.6	1.39	33.5	32.5	+	
28-1, 62–64	257.13	276.1	1.50	46.5	48.8	+	14 m.y.
28-2, 53–55	258.54	2.14	1.01	-10.8	-31.1	-	15 m.y.
29-1, 88–90	266.89	0.18	0.93	-43.4	-54.5	-	
29-3, 85–87	269.86	1.19	1.12	-38.4	-29.6	-	
30-1, 51–53	276.02	2.30	1.57	31.7	30.1	+	
30-2, 22–24	277.23	1.05	1.29	-19.9	-36.8	-	
30-3, 76–78	279.27	1.22	1.14	70.0	67.0	+	17 m.y.
442B-1-1, 76–78	268.27	0.99	0.48	50.4	-9.9	?	
1-2, 24–26	269.25	0.00	–	–	–	?	
1-2, 137–139	270.38	7.16	0.99	44.9	77.2	+	
2-1, 36–38	277.35	13.24	1.23	-66.4	-55.2	-	
2-2, 17–19	278.66	2.46	0.95	-62.0	-64.5	-	
2-3, 9–11	280.10	0.26	0.89	-84.1	-57.7	-	
2-4, 62–64	282.13	8.64	1.20	-26.4	-48.4	-	
2-5, 47–49	283.49	47.86	1.35	20.5	18.6	+	
3-2, 40–42	288.41	21.12	0.92	11.3	14.0	+	
3-2, 115–117	289.16	25.56	0.97	30.7	34.0	+	
3-3, 6–8	289.57	14.82	0.87	30.5	73.0	+	

[a] AFD is obtained by peak alternating demagnetizing field of 200 oe, decreasing to zero at a constant rate of 20 milligauss/cycle; polarity shows whether the inclination of NRM is positive (+) or negative (-); absolute age determined by shipboard paleontological studies.

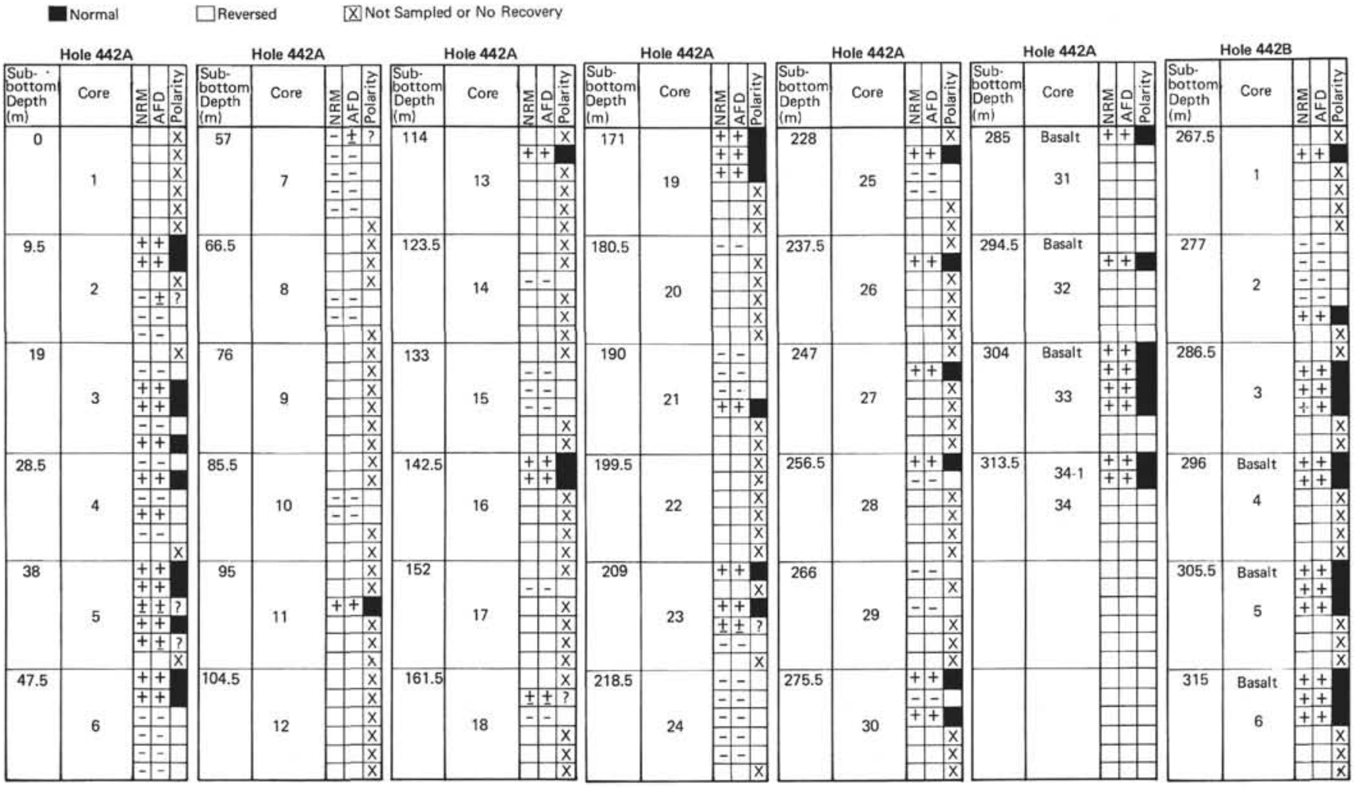


Figure 8. *Remanent-magnetization diagram of sedimentary cores from Holes 442A and 442B. (See Table 6.) Polarity diagrams for some basaltic cores next to the bottom layer of the sediments are also shown.*

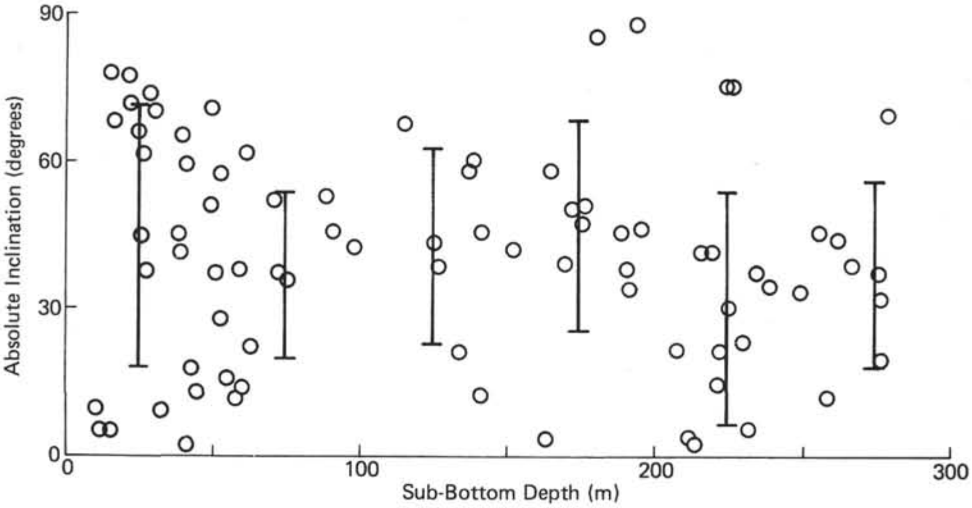


Figure 9. *Absolute values of inclination of NRM versus sub-bottom depth of the sedimentary layers. Data of Holes 442A and 442B are mixed. Mean values of the inclination taken every 50 meters; vertical bars represent standard deviations.*

PHYSICAL PROPERTIES

Physical properties measured on sediments and basalts recovered from Holes 442A and 442B included sonic velocity, density, porosity, water content, shear strength, and thermal conductivity. The analog output from the GRAPE unit provided additional approximations of density and porosity.

Sonic velocities were determined at atmospheric pressure and room temperature by measuring the travel time of a sound wave through a known length of material sandwched between two barium-titanate transducers on the Hamilton Frame Velocimeter. Wave-propagation directions were perpendicular to the core axis in sediments, and parallel to the core axis in basalts. All basalt samples were kept water-saturated until their measure-

TABLE 7
Statistics of NRM Inclinations of Sedimentary Cores of Holes 442A and 442B[a]

	Sub-bottom Depth (m)											
		50		100		150		200		250		300
Mean Inclination	45		37		43		48		30		37	
Standard Deviation	27		17.5		21		23		24		19	
Dispersion	736		284		395		471		553		316.5	

[a]Data are grouped every 50 Meters of Sub-bottom Depth; mean, standard deviation, and dispersion of individual 50-meter intervals are listed.

ment. Wet-bulk densities, porosities, and water content for syringe and chunk samples were calculated from relationships in Boyce (1976). Physical properties are tabulated in Table 10 for sediments and in Table 11 for igneous rocks. Although the data from the analog GRAPE will be referred to, the analog output will not be reproduced here. Special 2-minute GRAPE counts were made on selected basalt samples. A grain density of 2.924 g/cm^3, the average Site 442 basalt grain density, was assumed to calculate the porosities and wet-bulk densities listed in Table 12. Detailed treatment of the GRAPE technique can be found in shipboard manuals and in Boyce (1976).

Table 10 summarizes data from shear-strength measurements on clay samples from Holes 442A and 442B performed with the Soiltest Torvane. Shear-strength values were obtained by reading directly the shear strength from the instrument gauge and calculating the shear strength using the strength-correlation relationship included with the Torvane instructions. The axis of rotation of the vane was perpendicular to the core axis in all determinations. The shear-strength data show no apparent relationship to depth, as recognized on Leg 31 (Bouma and Moore, 1976). When the data are examined in comparison to the lithologic units recognized at Hole 442A, however, definite relationships are evident (Figure 12).

Shear strength increases with depth in the upper 85 meters of unit I, apparently reflecting the transition from silty clays in the upper 38 meters to higher-shear-strength clays below. A distinct decrease in shear strength occurs within unit I at 85 meters, a depth at which a considerable amount of drilling breccia was recovered. Shear strength increases again to 164 meters, the bottom of unit I, and decreases to a very low value in unit II. Several sections of drilling breccia were recovered in the upper part of unit II. Unit II is characterized by low shear strength. A third increase in shear strength is evident in unit IIIa. Strength is significantly reduced below 240 meters, where two sections of drilling breccia were recovered. Value of shear strength vary considerably in unit IIIb. The low values were obtained from ash units or intervals with a large ash component. The high shear-strength values are from intervals with a large clay component. The high values for unit IV apparently reflect the high clay content and better lithification of this unit.

The most significant aspects of the shear-strength data are the three intervals with systematic increases of shear strength with depth, followed by large drops in shear strength below. Each shear strength drop is characterized by the recovery of drilling breccia. During drilling a certain shear stress is exerted by the drill bit. If a lithologic unit of low shear strength is penetrated, the yield strength is exceeded, producing drilling breccia. It may be possible to use relationships similar to those presented in figure 12 to predict decreases in shear strength with depth and, therefore, to enhance recovery. This finding may be particulary useful for future drilling near Site 442.

Figure 13 shows sonic velocity as a function of depth. With few exceptions, velocities for sediments deviate little from the average of 1.58 km/s for the entire sediment thickness of 287 meters. Although distinctive lithologic units are present at this site, the sequence is dominated by clay minerals, producing a monotonous acoustic stratigraphy. Wet-bulk densities (Figure 13) also show little deviation from the average of 1.47 g/cm^3. The estimated average wet-bulk density for the sediments from the analog GRAPE is 1.54 g/cm^3, in close agreement with the laboratory values.

Thermal-conductivity values for sediments, summarized in Table 10, were measured using the transient-hot-wire method on the shipboard Quick Thermal Conductivity Meter manufactured by Showa Denko K. K. The stated accuracy of the meter is 5 per cent. No corrections were made for ocean-bottom pressures and temperatures (Ratcliffe, 1960). Figure 13 shows the variation of thermal conductivity with depth in the hole. Values of thermal conductivity of sediments are well within the range of values observed for deep-sea sediments (e.g., Clark, 1966). The average for Hole 442A sediments is 1.965 mcal/cm-s-°C. No systematic variation of thermal conductivity was observed with depth. A systematic relationship between per cent water content and thermal conductivity reported by previous workers (e.g., Ratcliffe, 1960) was not observed for sediments from Hole 442A. This may be the result of lack of thermal equilibration between the samples and ambient laboratory temperatures; the samples were given 4 hours to equilibrate, but this time may be insufficient.

Porosities in the sediments range from 48 to 85 per cent, average 72.2 per cent, and show no obvrious trend with depth. These exceptionally high porosities result

TABLE 8
Paleomagnetism of Basalts, Holes 442A and 442B[a]

Sample (interval in cm)	Sub-bottom Depth (m)	J_{NRM} (10^{-5} gauss)	Inclination NRM	Inclination AFD	MDF (oe)	X_{in} (10^{-5} gauss/oe)	Q'_n	Remarks
442A-31-1, 90–92	285.91	118.1	35.3	35.8	360	1.13	240	350 oe
32-2, 62–64	296.61	104.2	26.2	–	–	1.08	224	
33-1, 136–138	305.37	346.5	33.3	36.1	260	1.82	440	250 oe
33-2, 101–103	306.52	109.6	33.4	31.9	290	0.92	275	300 oe
33-3, 79–81	307.80	134.0	31.4	34.6	240	1.15	269	250 oe
33-4, 52–54	309.03	124.0	29.0	30.0	165	1.52	188	200 oe
34-1, 51–53	314.02	424.7	41.4	41.9	240	1.59	656	250 oe
34-1, 125–127	314.76	300.6	44.2	42.6	180	1.82	381	200 oe
442B-3-3, 118–120	290.69	537.7	27.7	–	–	1.68	739	
3-4, 54–56	291.55	301.1	39.0	45.3	260	1.73	402	300 oe
4-1, 117–119	297.18	420.6	50.8	51.8	320	1.87	519	350 oe
4-2, 118–120	298.67	119.9	32.0	(50.8)	n.d.	2.07	133	450 oe
5-1, 116–118	306.67	224.0	40.6	41.0	220	1.79	289	250 oe
5-2, 1–3	307.02	186.8	45.5	46.5	200	2.17	199	250 oe
5-3, 37–39	308.86	386.7	44.2	–	–	2.94	304	
6-1, 48–50	315.49	272.2	63.4	65.5	320	1.36	461	350 oe
6-1, 110–112	316.11	552.6	55.6	56.7	270	1.93	660	300 oe
6-2, 110–112	317.61	568.8	49.2	–	–	2.71	484	
6-3, 28–30	318.29	105.3	67.7	47.7	80	7.87	31	100 oe
7-1, 59–61	325.10	211.3	55.0	–	–	7.37	66	
7-1, 106–108	325.57	164.8	60.3	54.6	70	6.52	58	100 oe
8-1, 47–49	334.48	456.4	50.9	51.9	70	10.68	99	100 oe
8-2, 24–26	335.75	902.7	47.8	–	–	9.16	227	
8-3, 55–57	337.56	465.7	48.9	50.9	70	7.14	151	100 oe
8-4, 3–5	338.54	255.0	52.2	50.0	90	8.06	73	100 oe
8-5, 23–25	340.24	446.8	48.7	51.3	70	8.48	122	100 oe
8-6, 84–86	342.35	381.4	45.5	–	–	9.71	91	
8-7, 107–109	343.08	261.3	48.0	48.3	120	11.03	55	150 oe
9-1, 24–26	343.75	455.8	-1.2	-3.7	100	2.92	360	150 oe
9-1, 33–35	343.84	448.9	-3.1	-2.1	90	3.44	301	100 oe
9-1, 103–105	344.54	544.8	53.8	56.3	100	3.38	371	150 oe
9-2, 73–75	345.74	1940.1	47.6	47.8	80	2.80	1599	100 oe
9-3, 32–34	346.83	768.1	45.7	45.8	260	2.00	886	300 oe
9-3, 105–107	347.56	437.6	43.2	49.9	130	2.34	432	150 oe
11-1, 60–62	363.11	108.2	33.3	28.9	360	1.69	148	400 oe
11-2, 127–129	365.28	57.30	48.8	–	–	1.27	104	
11-3, 18–20	365.69	112.0	43.7	42.1	190	2.16	120	200 oe
12-1, 40–42	372.41	90.96	31.7	27.3	380	1.21	173	400 oe
12-1, 114–116	373.15	89.80	32.6	29.8	490	1.45	143	500 oe
13-1, 60–62	382.11	102.3	52.6	38.1	340	1.80	131	350 oe
13-2, 100–102	384.01	93.97	37.7	34.9	380	1.44	151	400 oe
13-3, 2–4	384.53	156.4	22.7	20.4	460	1.64	220	500 oe
14-1, 38–40	391.39	111.6	47.0	45.4	520	1.15	224	500 oe
14-1, 38–40	391.39	–	–	44.8	–	–	–	
16-1, 29–31	410.30	504.8	-47.4	–	–	1.82	640	
16-1, 35–37	410.36	154.6	-42.2	-43.5	320	2.07	172	350 oe
16-1, 105–107	411.06	349.2	-45.2	-46.6	310	1.25	644	350 oe
17-1, 104–106	420.55	491.2	-59.9	-60.4	480	1.66	682	500 oe
19-1, 43–45	438.92	217.2	-31.0	-34.3	180	2.34	214	200 oe
19-2, 62–64	440.63	182.8	-27.8	-36.4	260	2.62	161	300 oe
20-1, 27–29	448.28	387.9	-22.1	-21.6	460	1.88	476	500 oe (Orientation ambiguous)

[a] MDF is the median destructive field (of AF demagnetization) at which the remanent magnetism of a specimen decreases to 50% of its initial value; X_{in} is the initial susceptibility of a specimen; Q'_n is the Konigsberger ratio of NRM; peak field strength listed in remarks column is that at which inclination of AFD remanent magnetization was taken; for other notations, refer to Table 6.

from the loss of adsorbed water during heating to 110°C for water-content determinations.

The sonic velocity through the limestone recovered at 285.4 meters is 3.75 km/s, producing a major velocity discontinuity (Figure 13). The limestone is directly underlain by basalts at Hole 442A, which yield sonic velocities ranging from 3.85 to 5.25 km/s (Sample 442B-19-2, 12 cm). Velocities are variable in the upper 25 meters of basalt (Figure 14) and increase between 324 and 334 meters, a zone of gray, glomeroporphyritic basalt. Below this zone, velocities drop to 3.9 to 4.2 km/s. The variability of sonic velocities in basalt increases below 410 meters, with a maximum of 5.25 km/s and a minimum of 4.19 km/s. A major discontinuity in the basalt stratigraphy may occur at the 410-meter level (see section on magnetics). Wet-bulk densities follow the

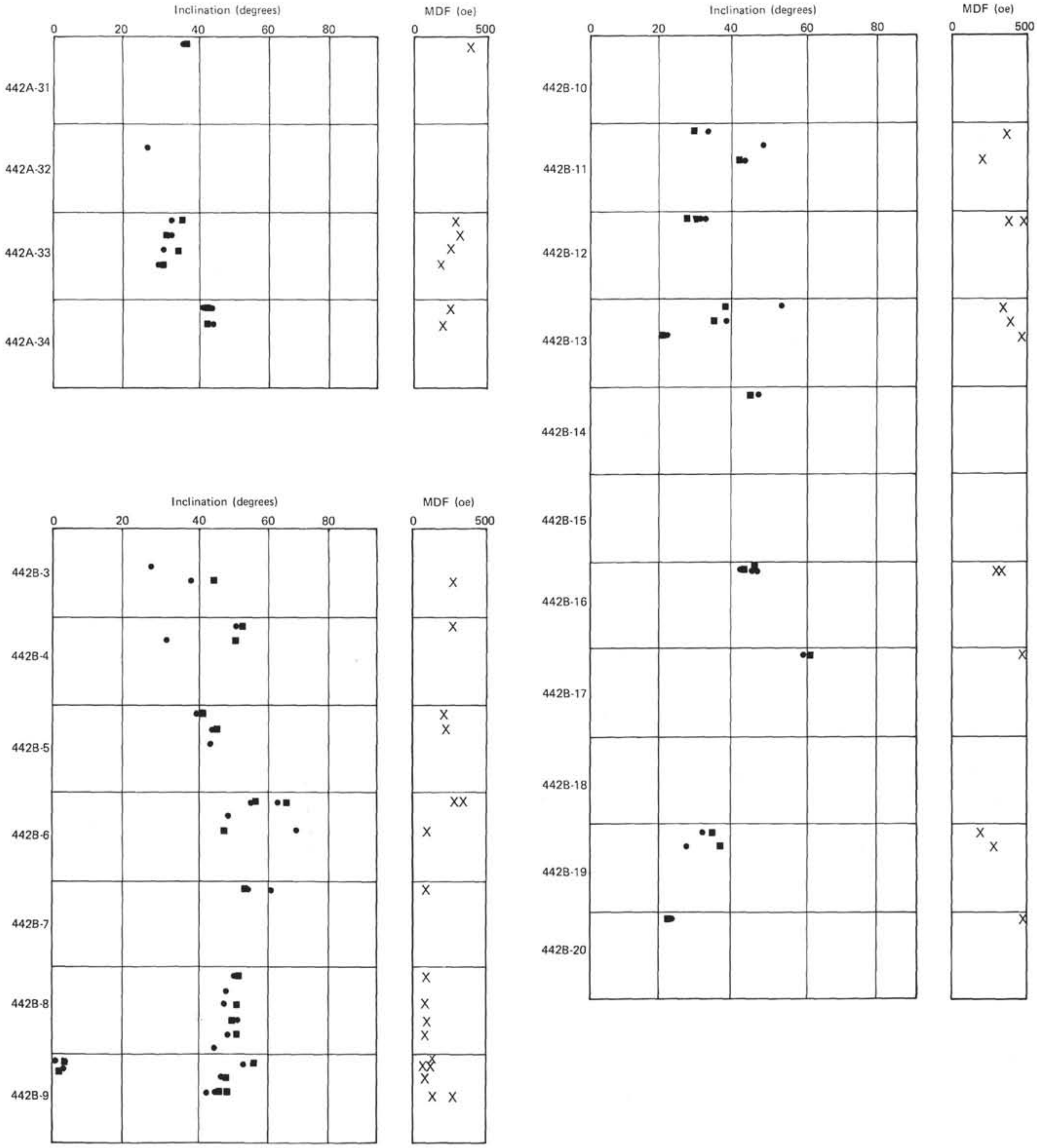


Figure 10. *Inclination of remanent magnetization and median destructive field (MDF) of basalts, plotted against sample positions in the cores. (Solid circles and squares represent positive inclination, normal polarity; open circles and squares represent negative inclination, reversed polarity.)*

same trend with depth (Figure 14) as do the sonic velocities. This result is not surprising, because sonic velocity is linearly related to density (Figure 15).

The average wet-bulk density of basalts recovered from Holes 442A and 442B is 2.50 g/cm^3, lower than the average oceanic-basalt density (Christensen and Salisbury, 1975). The variation with depth of wet-bulk density determined from laboratory measurements and two-minute GRAPE counts is shown in Figure 15. The low densities are caused by the relatively high porosities

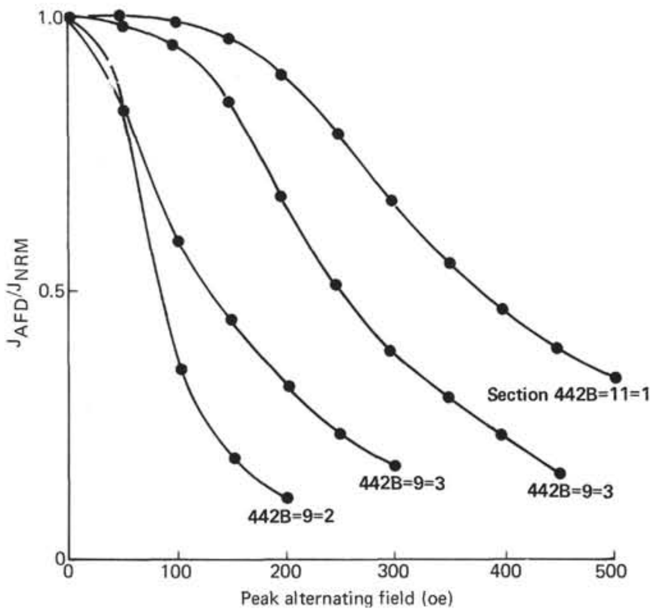


Figure 11. *Stability of NRM with respect to AF demagnetization. The horizontal axis represents the peak alternating magnetic field, decreasing to zero at a constant rate.* J_{NRM} *and* J_{AFD} *are intensities of NRM and AFD remanent magnetization of a specimen.*

TABLE 9
Statistical Treatment of Paleomagnetism Results of Basalt Samples, Holes 442A and 442B[a]

	Inclination (degrees)			Intensity (10^{-5} gauss/cm^3)		
Sample Set	Number of Samples	Mean	Standard Deviation	Number of Samples	Mean	Standard Deviation
Hole 442A, all	7	36.2	4.2	8	208.5	129.5
Hole 442B, normal	26	45.3	10.0	35	364.5	354.0
Hole 442B, reversed	6	40.7	13.2	7	326.9	144.5

[a] Samples from Section 442B-9-1 showed anomalous orientations of NRM which are not included here.

of the vesicular basalts. Figure 15 shows the relationship between basalt porosity and wet-bulk density. The lines on Figure 15 correspond to the predicted influence of porosity on wet-bulk density for basalts with near-ideal grain densities of 2.9 and 3.0 g/cm^3. Because the data for Site 442 basalts plot between the theoretical lines, it is apparent that mineral alteration does not, in this case, significantly influence wet-bulk density, and that porosity is the dominant control of wet-bulk density. This observation is confirmed by the high grain densities of the Site 442 basalts (Table 11). Christensen and Salisbury (1972) attributed low densities of oceanic basalts to the effects of submarine alteration. In this case, however, the low wet-bulk densities are directly related to the unusually high vesicularity of the basalts from Holes 442A and 442B.

Sonic velocity and wet-bulk density for Site 442 basalts are linearly related (Figure 16), with a correlation coefficient of 0.94. The slope is 3.06, and the intercept is -3.32; these values are significantly different from the parameters of the velocity–density relationship established by Christensen and Salisbury (1972) for deep-sea basalts. This discrepancy results from importance of porosity of Site 442 basalts. Figure 17 shows an excellent inverse relationship between porosity and sonic velocity, with a correlation coefficient of -0.97. This is the type of relationship expected when water-filled pore space influences sonic velocity of rocks. Clearly, wet-bulk densities and sonic velocities of Site 442 basalts are controlled by the porosity, and mineral alteration has little or no effect.

Thermal conductivity of basalts is variable (Table 11) and averages 3.40 mcal/cm-s-°C. The variability is probably related to the variable porosity, which determines the per cent water saturation. In general, increased water saturation will increase the thermal conductivity of rocks (e.g., Clark, 1966).

The average sonic velocity for the recovered basalts is much higher than the velocity for layer 2A (2.8 km/s) determined in a sonobuoy survey near this site. This discrepancy requires that unrecovered lower-velocity material must be interlayered with the basalt, or that the basalt must be severely fractured. Using the porosity–velocity relationship discussed above, the large-scale formation porosity would need to be considerably in excess of 30 per cent to explain the observed layer 2A velocities. This situation was encountered on Leg 37 while drilling the FAMOUS area (e.g., Hyndman, 1977). Alternatively, the sonobuoy profile for the nearby area may not be appropriate to this particular site.

CORRELATION OF GEOPHYSICAL DATA WITH DRILLING RESULTS

Introduction

Site 442 was chosen to be located on shot point 3550, line 2-2 of the S/S *Kaiyo-Maru* multichannel seismic-reflection profile (shot-point spacing 50 m, standard processing with 24-fold stack, deconvolution and time-variant filter) (Figure 1). The site is also on the western shoulder of a positive magnetic anomaly with appreciably large amplitude (about 300 gammas peak to peak) and wavelength (about 30 km) which was identified as anomaly 6 (19–20 m.y.), based upon its characteristic shape, with the aid of age information from DSDP Site 297 (Karig, Ingle, et al., 1975; Watts and Weissel, 1975; Kobayashi and Nakata, 1977).

A sonobuoy measurement was made along a NNW–SSE line about 20 km from the present site (Murauchi and Asanuma, per. comm.).

We attempt to correlate these site-survey data, and underway geophysical observations recorded when approaching and leaving the site, with the shipboard data about lithologies, paleontological ages, physical properties, and paleomagnetism direction and intensity of the cores recovered from various sub-bottom depths.

Sonic Velocity and Sub-Bottom Depth

Both previous and underway seismic-reflection profiles show a layering of semi-transparent sediment with two-way normal time of about 0.37 second overlying the acoustic basement. Shipboard measurement of the sonic velocity indicated that the V_P of sediment recovered is

TABLE 10
Summary of Physical Properties of Sediments, Site 442

Sample (interval in cm)	Lithology	Sonic Velocity (km/s)	Thermal Conductivity (mcal/cm-s-°C)	Shear Strength (× 10^{-5} dynes/cm^2)	Wet-Bulk Density (g/cm^3)	Porosity (%)	Water Content (%)
442A-2-1, 96–111	silty clay	1.499	2.267	0.24	–	–	–
2-3, 143–145	”	–	–	–	1.41	77.13	56.17
2-4, 77–79	”	–	–	–	1.44	75.91	54.10
2-6, 30–33	”	1.519	–	0.24	–	–	–
3-2, 88–98	”	1.484	2.622	–	–	–	–
3-3, 20–22	”	–	–	–	1.54	70.45	46.98
3-4, 36–39	”	–	–	0.72	–	–	–
3-4, 81–91	”	1.503	2.753	–	–	–	–
4-2, 107–123	”	–	2.522	0.29	–	–	–
4-2, 135–137	”	–	–	–	1.46	76.34	53.55
4-3, 68–78	”	1.505	2.553	0.29	1.49	74.06	50.98
4-5, 55–58	”	–	–	0.72	–	–	–
5-1, 95–98	gray clay	–	–	0.53	–	–	–
5-3, 69–85	”	1.484	2.558	0.29	1.50	75.26	51.33
5-4, 95–98	”	–	–	1.24	–	–	–
5-5, 73–83	”	1.212	1.836	1.68	–	–	–
6-1, 95–98	”	–	–	0.53	–	–	–
6-2, 69–72	”	–	–	1.15	–	–	–
6-3, 83–93	”	1.385	1.969	0.72	1.49	74.89	51.56
6-5, 115–129	”	–	2.525	0.38	–	–	–
7-1, 99–102	”	–	–	–	1.50	48.82	33.42
7-2, 48–51	”	–	–	1.15	–	–	–
7-4, 17–27	”	1.214	2.461	2.15	1.54	67.37	44.91
7-4, 140–150	”	–	–	–	1.53	66.89	44.76
7-5, 90–93	”	–	–	0.53	–	–	–
8-4, 74–84	”	1.472	1.983	1.66	1.57	85.55	55.70
8-5, 80–83	”	–	–	1.63	–	–	–
10-3, 86–98	”	1.518	1.836	0.48	1.48	80.16	55.31
13-2, 134–144	”	1.502	1.397	1.15	1.41	74.04	53.76
13-2, 143–145	”	–	–	–	1.47	76.46	53.35
14-3, 89–99	”	1.536	2.192	1.63	1.47	75.43	52.74
15-2, 37–52	”	1.531	3.153	2.15	1.48	75.21	51.99
15-3, 33–36	”	–	–	2.59	–	–	–
15-4, 33–43	”	1.544	0.987	4.21	1.49	75.56	51.90
16-2, 41–57	yellow-brown clay	2.091	1.731	2.30	1.55	71.51	47.41
18-3, 60–70	”	1.538	2.286	3.54	1.59	68.56	44.15
19-2, 70–82	”	1.515	2.083	3.93	1.53	71.62	47.92
19-3, 0–10	”	–	–	–	1.48	68.95	47.79
20-1, 88–98	brown clay	1.889	2.361	1.63	1.58	79.92	51.71
21-1, 34–37	”	–	–	1.20	–	–	–
21-2, 89–92	”	1.516	–	1.68	1.35	61.82	46.97
21-2, 116–119	”	1.543	–	–	–	–	–
21-3, 8–11	”	–	–	1.20	–	–	–
23-2, 93–95	yellow-brown clay	–	–	–	1.53	72.69	48.66
23-4, 5–15	”	1.528	1.339	–	–	–	–
24-4, 18–28	”	1.518	3.139	0.77	1.44	76.35	54.15
24-5, 25–35	”	1.535	2.142	4.21	–	–	–
25-3, 25–39	”	1.528	2.031	1.82	1.50	70.65	48.31
25-4, 73–76	”	1.982	–	3.16	–	–	–
26-2, 117–127	”	1.931	1.381	–	1.32	63.93	49.52
26-2, 120–121	”	–	–	5.08	–	–	–
26-2, 124–125	”	–	–	5.75	–	–	–
27-3, 0–8	”	–	–	–	1.43	72.65	52.16
28-3, 78–88	”	2.753	2.325	1.15	–	–	–
28-3, 118–128	gray-green clay	1.580	2.072	1.44	1.28	50.98	40.86
29-1, 44–47	”	–	–	4.50	–	–	–
29-1, 84–99	”	1.554	1.303	–	1.32	79.26	61.61
29-2, 31–42	”	1.613	2.161	0.72	–	–	–
29-2, 44–47	”	–	–	6.70	–	–	–
29-2, 99–109	”	1.510	1.969	–	–	–	–
29-3, 44–47	”	–	–	9.00	–	–	–
29-3, 94–104	”	1.511	1.228	–	1.50	75.30	51.58
30-2, 81–91	brown claystone	1.557	1.525	∿12.4	–	–	–
30-3, 85–97	”	1.568	2.356	∿12.0	1.47	68.86	48.10
31-1, 57–60	limestone	3.747	–	–	–	–	–

TABLE 10 – *Continued*

Sample (interval in cm)	Lithology	Sonic Velocity (km/s)	Thermal Conductivity (mcal/cm-s-°C)	Shear Strength (× 10^{-5} dynes/cm^3)	Wet-Bulk Density (g/cm^3)	Porosity (%)	Water Content (%)
442B-1-1, 70–73	gray-green clay	–	–	0.48	–	–	–
1-2, 13–17	”	1.550	–	1.15	–	–	–
1-2, 88–93	”	1.565	–	2.49	–	–	–
1-2, 123–126	yellow-brown clay	1.598	–	1.15	–	–	–
1-3, 34–37	”	–	–	∿11.5	–	–	–
1-3, 44–47	”	1.556	–	–	–	–	–
2-1, 115–118	brown claystone	–	–	6.70	–	–	–
2-2, 130–133	”	1.605	–	6.70	1.35	79.14	–
2-3, 54–57	”	–	–	5.84	–	–	–
2-5, 12–15	”	1.607	–	∿12.0	–	–	–
3-2, 70–73	”	1.568	–	–	–	–	–

TABLE 11
Summary of Physical Properties of Igneous Rocks, Site 442

Sample (interval in cm)	Piece No.	Sonic Velocity (km/s)	Thermal Conductivity (mcal/cm-s-°C)	Wet-Bulk Density (g/cm^3)	Grain Density (g/cm^3)	Porosity (%)
442A-31-1, 89–96	1b	4.535	–	2.52	2.92	21.13
32-1, 104–114	12b	–	3.542	–	–	–
32-2, 54–59	2a	4.050	–	2.50	2.97	23.60
32-2, 81–91	2d	–	3.728	–	–	–
33-2, 22–32	3a	–	3.336	–	–	–
33-2, 97–102	4d	4.663	–	2.60	2.91	16.28
33-3, 72–82	9a	–	3.328	–	–	–
33-3, 78–88	9a	–	3.158	–	–	–
34-1, 73–85	10b	3.984	3.022	2.43	2.91	24.78
442B-3-3, 49–55	3	3.952	–	2.37	2.94	29.50
3-4, 0–10	1a	–	1.625	–	–	–
4-1, 57–59	9	4.145	–	2.40	2.93	27.29
4-2, 109–119	16	–	4.014	–	–	–
5-2, 106–108	2h	4.155	–	–	–	–
5-3, 96–106	8a	–	–	2.40	2.89	25.69
5-3, 96–106	8a	–	3.319	–	–	–
6-2, 40–42	6	3.846	–	2.33	2.88	29.15
7-1, 49–65	7	4.133	3.839	2.50	2.98	23.96
8-1, 80–90	1i	–	4.197	–	–	–
8-2, 92–96	1k	4.918	–	2.70	2.95	12.50
8-5, 127–137	4	–	3.744	–	–	–
9-1, 67–77	6b	–	3.658	–	–	–
9-1, 110–116	6d	4.159	–	2.41	2.96	25.02
11-2, 121–123	16	4.130	–	–	–	–
13-1, 32–40	6	3.928	–	2.42	2.95	27.04
15-1, 77–80	13	4.141	–	2.42	2.88	24.46
16-1, 120–123	18	4.741	–	2.54	2.87	17.65
17-1, 104–106	20	4.187	–	–	–	–
19-2, 12–14	3	5.250	–	2.80	2.97	9.11
20-1, 27–29	5	4.077	–	–	–	–

TABLE 12
Wet-Bulk Density and Porosity from 2-minute GRAPE Counts for Igneous Rocks, Site 442

Sample (interval in cm)	Piece No.	Wet-Bulk Density (g/cm^3)	Porosity (%)
442A-31-1, 86–96	1b	2.48	23.39
32-2, 46–48	1f	2.48	23.20
33-2, 14–16	2	2.61	16.73
34-1, 50–52	9	2.38	28.85
442B-3-3, 49–51	3	2.24	35.93
4-1, 57–59	9	2.40	27.39
5-2, 73–75	3e	2.50	22.56
8-3, 135–137	4c	2.59	17.76
8-6, 12–14	1	2.43	26.03
9-1, 116–118	6e	2.49	22.94
11-2, 123–125	16	2.47	24.08
12-1, 55–57	8	2.39	28.21
13-1, 26–28	5	2.43	26.07
16-1, 124–126	18	2.71	11.41
17-1, 104–106	20	2.54	20.42
19-1, 46–48	6	2.41	27.17
19-2, 15–17	3	2.74	9.58

about 1.55 km/s on the average throughout the cores from this site. Thickness of sediment thus estimated is 287 meters, which is consistent with the depth of the first recovery of lithified rock (286 meters; limestone).

Sonobuoy observation by Murauchi and Asanuma provided information on V_P of layer 2A (thickness of about 570 meters) underlying the sediments as low as 2.8 km/s. One of several possible explanations of this discrepancy is interlayering of both sediments and basalts showing lower velocity with successions of pillow-lava flows. If the proportion of lava flows with $V_P = 4.6$ is only 40 per cent, and the remaining 60 per cent is sediments with $V_P = 1.55$, an estimated bulk sonic velocity of 2.8 km/s is in agreement with the observed value. This percentage of lava flows seems reasonable if we consider the poor recovery (<30%) of rocks below Core 442B-9. Fragmentation and brecciation of rocks which prevented deeper penetration of this hole possibly may be another cause of low bulk velocity.

According to the sonobuoy data, layer 2A is underlain here by a 450-meter-thick layer with $V_P = 4.0$ and a 270-meter-thick layer with $V_P = 4.7$, overlying layer 3 with $V_P = 6.9$. Composition and structure of these layers, however, were not determined from the present drilling because of insufficient penetration depth.

Magnetic Anomaly, Paleomagnetism, and Paleontological Age

Occurrence of normal and reversed polarities of natural remanent magnetization in rocks indicates that normally magnetized layers of rocks responsible for magnetic anomaly 6 observed at the site should exist below the reversely magnetized layers recovered at the bottom of Hole 442B. It also implies that ages of formation of rocks recovered by the present drilling are slightly younger than the postulated age of anomaly 6 (19–20 m.y.).

Paleontological age of sediment overlying the uppermost massive basalt flows is middle early Miocene (middle Burdigalian). The most up-to-date magnetic-polarity time scale (LaBrecque et al., 1977) shows that two intervals of normal magnetic polarity with time spans of 0.3

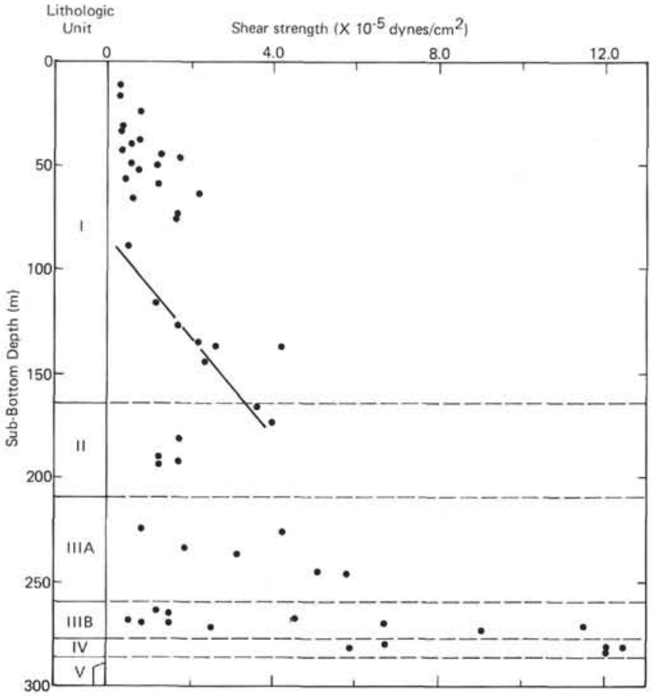


Figure 12. *Shear strength versus sub-bottom depth for Site 442 sediments.*

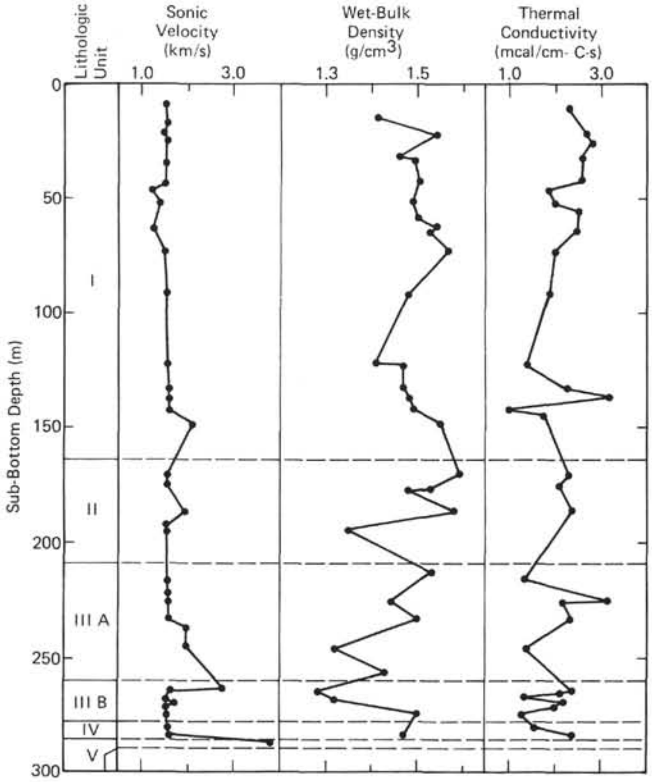


Figure 13. *Sonic velocity, wet-bulk density, and thermal conductivity versus sub-bottom depth for Site 442 sediments.*

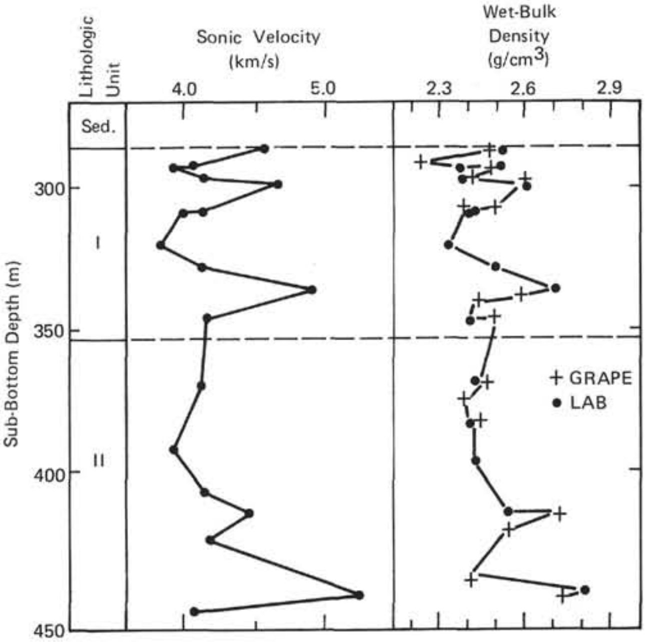


Figure 14. *Sonic velocity and wet-bulk density versus sub-bottom depth for Site 442 basalts. Crosses on wet-bulk-density graph correspond to values determined from 2-minute GRAPE counts, and dots correspond to values measured in the laboratory.*

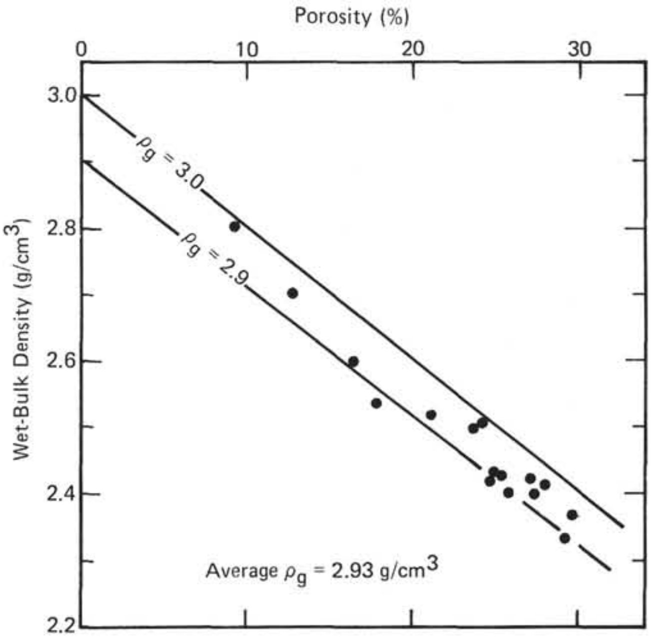


Figure 15. *Wet-bulk density of Site 442 basalts as a function of porosity. The lines are theoretical predictions of wet-bulk density for a rock of a given grain density (ϱ_g) with varying porosity.*

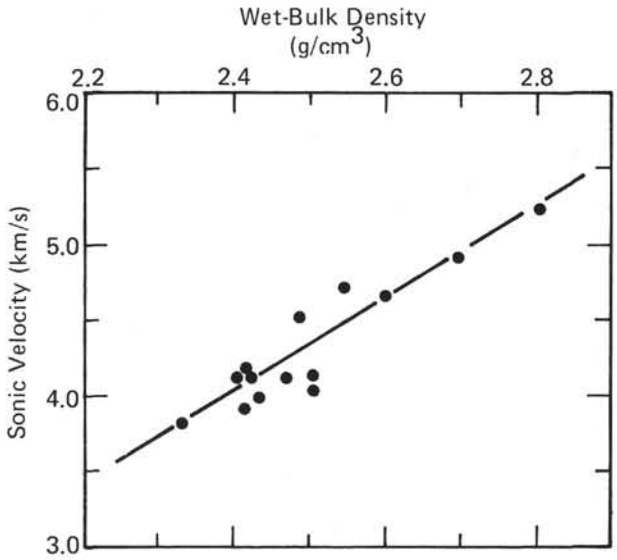


Figure 16. *Sonic velocity of Site 442 basalts as a function of wet-bulk density.*

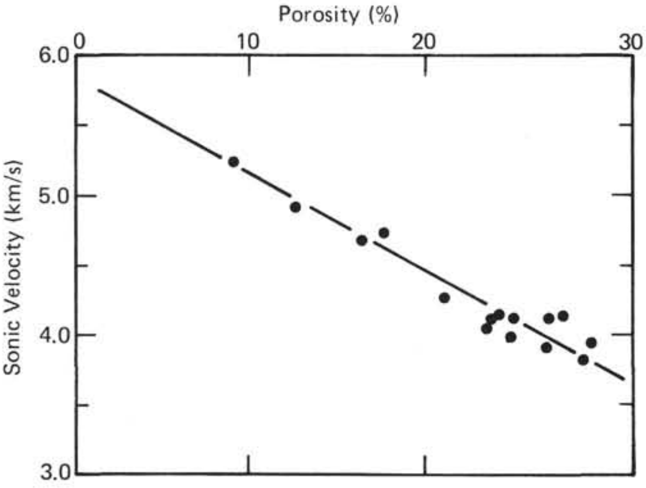


Figure 17. *Sonic velocity of Site 442 basalts as a function of porosity.*

to 0.5 m.y., corresponding to anomalies 5D and 5E, are included (together with succeeding reversed intervals) in the middle Burdigalian stage. A sediment layer intercalated between the massive and pillow basalt flows provides an age of 18 to 21 m.y. (Core 442B-9). Thus, it seems likely that both massive and pillow flows were formed during the period of anomaly 5E or, otherwise, the pillow flows were erupted during 5D, and massive lavas were erupted during 5D after a pause of volcanic activity for about 0.5 m.y. of reversed polarity.

Intensity of natural remanent magnetization of pillow-lava flows averaging about 3×10^{-3} emu/cm^3 is consistent with intensities of usual basalts collected by drilling at other sites and by dredge hauls (e.g., Lowrie, 1974). Approximate estimation of thickness of subbottom magnetic layers responsible for the observed magnetic anomaly (Talwani et al., 1971) indicates that magnetic layers only about 1000 meters thick and at a sub-bottom depth of 5 km, would be sufficient to cause an anomaly of 300 gammas in peak-to-peak amplitude, if the layers are *uniformly* magnetized.

However, layer 2A beneath this site does not seem to be the layer causing the observed anomaly because:

1. The layer contains alternating sequences of normal and reversed polarities which apparently cancel at the surface.

2. The layer consists of interlayered basalts and sediments. Bulk intensity of natural remanent magnetization is reduced with percentage of basalts; if basalts are only 40 per cent, the bulk intensity would be 0.8×10^{-3} emu/cm^3. Therefore, it seems more likely that layers 2B and 2C (total estimated thickness at this site 720 meters) are primarily responsible for the observed magnetic anomaly. This implication is also consistent with the age relationship showing that layer 2 is slightly younger than the anomaly.

SUMMARY AND CONCLUSIONS

Summary

The stratigraphic succession at Site 442 consists of seven lithologic units, five of which are sedimentary and range in age from early Miocene to Quaternary, and two of which are basalt. From the top downward, the units are:

Unit I (0–164 m): dark-greenish-gray mud and clay (Quaternary).

Unit II (164–209 m): yellow-brown mud (early Pleistocene and Pliocene) and (180.5–209 m) dark-brown mud with siliceous microfossils (Pliocene and possibly late Miocene).

Unit III (209–277.1 m):

Sub-unit IIIa (209–259.6 m): yellowish-brown mud and clay with volcanic ash (middle and late Miocene).

Sub-unit IIIb (259.6–277.1 m): interbedded gray and dark-greenish clay and volcanic ash (middle Miocene).

Unit IV (277.1–285.7 m): dark-brown zeolitic clay and claystone (early Miocene).

Unit V (285.7–286.1 m): pink limestone (early Miocene).

Basalt Unit 1 (286.1–353 m): aphyric, massive vesicular basalt.

Basalt Unit 2 (353–445 m): aphyric, vesicular, pillow-basalt flows.

The complete sedimentary section was recovered at Hole 442A. Hole 442B was drilled 70 meters north of Hole 442A and recovered sediments equivalent to Subunit IIIb and unit IV between 267.5 meters below the sea floor and the top of basalt unit I. The absence of unit V in Hole 442B suggests that its distribution is patchy or that is represents a local sediment pond.

The depth of deposition of the sedimentary units at Site 442 is shown in Figure 18. The lower part of unit III and units IV and V were deposited at a depth slightly above the CCD, whereas the lower part of unit II and the upper part of unit III were deposited below the CCD. Unit I and the upper part of unit II were deposited above the CCD.

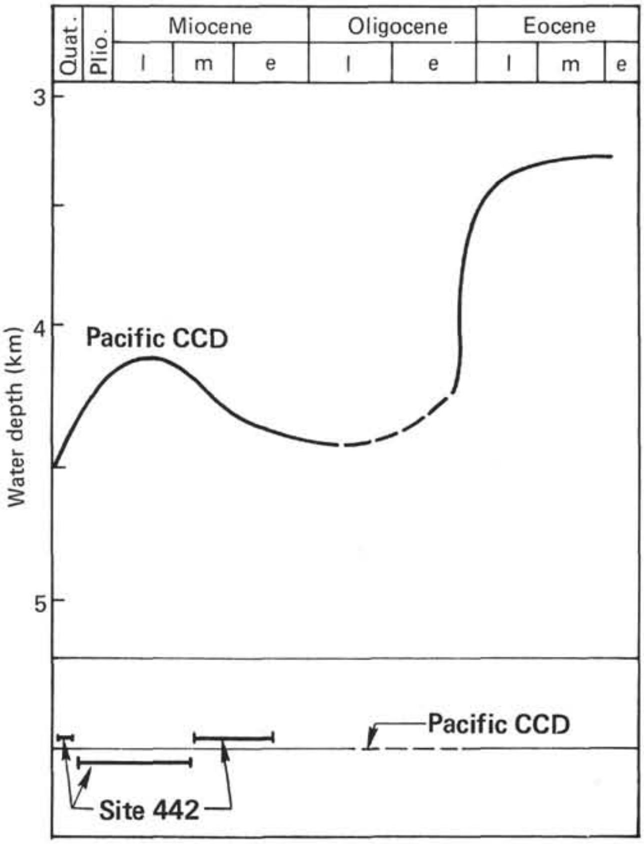


Figure 18. A. *General curve showing estimated water depth of CCD in Pacific Ocean (after van Andel et al., 1975, fig. 29, p. 47).* B. *Relative depth of deposition at Site 442 compared to CCD curve for Pacific Ocean.*

The sediment-accumulation rate increases upward through the section. Deposition of sediment appears to have been uninterrupted since the early Miocene, the high rates of sediment accumulation recorded during the Quaternary being a direct consequence of both increased regional volcanism and increased sediment yield during periods of lower sea level.

Most of the clays at this site are hemipelagic, authigenic minerals composing less than 10 per cent of the total sediment. Pelagic components are dominant only in units IV and V.

The organic chemical components in the sediments consist ony of kerogen and bitumen; light-hydrocarbon gases are absent. Organic-carbon content is low in units I and IV, very low in unit II and III, and virtually absent in unit V.

The pH of the sediment averages 7.71, the alkalinity averages 4.7 meq/kg, the salinity averages 35 per mill, and the chlorinity averages 19.29 per mill.

Examination of the physical properties shows several major changes. The sonic velocity of the sediments of units I through IV averages 1.58 km/s, whereas for the limestone of unit V it averages 3.75 km/s. Sonic velocities for the two basalt units average 4.2 km/s, with a range from 3.85 to 5.25 km/s. Average density for the sediments is 1.47 g/cm^3, and for the basalt 2.5 g/cm^3. Porosity averages 72.2 per cent for sediments (range 48 to 80%), and ranges from 10 to 29 per cent for basalts. The density and porosity of the basalts is lower than the average for oceanic basalts.

A systematic change was recorded in the shear strength of the sediments. Sediment shear strength increased with depth, but at certain horizons shear strength suddenly decreased. These horizons occurred at intervals where drilling breccia increased and recovery decreased. Shear strength of the sediments ranged from 0.2×10^{-5} to 12×10^{-5} dynes/cm^2.

Paleomagnetism data show that Site 442 has been approximately at the present latitude since the early Miocene. The average intensity of natural remanent magnetization is 3×10^{-3} emu/cm^3. Analysis of magnetic reversals in the lower part of basalt unit 2 indicates that the source of the magnetic-anomaly is below the present level of penetration in layer 2A and most probably occurs in layer 2B.

Visual examination and microscopic petrographic analysis of the basalts at Site 442 show that they are tholeiitic and that they are characterized by an absence of olivine, by high vesicularity, and by a cooling history dominated by an early crystallization of pyroxene. Both extrusive flows and intrusive sills are present.

Conclusions

Our data from Site 442 permit the following conclusions:

1. The depositional surface of sedimentation at Site 442 was slightly above or slightly below the carbonate-compensation depth (CCD). Deposition began above the CCD, but appears to have been below the lysocline, as indicated by the poor preservation of foraminifers during the early and early middle Miocene. From the late middle Miocene through the early Pliocene, sediment accumulation occurred below the CCD. During the late Pliocene and Quarternary, deposition occurred slightly above the CCD (Figure 18). The exact depth of deposition cannot be determined exactly, because no data exist concerning present or past elevations of the CCD in the Shikoku Basin. However, if one assumes that the general Pacific Ocean CCD curve of Van Andel et al. (1975) represents a maximum CCD curve for the Shikoku Basin, the depositional surface at Site 442 probably ranged from a water depth of no less than 4000 meters to no more than 4300 meters.

2. The clays and claystones of units I, II, and III are hemipelagic and were deposited in a distal or basinal facies. The terrigenous components account for an average of 80 per cent of total mineralogical components. The exact source of the sediments was not determined. However, Site 442 is on the eastern edge of a westward-thickening clastic wedge, recognized from seismic surveys by Murauchi and Asanuma (1974, 1977); this clastic wedge thickens against the Kyushu-Palau Ridge. Although it has not been proven, the Kyushu-Palau Ridge appears to be the most likely source for these sediments.

3. The age of the basaltic basement was dated from the sediments recovered in 442B-9, CC as earliest Miocene (18–21 m.y.; *Discoaster druggii* Zone of nannofossils, foraminifer Zone N.6). This biostratigraphic age is in agreement with the age of magnetic anomaly 6 postulated by Kobayashi and Nakata (1977), although the anomaly itself probably comes from layer 2B, which was not reached. This biostratigraphic age determination provides a key confirmation of the magnetic-anomaly age determination in back-arc and marginal basins and also provides a critical baseline for testing the idea of a spreading origin for the Shikoku Basin, an objective requiring drilling at Sites 443 and 444.

4. The basalts recovered at Site 442 are unique in several ways when compared to mid-ocean basalts, particularly those of the Mid-Atlantic Ridge. Both the massive lava flows of basalt unit 1 and the pillow lavas of basalt unit 2 are anomalously vesicular. High vesicularity is expected from basalts extruded in shallow water. A strong inverse correlation exists between vesicularity and water depth of basalt extrusion; vesicle-rich basalts almost disappear at a depth of 2000 meters. Because the extrapolated depth of sediment deposition immediately above basement exceeds 2000 meters, it would appear that the Site 442 basalts may have been characterized by a volatile content higher than normal for mid-ocean-ridge basalts.

The basalts at Site 442 also differ from Atlantic Ocean basalts in that they contain no olivine, whereas many basalts associated with mid-ocean ridges are olivine-bearing. The site 442 basalts contain many chromian spinels which are enclosed by pyroxene, indicating that the pyroxene in these basalts may have crystallized very early in the cooling of the melt (Dick, per. comm.). This early crystallization of pyroxene is also at variance with observations from other oceanic basalts, where pyroxene appears to crystallize later in the cooling history (Dick, 1975). The high volatile content, the lack of olivine, and the evidence of early pyroxene crystallization of the Site 442 basalts suggest that these basalts differ megascopically and petrographically from many mid-ocean-ridge basalts. However, the megascopic and petrographic characters of the Site 442 basalts are similar to those of some ophiolites, particularly in the western U.S. Chemical analysis of the glassy rinds of the Site 442 basalts shows similarity of the Site 442 basalts with those of mid-ocean ridges, however. (Dick et al., this volume)

5. The rate of sediment accumulation was low during the Miocene and Pliocene and became high during the Quarternary. The preservation of organic carbon in the sediments appears to reflect changes in the rate of sediment accumulation.

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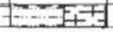
SITE 442 HOLE CORE 1 CORED INTERVAL: 0.0-0.5 m

TIME–ROCK UNIT	BIOSTRAT ZONE	FOSSIL CHARACTER FORAMS	FOSSIL CHARACTER NANNOS	FOSSIL CHARACTER RADS			SECTION	METERS	GRAPHIC LITHOLOGY	DRILLING DISTURBANCE	SEDIMENTARY STRUCTURES	LITHOLOGIC SAMPLE
Upper Pleistocene or Holocene	*Emiliania huxleyi* Zone (N) N 23 (*Grt. inflata–Grt. truncatulinoides* Zone)	FP	CG	AG			CC					



LITHOLOGIC DESCRIPTION

Siliceous Mud, with volcanic lapilli; rads (20%) >diatoms>silicos; dark greenish gray (5GY 4/1). Siliceous fossils are well-preserved.

0.1 m recovery included pumice fragments (1-2 cm diameter, rounded).

SMEARS:

CC Siliceous Mud.

Sand	2%	Quartz, Feldspar	25%
Silt	43%	Mica, Heavies	TR
Clay	55%	Clay minerals	43%
		Volcanic glass	5%
		Foraminifers	TR- 2%
		Nannofossils	5%
		Siliceous fossils (Radiolarians dominant)	20%
		Opaques	5%

SITE 442 HOLE A CORE 1 CORED INTERVAL: 0.0-9.5 m

TIME–ROCK UNIT	BIOSTRAT ZONE	FOSSIL CHARACTER FORAMS	FOSSIL CHARACTER NANNOS	FOSSIL CHARACTER RADS			SECTION	METERS	GRAPHIC LITHOLOGY	DRILLING DISTURBANCE	SEDIMENTARY STRUCTURES	LITHOLOGIC SAMPLE
Upper Pleistocene or Holocene	*Emiliania huxleyi* Zone (N)		CG				1	0.5 1.0				

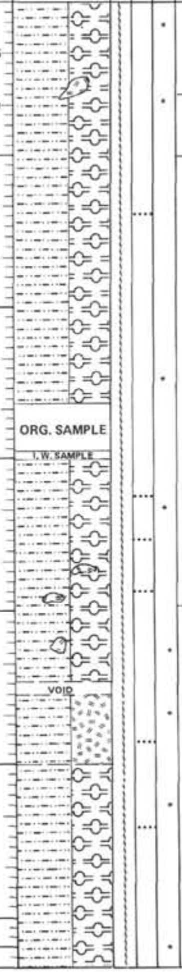
LITHOLOGIC DESCRIPTION

Siliceous Mud - No recovery.
Watery material appears similar to material in Hole 442, Core 1

Information on core description sheets, for ALL sites, represents field notes taken aboard ship under time pressure. Some of this information has been refined in accord with post-cruise findings, but production schedules prohibit definitive correlation of these sheets with subsequent findings. Thus the reader should be alerted to the occasional ambiguity or discrepancy.

SITE 442 HOLE A CORE 2 CORED INTERVAL: 9.5-19.0 m

TIME–ROCK UNIT	BIOSTRAT ZONE	FOSSIL CHARACTER FORAMS	FOSSIL CHARACTER NANNOS	FOSSIL CHARACTER RADS			SECTION	METERS	GRAPHIC LITHOLOGY	DRILLING DISTURBANCE	SEDIMENTARY STRUCTURES	LITHOLOGIC SAMPLE	
Pleistocene Upper Pleistocene or Holocene	N.23 (F) *Lamprocyrtis haysi* (R)/*Ceratolithus cristatus* Subzone (N) / *Emiliania huxleyi* Zone (N)	FP	CG	AG			1	0.5 1.0				•	N4 5GY 4/1
							2						
		FP	FM	AG			3					•	N4 & 5GY 4/1
							4					•	
		FP	R	AG			5					•	5GY 4/1
							6					•	N4
							7						
		FP	FM	AG			CC					•	



LITHOLOGIC DESCRIPTION

Mud
Dark gray to dark greenish gray with varying amounts of siliceous fossils (Radiolarians dominant) volcanic ash.

Deformation is intense throughout; scattered harder clay chunks, ash zones. Dark gray sediment >dark greenish gray; extremely difficult to distinguish bedding sequences, if any.

SMEARS:

1-25 Glassy, Siliceous Mud

Sand	10%	Quartz, Feldspar	15%
Silt	40%	Mica, Nannofossils, CO_3	TR
Clay	50%	Heavies	3%
		Volcanic glass	6%
		Siliceous fossils (R>D)	20%
		Opaques	3%
		Clay minerals	53%

1-100 Glassy Siliceous Mud
(20% sand, 30% siliceous fossils)

3-75 Siliceous Mud
(10% volcanic glass, 15% diatoms, 7% radiolarians, 10% sponge)

4-50 Siliceous Mud
(10% diatoms, 6% radiolarians)

5-45 Volcanic Mud (Minor)
(25% volcanic glass)

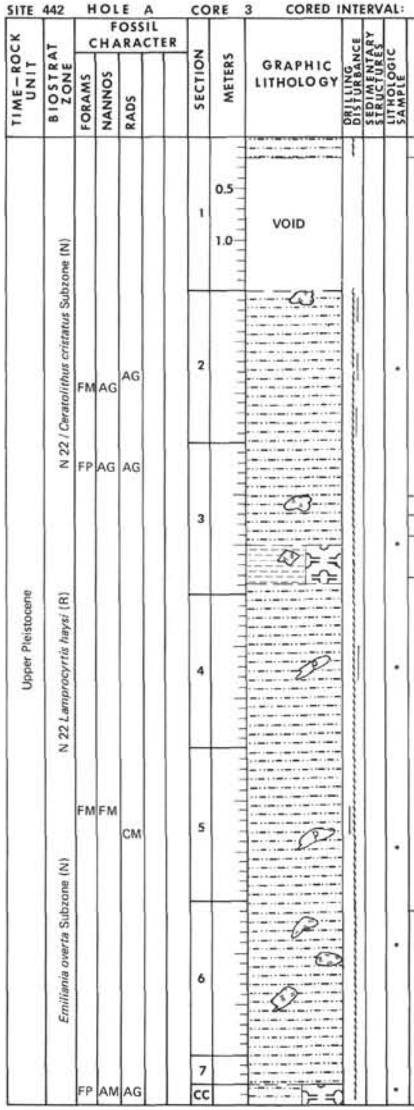
5-100 Volcanic Clayey Sand
(88% volcanic glass)

6-46 Siliceous Mud (Also CC Smear)
(15% quartz, 3% glass, 9% siliceous fossils)

GRAIN SIZE:
2-98 (0.4, 47.1, 52.5)
4-76 (0.0, 91.2, 8.7)
6-50 (2.9, 50.5, 46.7)

CARBONATE BOMB:
3-10 (6)

SITE 442 HOLE A CORE 3 CORED INTERVAL: 19.0-28.5 m



5Y 4/1

5Y 4/1
to
N4

Pumice fragment

5/1-4/1

Pyrite
(burrow fill?)

5Y 4/1

5Y 4/1
with
5Y 3/1
and
5Y 6/1

5Y 4/1

LITHOLOGIC DESCRIPTION

Mud
Generally intense deformation with some moderate deformation; vol. ash zones scattered throughout; two pyrite filled burrows noted; pumice fragments noted. Stringers of clay noted (3-100). Colors dominantely a dark greenish gray (5GY 4/1) and dark gray (N4).

SMEARS:
2-75 Mud

Sand	< 5%	Quartz, Feldspar	7%
Silt	>35%	Mica	TR
Clay	<60%	Heavies	1%
		Clay minerals	85%
		Opaques	2%
		Foraminifers	TR
		Diatoms	1%
		Radiolarians, Sponge spicules	2%

3-100 Siliceous Mud (Minor)
(80% clay minerals, 2-5% volcanic glass, 10% siliceous fossils)

4-75 Mud
(87% clay minerals)

5-100 Mud
(86% clay minerals, 3% siliceous fossils)

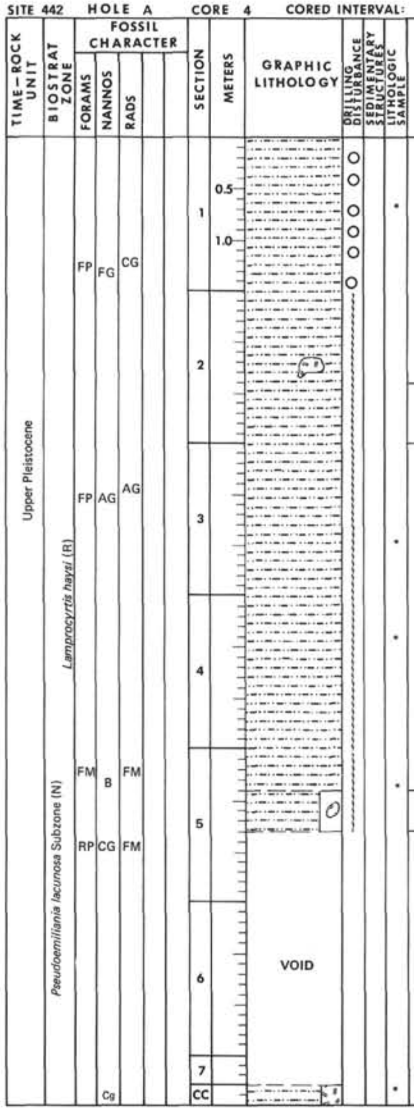
6-50 Volcanic Ash (Minor)
(81% volcanic glass)

CC Siliceous, Ash Mud (Silty Clay) (Minor)
(20% volcanic glass, 10% siliceous fossils)

GRAIN SIZE:
2-41 (3.8, 51.2, 45.1)
4-70 (0.3, 39.4, 60.2)
6-88 (1.3, 51.8, 47.0)

CARBON-CARBONATE:
4-80 (0.5, 0.5, 0)
6-74 (0.5, 0.5, 0)

SITE 442 HOLE A CORE 4 CORED INTERVAL: 28.5-38.0 m



5Y 4/1,
5GY 4/1
with N4

5GY 4/1

N4 with
5GY 4/1,
5Y 4/1

5B 4/1

N4 with
5GY 4/1,
and
5BG 4/1

5BY 4/1

5GY 4/1

N4 to 5GY 4/1

LITHOLOGIC DESCRIPTION

Mud
Generally intense deformation with some breccia zones; color mottling is common with dark gray to dark greenish gray (5Y 4/1-5GY 4/1), dark gray (N4), dark greenish gray (5BG 4/1). Occasional ash zones, clay nodules noted.

SMEARS:
1-75 Mud

Sand	< 1%	Quartz, Feldspar	2%
Silt	>45%	Heavies	TR
Clay	>50%	Clay minerals	87%
		Opaques	1%
		Volcanic glass	5%
		Carbonate unspecified	2%
		Nannofossils	TR
		Radiolarians	2%
		Sponge spicules	1%

3-104 Mud
(10% quartz, feldspar, 89% clay minerals, 2% siliceous)

4-51 Mud
(19% quartz, feldspar, 75% clay minerals)

5-48 Vitric Mud (Minor)
(10% volcanic glass)

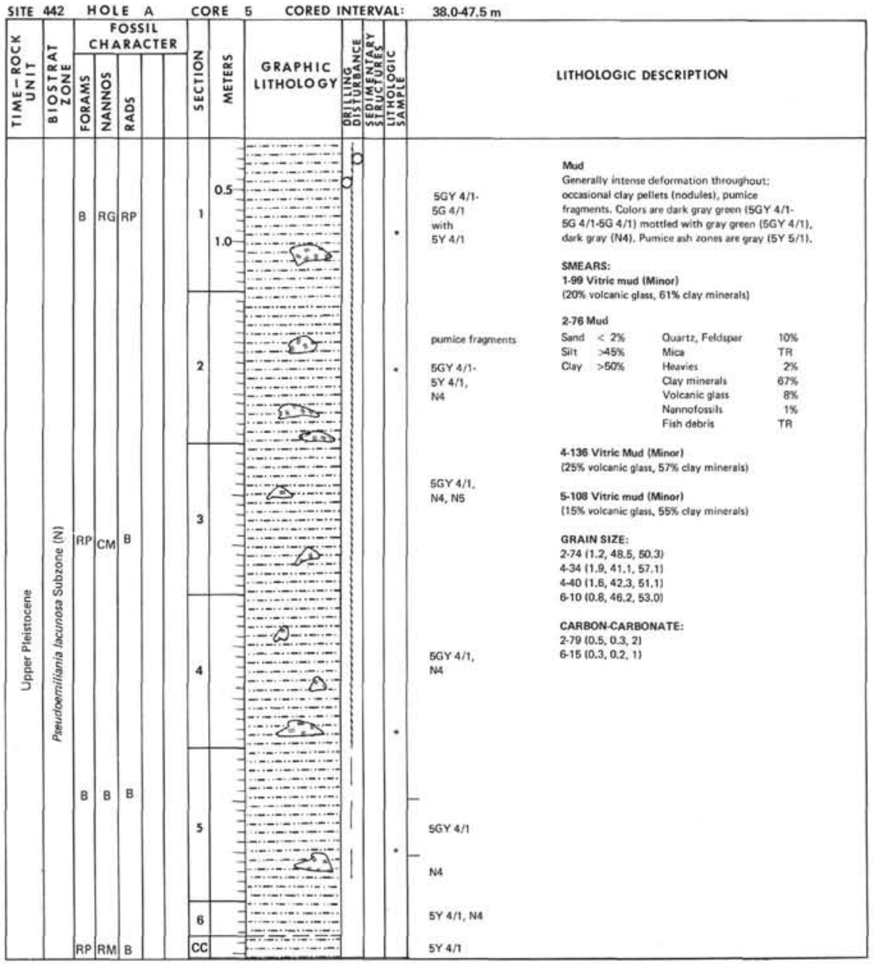
CC Vitric Mud (Minor)
(15% volcanic glass)

GRAIN SIZE:
2-70 (0.9, 46.8, 52.3)
4-82 (0.1, 49.0, 50.9)

CARBON-CARBONATE:
2-80 (0.3, 0.2, 1)
4-87 (0.6, 0.7, 0)

CARBONATE BOMB:
3-10 (12)

SITE 442 HOLE A CORE 5 CORED INTERVAL: 38.0-47.5 m



Section	Forams	Nannos	Rads	Colors
1	B	RG	RP	5GY 4/1- 5G 4/1 with 5Y 4/1
2				pumice fragments 5GY 4/1- 5Y 4/1, N4
3	RP	CM	B	5GY 4/1, N4, N5
4				5GY 4/1, N4
5	B	B	B	5GY 4/1 N4
6				5Y 4/1, N4
CC	RP	RM	B	5Y 4/1

Mud

Generally intense deformation throughout; occasional clay pellets (nodules), pumice fragments. Colors are dark gray green (5GY 4/1-5G 4/1-5G 4/1) mottled with gray green (5GY 4/1), dark gray (N4). Pumice ash zones are gray (5Y 5/1).

SMEARS:

1-99 Vitric mud (Minor)
(20% volcanic glass, 61% clay minerals)

2-76 Mud

Sand	< 2%	Quartz, Feldspar	10%
Silt	>45%	Mica	TR
Clay	>50%	Heavies	2%
		Clay minerals	67%
		Volcanic glass	8%
		Nannofossils	1%
		Fish debris	TR

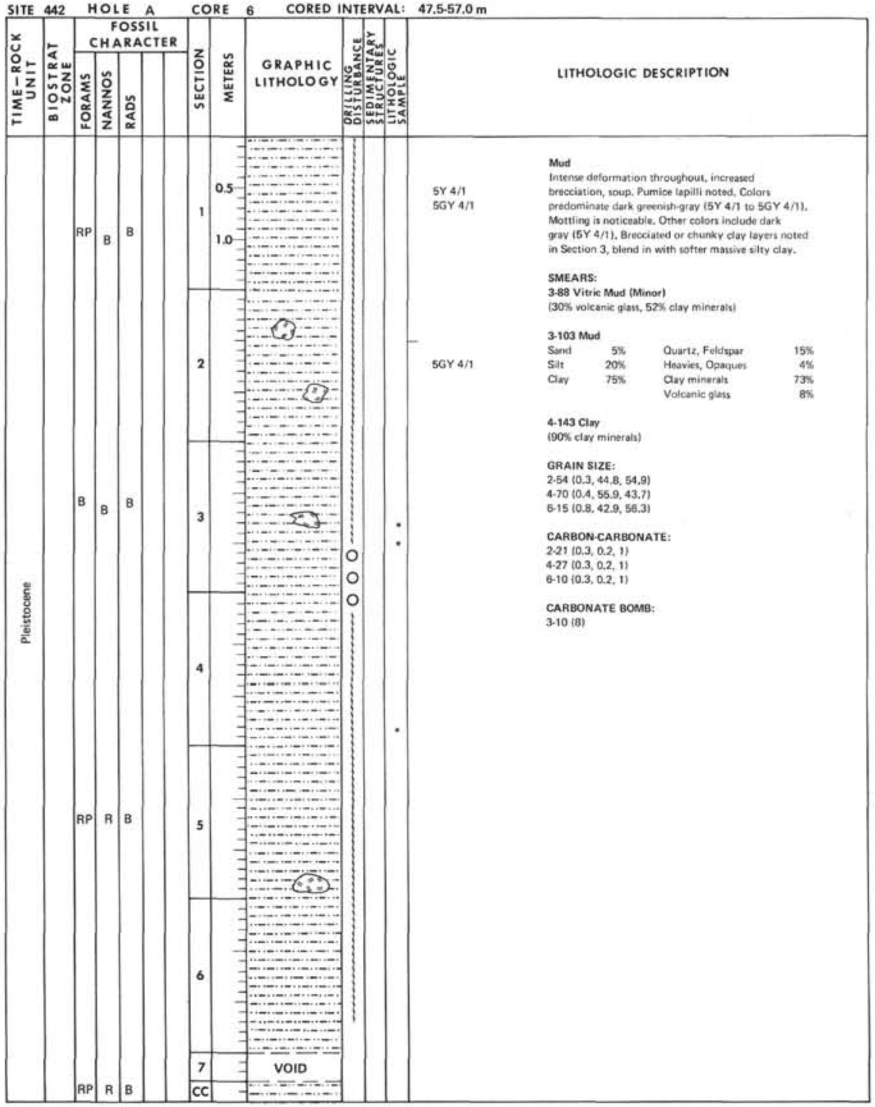
4-136 Vitric Mud (Minor)
(25% volcanic glass, 57% clay minerals)

5-108 Vitric mud (Minor)
(15% volcanic glass, 55% clay minerals)

GRAIN SIZE:
2-74 (1.2, 48.5, 50.3)
4-34 (1.9, 41.1, 57.1)
4-40 (1.6, 42.3, 51.1)
6-10 (0.8, 46.2, 53.0)

CARBON-CARBONATE:
2-79 (0.5, 0.3, 2)
6-15 (0.3, 0.2, 1)

SITE 442 HOLE A CORE 6 CORED INTERVAL: 47.5-57.0 m



Section	Forams	Nannos	Rads	Colors
1	RP	B	B	5Y 4/1 5GY 4/1
2				5GY 4/1
3	B	B	B	
5	RP	R	B	
CC	RP	R	B	

Mud

Intense deformation throughout, increased brecciation, soup. Pumice lapilli noted. Colors predominate dark greenish-gray (5Y 4/1 to 5GY 4/1). Mottling is noticeable. Other colors include dark gray (5Y 4/1). Brecciated or chunky clay layers noted in Section 3, blend in with softer massive silty clay.

SMEARS:

3-88 Vitric Mud (Minor)
(30% volcanic glass, 52% clay minerals)

3-103 Mud

Sand	5%	Quartz, Feldspar	15%
Silt	20%	Heavies, Opaques	4%
Clay	75%	Clay minerals	73%
		Volcanic glass	8%

4-143 Clay
(90% clay minerals)

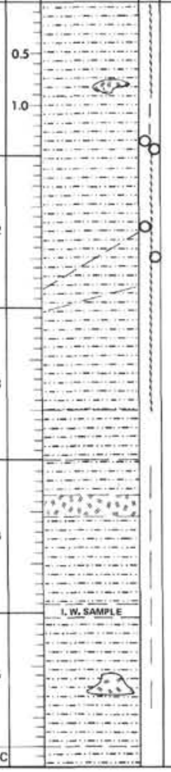
GRAIN SIZE:
2-54 (0.3, 44.8, 54.9)
4-70 (0.4, 55.9, 43.7)
6-15 (0.8, 42.9, 56.3)

CARBON-CARBONATE:
2-21 (0.3, 0.2, 1)
4-27 (0.3, 0.2, 1)
6-10 (0.3, 0.2, 1)

CARBONATE BOMB:
3-10 (8)

SITE 442 HOLE A CORE 7 CORED INTERVAL: 57.0-66.5 m

TIME-ROCK UNIT	BIOSTRAT ZONE	FORAMS	NANNOS	RADS	SECTION
Lower Pleistocene	*Crenalithus doronicoides* Zone (N)	B	AM	B	1
					2
		B	FG	B	3
			G		4
			B	B	5
		B	R	B	CC



5Y 4/1-
5GY 4/1

5GY 5/1

5GY 5/1
with
5G 4/1

5GY 5/1

10R 4/1

5Y 6/1-5G 4/2

5GY 5/1

5GY 5/1

LITHOLOGIC DESCRIPTION

Mud
Intense deformation throughout yet firm with scattered zones of clay chunks (brecciated zones).

SMEARS:
1-38 Mud

Sand	< 1%	Quartz, Feldspar	10%
Silt	>40%	Clay minerals	87%
Clay	>50%	Volcanic glass	< 1%
		Siliceous fragments	2%

1-100 Vitric Mud (Minor)
(20% volcanic glass, 65% clay minerals)

1-127 Mud
(10% quartz, feldspar; 84% clay minerals)

2-100 Mud (Clay)
(<5% quartz, feldspar; 20% silt)

4-52 Volcanic ash (Minor)

4-100 Mud
(20% quartz, feldspar; 5-7% volcanic glass)

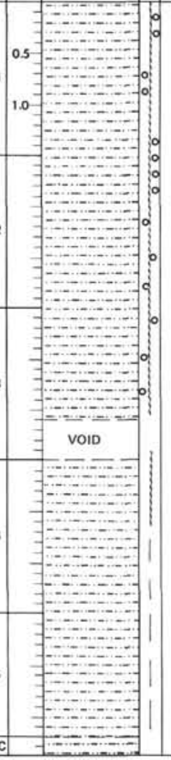
5-68 Ash-Rich Mud (Minor)

GRAIN SIZE:
2-60 (0.1, 43.5, 56.4)
4-60 (1.1, 42.0, 56.9)

CARBON-CARBONATE:
2-84 (0.4, 0.3, 1)
4-84 (0.5, 0.3, 2)

SITE 442 HOLE A CORE 8 CORED INTERVAL: 66.5-76.0 m

TIME-ROCK UNIT	BIOSTRAT ZONE	FORAMS	NANNOS	RADS	SECTION
Lower Pleistocene	*Crenalithus doronicoides* Zone (N)	B	CM	B	1
					2
		B	FM	B	3
					4
		B	B	B	5
		B	B	B	CC



5G 4/1

5YR 3/2

5Y 5/1

5G 4/1

LITHOLOGIC DESCRIPTION

Mud
Intense deformation, brecciated and soupy in upper part to moderate in lower. Colors - gray (5Y 5/1) are dominant.

SMEARS:
1-80, 4-90 Mud

Sand	< 1%	Quartz, Feldspar	15%
Silt	>40%	Clay minerals	80%
Clay	>50%	Volcanic glass	1- 2%
		Opaques	1%
		Spicules	1- 2%

GRAIN SIZE:
4-26 (0.3, 42.0, 57.7)

CARBON-CARBONATE:
4-30 (0.3, 0.2, 0)

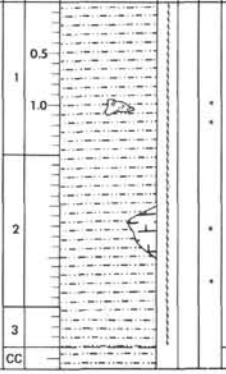
CARBONATE BOMB:
1-68 (8)

SITE 442 HOLE A CORE 9 CORED INTERVAL: 76.0-85.5 m

TIME-ROCK UNIT: Pleistocene

BIOSTRAT ZONE: *Crenalithus doronicoides* Zone (N)

FORAMS	NANNOS	RADS	SECTION
RP	AM	B	2
RP	FG	B	CC



pumice fragment

5G 4/1

5G 4/1

LITHOLOGIC DESCRIPTION

Mud
Hard, brecciated, soupy throughout. Pumice fragment noted in Section 1. Color - dark bluish-gray (5G 4/1).

SMEARS:
1-100 Volcanic Ash (Minor)
(30% volcanic glass, 43% clay minerals)

1-120, 2-130 Mud

Quartz, Feldspar	10-15%
Clay minerals	67-85%
Opaques	1%
Volcanic glass	5%
Sponge spicules	2%

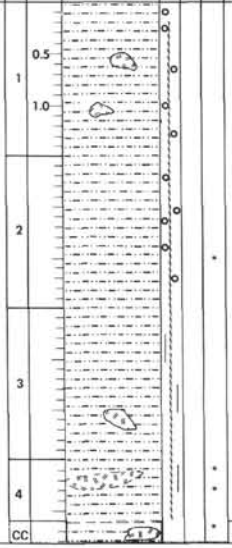
2-75 Nannofossil-Rich Mud (Minor)
(15% nannofossils, 60% clay minerals)

SITE 442 HOLE A CORE 10 CORED INTERVAL: 85.5-95.0 m

TIME-ROCK UNIT: Lower Pleistocene

BIOSTRAT ZONE: *Crenalithus doronicoides* Zone (N) Foram Zone N 22

FORAMS	NANNOS	RADS	SECTION
RP	FG	B	1
B	R	B	3
B	B	B	CC



5GY 6/1

5Y 5/1

5GY 5/1

5GY 5/1

LITHOLOGIC DESCRIPTION

Mud
Brecciated in upper portion to moderate increase deformation in lower portion; firm. Colors: dark greenish-gray (5G 5/1), greenish-gray (5G 5/1, 5GY 6/1). Scattered high volcanic ash zones.

SMEARS: Mud
2-103, 4-14 Silty Clay

Sand	< 1%	Quartz, Feldspar	5-15%
Silt	>40%	Clay minerals	83-89%
Clay	>50%	Opaques	<1%
		Volcanic glass	< 1%

4-34 Volcanic Sand (Volcanic Ash) (Minor)
(80% volcanic glass)

CC Volcanic Ash (Minor)

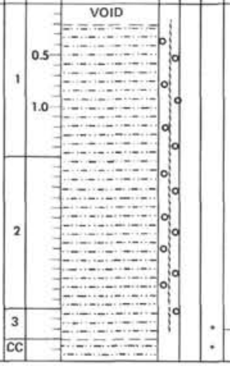
GRAIN SIZE:
2-124 (0.4, 40.0, 59.6)
4-30 (15.8, 60.2, 24.0)

CARBON-CARBONATE:
2-132 (0.3, 0.2, 1)
4-34 (0.3, 0.2 1)

SITE 442 HOLE A CORE 11 CORED INTERVAL: 95.0-104.5 m

TIME-ROCK UNIT: Pleistocene

FORAMS	NANNOS	RADS	SECTION
B	R	B	3
B	B	B	CC



5GY 4/1

LITHOLOGIC DESCRIPTION

Mud (Silty Clay)
Drilling breccia, soupy.

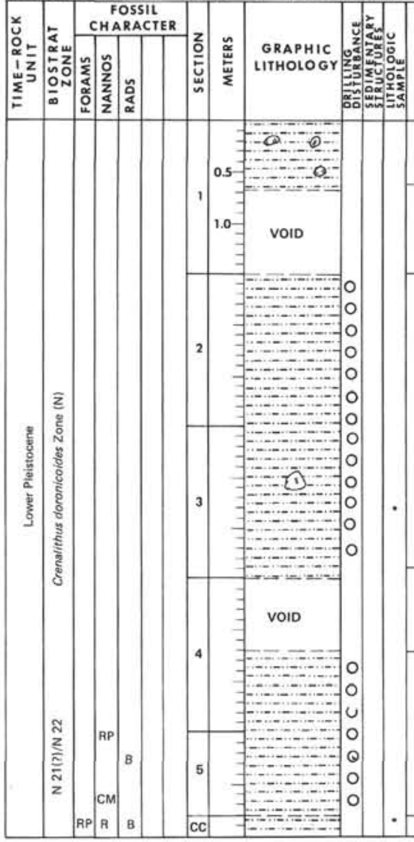
SMEARS:
3-15 Mud

Quartz, Feldspar	4%
Mica	TR
Heavies	1%
Clay minerals	88%
Volcanic glass	1%
Opaques	1%

CC Mud/Clay

Quartz, Feldspar	5%
Clay minerals	85%
Volcanic glass	5%
Opaques	1- 2%
Zeolite	1%
Carbonate unspecified	1- 2%
Nannofossils	TR
Siliceous fossils	TR

SITE 442 **HOLE** A **CORE** 12 **CORED INTERVAL:** 104.5-114.0 m



LITHOLOGIC DESCRIPTION

5Y 4/1

5Y 4/1

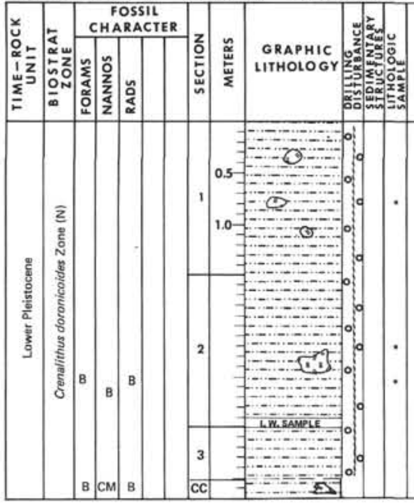
5Y 4/1

Mud
Deformed, brecciated, soupy; some scattered volcanic ash zones. Dominant color is dark gray (5Y 4/1).

SMEARS:
3-75, CC

Quartz, Feldspar	5%
Mica	TR
Heavies	1- 2%
Volcanic glass	1- 2%
Opaques	2%
Radiolarians	1- 2%
Clay minerals	81-88%

SITE 442 **HOLE** A **CORE** 13 **CORED INTERVAL:** 114.0-123.5 m



LITHOLOGIC DESCRIPTION

5Y 4/1

5GY 5/1

Mud
Drilling breccia to intensely deformed; soft to firm. Dark gray (5Y 4/1) to dark greenish-gray (5GY 5/1); local volcanic ash zones.

SMEARS:
1-80, 2-104 Mud

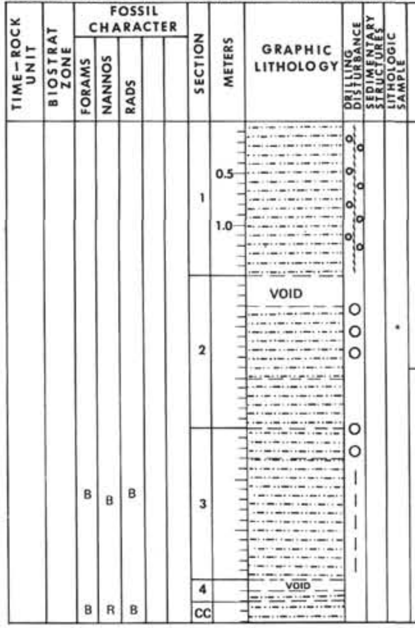
Sand	< 1%	Quartz, Feldspar	5%
Silt	>35%	Heavies	TR
Clay	>60%	Clay minerals	91%
		Volcanic glass	3%
		Opaques	1%
		Radiolarians, Sponge spicules	TR

2-75 Volcanic ash (Minor)

GRAIN SIZE:
2-130 (0.5, 39.4, 60.1)

CARBON-CARBONATE:
2-125 (0.2, 0.2, 0)

SITE 442 **HOLE** A **CORE** 14 **CORED INTERVAL:** 123.5-133.0 m



LITHOLOGIC DESCRIPTION

5Y 5/1

5Y 5/1

5Y 5/1

Mud
Breccia to start of moderate deformation in Section 3. Scattered clay chunks. Dominant color is gray (5Y 5/1).

SMEARS:
2-55 Mud

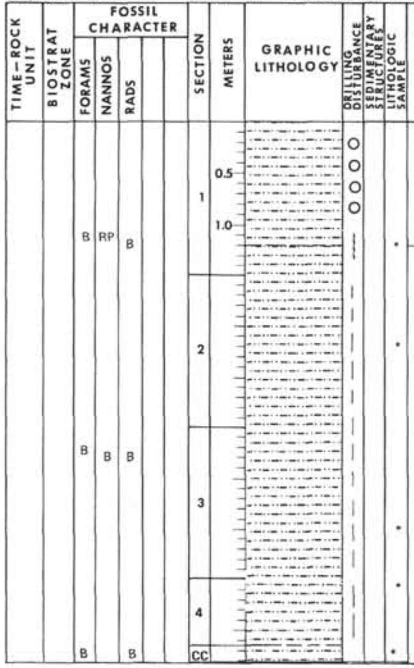
Sand	< 1%	Quartz, Feldspar	4%
Silt	>30%	Heavies	TR
Clay	>60%	Clay minerals	89%
		Volcanic glass	5%
		Opaques	1%
		Sponge spicules	1%

GRAIN SIZE:
3-45 (0.2, 39.0, 60.9)

CARBON-CARBONATE:
3-83 (0.3, 0.2, 1)

CARBONATE BOMB:
3-35 (6)

SITE 442 HOLE A CORE 15 CORED INTERVAL: 133.0-142.5 m



LITHOLOGIC DESCRIPTION

5Y 5/1

5GY 5/1

5Y 5/1-
5GY 5/1

5Y 4/2

5Y 5/1-5GY 5/1 to 5Y 6/1

Mud
Drilling breccia to 120 cm - Section 1 then changes to moderate deformation. Color change from gray (5Y 5/1) to greenish-gray (5GY 5/1) noted at 120 cm - Section 1.

SMEARS:
1-122, 3-100, CC Mud

Sand	< 1%	Quartz, Feldspar	5%
Silt	>35%	Heavies, Mica	TR
Clay	>60%	Clay minrals	90%
		Volcanic glass	2%
		Opaques	1%
		Carbonate unspecified	2%
		Sponge spicules	TR

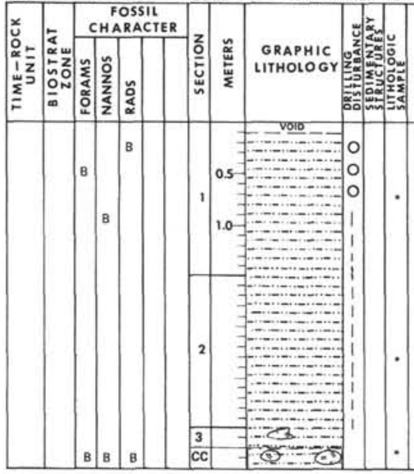
2-70 Mud (Minor?)
(with sericite 20%)

4-6 Mud (Minor)
(with zeolite 2%)

GRAIN SIZE:
2-11 (0.4, 36.8, 62.8)
4-24 (0.1, 34.7, 65.2)

CARBON-CARBONATE:
2-16 (0.4, 0.1, 2)
4-16 (0.2, 0.2, 0)

SITE 442 HOLE A CORE 16 CORED INTERVAL: 142.5-152.0 m



LITHOLOGIC DESCRIPTION

5Y 5/1

5Y 5/1-
5Y 4/2

pumice
5Y 5/1

Mud
Variable deformation from breccia to moderate; firm. Colors are gray (5Y 5/1) to some olive gray (5Y 4/2) in Section 2. Scattered pumice fragments noted.

SMEARS:
1-75, 2-75, CC

Sand	< 1%	Quartz, Feldspar	2%
Silt	>30%	Mica	TR
Clay	>60%	Clay minerals	96%
		Volcanic glass	2%

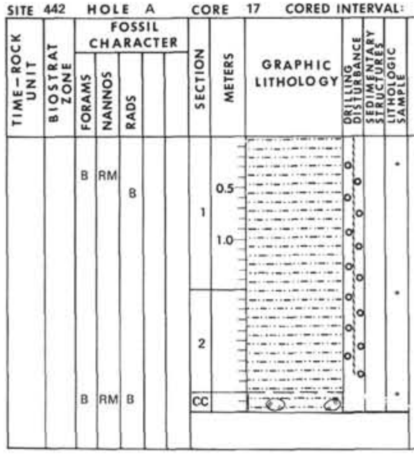
(CC has 8% glass)

GRAIN SIZE:
2-61 (0.2, 32.2, 67.6)

CARBON-CARBONATE:
2-22 (0.2, 0.2, 0)

CARBONATE BOMB:
2-30 (6)

SITE 442 HOLE A CORE 17 CORED INTERVAL: 152.0-161.5 m



LITHOLOGIC DESCRIPTION

5Y 5/1

Mud
Drilling breccia (soupy) of mud (5Y 5/1) with pebbles (drilling) of blackish dark green gray clay (5BG 4/1).

SMEARS:
2-7, CC, 1-30 Mud

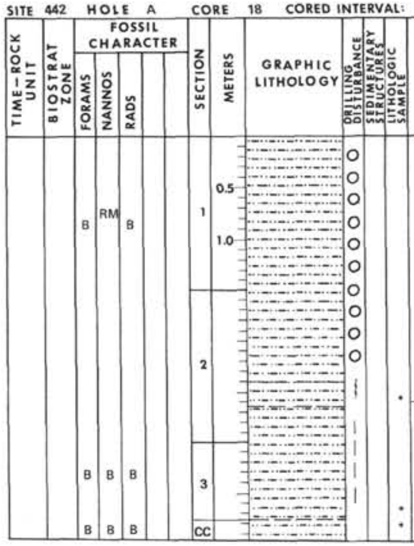
Sand	< 1%	Quartz, Feldspar	2- 3%
Silt	>35%	Clay minerals	91%
Clay	>60%	Volcanic glass	5%
		Opaques	1%

CC = Mud with 8% glass
1-30 = darker mud with up to 25% volcanic glass (these occur as fragments).

GRAIN SIZE:
2-51 (0.4, 36.3, 63.3)

CARBON-CARBONATE:
2-81 (0.2, 0.2, 0)

SITE 442 HOLE A CORE 18 CORED INTERVAL: 161.5-171.0 m



LITHOLOGIC DESCRIPTION

5Y 5/1

Change to yellow brown (10YR 5/4)

10YR 5/4

Mud (Silty Clay)
Highly brecciated in Section 1 with pebble-like (drill) fragments of (5Y 5/1) mud and (N4) clay (with ash). Yellowish brown (10YR 5/4) silty clay begins ≥ 105-140 cm in Section 2. Moderate deformation and darker zones at base of Section 3, 70 cm.

SMEARS:
2-110, CC Mud (yellow brown)

Silt	>35%	Quartz, Feldspar	< 1%
Clay	>60%	Clay minerals	97%
		Opaques	1%
		Volcanic glass	1%

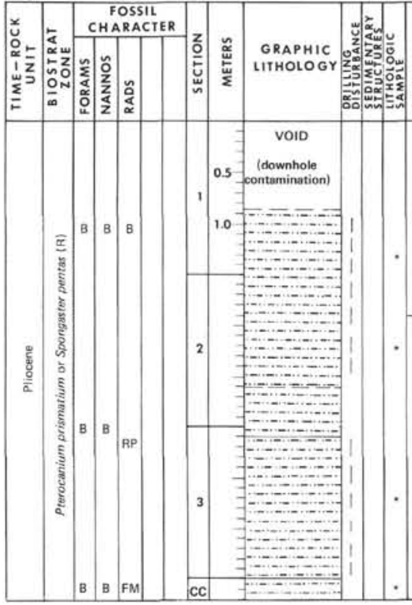
3-70 Clay (Altered Ash)

Silt	15%	Quartz, Feldspar	3- 5%
Clay	85%	Heavies	1%
		Clay (altered?)	68%
		Volcanic glass	25%
		Opaques	1%

GRAIN SIZE:
2-120 (0.5, 38.1, 61.5)

CARBON-CARBONATE:
2-129 (0.2, 0.2, 1)

SITE 442 HOLE A CORE 19 CORED INTERVAL: 171.0-180.5 m



10YR 5/4
darkens

darkens

10YR 5/4

10YR 5/4

LITHOLOGIC DESCRIPTION

Mud
Firm to hard with moderate deformation. Darker zones from ≈ 140 cm - Section 1 to 40 cm - Section 2.

SMEARS:
1-135 Clay
(2% quartz, feldspar, 96% clay minerals)

2-75 Clay (Mud)

Sand	TR	Quartz, Feldspar	20%
Silt	20%	Heavies	TR
Clay	80%	Clay minerals	80%
		Volcanic glass, Opaques	TR

3-75 Mud
(13% quartz, feldspar, 84% clay minerals)

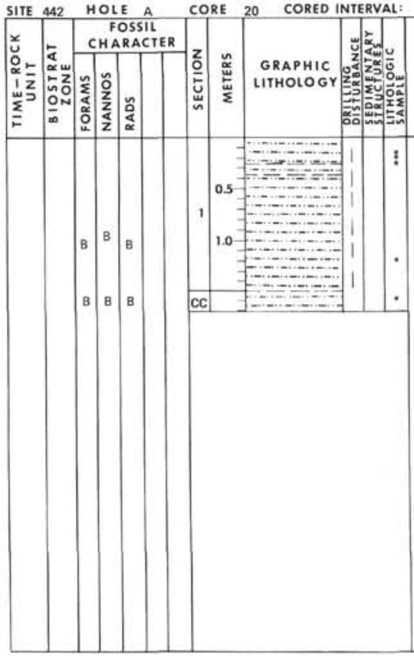
CC Mud
(3% quartz, feldspar, 8% volcanic glass)

GRAIN SIZE:
2-20 (1.9, 35.1, 62.9)

CARBON-CARBONATE:
2-7 (0.1, 0.1, 0)

CARBONATE BOMB:
3-5 (8)

SITE 442 HOLE A CORE 20 CORED INTERVAL: 180.5-190.0 m



10YR 5/2-4/2
to 10YR 7/3

10YR 5/2-10YR 4/2

LITHOLOGIC DESCRIPTION

Mud
Moderate deformation (slight in some cases). Color changes noticeable from grayish-brown to dark grayish-brown (0-12) with pumice noticed; dark gray brown (10YR 4/2) at 12-25; very pale brown (10YR 7/3) to pale brown (6/3) at 25-28, gray brown to very dark gray brown (10YR 5/2 to 4/2 to 3/2).

SMEARS:
1-10

Sand	TR	Quartz, Feldspar	10%
Silt	30%	Heavies	TR
Clay	70%	Clay minerals	90%
		Volcanic glass, Opaques	TR

1-14
(15% quartz, feldspar, 84% clay minerals, TR radiolarians)

1-26 Ash (Minor)

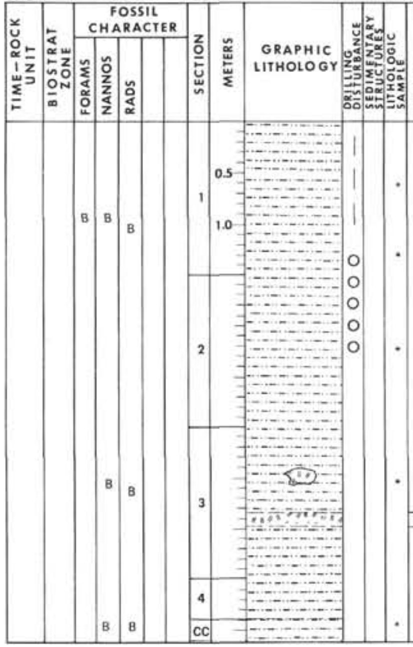
Sand	60%	Quartz, Feldspar	5%
Silt	40%	Heavies	TR
		Volcanic glass	95%

1-14
(15% quartz, feldspar, 84% clay minerals, TR radiolarians)

1-122 Silty Clay
(14% quartz, feldspar, 5% volcanic glass, TR radiolarians)

CC
(97% clay minerals, 2% quartz, feldspar)

SITE 442 HOLE A CORE 21 CORED INTERVAL: 190.0-199.5 m



10YR 5/3 to 4/3
to 10YR 4/2 to
10YR 3/2

10YR 5/2-5/3

10YR 5/4-4/3

10YR 4/1-3/2=ash

10YR 5/2-
10YR 4/2-4/3

10YR 5/2

LITHOLOGIC DESCRIPTION

Mud
Slight to moderate deformation with some brecciated zones in Section 1. Generally brown to dark brown (10YR 5/3-4/3) with changes to dark grayish-brown - or very dark grayish-brown. Section 2 is yellowish-brown to brown (10YR 5/4-4/3). Section 3 generally brown (4/3) to yellow brown (10YR 5/4) with ash noted at 55 and 85 cm; varying color changes.
3, 68-68 cm: Rare foram casts

SMEARS:
1-68, 1-135, 2-84, 3-55, CC

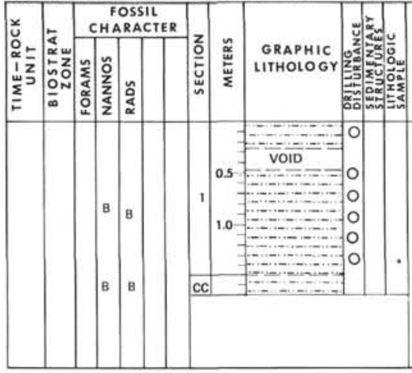
Sand	5%	Quartz, Feldspar	4-12%
Silt	10%	Mica, Heavies	TR
Clay	85%	Clay minerals	85%
		Volcanic glass	2- 3%
		Opaques	TR
		Radiolarians, Sponge spicules	TR

GRAIN SIZE:
2-43 (0.4, 29.7, 69.9)

CARBON-CARBONATE:
2-48 (0.1, 0.1, 0)

CARBONATE BOMB:
1-10 (6)

SITE 442 HOLE A CORE 22 CORED INTERVAL: 199.5-209.0 m



10YR 3/3-
10YR 4/1-
10YR 5/3

10YR 4/3-4/4

LITHOLOGIC DESCRIPTION

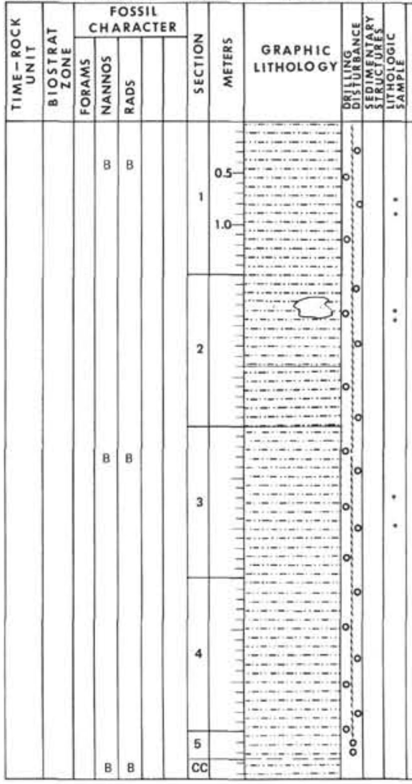
Mud
Drilling breccia of dark brown (10YR 3/3) and dark gray (10YR 4/1) clay. In CC clay is brown to dark brown plus dark yellow brown (10YR 4/3-4/4).
1, 97-99 cm: Rare foram casts

SMEARS:
1-140 Mud

Sand	TR	Quartz, Feldspar	2%
Silt	>25%	Clay minerals	90%
Clay	>70%	Volcanic glass	7-10%
		Sponge spicules	1%

GRAIN SIZE:
1-145 (0.6, 26.9, 72.5)

SITE 442 HOLE A CORE 23 CORED INTERVAL: 209.0-218.5 m



LITHOLOGIC DESCRIPTION

10YR 6/4

Mud
Firm, hard, brecciated especially in Section 1. Color dominately light yellowish-brown (10YR 6/4) mottled with dark grayish-brown (10YR 4/2).
1, 33-35 cm, 3, 33-35 cm, & CC common and abundant foram casts

SMEARS:

1-80 Mud

Sand	TR	Quartz, Feldspar	10%
Silt	10%	Clay minerals	90%
Clay	90%	Opaques, Volcanic glass	TR

dark gray brown
(10YR 4/2)
plant debris(?)

1-95 Mud
(2% diatoms, radiolarians, 3% sponge spicules, 5% opaques, 75% clay minerals)

2-40 Mud
(2-5% quartz, feldspar, 1-2% volcanic glass, TR radiolarians, diatoms)

2-47 Siliceous Mud
(2-3% diatoms, 3-6% radiolarians, 2-5% sponge spicules)

10YR 4/2

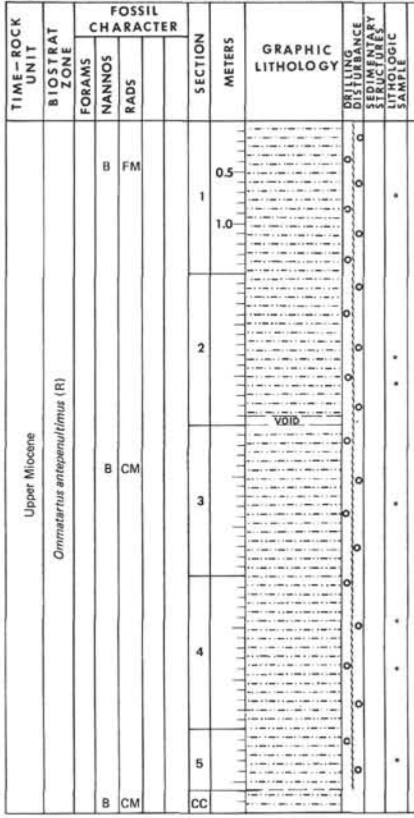
3-71 Mud
(90% clay minerals, 5% quartz, feldspar)

3-103 Mud
(10% quartz, feldspar, 2-5% volcanic glass, 2% radiolarians, sponge spicules)

GRAIN SIZE:
2-36 (0.9, 28.0, 71.1)

CARBON-CARBONATE:
2-47 (0.4, 0.1, 3)
4-47 (0.2, 0.2, 0)

SITE 442 HOLE A CORE 24 CORED INTERVAL: 218.5-228.0 m



LITHOLOGIC DESCRIPTION

Mud
Firm clay, brecciated. Dominant yellowish-brown (10YR 6/4) with bluish-gray (5B 5/1) fragments. Scattered in Section 2; dark grayish-brown spotting in Section 4.
1, 33-35 cm, 3, 31-33 cm: abundant foram casts

SMEARS:

1-75 Mud

Sand	< 5%	Quartz, Feldspar	6%
Silt	>30%	Heavy minerals	TR
Clay	>60%	Clay minerals	94%
		Radiolarians, Sponge spicules	TR

10YR 6/4

2-85 Mud
(19% quartz, feldspar, 80% clay minerals)

2-111 Mud
(95% clay minerals, TR radiolarians, sponge spicules)

3-85 Mud
(5% quartz, feldspar, 1% volcanic glass)

4-46 Mud
(88% clay minerals, 1% sponge spicules, 11% quartz, feldspar)

4-97 Mud (Minor)
(15% quartz, feldspar, 1% diatoms, radiolarians, sponge spicules)

5-35 Mud (Minor)
(13% quartz, feldspar, 85% clay minerals)

GRAIN SIZE:
2-109 (4.8, 33.7, 61.5)
4-109 (1.2, 37.0, 61.8)

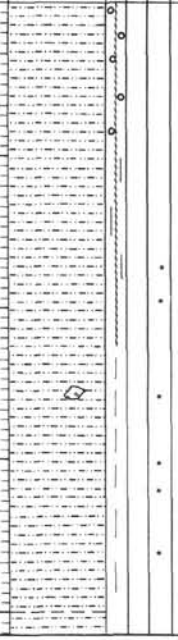
10YR 6/4

CARBON-CARBONATE:
2-113 (0.1, 0.1, 0)
4-113 (0.1, 0.1, 0)

SITE 442 HOLE A CORE 25 CORED INTERVAL: 228.0-237.5 m

TIME-ROCK UNIT	BIOSTRAT ZONE	FOSSIL CHARACTER FORAMS	NANNOS	RADS	SECTION	METERS
Middle Miocene	*Cannartus petterssoni* (R)				1	0.5 1.0
					2	
			B	CM	3	
					4	
			B	CM	CC	

GRAPHIC LITHOLOGY · DRILLING DISTURBANCE · SEDIMENTARY STRUCTURES · LITHOLOGIC SAMPLE



10YR 5/4
with 10YR 4/3-3/3-
10YR 4/2-10YR 3/2

10YR 5/3

10YR 3/3 with
10YR 2/1-10YR 3/1

LITHOLOGIC DESCRIPTION

Mud

Firm, brecciated clay; dark yellowish-brown (10YR 5/4) to brown (10YR 4/3). Mottling with grayish-brown (10YR 5/2) to dark grayish-brown (10YR 4/2); pyritic zones noted in Sections 2 and 3. Dark layers may mark relict bedding; colors very dark gray (10YR 3/1) to very dark grayish-brown (10YR 3/2).

3, 41-43 cm: Rare foram casts

SMEARS:

2-110 Siliceous Mud

(3-5% diatoms, radiolarians, sponge spicules, 70-75% clay minerals)

2-143 Mud (pyritic)

Sand	< 1%	Quartz, Feldspar	10-15%
Silt	>40%	Clay minerals	68-70%
Clay	>50%	Pyrite	7-10%
		Volcanic glass	2%
		Siliceous fragments	1%

3-90 Mud (with pyrite, siliceous)

(5% pyrite, 3-5% diatoms, radiolarians)

4-6 Mud (with siliceous fragments)

(3-5% pyrite, diatoms, radiolarians, siliceous?)

4-32 Mud (with siliceous)

(1-2% volcanic glass, 3-5% diatoms, radiolarians, 5-8% quartz, feldspar)

4-92 Mud

(6-11% siliceous fragments, 5-7% pyrite)

GRAIN SIZE:

2-41 (1.5, 48.3, 50.2)
4-41 (1.1, 42.6, 56.2)

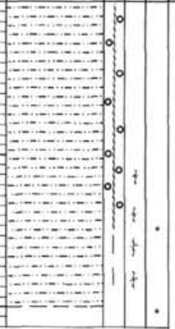
CARBON-CARBONATE:

2-60 (0.2, 0.1, 1)
4-60 (0.1, 0.1, 0)

SITE 442 HOLE A CORE 26 CORED INTERVAL: 237.5-247.0 m

TIME-ROCK UNIT	BIOSTRAT ZONE	FOSSIL CHARACTER FORAMS	NANNOS	RADS	SECTION	METERS
Middle Miocene	*Dorcadospyris alata* (R) *Discoaster exilis* Zone (N)				1	0.5 1.0
			RP	CP	2	
		B	B	CM	CC	

GRAPHIC LITHOLOGY · DRILLING DISTURBANCE · SEDIMENTARY STRUCTURES · LITHOLOGIC SAMPLE



10YR 5/4

10YR 5/4

LITHOLOGIC DESCRIPTION

Mud

Breccia in Section 1 with burrows noted in the lower part. Intense deformation continues to 55 cm, Section 2 with moderate below. Scattered diffuse areas with pyrite occur in Section 2. Burrows with pyrite are noted in Section 2 (<20%). Clay is firm but disturbed in Section 2.

2, 68-70 cm: Rare foram casts

SMEARS:

2-75 Mud

Sand	< 2%	Quartz, Feldspar	5%
Silt	>40%	Mica	TR
Clay	>50%	Clay minerals	80%
		Volcanic glass	TR
		Pyrite	2%
		Zeolite	1%
		Siliceous fragments	10%

CC Mud

(3% pyrite, 10% siliceous fragments)

GRAIN SIZE:

2-94 (1.6, 41.3, 57.1)

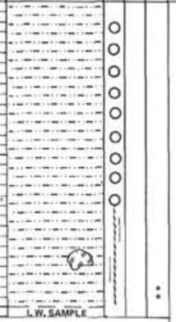
CARBON-CARBONATE:

2-106 (0.2, 0.1, 1)

SITE 442 HOLE A CORE 27 CORED INTERVAL: 247.0-256.5 m

TIME-ROCK UNIT	BIOSTRAT ZONE	FOSSIL CHARACTER FORAMS	NANNOS	RADS	SECTION	METERS
Middle Miocene	*Dorcadospyris alata* (R)				1	0.5 1.0
			B	CM	2	

GRAPHIC LITHOLOGY · DRILLING DISTURBANCE · SEDIMENTARY STRUCTURES · LITHOLOGIC SAMPLE



10YR 5/4

10YR 5/4
mottled with
10YR 4/2

LITHOLOGIC DESCRIPTION

Mud

Section 1 = drilling breccia. Moderate to intense disturbance in Section 2 (50-150) with yellow brown (10YR 5/4) mottled with dark grayish-brown (10YR 4/2). Pumice pebble noted in Section 2.

2, 90-92 cm: Rare foram casts

SMEARS:

2-135 Mud (dark color) (Minor)

Sand	10%	Quartz, Feldspar	3%
Silt	10%	Mica	TR
Clay	80%	Heavies	1%
		Clay minerals	84%
		Volcanic glass	1%
		Pyrite	7%
		Radiolarians	2%
		Sponge spicules	1%

2-140 Mud (light color)

(TR radiolarians, 1% sponge spicules, 5% volcanic glass)

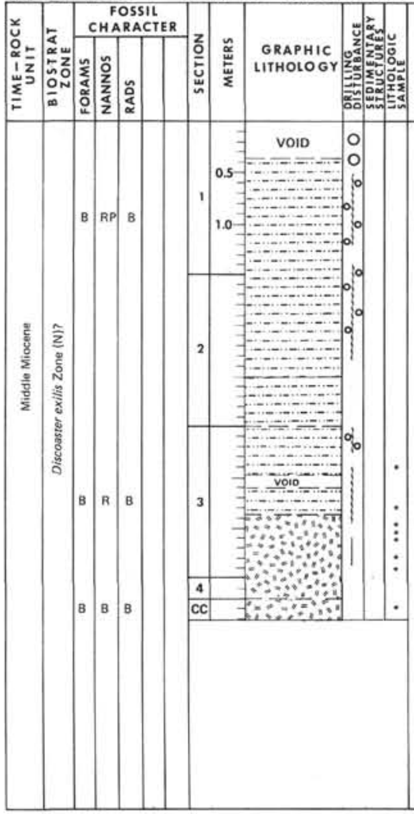
GRAIN SIZE:

2-103 (3.6, 47.0, 49.4)

CARBON-CARBONATE:

2-107 (0.1, 0.1, 0)

SITE 442 HOLE A CORE 28 CORED INTERVAL: 256.5-266.0 m



LITHOLOGIC DESCRIPTION

10YR 5/4

5G 5/1

5G 5/1

Mud
Section 1 to 100 cm is near total drilling breccia with irregular dark (pyrite) (10YR 4/1) zones, possible ash. Also occurs to 35 cm in Section 3.
Section 3:
35-45 cm – darkening from 10YR 5/4 to 10YR 4/1 = clay with pyrite; 60-85 cm – (10YR 5/4) clay; 85-105 cm – zone of color change from 10YR 5/4 to 5GY 4/1 including dark gray brown (10YR 4/2) and greenish-gray (5GY 6/1); 105-150 cm – dark greenish-gray with grayish-green (5G 4/2) band (2 cm) at 135 cm.
1, 37-39 cm: very rare foram casts

SMEARS:
3-45 Mud
(5% pyrite)

3-80 Mud
(91% clay minerals, 2% volcanic glass)

3-102 Mud
(30% volcanic glass)

3-103 Volcanic Ash
(40% clay minerals)

3-110 Volcanic Ash
(39% clay minerals)

3-135 Volcanic Ash
(37% clay minerals)

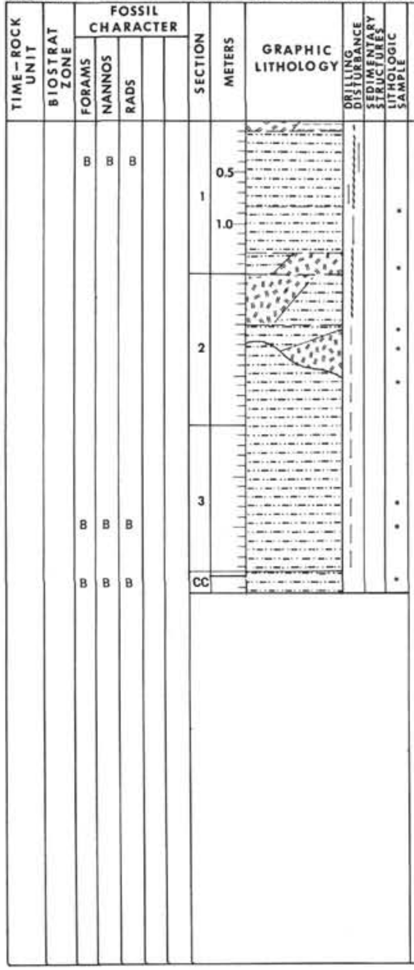
3-145 Volcanic Ash
(50% clay minerals)

CC Volcanic Ash
(32% clay minerals)

GRAIN SIZE:
2-28 (0.5, 47.8, 51.7)
3-129 (7.5, 73.8, 18.7)

CARBON-CARBONATE:
2-49 (0.1, 0.1, 0)

SITE 442 HOLE A CORE 29 CORED INTERVAL: 266.0-275.5 m



LITHOLOGIC DESCRIPTION

10YR 5/4

5Y 7/1

2.5Y 4/4

2.5Y 4/4

Mud
Section 1 – 0-10 cm - interbedded ash/clay as continued from Core 28; 10-80 cm - yellowish-brown (10YR 5/4) clay; firm, moderately disturbed with black specking; 80-130 cm clay with black specking/streaking; organics(?); 130-150 cm - light gray ash.

Section 2 – 0-50 cm - with interbedded ash (2.5Y 6/2 = light brownish-gray) and clay (10YR 5/4); 50-80 cm - light yellowish-brown (2.5Y 6/4) grades to dark gray brown (2.5Y 4/2) ash; 80-150 cm clay (10YR 5/4) grading downward to olive brown clay (2.5Y 4/4).

Section 3 – olive brown (2.5Y 4/4) firm with pumice fragments, mottled = burrows?

SMEARS:
1-90 Clay

Sand	< 2%	Quartz, Feldspar	2%
Silt	>40%	Heavies	1%
Clay	>50%	Clay minerals	90%
		Volcanic glass	4%
		Opaques	1%
		Radiolarians, Sponge spicules	1%

1-145 Clayey/Silty Volcanic Ash
(60% volcanic glass, 39% clay minerals, 1% quartz)

2-59 Volcanic Sand
(75% volcanic glass)

2-68 Micaceous Volcanic Sand
(12% biotite, 58% volcanic glass)

2-110 Mud
(96% clay minerals, 2% quartz, feldspar)

3-80 Pyrite-bearing Clay

3-100 Clay
(88% clay, 5% volcanic glass)

CC Clay
(92% clay, 2% volcanic glass, 3% pyrite with pumice)

GRAIN SIZE:
2-104 (1.2, 48.1, 50.7)

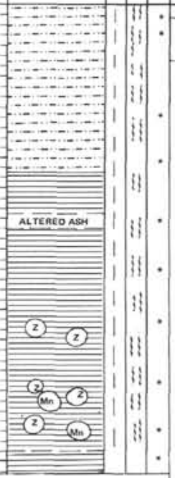
CARBON-CARBONATE:
2-103 (0.1, 0.0, 0)

CARBONATE BOMB:
3-4 (6)
3-137 (6)

SITE 442 HOLE A CORE 30 CORED INTERVAL: 275.5-285.0 m

TIME-ROCK UNIT	BIOSTRAT ZONE	FOSSIL CHARACTER FORAMS	FOSSIL CHARACTER NANNOS	FOSSIL CHARACTER RADS	SECTION	METERS
		B	B	B	1	0.5 1.0
					2	
		B	R		3	
		B	B	B	CC	

GRAPHIC LITHOLOGY / DRILLING DISTURBANCE / SEDIMENTARY STRUCTURES / LITHOLOGIC SAMPLE



10YR 5/4-10YR 4/2
10YR 3/4
7.5YR 5/6
10YR 3/4
5YR 8/3
10YR 3/4
10YR 3/4

LITHOLOGIC DESCRIPTION

Mud to Clay

Section 1 –
0-16 cm – contains yellowish-brown (10YR 5/4) silty clay with dark yellowish-brown (10YR 4/2) clay. Mottled appearance due to disturbance but also with burrows. Grades downward into dark yellow brown clay (pelagic?) (10YR 3/4). Contact relatively sharp at 65 cm.
16-55 cm – dark yellow brown (10YR 3/4) clay with extensive burrows, sharp contact at 55 cm.
55-65 cm – yellow brown (10YR 5/4) clay grades irregularly downward to dark yellow brown (10YR 3/4) clay. Relatively sharp contact.
65-102 cm – dark yellow brown with extensive burrows.
102-119 cm – yellowish-brown (10YR 5/6) clay grading down to mottled mixture of yellowish-brown and dark yellowish-brown clay (10YR 3/4) with burrows to 150 cm.
Section 2 –
Clay, strong brown (7.5YR 5/6) mottled, brecciated with sharp contact at 13 cm to dark yellow brown (10YR 3/4) clay, mottled, burrowed with manganese.
53-70 cm – pink (5YR 8/3) pink clay with sharp contact at 70 cm to dark yellow brown burrowed clay to 150 cm.
Section 3 –
Dark yellow brown (10YR 3/4) clay, burrows, (Mn)
CC –
Dark yellow brown with pink = clay.

SMEARS:
1-15 Clay (10YR 4/2)

Sand	1%	Feldspar	2%
Silt	5%	Augite	1%
Clay	94%	Clay minerals	94%
		Volcanic glass	1%
		Opaques	1%
		Sponge spicules	1%

1-30 Clay (10YR 3/4)
(93% clay minerals, 2% opaques)

2-3 Clay
(94% clay, 2% opaques)

2-62 Clay
(98% clay)

2-111 Clay
(91% clay, 7% opaques [Mn])

3-15 Zeolitic Clay (25% zeolites)
3-75 Zeolitic Clay (20% zeolites)
3-123 Zeolitic Clay (with Mn)

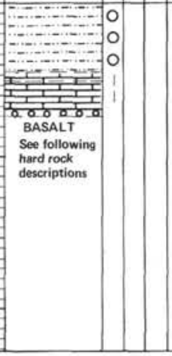
GRAIN SIZE:
2-26 (24, 22.4, 75.2)

CARBON-CARBONATE:
2-33 (0.0, 0.0, 0)

SITE 442 HOLE A CORE 31 CORED INTERVAL: 285.0-290.0 m

TIME-ROCK UNIT	BIOSTRAT ZONE	FOSSIL CHARACTER FORAMS	FOSSIL CHARACTER NANNOS	FOSSIL CHARACTER RADS	SECTION	METERS
Lower or middle Miocene	*Helicosphaera ampliaperta* Zone (N) or *Sphenolithus heteromorphos* Zone (N)	B	RP	B	1	0.5 1.0
					2	

GRAPHIC LITHOLOGY / DRILLING DISTURBANCE / SEDIMENTARY STRUCTURES / LITHOLOGIC SAMPLE



See following hard rock descriptions

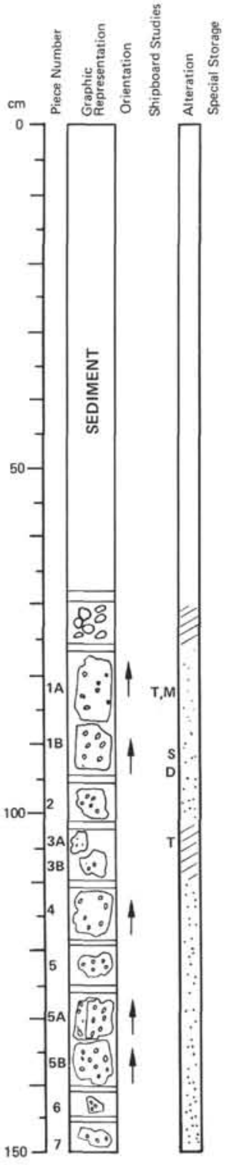
LITHOLOGIC DESCRIPTION

Section 1 –
0-65 cm – drilling breccia of light olive gray (5Y 6/2) vitric zeolitic mudstone (85% clay, 12-15% volcanic glass); dark reddish brown (5YR 3/4) silty clay (with 3-5% volcanic glass, 7% opaques); pale brown (10YR 6/3) silty clay; dark reddish brown (5YR 2/2) mud.
65-76 cm – Very hard pinkish-gray (7.5YR 2/2) dense fine limestone with Mn specks.
76-81 cm – Limestone.
81-101 cm – Limestone.
101-107 cm – Weathered basalt, limestone and dark reddish brown (5YR 3/2) mud fragments.

Basalt at 107 cm.

GRAIN SIZE:
1-22 (0.5, 26.1, 73.3)

CARBONATE BOMB:
1-10 (6)
1-30 (86.7)



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG		SITE			HOLE	CORE		SECT.
5	8	4	4	2	A	3	1	1

Depth 286.0 to 286.5 m

Visual Description

35-70 cm: lithified calcareous ooze.

70-75 cm: lightly weathered aphyric basalt pebbles.

77-150 cm: *lightly weathered to moderately weathered aphyric basalt (no phenocrysts),* 40% fine vesicles (<1 mm), 2% medium vesicles (>1 mm) graded.

127-134 cm: alteration vein exposed on fracture surface at back of piece – mainly zeolites with some calcite, 1/2 to 1 mm thick.

Thin Section Description – 90-92 cm

Groundmass: plagioclase 25%, 1/4 to 1 1/2 mm, An_{73}, lathes (Carlsbad twin); clinopyroxene 15%, 0.1 to 0.3 mm, augite, anhedral; magnetite 1%, 0.01 to 0.03 mm; other cryptocrystalline 24%.

Vesicles: 25%, 0.1 to 1.0 mm, round to irregular.

Texture: intersertal.

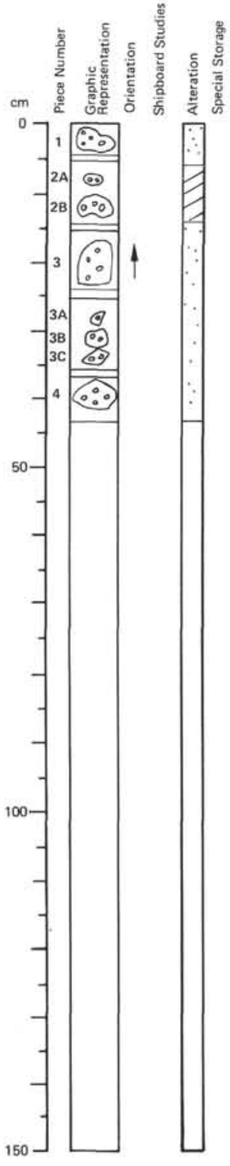
Alteration: 10% clays intergranular replacing groundmass.

Shipboard Data

Bulk Analysis:	**85 cm**
SiO_2	49.79
Al_2O_3	15.49
Fe_2O_3	1.14
FeO	7.54
MgO	6.76
CaO	13.58
Na_2O	3.10
K_2O	0.31
TiO_2	1.27
P_2O_5	0.16
MnO	0.14
LOI	—
H_2O^+	—
H_2O^-	—
CO_2	—
Cr	220
Ni	45
Sr	188
Zr	84

Magnetic Data:	**90 cm**
Intensity (emu/cc)	118.1
Inclination before demag.	35.3
Stable Inclination	35.8

Physical Properties:	**89 cm**
$\overline{V}p$ (km/s)	4.54
Porosity (%)	21.13
Wet Bulk Density	2.52
Grain Density	2.92



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

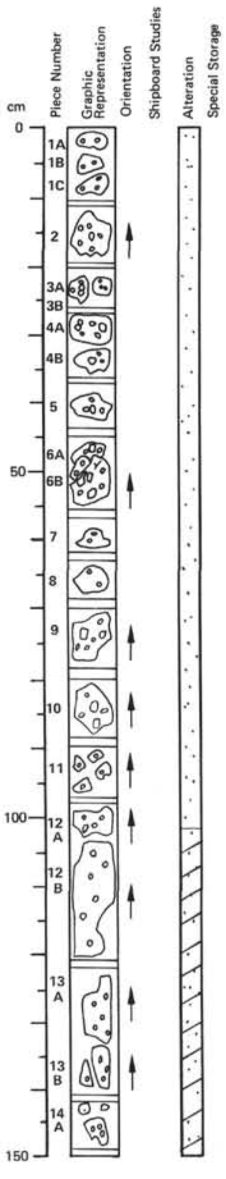
LEG		SITE			HOLE	CORE		SECT.
5	8	4	4	2	A	3	1	2

Depth 286.5 to 286.9 m

Visual Description

0-41 cm: aphyric basalt, gray to dark gray; vesicular. Fine vesicles (40%); <1 mm; medium vesicles (2%); >1 up to 4 mm.

7-14 cm: moderately altered basalt.



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

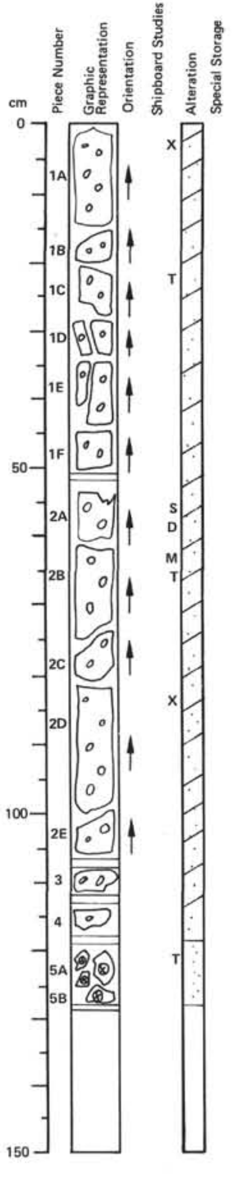
LEG	SITE	HOLE	CORE	SECT.
5 8	4 4 2	A	3 2	1

Depth 290.0 to 291.5 m

Visual Description

0-150 cm: aphyric basalt; dark gray; vesicular; slightly altered. Fine vesicles 40% (<1 mm); medium vesicles ~2% (>1 mm and partly up to 5-7 mm).

98-150 cm: vesicles (~50%) contain some secondary minerals.



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
5 8	4 4 2	A	3 2	2

Depth 291.5 to 292.8 m

Visual Description

0-128 cm: aphyric basalt; dark gray, vesicular, lightly altered. Fine vesicles 40% (<1 mm); medium vesicles (>1 mm) occur in the 0-51 cm interval - 2%, 50% of the vesicles contain secondary minerals.

98-128 cm: vesicles are 20-30%.

128-138 cm: variolitic basalt gray to dark gray; varioles are an aggregate of plagioclase (30-40%) up to 20 mm in an aphanitic groundmass.

Thin Section Description – 62 cm

Groundmass: plagioclase 30%, 0.6 x 0.1 mm, An_{54}, subhedral; clinopyroxene 7%, 0.4 x 0.2 mm, augite, anhedral; glass 30%, interstitial.

Vesicles: 30%, 0.1-2.0 mm, round irregular.

Texture: intergranular-intersertal.

Alteration: 3% carbonate in vesicles.

Thin Section Description – 126 cm

Groundmass: plagioclase 10%, 0.1-2 mm, An_{62}, euhedral, skeletal, light zonation; glass+py+pe+mt 50%, microlite (half crystalline).

Vesicles: 40%, 0.05-1.5 mm, round irregular, unfilled.

Texture: variolitic - intersertal.

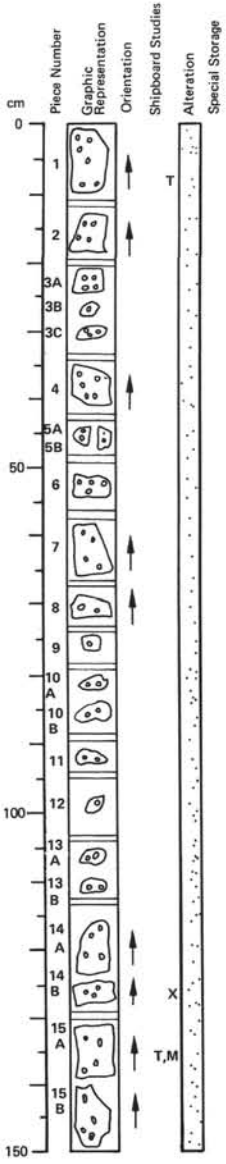
Shipboard Data

Bulk Analysis:	**0 cm**	**80 cm**
SiO_2	48.80	49.60
Al_2O_3	14.82	15.17
Fe_2O_3	1.12	1.03
FeO	7.39	6.80
MgO	5.64	7.72
CaO	15.37	13.93
Na_2O	3.07	3.20
K_2O	0.47	0.30
TiO_2	1.15	1.19
P_2O_5	0.14	0.12
MnO	0.15	0.11
LOI	—	—
H_2O^+	—	—
H_2O^-	—	—
CO_2	—	—
Cr	234	240
Ni	57	130
Sr	183	182
Zr	86	86

Magnetic Data:	**62 cm**
Intensity (emu/cc)	104.2
Inclination before demag.	26.2

Physical Properties:	**54 cm**
$\bar{V}p$ (km/s)	4.05
Porosity (%)	23.60
Wet Bulk Density	2.50
Grain Density	2.97

Other Data:	**81 cm**
Therm. cond. (mcal/cm-s-° C)	3.73



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
58	442	A	33	1

Depth 294.5 to 296.0 m

Visual Description

0-10 cm: light gray aphyric basalt 40% vesicles (<1 mm), 5% vesicles (>1 mm) calcite infilling of larger vesicles

10-150 cm: light gray aphyric basalt 30% vesicles (<1 mm), up to 5% vesicles (>1 mm) occasional calcite infilling of larger vesicles. Largest vesicles are approximately 2 to 3 mm across.

Alteration - light.

Thin Section Description – 9 cm

Groundmass: plagioclase 25%, 0.5-1.0 mm, An_{59}, laths; clinopyroxene 20%, 0.05-0.2 mm, anhedral; magnetite 3%; other 25%, cryptocrystalline matrix.

Vesicles: 25%, 0.1-1.0 mm.

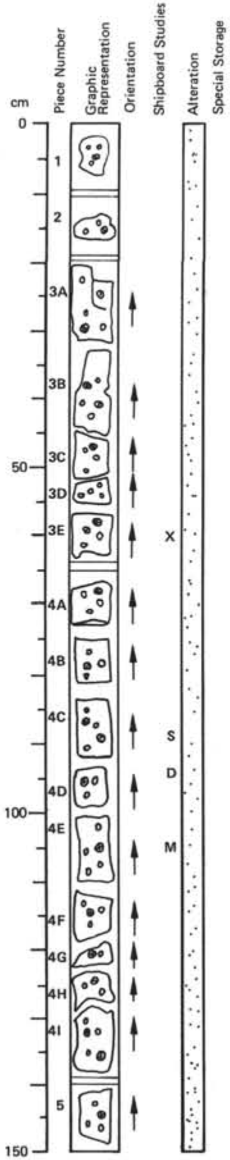
Texture: intersertal.

Alteration: 1% carbonate in vesicles; 1% clays in vesicles.

Shipboard Data

Bulk Analysis:	**124 cm**
SiO_2	47.97
Al_2O_3	14.16
Fe_2O_3	1.08
FeO	7.16
MgO	6.80
CaO	16.93
Na_2O	2.75
K_2O	0.29
TiO_2	1.11
P_2O_5	0.14
MnO	0.13
LOI	—
H_2O^+	—
H_2O^-	—
CO_2	—
Cr	216
Ni	53
Sr	186
Zr	82

Magnetic Data:	**136 cm**
Intensity (emu/cc)	346.5
Inclination before demag.	33.3
Stable Inclination	36.1



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
58	442	A	33	2

Depth 296.0 to 297.5 m

Visual Description

Light gray, vesicular, variolitic basalt. Vesicle approximately 30% (<1 mm) and 5% (>1 mm). Largest vesicles are up to 5 mm across. Infilling of vesicles by brown and light greenish-gray alteration products.

20-33 cm: (3A) - fracture with weathered surfaces.

129-137 cm: (4I) - at 132 cm large vesicle occurs with well-developed crystals of calcite(?).

Thin Section Description – 102 cm

Groundmass: plagioclase 35%, 0.1-3.0 mm, An_{60}, laths; clinopyroxene 25%, 0.1-0.5 mm, anhedral; magnetite 4%, 0.05-0.1 mm, granular; other 20%, cryptocrystalline matrix.

Vesicles: 15%, 0.3-1.0 mm.

Texture: intersertal.

Alteration: 1% clays lining vesicles.

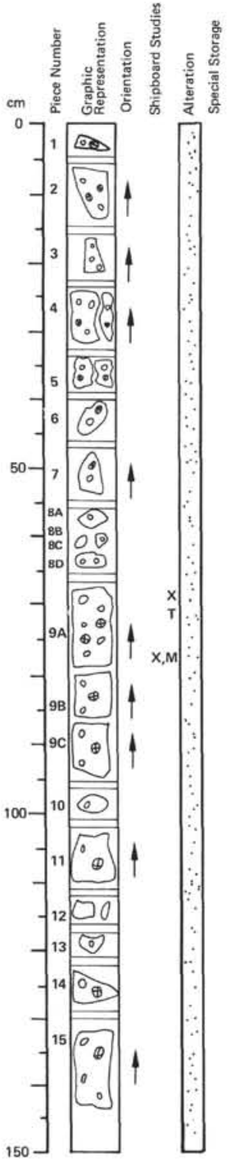
Shipboard Data

Bulk Analysis:	**57 cm**
SiO_2	50.17
Al_2O_3	15.02
Fe_2O_3	1.22
FeO	8.08
MgO	7.36
CaO	11.54
Na_2O	3.18
K_2O	0.44
TiO_2	1.25
P_2O_5	0.13
MnO	0.13
LOI	—
H_2O^+	—
H_2O^-	—
CO_2	—
Cr	233
Ni	49
Sr	189
Zr	86

Magnetic Data:	**101 cm**
Intensity (emu/cc)	109.6
Inclination before demag.	33.4
Stable Inclination	31.9

Physical Properties:	**97 cm**
$\overline{V}p$ (km/s)	4.66
Porosity (%)	16.28
Wet Bulk Density	2.60
Grain Density	2.91

Other Data:	**22 cm**
Therm. cond. (mcal/cm-s-°C)	3.34



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
58	442	A	33	3

Depth 297.5 to 299.0 m

Visual Description

Light gray, vesicular, variolitic basalt. Vesicles approximately 20% to 30% (<1 mm) and 2% to 10% (>1 mm). Largest approximately 3 mm across. Some infilling of vesicles by brown alteration products.

24-32 cm: (4) - pieces split by heavily weathered fracture.

66-79 cm: (9a) - two distinct vesicle-rich zones at 66-68 cm and 71-73 cm.

130-141 cm: (15) - fracture at lower end with weathered surfaces.

Thin Section Description – 80 cm

Groundmass: plagioclase 30%, 0.1-1.0 mm, An_{59}, laths; clinopyroxene 20%, 0.1-0.5 mm, anhedral; magnetite 3%, <0.02 mm, granular; other 20%, cryptocrystalline matrix.

Vesicles: 25%, 0.05-1.0 mm.

Texture: intersertal.

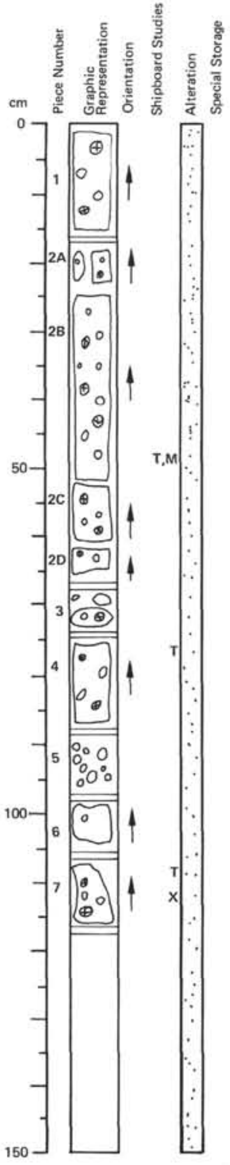
Alteration: 1% carbonate filling vesicles; 1% clays lining vesicles.

Shipboard Data

Bulk Analysis:	**68 cm**
SiO_2	50.04
Al_2O_3	14.93
Fe_2O_3	1.18
FeO	7.80
MgO	8.31
CaO	11.68
Na_2O	3.25
K_2O	0.38
TiO_2	1.24
P_2O_5	0.12
MnO	0.12
LOI	—
H_2O^+	—
H_2O^-	—
CO_2	—
Cr	245
Ni	77
Sr	182
Zr	89

Magnetic Data:	**79 cm**
Intensity (emu/cc)	134.0
Inclination before demag.	31.4
Stable Inclination	34.6

Other Data:	**72 cm**	**78 cm**
Therm. cond. (mcal/cm-s-°C)	3.33	3.16



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
58	442	A	33	4

Depth 299.0 to 300.2 m

Visual Description

Light gray, vesicular, variolitic basalt. Vesicles approximately 20% to 30% (<1 mm) and 2% (>1 mm). Some vesicles infilled by calcite. Alteration internally to olive green products (approximately 20%).

0-15 cm: (1) - 2 large vesicles at the base of this piece (14-15 cm) are lined by crystals of calcite and yellow brown palagonite(?).

24-52 cm: (2B) - large inclusion approximately 4 cm across at top (25-26 cm).

89-97 cm: (5) - drilling breccia.

Thin Section Description – 53 cm

Groundmass: plagioclase 30%, 0.2-1.0 mm, An_{69}, laths; clinopyroxene 20%, 0.1-1.0 mm, anhedral; magnetite 2%, 0.02-0.1 mm, granular; other 25%, cryptocrystalline matrix.

Vesicles: 19%, 0.1-1.0 mm, anhedral.

Texture: intersertal.

Alteration: 2% carbonate infilling vesicles; 2% clays lining vesicles.

Thin Section Description – 109 cm

Groundmass: plagioclase 25%, 0.3-1.0 mm, An_{60}, laths, some in spherulitic groups; clinopyroxene 15%, 0.01-1.0 mm, anhedral, often fine-grained, not acicular; magnetite 2%, 0.01-0.2 mm, granules; other 8%, cryptocrystalline matrix.

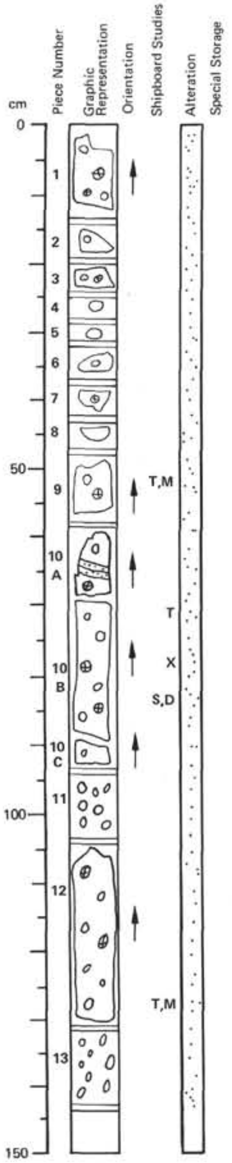
Vesicles: 50%, 0.05-2.0 mm.

Texture: intersertal.

Shipboard Data

Bulk Analysis:	**111 cm**
SiO_2	50.09
Al_2O_3	13.90
Fe_2O_3	1.26
FeO	8.32
MgO	7.39
CaO	11.81
Na_2O	3.27
K_2O	0.60
TiO_2	1.23
P_2O_5	0.12
MnO	0.13
LOI	—
H_2O^+	—
H_2O^-	—
CO_2	—
Cr	214
Ni	35
Sr	178
Zr	88

Magnetic Data:	**52 cm**
Intensity (emu/cc)	124.0
Inclination before demag.	29.0
Stable Inclination	30.0



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
58	442	A	34	1

Depth 304.0 to 305.4 m

Visual Description

Light gray, vesicular, variolitic basalt. Vesicles approximately 10% to 30% <1 mm and occasionally >1 mm.

59-69 cm: (10A) - fracture with weathered zone on either side (mainly palagonite).

93-103 cm: (11) - drilling breccia.

131-141 cm: (13) - drilling breccia.

Thin Section Description – 52 cm

Groundmass: plagioclase 5%, 0.05-1.0 mm, An_{56}, acicular; other 55%, cryptocrystalline matrix.

Vesicles: 40%, 0.02-3.0 mm.

Texture: variolitic.

Thin Section Description – 126 cm

Groundmass: plagioclase 21%, 0.05-1.5 mm, An_{67}, laths; clinopyroxene 21%, 0.05-0.5 mm, anhedral; magnetite 2%, 0.01-0.1 mm, granular; other 21%, cryptocrystalline matrix.

Vesicles: 30%, 0.1-2.0 mm.

Texture: intersertal.

Alteration: 1% carbonate infilling vesicles; 4% clays lining vesicles.

Shipboard Data

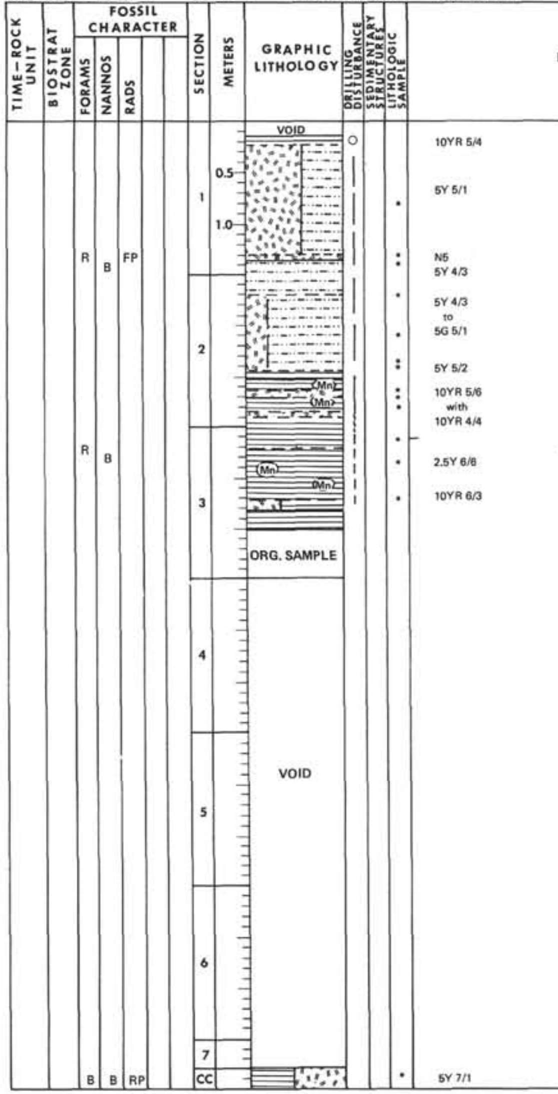
Bulk Analysis:	**78 cm**
SiO_2	49.96
Al_2O_3	15.44
Fe_2O_3	1.14
FeO	7.52
MgO	8.12
CaO	12.46
Na_2O	3.13
K_2O	0.28
TiO_2	1.17
P_2O_5	0.12
MnO	0.12
LOI	---
H_2O^+	---
H_2O^-	---
CO_2	---
Cr	245
Ni	64
Sr	186
Zr	87

Magnetic Data:	**51 cm**	**125 cm**
Intensity (emu/cc)	424.7	300.6
Inclination before demag.	41.4	44.2
Stable Inclination	41.9	42.6

Physical Properties:	**73 cm**
$\overline{V}p$ (km/s)	3.98
Porosity (%)	24.78
Wet Bulk Density	2.43
Grain Density	2.91

Other Data:	**73 cm**
Therm cond. (mcal/cm-s-°C)	3.02

SITE 442 HOLE B CORE 1 CORED INTERVAL: 267.5-277.0 m



LITHOLOGIC DESCRIPTION

Clay and Ash

Section 1:
15-21 cm: soft, brecciated, light yellowish-brown (10YR 5/4) clay.
21-132 cm: gray (5Y 5/1), massive, soft sticky clayey ash.
132-135 cm: gray (N5), ash bed (volcanic sand), with mixture of yellow brown (10YR 5/4) clay; sharp boundary to clay below from 135-144 cm.

Section 2:
0-95 cm: olive (5Y 4/3), grading down to greenish-gray (5G 5/1), firm stiff clay, and vitric mud.
95-98 cm: olive gray (5Y 5/2) clay with zeolite, radiolarians.
98-150 cm: yellowish-brown (10YR 5/6) clay with bands of dark yellow brown (10YR 4/4) ash. Scattered (Mn) micronodules; firm, stiff.

Section 3:
0-16 cm: 10YR 5/4 clay with Mn streaking; pumice pebbles, ash zones.
16-75 cm: olive yellow (1.5Y 6/6), firm stiff clay, (Mn) micronodules.
75-80 cm: pale brown (10YR 6/3) ashy clay.
CC: light gray (5Y 7/1) clayey ash.
1, 134-136 cm: very rare replaced foram casts

SMEARS:

1-89 Clayey Ash
(30% clay minerals, 68% volcanic glass)

1-133 Volcanic Sand
(84% volcanic glass, 10% clay minerals)

1-144 Clay
(92% clay minerals, 2% quartz, feldspar)

2-23 Clay
(88% clay minerals,5-7% Mn, 3-5% quartz, feldspar)

2-66 Vitric Mud
(72% clay minerals, 15% volcanic glass, 10% quartz, feldspar)

2-89 Clay
(90% clay minerals, 7% quartz, feldspar)

2-96 Clay
(3-5% radiolarians, 1-2% zeolites)

2-112 Ash
(50% volcanic glass, 45% clay minerals)

2-123 Clay and 2-136 Ash
(5% zeolites)

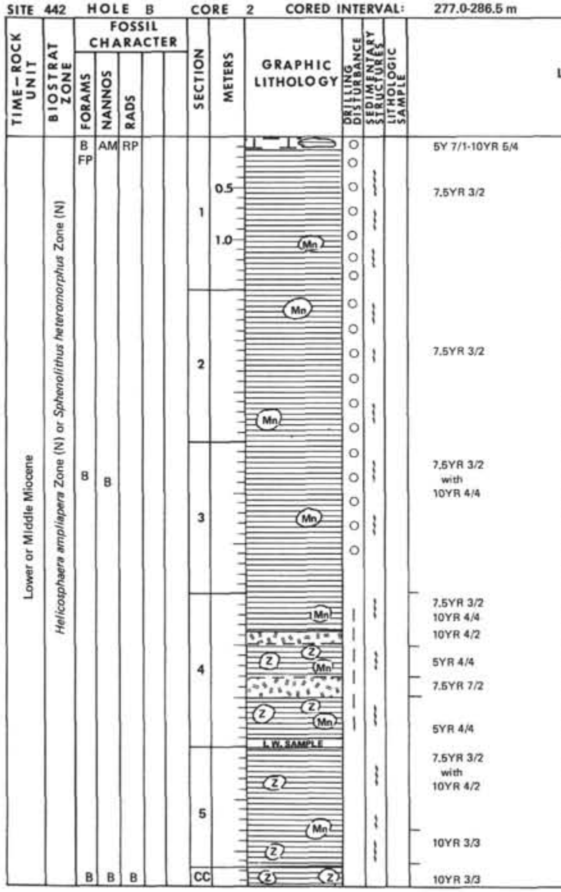
3-16 Clay, 3-40 Clay Minerals, and 3-76 Clay with Ash

CC Clayey Volcanic Ash

GRAIN SIZE:
2-73 (2.4, 72.2, 25.4)

CARBON-CARBONATE
2-64 (0.1, 0.1, 0)

SITE 442 HOLE B CORE 2 CORED INTERVAL: 277.0-286.5 m



LITHOLOGIC DESCRIPTION

Clays, Zeolitic Clays, Altered Ash

Section 1:
0-13 cm: brecciated light gray (5Y 7/1) clay with yellowish brown (10YR 5/4) nannofossil-bearing clay.
13-150 cm: dark brown (7.5YR 3/2) brecciated, stiff, hard clay; extensive bioturbation, (Mn) micronodules/ streaking; Mn nodule (2-3 cm) at 55-57 cm.

Section 2:
0-150 cm: stiff, hard, dark brown (7.5YR 3/2) clay; extensive bioturbation (35-68 cm), micronodules, (Mn) streaking.

Section 3:
0-100 cm: dark brown (7.5YR 3/2) with dark yellowish-brown (10YR 4/4) clay; moderate to intense brecciation; extensive bioturbation (11-30, 73-100 cm), Mn micronodules, streaking.

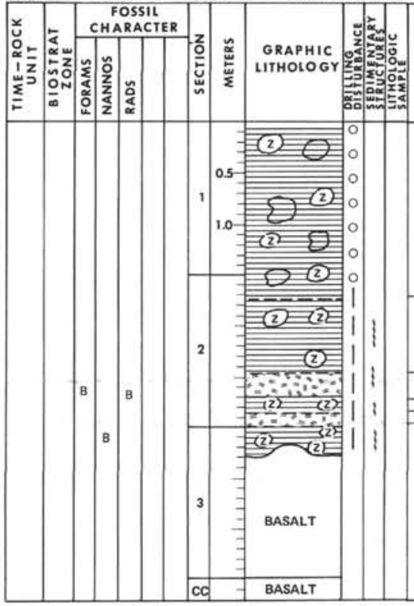
Section 4:
0-33 cm: dark brown (7.5YR 3/2), yellow brown (10YR 4/4) clay, mottled by bioturbation; Mn micronodules – grades to pinkish-gray (7.5YR 7/2) at 25-33 cm.
33-38 cm: dark grayish-brown (10YR 4/2) sandy appearing volcanic ash.
38-41 cm: yellow brown (10YR 4/4) clay with sharp contact to unit below.
41-79 cm: dark brown (5YR 4/4) hard stiff zeolite clay with vague boundary to below into pinkish-gray (7.5YR 7/2).
79-109 cm: pinkish gray (7.5YR 7/2) and reddish-yellow (7.5YR 7/6) altered ash.
109-140 cm: stiff, hard, dark brown (5YR 4/4) zeolitic clay; extensive bioturbation, Mn micronodules, streaking.

Section 5:
0-115 cm: hard stiff zeolitic clay with bioturbation; mixture of dark brown (7.5YR 3/2) and dark grayish-brown (10YR 4/2) zeolite clay. Mn micronodule-streaking and concentrated in layers; gradation into dark brown (10YR 3/3) with less bioturbation.

GRAIN SIZE:
2-38 (2.4, 44.6, 53.0)

CARBON-CARBONATE:
2-60 (0.1, 0.1, 0)

SITE 442 HOLE B CORE 3 CORED INTERVAL: 286.5-296.0 m



LITHOLOGIC DESCRIPTION

7.5YR 3/2

2.5Y 6/4

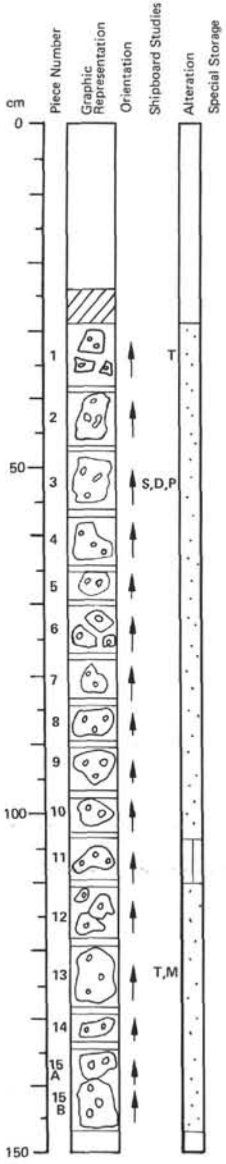
N7

Zeolitic Clay, Claystone, Basalt

Section 1:
Drillling breccia of claystone fragments (average 2 cm, up to 6 cm), rounded in a zeolite clay matrix; dark brown (7.5YR 3/2). Claystone may be altered ash, Mn staining.

Section 2:
0-13 cm: continuation of Section 1;
13-99 cm: dark brown (7.5Y 3/2) zeolite clay with extensive bioturbation, Mn streaking and micronodules.
99-108 cm: light yellowish-brown (2.5Y 6/4) altered ash clay. Upper boundary is bioturbated.
108-150 cm: dark brown (7.5 YR 3/2) zeolite clay; extensive bioturbation and Mn streaking with micronodules.

Section 3:
0-5 cm: dark brown (7.5YR 3/2) brecciated zeolite clay with burrowed boundary.
5-6 cm: pale yellow (2.5Y 7/4)-altered ash.
6-11 cm: dark brown (7.5YR 3/2) zeolite clay, burrowing; Mn streaks; burrowed lower boundary.
11-20 cm: light yellowish-brown (2.5Y 6/4) altered ash; with evidenceof distinct layering.
11-13 cm: light yellowish-brown
13-14 cm: gray brown
14-18 cm: light yellow with pink
18-20 cm: light yellow
20-21 cm: dark brown



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
58	442	B	3	3

Depth: 289.5 to 291.0 m

Visual Description

0-23 cm: sedimentary rocks.

29-147 cm: basalt, aphyric, dark gray, vesicular, lightly altered. Vesicles about 30% (1 mm and less).

The 40-49 cm interval contains more vesicles (1 mm [up to 5-10 mm] - 1%).

103-109 cm: heavily altered basalt.

The 29-38 cm interval probably represents a cooling zone.

Thin Section Description – 115 cm

Groundmass: plagioclase = 30%, 0.1-3.0 mm, An_{65}, subhedral; clinopyroxene = 18%, 0.1-0.5 mm, euhedral; glass = 20%.

Vesicles: 30%, 0.05-0.1 mm, round irregular.

Texture: intergranular-intersertal.

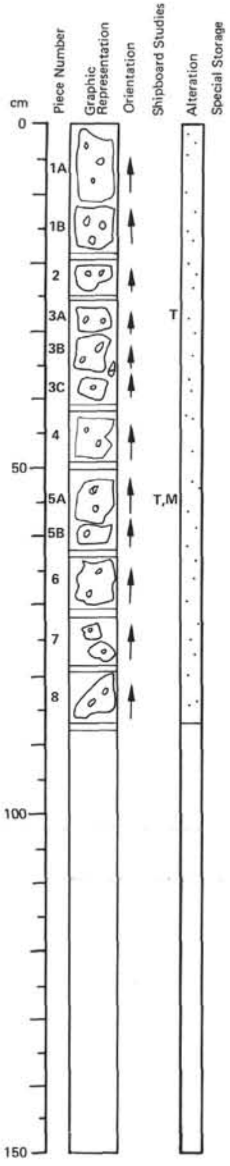
Alteration: 1% carbonate in vesicles, 1% clays in vesicles.

Shipboard Data

Bulk Analysis:	**40 cm**	**140 cm**
SiO_2	50.66	50.23
Al_2O_3	15.05	16.03
Fe_2O_3	1.19	1.18
FeO	7.85	7.76
MgO	6.68	7.51
CaO	12.24	12.54
Na_2O	3.12	3.17
K_2O	0.42	0.34
TiO_2	1.40	1.26
P_2O_5	0.16	0.13
MnO	0.17	0.13
LOI	—	—
H_2O^+	—	—
H_2O^-	—	—
CO_2	—	—
Cr	193.00	247.00
Ni	44.00	57.00
Sr	192.00	186.00
Zr	98.00	89.00

Magnetic Data:	**118 cm**
Intensity (emu/cc)	537.7
Inclination before demag.	27.7

Physical Properties:	**49 cm**
$\bar{V}p$ (km/s)	3.95
Porosity (%)	29.50
Wet Bulk Density	2.37
Grain Density	2.94



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
58	442	B	3	4

Depth 291.0 to 291.9 m

Visual Description

0-86 cm: basalt, aphyric, dark gray, vesicular, lightly altered. Vesicles (1 mm or less) about 30-40%.

26-35 cm: a few vesicles, but some have sizes up to 7-10 mm with yellow secondary minerals.

26-31 cm: probable chill zone.

Thin Section Description – 54 cm

Phenocrysts: plagioclase < 1%, 0.4-1.5 mm, euhedral.

Groundmass: plagioclase 30%, 0.05-1.0 mm, An_{60}, subhedral; clinopyroxene 20%, 0.05-0.1 mm, augite, anhedral; glass + mt 20%.

Vesicles: 25%, round irregular.

Texture: intersertal.

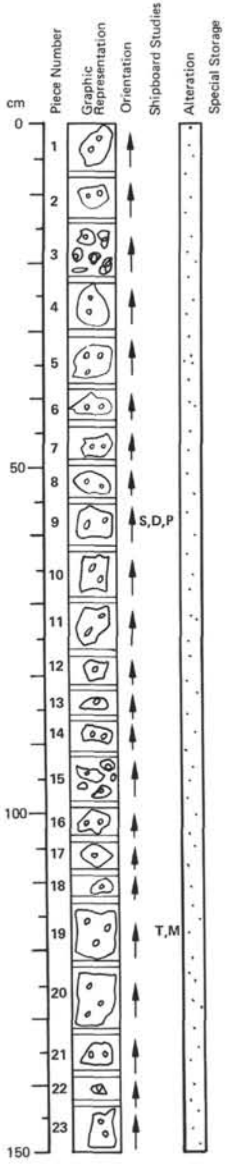
Alteration: 1% carbonate in vesicles and 1% clays in vesicles.

Shipboard Data

Bulk Analysis:	**13 cm**
SiO_2	50.33
Al_2O_3	15.06
Fe_2O_3	1.25
FeO	8.24
MgO	7.14
CaO	11.77
Na_2O	3.35
K_2O	0.39
TiO_2	1.30
P_2O_5	0.13
MnO	0.14
LOI	—
H_2O^+	—
H_2O^-	—
CO_2	—
Cr	221.00
Ni	52.00
Sr	180.00
Zr	96.00

Magnetic Data:	**54 cm**
Intensity (emu/cc)	301.1
Inclination before demag.	39.0

Other Data:	**0 cm**
Therm. cond. (mcal/cm-s-°C)	1.63



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG		SITE			HOLE	CORE			SECT.	
5	8	4	4	2	B			4		1

Depth: 296.0 to 297.5 m

Visual Description

0-150 cm: basalt - aphyric, gray to dark gray, vesicular, lightly altered. Vesicles (<1 mm) 40%; in some places. Vesicles are 1-5 mm, 1-2%, partly filled with calcite(?).

88-102 cm: chill zone.

Thin Section Description — 116 cm

Groundmass: plagioclase 30%, 0.1-0.5 mm, An_{60}, subhedral; clinopyroxene 20%, 0.03-0.1 mm, augite, anhedral; glass + mt 20%.

Vesicles: 28%, 0.01-0.1 mm

Texture: intersertal.

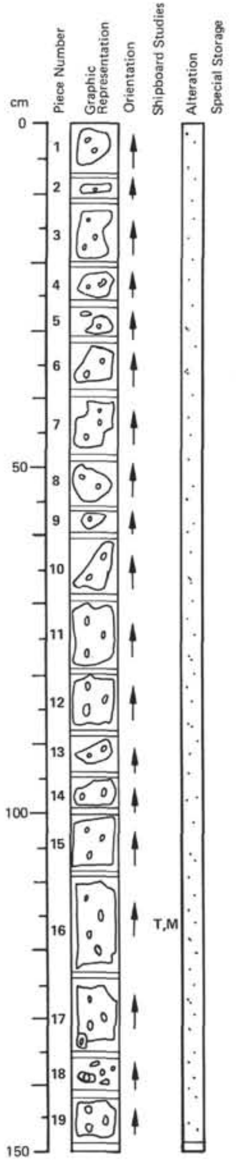
Alteration: 1% carbonate in vesicles.

Shipboard Data

Bulk Analysis:	**57 cm**
SiO_2	49.72
Al_2O_3	15.99
Fe_2O_3	1.16
FeO	7.66
MgO	6.57
CaO	12.93
Na_2O	3.32
K_2O	0.37
TiO_2	1.21
P_2O_5	0.15
MnO	0.15
LOI	—
H_2O^+	—
H_2O^-	—
CO_2	—
Cr	258.00
Ni	60.00
Sr	189.00
Zr	89.00

Magnetic Data:	**117 cm**
Intensity (emu/cc)	420.6
Inclination before demag.	50.8
Stable inclination	51.8

Physical Properties:	**57 cm**
$\overline{V}p$ (km/s)	4.15
Porosity (%)	27.29
Wet Bulk Density	2.40
Grain Density	2.93



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG		SITE			HOLE	CORE			SECT.	
5	8	4	4	2	B			4		2

Depth 297.5 to 299.0 m

Visual Description

0-149 cm: basalt-aphyric, dark gray, vesicular, lightly altered.

0-80 cm: vesicles (<1 m) 40%.

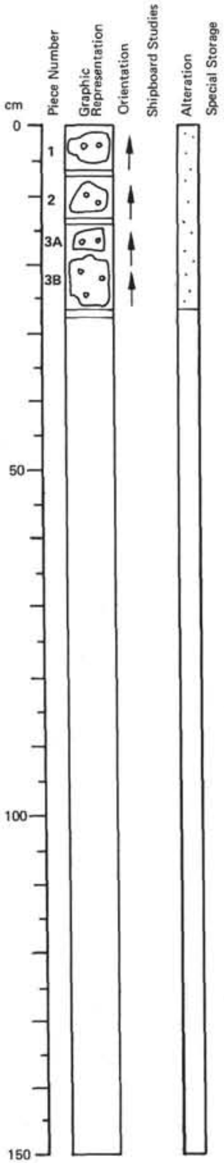
80-149 cm: vesicles 40%, including ones more than 1 mm across (15%). Vesicles partly contain a white mineral (calcite?).

Shipboard Data

Bulk Analysis:	**110 cm**
SiO_2	50.55
Al_2O_3	15.19
Fe_2O_3	1.16
FeO	7.69
MgO	7.25
CaO	12.07
Na_2O	3.49
K_2O	0.39
TiO_2	1.22
P_2O_5	0.12
MnO	0.11
LOI	—
H_2O^+	—
H_2O^-	—
CO_2	—
Cr	222.00
Ni	42.00
Sr	187.00
Zr	85.00

Magnetic Data:	**118 cm**
Intensity (emu/cc)	119.9
Inclination before demag.	32.0
Stable inclination	50.8

Other Data:	**109 cm**
Therm. cond. (mcal/cm-s-°C)	4.01



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG		SITE			HOLE	CORE			SECT.	
5	8	4	4	2	B			4		3

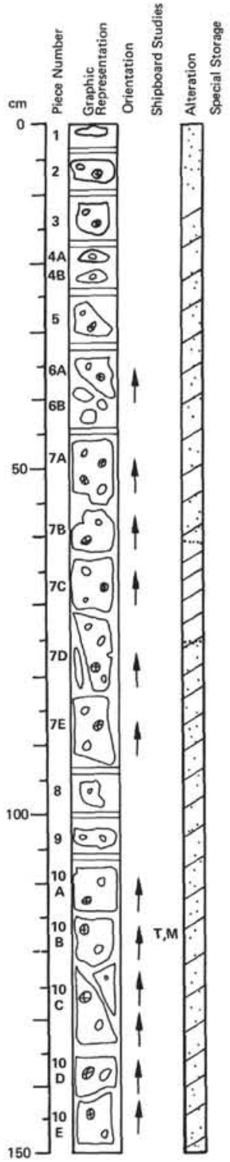
Depth: 299.0 to 299.9 m

Visual Description

0-27 cm: basalt-aphyric, dark gray, vesicular, lightly altered. Vesicles (1 mm and less) 40%.

Shipboard Data

Bulk Analysis:	**21 cm**
SiO_2	49.63
Al_2O_3	14.96
Fe_2O_3	1.18
FeO	7.82
MgO	7.52
CaO	12.52
Na_2O	3.79
K_2O	0.35
TiO_2	1.21
P_2O_5	0.12
MnO	0.13
LOI	—
H_2O^+	—
H_2O^-	—
CO_2	—
Cr	216.00
Ni	53.00
Sr	184.00
Zr	90.00



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG		SITE			HOLE	CORE			SECT.	
5	8	4	4	2	B			5		1

Depth 305.5 to 307.0 m

Visual Description

Light gray, vesicular, aphyric basalt. Green tinge increasing with weathering. Vesicles approximately 30 to 40% < 1 mm and 2 to 10% > 1 mm, some infilling by smectite (light olive green) and brown (stain?), clay, occasional calcite.

34-40 cm (6A): weathered surface on angled side, olive yellow alteration products.

64 cm (Top 7C): weathered surface, brown alteration products.

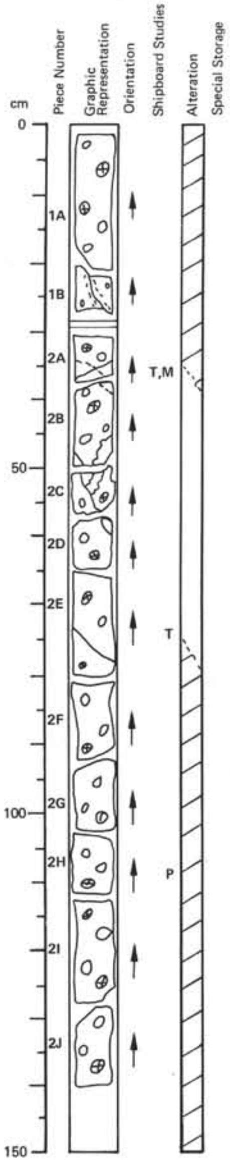
108 cm (Top 10A): yellow brown alteration products.

120-134 cm (10B through 10C): cross cutting fracture with weathered surfaces; light olive brown alteration products and calcite.

Shipboard Data

Bulk Analysis:	**120 cm**
SiO_2	50.27
Al_2O_3	15.25
Fe_2O_3	1.15
FeO	7.58
MgO	8.79
CaO	11.68
Na_2O	3.33
K_2O	0.30
TiO_2	1.31
P_2O_5	0.12
MnO	0.12
LOI	—
H_2O^+	—
H_2O^-	—
CO_2	—
Cr	222.00
Ni	84.00
Sr	188.00
Zr	89.00

Magnetic Data:	**116 cm**
Intensity (emu/cc)	224.0
Inclination before demag.	40.6
Stable inclination	41.0



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
58	442	B	5	2

Depth 307.0 to 308.4 m

Visual Description

0-37 cm: green-gray, weathered vesicular, aphyric basalt. Smectite and calcite infilling of vesicles. Fracture from 18-28 cm is lined by calcite and brown alteration zone. White calcite vein at 34-36 cm, cuts into lower fresh zone.

37-77 cm: gray, vesicular, variolitic basalt cut by white calcite veins. Some infilling of vesicles mainly by calcite.

77-140 cm: green-gray, weathered, vesicular variolitic basalt. Smectite and calcite infilling of vesicles. At 126-132 cm between 2I and 2J – fracture with weathered surface and 1-2 mm wide weathered zone.

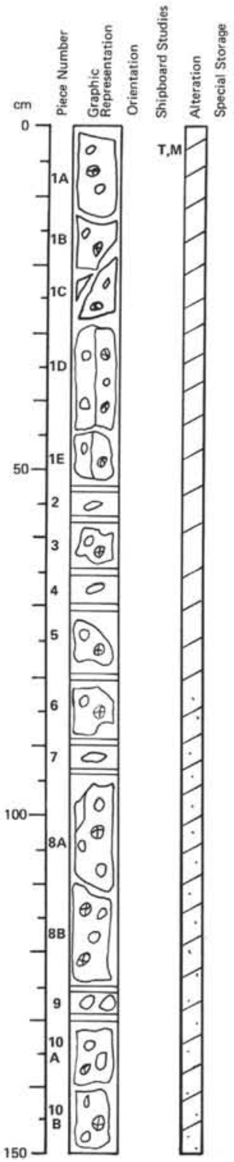
Sharp boundary between fresh and weathered basalt. Thin section at 75 cm and covers lower boundary. Vesicles throughout approximately 30-40% <1 mm and up to 5% >1 mm.

Shipboard Data

Bulk Analysis:	**1 cm**	**60 cm**	**106 cm**
SiO_2	50.10	50.65	50.01
Al_2O_3	15.04	15.06	14.92
Fe_2O_3	1.13	1.14	1.12
FeO	7.44	7.54	7.40
MgO	9.01	9.45	8.54
CaO	11.50	11.17	12.40
Na_2O	3.42	3.22	3.21
K_2O	0.29	0.26	0.40
TiO_2	1.26	1.28	1.18
P_2O_5	0.11	0.11	0.10
MnO	0.10	0.10	0.11
LOI	—	—	—
H_2O^+	—	—	—
H_2O^-	—	—	—
CO_2	—	—	—
Cr	237.00	232.00	244.00
Ni	103.00	157.00	80.00
Sr	183.00	179.00	178.00
Zr	91.00	91.00	84.00

Magnetic Data:	**1 cm**
Intensity (emu/cc)	186.8
Inclination before demag.	45.5
Stable inclination	46.5

Physical Properties:	**106 cm**	**109 cm**
$\overline{V}p$ (km/s)	4.16	—
Porosity (%)	—	25.69
Wet Bulk Density	—	2.40
Grain Density	—	2.89



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
58	442	B	5	3

Depth 308.4 to 309.9 m

Visual Description

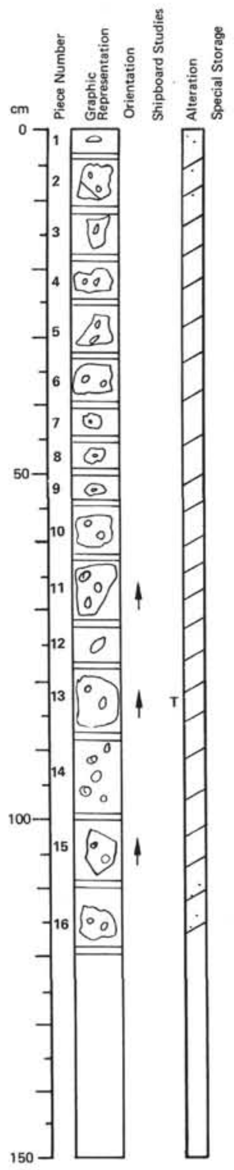
Green-gray, vesicular, aphyric basalt. Smectite and/or calcite lining of some vesicles. Vesicles approximately 30 to 40% <1 mm and approximately 2% >1 mm. Fracture in Pieces 1D through 1E (29-51 cm) along zone of vesicles. Brown weathered surface.

Shipboard Data

Bulk Analysis:	**94 cm**
SiO_2	49.77
Al_2O_3	14.48
Fe_2O_3	1.14
FeO	7.50
MgO	7.63
CaO	12.95
Na_2O	3.19
K_2O	0.37
TiO_2	1.20
P_2O_5	0.12
MnO	0.12
LOI	—
H_2O^+	—
H_2O^-	—
CO_2	—
Cr	226.00
Ni	74.00
Sr	179.00
Zr	90.00

Magnetic Data:	**37 cm**
Intensity (emu/cc)	386.7
Inclination before demag.	44.2

Other Data:	**96 cm**
Therm. cond. (mcal/cm-s-°C)	3.319



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG		SITE			HOLE	CORE			SECT.	
5	8	4	4	2	B			5		4

Depth: 309.9 to 311.1 m

Visual Description

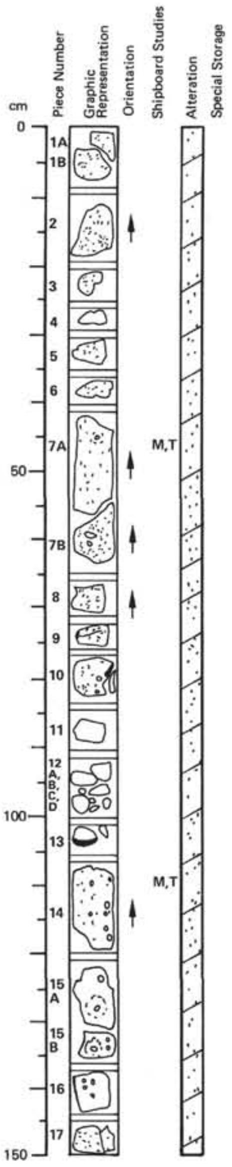
Gray, vesicular, aphyric basalt, green tinge. Vesicles approximately 30 to 40% <1 mm up to 5% >1 mm. Some calcite and smectite infilling of vesicles.

5-12 cm (3): calcite filled vein.

88-100 cm (14): drilling breccia.

Shipboard Data

Bulk Analysis:	**79 cm**
SiO_2	49.82
Al_2O_3	15.21
Fe_2O_3	1.17
FeO	7.73
MgO	7.38
CaO	12.91
Na_2O	3.11
K_2O	0.27
TiO_2	1.20
P_2O_5	0.12
MnO	0.12
LOI	—
H_2O^+	—
H_2O^-	—
CO_2	—
Cr	233.00
Ni	60.00
Sr	185.00
Zr	84.00



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG		SITE			HOLE	CORE			SECT.	
5	8	4	4	2	B			6		1

Depth: 315.0 to 316.5 m

Visual Descriptions

0-100 cm: light to moderately weathered aphyric fine-grained basalt, 30% fine vesicles (<1.0 mm), 3% medium and coarse vesicles and vugs up to 1 cm across, 1% calcite filled amygdules. Gray, large vug at center of 2 1/2 x 4 cm dark patch.

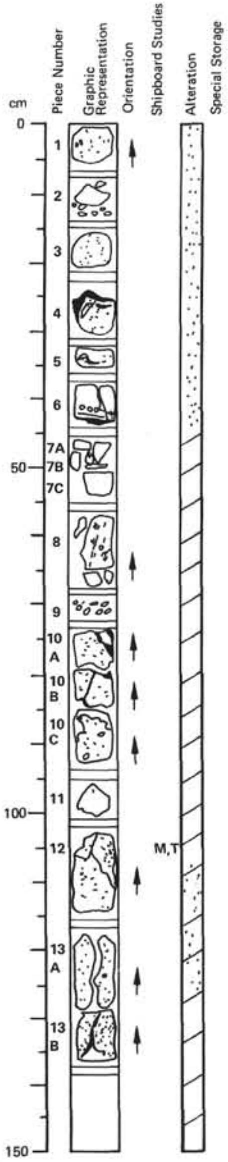
101-105 cm: chilled margin (no orientation), 2 mm thick glassy zone.

106-150 cm: same basalt as 0-100 cm interval, larger vugs surrounded by 1 cm path of dark discoloration – probably a reaction zone with contents of vug during cooling; 1-2% calcite amygdules.

Shipboard Data

Bulk Analysis:	**53 cm**
SiO_2	49.95
Al_2O_3	14.46
Fe_2O_3	1.17
FeO	7.71
MgO	7.89
CaO	13.05
Na_2O	3.20
K_2O	0.30
TiO_2	1.21
P_2O_5	0.13
MnO	0.12
LOI	—
H_2O^+	—
H_2O^-	—
CO_2	—
Cr	237.00
Ni	64.00
Sr	130.00
Zr	88.00

Magnetic Data:	**48 cm**	**110 cm**
Intensity (emu/cc)	272.2	552.6
Inclination before demag.	63.4	55.6
Stable Inclination	6.5	56.7



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
5 8	4 4 2	B	6	2

Depth: 316.5 to 318.0 m

Visual Description

0-24 cm: gray aphyric vesicular basalt. Fine grained, 20-30% fine vesicles, 1-2% medium vesicles, 3% calcite filled amygdules.

24-31 cm: quench or chill zone with thin glass rind, aphyric vesicular basalt similar to 0-24 cm interval. Flow structures parallel to rind.

30-36 cm: fine-grained aphyric basalt with flow structures. Basalt similar to above.

38-44 cm: chill zone with 3 mm glassy zone and variolitic zone grading into aphanitic basalt. ~5-10% very fine vesicles in basalt. Basalt has distinct orange red cast to gray color.

46-56 cm: loose basalt fragments.

56-68 cm: variolitic basalt, fine-grained greenish gray ~15% fine vesicles.

70-73 cm: loose basalt fragments.

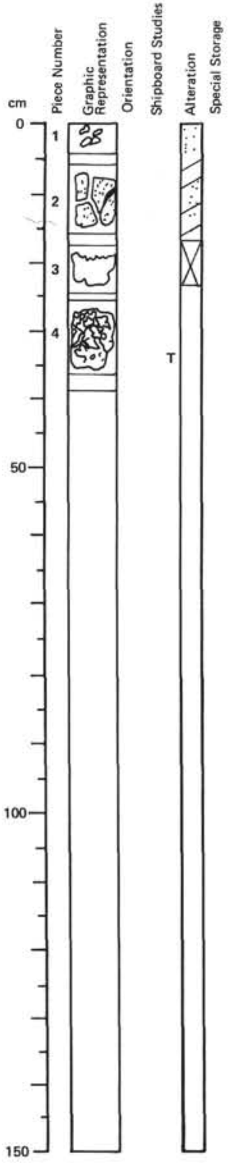
74-150 cm: aphyric vesicular basalt, gray colored with slight greenish cast. Fine-grained - 40% fine vesicles, 1-2% medium vesicles. Calcite filled alteration veins with iron oxide staining where calcite is absent and at margins of veins.

Shipboard Data

Bulk Analysis:	**32 cm**	**147 cm**
SiO_2	50.04	50.38
Al_2O_3	14.88	15.66
Fe_2O_3	1.13	1.09
FeO	7.45	2.20
MgO	8.02	9.84
CaO	12.99	11.02
Na_2O	3.14	3.13
K_2O	0.31	0.24
TiO_2	1.22	1.26
P_2O_5	0.13	0.11
MnO	0.11	0.13
LOI	---	---
H_2O^+	---	---
H_2O^-	---	---
CO_2	---	---
Cr	277.00	247.00
Ni	71.00	82.00
Sr	152.00	183.00
Zr	86.00	83.00

Magnetic Data	**110 cm**
Intensity (emu/cc)	568.8
Inclination before demag.	49.2

Physical Properties:	**40 cm**
$\overline{V}p$ (km/s)	3.85
Porosity (%)	29.15
Wet Bulk Density	2.33
Grain Density	2.88



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
5 8	4 4 2	B	6	3

Depth: 318.0 to 318.36 m

Visual Description

0-16 cm: dark gray to brownish gray basalt, light to moderate weathering, fine vesicles.

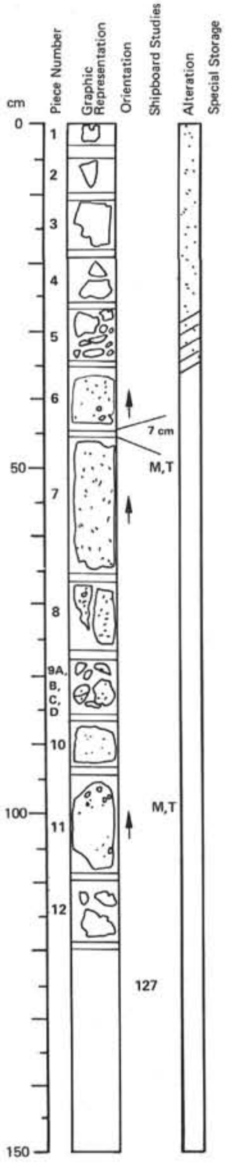
18-24 cm: drilling breccia cemented with rock flour paste.

27-30 cm: splotchy variolitic basalt grading upper 1/2 mottled dark and light gray. White calcite vein 1.0-2.0 mm. Vesicles. Fresh.

Shipboard Data

Bulk Analysis:	**28 cm**
SiO_2	50.38
Al_2O_3	15.66
Fe_2O_3	1.09
FeO	7.2
MgO	8.2
CaO	11.98
Na_2O	3.45
K_2O	0.34
TiO_2	1.26
P_2O_5	0.12
MnO	0.13
LOI	---
H_2O^+	---
H_2O^-	---
CO_2	---
Cr	232.00
Ni	49.00
Sr	185.00
Zr	89.00

Magnetic Data:	**28 cm**
Intensity (emu/cc)	105.3
Inclination before demag.	67.7
Stable Inclination	47.7



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
5 8	4 4 2	B	7	1

Depth: 324.5 to 375.7 m

Visual Description

0-25 cm: gray aphyric basalt. Orangish cast, grades downwards from aphanitic to fine-grained. Vesicular: 10-20% fine, 2% medium. Apparently chill margin for underlying basalt.

26-34 cm: basalt fragments.

36-86 cm: fresh basalt – fine-grained, approaching diabase, 5-10% medium vesicles, 5-10% fine vesicles.

86-93 cm: drilling debris and basalt fragments and rock powder.

94-108 cm: fine-grained gray aphyric basalt. Upper 1/3 has 4% medium vesicles. Vesicles scarce to absent in lower 2/3. Otherwise is similar to 36-86 cm interval.

100-107 cm: drilling debris and rock powder.

45-52 cm: same as rest in 36-86 cm.

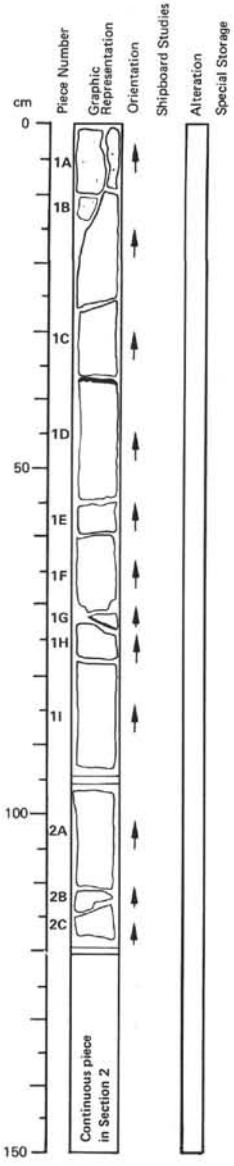
Shipboard Data

Bulk Analysis:	**46 cm**	**110 cm**
SiO_2	50.73	50.57
Al_2O_3	14.77	10.48
Fe_2O_3	1.25	1.26
FeO	8.24	8.32
MgO	9.47	8.92
CaO	10.23	10.55
Na_2O	3.24	3.20
K_2O	0.24	0.20
TiO_2	1.22	1.38
P_2O_5	0.14	0.11
MnO	0.16	0.16
LOI	—	—
H_2O^+	—	—
H_2O^-	—	—
CO_2	—	—
Cr	209.00	211.00
Ni	59.00	201.00
Sr	161.00	135.00
Zr	93.00	67.00

Magnetic Data:	**59 cm**	**106 cm**
Intensity (emu/cc)	211.3	164.8
Inclination before demag.	55.0	60.3
Stable Inclination	—	54.6

Physical Properties:	**49 cm**
$\bar{V}p$ (km/s)	4.13
Porosity (%)	23.96
Wet Bulk Density	2.50
Grain Density	2.98

Other Data:	
Therm. cond. (mcal/cm-s-°C)	3.84



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
5 8	4 4 2	B	8	1

Depth 334.0 to 335.2 m

Visual Description

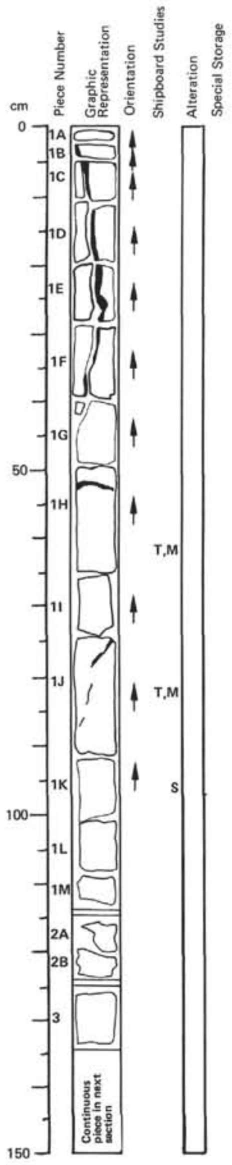
0-117 cm: gray aphyric diabase, 1% vesicles at top and less than that through rest of Section. Larger vesicles have free growing glomerocrysts of pyrite and calcite (Piece 2C). At 36 cm, white calcite vein and at several other breaks in core. Pyrites found along vein surfaces where exposed. Fresh-little evidence of any weathering. Grain size fairly uniform down section. Between 23-39 cm ~1-3 mm phenocrysts which could be slightly altered plagioclase which stands out rather than phenocrysts.

Shipboard Data

Bulk Analysis:	**32 cm**
SiO_2	48.03
Al_2O_3	13.24
Fe_2O_3	1.25
FeO	8.24
MgO	15.26
CaO	9.39
Na_2O	2.38
K_2O	0.14
TiO_2	0.94
P_2O_5	0.09
MnO	0.18
LOI	—
H_2O^+	—
H_2O^-	—
CO_2	—
Cr	412.00
Ni	201.00
Sr	135.00
Zr	67.00

Magnetic Data:	**47 cm**
Intensity (emu/cc)	456.4
Inclindation before demag.	50.9
Stable Inclination	51.9

Other Data:	**80 cm**
Therm. cond. (mcal/cm-s-°C)	4.20



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
58	442	B	8	2

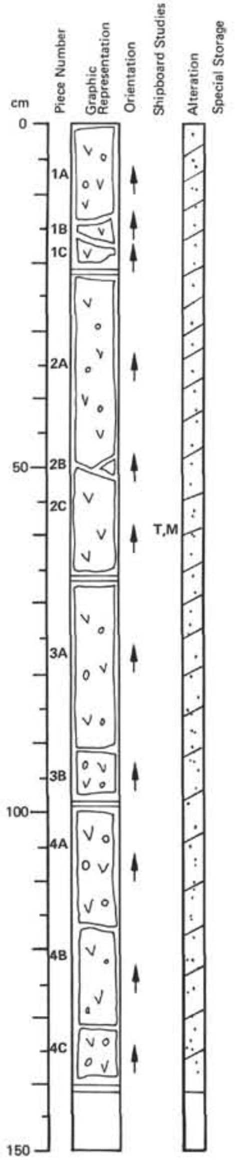
Depth 335.2 to 336.6 m

Visual Description

Gray aphyric diabse – < 1% vesicles. Calcite veins common and core has fractured along these (particularly between 0 and 45 cm). Pyrites also found on vein surfaces. Rock is fresh, but much of plagioclase has a greenish cast which may indicate alteration medium grained.

Shipboard Data

Magnetic Data:	**24 cm**
Intensity (emu/cc)	902.7
Inclination before demag.	47.8
Physical Properties:	**92 cm**
$\overline{V}p$ (km/s)	4.92
Porosity (%)	12.50
Wet Bulk Density	2.70
Grain Density	2.95



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
58	442	B	8	3

Depth: 336.6 to 338.0 m

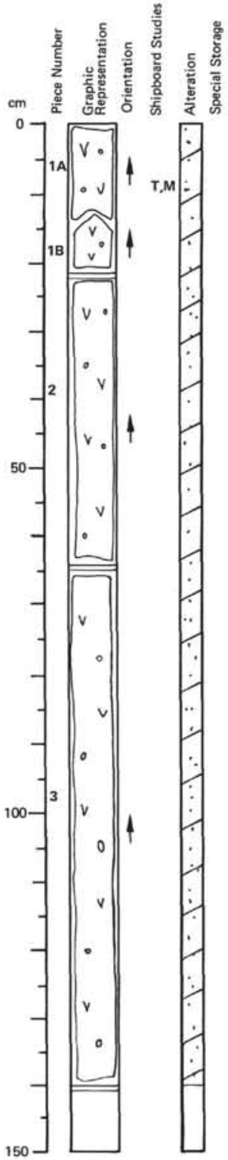
Visual Description

0-140 cm: diabase identical to that described for Sections 1 and 2. Diabase, dense, dark greenish-gray, vesicular, moderately altered. Vesicles 5%, 1-3 mm, all filled with calcite and chlorite.

22-80 cm: vesicles, up to 5 mm in diameter. Diabase-aphyric, fine-grained.

Shipboard Data

Magnetic Data:	**55 cm**
Intensity (emu/cc)	465.7
Inclination before demag.	48.9
Stable Inclination	50.9



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
58	442	B	8	4

Depth: 338.0 to 339.4 m

Visual Description

0-140 cm: identical to diabase of Sections 1, 2, 3. Diabase, dense, dark greenish-gray, vesicular, moderately altered. Vesicles 5-10%, <1 mm, vesicles in diameter (vugs) 3-5 mm filled with secondary minerals.

0-28 cm: vugs filled by calcite with chlorite (the same at 115-140 cm).

28-115 cm: vugs filled by chlorite. Diabase-aphyric, fine-grained.

Thin Section Description – 3 cm

Phenocrysts: plagioclase 27%, 1-5 mm, An_{70}, euhedral, subhedral, partly skeletal; clinopyroxene 20%, 1-5 mm, augite, anhedral.

Groundmass: magnetite 1-2%, 0.7-1 mm, skeletal, isometric, mainly in groundmass.

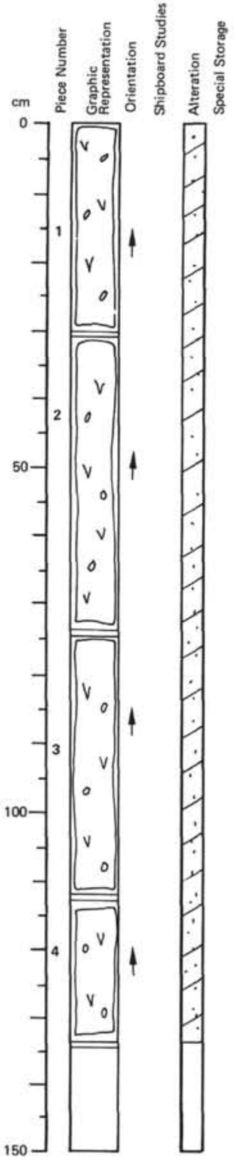
Vesicles: 1-2%, 0.1-0.5 mm round, border of chlorites and zeolites.

Texture: intersertal, partly ophitic.

Alteration: Few carbonate in vesicles and 50% zeolites (in vesicles) and chlorite (in groundmass and vesicles).

Shipboard Data

Magnetic Data:	**3 cm**
Intensity (emu/cc)	255.0
Inclination before demag.	52.2
Stable Inclination	50.0



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
58	442	B	8	5

Depth: 339.4 to 340.7 m

Visual Description

0-133 cm: same diabase, as in Sections 1-4. Diabase, dense, aphyric, dark greenish gray, moderately altered, vesicular. Vesicles 5-10%, <1 mm, vuggy 3-5%, vugs as large as 3-7 mm filled with secondary minerals.

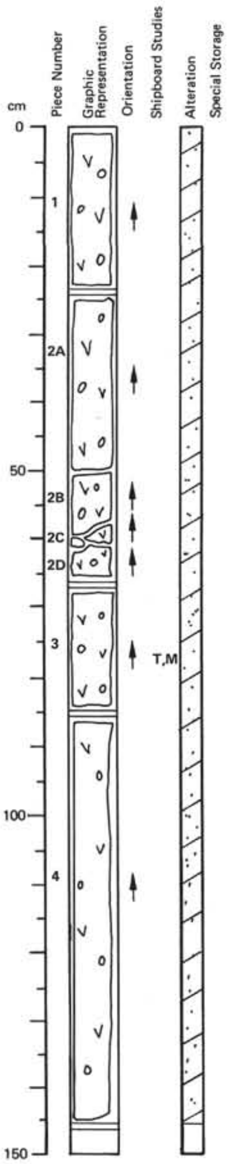
0-50 cm and 120-133 cm: vugs filled by calcite with chlorite and at 50-120 cm by chlorite. Vesicles unfilled.

Shipboard Data

Bulk Analysis:	**74 cm**
SiO_2	49.57
Al_2O_3	14.39
Fe_2O_3	1.21
FeO	8.00
MgO	10.87
CaO	10.38
Na_2O	3.03
K_2O	0.15
TiO_2	1.18
P_2O_5	0.11
MnO	0.15
LOI	—
H_2O^+	—
H_2O^-	—
CO_2	—
Cr	255.00
Ni	100.00
Sr	159.00
Zr	84.00

Magnetic Data:	**23 cm**
Intensity (emu/cc)	446.8
Inclination before demag.	48.7
Stable Inclination	51.3

Other Data:	**127 cm**
Therm. cond. (mcal/cm-s-°C)	3.744



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
58	442	B	8	6

Depth: 340.7 to 342.1 m

Visual Description

The rocks in this sections is identical to the diabase of Sections 1-5. Diabase, aphyric, vesicular. There is difference between the two parts of the section.

0-65 cm: is identical to the diabase of Section 5. Vesicles 5-10°, < 1 mm and 3-5%, 1-3 mm, filled with calcite and chlorite.

65-145 cm: vesicles are open, unfilled. It is the freshest part of the core.

Thin Section Description – 84 cm

Groundmass: plagioclase 40%, 0.5-5 mm, An_{60}, euhedral, subhedral; clinopyroxene 25%, 1-4 mm, augite, anhedral; magnetite 1%, 0.1-0.6 mm

Vesicles: 5%, 0.7-6.0 mm, round, on the walls rims chlorites and zeolites.

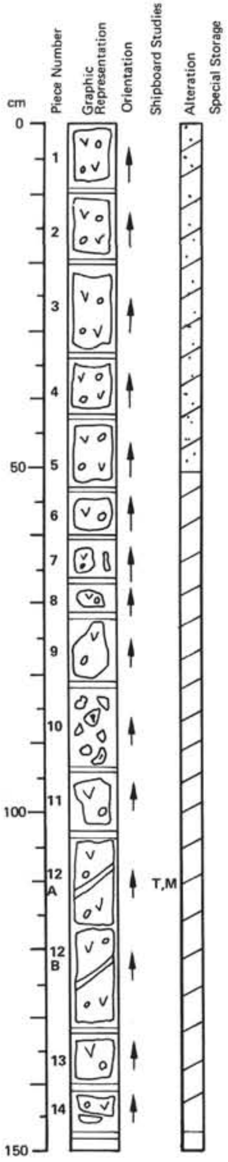
Texture: subophitic.

Alteration: 30% zeolites (in groundmass replacing vesicles) and chlorite (in vesicles replacing groundmass).

Shipboard Data

Bulk Analysis:	**141 cm**
SiO_2	49.64
Al_2O_3	13.82
Fe_2O_3	1.20
FeO	7.92
MgO	11.47
CaO	10.17
Na_2O	3.11
K_2O	0.18
TiO_2	1.26
P_2O_5	0.14
MnO	0.13
LOI	—
H_2O^+	—
H_2O^-	—
CO_2	—
Cr	258.00
Ni	105.00
Sr	169.00
Zr	91.00

Magnetic Data:	**84 cm**
Intensity (emu/cc)	381.4
Inclination before demag.	45.5



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
58	442	B	8	7

Depth: 342.1 to 343.6 m

Visual Description

0-50 cm: upper 50 cm appears identical to diabase described in this core, Sections 1-6. In comparison with the lower part of Section 6, the vesicles are filled with calcite and chlorite.

50-146 cm: another type of alteration of the same diabase. Color returns to a yellow-gray. Vesicles are filled with clay minerals. Calcite vein observed in Pieces 12A and 12B (thickness 1-3 mm).

146-147 cm: reddish color. In this part and above (4-5 cm) the diabase is dense. Probably it is the top of a lava flow.

Thin Section Description – 107 cm

Groundmass: plagioclase 45%, 1-4 mm, An_{60}, subhedral, skeletal; clinopyroxene 35%, 1-3 mm, augite, anhedral; magnetite 1%, 0.1-0.5 mm, skeletal, rectangle

Vesicles: 10%, 1-3 mm, round.

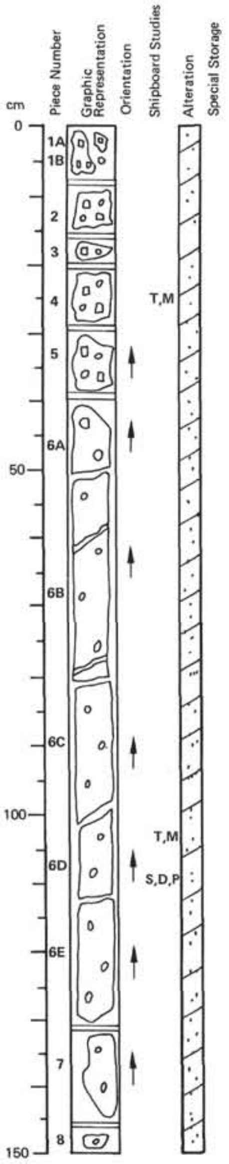
Texture: ophytic.

Alteration: 10% zeolites (in vesicles) and chlorite (in vesicles, groundmass replacing groundmass), partly colored by hydro iron oxide.

Shipboard Data

Bulk Analysis:	
SiO_2	50.57
Al_2O_3	15.26
Fe_2O_3	1.16
FeO	7.68
MgO	8.70
CaO	10.78
Na_2O	3.74
K_2O	0.43
TiO_2	1.23
P_2O_5	0.12
MnO	0.13
LOI	—
H_2O^+	—
H_2O^-	—
CO_2	—
Cr	228.00
Ni	66.00
Sr	154.00
Zr	94.00

Magnetic Data:	**107 cm**
Intensity (emu/cc)	261.3
Inclination before demag.	48.0
Stable Inclination	48.3



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
58	442	B	9	1

Depth: 343.5 to 345.0 m

Visual Description

0-49 cm: basalt, glomerophyric yellow-gray, vesicular, altered. Vesicles 15% (1-2 mm and less) are open and contain a few iron oxides. Aggregates of plagioclase (diameter 1-1.5 mm) 25-30%.

49-150 cm: basalt, aphyric, dense, yellow-gray, vesicular, altered. Vesicles less than 0.5 mm (5-10%) partly filled with calcite and iron oxide.

65-80 cm: two calcite veins with oxidized ore minerals (probably pyrite).

Thin Section Description – 24 cm

Phenocrysts: plagioclase 50%, 0.3-3 mm, An_{58}, subhedral, sometimes light zonation; clinopyroxene 20%, 0.5-2 mm, augite, euhedral.

Groundmass: groundmass substitute by secondary minerals.

Vesicles: 3%, 0.1-1.5 mm.

Texture: glomerophyric, intersertal, subophitic.

Alteration: clays, zeolites, chlorite – 25% in groundmass, groundmass partly filled vesicles.

Thin Section Description – 103 cm

Groundmass: plagioclase 20%, 0.2-1 mm, An_{60}, subhedral, needles; clinopyroxene 25%, 0.2-3 mm, augite, anhedral; magnetite < 1, 0.04-0.08; glass 50% , microlite, Pl+Py+Mt.

Vesicles: 5%, 0.2-1.0 mm, partly filled carbonate and clay.

Texture: intersertal.

Alteration: 3% carbonate in vesicles and 2% clays in vesicles.

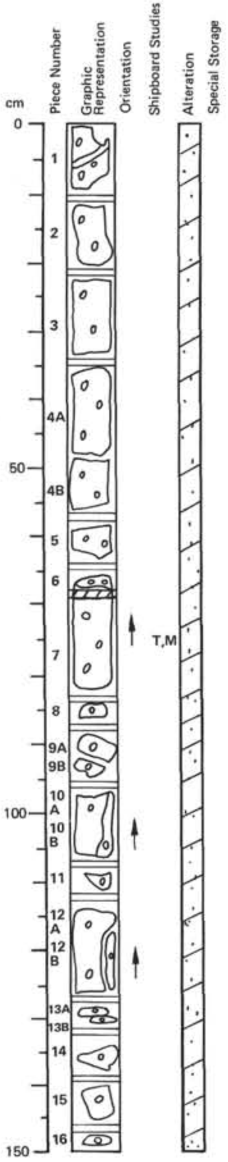
Shipboard Data

Bulk Analysis:	**34 cm**	**107 cm**
SiO_2	49.46	49.31
Al_2O_3	15.42	13.18
Fe_2O_3	1.10	1.19
FeO	7.35	7.82
MgO	9.22	9.02
CaO	11.03	12.60
Na_2O	2.97	3.05
K_2O	0.30	0.59
TiO_2	1.16	1.11
P_2O_5	0.11	0.11
MnO	0.14	0.13
LOI	—	—
H_2O^+	—	—
H_2O^-	—	—
CO_2	—	—
Cr	300.00	282.00
Ni	118.00	100.00
Sr	164.00	173.00
Zr	79.00	84.00

Magnetic Data:	**24 cm**	**33 cm**	**103 cm**
Intensity (emu/cc)	455.8	448.9	544.8
Inclination before demag.	– 1.2	– 3.1	53.8
Stable Inclination	– 3.7	– 2.1	56.3

Physical Properties:	**110 cm**
$\overline{V}p$ (km/s)	4.16
Porosity (%)	28.02
Wet Bulk Density	2.41
Grain Density	2.96

Other Data:	**67 cm**
Therm. cond. (mcal/cm-s-° C)	3.66



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
58	442	B	9	2

Depth: 345.0 to 346.5 m

Visual Description

0-150 cm: basalt is identical to that described at the base of Section 1. Aphyric, dark gray, vesicular, altered. Vesicles, 0.5 mm and less than 10%.

114-150 cm: basalt more dense and has 1% vesicles (1-3 mm).

114-126 cm: vesicles partly filled with calcite.

0-10 cm: a calcite vein occurs with small iron oxides (Piece 1).

Thin Section Description – 73 cm

Phenocrysts: plagioclase 10%, 0.4-1 mm, An_{60}?, needles.

Groundmass: glass 50%, microlites, Py+Pl+glass.

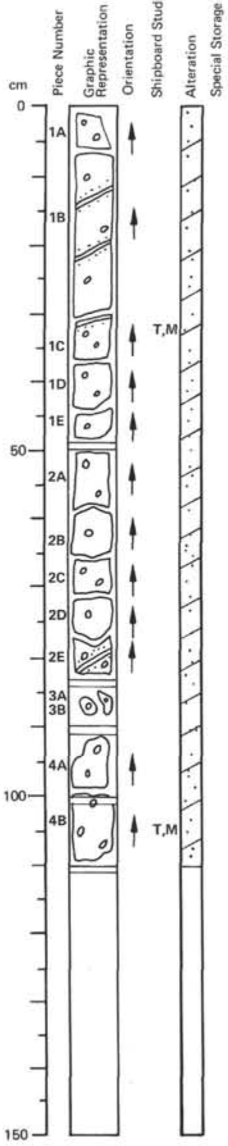
Vesicles: 40%, 0.1-1.0 mm, unfilled, round

Texture: intersertal.

Shipboard Data

Bulk Analysis:	**37 cm**
SiO_2	49.32
Al_2O_3	14.04
Fe_2O_3	1.12
FeO	7.42
MgO	7.66
CaO	14.12
Na_2O	3.13
K_2O	0.39
TiO_2	1.16
P_2O_5	0.12
MnO	0.12
LOI	—
H_2O^+	—
H_2O^-	—
CO_2	—
Cr	270.00
Ni	100.00
Sr	173.00
Zr	84.00

Magnetic Data:	**73 cm**
Intensity (emu/cc)	1940.1
Inclination before demag.	47.6
Stable Inclination	47.8



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG		SITE			HOLE	CORE		SECT.	
5	8	4	4	2	B		9		3

Depth: 346.5 to 347.6 m

Visual Description

0-110 cm: basalt, aphyric, dark gray, vesicular, altered. More vesicles than in the basalt of Section 2 (10-15%, <1 mm). Partly filled with calcite and iron oxides.

In Pieces 1B, 1C, and 2E: a calcite vein occurs with an altered zone next to it (iron oxide alteration).

Thin Section Description – 32 cm

Groundmass: plagioclase 30%, 0.5-2 mm, An_{68}, needles, partly laths; clinopyroxene 20%, 0.2-1.5 mm, augite, subhedral, euhedral; glass 45%, mixrolites, Pl+Py+Mt.

Vesicles: 3%, 0.2-2.0 mm, partly filled by calcite.

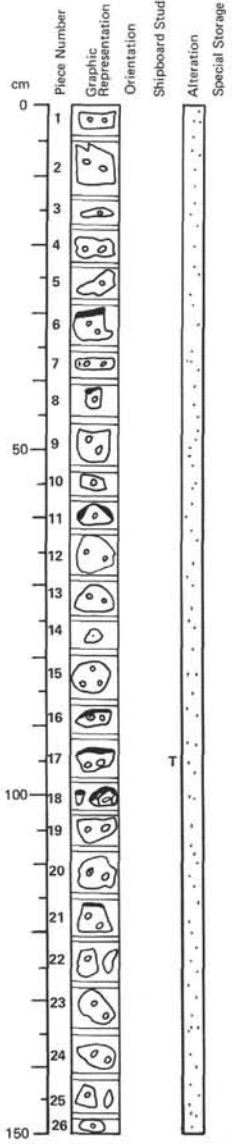
Texture: subophitic - intersertal.

Alteration: 1% carbonate, at 0.2-1.5 mm replacing vesicles.

Shipboard Data

Bulk Analysis:	**54 cm**
SiO_2	50.61
Al_2O_3	13.44
Fe_2O_3	1.34
FeO	8.87
MgO	9.33
CaO	10.06
Na_2O	3.42
K_2O	0.35
TiO_2	1.42
P_2O_5	0.15
MnO	0.14
LOI	—
H_2O^+	—
H_2O^-	—
CO_2	—
Cr	251.00
Ni	118.00
Sr	177.00
Zr	106.00

Magnetic Data:	**32 cm**	**105 cm**
Intensity (emu/cc)	768.1	437.6
Inclination before demag.	45.7	43.2
Stable Inclination	45.8	49.9



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG		SITE			HOLE	CORE		SECT.	
5	8	4	4	2	B	1	0		1

Depth: 353.0 to 354.5 m

Visual Description

Light gray, vesicular, aphyric, aphanitic basalt (approximately 10% vesicles). Glassy margins at 30 cm (6), 41 cm (8), 60 cm (11), 87 cm (16), 92 cm (17), 97 cm (18), and 116 cm (21). Vesicles generally <1 mm across and collect in zones approximately 1 cm below glassy margins, some infilling by clay minerals and occasional calcite.

97-101 cm (18): several fractures infilled by alteration products (clays?).

Thin Section Description – 94 cm

Groundmass: plagioclase 10%, 0.02-0.2 mm, laths or acicular, microlites; glass 70% and cryptocrystalline material 20%.

Texture: glassy.

Thin Section Description – 94 cm

Phenocrysts: plagioclase 0.5%, 0.2-1 mm, An_{58}, laths.

Groundmass: cryptocrystalline matrix 68.5%.

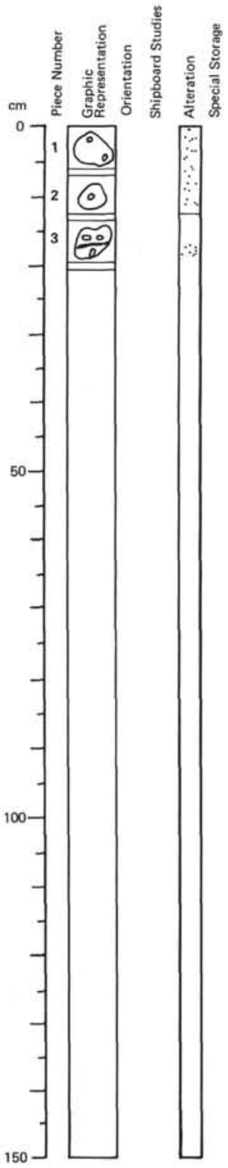
Vesicles: 20%, 0.02-1 mm

Texture: sparsely phyric.

Alteration: 1% clays in vesicles.

Shipboard Data

Bulk Analysis:	**110 cm**
SiO_2	50.16
Al_2O_3	15.21
Fe_2O_3	1.33
FeO	8.79
MgO	5.47
CaO	12.27
Na_2O	3.33
K_2O	0.40
TiO_2	1.58
P_2O_5	0.19
MnO	0.17
LOI	—
H_2O^+	—
H_2O^-	—
CO_2	—
Cr	150.00
Ni	50.00
Sr	162.00
Zr	105.00



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

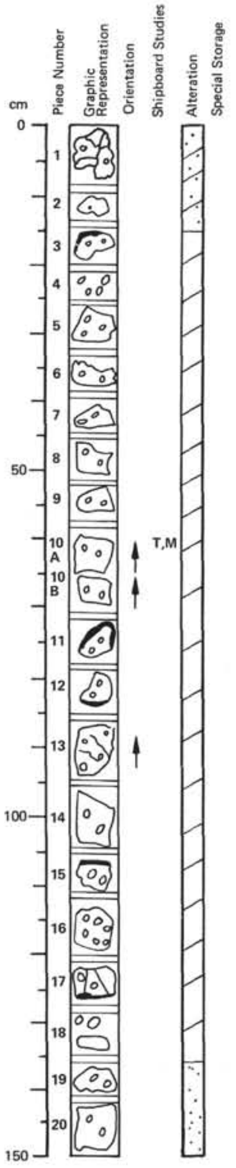
LEG	SITE	HOLE	CORE	SECT.
58	442	B	10	2

Depth: 354.5 to 354.7 m

Visual Description

0-14 cm: light gray, vesicular, aphyric, aphanitic, basalt, approximately 10% vesicles.

14-20 cm (3): glassy margin material, brecciated and cemented by white (8/2) chalk or limestone.



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
58	442	B	11	1

Depth 362.5 to 364.0 m

Visual Description

Sample 1 – pillow bed with radiating pipe vesicles.

1) 0-14 cm: light gray, vesicular, aphyric aphanitic basalt.
   0-8 cm (Piece 1): surrounded by glassy margin and dark zone from 1 to 5 mm thick. Vesicular zone 1 cm from surface. Linear groups of vesicles normal to surface, some lined by smectite, some fractures containing calcite.
2) 14-128 cm: light gray-green, vesicular, aphyric basalt except for dark gray zones next to glassy margins (approximately 5 mm thick).
   86-95 cm and 113-121 cm (Piece 16): abundant large (1-3 mm) infilled vesicles - possibly formed by accretion of small vesicles (< 1 mm).
3) 128-150 cm: light gray, vesicular, aphyric basalt. Vesicles generally <1 mm (approximately 30%.
   143-150 (Piece 20): 2 linear groups of larger vesicles line by alteration products.

Thin Section Description – 61 cm

Phenocrysts: spinel 0.1 mm, rounded, triangle, 1 piece red-brown.

Groundmass: plagioclase 20%, 0.2-1 mm, acicular, some with plumose texture (pyroxene features); other 39%, cryptocrystalline matrix

Vesicles: 40%, 0.1-0.5 mm.

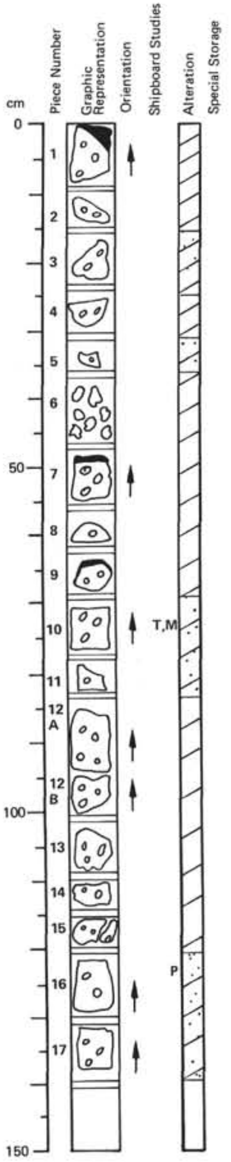
Texture: intersertal.

Alteration: 1% clays lining fracture and replacing some crytocrystalline material.

Shipboard Data

Bulk Analysis:	**146 cm**
SiO_2	48.97
Al_2O_3	15.87
Fe_2O_3	1.40
FeO	9.27
MgO	4.36
CaO	12.53
Na_2O	3.05
K_2O	0.48
TiO_2	1.55
P_2O_5	0.28
MnO	0.19
LOI	—
H_2O^+	—
H_2O^-	—
CO_2	—
Cr	192.00
Ni	58.00
Sr	185.00
Zr	114.00

Magnetic Data:	**60 cm**
Intensity (emu/cc)	108.2
Inclination before demag.	33.3
Stable Inclination	28.9



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
58	442	B	11	2

Depth 364.0 to 365.4 m

Visual Description

Light gray, vesicular, aphyric basalt when lightly to moderately weathered green-gray where moderately weathered.

0-2 cm (Piece 1): glassy zone showing alteration to yellow palagonite.

87-88 cm (Piece 12A): glassy zone completely replaced by yellow palagonite and chilled margin, altered.

Some vesicles lined by brown alteration product others by light olive green smectite.

37-47 cm (Piece 6): drilling breccia.

Thin Section Description – 28 cm

Groundmass: plagioclase 25%, 0.02-1 mm, An_{62}, elongate laths; clinopyroxene 10%, 0.02-0.5 mm, acicular; magnetite 2%, <0.02 mm, granular; other 28%.

Vesicles: 35%, 0.05-0.5 mm, rounded.

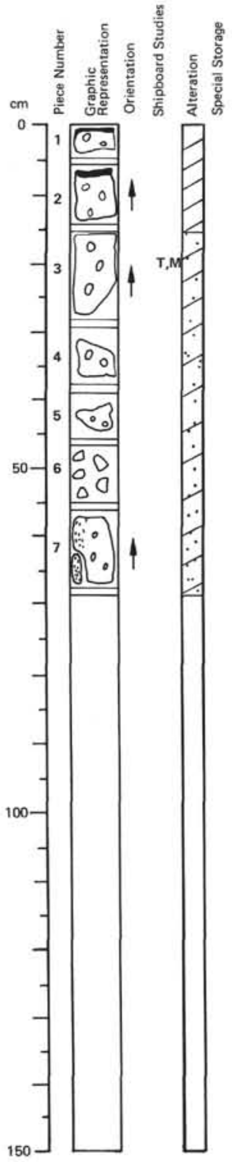
Texture: intersertal.

Shipboard Data

Bulk Analysis:	**70 cm**
SiO_2	49.99
Al_2O_3	15.38
Fe_2O_3	1.28
FeO	8.48
MgO	6.41
CaO	12.05
Na_2O	3.25
K_2O	0.39
TiO_2	1.50
P_2O_5	0.21
MnO	0.16
LOI	—
H_2O^+	—
$H_2)^-$	—
CO_2	—
Cr	192.00
Ni	58.00
Sr	185.00
Zr	114.00

Magnetic Data:	**127 cm**
Intensity (emu/cc)	57.3
Inclination before demag.	48.8

Physical Properties:	**121 cm**
$\overline{V}p$ (km/s)	4.13



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
58	442	B	11	3

Depth: 365.4 to 366.1 m

Visual Description

Light gray, vesicular, aphyric basalt gray-green when moderately weathered. Vesicles approximately 20% <1 mm.

10-20 cm: several large vesicles 3 mm to 10 mm across, lined by light gray or brown material.

55-67 cm: alteration zone (brown coloration) through Piece 7.

46-54 cm(Piece 6): drilling breccia.

Thin Section Description – 19 cm

Phenocrysts: plagioclase 1%, 0.3-1.20 mm, laths, euhedral.

Groundmass: plagioclase 30%, 0.2-0.5 mm, An_{69}, acicular laths, microlites; magnetite 0.5%, 0.01-0.02%, granular; other, cryptocrystalline matrix.

Vesicles: 35%, 0.02-1 mm.

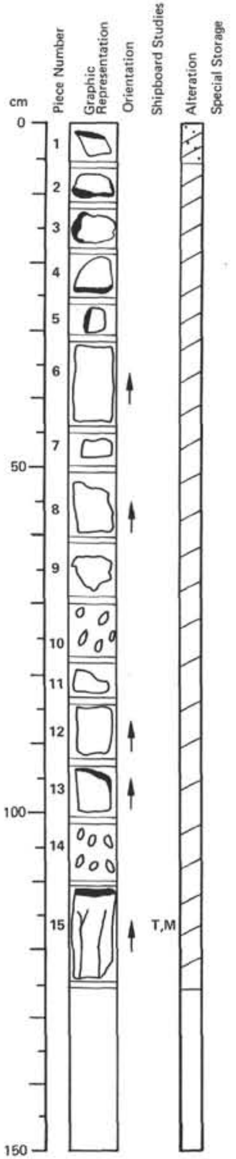
Texture: very sparsely phyric (aphyric)

Alteration: 1% clays lining vesicles.

Shipboard Data

Bulk Analysis:	**24 cm**
SiO_2	49.98
Al_2O_3	15.74
Fe_2O_3	1.28
FeO	8.48
MgO	5.19
CaO	12.26
Na_2O	3.30
K_2O	0.38
TiO_2	1.54
P_2O_5	0.21
MnO	0.18
LOI	—
H_2O^+	—
H_2O^-	—
CO_2	—
Cr	267.00
Ni	71.00
Sr	178.00
Zr	115.00

Magnetic Data:	**18 cm**
Intensity.(emu/cc)	112.0
Inclination before demag.	43.7
Stable Inclination	42.1



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
5 8	4 4 2	B	1 2	1

Depth: 372.0 to 373.3 m

Visual Description

Light gray, vesicular, aphyric basalt, gray-green when moderately weathered, chill zones below glass (relatively fresh).

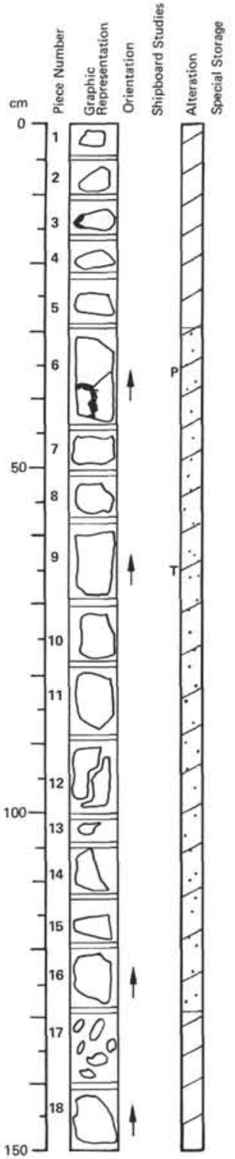
0-5 cm (Piece 1), 33-39 cm (Top of Piece 6), 96-99 cm (Bottom of Piece 13), and 113-125 cm (Piece 15 below chilled margin): all regions with large vesicles 1 mm to 5 mm across. In above regions 30-40% vesicles, otherareas approximately 10% vesicles generally <1 mm. Vesicles are lined by smectite, calcite or brown material.

71-77 cm and 102-110 cm: drilling breccia.

Shipboard Data

Bulk Analysis:	**52 cm**
SiO_2	49.27
Al_2O_3	15.66
Fe_2O_3	1.38
FeO	9.11
MgO	4.58
CaO	12.21
Na_2O	2.97
K_2O	0.58
TiO_2	1.55
P_2O_5	0.31
MnO	0.19
LOI	—
H_2O^+	—
H_2O^-	—
CO_2	—
Cr	194.00
Ni	67.00
Sr	181.00
Zr	120.00

Magnetic Data:	**40 cm**	**114 cm**
Intensity (emu/cc)	90.96	89.80
Inclination before demag.	31.7	32.6
Stable Inclination	27.3	29.8



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
5 8	4 4 2	B	1 3	1

Depth: 381.5 to 383.0 m

Visual Description

0-30 cm: moderately weathered, green-gray aphanitic, vesicular, aphyric basalt, 20-30% vesicles mainly <1 mm up to 10% >1 mm.

30-130 cm: light to moderately weathered, green tinged, light gray, vesicular, aphyric basalt. No glass margins or chilled zones in this section, uniform texture.

130-139 cm: drilling breccia, includes glass fragments.

139-150 cm: moderately weathered, green-gray vesicular, aphyric, aphanitic basalt, 10% vesicles of which 7.5% are between 1 mm and 5 mm across.

Thin Section Description – 61 cm

Groundmass: plagioclase 25%, 0.2-1 mm, An_{59}, laths; clinopyroxene 25%, 0.1-0.5 mm, anhedral; magnetite 0.5%, <0.02 mm, granular.

Other: 34.5%, cryptocrystalline matrix.

Vesicles: 15%, 0.2-0.5 mm.

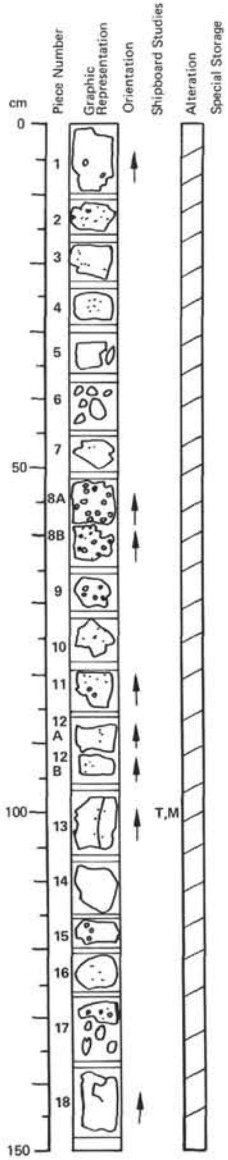
Texture: intersertal.

Shipboard Data

Bulk Analysis:	**34 cm**
SiO_2	50.12
Al_2O_3	15.38
Fe_2O_3	1.33
FeO	8.79
MgO	5.97
CaO	12.09
Na_2O	3.16
K_2O	0.42
TiO_2	1.68
P_2O_5	0.24
MnO	0.19
LOI	—
H_2O^+	—
H_2O^-	—
CO_2	—
Cr	201.00
Ni	66.00
Sr	171.00
Zr	124.00

Magnetic Data:	**60 cm**
Intensity (emu/cc)	102.3
Inclination before demag.	52.6
Stable Inclination	38.1

Physical Properties:	**32 cm**
$\overline{V}p$ (km/s)	3.93
Porosity (%)	27.04
Wet Bulk Density	2.42
Grain Density	2.95



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
58	442	B	13	2

Depth: 381.5 to 383.0 m

Visual Description

Moderately weathered pillow basalt. Aphyric, fine-grained to aphanitic. Plagioclase laths just visible, 0-15% vesicles, mostly fine. Calcite veins in center of Piece 17, side of Pieces 1, 2, 3, 4, 5, 8, 10, and 11. May be additional mineral in veins – zeolite?.

Piece 17, 127-130 cm: has glassy chill margin.

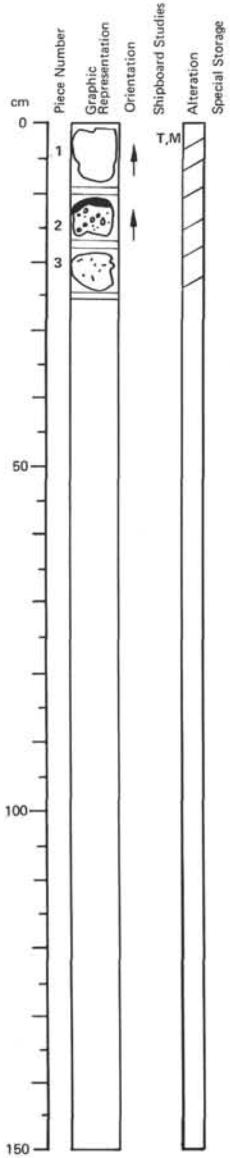
Pieces 8, 16, and 17: have composite vesicles containing highly vesicular darker basalt.

< 1% amygdules; calcite filled.

Shipboard Data

Bulk Analysis:	**92 cm**
SiO_2	49.38
Al_2O_3	15.36
Fe_2O_3	1.37
FeO	9.03
MgO	4.56
CaO	2.55
Na_2O	3.14
K_2O	0.45
TiO_2	1.60
P_2O_5	0.33
MnO	0.16
LOI	—
H_2O^+	—
H_2O^-	—
CO_2	—
Cr	197.00
Ni	48.00
Sr	186.00
Zr	114.00

Magnetic Data:	**100 cm**
Intensity (emu/cc)	93.97
Inclination before demag.	37.7
Stable Inclination	34.9



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
58	442	B	13	3

Depth: 383.0 to 383.3 m

Visual Description

0-10 cm: aphyric fine-grained basalt. Cracks contain some calcite, < 1% calcite amygdules, < 1% vesicles.

10-15 cm: vesicular aphyric basalt with glass rind. Composite vesicles with highly vesicular dark basalt in their interiors.

18-25 cm: fine-grained basalt, 3% fine vesicles. A few amygdules – (possibly iddingsitized olivine, < 1% small 3x1 mm plagioclase phenocrysts.

Thin Section Description – 3 cm

Groundmass: plagioclase 33%, 0.1-1 mm, An_{60}, acicular, microlites; magnetite, trace, very fine-grained; other 33%, cryptocrystalline matrix.

Vesicles: 33%, 0.1-0.4 mm .

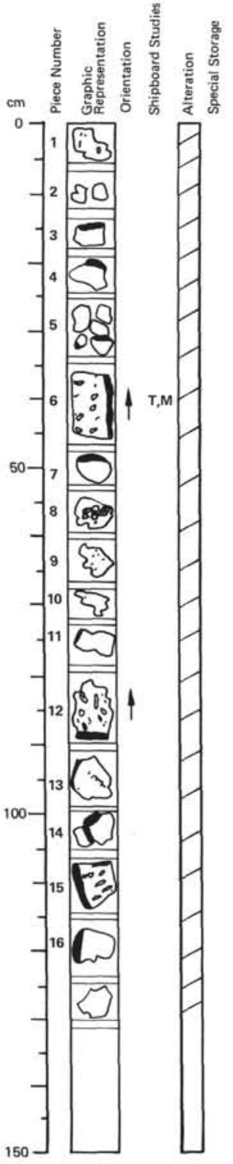
Texture: intersertal.

Alteration: 1% clays replacing cryptocrystalline matrix.

Shipboard Data

Bulk Analysis:	**19 cm**
SiO_2	49.63
Al_2O_3	15.39
Fe_2O_3	1.32
FeO	8.71
MgO	5.38
CaO	12.36
Na_2O	3.21
K_2O	0.46
TiO_2	1.53
P_2O_5	0.35
MnO	0.14
LOI	—
H_2O^+	—
H_2O^-	—
CO_2	—
Cr	195.00
Ni	51.00
Sr	182.00
Zr	115.00

Magnetic Data:	**2 cm**
Intensity (emu/cc)	156.4
Inclination before demag.	22.7
Stable Inclination	20.4



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
58	442	B	14	1

Depth: 391.0 to 392.3 m

Visual Description

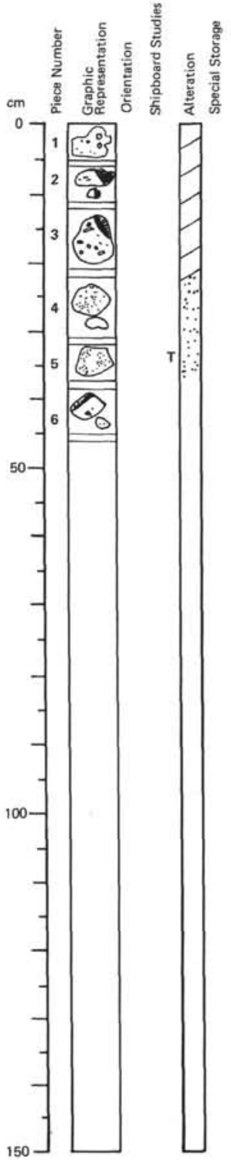
Fine-grained to aphanitic basalt. Moderately weathered, calcite amygdules common but <1%. Vesicles from <1% to 10%. Many samples have pipe vesicles at right angles to chill margins; these are generally composite vesicles filled with dark gray highly vesicular basalt.

Glass chill zones.

Calcite veins and coatings common on many samples.

Shipboard Data

Magnetic Data:	38 cm
Intensity (emu/cc)	111.6
Inclination before demag.	47.0
Stable Inclination	45.4



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
58	442	B	14	2

Depth: 392.3 to 392.7 m

Visual Description

0-21 cm: aphyric basalt. Composit vesicles filled with dark highly vesicular basalt – medium to coarse vesicles – 3-5%. Calcite veins, and amygdules present. Glass zone in Piece 2 has outer 1 cm thick palagonite zone.

23-38 cm: fine-grained, highly vesicular aphyric basalt, numerous brown vesicular inclusions. Fine vesicles ~30%. Gray colored, lightly to moderately weathered.

40-45 cm: glassy chill zone on fine-grained aphyric nonvesicular basalt.

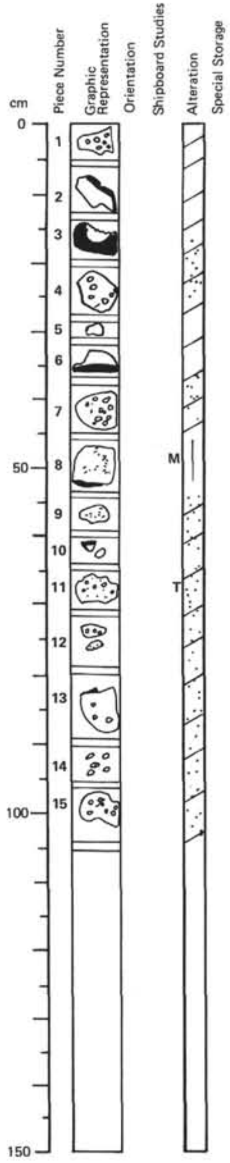
Thin Section Description – 35 cm

Phenocrysts: plagioclase 0.5 mm, lath, 1 only 0.5 x 0.2 mm; spinel <0.02 mm, euhedral, odd grains in pyroxene

Groundmass: plagioclase 20%, 0.1-0.5 mm, An_{59}, acicular or elongate laths; clinopyroxene 10%, 0.1-0.3 mm, anhedral, poorly developed; magnetite <0.01 mm, disseminated in odd areas; other 20% cryptocrystalline matrix and 20% glassy spheres with plagioclase microlites.

Vesicles: 30%, 0.02-0.5 mm.

Texture: aphyric, intersertal.



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
58	442	B	15	1

Depth:

Visual Description

Aphyric pillow basalt. Pillow rinds common and appear to zone from glass (nonvesicular) to dense brown (moderately weathered) basalt which is aphanitic to fine-grained into dark gray lightly weathered highly vesicular basalt. Vesicular basalt has ~30% vesicles, brown to moderately weathered zone has ~5% vesicles (generally medium sized) and glass generally has no vesicles. Gray basalt has brown vesicular inclusions ~1/2 cm across. Four glassy chill margins. Exterior of pillow rind of Piece 2 is coated with 1 mm thick coating of crystalline calcite.

Thin Section Description – 69 cm

Groundmass: plagioclase 20%, 0.05-0.5 mm, An_{55}, acicular or elongate laths; clinopyroxene 15%, 0.05-0.4 mm; magnetite <0.02 mm, trace; other 30%.

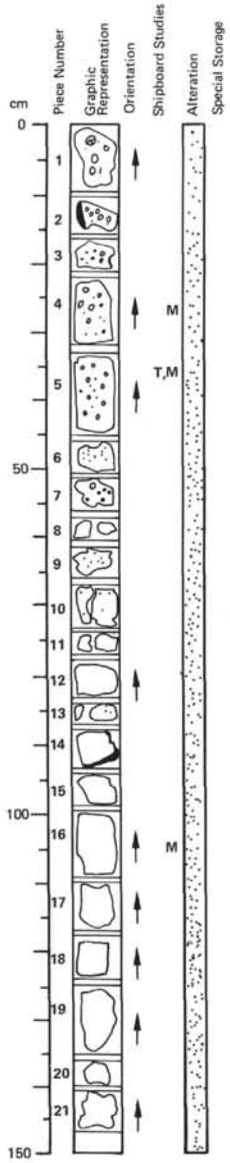
Vesicles: 35%, 0.1-1.5 mm .

Texture: intersertal.

Shipboard Data

Bulk Analysis:	**40 cm**
SiO_2	49.91
Al_2O_3	15.76
Fe_2O_3	1.25
FeO	8.24
MgO	5.85
CaO	12.76
Na_2O	2.80
K_2O	0.45
TiO_2	1.26
P_2O_5	0.40
MnO	0.16
LOI	---
H_2O^+	---
H_2O^-	---
CO_2	---
Cr	49.00
Ni	32.00
Sr	219.00
Zr	88.00

Physical Properties:	**77 cm**
$\overline{V}p$ (km/s)	4.14
Porosity (%)	24.46
Wet Bulk Density	2.42
Grain Density	2.88



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
58	442	B	16	1

Depth: 410.0 to 411.5 m

Visual Description

10-15 cm: pillow rind, oriented vertically, only glass in core.

0-10 cm: lightly weathered aphyric vesicular basalt. Composite vesicles of highly vesicular brown basalt in gray basalt. Fine vesicles ~20% coarse ~3%. Fine-grained.

10-45 cm: dark gray aphyric vesicular basalt, pillow rind on upper fragment. Fine vesicles ~10%, medium ~7%. Fine-grained.

46-40 cm: gray brown aphyric vesicular basalt. Fine vesicles 20%, no medium vesicles.

51-56 cm: reddish gray vesicular basalt with chill margin. Composite vesicles. Medium vesicles ~10% fine ~2%.

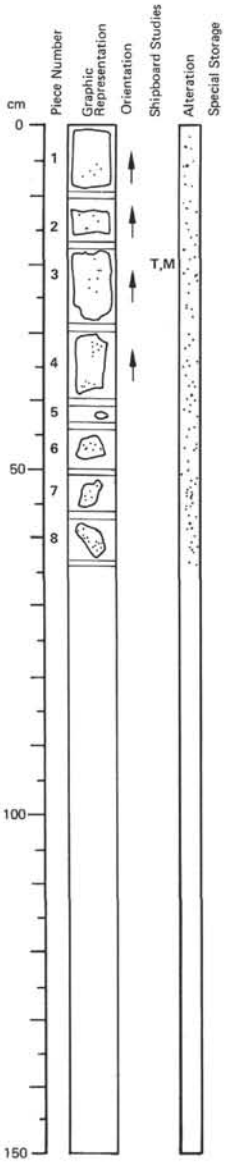
57-146 cm: fine-grained aphyric basalt, <1% fine vesicles at top, none at base of section.

Shipboard Data

Bulk Analysis:	**24 cm**	**47 cm**	**111 cm**
SiO_2	50.21	49.85	50.55
Al_2O_3	16.35	16.20	15.67
Fe_2O_3	1.31	1.24	1.14
FeO	8.63	8.15	7.58
MgO	5.95	5.84	7.77
CaO	11.78	12.78	12.24
Na_2O	3.26	2.73	2.96
K_2O	0.55	0.44	0.35
TiO_2	1.34	1.25	1.16
P_2O_5	0.18	0.21	0.12
MnO	0.16	0.17	0.12
LOI	---	---	---
H_2O^+	---	---	---
H_2O^-	---	---	---
CO_2	---	---	---
Cr	35.00	52.00	50.00
Ni	39.00	42.00	59.00
Sr	208.00	210.00	200.00
Zr	95.00	88.00	81.00

Magnetic Data:	**29 cm**	**35 cm**	**105 cm**
Intensity (emu/cc)	504.8	154.6	349.2
Inclination before demag.	–47.4	–42.2	–45.2
Stable Inclination	---	–43.5	–46.6

Physical Properties:	**120 cm**
$\overline{V}p$ (km/s)	4.47
Porosity (%)	17.65
Wet Bulk Density	2.54
Grain Density	2.87



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG		SITE			HOLE	CORE			SECT.	
5	8	4	4	2	B		1	6		2

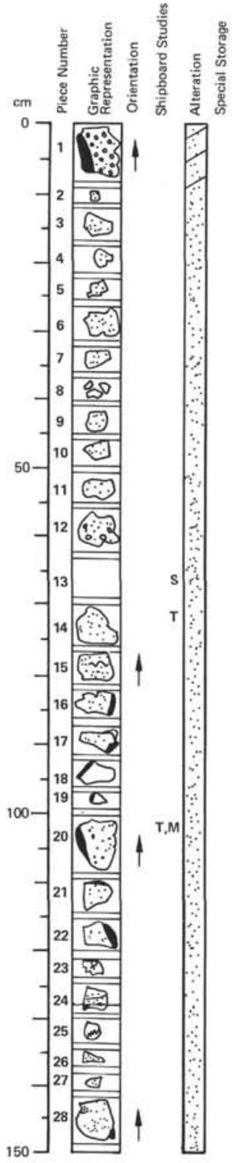
Depth: 411.5 to 411.7 m

Visual Description

0-65 cm: light gray basalt similar to that in the bottom interval of the last section. Vesicularity increases towards base from < 1% to ~5%, fine vesicles.

Shipboard Data

Bulk Analysis:	**15 cm**
SiO_2	49.52
Al_2O_3	14.86
Fe_2O_3	1.20
FeO	7.92
MgO	6.96
CaO	11.37
Na_2O	3.00
K_2O	0.49
TiO_2	1.29
P_2O_5	0.14
MnO	0.13
LOI	—
H_2O^+	—
H_2O^-	—
CO_2	—
Cr	42.00
Ni	39.00
Sr	204.00
Zr	93.00



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG		SITE			HOLE	CORE			SECT.	
5	8	4	4	2	B		1	7		1

Depth: 417.0 to 418.5 m

Visual Description

Aphyric fine-grained to aphanitic, gray basalt, 10-25% vesicles, < 1% very small plagioclase phenocrysts. Some samples have composite vesicles, lightly weathered.

Glass at Pieces 1, 16, 17, 18, 19, 20, 21, 22, 23, 28.

Piece 1 has crystalline calcite covering glass rind, and rind has a thick palagonite zone 2-3 mm thick.

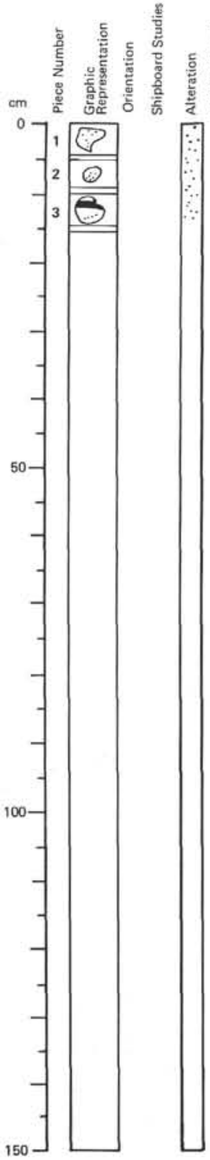
Piece 17 has indurated sediment with palagonite fragments adhering to fracture surface of the basalt.

Shipboard Data

Bulk Analysis:	**14 cm**	**64 cm**	**142 cm**
SiO_2	49.74	50.46	50.60
Al_2O_3	16.10	17.07	14.39
Fe_2O_3	1.26	1.21	1.34
FeO	8.32	8.00	8.87
MgO	5.89	5.64	6.19
CaO	12.76	13.06	12.03
Na_2O	2.71	3.10	3.07
K_2O	0.43	0.55	0.39
TiO_2	1.27	1.24	1.59
P_2O_5	0.20	0.18	0.24
MnO	0.15	0.16	0.17
LOI	—	—	—
H_2O^+	—	—	—
H_2O^-	—	—	—
CO_2	—	—	—
Cr	57.00	58.00	59.00
Ni	43.00	50.00	47.00
Sr	211.00	210.00	185.00
Zr	94.00	87.00	121.00

Magnetic Data:	**104 cm**
Intensity (emu/cc)	491.2
Inclination before demag.	− 59.9
Stable Inclination	− 60.4

Physical Properties:	**104 cm**
$\overline{V}p$ (km/s)	4.19



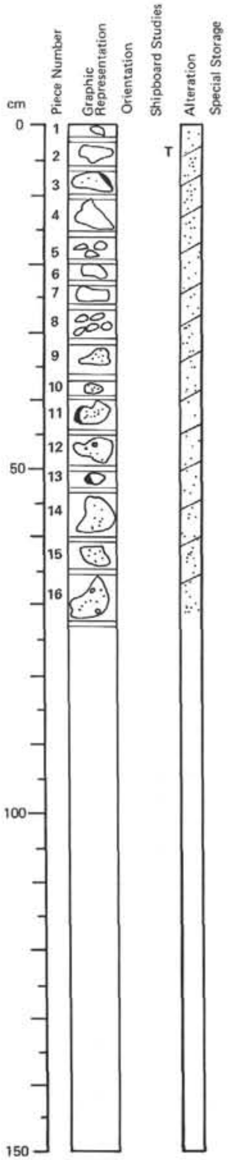
VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
58	442	B	17	2

Depth: 418.5 to 418.7 m

Visual Description

Aphyric aphanitic vesicular basalt pillow rinds, < 1% very small plagioclase phenocrysts. Pieces 3 and 1 have sediment/palagonite rim 1 cm thick, lightly altered.



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
58	442	B	18	1

Depth:

Visual Description

Vesicular gray aphyric pillow basalt and rubble. Talux nature of zone clearly indicated by presence of angular fragments of basalt covered with free growing crystalline calcite on all sides: Pices 2, 4, 13. Glass rinds on Pieces 3 and 13, 1-20% vesicles.

Thin Section Description – 4 cm

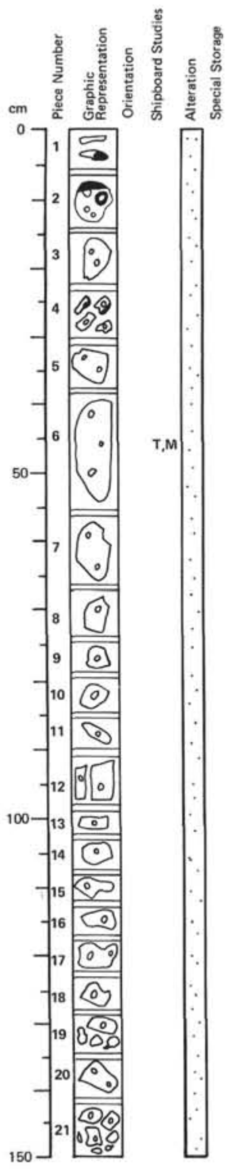
Phenocrysts: plagioclase 0.5 x 0.2 mm, laths, zoned; clinopyroxene 0.2 x 0.3 mm, subhedral, hour glass zoning.

Groundmass: plagioclase 25%, 0.1-1 mm, acicular or elongate laths; clinopyroxene 25%, 0.01-0.1 mm, anhedral, mainly finely crystalline; magnetite 0.5%, <0.01 mm, granular; other 9.5%, cryptocrystalline matrix.

Texture: intersertal, very sparsely phyric.

Shipboard Data

Bulk Analysis:	**46 cm**
SiO_2	50.56
Al_2O_3	15.23
Fe_2O_3	1.27
FeO	8.40
MgO	5.87
CaO	12.40
Na_2O	3.24
K_2O	0.34
TiO_2	1.57
P_2O_5	0.25
MnO	0.16
LOI	—
H_2O^+	—
H_2O^-	—
CO_2	---
Cr	59.00
Ni	48.00
Sr	189.00
Zr	123.00



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
58	442	B	19	1

Depth: 436.0 to 437.5 m

Visual Description

0-145 cm: basalt representing top of lava flow. Aphyric, fine-grained. Pieces 1 and 2 have glass on the one side on the surface. The glass is dark, the rock – dark-gray, the border is gray (1-2 mm). Vesicular, lightly altered. Vesicles about 5-10% (<1 mm). Vesicles 1-2 mm, 2%.

14-150 cm: basalt, aphyric, dark gray, vesicular, lightly altered. Vesicles 10-15% (<1 mm), unfilled.

100-150 cm: dense basalt.

Thin Section Description – 42 cm

Groundmass: plagioclase 25%, 0.2-1.5 mm, An_{64}, euhedral, subhedral; clinopyroxene 30%, 0.03-0.5 mm, augite, anhedral; glass + Mt 20%, in groundmass and around vesicles.

Vesicles: 25%, 0.1-2.0 mm, round irregular.

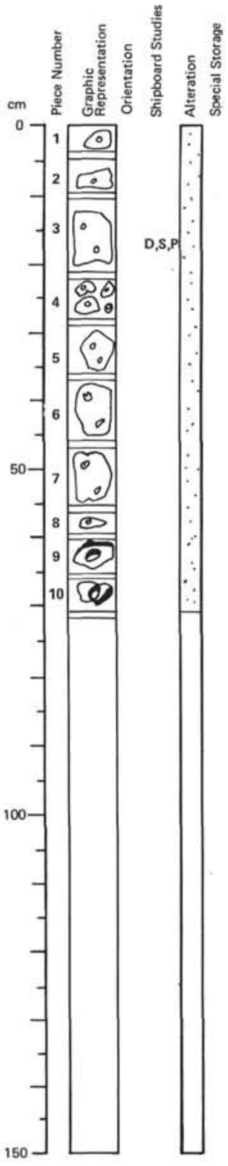
Texture: intergranular-intersertal.

Alteration: very few zeolites.

Shipboard Data

Bulk Analysis:	**45 cm**
SiO_2	51.65
Al_2O_3	14.87
Fe_2O_3	1.28
FeO	8.48
MgO	6.64
CaO	11.48
Na_2O	3.75
K_2O	0.37
TiO_2	1.60
P_2O_5	0.16
MnO	0.15
LOI	—
H_2O^+	—
H_2O^-	—
CO_2	—
Cr	58.00
Ni	59.00
Sr	173.00
Zr	123.00

Magnetic Data:	**43 cm**
Intensity (emu/cc)	217.2
Inclination before demag.	–31.0
Stable Inclination	–34.3



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
58	442	B	19	2

Depth: 437.5 to 438.2 m

Visual Description

0-28 cm: upper 28 cm appears identical to that described at the base of Section 1.

28-60 cm: similar basalt but more vesicular. Aphyric, dark gray, lightly altered. Vesicles <0.5 mm, 15%.

60-70 cm: pillow lava. Pieces 9 and 10 with glass on the one side of surface. Basalt is dense (fine-grained) dark gray, lightly altered. Vesicles <2 mm, 5-10%. Basalt close to that of top of lava flow 0-14 cm, Section 1), but fresher.

Thin Section Description – 62 cm

Phenocrysts: plagioclase 3%, 0.7-0.1 mm, An_{60}, euhedral; clinopyroxene 1%, 0.5-0.1 mm, augite, subhedral.

Groundmass: plagioclase mictolite; clinopyroxene mictolite.

Vesicles: 30%, 0-1.5 mm, round, irregular, unfilled.

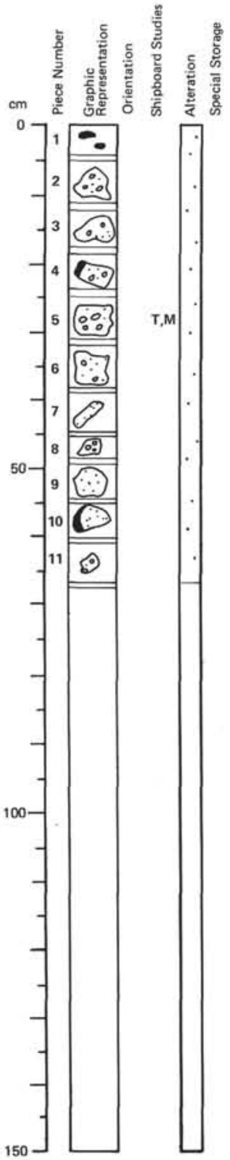
Texture: variolitic.

Shipboard Data

Bulk Analysis:	**36 cm**	**51 cm**
SiO_2	50.93	50.65
Al_2O_3	15.78	15.46
Fe_2O_3	1.26	1.28
FeO	8.32	8.48
MgO	5.64	5.76
CaO	12.35	12.22
Na_2O	3.56	3.62
K_2O	0.38	0.44
TiO_2	1.59	1.53
P_2O_5	0.20	0.18
MnO	0.16	0.19
LOI	—	—
H_2O^+	—	—
H_2O^-	—	—
CO_2	—	—
Cr	59.00	60.00
Ni	57.00	63.00
Sr	189.00	188.00
Zr	129.00	123.00

Magnetic Data:	**62 cm**
Intensity (emu/cc)	182.8
Inclination before demag.	–27.8
Stable Inclination	–36.4

Physical Properties:	**12 cm**
$\overline{V}p$ (km/s)	5.25
Porosity (%)	9.11
Wet Bulk Density	2.80
Grain Density	2.97



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
58	442	B	20	1

Depth: 445.5 to 446.2 m

Visual Description

0-66 cm: pillow lava, aphyric, fine-grained, light-gray to gray, vesicular, lightly altered. Pieces at 0-4 cm, 18-24 cm, 55-60 cm: have glass veins. Vesicles 30-40% (<5-7 mm). Vesicles are 2-7 mm (3-5%) in Piece 5 at 31 cm and 45-48 cm interval.

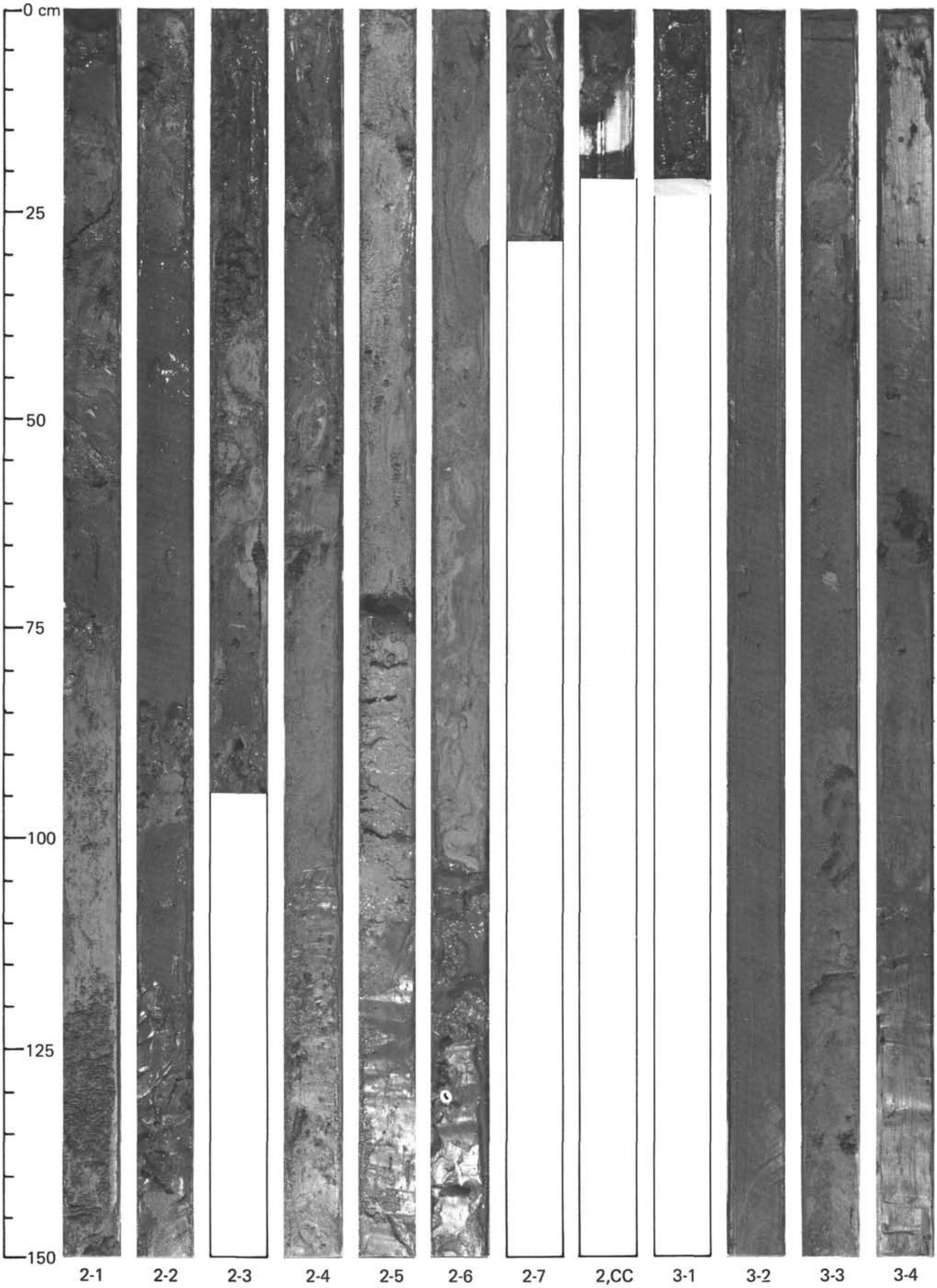
Shipboard Data

Bulk Analysis:	**50 cm**
SiO_2	50.37
Al_2O_3	15.07
Fe_2O_3	1.33
FeO	8.79
MgO	5.78
CaO	12.13
Na_2O	3.17
K_2O	0.54
TiO_2	1.56
P_2O_5	0.21
MnO	0.17
LOI	—
H_2O^+	—
H_2O^-	—
CO_2	—
Cr	64.00
Ni	41.00
Sr	179.00
Zr	124.00

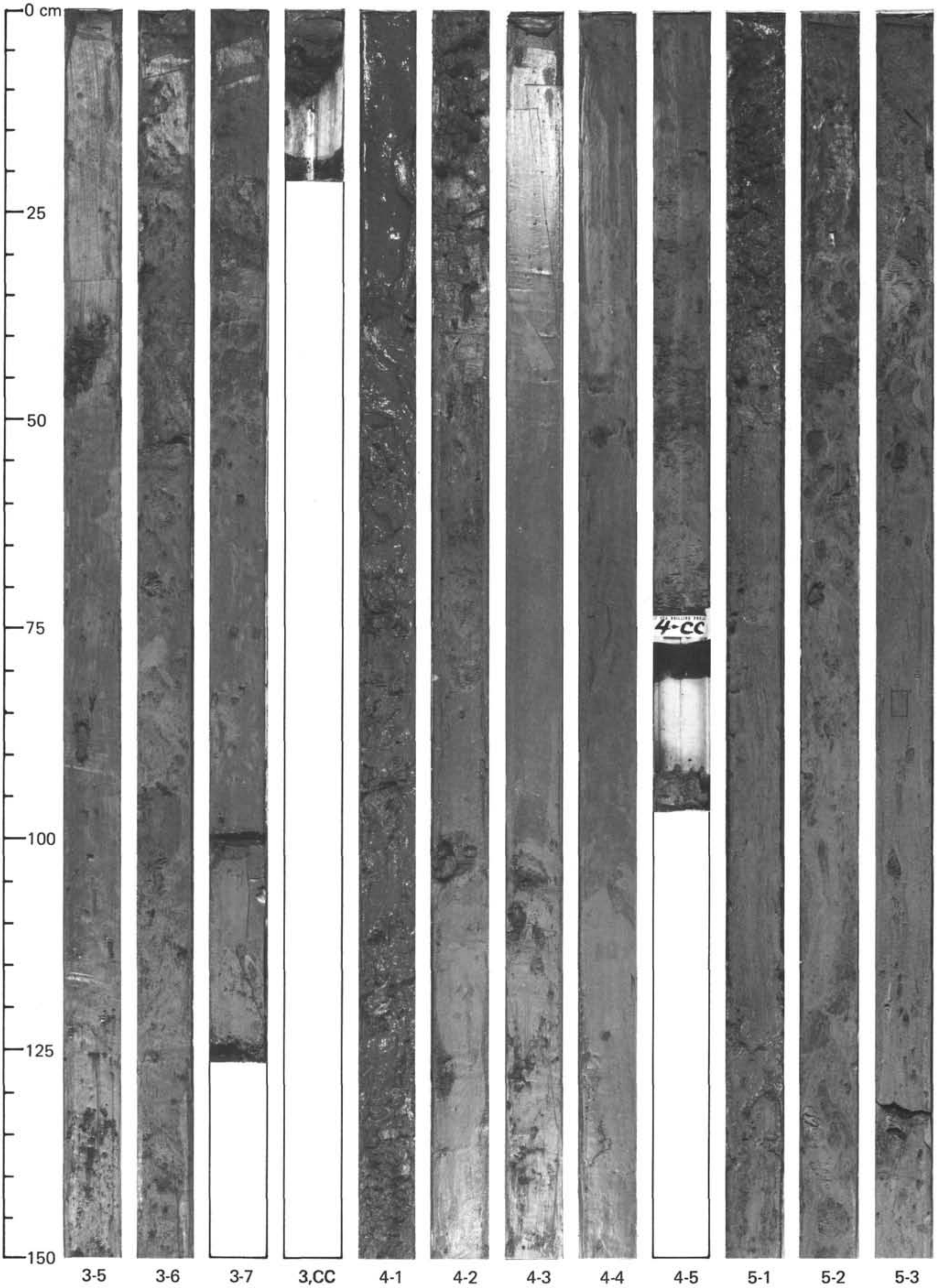
Magnetic Data:	**27 cm**
Intensity (emu/cc)	387.9
Inclination before demag.	−22.1
Stable Inclination	−21.6

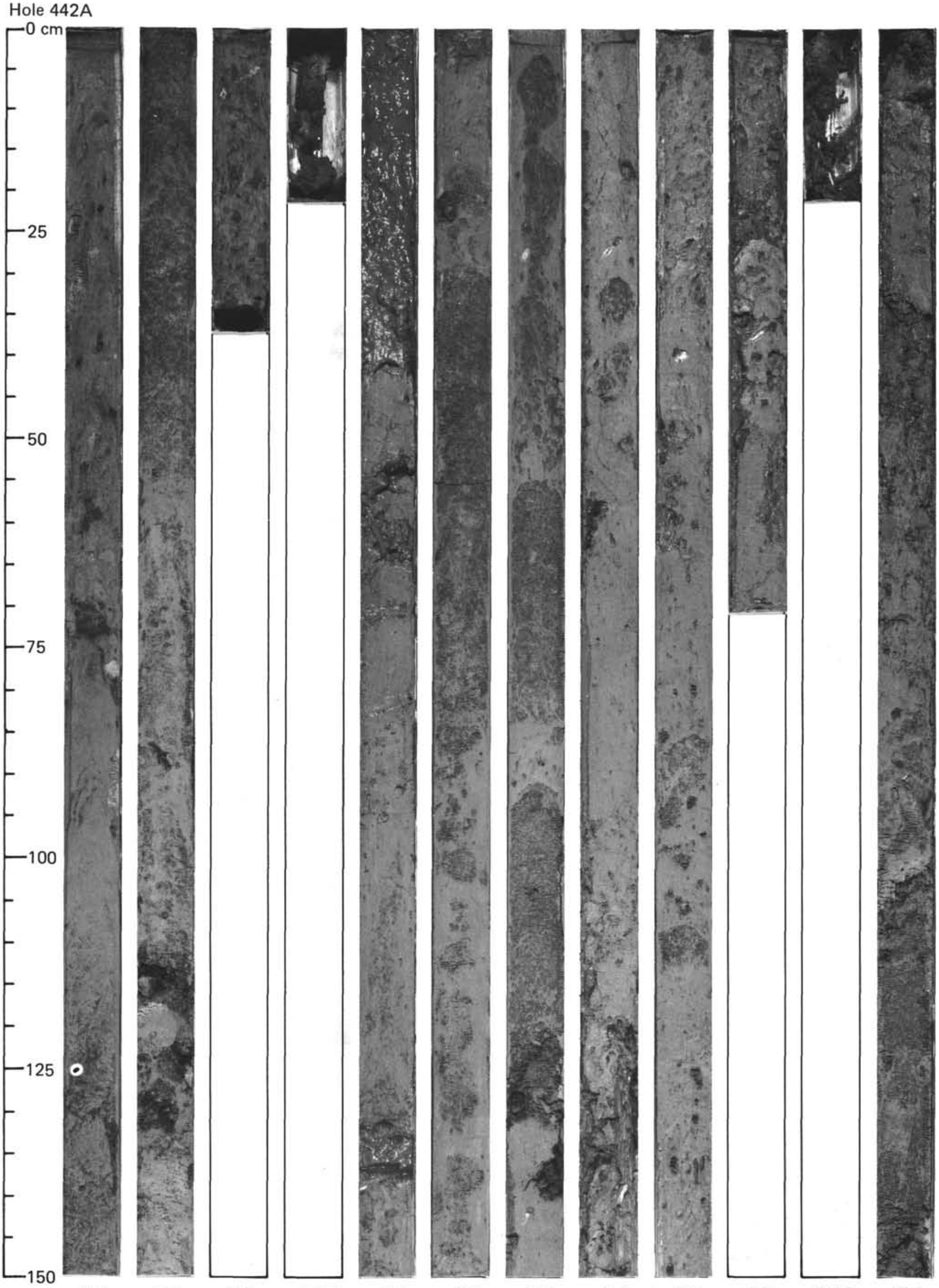
Physical Properties:	**27 cm**
$\bar{V}p$ (km/s)	4.08

Hole 442A (no photograph available for Cores 442-1 and 442A-1)



Hole 442A




Hole 442A
0 cm
25
50
75
100
125
150
5-4
5-5
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5,CC
6-1
6-2
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6-4
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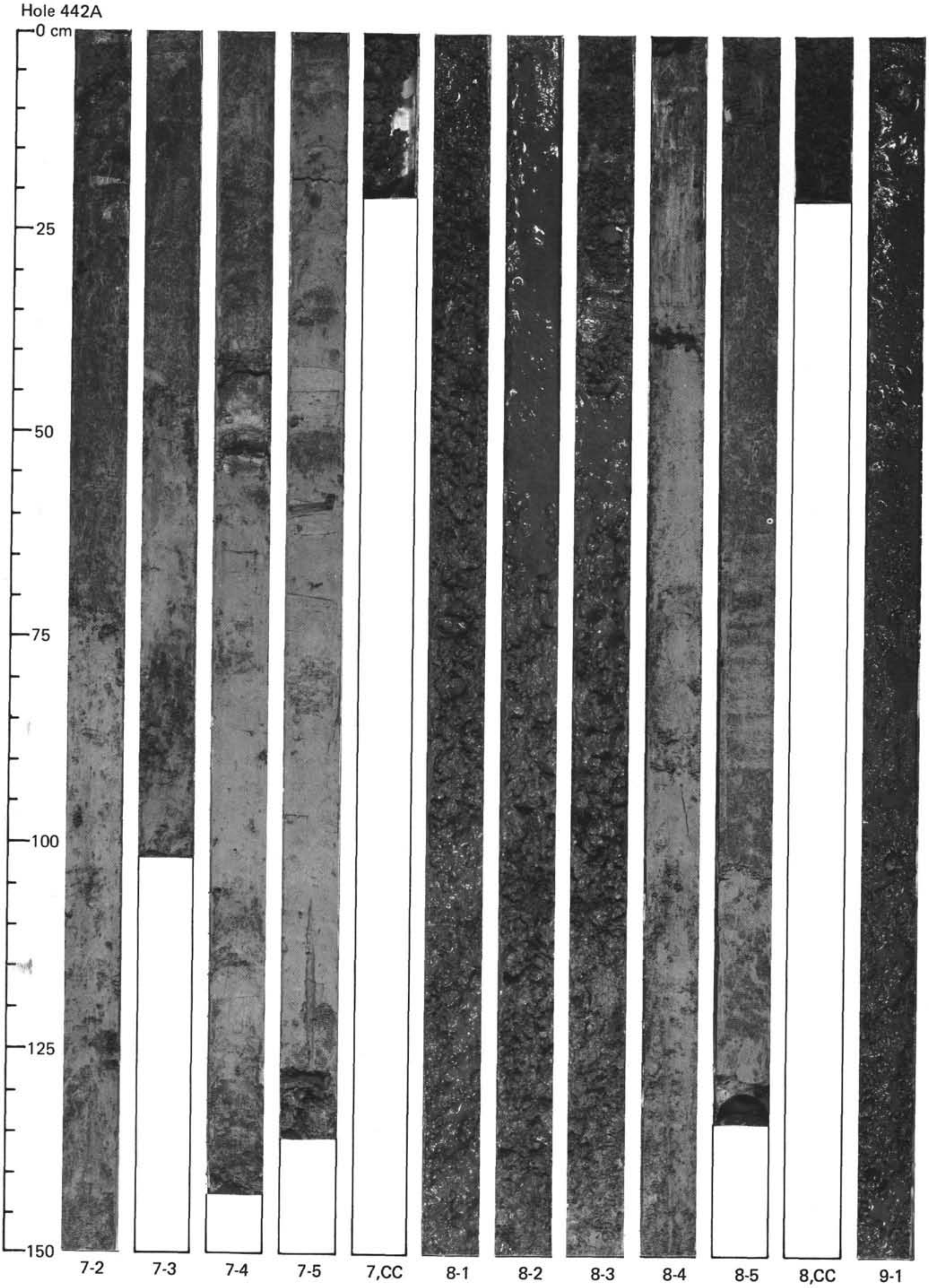
6-6
6,CC
7-1


Hole 442A
0 cm
25
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75
100
125
150
7-2
7-3
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7-5
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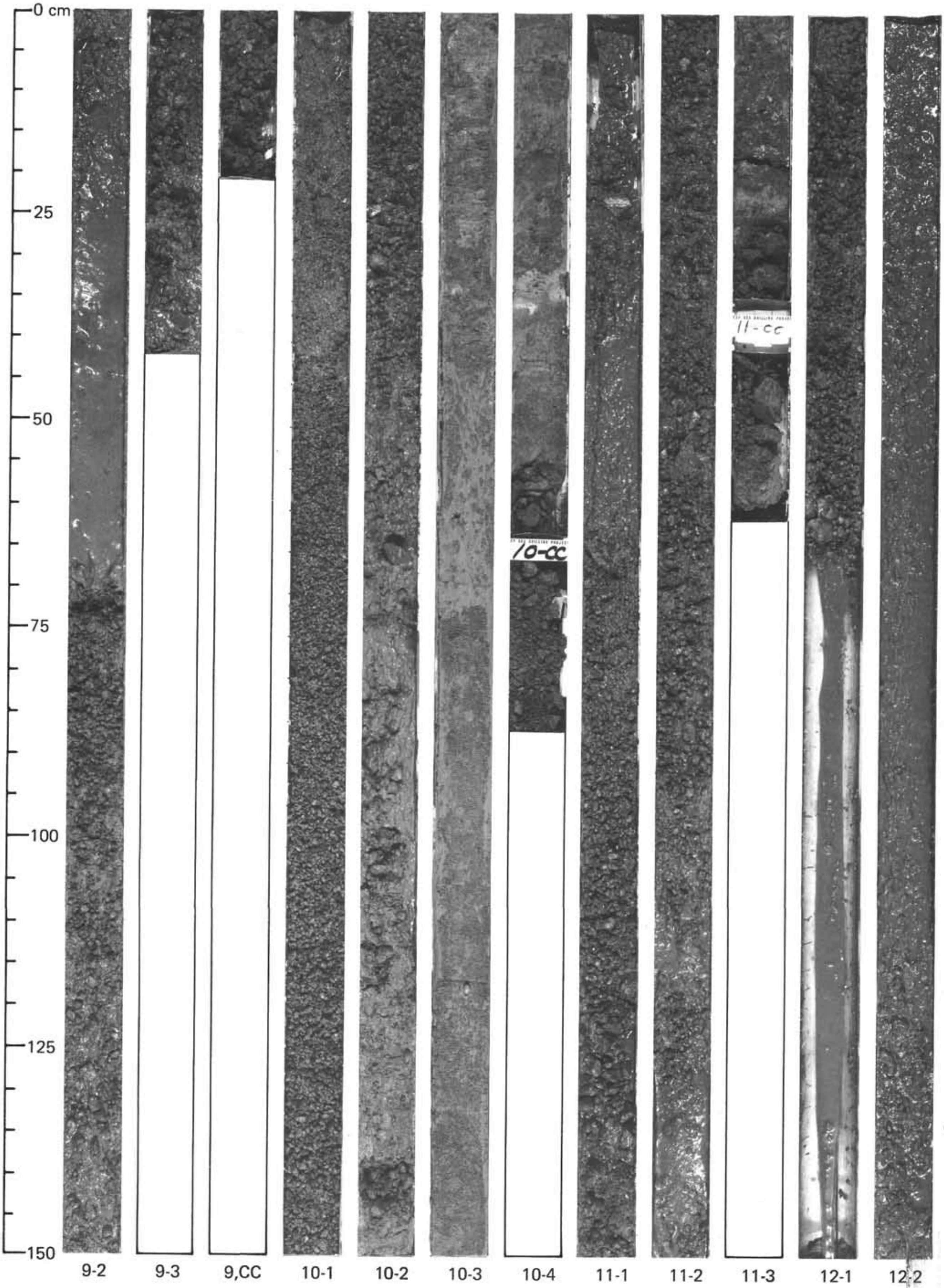
8-2
8-3
8-4
8-5
8,CC
9-1

Hole 442A


0 cm
25
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150
9-2
9-3
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10-1
10-2
10-3
10-4
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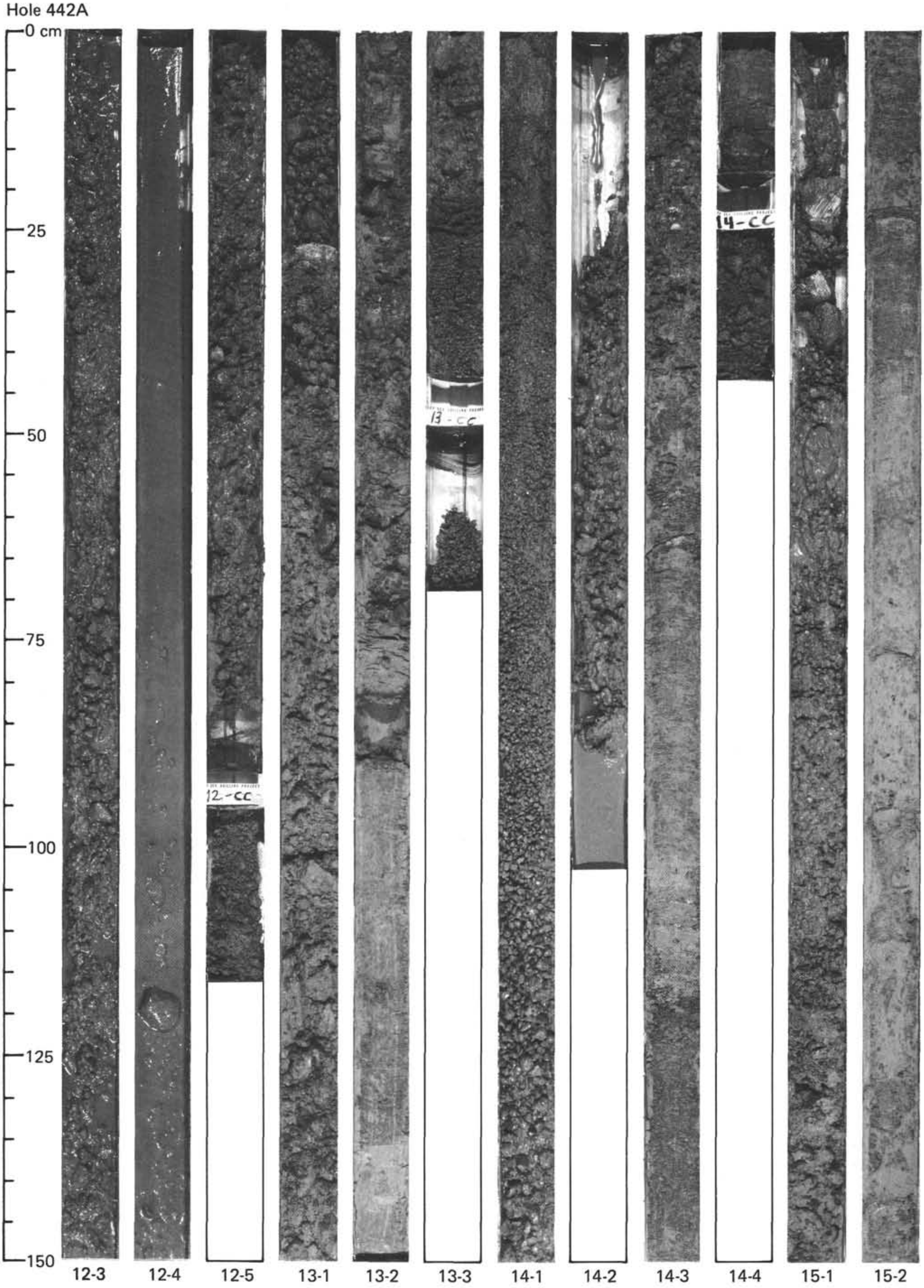
12-2
10-CC
11-CC


Hole 442A
0 cm
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12-3
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12-5
12-CC
13-1
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13-CC
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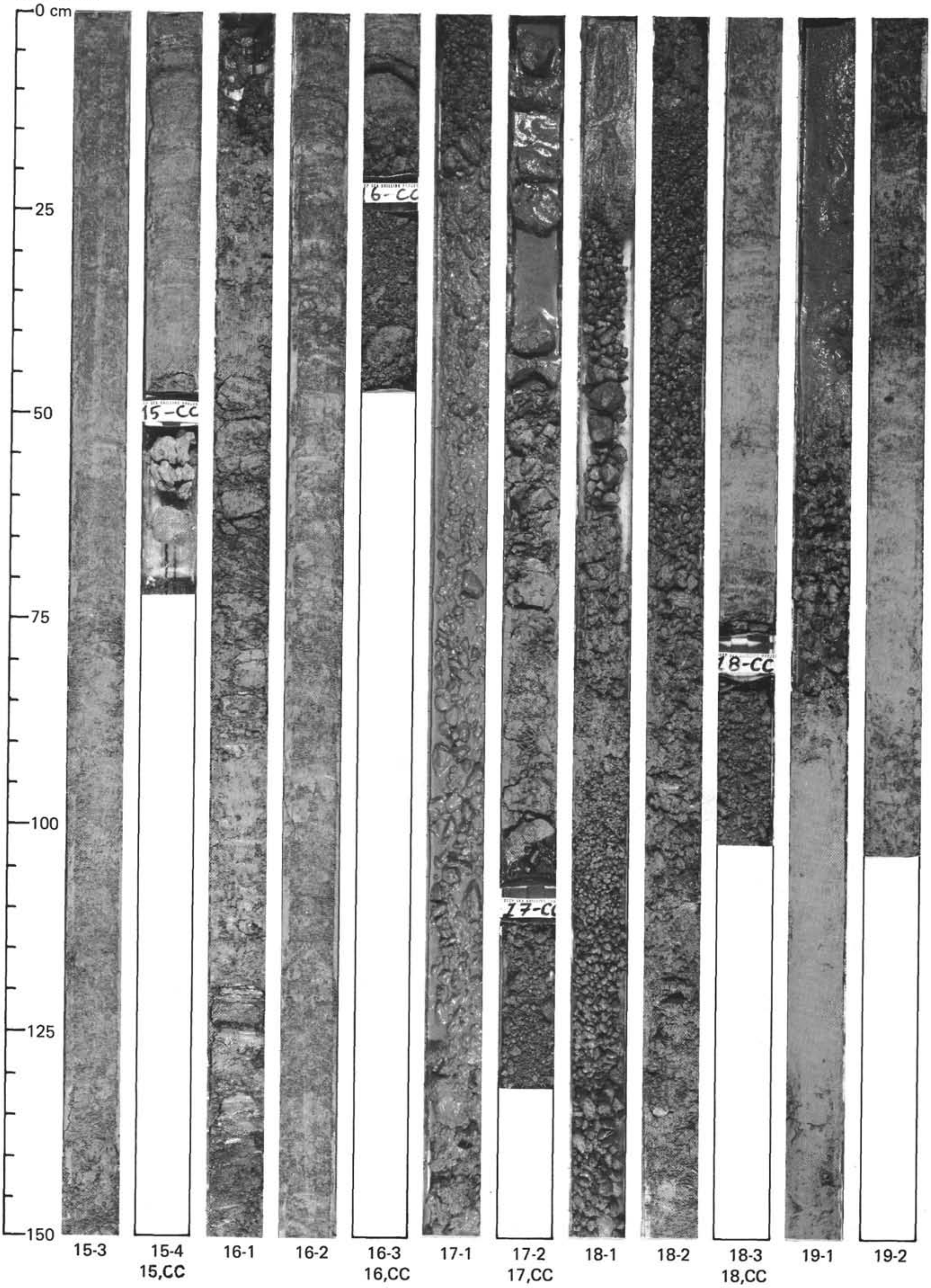
14-2
14-3
14-4
14-CC
15-1
15-2

Hole 442A


0 cm
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15-CC
16-CC
17-CC
18-CC
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15,CC
16-1
16-2
16-3
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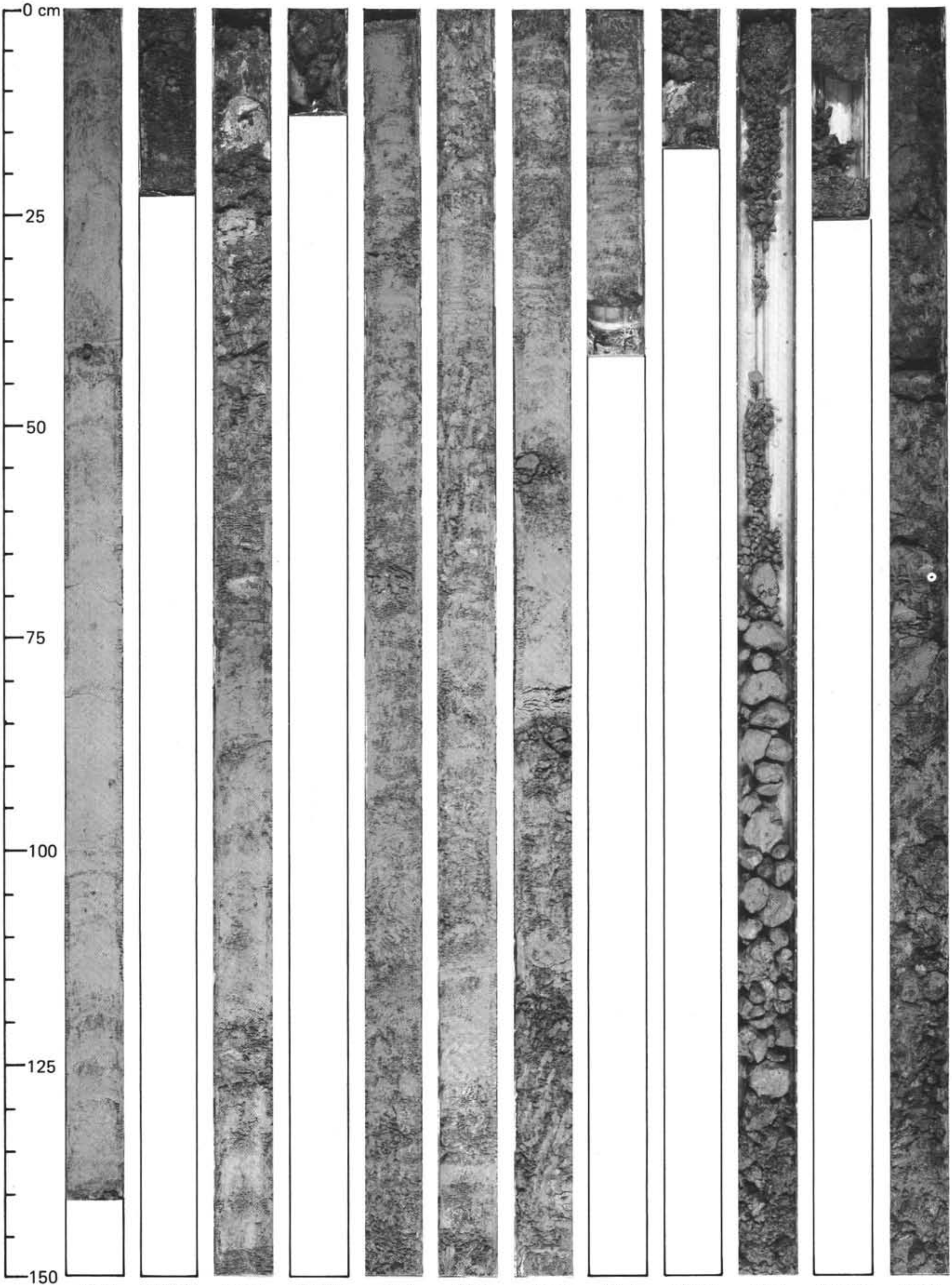
17,CC
18-1
18-2
18-3
18,CC
19-1
19-2

Hole 442A


0 cm
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50
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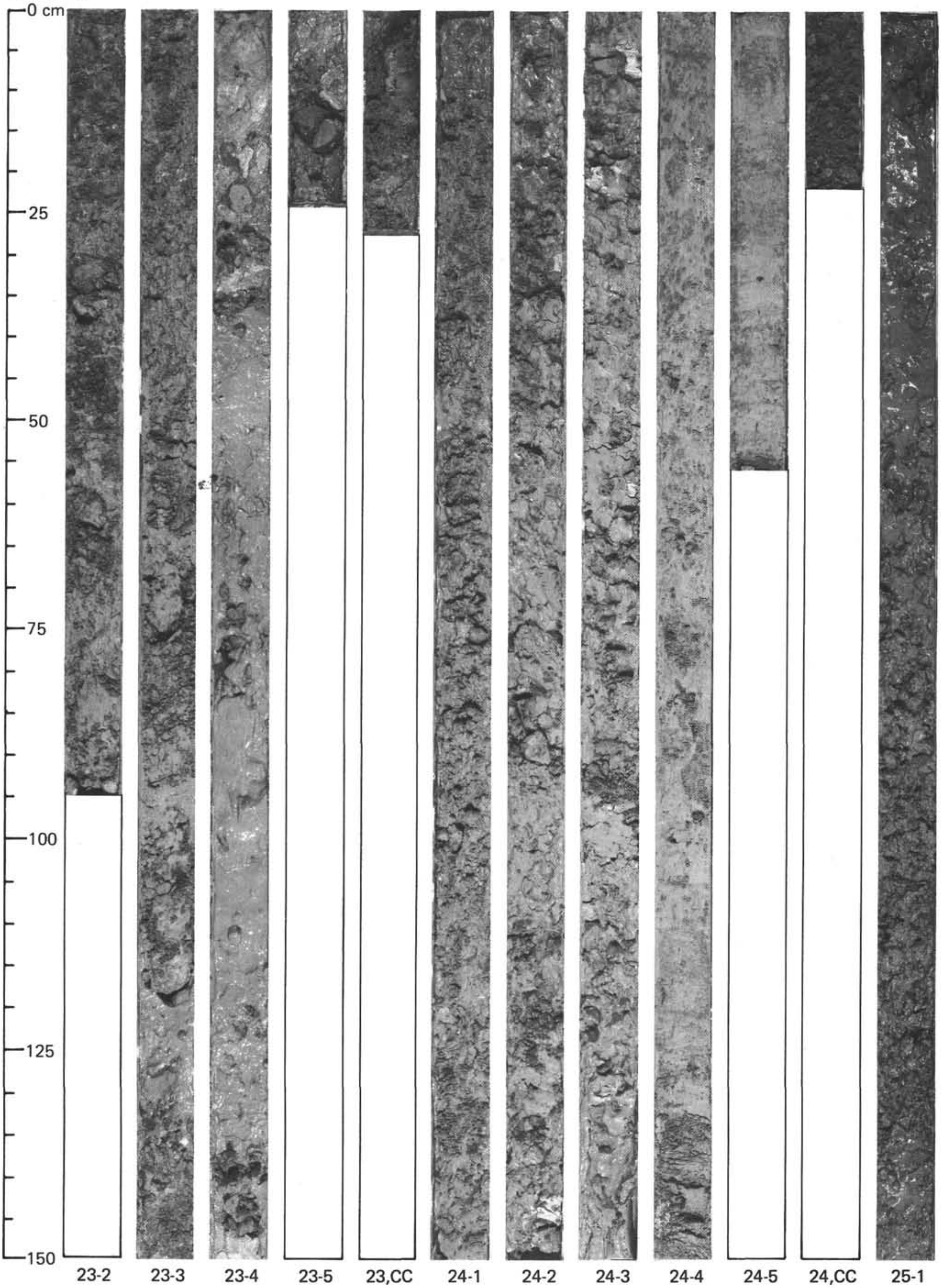
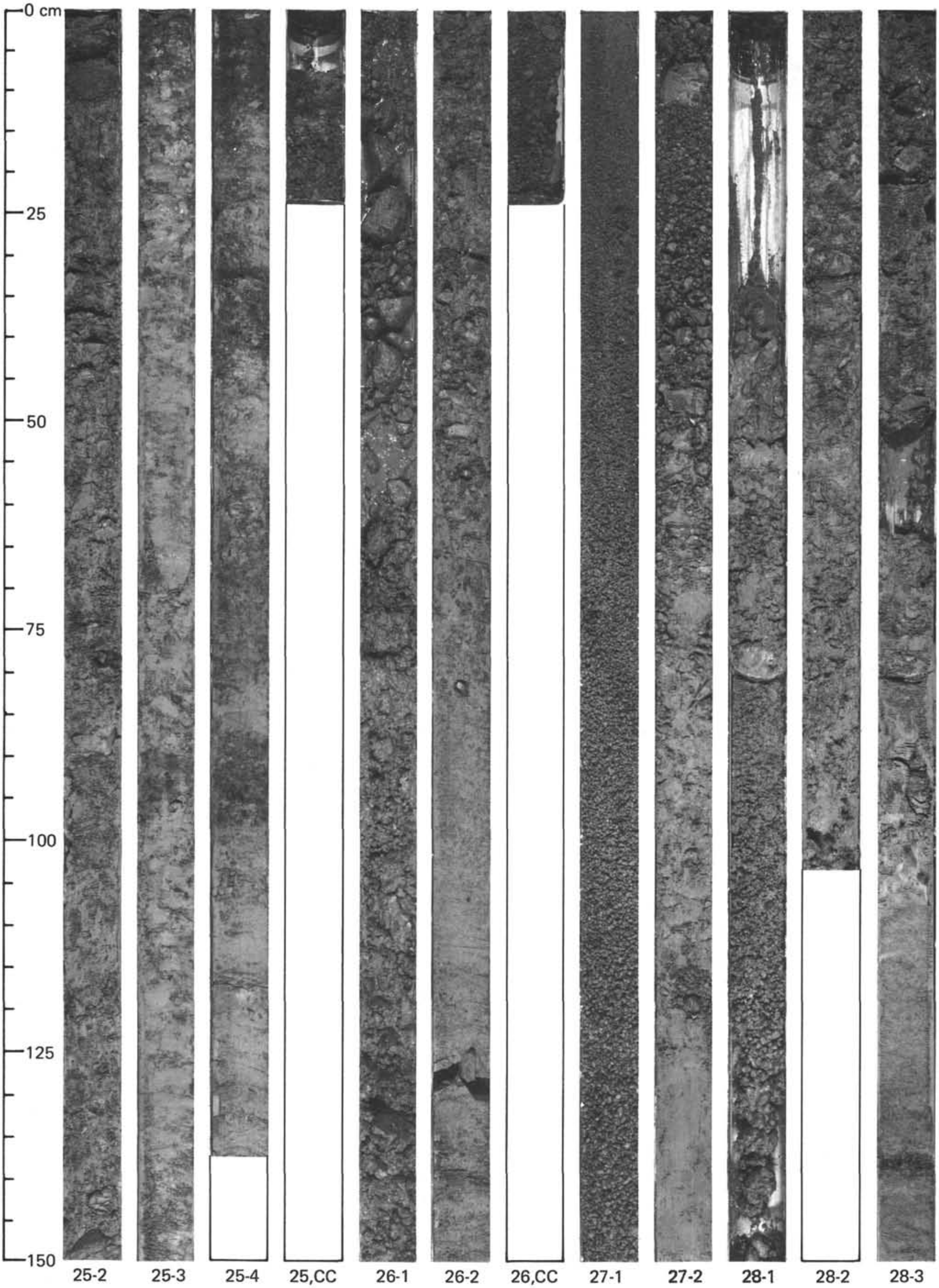
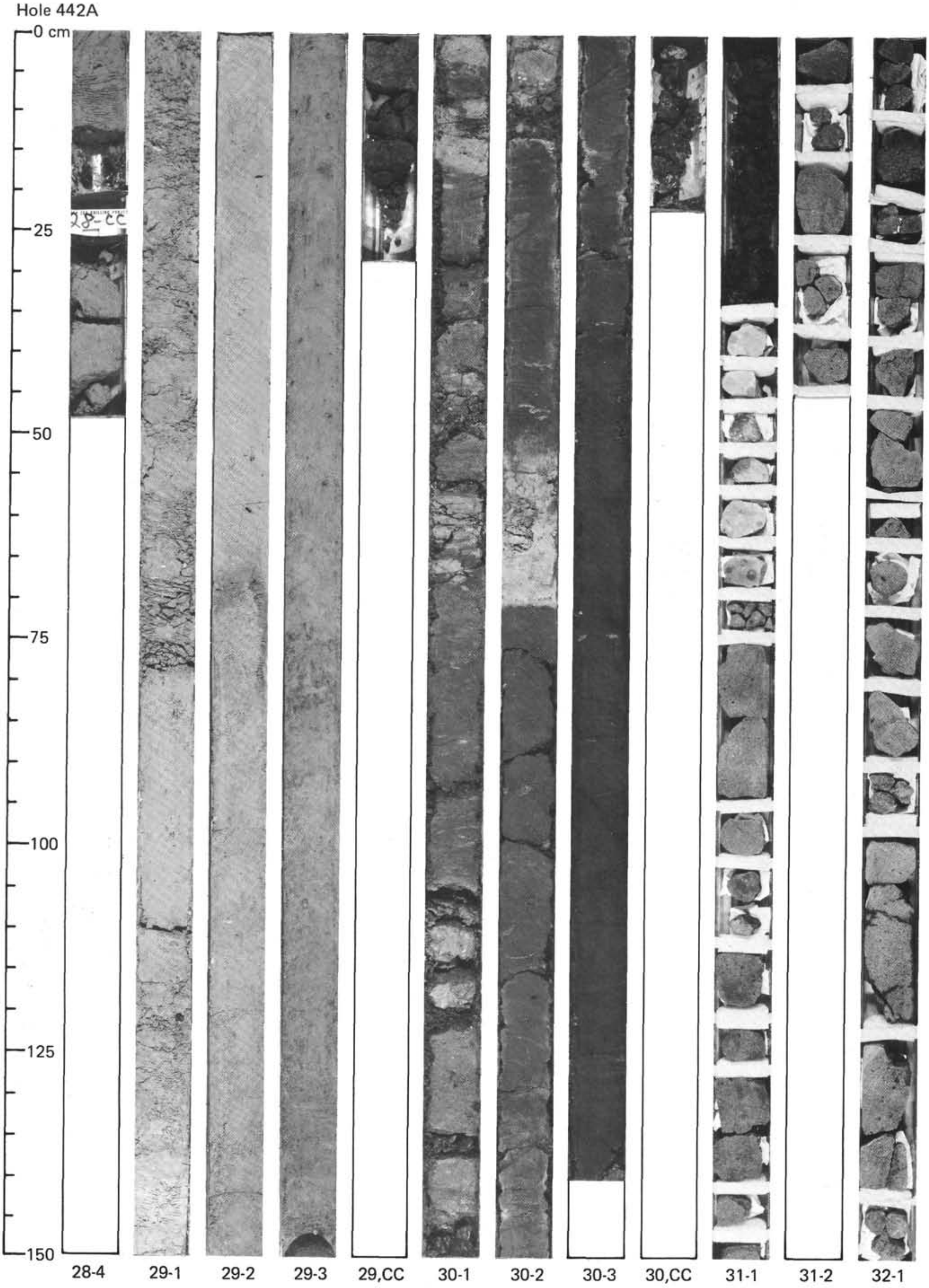
100
125
150
19-3
19,CC
20-1
20,CC
21-1
21-2
21-3
21-4
21,CC
22-1
22,CC
23-1

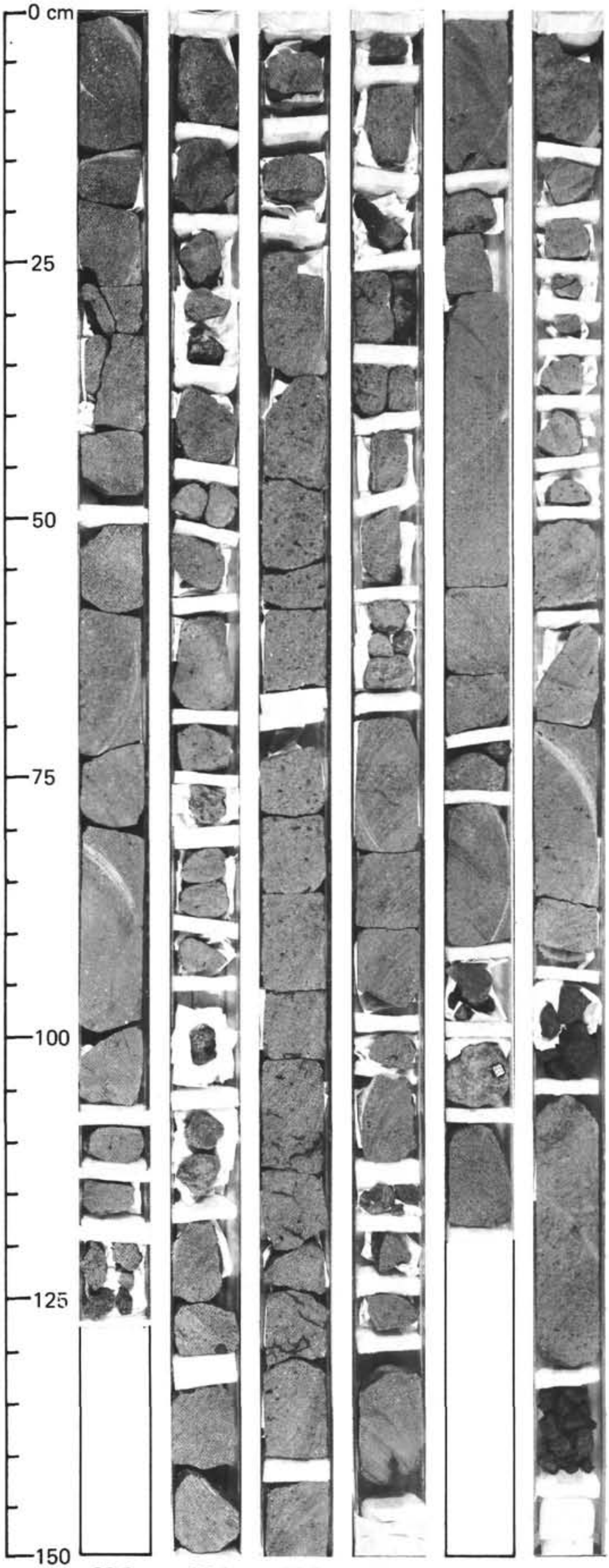
Hole 442A


0 cm
25
50
75
100
125
150
23-2
23-3
23-4
23-5
23,CC
24-1
24-2
24-3
24-4
24-5
24,CC
25-1

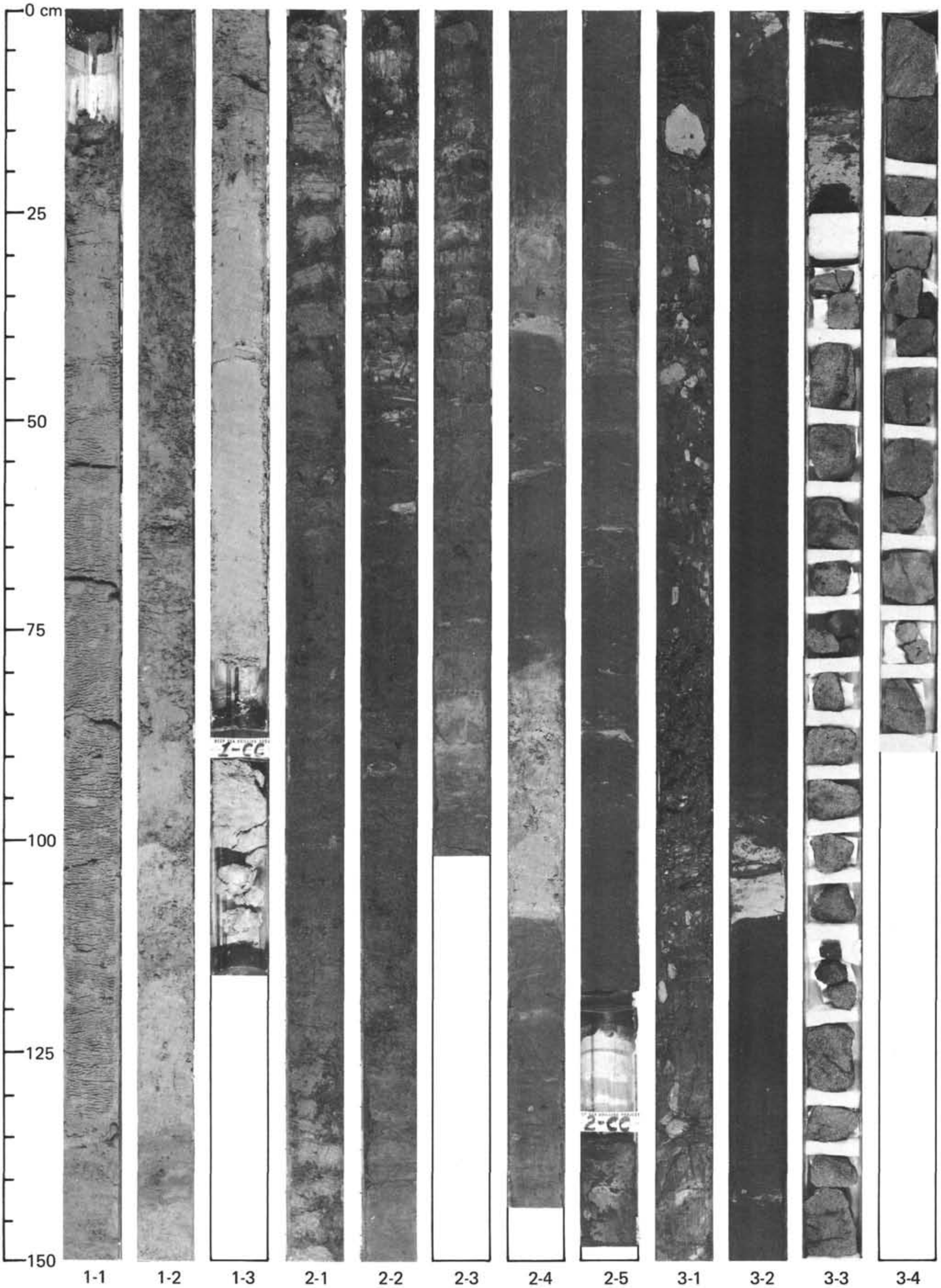
Hole 442A


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

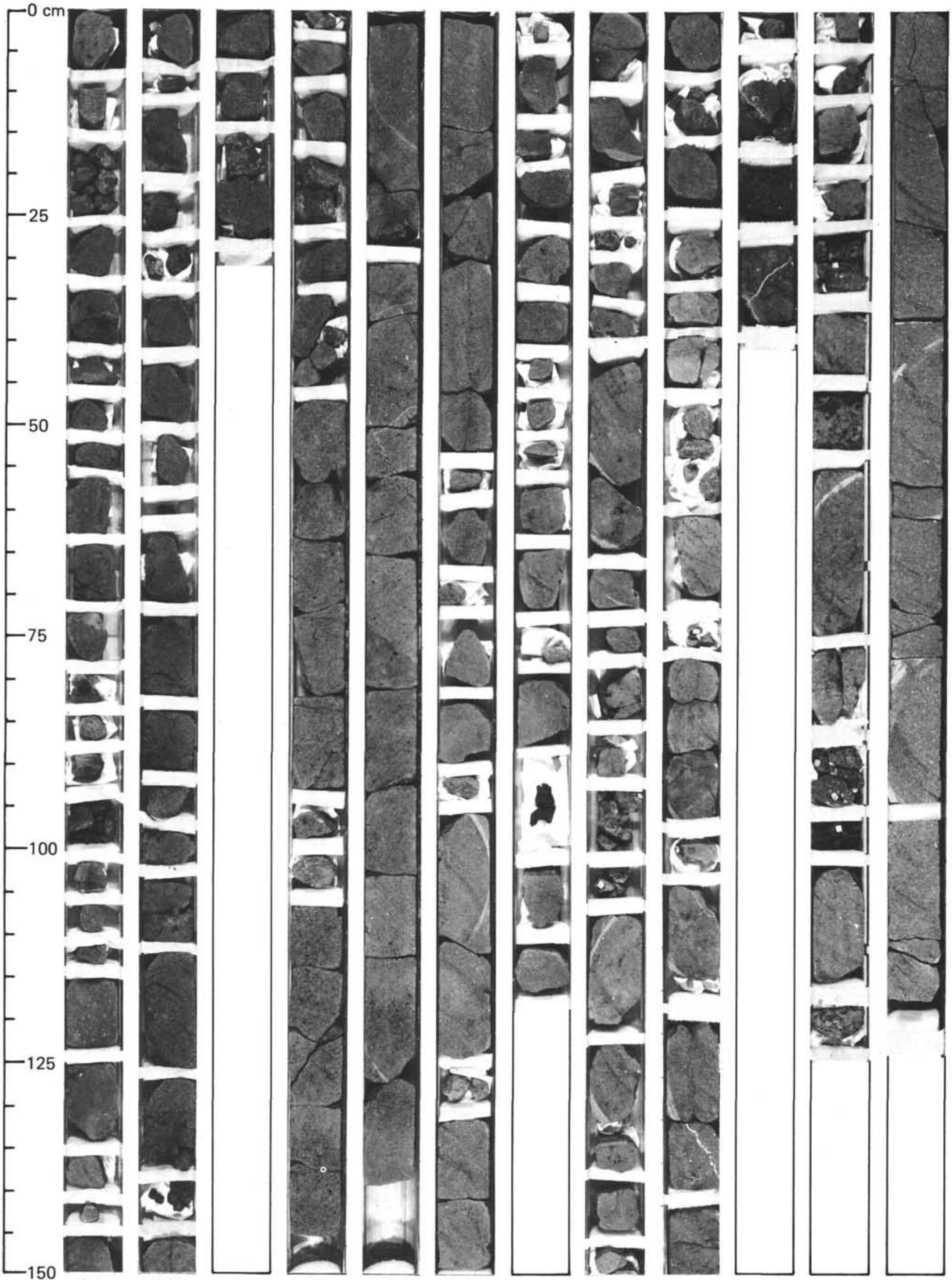

Hole 442A
0 cm
25
50
75
100
125
150
28-CC
28-4
29-1
29-2
29-3
29,CC
30-1
30-2
30-3
30,CC
31-1
31-2
32-1

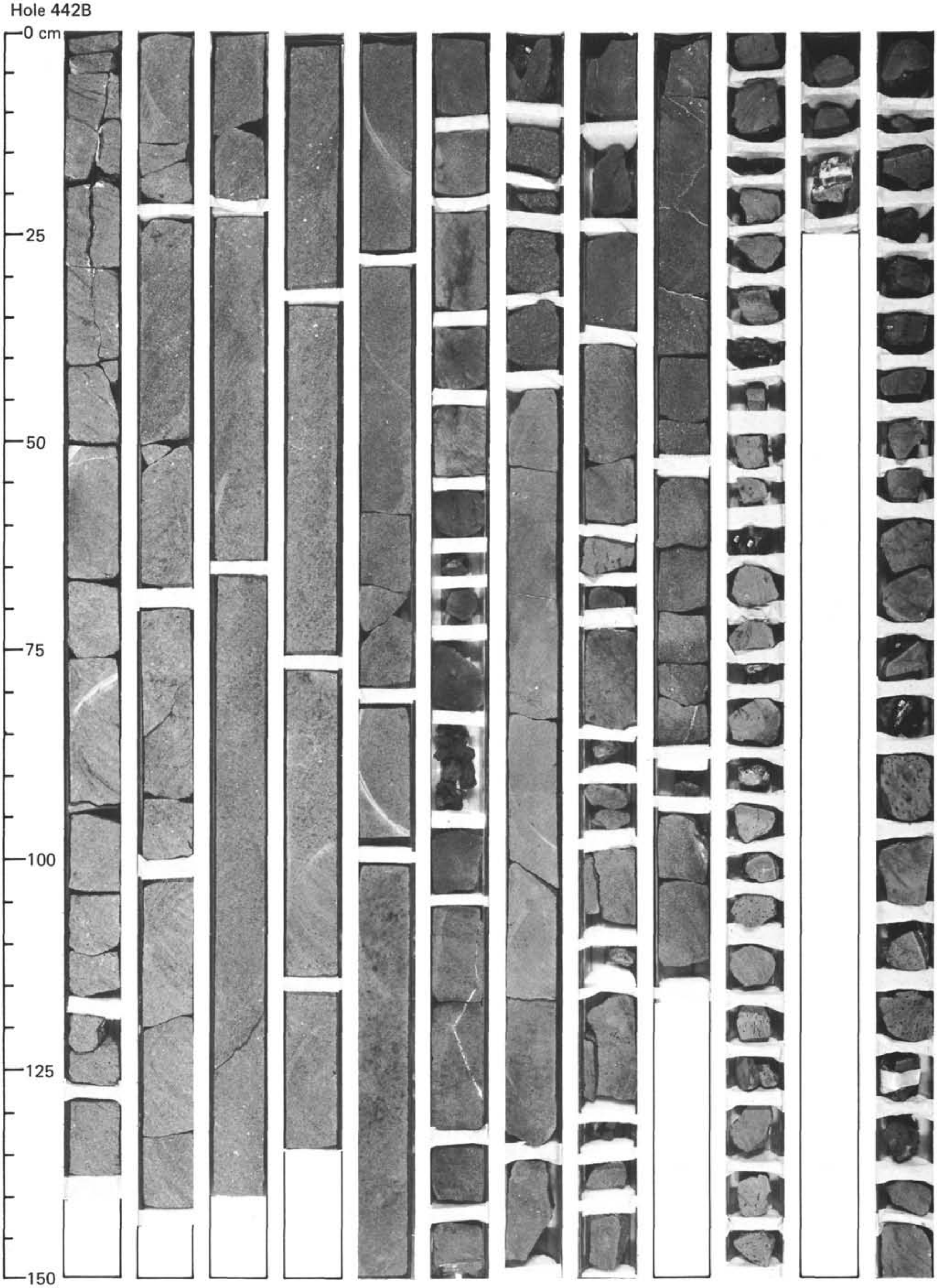

0 cm
25
50
75
100
125
150
32-2
33-1
33-2
33-3
33-4
34-1

Hole 442B

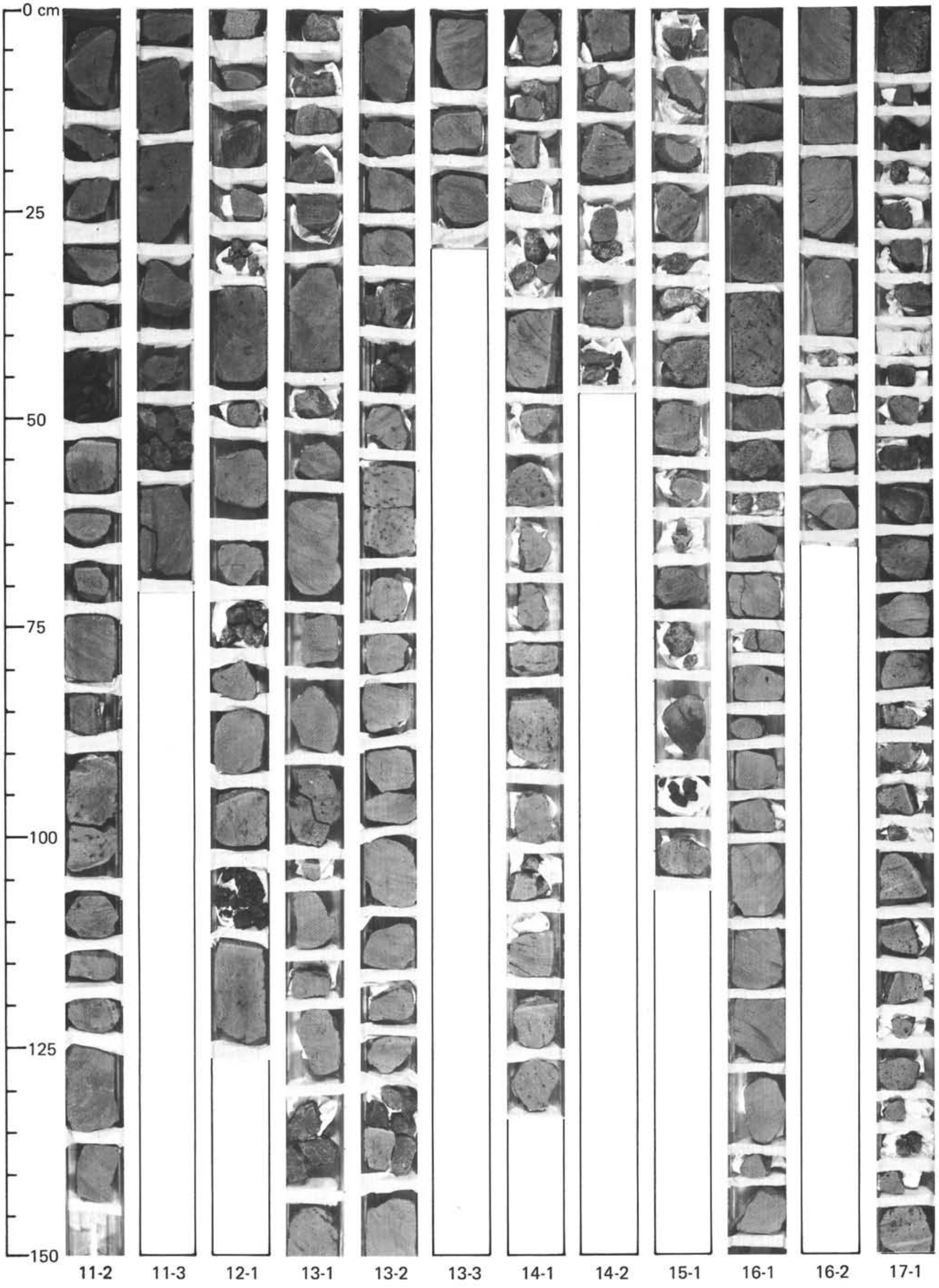


Hole 442B




Hole 442B
0 cm
25
50
75
100
125
150
8-2
8-3
8-4
8-5
8-6
8-7
9-1
9-2
9-3
10-1
10-2
11-1

Hole 442B


0 cm
25
50
75
100
125
150
11-2
11-3
12-1
13-1
13-2
13-3
14-1
14-2
15-1
16-1
16-2
17-1

Hole 442B