2. SITE 482[1]

Shipboard Scientific Party[2]

HOLE 482

Date occupied: January 24, 1979

Date departed: January 25, 1979

Time on hole: 20.1 hours

Position: 22°47.38′N; 107°59.63′W

Water depth (sea level; corrected m, echo-sounding): 2998

Water depth (rig floor; corrected m, echo-sounding): 3015

Bottom felt (m, drill pipe): 3015

Penetration (m): 57.0

Number of cores: 1

Total length of cored section (m): 4.0

Total core recovered (m): 3.94

Core recovery (%): 99

Oldest sediment cored:
Depth sub-bottom (m): 4.0
Nature: Silty clay
Age: Quaternary

Principal results: Hole 482 was a wash-in test to determine how much casing to use for setting the re-entry cone for Hole 482C. A single mudline core of Quaternary silty clay was recovered.

HOLE 482A

Date occupied: January 25, 1979

Date departed: January 25, 1979

Time on hole: 6.3 hours

Position: 22°47.38′N; 107°59.60′W

Water depth (sea level; corrected m, echo-sounding): 2998

Water depth (rig floor; corrected m, echo-sounding): 3015

Bottom felt (m, drill pipe): 3015

Penetration (m): 44.0

Number of cores: 5

Total length of cored section (m): 44.0

Total core recovered (m): 33.25

Core recovery (%): 76

Oldest sediment cored:
Depth sub-bottom (m): 44.0
Nature: Silty clay
Age: Quaternary
Measured velocity (km/s): 1.5

Principal results: Hole 482A, located about 100 meters east of Hole 482, was a single bit hole designed to test basement drilling conditions prior to attempting a deep re-entry hole. The hole was abandoned at 44 meters sub-bottom because of a failure in the ship's positioning system. The recovered core consists of silty clay of Quaternary age.

HOLE 482B

Date occupied: January 25, 1979

Date departed: January 29, 1979

Time on hole: 99.6 hours

Position: 22°47.38′N; 107°59.60′W

Water depth (sea level; corrected m, echo-sounding): 2998

Water depth (rig floor; corrected m, echo-sounding): 3015

Bottom felt (m, drill pipe): 3015

Penetration (m): 229.0

Number of cores: 24

Total length of cored section (m): 185

Total core recovered (m): 99.87

Core recovery (%): 54

Oldest sediment cored above basement:
Depth sub-bottom (m): 136
Nature: Shale
Age: Quaternary
Measured velocity (km/s): 1.6

Basement:
Depth sub-bottom (m): 136.5
Nature: Basalt
Velocity range (km/s): 5.6

Principal results: Hole 482B, located about 150 meters east of Hole 482, was a single bit basement hole. A 137-meter-thick sequence of Quaternary siltstone, claystone, and shale overlies aocustic basement, which consists of interlayered sediments and massive basalts. The hole was terminated at 229 meters sub-bottom because of a stuck pipe.

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[1] Lewis, B. T. R., Robinson, P., et al., *Init. Repts. DSDP*, 65: Washington (U.S. Govt. Printing Office).

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HOLE 482C

Date occupied: January 29, 1979

Date departed: February 3, 1979

Time on hole: 122.2 hours

Position: 22°47.34′N; 107°59.57′W

Water depth (sea level; corrected m, echo-sounding): 2998

Water depth (rig floor; corrected m, echo-sounding): 3015

Bottom felt (m, drill pipe): 3015

Penetration (m): 184

Number of cores: 15

Total length of cored section (m): 120.5

Total core recovered (m): 84.56

Core recovery (%): 70

Oldest sediment cored above basement:
Depth sub-bottom (m): 135
Nature: Silty clay and dolomite
Age: Quaternary
Measured velocity (km/s): 2.0

Basement:
Depth sub-bottom (m): 135
Nature: Basalt
Velocity range (km/s): 5.6

Principal results: Hole 482C is a single bit hole drilled about 100 meters east of Hole 482B in order to test for lateral continuity in the basement and to carry out the Hawaiian Institute of Geophysics downhole seismometer experiment. The drill penetrated 137 meters of sediment and 47 meters of basement consisting of interlayered massive basalts and sediments. Basalt cooling units can be correlated petrologically and magnetically between Holes 482B and C.

HOLE 482D

Date occupied: February 3, 1979

Date departed: February 8, 1979

Time on hole: 5 days

Position: 22°47.31′N; 107°59.51′W

Water depth (sea level; corrected m, echo-sounding): 3008

Water depth (rig floor; corrected m, echo-sounding): 3015

Bottom felt (m, drill pipe): 3015

Penetration (m): 186.5

Number of cores: 13

Total length of cored section (m): 115.0

Total core recovered (m): 64.41

Core recovery (%): 56

Oldest sediment cored above basement:
Depth sub-bottom (m): 138
Nature: Silty clay
Age: Quaternary
Measured velocity (km/s): 1.5

Basement:
Depth sub-bottom (m): 138
Nature: Basalt
Velocity range (km/s): 5.6

Principal results: Drilling in Holes 482B and C suggested that this would be a good site for a deep re-entry hole in basement. Accordingly, a cone with 16-inch casing was set and Hole 482D was begun. The pipe penetrated 50 meters into acoustic basement, then stuck after it was raised above the bottom of the hole in order to cement the basaltic section. Here, acoustic basement consists of interlayered sediments and massive basalts, some of which can be correlated with cooling units in Holes 482B and C.

HOLE 482E

Date occupied: February 8, 1979

Date departed: February 10, 1979

Time on hole: 34 hours

Position: 22°47.37′N; 107°59.56′W

Water depth (sea level; corrected m, echo-sounding): 3008

Water depth (rig floor; corrected m, echo-sounding): 3015

Bottom felt (m, drill pipe): 3015

Penetration (m): 48.5

Number of cores: 0

Total length of cored section (m): 0

Total core recovered (m): 0

Core recovery (%): 0

Principal results: Hole 482E was an attempt to set a cone with 16-inch casing preparatory to drilling another re-entry hole at this site. The casing could not be worked all the way into the sediments, so it was withdrawn and a new attempt made at Hole 482F.

HOLE 482F

Date occupied: February 10, 1979

Date departed: February 12, 1979

Time on hole: 54.5 hours

Position: 22°47.36′N; 107°59.61′W

Water depth (sea level; corrected m, echo-sounding): 3008

Water depth (rig floor; corrected m, echo-sounding): 3015

Bottom felt (m, drill pipe): 3015

Penetration (m): 145.0

Number of cores: 5

Total length of cored section (m): 39.0

Total core recovered (m): 16.07

Core recovery (%): 41

Oldest sediment cored above basement:
Depth sub-bottom (m): 136
Nature: Nannofossil chalk and silty clay
Age: Quaternary
Measured velocity (km/s): 1.5

Basement:
Depth sub-bottom (m): 136.2
Nature: Basalt
Velocity range (km/s): 5.6

Principal results: This was the third re-entry hole attempted at Site 482. Again, the casing could not be worked all the way into the sediments, leaving the cone suspended above the mudline. During an attempt to re-enter the cone, it was apparently knocked over, causing the hole to be aborted. The upper part of basement consists of massive basalt, similar to that encountered in Holes 482B, C, and D.

BACKGROUND AND OBJECTIVES

The primary goal of Leg 65 was to sample young ocean crust formed at the East Pacific Rise in order to understand better the processes of crustal construction at intermediate to fast-spreading ridges. The original plan called for drilling a series of holes along a transect across the Rise at the mouth of the Gulf of California in crust ranging in age from about 0.5 to 3.0 m.y. One or more deep re-entry holes were planned along this transect in order to sample the lower parts of the crust.

Site 482 was selected as a prime deep-drilling site because seismic velocities of the basement are similar to those of old North Atlantic crust drilled successfully at Sites 477 and 418, and because the high sedimentation rate here makes it possible to spud into the very young crust. The site is located in a broad sediment-filled valley about 12 km east of the axis of the East Pacific Rise and about 15 km south of the Tamayo Fracture Zone (Fig. 1). Magnetic anomalies indicate a crustal age of about 0.5 m.y. for the site, and reflection profiles suggest a sediment thickness of about 150 meters (Fig. 2).

Prior to establishing a re-entry hole, we planned to drill a single-bit hole through the sediments and as deeply as possible into basement in order to determine the suitability of this site for deep drilling. We planned to place the Hawaii Institute of Geophysics seismometer into this hole after coring and downhole logging were completed.

If the preliminary drilling proved to be successful, we planned to establish a re-entry hole to be drilled and cored to the greatest possible depth. In this hole, the principal objectives were: (1) to determine the structure, petrology, and state of alteration of the upper crust; (2) to establish physical-property profiles for comparison with *in situ* velocities and densities to be determined from downhole logs; (3) to conduct an oblique seismic experiment by shooting to a downhole seismometer; (4) to determine the magnetic intensities and paleoinclinations of the core samples to investigate the origin of magnetic anomalies, and (5) to determine the strength of the rocks and *in situ* permeability by carrying out a hydrofracturing experiment.

OPERATIONS

The *Glomar Challenger* departed San Pedro on January 20, 1979 at about 1200 hours for Site 482. Enroute from San Pedro the normal underway geophysical gear was towed along the track line shown in Figure 3. The ship arrived at Site 482 (22°47.38′N; 107°59.63′W) about mid-day on January 24, and after verifying the location by running a single air-gun and 3.5 kHz-line across the area, a 13.5-kHz beacon was dropped on January 24 at 2025Z (1225 local). The general location of Site 482 is shown in Figure 1, and a seismic reflection profile across the site is shown in Figure 2.

The first exercise was to perform a wash-in test and take a mudline core at Hole 482. This was started at 0223 hours (local) on January 25 and completed at about 0800 January 25. In this hole, located about 100 meters east of the beacon, the mudline was found to be at about 3115 meters below the rig floor, and the string was washed to 60 meters sub-bottom.

The second exercise, a single-bit hole at 482A, was started at 0900 on January 25, with beacon offsets of zero meters north and 97 meters east. This hole was cored to 44 meters, at which time the ship lost position; the drill string was pulled out of the hole at about 1700 hours on January 25.

A new hole, 482B, was started at about 1800 hours on January 25, with beacon offsets of zero meters north and 147 meters east. This hole was washed in to 44 meters and the sediments cored to 137 meters sub-bottom (Table 1). Two temperature measurements were attempted in the sediment with the Uyeda tool, one of which was successful. Basalt was first encountered at 137 meters sub-bottom, about 7 meters shallower than the depth predicted from the site-survey reflection records. The hole penetrated about 92 meters into basement to a total sub-bottom depth of about 229 meters (Table 1). On January 25 at about 1330 hours, the ship lost and regained position, pulling the string out an unknown amount; at about 1600 hours, after a change of pipe, it was found that the drill string was stuck. It also appeared that there was no movement of the bumper subs, and repeated pulling failed to release the drill string. Early on January 29, it was decided to release the bit, on the assumption that it was jammed. However, in this exercise a bolt on the overshot (which was attached to the sand line) broke, leaving the bit-release mechanism and overshot at the bottom of the drill string. It was then decided to shoot off the string above the bumper subs because the bumper subs (at this time in the sediments) also appeared to be stuck. On January 29, at about 0800 hours, the magnetic-collar locator was lowered on the logging cable to ascertain the best depth at which to shoot the pipe. This got stuck for a while, but finally, at 1300 hours on January 29, the pipe was shot off above the bottom-hole assembly using a prima-cord charge attached to the logging cable. The remainder of the pipe was pulled during the afternoon and evening of the 29th.

At this point, we concluded that drilling conditions at Site 482 warranted an attempt to drill a deep re-entry hole. However, because Hole 482B was clogged with drill pipe, another hole was needed for the Hawaii Institute of Geophysics downhole seismometer experiment. Thus, we decided to drill another single-bit hole for emplacement of the seismometer and to test for lateral variability or continuity in the upper basement section.

Hole 482C was therefore started at an offset from the 13.5-kHz beacon of 47 meters south and 229 meters east in the early hours of January 30. This hole was washed in to about 60 meters and cored from 60 meters to 184 meters sub-bottom (Table 1), of which about 50 meters were in basalt. Three successful temperature measurements were made in the sediments, which when extrapolated to basement, gave a temperature of about 90°C. The last basalt core was pulled on February 1 at 1800 hours, about two days after the hole was started. Using the mechanical bit release, the bit was successfully released and a logging run started late on February 1, with the drill string pulled so that its bottom was about 20 meters into the basalt. The logging was finished at about 1100 hours on February 2 with no complications. The Hawaii Institute of Geophysics seismometer was then started down the hole at about 1300 hours, after it had been connected to the logging cable; its deployment

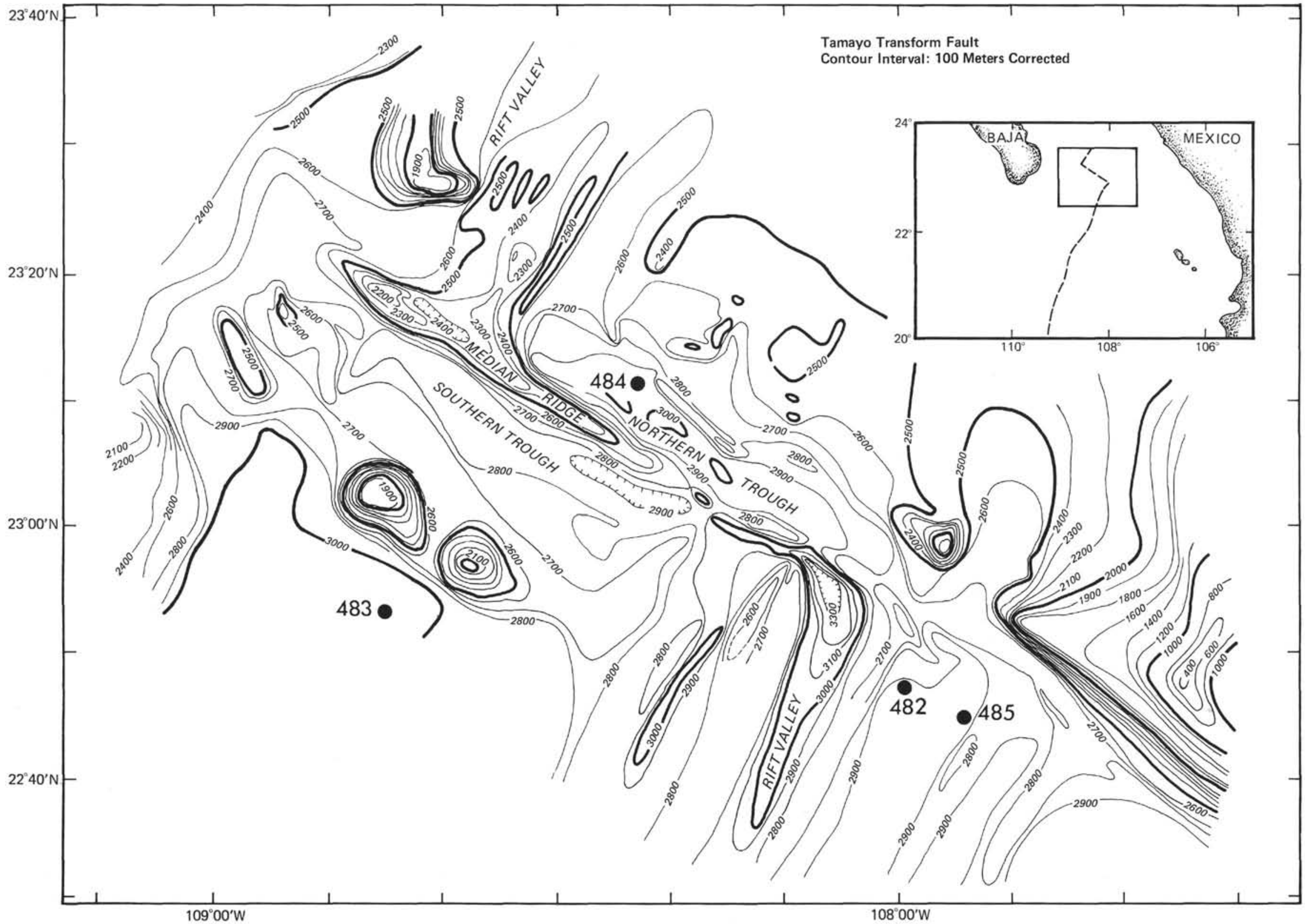


Figure 1. Bathymetry map of the Tamayo Fracture Zone, showing location of Site 482. (Depths in meters.)

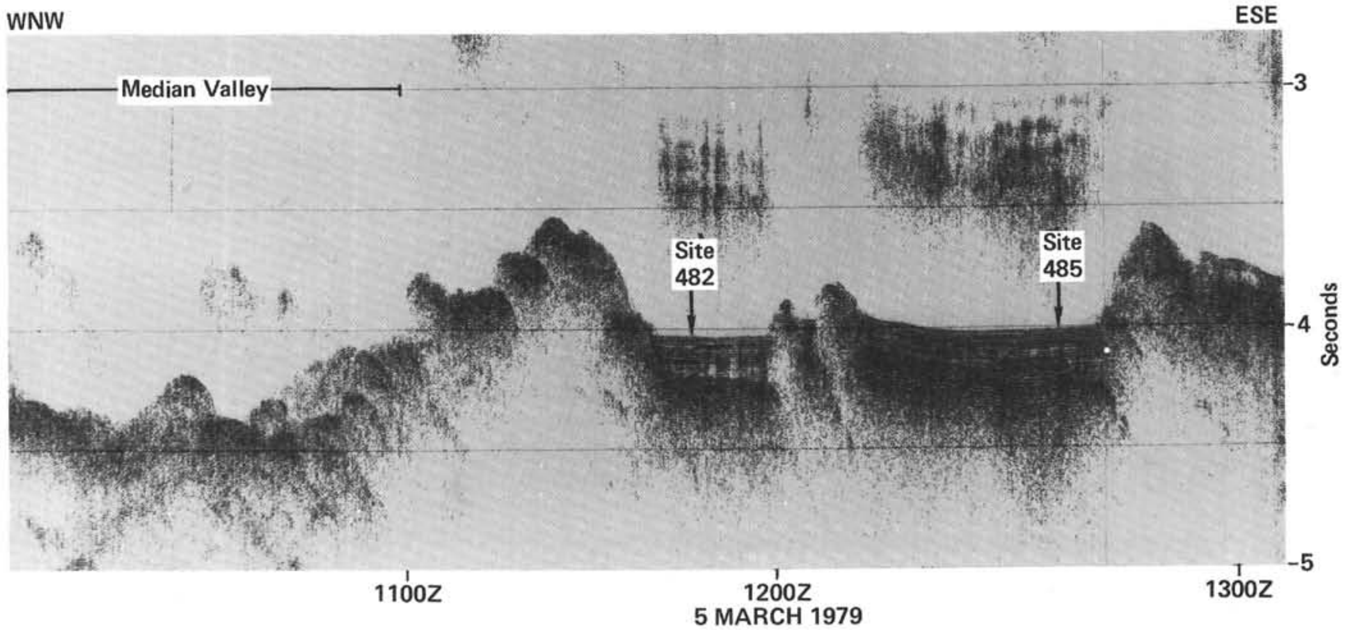


Figure 2. Seismic reflection profile recorded aboard *Glomar Challenger* through Sites 482 and 485, using an air-gun sound source. (Vertical scale in seconds of two-way reflection time. Horizontal scale is given in time along ship's track. One hour represents about 10 km).

took about 30 hours (for details see the section on down-hole instruments). During the deployment, an additional 13.5-kHz beacon was dropped about 20,000 ft. from the first beacon.

Having successfully completed Hole 482C we decided to begin a re-entry hole, 482D. From a study of the petrology and paleomagnetism of the basalts cored thus far, it appeared that alteration might increase slightly to the east. Thus, in an attempt to assure the best possible conditions for deep drilling, Hole 482D was positioned 100 meters to the east of 482C, with offsets from the beacon of 80 meters south and 321 meters east. This hole was occupied at 2100 hours February 4, and by 2200 hours the re-entry cone with about 57 meters of 16-inch casing was attached to the drill string with a release sub and was washed in. The lowermost section of sediments was cored and basement reached at 137 meters sub-bottom at about 0800 hours on February 5. At 0830 hours a red buoy attached to the yellow retrieval line of the Hawaii Institute of Geophysics seismometer was sighted at the bow, indicating that the recovery system had released prematurely. This necessitated our pulling the drill string to redeploy this system. In the meantime, a 16-kHz beacon had been dropped at Hole 482D. By 1700 hours on February 5, the recovery line for the seismometer had been redeployed. At about 1800 hours, Duennebier and Blackinton transferred to the Mexican Navy launch to depart for Mazatlán, and Kudo and Roman transferred to the *Challenger*. Hole 482D was re-entered on February 6 at about 0530 hours, and the first basalt core retrieved at 1300.

On February 7 at about 1700 hours, after we had drilled about 47 meters into basement, we noticed a decrease in core diameter, suggesting deterioration of the bit. In order to maintain the best possible hole conditions, it was decided to fill the basement portion of the hole with cement before changing bits. Before pumping cement, the hole was flushed with mud; circulation appeared normal. At 2200 hours the drill crew tried to pump cement, but found they had no circulation and, furthermore, that the drill string was stuck. Again, it appeared that the whole bottom-hole assembly was stuck, because there was no free movement of the bumper subs. Repeated tugging on the string failed to free it, and on February 8, at about 1030 hours, the string was blasted off above the bottom-hole assembly and the remainder of the pipe retrieved.

On previous legs, drilling problems of this kind were generally attributed to jamming of the bit assembly by basalt fragments that had fallen into the hole. However, this would not explain the loss of circulation and the lack of movement of the bumper subs, which were in the sediments above basement. It was thought that these problems might be the result of slumping of poorly consolidated sediments in the upper part of the hole. Such slumping could result from a pressure differential (about 125 psi at 140 m sub-bottom) between the water in the hole and the sediments—produced by the density difference between the two media. During circulation, the water pressure in the hole varies from about 400 to 500 psi at the bottom to zero at the top. This water pressure is greater than the sediment overpressure and might cause water to infiltrate the sediments over several days of pumping, thereby weakening material which already has a low shear strength (about 4 to 10 lbs./in.^{2}). Once circulation is stopped, the sediment overpressure could cause the sediment to collapse around the drill string. The skin friction exerted by the sediments over 80 meters of pipe could be as high as 500,000 lbs., which exceeds the force that can be exerted by the drill rig. In an attempt to overcome this problem it was decided to case the next re-entry hole to basement.

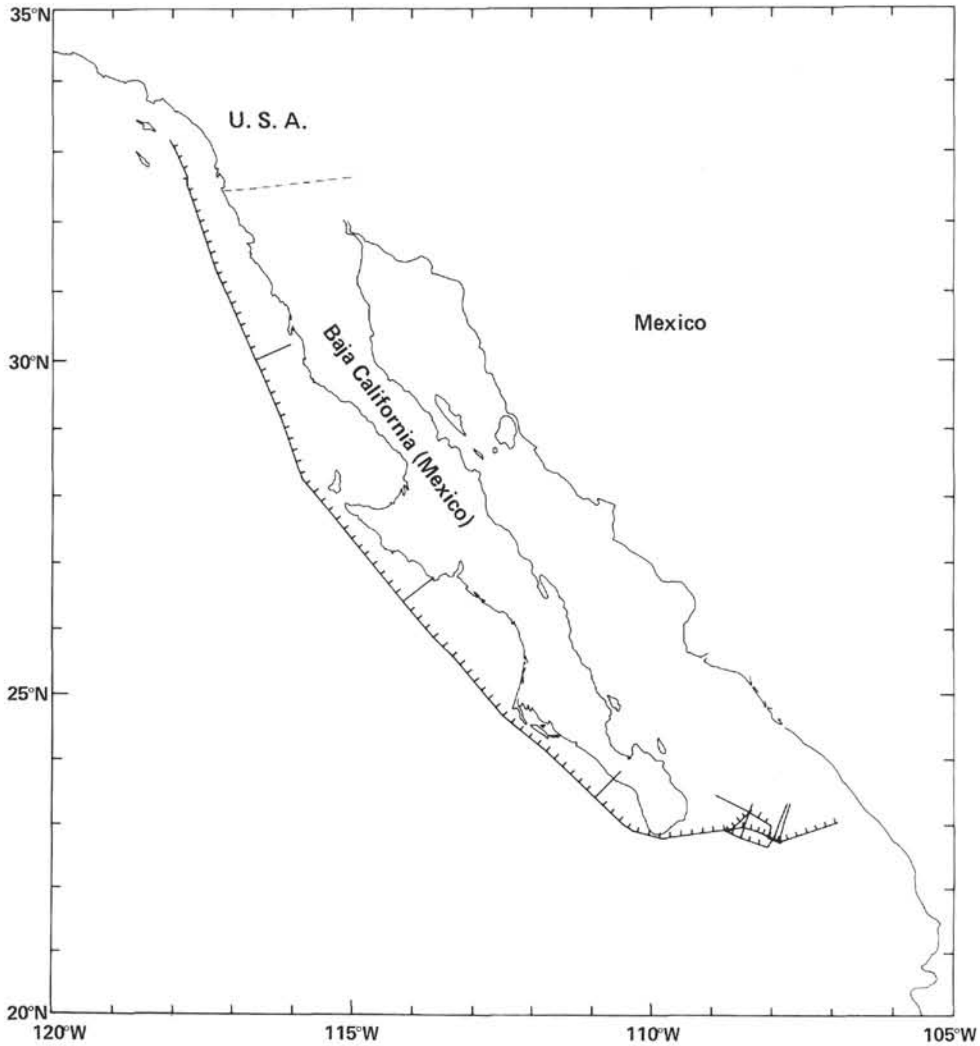


Figure 3. Track chart of *Glomar Challenger* between San Pedro, California, and Leg 65 drilling sites at the mouth of the Gulf of California. (Each tick mark represents one hour.)

Work on a new re-entry cone, casing, and bottom-hole assembly was started on February 8 at about 1600 hours and washing in of Hole 482E was begun at 2200 hours on February 9. Hole 482E was located about 100 meters north of 482C so as to be at least 175 meters from the cone at Hole 482D. After washing for 6 hours, the 60 meters of casing could not be lowered full depth into the sediments. Thinking that a stiff layer had been encountered in the sediments, we decided to pull the casing and cone and try washing in near Hole 482B, where no such layer had been encountered. With the bottom of the string just above bottom, we moved over about 300 ft. to Hole 482B and began Hole 482F.

On Saturday, February 10, at about 0530, we started washing in the 16-inch casing and cone assembly at Hole 482F. Once again the casing could not be washed all the way in, which left the cone about 10 meters above the mudline. At this point, the possibility of a pipe miscount was raised, which would have implied that the cone was at mudline, because we had previously washed to 60 meters at this location. Therefore, it was decided to release the drill string from the casing and drill with the 14⅞-inch bit to basement. Basement was reached at about 140 meters sub-bottom at 1700 hours on February 10. This basement depth was the same as at Hole 482B, as closely as could be determined, leading us to suspect that the pipe count was correct and that the cone was suspended above the mudline. A logging run with the natural gamma and neutron tools was then undertaken to verify the location of the casing. The logging confirmed that the cone was above the mudline.

Before deploying the 11-inch casing to basement, it was decided to try a re-entry with the 9-inch bit and regular drill string. The string was pulled, the bit changed, and the string relowered by about 1900 hours on February 11. The EDO acoustic re-entry tool was lowered but found not to work. In our attempt to verify the malfunction of this tool, we lowered the string 8 meters, and the rig floor reported losing weight while still above the mudline. It was thought that the cone had been hit. A new re-entry tool was lowered and by 0230 on February 12 it was discerned that the cone had been knocked

Table 1. Coring summary, Site 482.

Core	Date	Time	Depth from Drill Floor (m)	Depth below Seafloor (m)	Length Cored (m)	Length Recovered (m)	Recovery (%)
Hole 482							
1	1/25/79	0314	3017.0-3021.0	0.0-4.0	4.0	3.94	99
Hole 482A							
1	1/25/79	1028	3015.0-3021.0	0.0-6.0	6.0	5.99	100
2	1/25/79	1125	3021.0-3030.5	6.0-15.5	9.5	9.50	100
3	1/25/79	1225	3030.5-3040.0	15.5-25.0	9.5	1.45	15
4	1/25/79	1323	3040.0-3049.5	25.0-34.5	9.5	8.53	90
5	1/25/79	1419	3049.5-3059.0	34.5-44.0	9.5	7.78	82
Hole 482B							
1	1/25/79	1916	3059.0-3068.5	44.0-53.5	9.5	7.26	76
2	1/25/79	2019	3068.5-3078.0	53.5-63.0	9.5	6.43	68
3	1/25/79	2126	3078.0-3087.5	63.0-72.5	9.5	0.10	1
4	1/25/79	2228	3087.5-3097.0	72.5-82.0	9.5	4.28	45
	heat-flow measurement						
5	1/26/79	0105	3097.0-3106.5	82.0-91.5	9.5	3.88	41
6	1/26/79	0225	3106.5-3116.0	91.5-101.0	9.5	8.09	85
7	1/26/79	0335	3116.0-3125.5	101.0-110.5	9.5	2.68	28
8	1/26/79	0450	3125.5-3135.0	110.5-120.0	9.5	7.04	74
	heat-flow measurement						
9	1/26/79	0725	3135.0-3144.5	120.0-129.5	9.5	9.13	96
10	1/26/79	0931	3144.5-3152.0	129.5-137.0	7.5	9.58	128
11	1/26/79	1236	3152.0-3154.0	137.0-139.0	2.0	2.67	134
12	1/26/79	1705	3154.0-3159.0	139.0-144.0	5.0	2.59	52
13	1/26/79	1941	3159.0-3163.0	144.0-148.0	4.0	2.11	53
14	1/26/79	2326	3163.0-3172.0	148.0-157.0	9.0	3.55	39
15	1/27/79	0410	3172.0-3181.0	157.0-166.0	9.0	5.50	61
16	1/27/79	1024	3181.0-3190.0	166.0-175.0	9.0	5.52	61
17	1/27/79	1409	3190.0-3199.0	175.0-184.0	9.0	2.39	27
18	1/27/79	2009	3199.0-3208.0	184.0-193.0	9.0	1.86	21
19	1/27/79	2245	3208.0-3212.5	193.0-197.5	4.5	1.50	33
20	1/28/79	0250	3212.5-3217.0	197.5-202.0	4.5	3.16	70
21	1/28/79	0920	3217.0-3226.0	202.0-211.0	9.0	3.11	35
22	1/28/79	1416	3226.0-3235.0	211.0-220.0	9.0	4.21	47
23	1/28/79	1534	3235.0-3239.5	220.0-224.5	4.5	0.23	5
24	1/28/79	1806	3239.5-3244.0	224.5-229.0	4.5	3.00	67
Hole 482C							
1	1/30/79	1351	3059.5-3069.0	44.5-54.0	9.5	3.24	34
2	1/30/79	1608	3069.0-3078.5	54.0-63.5	9.5	4.31	45
3	1/30/79	1712	3078.5-3088.0	63.5-73.0	9.5	9.65	102
4	1/30/79	1820	3088.0-3097.5	73.0-82.5	9.5	9.42	99
5	1/30/79	2035	3097.5-3107.0	82.5-92.0	9.5	9.73	102
	wash		3107.0-3126.0	92.0-111.0			
6	1/30/79	2315	3126.0-3135.5	111.0-120.5	9.5	7.83	82
7	1/31/79	0200	3135.5-3145.0	120.5-130.0	9.5	9.42	99
8	1/31/79	0350	3145.0-3147.0	130.0-132.0	2.0	1.67	84
9	1/31/79	0610	3147.0-3154.0	132.0-139.0	7.0	1.31	19
10	1/31/79	1237	3154.0-3163.0	139.0-148.0	9.0	3.70	41
11	1/31/79	1849	3163.0-3172.0	148.0-157.0	9.0	5.28	59
12	1/31/79	2241	3172.0-3176.5	157.0-161.5	4.5	2.99	66
13	2/1/79	0338	3176.5-3181.0	161.5-166.0	4.5	3.80	84
14	2/1/79	1025	3181.0-3190.0	166.0-175.0	9.0	6.21	69
15	2/1/79	2023	3190.0-3199.0	175.0-184.0	9.0	6.0	67
Hole 482D							
1	2/4/79	2329	3083.5-3093.0	71.5-81.0	9.5	9.79	103
2	2/5/79	0058	3093.0-3102.5	81.0-90.5	9.5	6.08	64
3	2/5/79	0227	3102.5-3112.0	90.5-100.0	9.5	9.60	101
4	2/5/79	0340	3112.0-3121.5	100.0-109.5	9.5	4.00	42
5	2/5/79	0445	3121.5-3131.0	109.5-119.0	9.5	3.17	33
6	2/5/79	0603	3131.0-3140.5	119.0-128.5	9.5	7.32	77
7	2/5/79	0740	3140.5-3150.0	128.5-138.0	9.5	4.76	50
8	2/6/79	1238	3150.0-3153.5	138.0-141.5	3.5	1.50	43
9	2/6/79	1716	3153.5-3162.5	141.5-150.5	9.0	3.65	41
10	2/6/79	2226	3162.5-3171.5	150.5-159.5	9.0	3.80	42
11	2/7/79	0500	3171.5-3180.5	159.5-168.5	9.0	3.27	36
12	2/7/79	1230	3180.5-3189.5	168.5-177.5	9.0	4.24	47
13	2/7/79	1625	3189.5-3198.5	177.5-186.5	9.0	3.23	36
Hole 482E							
	2/9/79	Hole drilled to 48.5 meters; nothing cored, nothing recovered.					
Hole 482F							
1	2/10/79	1128	3064.0-3071.5	49.0-56.5	7.5	0.00	0
	wash		3071.5-3128.5	56.5-113.5			
2	2/10/79	1450	3128.5-3138.0	113.5-123.0	9.5	4.22	44
3	2/10/79	1600	3138.0-3147.5	123.0-132.5	9.5	7.04	74
4	2/10/79	1823	3147.5-3157.0	132.5-142.0	9.5	3.31	35
5	2/10/79	2223	3157.0-3160.0	142.0-145.0	3.0	1.50	50

over. The drill string was pulled and the hole abandoned at 1200 hours, February 12.

At this point we decided to abandon Site 482 and drill two or three single-bit holes elsewhere along the transect. If a more suitable site were found, we planned to attempt another deep re-entry hole. Therefore, at 1200 on February 12, we departed for Site 483.

The locations of all holes drilled at Site 482 are shown in Figure 4, together with the locations of the beacons used for navigation.

SEDIMENT LITHOLOGY

Site 482 is located on the east flank of the East Pacific Rise in a sediment-filled valley that parallels the rift axis (Figs. 1 and 2). Seven holes were drilled at this site (Fig. 4), five of which (482A, 482B, 482C, 482D, and 482F) had significant sediment recovery (Table 2). Holes 482, 482A, and 482B combined provide the most complete stratigraphic section, thus these holes are discussed together; the sedimentary sections in the other holes are summarized separately.

The top of acoustic basement is taken as the first sediment/basalt contact, but thick layers of sediment occur between many basalt units below the contact (Fig. 5). In the following discussion, the sediments from each hole are divided into those above basement and those interlayered with basalts.

Holes 482, 482A, and 482B

Holes 482, 482A, and 482B were cored, respectively, to depths of 3.5 meters, 44 meters, and 229 meters below the mudline. Hole 482B was washed from the mudline to 44 meters, the depth to which Hole 482A was drilled. The sediment/basalt contact, which is taken as the top of acoustic basement, lies at 137 meters sub-bottom depth. Recovery of the sediments above basement was generally good, but those between the basalt layers were usually washed away during drilling. The thickness of the sediment layers between basalt was determined from changes in the drilling rate.

Sediments Overlying Basement

The sediments overlying basement are largely silty clays with a few interlayered beds of sandy clay, sandy silt, and silty sand. The sediments are grouped into a single lithologic unit because of the overall uniformity of the section.

The silty clays are olive gray to grayish olive, fine-grained sediments with an average composition of 60% clay, 35% silt, and 5% sand. Significant grain-size vari-

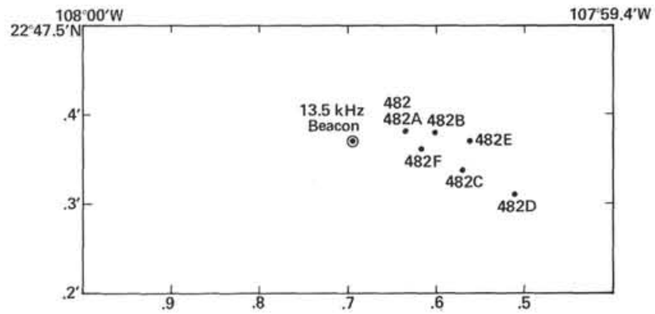


Figure 4. Location of drill holes at Site 482 in relation to 13.5-kHz beacon, based on satellite fixes.

Table 2. Sedimentary lithologic units, Site 482.

Unit	Lithology	Age	Depth (m)	Thickness (m)	Core-Section (level in cm)
Hole 482					
Sediments overlying basement					
I	Silty clay with nannofossil-bearing layers and plant fragments	late Quaternary	0-4.0	4.0	1-1, 0 to 1,CC
Hole 482A					
Sediments overlying basement					
I	Silty clay with thin turbidites composed of sandy silt and clay	late Quaternary	0-44.0	44.0	1-1, 0 to 5-7, 30
Hole 482B					
Sediments overlying basement					
I	Chiefly clay and silty clay with thin layers of sandy silt and sandy clay. Some shale layers occur in Cores 9 and 10.	late Quaternary	0-137.0	137.0	1-1, 0 to 10-7, 8
Sediments interlayered in basement					
	Silty clay; probably a fragment that fell into hole	late Quaternary	157.0-157.04	0.04	15-1, 0 to 15-1, 4
	Indurated nannofossil-bearing clay	late Quaternary	184.0[a]-185.5[a]	1.5[a]	18-1, 0 to 18-1, 5
	Indurated silty clay and mudstone	late Quaternary	191.5[a]-195.0[a]	4.5[a]	19-1, 5 to 19-1, 61
	Firm silty clay; probably a fragment that fell into hole	late Quaternary	202.0-202.05	0.05	21-1, 0 to 21-1, 5
	Indurated, nannofossil-bearing silty clay	late Quaternary	223.0[a]-225.0[a]	2.0[a]	24-1, 0 to 24-1, 14
Hole 482C					
Sediments overlying basement					
I	Silty clay with minor layers of silty sand and some sand-filled burrows. Dolomite mixed with mudstone and silty clay occurs in thin layers in Cores 8 and 9.	late Quaternary	44.5	91.0	1-1, 5 to 9-1, 60
Sediments interlayered in basement					
	Claystone; probably a fragment that fell into hole	late Quaternary	161.5-161.51	0.01	13-1, 0 to 13-1, 1
	Indurated mudstone; probably a fragment that fell into hole	late Quaternary	166.0-166.01	0.01	14-1, 0 to 14-1, 1
	Dolomite; probably a fragment that fell into hole	late Quaternary	175.0-175.01	0.01	15-1, 0 to 15-1, 1
Hole 482D					
Sediments overlying basement					
I	Silty clay and minor nannofossil-bearing silty clay and nannofossil ooze. A few layers of silty sand and sparse carbonate concretions. A thin layer of dolomite overlies the basement	late Quaternary	71.5-138.0	66.5	1-1, 0 to 8-1, 2
Sediments interlayered in basement					
	Nannofossil-bearing silty clay and muddy nannofossil ooze	late Quaternary	141.5[a]-142.5[a]	1.0[a]	9-1, 0 to 9-1, 15
	Zeolitic dolomite	late Quaternary	154.0[a]-154.5[a]	0.5[a]	10-3, 60 to 10-3, 65
Hole 482F					
Sediments overlying basement					
I	Silty clay and shale with minor siltstone and nannofossil chalk just above the basement.	late Quaternary	113.5-136.2	22.7	2-1, 0 to 4-3, 117

[a] Values derived from downhole logs or drilling logs.

ations were not observed, but some sections (e.g., Section 482A-2-3) show deformed color banding. Locally, the clays show evidence of bioturbation, suggesting relatively slow sedimentation rates.

The coarser-grained sediments interlayered with the clays form graded beds generally ranging from 5 cm to 1.5 meters thick. These beds usually have a basal sandy zone, often containing 5 to 10% benthic foraminifers, probably reworked from the middle or lower continental slope. Above the sandy zone the sediment grades into sandy to silty clay, which in turn grades upward into silty clay.

Because of the character of the sediments and the high sedimentation rates calculated for this section, we believe it comprises mostly fine-grained mud turbidites. Each silty to sandy layer is interpreted as the base of a new turbidite layer which becomes increasingly finer-grained upward. Most of the bioturbated zones appear to lie near the top of one such sequence. The turbidites probably were derived from sediment previously deposited on the continental shelf and slope of mainland Mexico. In a 3- to 4-meter-thick zone directly above the first basalt, sediments show evidence of dehydration and induration. The clay is fissile, dry, and firm, but does not appear to be baked. Calcareous nannofossils are preserved in this layer, and there is a significant enrichment in dolomite about 2.7 meters above basement. Pyrite and zeolite are also present, generally increasing downward toward the top of the basalt.

Sediments Interlayered in Basement

In Hole 482 the drilled basement consists of interlayered massive basalts and sediments. Recovery of these interlayered sediments was very poor, but the true thick-

Figure 5. Sediment and basement stratigraphy, Site 482. (For explanation of symbols see Explanatory Notes).

nesses of these layers can be estimated from the drilling record and the logging results. In several cases small pieces of sediment were recovered at the top of a core in intervals where there is no indication from the logging results of a break in the basalt stratigraphy. These pieces probably fell into the hole when the bit was raised from the bottom of the hole during retrieval of the core barrel.

No attempt has been made to divide the interlayered sediments into units because of the poor recovery and because at least some of the basalts may be intrusive. All of the interlayered sediments are inferred to be Quaternary in age based on the magnetic anomaly age of 0.5 m.y. for this site.

157.0–157.1 m. A single piece of olive gray silty clay was recovered at the top of Core 15. Because there is no indication of a sediment layer at this level from the drilling record or from the downhole logging, this is interpreted as a fragment that slumped from above.

184.0–185.5 m. A 1.5-meter-thick sedimentary layer is inferred here from the downhole logs. Three centimeters of yellowish gray, indurated, nannofossil-bearing clay were recovered from this interval. The top of the underlying basalt has a glassy chilled zone about 3 cm thick (Fig. 6).

191.5–195.0 m. Sixty-one centimeters of clay and mudstone were recovered at the top of Core 19, and the downhole logs suggest a sedimentary layer at least 4.5 meters thick. The recovered sediment is dark gray to black highly indurated material containing a few small pieces of basalt (Fig. 7). Again, a glassy chilled zone marks the top of the underlying basalt.

202.0–202.05 m. No sedimentary interbed is indicated at this level on the downhole logs, and this fragment of

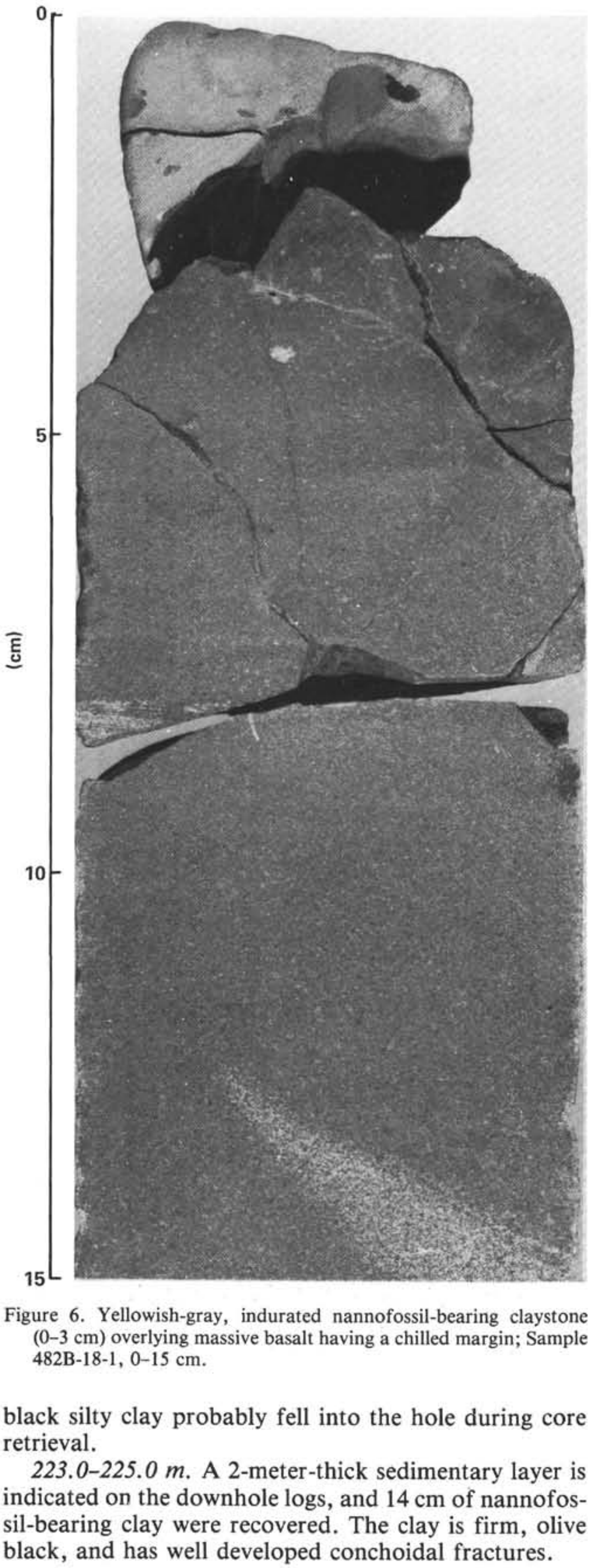


Figure 6. Yellowish-gray, indurated nannofossil-bearing claystone (0–3 cm) overlying massive basalt having a chilled margin; Sample 482B-18-1, 0–15 cm.

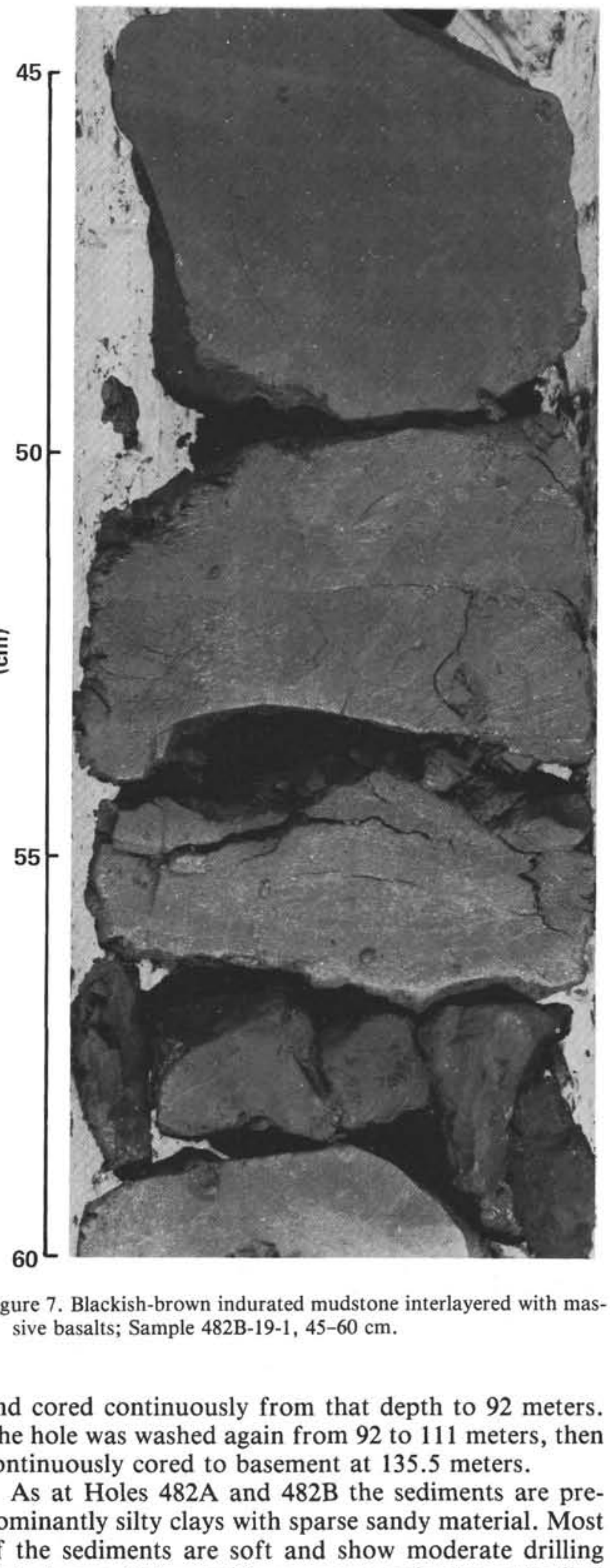


Figure 7. Blackish-brown indurated mudstone interlayered with massive basalts; Sample 482B-19-1, 45–60 cm.

black silty clay probably fell into the hole during core retrieval.

223.0–225.0 m. A 2-meter-thick sedimentary layer is indicated on the downhole logs, and 14 cm of nannofossil-bearing clay were recovered. The clay is firm, olive black, and has well developed conchoidal fractures.

Hole 482C

Hole 482C, located about 82 meters southeast of Hole 482B, was washed from the mudline to 44.5 meters and cored continuously from that depth to 92 meters. The hole was washed again from 92 to 111 meters, then continuously cored to basement at 135.5 meters.

As at Holes 482A and 482B the sediments are predominantly silty clays with sparse sandy material. Most of the sediments are soft and show moderate drilling disturbance. Indurated layers occur only above the first basalt and consist of dolostone or compacted claystone. The few sedimentary fragments recovered from the basement are believed to have fallen into the hole.

Sediments Overlying Basement

Only one lithologic unit was recognized in the sediments overlying basement, but some compositional variations are present. The interval from 44.5 to 92.0 meters sub-bottom consists of olive gray, silty clay composed of about 60 to 70% clay, 30 to 35% silt, and 0 to 5% sand. Numerous burrows filled with olive black silty sand occur between 63.5 and 66 meters sub-bottom, but the sequence is otherwise very homogeneous.

From 111 to 120.5 meters sub-bottom the sediments are olive gray silty claystones which are slightly coarser grained than those in the upper sequence. Sand-size material composes about 10% of these clays and commonly fills small burrows scattered throughout the interval.

Sediments in the basal 1.5-meter interval above the first basalt are rich in dolomite. The dolomite occurs as rhombs in the claystone or in hard dolostone beds up to 70 cm thick. These beds are dark gray to olive black and are composed of about 98% dolomite with minor amounts of calcite still preserved. A few specimens contain up to 2% of subangular quartz grains between the dolomite rhombs. Calcite is irregularly replaced by dolomite in these sediments, suggesting that the dolomite is diagenetic in origin.

Sediments Interlayered in Basement

Small pieces of sediment were recovered from the tops of Cores 13, 14, and 15. These are composed of clay and dolostone similar to the sediments above basement, and they are believed to have fallen into the hole.

Hole 482D

Hole 482D was washed from mudline to a depth of 71.5 meters and then cored continuously to a total depth of 186.5 meters sub-bottom. Recovery of the sediments averaged about 60%, being highest at the top of the hole and gradually decreasing downward. As in the other holes at this site, silty clays make up the bulk of the section, with minor sandy and silty layers occurring in Cores 5 and 6. A few interbeds of nannofossil ooze are also present.

Sediments Overlying Basement

Very uniform, olive gray, silty clay composes the bulk of the sediments above basement. These consist of an average of about 70% clay and 30% silt with little or no sand. Calcite concretions ranging in size from 1 to 8 cm occur in the clays near the top of Core 1 (Fig. 8).

Interlayered with the silty clays are beds of nannofossil rich clays and clayey nannofossil oozes from 0.5 to 4.5 meters thick. These are dark gray, firm sediments that grade into the silty clays with increasing percentages of detrital quartz and feldspar. In Cores 5 and 6 the nannofossil clays and oozes directly overlie sandy sequences interpreted as turbidites. These turbidite layers are 1.5 to 2 meters thick and are graded from silty sands at the base to silty clays at the top. They are lighter colored than the clays and characterized by having high percentages of detrital minerals, particularly quartz and feldspar. Rare sandy layers a few centimeters thick are scattered through the clays and could result either from bioturbation or *in situ* sorting by bottom currents.

Recovery was poor near the contact with the uppermost basalt. Two small pieces of grayish olive dolomitic mudstone occur at the immediate contact and overlie slightly altered basalt.

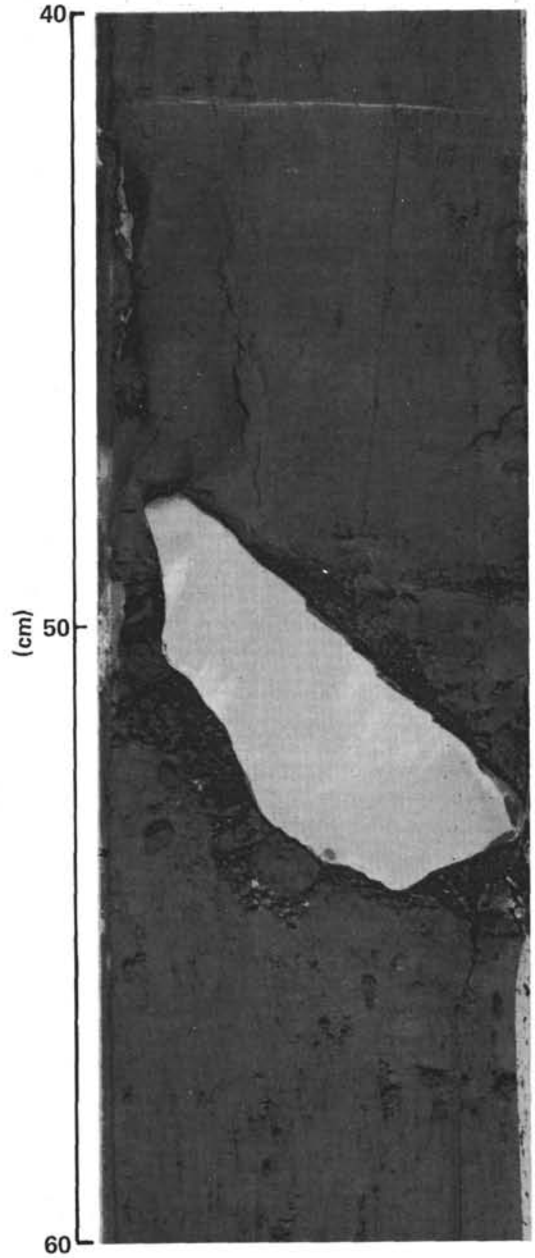


Figure 8. Carbonate concretion in soft olive-gray silty clay; Sample 482D-1-3, 40–60 cm.

Sediments Interlayered in Basement

Sediments were recovered from two intervals in the basement section. Although downhole logs were not run in Hole 482D, the lithology of the recovered sediments and their relationship to the surrounding basalts suggest that they represent true sediment layers ranging from about 0.5 to 1 meter thick.

141.5–142.5 m. Several pieces of yellowish brown to olive black mudstone were recovered at the top of Core 9. These contain from 5 to 20% of carbonate cement and are well indurated. A single piece of black chert containing sparse pyrite is also present. This may represent a fragment of a siliceous vein in the sediments.

154.0–154.5 m. Several pieces of firm olive black mudstone were recovered from this interval. The basalts above and below have chilled glassy margins indicating a definite cooling break.

Hole 482F

Hole 482F was drilled about 50 meters west of Holes 482A and B. No sediments were recovered from Core 1, taken between 49.0 and 56.5 meters sub-bottom. The hole was washed from 56.5 to 113.5 meters sub-basement and then continuously cored from 113.5 to 186 meters sub-bottom. Sediment recovery averaged about 70% and was exclusively from the section above acoustic basement. Yellowish-brown silty clays again make up the bulk of the section. Several intervals also contain small percentages of nannofossils, and a few are highly disturbed. The basal sediments are somewhat stiffer and more compact than comparable materials from adjacent holes (Fig. 9).

From the foregoing description it is clear that the sedimentary sequence at this site consists largely of fine-grained silty clays with minor interbedded silty sands and nannofossil-rich clays. The relatively coarse-grained layers are interpreted as distal turbidites that originated on the outer shelf and continental slope of mainland Mexico. A relatively high quartz content in these sands suggests that they were derived from silicic igneous and metamorphic rocks, which are common in the states of Sinaloa and Nayarit. The displaced foraminifers and diatoms filled with pyrite, which are common in the sandy intervals, suggest that these deposits were recycled.

The sandy layers occur mostly between 90 and 120 meters sub-bottom and appear to thicken somewhat toward the center of the valley in which Site 482 is located. Sediment transport was probably from NE to SW, parallel to the axis of the valley.

The origin of the fine-grained silty clays is not as clear. They may be largely hemipelagic in origin, but the high sedimentation rate at this site, coupled with the presence of thin sandy layers, suggests that at least some of these sediments originated as mud turbidites. Bioturbation is rare and is restricted to distinct intervals. These may represent periods of relatively slow deposition interspersed with turbidite layers.

Pelagic material is sparse, being represented by the nannofossil-rich clays and rare diatomaceous or radiolarian clays.

Most of the sediments above basement are soft and appear to have undergone little compaction and dehydration. Obvious diagnesis can be recognized only in the few meters of sediment directly overlying basement. Here calcareous nannofossils are partly-to-completely dissolved, the sediments are more highly indurated, and secondary minerals such as dolomite, pyrite, and zeolites become abundant.

The sediments interlayered with the basalts are silty clays similar to those above basement except for being somewhat more indurated.

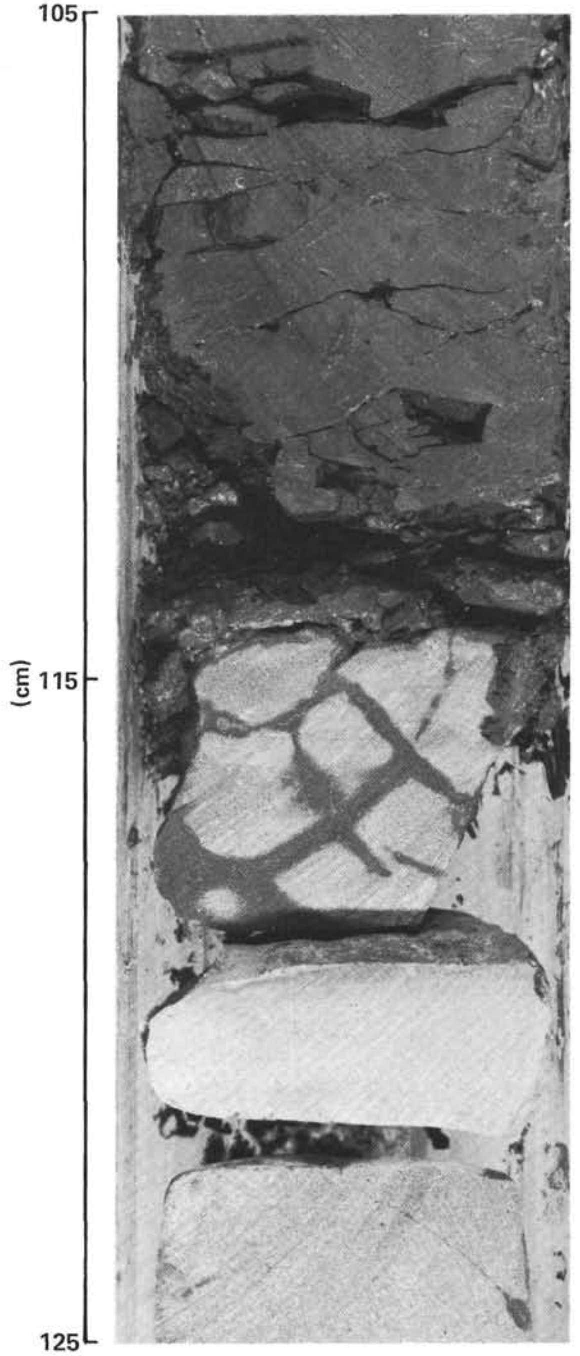


Figure 9. Olive black nannofossil-bearing claystone at top of acoustic basement; Sample 482F-4-3, 105–125 cm.

Several small faults are inferred in the vicinity of Site 482 from offsets on sediment reflectors. The largest of these is located just east of the center of the valley where it clearly offsets the lowest reflectors (Fig. 10). Higher reflectors show less offset, and the upper sedimentary layer is apparently not greatly affected. Only a small flexure can be observed where the fault intersects the mudline. These relationships suggest that movement along the fault was contemporaneous with sedimentation and that the fault may still be active. Other small faults show

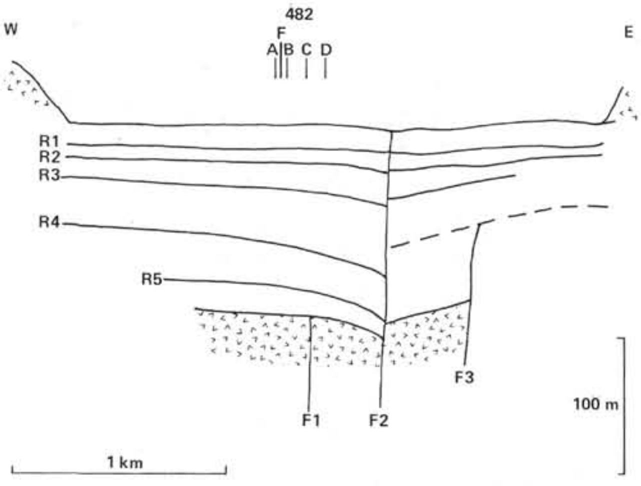


Figure 10. Cross section through Site 482 showing principal reflections (R1 to R5) and acoustic basement. Small faults (F1 to F3) show decreasing offsets on successively younger reflectors.

similar relationships but do not appear to reach the mudline.

BIOSTRATIGRAPHY

Calcareous nannofossils, foraminifers, and radiolarians constitute the observed microfossils from Site 482. Nannofossils are the most abundant, occurring in most clays in the section above basement. These are moderately to well preserved except in the few meters above the first basalt and in the interlayered sediments within the basement sequence. Foraminifers are most abundant in the sandy and silty layers, suggesting that they were transported from sources on the continental shelf or slope. Radiolarians are present in most specimens examined, but their distribution is more sporadic than that of the other microfossils (Fig. 11).

Calcareous Nannofossils

Calcareous nannofossils are the most abundant fossil taxa observed at Site 482 and thus were used as the principal biostratigraphic control. They are generally abundant and moderately well preserved; however, in many cases species identification was difficult owing to the small size of the preserved specimens. The most commonly recognized species are *Gephyrocapsa oceanica, G.* spp., *Helicopontosphaera kamptneri, H.* spp., *Cyclococcolithus leptoporus*, and *Coccolithus pelagicus*. In the absence of *Pseudoemiliania lacunosa*, the calcareous nannofossils indicate that the entire section, including the sediments intercalated in basalts, is no older than the *Gephyrocapsa oceanica* Zone (NN20) (0.44–0.27 m.y. ago). Zonation is after Martini (1971) and Gartner (1977) as combined by Cepek and Wind (1979).

Radiolarians

None of the radiolarian species which define Nigrini's (1971) fourfold zonation of equatorial Pacific sediments of Quaternary age was observed at Site 482. These include *Buccinosphaera invaginata, Collosphaera tuberosa, Anthocyrtidium angulare*, and *Theocorythium vetulum*. Species defining North Pacific Quaternary radiolarian zones established by Hays (1970) and utilized by Kling (1973, DSDP Leg 18) likewise were not observed at Site 482, presumably because the sediments are not old enough. The species and their dates of extinction include *Stylacontarium acquilonium* (= *Druppatractus acquilonius*)—0.31 m.y. ago, *Axoprunum angelinum* (= *Stylatractus universus*)—0.4 m.y. ago, and *Eucyrtidium matuyamai*—0.9 m.y. ago. The absence of *A. angelinum* at Site 482 suggests that the late Quaternary sediments here are younger than 410,000 years. This species is present at Sites 483, 484, and 485, but the other two are absent at all Leg 65 sites.

The same radiolarian species present in the entire sedimentary section at Site 482 are found in Holocene sediments throughout the Gulf of California, as reported by Benson (1966). Both the Gulf Holocene and Site 482 assemblages are tropical to subtropical, with the addition of some higher latitude species which appear to have been carried to this region by the California Current System. Because of the mixture of these assemblages in the region of the Gulf, it is not possible to subdivide the sedimentary section at Site 482 into intervals defined by cold- and warm-water species.

Foraminifers

Foraminifers are common throughout the sedimentary section but are most abundant in sediments having higher than average percentages of fine quartz sand and silt of terrigenous origin. Such sediments are particularly common in Cores 1, 4, and 5 of Hole 482A, Cores 6 and 8 of Hole 482B, and Core 6 of Hole 482C, where they are interpreted as fine-grained turbidites.

Sediment Accumulation Rate

No biostratigraphic zonal boundaries or paleontological datums were recognized in the 137 meters of sediment drilled at Site 482. Thus, only minimum rates of sediment accumulation can be calculated. If the sedimentary section is no older than the base of Zone NN21, dated at about 250,000 years before present, the minimum rate of accumulation is 54.8 cm/1000 y. (548 m/m.y.). If the maximum age is taken as 410,000 years, (i.e., most of Zone NN20), the minimum sedimentation rate is 33.4 cm/1000 y. (334 m/m.y.).

Both of these estimates represent very high rates of accumulation. This is not surprising because a major supply of terrigenous sediment, the steeply bordered, submerged continental land mass of Mexico, is less than 20 miles to the ENE, across the Tamayo Fracture Zone. Turbidity currents and perhaps deep contour currents as well have concentrated sediments in low areas along this fracture zone and the East Pacific Rise.

SEDIMENT GEOCHEMISTRY

Numerous shipboard measurements were made to determine the $CaCO_3$ and reduced (organic) carbon contents of the sediments (Table 3). These preliminary data were checked with later shore-based analyses of total carbon, organic carbon, and $CaCO_3$ (Table 4) made with a LECO WR-12 analyzer, using the techniques described

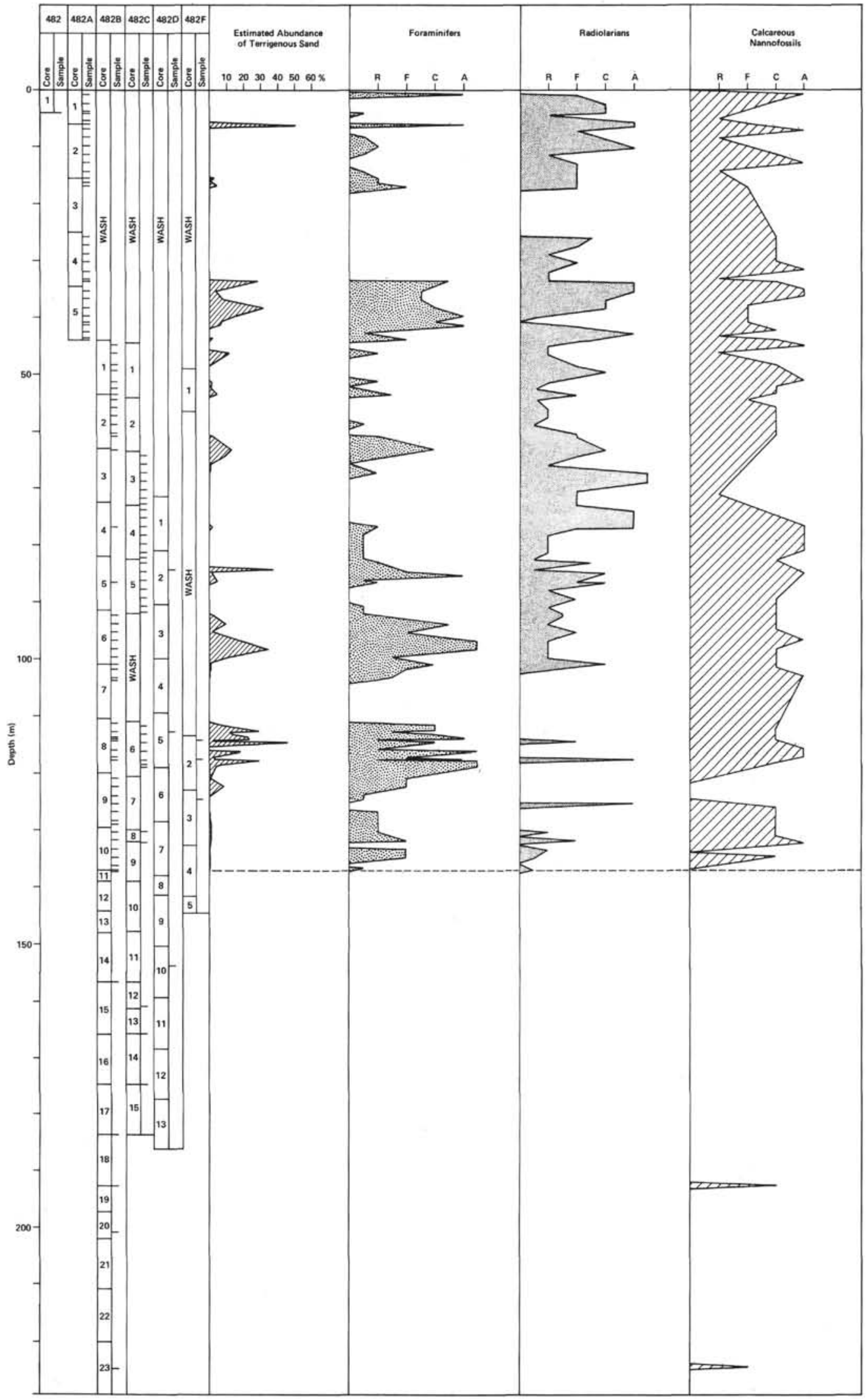

482
482A
482B
482C
482D
482F
Core
Sample
WASH
Estimated Abundance of Terrigenous Sand
10 20 30 40 50 60 %
Foraminifers
Radiolarians
Calcareous Nannofossils
R F C A
Depth (m)
0
50
100
150
200

Table 3. $CaCO_3$ (bomb) and reduced carbon determinations, Site 482.

Sample (interval in cm)	$CaCO_3$ (%)	Reduced Carbon (%)	Lithology
Hole 482			
1-2, 47-49	7	—	Silty clay
1-2, 57-59	2.5	2.7	Silty clay
Hole 482A			
1-2, 28-30	3.4	2.7	Silty mud
2-2, 20-22	7	—	Diatomaceous silty clay
2-4, 112-114	4	2.2	Diatomaceous silty clay
3-1, 116-118	4	2.0	Sandy mud
4-2, 31-33	9	—	Silty clay
4-2, 37-39	4.5	2.4	Silty clay
5-2, 32-34	9	—	Silty clay
5-5, 96-98	5	1.9	Sandy mud
Hole 482B			
1-2, 20-22	4	—	Silty clay
1-2, 28-30	1.5	1.2	Silty clay
2-2, 20-22	7	—	Silty clay
2-2, 28-30	2.5	1.9	Silty clay
3-1, 106-108	7	—	Silty clay
3-1, 116-118	4	2.0	Silty clay
4-2, 20-22	4	—	Silty clay
4-2, 28-30	5.5	1.9	Silty clay
5-2, 100-102	7	—	Nannofossil-bearing silty clay
5-2, 108-110	6.5	1.9	Nannofossil-bearing silty clay
6-2, 10-12	8	—	Sandy mud
6-2, 17-19	5	1.1	Sandy mud
7-2, 18-20	11	—	Clay
7-2, 26-28	8	1.4	Clay
8-3, 111-113	6	—	Silty clay
8-4, 118-120	6	1.7	Silty clay
9-3, 61-63	7	—	Shale
9-3, 70-72	2.5	2.3	Shale
10-4, 116-118	2	—	Shale
10-4, 118-120	11.5	1.8	Shale
Hole 482C			
7-4, 48-50	2	3.1	Silty clay
8-2, 0-2	0	2.3	Silty clay
9-1, 27-29	4	1.6	Silty clay
Hole 482D			
1-2, 117-119	3	3.8	Silty clay
2-2, 118-120	2	3.3	Nannofossil-bearing silty clay
3-2, 68-70	5.5	2.6	Nannofossil-bearing silty clay
4-2, 23-25	5.5	3.9	Silty clay
5-2, 105-107	5	1.0	Silty sand
6-4, 29-31	3	2.4	Silty clay
7-4, 111-113	5	1.9	Zeolite-bearing silty clay

Note: — = not determined.

by Bader et al. (1970) and Boyce and Bode (1972). The correspondence between the two data sets is good.

$CaCO_3$ content is low throughout the section, never exceeding 12%. These values reflect the low fossil content in the sediments and the lack of secondary carbonate cement. Organic carbon content is also low (<4%) and shows no systematic variations through the section. Values are highest in the silty clays and lowest in the sandy layers despite the presence of fossil plant fragments in the latter. In several holes, clays and shales just above the basement have lower organic carbon contents than similar sediments higher in the section.

Table 4. Carbon and carbonate analyses, Site 482.

Sample (level in cm)	Depth (m)	Total Carbon (%)	Organic Carbon (%)	$CaCO_3$ (%)	Lithology
Hole 482A					
1-2, 30	1.80	3.6	2.8	7	Silty clay
3-1, 112	16.62	2.8	2.1	6	Sandy mud
4-2, 29	26.79	3.4	2.5	7	Silty clay
Hole 482B					
1-2, 30	45.80	1.7	1.1	4	Silty clay
2-2, 30	55.30	2.8	2.0	6	Silty clay
5-2, 110	85.10	3.0	2.0	9	Nannofossil-bearing silty clay
7-2, 16	102.66	2.8	1.7	10	Clay
8-3, 109	114.59	2.7	1.8	8	Silty clay
9-3, 72	123.72	3.1	2.5	5	Shale
10-4, 110	135.10	2.8	2.1	6	Shale
Hole 482D					
1-2, 9	73.09	3.4	2.3	9	Silty clay
2-2, 109	82.59	3.3	2.3	8	Nannofossil-bearing silty clay
3-2, 58	91.58	2.9	2.0	7	Nannofossil-bearing silty clay
4-2, 14	100.64	3.8	2.6	10	Silty clay
5-2, 113	111.13	1.8	0.8	8	Silty sand
6-4, 21	122.71	2.9	2.2	6	Silty clay
Hole 482F					
2-2, 49	115.49	3.0	2.4	5	Silty clay
3-2, 60	125.10	2.8	2.1	6	Shale
4-2, 48	134.48	3.0	2.2	7	Shale

SEDIMENT PHYSICAL PROPERTIES

Measurements of wet-bulk density, compressional-wave velocity (V_p), porosity, and shear strength were made at closely spaced intervals in the sediments recovered at Site 482 for comparison with the seismic reflection record over the site. The data are tabulated in Table 5 and, together with computed values of acoustic impedance, are shown as a function of depth below the mudline in Figure 12.

Reported values of wet-bulk density were determined at room temperature and pressure by either the cylinder technique or by double-weighing, depending on the induration of the material, and are considered accurate to ±2% by either technique. The porosities of the unconsolidated sediments were calculated from the wet-bulk densities, assuming a grain density of 2.60 g/cm^3; the porosities of the indurated sediments were determined from the decrease in density produced by heating each sample for 24 hours in air at 110°C. Continuous GRAPE determinations of these parameters were also obtained and will be reported after computer processing at the University of California. The values of sediment wet-bulk density and porosity obtained for the site vary reg-

Table 5. Sediment physical properties, Site 482.

Sample (interval in cm)	Wet-Bulk Density (g/cm^3)	*P*-Wave[a] Velocity (km/s)	Acoustic Impedance ($\times 10^5$ $g/cm^2 \cdot s$)	Shear[b] Strength (tons/ft.^{2})	Porosity[c] (vol.%)	Remarks
Hole 482A						
1-4, 80-90	1.57	1.51	2.37	0.05	64	Soft
2-4, 60-68	1.51	1.49	2.25	0.09	68	Soft
4-4, 37-49	1.65	—	—	0.25	59	Stiff
4-4, 80-82	—	1.52	2.51	—	—	Gassy
5-4, 25-27	1.66	—	—	—	59	Gassy
5-4, 76-78	—	—	—	0.23	—	Gassy
Hole 482B						
1-4, 115-117	—	—	—	0.18	—	Gassy
1-4, 139-141	1.55	—	—	—	66	Gassy
2-4, 35-41	1.65	—	—	0.18	59	Gassy
4-3, 63-76	—	1.54	2.51	0.19	—	Gassy
4-3, 95-97	1.63	—	—	—	61	Soft
5-3, 5-7	—	—	—	0.26	—	Soft
5-3, 36-38	1.62	—	—	—	61	Soft
6-4, 24-36	1.75	1.58	2.77	0.08	53	Disturbed
7-2, 50-63	1.70	1.49	2.53	0.57	56	Stiff
8-4, 71-74	1.77	—	—	—	52	Stiff
8-4, 95-97	—	—	—	0.80	—	Stiff
8-4, 116-118	—	1.52	2.69	—	—	Stiff
9-3, 17-28	1.75	1.49	2.61	0.63	53	Stiff
10-5, 75-77	—	1.53	2.77	—	—	Stiff
10-5, 95-105	1.81	—	—	0.95	49	Stiff
19-1, 31-33	(1.9)	1.99	3.78	—	44	Stiff mudstone layer in basalt
Hole 482C						
8-1, 72-75	2.58	4.25	10.97	—	13	Dolostone
9-1, 8-10	—	2.76	—	—	—	Dolostone
Hole 482D						
1-3, 35-37	—	—	—	0.35	—	Soft
1-3, 120-131	1.64	1.47	2.41	—	60	Gassy
2-3, 95-100	1.73	1.42	2.46	—	54	Gassy
2-3, 143-145	—	—	—	0.35	—	Soft
3-2, 63-65	—	1.48	2.53	—	—	Soft
3-2, 100-114	1.71	—	—	0.55	56	Soft
4-2, 99-117	1.71	1.41	2.41	0.40	56	Stiff
5-1, 49-54	—	1.51	2.60	0.63	—	Stiff
5-1, 95-98	1.72	—	—	—	55	Stiff
6-2, 13-16	1.59	—	—	—	63	Disturbed
6-2, 40-43	1.74	1.67	2.91	—	57	Indurated
7-2, 20-29	1.80	—	—	0.40	50	Disturbed

Note: — = not determined.
[a] Measured at atmospheric pressure.
[b] Torvane measurement.
[c] Assuming a grain density of 2.60 g/cm^3.

ularly with depth, the density increasing from approximately 1.55 g/cm^3 near the top of the column to about 1.80 g/cm^3 near the base, while the porosity decreases from approximately 65% to 50% over the same interval. The only significant departures from this trend are observed in sediments intercalated in the basement in Hole 482B, where densities as high as 1.9 g/cm^3 and porosities as low as 45% are encountered, and in the dolostones recovered near the basalt/sediment contact in Hole 482C, where densities as high as 2.58 g/cm^3 and porosities as low as 13% are present.

The values of compressional-wave velocity shown in Figure 12 were obtained at room temperature and pressure using the Hamilton Frame Velocimeter (Boyce, 1973). Aside from a sharp increase in velocity to values as high as 4.3 km/s in the basalt sediments in Hole 482C and 2.0 km/s in the sediments intercalated in basement in Hole 482B, the velocities range for the most part between 1.5 and 1.6 km/s and show only a weak tendency to increase with depth. Interestingly, the velocities of the sediments between 40 and 70 meters sub-bottom could not be determined because of high signal attenuation caused by gas bubbles in the sediment.

Values of shear strength were obtained at close intervals in the sediment column using the Torvane meter. The shear strength is extremely low in the upper part of the column, ranging from 0.05 tons/ft.^{2} at the mudline to approximately 0.25 tons/ft.^{2} at 30 meters and then decreasing again to about 0.2 tons/ft.^{2} at 70 meters. Below this level, the shear strength increases rapidly to approximately 0.95 tons/ft.^{2} at 135 meters. Because the sediments are composed predominantly of clay throughout the column, the change near the base of the column is tentatively attributed to a change in clay packing.

As expected, the computed values of acoustic impedance increase with increasing sediment density and compressional wave velocity. Based on shear strength and impedance contrasts, reflectors are potentially present in the sediment column at 30 ± 10 meters and at about 100 meters. Because the sediments, with the exception of those recovered near the base of the section in Holes C and F, were commonly disturbed, and because the shipboard measurements of physical properties were conducted at room rather than *in situ* conditions, it must be cautioned that both the conclusions and the measurements from which they are drawn should be regarded as only qualitative.

IGNEOUS PETROGRAPHY

Four holes (482B, C, D, and F) penetrated acoustic basement beneath about 137 meters of sediment. The depth of basement penetration ranged from a maximum of 90 meters in Hole 482B to a minimum of 8.8 meters in Hole 482F.

In all four holes the basement section consists chiefly of massive basalts with lesser quantities of interlayered sediment (Fig. 5). A 13-meter-thick sequence in Hole 482D is characterized by many thin cooling units bounded by flat glassy rinds. Though we tentatively interpret these to be thin sheet flows, they may be pillows. Basement recovery at this site averaged about 50%, being highest in the massive basalts and lowest in the interlayered sediments.

In each hole we have divided the basement section into numerous lithologic units on the basis of changes in mineralogy, phenocryst content, and grain size and on the basis of the presence of interlayered sediments or drilling breaks. These large-scale units may consist of one or more cooling units bounded by glassy or fine-grained chill zones.

Hole 482B

Hole 482B penetrated 90 meters into basement with an average recovery of 50%. In this section we have distinguished 16 cooling units, none of which is unequivocally complete. Most are relatively thick units (5–10 m) with thin fine-grained zones at the top, never more than a few centimeters thick, and poorly defined lower contacts. Thinner cooling units, less than 1 to 2 meters thick, occur in Cores 14 and 15, and these have distinct glassy rinds.

We tentatively interpret the basalt cooling units as submarine lava flows because of the absence of obvious intrusive relationships. Some sediments near basalt contacts are indurated, but these are not obviously baked (Rangin et al., this volume). In many cases the sediment/basalt contacts have been disturbed by drilling, and it is not clear where the indurated sediments originated.

Three major basalt types are distinguished on the basis of phenocryst abundance: aphyric basalts, sparsely plagioclase-phyric (generally less than 5 vol.%) basalts with very rare clinopyroxene and olivine phenocrysts, and moderately phyric plagioclase-olivine-clinopyroxene basalts with up to 10% total phenocrysts. Basalts in the interval from Core 10, Section 7 (8 cm) to Core 15, Section 1 (115 cm) are essentially aphyric with very rare plagioclase phenocrysts. Those in Sections 15-1 (115 cm) to 20-2 (83 cm) are sparsely plagioclase-phyric (1–5 vol.%), and those in Sections 20-2 (83 cm) to 23-1 are moderately phyric, containing plagioclase, olivine, and clinopyroxene. Basalts in Core 24 are again aphyric.

Plagioclase phenocrysts commonly occur as glomerophyric clots, sometimes with intergrown clinopyroxene. Some large plagioclase crystals show complex zoning and have glassy inclusions in their cores. The clinopyroxene is strikingly green and translucent in hand specimens. Many thicker cooling units are relatively coarse grained, with groundmass clinopyroxene and plagioclase crystals 1 to 2 mm long. These have subophitic textures and in some cases the mesostasis is holocrystalline. Vesicles are rare (generally less than 1%) except in a few zones, and mostly less than 1 mm in diameter.

Most of the basalts are relatively fresh, with significant alteration occurring only in Cores 19 and 20. Here, groundmass plagioclase and pyroxene are partly replaced with smectite. Elsewhere, these minerals are unaltered and only olivine and groundmass glass are altered. Vesicles and hairline fractures are usually filled with brown smectite and, less commonly, with carbonate and sulfide. Sulfides are especially common close to basalt/sediment contacts where they are disseminated through the basalt groundmass.

Eight major lithologic units were identified in Hole 482B, and two of these we subdivided on the basis of cooling breaks (Table 6).

Unit 1

Unit 1 (Section 10-7, 8 cm to Section 15-1, 115 cm) consists of four massive cooling units ranging from about 0.6 to 21.5 meters thick. Just above the uppermost cooling unit the clays are strongly indurated but not obviously baked. Glassy margins are preserved at the top and bottom of Unit 1b and at the top Unit 1d, but there are no sedimentary intercalations at these boundaries.

All of the basalts of Unit 1 are aphyric with fine-grained intergranular to intersertal textures. Most specimens contain 1 to 3% of groundmass olivine, which is replaced by brown smectite.

Unit 2

Unit 2 (Section 15-1, 115 cm to Section 17-2, 150 cm) comprises two massive cooling units separated by a glassy rind at the top of Core 16. Unit 2 is easily distinguished from the overlying Unit 1 by its sparsely plagioclase-phyric texture. A cooling break at the top of the unit is indicated by decreasing grain size toward the contact, although no glassy rind was recovered. Unit 2 is separated from Unit 3 by about 1.5 meters of indurated silty claystone.

Small plagioclase phenocrysts are ubiquitous in Unit 2a, constituting 2–6 modal percent and often occurring in glomerophyric clots with clinopyroxene. Basalts in Unit 2b are very sparsely phyric, rarely containing more than 1% phenocrysts. Groundmass textures are typically fine to medium grained, intergranular to intersertal, but some specimens have quench features. Olivine com-

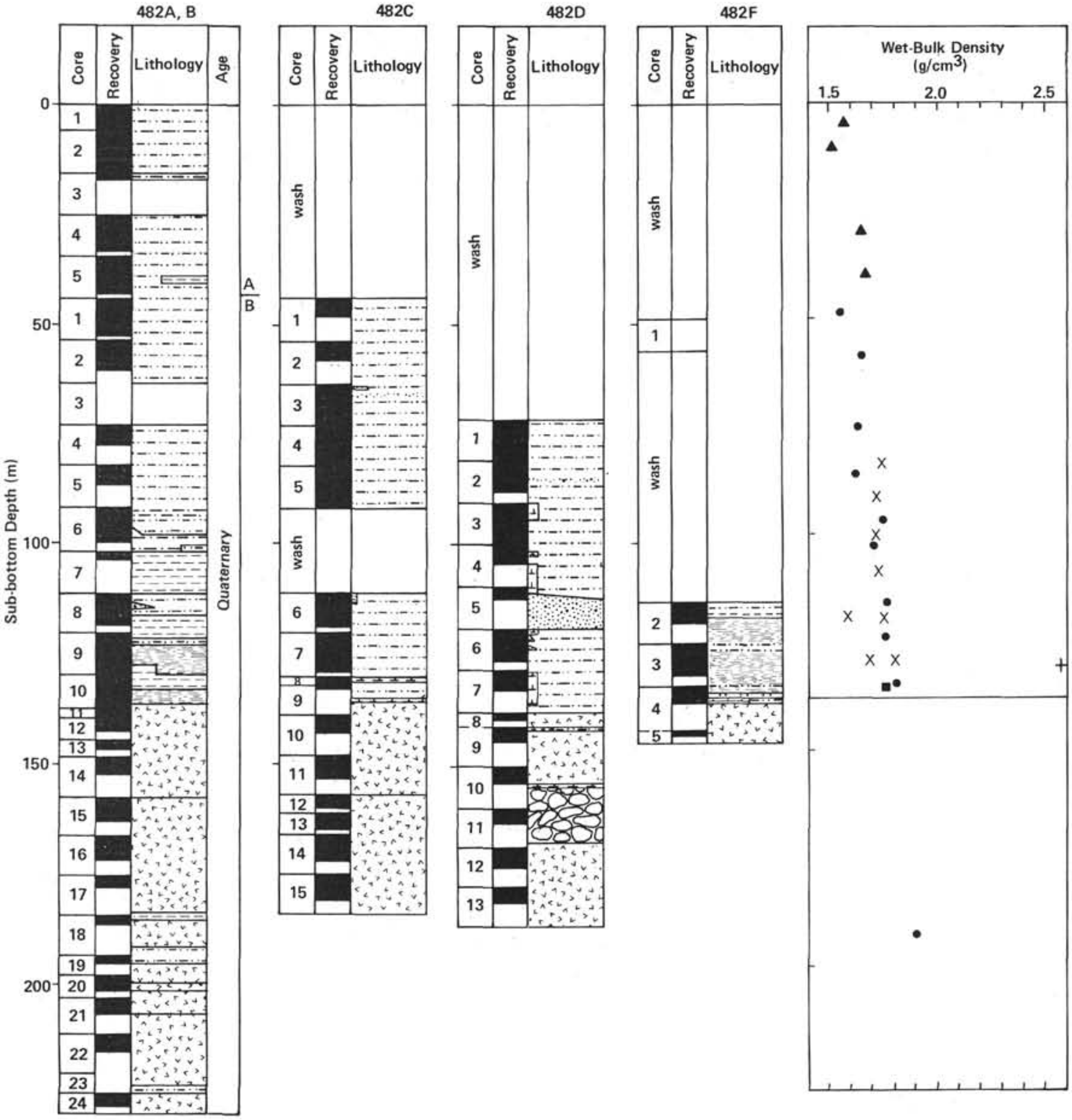


Figure 12. Sediment physical properties for Site 482 plotted as a function of depth. For explanation of lithologic symbols, see Explanatory Notes (this volume); Hole 482A, ▲; Hole 482B, ●; Hole 482C, +; Hole 482D, ×; Hole 482F, ■.

prises 5% of the groundmass and is altered to smectite. Interstitial groundmass material is cryptocrystalline, often with some microcrystalline quartz and magnetite.

Unit 3

Unit 3 (Section 18-1, 9 cm to Section 18-2, 107 cm) is a single cooling unit of massive basalt estimated from the drilling record to be about 6 meters thick. A glassy rind was recovered at the top of the unit beneath a few centimeters of indurated claystone. The unit is separated from Unit 4 below by about 4.5 meters of moderately indurated silty clay. The upper 50 cm of Section 18-2 is vesicular and amygdaloidal; elsewhere vesicles are small and sparse.

Plagioclase phenocrysts generally comprise < 1% by volume and are set in a fine- to medium-grained intergranular groundmass. Olivine forms 2 to 3% of the groundmass and is usually replaced by smectite. Some interstitial material is also altered to smectite, and veinlets are filled with smectite and carbonate.

Unit 4

Unit 4 (Section 19-1, 60 cm to Section 20-2, 83 cm) consists of a single cooling unit of massive, aphyric to very sparsely phyric basalt. It is separated from the overlying unit by about 4.5 meters of sediment, and the top of the unit is chilled against the sedimentary interbed. A finer-grained section at 83 cm in Section 20-2 is taken as the chilled top of Unit 5. Groundmass textures in Unit 4 are fine to medium grained, more rarely quenched. Alternations of fine- and medium-grained material may mark cooling breaks, but no glassy rinds were recovered except at the top of the unit. Vesicles are sparse, but veinlets filled with smectite, pyrite, and calcite are often

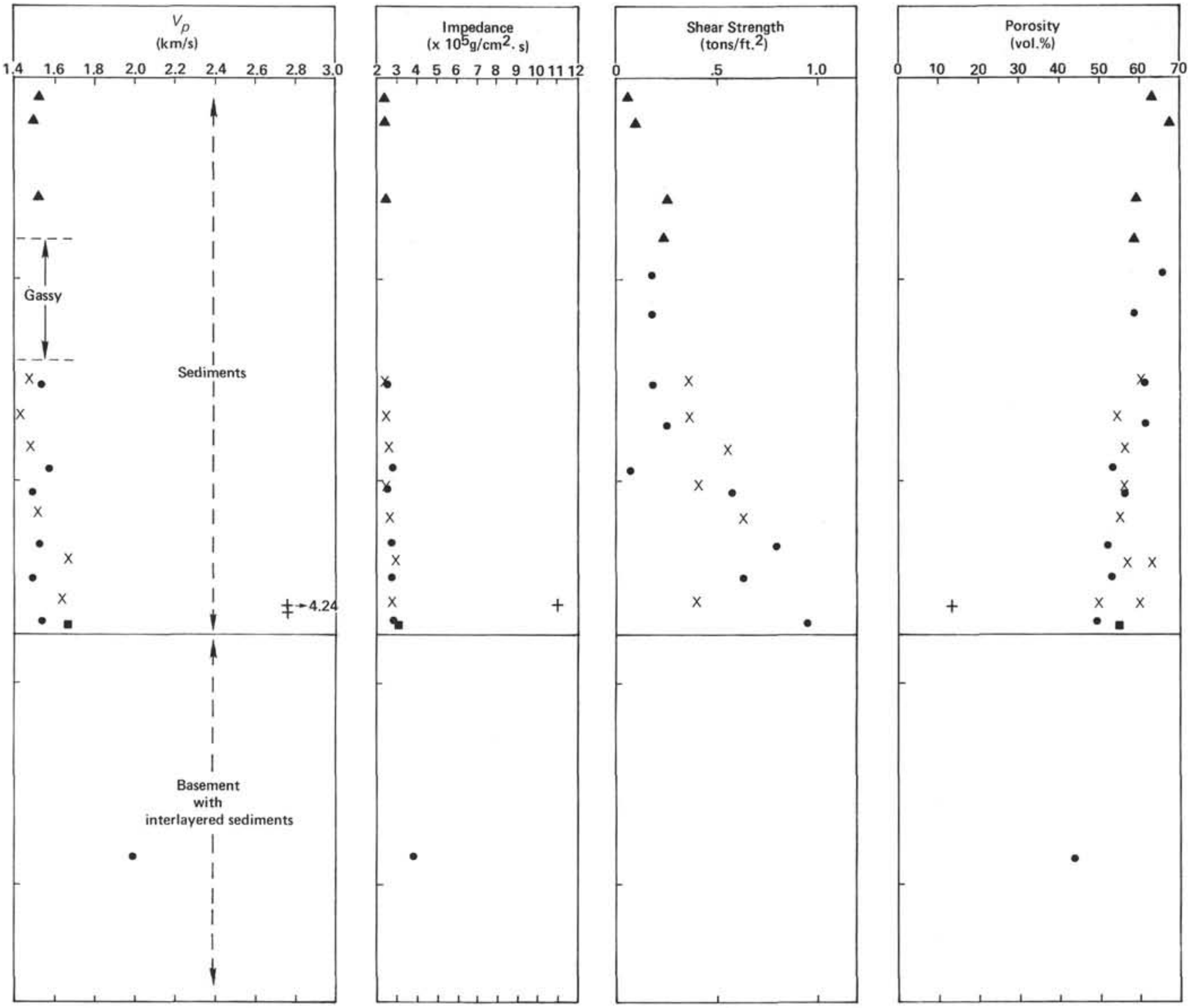


Figure 12. (Continued).

present. Olivine comprises 1 to 2% of the groundmass and, along with glassy interstitial material, is replaced by smectite.

Unit 5

Unit 5 (Section 20-2, 83 cm to Section 20-3, 130 cm) is distinguished from the overlying and underlying units largely on the basis of phenocryst mineralogy. It is composed of a single cooling unit of massive basalt about 2 meters thick with fine-grained zones at the top and bottom. The rock is sparsely plagioclase phyric and fine grained, with intersertal to intergranular textures. Some of the plagioclase phenocrysts are intergrown with green clinopyroxene in glomerophyric clots. Small grains of altered olivine make up 3 to 5% of the groundmass. Vesicles are small and sparse, but a few hairline fractures are filled with smectite and pyrite.

Unit 6

Unit 6 (Section 20-3, 130 cm to Section 21-3, 50 cm) is interpreted to be a single cooling unit of massive basalt about 5.5 meters thick. The top of the unit is marked by a 5-cm-thick zone of very fine-grained basalt, and the base is taken at the top of a similar sequence believed to mark the beginning of Unit 7. A single piece of sediment was recovered in the middle of this unit at the top of Core 21, but in the absence of a grain-size change in the basalt or of a drilling break, it is not taken as a cooling unit boundary. It probably is a piece of sediment that slumped into the hole during retrieval of the core barrel.

The basalts of Unit 6 are sparsely phyric, containing an average of 3 to 5% plagioclase phenocrysts, 1 to 2% olivine phenocrysts, and 1% or less clinopyroxene phenocrysts. The phenocrysts often occur in small clots or

Table 6. Basement lithologic units, Site 482.

Unit	Top (m) a	Top (m) b	Base (m) a	Base (m) b	Thickness (m) a	Thickness (m) b	Type of Cooling Unit	Phenocryst Assemblage	Core-Section, (level in cm)
Hole 482B									
1a	136.5	136.5	148.9	ND	21.5	21.5	Massive basalt	Aphyric	10-7, 8 to 14-1, 90
1b	148.9	ND	149.5	ND	0.6	ND	Massive basalt	Aphyric	14-1, 90 to 14-1, 150
1c	149.5	ND	150.8	ND	1.3	ND	Massive basalt	Aphyric	14-2, 0 to 14-2, 133
1d	150.8	ND	158.0	158.0	7.2	ND	Massive basalt	Aphyric	14-2, 133 to 15-1, 115
2a	158.0	158.0	166.0	ND	8.0	ND	Massive basalt	Plagioclase	15-1, 115 to 15-5, 70
2b	166.0	ND	175.0	184.0	9.0	ND	Massive basalt	Plagioclase	16-1, 0 to 17-2, 150
	Interlayered Sediment								
3	184.1	185.5	186.2	191.5	2.1	6.0	Massive basalt	Plagioclase	18-1, 9 to 18-2, 107
	Interlayered Sediment								
4	193.5	195.0	199.5	199.5	6.0	4.5	Massive basalt	Plagioclase	19-1, 60 to 20-2, 83
5	199.5	199.5	201.5	201.5	2.0	2.0	Massive basalt	Plagioclase-Clinopyroxene	20-2, 83 to 20-3, 130
6	201.5	201.5	205.0	207.0	3.5	5.5	Massive basalt	Plagioclase-Clinopyroxene-Olivine	20-3, 130 to 21-3, 50
7	205.0	207.0	220.3	223.0	15.3	16.0	Massive basalt	Plagioclase-Clinopyroxene-Olivine	21-3, 50 to 23-1, 30
	Interlayered Sediment								
8	224.7	225.0	229.0	229.0	4.3	4.0	Massive basalt	Aphyric	24-1, 25 to 24-3, 130
Hole 482C									
1a	135.5	ND	149.5	ND	14.0	ND	Massive basalt	Aphyric	9-1, 60 to 11-1, 130
1b	149.5	ND	150.1	ND	0.6	ND	Massive basalt	Aphyric	11-1, 130 to 11-2, 65
1c	150.1	ND	157.0	ND	6.9	ND	Massive basalt	Aphyric	11-2, 65 to 11-4, 150
2a	157.0	ND	161.5	ND	4.5	ND	Massive basalt	Plagioclase	12-1, 0 to 12-3, 20
2b	161.5	ND	166.0	ND	4.5	ND	Massive basalt	Plagioclase	13-1, 0 to 13-3, 150
2c	166.0	ND	175.0	ND	9.0	ND	Massive basalt	Plagioclase	14-1, 0 to 14-5, 50
2d	175.0	ND	184.0	ND	9.0	ND	Massive basalt	Plagioclase-Clinopyroxene-(Olivine)	15-1, 0 to 15-4, 150
Hole 482D									
1	138.0	138.0	139.6	141.5	1.6	3.5	Massive basalt	Aphyric	8-1, 5 to 8-2, 30
	Interlayered Sediment								
2a	141.7	142.5	152.3	ND	10.6	ND	Massive basalt	Aphyric	9-1, 15 to 10-2, 30
2b	152.3	ND	154.0	154.0	1.7	ND	Massive basalt	Olivine-Plagioclase	10-2, 30 to 10-3, 60
	Interlayered Sediment								
3	154.1	154.5	169.6	167.5	15.5	13.0	Pillowed? basalt	Aphyric	10-3, 65 to 12-1, 130
4a	169.6	167.5	170.7	ND	1.1	ND	Massive basalt	Plagioclase-Olivine-Clinopyroxene	12-1, 130 to 12-2, 73
4b	170.7	ND	177.6	ND	6.9	ND	Massive basalt	Plagioclase	12-2, 73 to 13-1, 10
4c	177.6	ND	178.9	ND	1.3	ND	Massive basalt	Plagioclase	13-1, 10 to 13-1, 135
4d	178.9	ND	186.5	186.5	7.6	ND	Massive basalt	Plagioclase-Olivine	13-1, 135 to 13-3, 35
Hole 482F									
1	136.2	ND	145.0	ND	8.8	ND	Massive basalt	Aphyric	4-3, 117 to 5-2, 30

Note: ND = not determined.
[a] Calculated from core, corrected for spacers.
[b] Calculated from drilling rate and downhole logs.

clusters with subophitic textures and are set in a fine- to medium-grained groundmass. Most phenocrystic and groundmass olivine is altered to smectite, as is some interstitial groundmass material. Sparse vesicles and veinlets are filled with smectite and minor carbonate.

Unit 7

Unit 7 (Section 21-3, 50 cm to Section 23-1, 30 cm) consists of about 16 meters of massive, sparsely phyric basalt interpreted as a single cooling unit. A fine-grained zone marks the top of the unit and at the base the unit overlies a 2-meter-thick sequence of firm nannofossil-bearing silty clay.

Phenocrysts average about 5 modal percent and consist chiefly of plagioclase with about 1% each of olivine and clinopyroxene. Many phenocrysts form small glomerophyric clots with subophitic textures but single crystals are also present. The groundmass is fine to medium grained, being coarsest near the middle of the unit, with intergranular to intersertal textures. Most olivine grains and some interstitial material is altered to smectite. Smectite- and carbonate-filled vesicles make up 1 to 2%, and small smectite-lined veins are common.

Unit 8

Unit 8 (Section 24-1, 25 cm to Section 24-3, 130 cm) extends from the sedimentary interbed at the top of Core 24 to the bottom of the hole, a distance of about 4 meters. The unit comprises a single cooling unit of massive aphyric basalt characterized by a fine-grained intergranular to intersertal texture. Groundmass olivine and some interstitial material are altered to smectite. Smectite-filled vesicles make up 1 to 5 volume percent, generally increasing in size and abundance with depth. Veinlets are sparse and randomly distributed and are filled with smectite and pyrite. A few have narrow alteration halos 1 to 2 mm wide.

Hole 482C

Hole 482C reached acoustic basement at 135.5 meters and terminated drilling at 184 meters sub-bottom. Of the 50.5 meters drilled into basement, 28.9 meters were recovered (57%). The recovered material consists entirely of massive basalt with no interbedded sediments. Two major lithologic units have been distinguished on the basis of phenocryst content, and each of these has been subdivided into several cooling units (Table 6).

As in Hole 482B contact relationships between the basalt and the overlying sediments are ambiguous, but we tentatively interpret the massive units as flows rather than later intrusives. This interpretation is based on the absence of clearly intrusive contacts and the relatively fine-grained nature of the basalts.

The upper lithologic unit is aphyric whereas the lower one contains sparse plagioclase phenocrysts. An altered zone in which actinolite and chlorite are present occurs in the interval from Section 10-2 to Section 11-2. These minerals probably reflect relatively high-temperature hydrothermal activity.

Unit 1

Unit 1 (Section 9-1, 60 cm to Section 11-1, 130 cm) is a 21.5-meter-thick sequence of massive basalt in which three subunits have been recognized. The sediments directly above the uppermost basalt are indurated olive black claystones with some layers of gray dolomite. Although indurated, these sediments do not appear to have been baked. No glassy rinds were recovered in the unit, and cooling breaks are difficult to recognize. The subunits were distinguished largely on the basis of chemical composition and magnetic inclinations.

Groundmass textures range from fine grained, intergranular to medium grained, subophitic with the coarsest-grained portions being in the central part of the unit. Groundmass olivine and interstitial material are altered to smectite throughout the unit. In the interval from Section 10-2 to 11-2, some alteration of plagioclase and clinopyroxene has also occurred, particularly adjacent to fractures. Here, chlorite, carbonate, and sulfides are common and some actinolite has formed after clinopyroxene. Smectite-filled vesicles are common in Sections 10-1 to 10-3, comprising 1 to 5 volume percent and ranging up to 2 mm across. A major vein 2 to 3 cm wide is present in the upper 40 cm of Section 10-1. This vein is strongly zoned and partly filled with sulfides, carbonate, and zeolite (Fig. 13); it has a pronounced alteration halo in which vesicles are lined with smectite and partly filled with pyrite and carbonate.

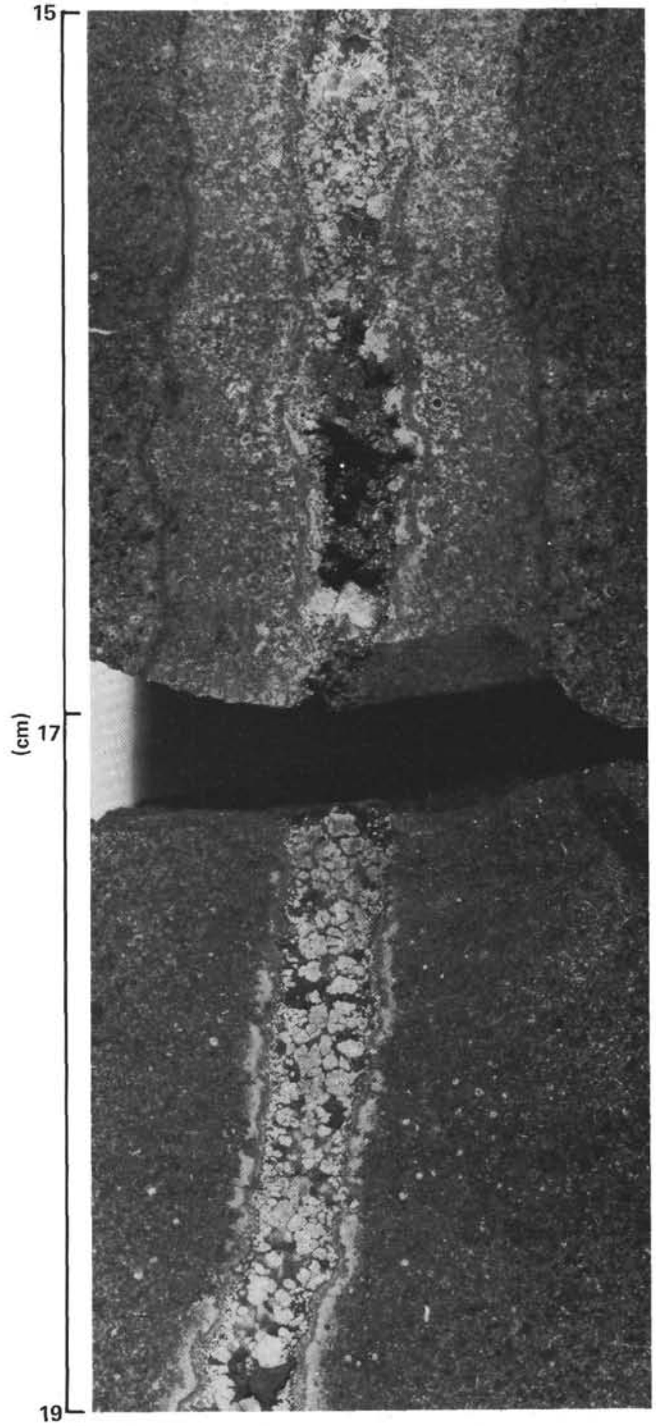


Figure 13. Close-up of sulfide-carbonate-zeolite-filled vein with some crystal-lined vugs. (Note pronounced alteration halos in which the rock is bleached and the vesicles are filled with smectite, pyrite, and calcite; Sample 482C-10-1, 15–19 cm.)

Unit 2

Unit 2 (Section 12-1, 0 cm to Section 15-4, 150 cm) comprises four cooling units of massive basalt with a combined thickness of 27 meters. A fine-grained zone occurs at the top of the unit and there is an abrupt increase in phenocryst content across the contact between Units 1 and 2. Other cooling breaks, characterized by fine-grained basalt, occur at the top of Core 12 and in Core 15, Section 1. Glassy fragments of porphyritic basalt with thin coatings of indurated sediment were recovered at the tops of Cores 13 and 14 (Fig. 14). However, rocks on either side of these fragments show no changes in grain size or alteration toward these inter-

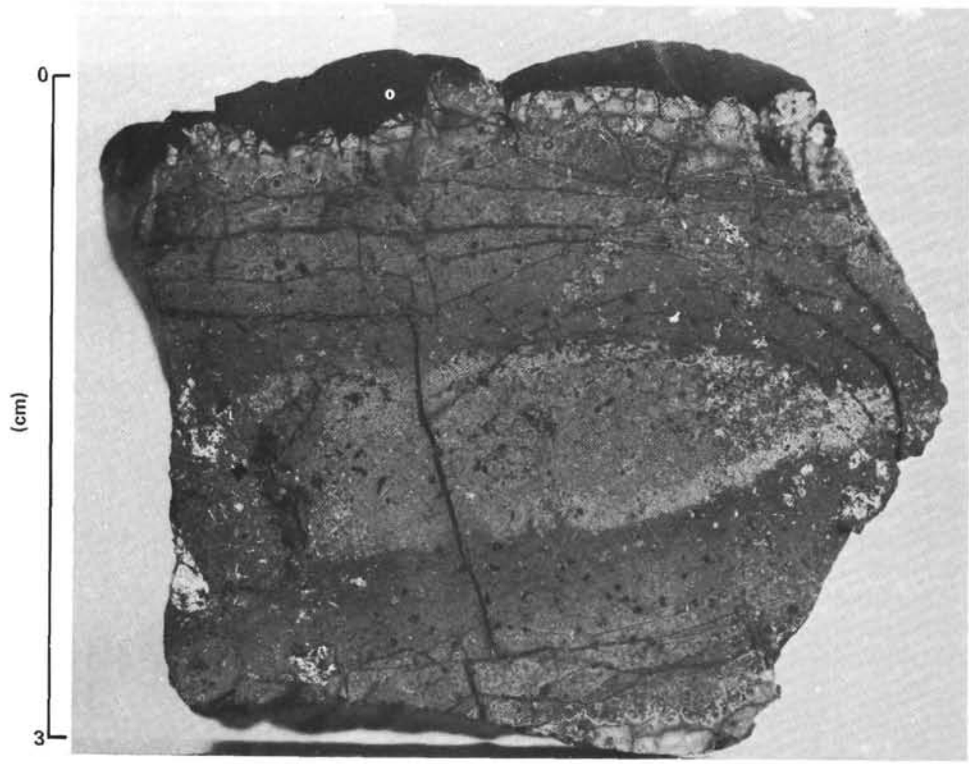


Figure 14. Basalt fragment with chilled margins above and below and a coating of dark brown indurated mudstone at the top. The basalt is zoned with an outer layer of bluish, devitrified glass followed inward by a variolitic zone and tachylite in the light-colored center; Sample 482C-13-1, 0–3 cm.

vals, suggesting that these are not true cooling breaks. The glassy fragments may have fallen into the hole from above, although no such material was recovered at higher levels. Because the nature of these intervals is uncertain, they are interpreted as cooling breaks in Table 6.

All of the basalts of Unit 2 are sparsely plagioclase phyric and those of the lowest cooling unit also contain sparse olivine and clinopyroxene phenocrysts. In the upper cooling units the plagioclase phenocrysts generally occur as individual crystals, but in the lowest unit the phenocrysts form glomerophyric clots with subophitic textures. Groundmass textures range from fine-grained intergranular to medium-grained subophitic. Even the relatively coarse-grained specimens, however, have some cryptocrystalline-to-glassy interstitial material. Olivine crystals and some of the interstitial material are replaced by smectite. Vesicles and veinlets are small and sparse. Where present, they are filled with smectite and minor calcite.

Hole 482D

Hole 482D reached basement at 138 meters and terminated at 186.5 meters sub-bottom depth. Of the 48.5 meters of basalt drilled, 40.6% (or 19.7 m) was recovered, compared to 57.2% in Hole 482C and 46% in Hole 482B. Basalts in Hole 482D are generally more fractured, finer grained, and contain more cooling units than those of nearby Holes 482B and C.

Four major units are distinguished on the basis of phenocryst content, and several of the unit boundaries coincide with changes in chemical composition and magnetic inclinations. Units 2 and 4 are further subdivided into multiple cooling units. Three of the major lithologic units clearly consist of massive basalt. Unit 3 contains many thin cooling units bounded by glassy rinds, which may be pillows. However, the glassy rinds are generally flat rather than curved, and the vesicle zones commonly separating glassy pillow rinds from their inner variolitic zones are absent. Thus, these units may represent thin massive flows rather than pillows.

Alteration in the drilled sequence is most intense in the upper 10 to 15 meters of basement and is generally restricted to halos surrounding fractures filled with smectite, calcite, and pyrite.

Unit 1

Unit 1 (Section 8-1, 5 cm to Section 8-2, 30 cm) is a 3.5-meter-thick cooling unit of massive, aphyric basalt. The grain size generally increases from the margins toward the center of the unit, but glassy rinds were not recovered at the contacts. The sediments directly above Unit 1 are indurated grayish olivine mudstone lacking any evidence of baking. Unit 1 is separated from the underlying Unit 2 by about 1 meter of nannofossil-bearing clay.

The groundmass consists of fine-grained mixtures of plagioclase, clinopyroxene, iron oxide, and minor olivine with variable amounts of cryptocrystalline interstitial material. Textures are intergranular to intersertal, grading into subophitic in the coarsest-grained intervals.

The olivine and some of the interstitial material are replaced by smectite. Sparse vesicles in Section 8-1 are filled with mixtures of smectite and calcite.

Unit 2

Unit 2 (Section 9-1, 15 cm to Section 10-3, 60 cm) is a massive basalt bounded above and below by interlayered sediments. There is no obvious chilling at the upper contact, but a glassy margin occurs at the base of the unit. Two subunits are recognized on the basis of phenocryst content even though a clear cooling break was not observed in the section. The upper subunit is aphyric and petrographically very similar to Unit 1; the lower subunit is very sparsely phyric with about 1% each of small plagioclase and olivine phenocrysts. Groundmass textures in both subunits are similar, ranging from fine-grained intersertal to medium-grained subophitic. Olivine and interstitial groundmass material are replaced by smectite. Vesicles are small and sparse but veinlets are common throughout the unit. These are filled with smectite, calcite, and pyrite and often have narrow alteration halos.

Unit 3

Unit 3 (Section 10-3, 65 cm to Section 12-1, 130 cm) is a 13-meter-thick section of aphyric basalt with numerous glassy rinds representing cooling unit boundaries. Most of the cooling units are from 30 to 150 cm thick and may be pillows. However, several features of typical pillows are absent, including rapid grain-size change inward from the pillow rim, the vesicle zone between the glassy rim and the variolitic zone, and the expected curvature of the glassy rinds. Though the evidence is insufficient, these observations suggest that the thin cooling units may be sheet flows rather than pillows.

Because the cooling units are thin, most of the rocks have a fine-grained quench texture. Coarser-grained intersertal textures are present in the centers of some units. The rocks consist of plagioclase and olivine microlites surrounded by poorly crystallized clinopyroxene in radiating sheaves or clusters. The olivine and some of the glassy interstitial material is replaced by smectite. Vesicles comprise 1 to 2% and are filled with smectite and calcite.

Unit 4

Unit 4 (Section 12-1, 130 cm to Section 13-3, 35 cm) is a series of four massive cooling units with a total thickness of just under 17 meters. These basalts are easily distinguished from those of Unit 3 by their higher phenocryst content and coarser grain size. A cooling break between Units 3 and 4 is indicated by decreasing grain size toward the contact, but no glassy material was recovered. Individual cooling units within Unit 4 range from about 1 to 7.5 meters in thickness and are separated by glassy rinds.

Phenocrysts compose from 5 to 10 modal percent, the most abundant being plagioclase. Phenocrystic olivine is present in two of the cooling units, and clinopyroxene accompanies plagioclase and olivine in one. In the latter unit the phenocrysts often form glomerophyric clots with subophitic textures. Groundmass textures range from medium-grained intergranular to quench and generally vary systematically in each cooling unit. All of the basalts have 3 to 5% groundmass olivine which, along with some interstitial material, is replaced by smectite. Vesicles are small and sparse, usually comprising less than 1 volume percent. These are filled with smectite, as are rare veinlets.

Hole 482F

About 2 meters of massive basalt were recovered from 8.8 meters of basement penetration in Hole 482F. The rock is uniformly fine to medium grained with about 1% plagioclase phenocrysts, some of which are intergrown with clinopyroxene. The groundmass is fine grained with an intergranular to intersertal texture. Small spherical vesicles constitute about 1 volume percent, and these are filled with brown smectite. A few veinlets filled with smectite and pyrite have dark alteration halos characterized by small amounts of disseminated pyrite.

Igneous Rock Chemistry

Shipboard chemical analyses were carried out on most basement lithologic units in order to provide preliminary data on chemical variation in the basalts (Table 7).

Major elements and selected trace elements (Ni, Sr, Zr) were analyzed with the CNEXO X-ray fluorescence unit. Analytical techniques and sample preparation followed the procedures established for Legs 45, 46, and 55, the details of which are given in the appropriate *Initial Reports*. Na_2O was measured on board ship for the first time using a flat TLAP crystal. Use of this crystal also improved the analytical accuracy for MgO. Water and CO_2 were determined with the CHN analyzer, using standard shipboard techniques.

For the purpose of plotting the chemical data on variation diagrams the following adjustments were made: (1) a correction was made for secondary carbonate by subtraction of CO_2-equivalent CaO from the dry-weight analysis of the ignited sample; (2) total iron was expressed as FeO by multiplying Fe_2O_3 by 0.8998; (3) the adjusted oxide data were normalized to a dry-weight basis. These values were then plotted on MgO variation diagrams, and basalt chemical types determined on the basis of major and trace element compositions. Average compositions for each chemical type at the different holes are given in Table 7.

CHEMICAL COMPOSITION OF IGNEOUS ROCKS

Hole 482B

Seventeen samples from this hole were analyzed, representing most of the recognized cooling units (Table 7). All of the basalts are sparsely to moderately phyric tholeiites, characteristic of the East Pacific Rise—with MgO contents between 6.5% and 8.5%; TiO_2, 1 and 2%; Al_2O_3, 14 and 17%; CaO, 11 and 13% (except where leached by alteration); and K_2O, less than 0.1% (cf. Yeats et al., 1975; Rosendahl, Hekinian, et al., 1980). Within this compositional range, distinct magma

Table 7. Shipboard X-ray fluorescence analyses of basalts, Site 482.

Sample	Major Elements (wt.%)											Volatiles (wt.%)			Trace Elements (ppm)		
(interval in cm)	SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO	MgO	CaO	Na_2O	K_2O	P_2O_5	Total	LOI[a]	H_2O+[b]	CO_2[b]	Ni	Sr	Zr
Hole 482B																	
10-7, 14-16	47.11	1.92	15.14	14.15	0.25	7.24	10.38	2.80	0.09	0.18	99.26	7.78	1.34	0.50	65	107	103
11-1, 23-25	49.78	1.79	14.16	11.58	0.20	7.60	12.16	2.40	0.08	0.17	99.92	1.61	0.49	0.86	74	111	119
12-2, 135-137	49.82	1.76	14.20	11.74	0.18	8.00	11.77	2.20	0.08	0.18	99.93	1.11	0.67	0.20	73	107	n.d.
14-2, 121-124	49.59	1.41	14.64	11.24	0.18	7.92	12.19	2.22	0.05	0.13	99.57	1.47	0.95	0.20	98	91	84
15-1, 135-139	49.71	1.32	14.74	11.18	0.18	8.09	12.13	2.04	0.04	0.12	99.55	1.73	0.95	0.32	58	92	80
15-3, 117-119	49.96	1.28	14.48	11.10	0.16	7.91	12.32	2.20	0.05	0.11	99.57	1.33	0.59	0.18	57	94	81
16-1, 36-38	50.00	1.28	14.60	11.06	0.16	7.89	12.24	2.10	0.05	0.11	99.49	1.12	0.58	0.18	63	93	84
17-2, 111-113	49.88	1.31	14.42	11.47	0.19	7.81	12.49	2.00	0.02	0.12	99.71	1.04	0.45	0.23	60	94	79
18-1, 18-20	50.25	1.31	14.22	11.39	0.17	7.97	12.08	2.20	0.06	0.11	99.76	1.12	0.46	0.25	60	93	83
18-2, 99-101	49.45	1.56	14.26	11.94	0.19	7.63	12.18	2.05	0.04	0.13	99.43	1.10	0.67	0.11	64	90	101
19-1, 96-100	49.87	2.29	16.72	12.01	0.12	7.42	7.40	3.16	0.06	0.21	99.26	3.77	1.93	0.48	51	119	151
20-3, 24-26	49.84	1.58	15.74	10.23	0.16	7.50	11.68	2.45	0.04	0.14	99.36	2.58	1.26	0.55	67	97	103
21-1, 62-64	49.11	1.91	14.10	11.92	0.16	7.61	11.41	2.48	0.06	0.16	98.92	1.82	0.86	0.18	67	112	130
21-3, 74-76	49.70	1.63	15.38	10.80	0.17	7.25	12.20	2.40	0.03	0.16	99.72	1.40	0.72	0.10	62	126	116
22-2, 34-36	50.00	1.58	15.80	10.80	0.16	7.04	12.22	2.40	0.03	0.15	100.18	1.47	0.66	0.12	61	125	116
22-4, 34-36	50.00	1.55	15.30	10.67	0.16	6.87	12.22	2.30	0.06	0.14	99.27	2.79	0.85	0.18	71	125	106
24-1, 93-95	49.91	1.69	16.00	10.60	0.16	7.47	10.74	2.55	0.05	0.15	99.32	3.62	0.83	0.30	63	96	108
Hole 482C																	
9-1, 121-123	49.68	1.81	14.53	11.81	0.20	7.72	11.86	2.10	0.08	0.17	99.96	1.96	0.80	0.88	67	110	125
10-2, 73-75	49.73	1.74	14.54	11.62	0.19	8.09	11.66	2.10	0.06	0.16	99.89	1.81	0.95	0.31	72	106	121
11-1, 115-117	49.22	1.81	14.65	11.54	0.17	7.80	11.85	2.20	0.06	0.17	99.47	1.56	0.92	0.19	81	114	127
11-1, 138-139	49.50	1.76	14.55	11.24	0.17	7.94	12.00	2.30	0.07	0.17	99.70	1.46	0.66	0.16	84	111	122
11-2, 16-18	50.09	1.38	14.11	11.10	0.16	10.04	9.66	2.65	0.07	0.15	99.41	4.66	2.19	0.32	79	92	88
11-2, 21-24	49.37	1.24	14.33	12.01	0.14	10.69	8.67	2.50	0.08	0.13	99.18	4.15	2.86	0.33	80	84	75
11-3, 141-143	49.90	1.82	14.06	11.84	0.18	7.86	11.79	2.25	0.07	0.17	99.94	1.46	0.49	0.23	72	113	120
12-1, 11-13	49.74	1.31	14.50	11.32	0.18	8.11	12.00	1.90	0.05	0.12	99.23	1.04	0.65	0.23	59	93	81
12-2, 95-97	50.09	1.32	14.58	11.47	0.18	7.90	12.30	2.00	0.03	0.11	99.98	1.19	0.55	0.23	58	94	87
13-1, 22-24	49.84	1.33	14.90	10.71	0.15	8.45	11.71	2.10	0.03	0.10	99.32	2.28	0.88	0.22	55	93	80
13-1, 125-127	49.89	1.31	14.40	11.28	0.17	7.90	12.21	2.05	0.04	0.11	99.36	1.33	0.59	0.30	56	93	76
13-3, 108-110	49.83	1.31	14.45	11.39	0.18	7.74	12.23	2.05	0.05	0.12	99.35	1.09	0.65	0.15	57	93	78
14-1, 40-42	50.06	1.30	14.46	11.30	0.17	7.77	12.32	2.00	0.04	0.12	99.54	1.31	0.51	0.14	54	94	81
14-4, 127-129	49.80	1.30	14.35	11.34	0.17	8.01	12.27	1.95	0.05	0.12	99.36	1.10	0.51	0.11	57	92	75
15-1, 44-46	49.96	1.30	14.36	11.32	0.18	7.83	12.23	2.05	0.04	0.11	99.38	1.11	0.58	0.10	58	92	80
15-2, 132-124	49.97	1.29	14.36	11.20	0.17	8.00	12.24	2.00	0.05	0.12	99.40	0.53	0.59	0.12	59	92	75
15-3, 97-99	50.11	1.29	14.52	11.29	0.18	7.90	12.27	2.00	0.02	0.12	99.70	1.18	0.52	0.11	56	94	74
15-4, 119-121	50.20	1.28	14.45	11.23	0.18	7.77	12.30	2.05	0.05	0.11	99.62	1.18	0.56	0.13	60	92	82
Hole 482D																	
8-1, 30	48.99	1.90	15.20	11.55	0.26	6.87	11.19	2.20	0.49	0.18	98.83	5.61	0.79	0.41	60	104	111
8-1, 109-111	49.83	1.78	14.30	11.72	0.19	7.71	12.06	2.10	0.04	0.16	99.89	1.81	0.68	0.20	70	111	119
9-1, 48-50	49.94	1.81	14.07	11.76	0.20	7.81	11.97	2.20	0.04	0.17	99.96	1.46	0.72	0.11	73	107	120
9-3, 50-52	49.58	1.82	14.08	12.00	0.20	7.54	11.89	2.39	0.05	0.17	99.72	1.31	0.69	0.11	71	109	124
10-2, 52-55	50.01	1.78	14.04	11.76	0.19	7.75	11.91	2.42	0.05	0.17	100.08	1.39	0.63	0.27	71	108	127
10-2, 109-112	50.04	1.80	14.22	11.62	0.18	7.92	11.76	2.35	0.07	0.16	100.12	1.88	0.63	0.12	73	106	122
10-3, 14-16	50.02	1.93	14.08	12.08	0.19	7.61	11.48	2.64	0.04	0.17	100.24	1.32	0.69	0.14	65	108	133
10-3, 101-103	49.56	1.44	15.13	11.29	0.18	7.45	12.25	2.52	0.05	0.13	100.00	2.16	1.23	0.25	99	91	91
11-1, 135-137	49.51	1.43	14.57	11.30	0.18	8.00	12.12	2.35	0.04	0.12	99.62	1.73	1.07	0.24	86	94	91
12-1, 105-107	49.53	1.41	14.63	11.32	0.18	8.00	12.00	2.24	0.04	0.13	99.48	1.11	0.76	0.21	96	97	84
12-2, 50-52	49.71	1.31	14.33	11.38	0.18	8.19	12.25	2.26	0.03	0.11	99.75	1.25	0.57	0.15	63	93	78
12-2, 82-84	49.86	1.30	14.33	11.30	0.17	8.11	12.13	2.17	0.03	0.11	99.51	1.11	0.58	0.17	63	91	79
12-3, 118-120	49.87	1.28	14.58	11.18	0.17	7.72	12.31	2.24	0.03	0.11	99.49	1.04	0.48	0.15	59	95	83
13-1, 127-129	49.92	1.36	15.00	10.70	0.16	8.43	11.63	2.41	0.03	0.12	99.76	1.80	1.03	0.22	64	99	80
13-3, 4-6	49.87	1.33	14.36	11.34	0.17	8.81	11.76	2.36	0.06	0.11	100.17	1.60	0.74	0.28	61	95	85
Hole 482F																	
4-3, 131-137	49.60	1.97	13.90	12.42	0.19	7.60	11.44	2.41	0.08	0.19	99.80	1.11	0.47	0.59	64	113	135

[a] Loss on ignition.
[b] Percent composition after baking off H_2O-.

groups are observed from MgO variation diagrams (Fig. 15).

Lithologic Unit 1a, composed of aphyric basalt, is designated Chemical Type A; it is high in TiO_2, P_2O_5, and Fe_2O_3 and low in Al_2O_3 and CaO as compared to other groups. Units 1c and 2, which are aphyric to sparsely plagioclase phyric, form a second chemical type (B), higher in Al_2O_3 and CaO and lower in TiO_2, P_2O_5, and FeO than Type A for equivalent contents of MgO (Fig. 15). Unit 3, whose only representative analysis reflects alteration, appears to indicate a further distinct magmatic variant (Chemical Type C), characterized by high Al_2O_3, TiO_2, P_2O_5, FeO, and Zr. All of these elements are probably resistant to alteration of the type encountered here.

Units 4, 6, and 7 are sparsely to moderately (plagioclase, clinopyroxene, and olivine) phyric, and form a distinct chemical type (D). This type has lower MgO and

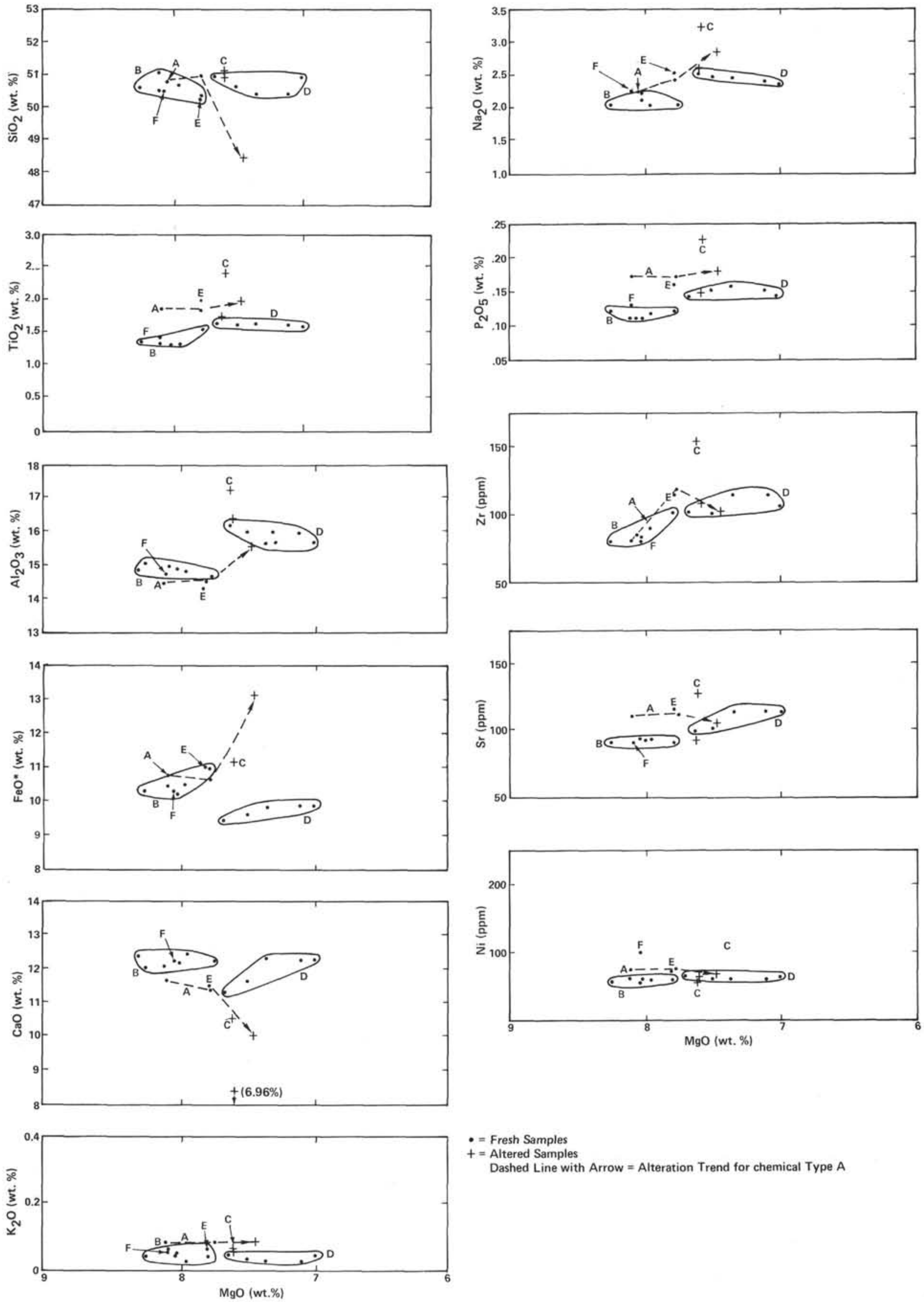


Figure 15. MgO variation diagrams for basalts from Hole 482B. (Chemical types are lettered A–F.)

FeO and higher Sr contents than types A and B, and TiO_2, P_2O_5, and Zr content intermediate between A and B types. The oxide variation (Fig. 15) suggests that Type D could be related to Type A (essentially a liquid composition) by accumulation of phenocryst phases, especially plagioclase. A single analysis from Unit 5 (Sample 482B-21-1, 62–64 cm), interlayered with the sequence represented by Type D, is compositionally similar to Type A (i.e., high in TiO_2, P_2O_5, low in Al_2O_3) but may possibly represent a separate chemical type (E).

The stratigraphic relations of each chemical type are shown in Figure 16, in which the atomic ratios TiO_2/Al_2O_3 and $Mg/(Mg + Fe^{2+})$ are plotted versus sub-bottom depth in relation to lithologic units. These parameters are sensitive to the effects of plagioclase and mafic phase redistribution, respectively, in the magma.

Three "altered" samples from Hole 482B were analyzed from Units 1 (Sample 482B-10-7, 14–16 cm), 3 (Sample 482B-19-1, 96–100 cm), and 7 (Sample 482B-24-1, 93–95 cm). Although no single chemical criterion appears to be a suitable index of alteration, leaching of Ca^{2+} is the most obvious chemical effect accompanying secondary growth of smectite (Fig. 15). Interestingly, none of the altered samples shows enrichment of K_2O (Fig. 15), which remains consistently lower than ocean-ridge basalt "averages" (ca. 0.16%) despite increased contents of H_2O^+. Leaching of Ca^{2+} seems to be accompanied by loss of Mg^{2+}, and in one sample from Unit 1, near the upper contact with sediment, by a sharp depletion of SiO_2 and possibly a slight increase of Na_2O (Fig. 15). The sample from Unit 3 is the most depleted in CaO (it has only 7.4%), but nonetheless shows a high ratio of TiO_2/Al_2O_3—two oxides considered alteration resistant. In general, chemical mobility is slight, although sufficiently characteristic to pinpoint analyses of altered material.

Hole 482C

Sixteen chemical analyses were made of basalts from the two major lithologic units identified in the basement

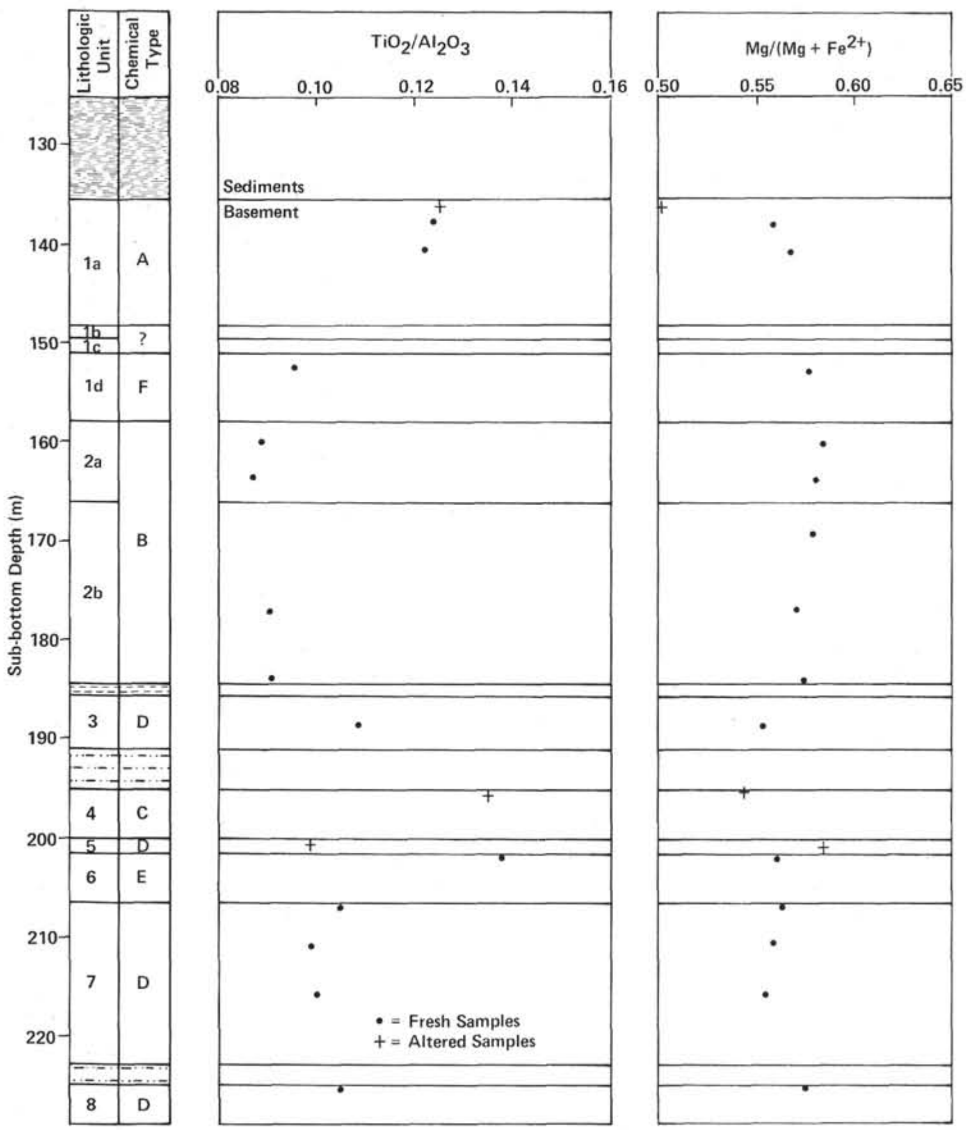


Figure 16. Downhole variation in TiO_2/Al_2O_3 and $Mg/(Mg + Fe^{2+})$ ratios in basalts from Hole 482D.

section of Hole 482C. The oxide variation is less than the overall range for Hole 482B, with only two chemical types being recognized from the variation diagrams (Fig. 17). These correspond almost exactly to Hole 482B Chemical Types A and B.

Chemical Type A forms the upper aphyric cooling unit in Hole 482C, whereas Chemical Type B, distinctly different from A and showing significantly lower ratios of TiO_2/Al_2O_3, characterizes the lower part of the hole, consisting of slightly plagioclase-clinopyroxene phyric basalt (Fig. 18).

Two altered samples (Samples 482C-11-2, 21–24 cm and 13-1, 22–24 cm) were analyzed. The first of these shows secondary actinolite, chlorite, and possibly epidote and sphene. Both samples show enrichment in MgO and Na_2O and depletion of CaO, but exhibit no evidence of mobility of TiO_2, Al_2O_3, P_2O_5, K_2O, and SiO_2. This pattern contrasts with that usually observed in oceanic basalts affected by low-temperature basalt–seawater interaction. We speculate that the growth of actinolite and chlorite (both high-MgO phases) may result from basalt–seawater interaction at high temperature.

Hole 482D

Fourteen analyses were obtained from the four major lithologic units in Hole 482 (Table 7). Two distinct chemical types are recognized, corresponding to Chemical Types A and B as defined for Holes 482B and C (Type A richer in TiO_2, P_2O_5, FeO, Na_2O, Zr, and Sr and poorer in Al_2O_3 than Type B, for equivalent content of MgO). (See Fig. 19.) A probable third type (F) is distinguished by its slightly higher P_2O_5 and distinctly higher Ni contents than B or A types. Type F was not identified in Holes 482B or C and may be unique to Hole 482D. However, the altered samples from Unit 1 in Hole 482C (tentatively assigned to B-type) have F-type Zr/Ni ratios and may actually belong to this group. The B chemical type in Hole 482D has a greater range of MgO content (7.7–8.6 wt.%) than do B types in Holes 482B and C. The high values do not apparently result from alteration but may be related to olivine accumulation (olivine phenocrysts are observed in Core 13), or they may simply reflect a more primitive, less fractionated magma composition than at the other holes. A single analysis from Unit 2b (Sample 482D-10-3, 14–16 cm) shows a higher TiO_2/Al_2O_3 ratio than other A-type samples in this hole (Fig. 20). While possibly related to this group, it may represent Chemical Type E (see Fig. 15), encountered at Hole 482B.

Chemical Type A in Hole 482D comprises aphyric basalt from Units 1 and 2a whereas Type E comprises Unit 2b (Fig. 20). Chemical Type F forms the aphyric to sparsely plagioclase-phyric basalts of Unit 3, apparently reflecting a continuous sequence between Sections 10-2 and 11-3 (Fig. 20). These cooling units separate the topmost A-type (common to all Site 482 holes) from the lower plagioclase-phyric lithologies of B-type (Unit 4), and show a general downhole increase in $Mg/(Mg + Fe^{2+})$ (Fig. 20).

The only altered sample analyzed from Hole 482D is from near the sediment/basement contact and shows: leaching Ca^{2+}, Mg^{2+}, and Si^{4+}, possible enrichment of Al_2O_3, and (in contrast to altered samples from Holes 482B and C) an eightfold enrichment of K_2O. Sr, usually a mobile element, appears in this sample to be unaffected by alteration (Fig. 19).

Hole 482F

One analysis was obtained from the basalts of Hole 482F. This specimen appears to be chemically similar to Chemical Type A in Hole 482B (Table 8).

In summary, Chemical Types A and B at this site comprise aphyric and/or sparsely plagioclase-($\pm$olivine) phyric basalts and appear to be good candidates for liquid magma compositions. The more coarsely (plagioclase $\pm$ clinopyroxene $\pm$ olivine) phyric Chemical Type D may represent cumulate compositions resulting from enrichment of phenocrysts in a liquid batch.

Semi-quantitative interpretation of the oxide and element variation for each chemical type indicates several possibilities:

1) Type D may be related to Type A liquid by accumulation of plagioclase (ca. An_{70-80}), with or without olivine and clinopyroxene, resulting in lower MgO, TiO_2, FeO, Zr, and Ni, and higher Al_2O_3, CaO(?), and Na_2O contents in Type D.

2) "Liquid" Types A and B are not related to each other by simple fractional crystallization, unless plagioclase greatly exceeded olivine and clinopyroxene in the fractionation extract. This would be inconsistent with low-pressure basalt-phase equilibrium and empirical fractionation solutions for other East Pacific Rise basalts (Clague and Bunch, 1976).

3) Chemical Type F, although similar in oxide content to Type B, seems to have a separate fractionation history in view of its significantly higher Ni content for both equivalent and higher MgO content. This could not be explained by a simple fractionation scheme involving olivine and/or other Ni-rich mafic phase; sulfide fractionation may have been important, however.

4) Plagioclase-phyric Type C, represented by one analysis only of an altered rock, shows significant enrichment of TiO_2, P_2O_5, Zr, and Al_2O_3 (all considered alteration-resistant elements) relative to all other types. The plagioclase-rich lithology and exceptionally high TiO_2/Al_2O_3 ratio distinguish this type and suggest an independent derivation.

5) The sparsely (plagioclase $\pm$ clinopyroxene $\pm$ olivine) phyric Type E, also represented by one analysis and slightly altered, may be cogenetic with Type A, but it is interesting mainly in its stratigraphic location (i.e., interlayered) near the top of the Type D sequence. Types A and D are separated by about 50 meters in the vertical succession and, as previously mentioned, show a plausible cogenetic relation.

Thus, the chemical stratigraphy shows that inferred cogenetic magmas are not necessarily contiguous in vertical section and may be interlayered with others from independent conduit or magma reservoir systems.

We infer that parent magmas giving rise to the observed chemical types were probably of two families based on observed Ti/Zr ratios. The first, including

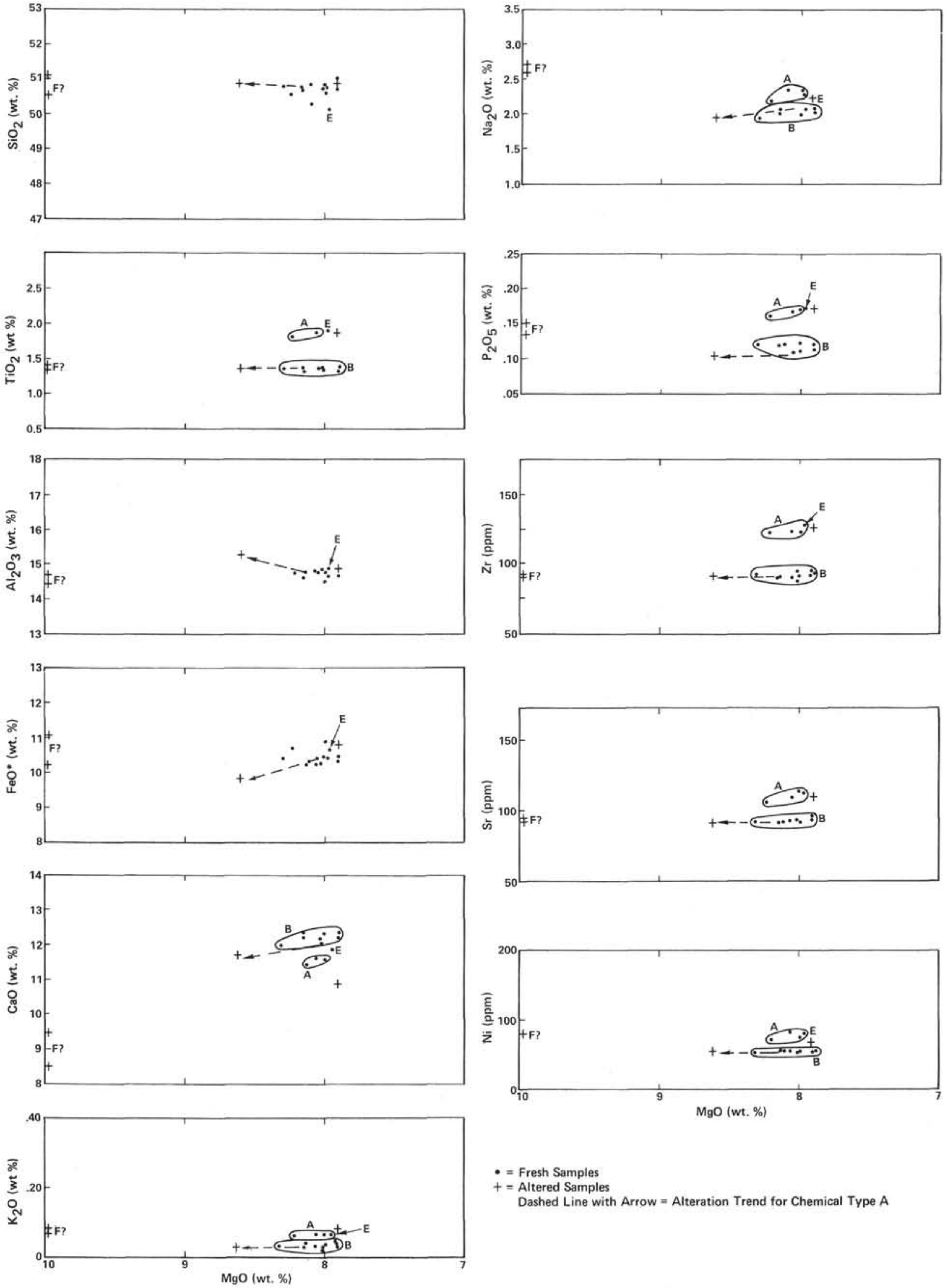


Figure 17. MgO variation diagrams for basalts from Hole 482C. (Chemical types are lettered A, B, E, and F.)

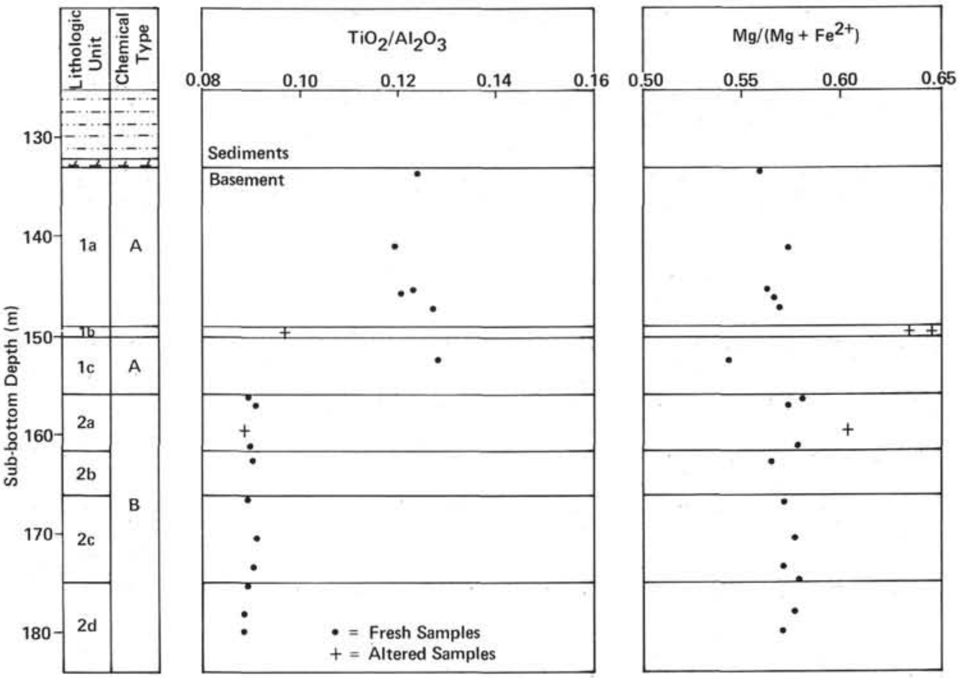


Figure 18. Downhole variation in TiO_2/Al_2O_3 and $Mg/(Mg + Fe^{2+})$ ratios in basalts from Hole 482C.

Chemical Types A, C, D, and E, has Ti/Zr ratios between 84 and 89, whereas the second (Chemical Types B and F) has Ti/Zr ratios of between 94 and 100. As Ti/Zr is unlikely to have been changed during fractionation of olivine, plagioclase, clinopyroxene, or orthopyroxene, Ti/Zr changes probably reflect mantle-source effects such as the degree of partial melting.

BASALT PHYSICAL PROPERTIES

Measurements of wet-bulk density, compressional-bulk density, wave velocity, and porosity were made on the basalts recovered at this site for comparison with the results of downhole logging and refraction studies. The results of these measurements are tabulated in Table 9 and presented in Figures 21 through 23. Also presented are values of grain density and acoustic impedance calculated from the porosity, density, and velocity data. The velocities reported are for water-saturated samples. Basalt porosities were determined from the decrease in density produced by heating in air for 24 hours at 110°C.

The densities of the basalts from Holes 482B, C, and D range from 2.74 to 3.11 g/cm^3, with most values falling between 2.9 and 3.0 g/cm^3 in the upper 50 meters of basement in each hole. Although these values are typical of fresh basalt, and are thus consistent with the age of the site (~400,000 years), the lower values observed in the topmost sample in each hole and deeper in the section (between 190 and 229 m sub-bottom) in Hole B are suggestive of incipient alteration. This pattern is also suggested by the porosity values, which are high (~5%) at the top of the basalt in all three holes and in the basal section in Hole 482C and low (2 to 3%) throughout the remainder of the other three sections. Since the patterns of wet-bulk density and porosity discussed above are roughly mirror images (except for the extreme values observed near the unit boundaries in Cores 19 and 20 in Hole 482B), it is to be expected that the grain densities will remain relatively constant with depth. This is indeed the case; for the most part, the grain-density values range rather narrowly about 3.0 g/cm^3 and show no regular trend with depth.

The compressional-wave velocity values shown in Figures 21 through 23 range, for the most part, between 5.5 and 6.0 km/s and average 5.8 km/s, again suggesting that most of the basalts are only slightly altered. Although there is considerable scatter in the data (as is usually the case with velocities measured at room pressure), several trends can be observed: (1) the velocities decrease with decreasing wet-bulk density and increasing alteration toward the base of Hole 482B, and (2) the velocities decrease with increasing alteration toward the top of basement in Hole 482C. The latter case is particularly striking because the decrease in velocity is large (0.4 km/s) and clearly related to the appearance of chlorite.

Finally, it should be noted that if the average laboratory velocity for the basalts is 5.8 km/s and the formation velocity for the upper levels of the basement at this site is 4.8 km/s, as suggested by seismic refraction studies, then the upper few hundred meters of the crust at Site 482 must contain about 7% water-filled cracks (vs. 3% for the 5-m interval logged in Hole 482C with the gamma-density tool). Both values are much lower than those deduced from downhole logging in young crust composed predominantly of pillow basalts on the Mid-Atlantic Ridge (Hole 396B; Kirkpatrick, 1976) and are consistent with the recovery of predominantly massive basalt. This observation suggests that the mechanism of extrusion, at least along this section of the East

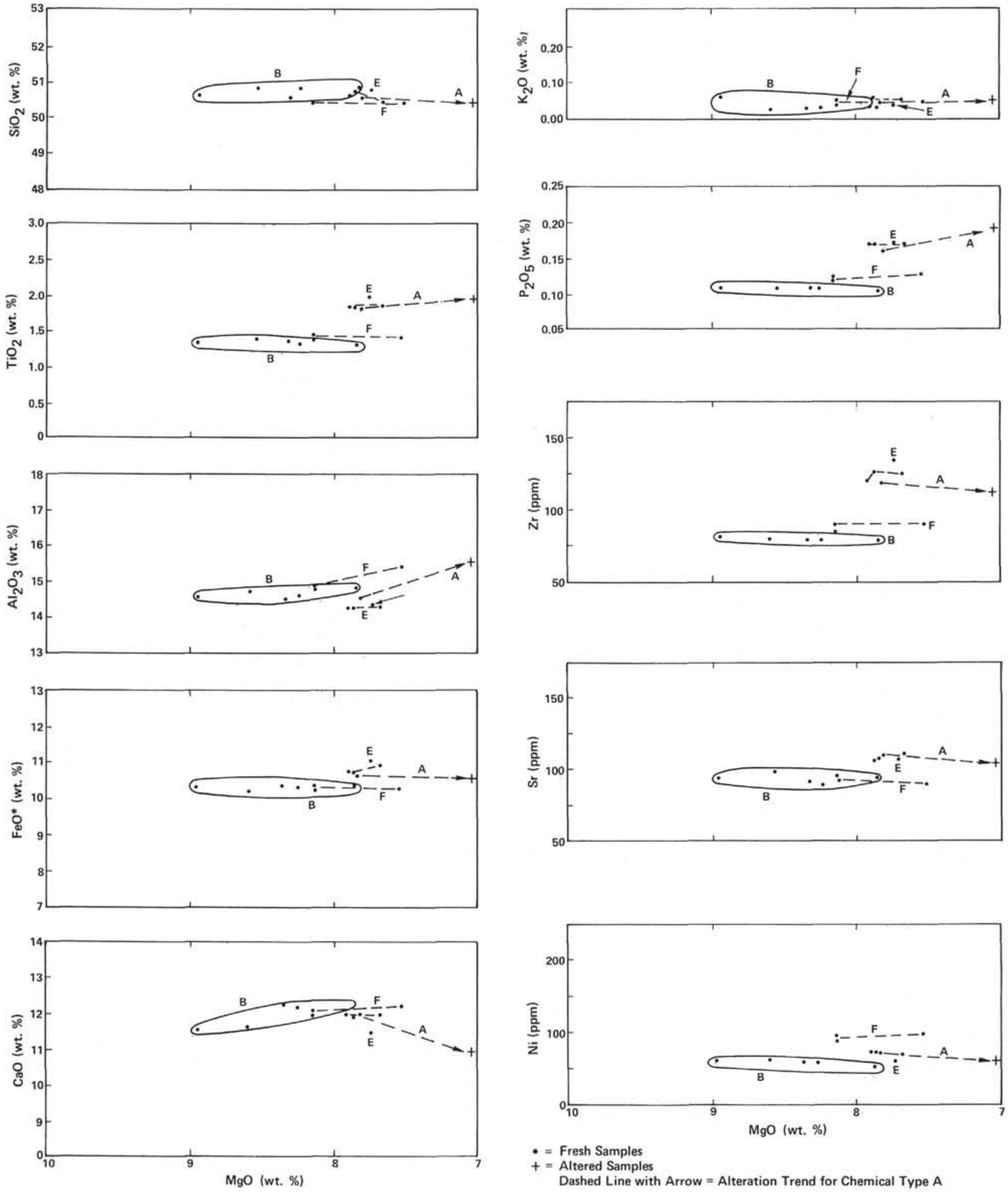


Figure 19. MgO variation diagrams for basalts from Hole 482D. Chemical types are lettered A, B, E, and F.

Pacific Rise, is fundamentally different from that on the Mid-Atlantic Ridge.

PALEOMAGNETISM

The close proximity of three holes (482B, C, and D) within a basin 12 km from the axis of the East Pacific Rise provides an opportunity to investigate the lateral homogeneity of the upper 50 meters of the oceanic crust in the mouth of the Gulf of California. The age of basement at Site 482 is thought to be about 0.48 million years (from fossil data and spreading rate); it is certainly within the Brunhes Normal Polarity Epoch. Hence, it is the youngest basement penetrated by any DSDP leg. The volcanic rocks are generally fresh, and preliminary pe-

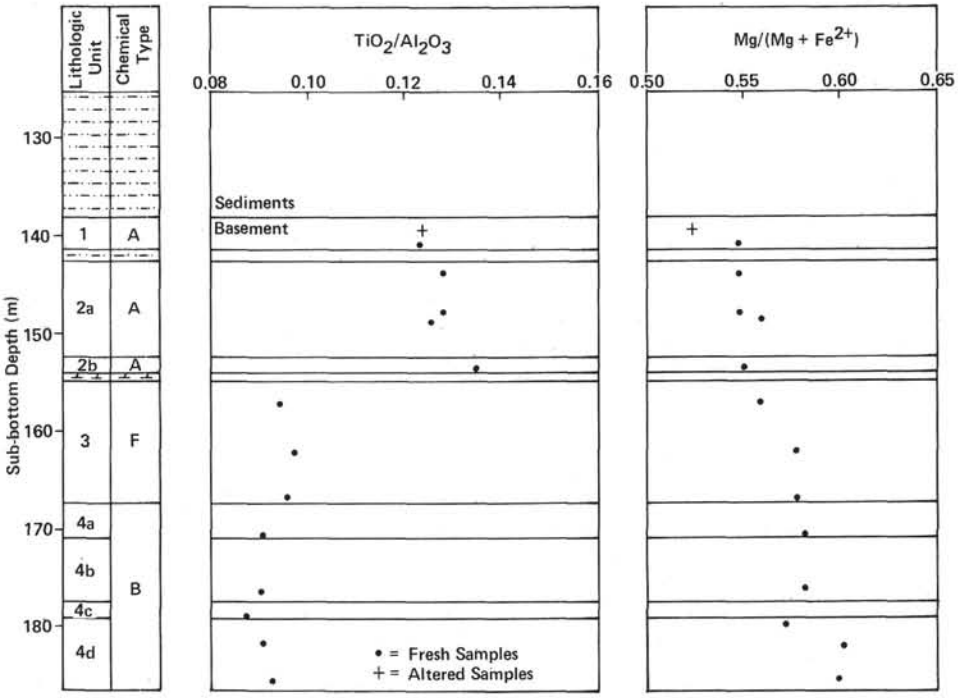


Figure 20. Downhole variation in TiO_2/Al_2O_3 and $Mg/(Mg + Fe^{2+})$ ratios in basalts from Hole 482D.

Table 8. Average chemical composition of basalt chemical types at Site 482.[a]

Magma Group	Major Elements (wt.%) SiO_2	Al_2O_3	FeO^{*b}	MgO	CaO	Na_2O	K_2O	TiO_2	P_2O_5	Trace Elements (ppm) Ni	Sr	Zr	Ratios $\frac{TiO_2}{Al_2O_3}$	$\frac{Mg}{(Mg + Fe^{2+})}$	$\frac{Ti}{Zr}$	$\frac{Zr}{Ni}$	$\frac{P}{Zr}$	No. of Analyses
Hole 482B																		
A	50.92	14.40	10.78	7.95	11.56	2.34	0.06	1.81	0.18	74	109	119	0.126	0.59	91.13	1.61	6.64	2
B	50.90	14.77	10.43	8.05	12.81	2.14	0.04	1.37	0.12	60	93	85	0.093	0.60	96.58	1.42	6.20	6
C	50.90	17.14	11.01	7.57	7.55	3.22	0.06	2.34	0.21	51	119	151	0.137	0.58	121.92	2.96	6.11	1
D	50.85	15.86	9.74	7.30	12.01	2.43	0.04	1.62	0.15	65	125	113	0.103	0.59	85.90	1.74	5.83	4
E	50.45	14.49	11.02	7.82	11.49	2.55	0.06	1.96	0.16	67	112	130	0.135	0.56	90.34	1.94	5.41	1
F	50.60	14.94	10.32	8.08	12.18	2.27	0.05	1.44	0.13	98	91	84	0.096	0.61	102.71	0.86	6.80	1
Hole 482C																		
A	50.64	14.90	10.72	8.04	11.45	2.18	0.07	1.83	0.17	73	110	124	0.123	0.60	88.43	1.70	6.02	3
B	50.96	14.78	10.40	8.10	12.22	2.05	0.04	1.33	0.12	57	93	79	0.090	0.61	100.87	1.39	6.67	11
C	50.41	14.82	10.30	8.09	12.01	2.34	0.07	1.79	0.17	80	88	82	0.092	0.61	130.79	1.03	9.11	1
Hole 482D																		
A	50.72	14.60	10.92	7.72	11.61	2.31	0.05	1.89	0.18	71	109	122	0.127	0.59	92.83	1.72	6.48	6
B	50.79	14.81	10.24	8.40	11.99	2.28	0.04	1.34	0.11	62	95	81	0.095	0.62	99.12	1.31	5.96	5
C	50.76	14.32	10.80	7.87	11.66	2.51	0.05	1.87	0.17	65	108	133	0.137	0.58	84.25	2.05	5.62	3
D	50.50	15.06	10.37	7.97	12.06	2.42	0.04	1.45	0.13	94	94	89	0.097	0.60	97.62	0.95	6.42	3

[a] All analyses are carbonate corrected and normalized on an anhydrous basis.
[b] Total iron as FeO.

trological studies suggest that they were emplaced as lava flows rather than sills. A number of chemical, petrological, and cooling units have been defined, and many of these can be correlated with the preliminary magnetic properties.

Hole 482B

Ninety meters of basement were penetrated at Hole 482B, with about 50% recovery. Fifty-three oriented samples were selected for shipboard measurements, and, whenever possible, they were taken adjacent to X-ray fluorescence and thin-section samples. Forty-three of the oriented samples were stepwise demagnetized to determine stable inclination and paleomagnetic stability. The results for individual samples are given in Table 10 and the mean values in Table 11.

The magnetic polarity of the basement (at least down to 90 m) is consistent with the sign of the surface magnetic anomalies (Brunhes). Two samples from Core 19 are reversely magnetized, but a detailed investigation of this core (including a normally magnetized sample between the two reversed ones) suggests that two pieces of

Table 9. Basalt physical properties, Site 482.

Sample (interval in cm)	Density Wet-Bulk (g/cm³)	Density Grain[a] (g/cm³)	P-Wave Velocity[b] (km/s)	Acoustic Impedance ($\times 10^5$ g/cm²·s)	Porosity (vol.%)
Hole 482B					
11-2, 37-39	2.923	3.01	5.75	16.8	4.5
12-2, 147-149	2.939	3.00	5.97	17.5	3.2
13-1, 83-85	3.021	3.07	5.63	17.0	2.6
14-3, 128-130	2.959	2.99	6.11	18.1	1.6
15-4, 76-78	2.946	3.03	5.95	17.4	4.0
16-3, 47-49	2.972	3.02	5.97	17.7	2.5
17-2, 137-139	2.970	3.02	6.06	18.0	2.6
18-2, 88-90	2.995	3.09	5.70	17.1	4.5
19-1, 118-120	2.742	2.84	5.46	15.0	5.1
20-2, 8-10	3.110	3.24	5.66	17.7	5.8
21-3, 85-91	2.895	2.99	5.60	16.2	5.0
22-2, 143-145	2.846	2.91	5.92	16.8	3.4
24-1, 51-53	2.898	3.02	5.51	16.0	6.1
Hole 482C					
9-2, 16-19	2.846	2.97	5.44	15.5	6.1
10-2, 44-46	2.922	3.00	5.66	16.5	3.9
11-1, 18-20	2.917	3.00	5.58	16.3	4.1
12-2, 80-82	2.953	3.01	5.95	17.6	2.6
13-2, 30-32	2.957	3.01	5.92	17.5	2.7
14-1, 50-52	2.963	3.01	5.98	17.7	2.1
15-2, 97-99	2.948	3.00	6.01	17.7	2.6
Hole 482D					
9-2, 81-84	2.861	2.99	5.85	16.7	6.7
10-1, 57-59	2.961	3.02	5.94	17.6	2.8
11-3, 99-101	2.960	3.00	6.14	18.2	2.1
12-2, 128-131	2.930	3.01	5.91	17.3	4.2
13-3, 18-20	2.964	3.02	5.72	17.0	3.0

[a] Determined by heating for 24 hours in air at 110°C.
[b] Measured at atmospheric pressure.

Core 19 were inverted. The mean inclination of Hole 482B is 39°, the value expected from an axial geomagnetic dipole, and most of the observed inclinations can be explained by secular variation (23° to 54°) although other effects, such as tectonic tilting, cannot be ruled out. The stable inclinations in the upper 50 meters of the core are shallow (mean = 30°), and the inclination decreases slightly with depth (Fig. 24). This decrease is followed by an abrupt jump to steeper inclinations in the lower 50 meters (mean inclination = 50°). These changes might be interpreted as the result of one period of secular variation, but the control is insufficient to rule out other possibilities.

The mean intensity of the natural remanent magnetization (NRM) is 1.12×10^{-2} G (gauss)—about three times the value normally found for ocean basalts. These high values are expected from young, relatively thin, lava flows. However, the observed Q values (Koenigsberger ratio) and median destructive fields (MDF—mean value of 55 Oe) indicate that the grains of Fe-Ti oxides are larger than those usually found in other holes. Preliminary microscopic observations and estimates from the magnetic properties give grain-size estimates of about 50 μm or larger.

Hole 482C

In Hole 482C, 50.5 meters of basalt were cored with 28.9 meters recovered. Forty-four paleomagnetic samples were taken, and thirty-two of these were demagnetized. The individual results are given in Table 10 and the mean values are given in Table 11.

The average intensity of NRM (Table 11) is much lower in this hole than in the previous hole (mean 3.92×10^{-3} G). This causes a decrease in the mean Q ratio (from 12.2 to 3.26) because the susceptibilities of the basalts in the two holes are comparable (2.50×10^{-3} G/Oe in Hole 482B, 2.75×10^{-3} G/Oe in Hole 482C). There are no obvious reasons for this decrease in intensity. The MDF's are not significantly different (mean of 51 Oe in Hole 482C, 55 Oe in Hole 482B). The polarity is normal, but the inclinations (mean = 23°) are shallower than those expected from an axial dipole. They are, however, comparable with those in the upper part of Hole 482B (the mean inclination of the upper 50 meters of Hole 482B is 29°) (Fig. 25).

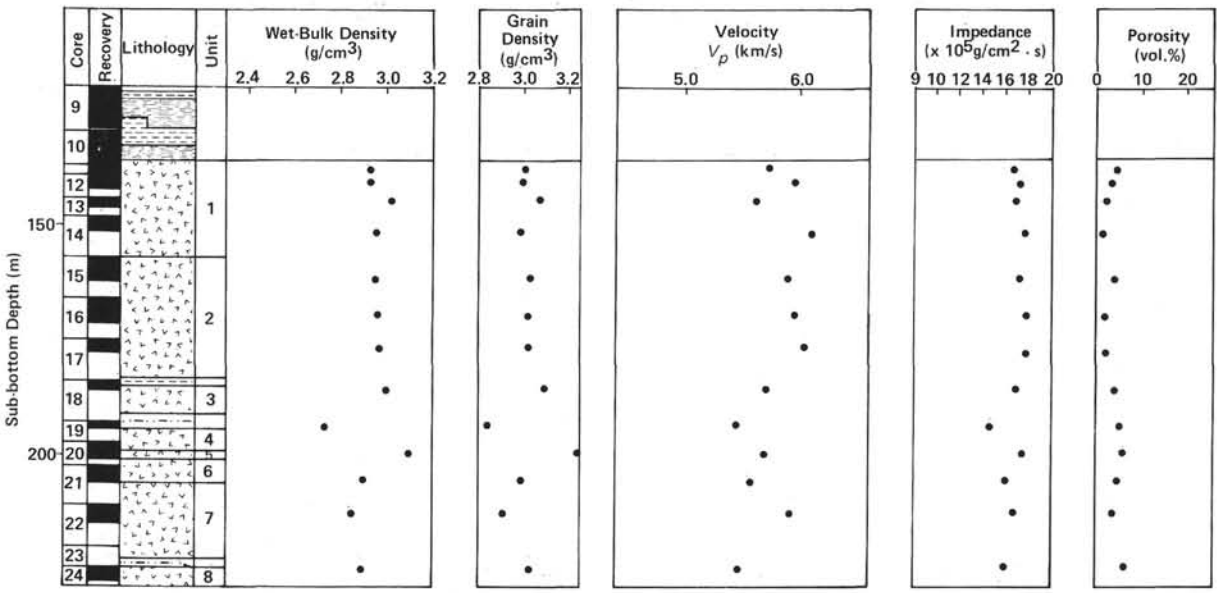


Figure 21. Basalt physical properties plotted against sub-bottom depth in Hole 482B. For explanation of lithologic symbols, see Explanatory Notes (this volume).

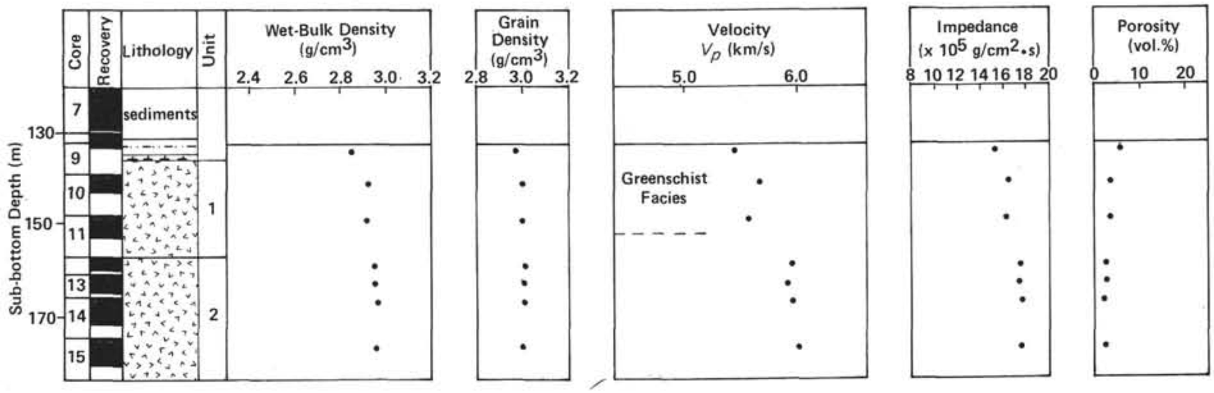


Figure 22. Basalt physical properties plotted against sub-bottom depth in Hole 482C. For explanation of lithologic symbols, see Explanatory Notes (this volume).

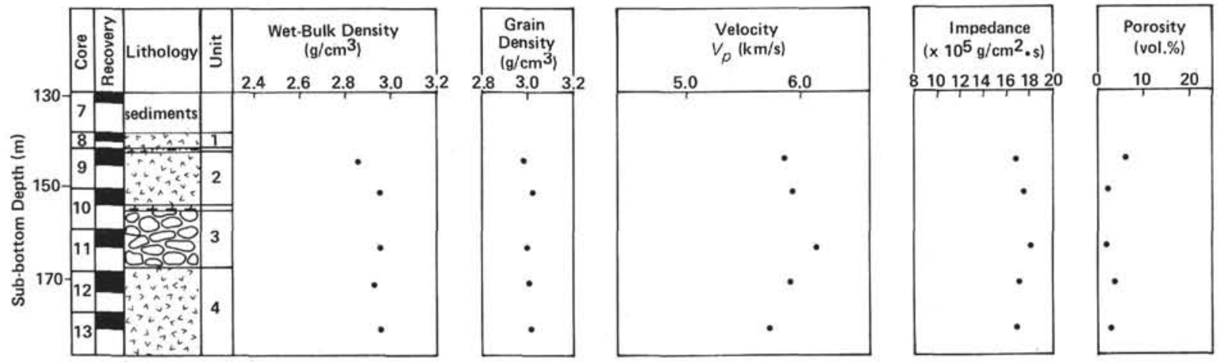


Figure 23. Basalt physical properties plotted against sub-bottom depth in Hole 482D. For explanation of lithologic symbols, see Explanatory Notes (this volume).

Hole 482D

Hole 482D was drilled 100 meters east of Hole 482C such that the three basement holes at Site 482 provide a "mini-transect" along a flowline.

Twenty-nine oriented samples were taken for paleomagnetic measurements, and twenty-four were demagnetized. The individual results are given in Table 10 and the mean values in Table 11.

This hole contains the most stable samples of any taken on this leg. The average median destructive field is 110 Oe, and values up to 490 Oe are observed. This is not altogether surprising because there are many cooling boundaries in this hole. The mean susceptibility is not significantly different from that found in other holes, but the variation within the hole is much greater (Fig. 26). The mean intensity (and Q ratio) are intermediate between those found in the Holes 482B and 482C. The magnetic polarity is appropriate for the age of the site, and the stable inclinations are very similar to those found in the top 50 meters of the previous two holes. However, the inclination change on demagnetization is markedly smaller in this hole (in keeping with the greater stability).

Hole 482F

Hole 482F (less than 100 m from Hole 482B) was abandoned after 8.8 meters of basement penetration. Three samples were taken for paleomagnetic measurements (Table 10). The inclination of these three samples (and the rest of the paleomagnetic properties) are the same as for the uppermost section of Hole 482B.

Summary

In summary, the stable inclinations of most samples fall within the range expected from secular variation around an axial dipole (inclination 39° at Site 482). The top 50 meters of each hole have shallow (~25–30°) inclinations whereas the bottom 50 meters of Hole 482B have steeper (~50°) inclinations (Figs. 24–26).

The intensity of NRM varies from 5.5×10^{-4} to 2.6×10^{-2} G/Oe with a mean of 8×10^{-3}. The intensities of basalts in Hole 482C are distinctly lower than the other two holes. Except in a few isolated sections of core (i.e., top of Hole 482D), the stability of NRM is low. The average MDF is only 67 Oe, with Hole 482D providing many of the stable samples. This low stability NRM is in contrast to results obtained from most Atlantic sites, but it is consistent with many sites in the Pacific. It could well reflect the dominance of massive flows at Site 482.

DOWNHOLE MEASUREMENTS

Ocean Sub-bottom Seismometer Emplacement

An experiment package containing seismic, tilt, and temperature sensors was successfully emplaced in Hole 482C at the mouth of the Gulf of California on Febru-

Table 10. Paleomagnetic properties of basalts, Site 482.

Unit	Sample (level in cm)	Depth (m)	Declination (°)	Inclination (°)	NRM Intensity ($\times 10^{-3}$G)	Stable Inclination (°)	Susceptibility ($\times 10^{-3}$G/Oe)	Median Destructive Field (Oe)	Koenigsberger Ratio, ϕ
Hole 482B									
	11-1, 21	137.21	10	63	9.37	40	2.87		7.3
	11-2, 41	138.91	251	49	7.43	35	2.76	68	6.0
	11-3, 15	140.15	74	68	9.75	40	3.18	35	6.8
1a	12-1, 63	139.63	90	42	26.4	32	1.96	50	30.0
	12-1, 89	139.89	141	42	24.4				
	12-2, 44	140.94	260	59	6.12				
	12-2, 143	141.93	269	50	18.9	31	2.57	40	16.3
	13-1, 126	145.26	102	48	10.1	33	2.33	62	9.7
1b	14-1, 97	148.97	272	29	17.2	25	0.55	317	69.6
	14-3, 126	152.26	201	54	13.8	28	1.57	47	19.6
1c	15-1, 16	157.16	321	36	19.1	24	1.25	68	34.0
	15-2, 39	158.89	116	52	10.2	25	1.89	48	12.0
	15-3, 114	161.14	308	67	8.61	28	2.26	32	8.5
	15-4, 125	162.75	284	63	5.85	26	2.44		5.3
2	16-1, 31	166.31	92	80	10.3	26	2.28	30	10.0
	16-1, 56	166.56	338	70	10.7				
	16-1, 84	166.84	341	55	10.9	20	2.39	37	10.1
	16-1, 100	167.00	123	29	12.3	12	2.00	80	13.6
	16-1, 117	167.17	92	19	11.5	2	1.93	110	13.2
	16-2, 54	168.04	137	58	6.69				
	16-2, 87	168.37	177	55	5.11	29	2.19	47	5.2
	16-3, 78	169.78	237	63	4.07	50	2.69	35	3.4
	16-4, 42	170.92	164	61	6.33	41	2.56	41	5.5
	16-4, 125	171.75	178	59	7.10	24	2.38	35	6.2
	17-1, 70	175.70	190	56	4.79	30	2.30	50	4.6
	17-2, 55	177.05	48	62	6.29	27	2.53	70	5.5
	17-2, 143	177.93	82	82	13.9				
	18-1, 16	184.16	94	77	7.69	36	2.13	38	8.0
3	18-1, 97	184.97	219	57	4.15				
	18-2, 84	186.34	115	60	15.0	51	2.00	63	16.7
	18-2, 96	186.46			13.1				
	19-1, 78	193.78	322	66	20.2	54	2.32	68	19.4
	19-1, 108	194.08	356	70	11.3	−53	2.95	59	8.5
4	19-1, 134	194.34	242	54	11.2	−45	2.97	68	8.4
	20-1, 39	197.89	81	70	8.75	53	2.58	40	7.6
	20-1, 143	198.93	118	65	10.7	53	2.50	35	9.5
5	20-3, 17	200.17	288	69	14.1	50	2.28	47	13.8
	20-3, 141	201.91	330	66	19.6	53	2.45	37	17.7
	21-1, 95	202.95	140	59	12.5	44	2.42	44	11.4
	21-2, 30	203.80	46	71	5.55				
6	21-2, 33	204.83	68	77	6.72	58	2.69	40	5.6
	21-2, 64	204.14	178	62	7.35				
	21-2, 78	203.28	230	60	8.24	53	2.54	35	7.2
	21-2, 111	204.61	250	63	6.79	55	2.67	39	5.6
	21-3, 69	205.69	170	67	15.8	54	2.18	41	16.1
	21-3, 98	205.98	218	59	23.5				
	22-1, 83	211.83	192	63	19.0	49	2.28	32	18.6
7	22-2, 32	212.82	241	66	13.5	53	2.38	40	12.6
	22-3, 99	214.99	330	63	14.9	41	1.89	47	17.6
	22-4, 57	216.07	302	63	6.46	53	2.40	47	6.0
	24-1, 43	224.93	137	56	6.33	43	3.01	57	4.7
8	24-1, 106	227.06	312	63	6.57	47	3.45	45	4.2
	24-3, 70	228.20	124	52	6.40	47	3.43	47	4.2
Hole 482C									
	9-1, 113	133.13	219	39	3.61	30	4.74	55	1.7
	9-1, 138	133.38	309	35	5.59	31	3.28	81	2.4
	10-2, 58	141.08	291	31	4.27	27	3.57	57	2.7
	10-2, 61	141.11	298	31	4.02	28	3.62	53	2.5
1a	10-2, 65	141.15	295	38	4.00		3.77		2.4
	10-2, 78	141.28	290	34	4.10	30	3.87	64	2.4
	10-3, 9	142.09	29	36	2.91		2.88		2.2
	10-3, 113	143.13	34	−33	4.07	−30	3.34	70	2.6
	11-1, 97	148.97	97	36	2.08	28	2.16	41	2.1
1b	11-2, 11	149.61	324	44	5.30	37	2.70	66	4.4
	11-2, 44	149.94	338	52	0.55	36	1.34	55	0.9
	11-2, 115	150.65	116	36	5.92		2.83		4.64
	11-3, 26	151.26	140	43	4.74	35	3.25	62	3.2
1c	11-3, 63	151.63	111	39	4.05	36	3.33	54	2.7

Table 10. (Continued).

Unit	Sample (level in cm)	Depth (m)	Declination (°)	Inclination (°)	NRM Intensity ($\times 10^{-3}$G)	Stable Inclination (°)	Susceptibility ($\times 10^{-3}$G/Oe)	Median Destructive Field (Oe)	Koenigsberger Ratio, ϕ
Hole 482C (cont.)									
	11-3, 128	152.28	341	43	4.53	38	3.09	54	3.3
	11-4, 107	153.57	24	42	5.26	37	2.75	59	4.3
	11-4, 122	153.72	113	36	4.16		2.61		3.5
	12-1, 39	157.39	309	42	3.58	12	2.70	45	2.9
2a	12-1, 146	158.46	279	40	3.39	14	2.61	34	2.9
	12-2, 92	159.42	108	32	3.30	11	2.40	45	3.1
	13-1, 56	162.06	79	30	5.96	11	2.33	50	5.7
	13-2, 17	163.17	358	33	3.28	11	2.17	72	3.4
	13-2, 96	163.96	238	19	2.62	9	2.28	81	2.6
	13-3, 2	164.52	143	40	2.10		2.51		1.9
2b	13-3, 25	164.75	132	37	3.07	27	2.43	37	2.8
	13-3, 80	165.30	47	39	2.60	26	2.91	30	2.0
	13-3, 132	165.82	348	39	2.80	19	2.85	53	2.2
	14-1, 44	166.44	347	21	4.90	7	2.76	73	3.9
	14-2, 22	167.27	42	41	4.25	13	2.38	46	4.0
	14-2, 131	168.81	22	33	5.02	11	2.52	43	4.4
	14-3, 77	169.77	55	55	3.68	17	2.71	33	3.1
2c	14-3, 122	170.22	205	50	2.63	27	2.53	35	2.3
	14-4, 61	171.11	45	52	2.49	32	2.58	43	2.1
	14-4, 132	171.82	120	69	2.46	27	2.92	29	1.9
	14-5, 46	172.46	262	54	2.10	36	2.42	50	1.9
	15-1, 42	175.42	216	50	2.76	18	2.37	50	2.6
	15-1, 103	176.03	285	31	3.77		2.29		3.7
	15-1, 132	176.32			8.00		2.08		8.5
	15-2, 11	176.61	238	31	8.35	18	1.98	40	9.4
2d	15-2, 92	177.42	86	48	5.43	15	2.23	45	5.4
	15-3, 63	178.63	57	38	3.34		2.53		2.9
	15-3, 93	178.93	351	44	4.36	14	2.60	26	3.7
	15-4, 68	180.18	213	28	3.42	14–18	2.44	50	3.0
	15-4, 117	180.18	108	41	3.68	21	2.52	37	3.3
Hole 482D									
1	8-1, 106	139.06	201	25	4.39	24	1.80	385	5.57
	9-1, 51	142.01	313	25	3.96	25	1.75	490	5.03
	9-2, 6	143.06	0	25	4.49		2.16		4.61
	9-2, 54	143.54	147	28	4.77		2.95		3.59
2a	9-2, 106	144.06	184	26	6.74	26	3.15	229	4.75
	9-3, 23	144.73	85	21	6.16	25	3.27	108	4.19
	9-3, 54	145.04	195	28	5.88	26	2.95	109	4.42
	10-1, 69	151.19	24	39	17.0	40	3.41	78	11.1
	10-2, 11	152.11	194	33	8.81	31	3.24	85	6.0
	10-2, 57	152.57	49	34	4.76	32	3.35	50	3.16
2b	10-2, 111	153.11	1	33	3.53	40–42	3.11	61	2.5
	10-3, 18	153.68	152	30	3.48	37	3.23	58	2.39
	10-3, 109	154.59	180	17	15.92	16	1.08	145	32.9
	11-1, 13	159.63	188	13	16.69		0.97		38.35
	11-1, 128	160.78	180	22	15.88	22	1.17	107	30.2
3	11-2, 101	162.01	52	31	8.78		1.41		13.82
	11-3, 80	163.30	248	26	10.25	24	1.38	68	16.54
	12-1, 27	168.77	151	28	4.50	13	1.95	59	5.1
	12-1, 65	169.15	154	25	5.82	19	1.97	53	6.6
	12-1, 119	169.69	332	36	6.00	30	1.71	50	7.81
	12-2, 86	170.86	80	3	20.4	2	2.18	80	20.8
	12-3, 21	171.71	257	12	10.2	4	1.88	57	12.0
4b	12-3, 61	172.11	352	11	11.5	5	2.28	55	11.2
	12-3, 122	172.72	167	30	3.25	9	2.65	75	2.7
	12-4, 2	173.02	3	24	4.91		2.04		5.34
	12-4, 45	173.45	18	20	17.99	6	2.06	62	19.4
4c	13-1, 127	178.77	165	30	6.99	14	2.08	45	7.5
4d	13-2, 12	179.12	107	26	9.66	18	1.82	77	11.8
	13-3, 33	180.83	202	35	2.41	25	2.62	52	2.0
Hole 482F									
	4-3, 129	136.79	147	49	9.30	41	2.85	65	7.3
1	5-1, 7	142.07	266	51	9.79	43	3.04	42	7.2
	5-1, 141	143.41	147	43	11.35	34	2.85	47	8.9

Table 11. Average of paleomagnetic properties, Site 482.

	Hole 482B		Hole 482C		Hole 482D	
	Value	Number	Value	Number	Value	Number
Inclination before demagnetization	58°[a]	43	38°	32	26°	27
Stable inclination	39°	43	23°	32	21°	27
NRM intensity ($\times 10^{-3}$ G)	11.2	53	3.92	44	8.45	29
Median destructive field (MDF) (Oe)	55	41	51	32	110	24
Susceptibility ($\times 10^{-3}$ G/Oe)	2.50	53	2.75	44	2.26	29
Koenigsberger ratio (ϕ)	12.2	53	3.3	44	10.4	29

[a] For top 50 meters, mean inclinations before and after demagnetization are 54° and 29°, respectively.

ary 3, 1979. This marked the first time that an instrument was left in a hole in the ocean to record scientific information after the drill ship had left the site. This particular package consisted of two parts: the sensor package in the hole and the recording package on the ocean bottom. The recording package was recovered on March 17 by the R/V *Kana Keoki* from the University of Hawaii. Few of the sensors were operating at that time, and a successful attempt was made to recover the downhole sensor package.

The purpose of this experiment was twofold: (1) to explore the hypothesis that a hole into basement in the ocean will provide a very quiet and uncomplicated site for seismic observations, and (2) to determine whether the emplacement of an instrument package in a DSDP hole for long-term operation is practical. Sixteen data channels were available in this particular package and, in addition to the three seismometers, temperature data (absolute $\pm 2\frac{1}{2}$ °C), the temperature difference between the top and bottom of the package (± 0.02°C), tilt, and differential tilt were measured.

Site 482 was planned as a re-entry site at a point just south of the Tamayo Fracture Zone in a sediment pond about 12 km east of the crest of the East Pacific Rise in crust less than 0.7 m.y. old. Hole 482B was a pilot hole to be continuously cored to bit destruction and logged.

The seismic package was to be emplaced in this hole. Unfortunately, the pipe became completely stuck after drilling about 90 meters into basement, and the bottom-hole assembly had to be blown off. It was then decided to drill another hole (482C) to a depth of 50 meters into basement, log it, and emplace the seismic experiment. Drilling of this hole was completed late on February 1, 1979, with the resulting hole beginning 3010 meters below sea level, with about 50 meters of mostly massive basalts covered by 140 meters of sediments. During drilling, temperature probes indicated that the temperature at the sediment/basement contact would be about 90°C. Deviation surveys indicated that the hole angle would be less than 6° from vertical. Logging was completed at 1030 hours on February 2, and emplacement of the seismic experiment begun at 1130 hours. Before logging was begun, the logging cable was reheaded with a standard Gearhart-Owen head in such a way as to give the head more mechanical strength and better long-term isolation from sea water. This was possible because the seismic tool uses the same cable as the logging tool. When an attempt was made to connect the new head to the seismic tool, it was found that the head was several thousandths of an inch too large to fit. Since the section that was too large was not critical, it was filed down and the attachment was made. The tool was tested completely, using a test box connected through the cable into the logging shack. The caliper arms were extended and retracted, and a tape recording was made of the data being sent by the tool.

Lowering was started at 1121 hours at about 40 ft./min. The slow speed was used since the line wiper and pump could not be used as a result of damage to the cable during the logging run. At 1532 hours, cable tension and a drop in seismic noise indicated that bottom had been reached. To be certain that the stopping point was true bottom, several attempts were made to break through. To be sure that the tool was not stopping inside the pipe, the tool was raised 10 meters and the pipe 5 meters. When the tool was lowered, it stopped at the same depth as previously, indicating that bottom had been reached. Tape and chart recordings were made during much of the period when the tool was descending and while testing at the bottom. All data appeared to be normal, and the tool was lifted 9 meters off the bottom and the cable was clamped and cut at the drill floor at 1611 hours on February 2. The winch-side of the cable was prepared for the torpedo splice while the other end was attached to an over-shot device for stripping. Stripping the pipe from the logging cable was begun at 1730 hours. As the first stand was raised, it was noticed that the tension in the sand line had dropped, indicating that the tool was being lifted along with the pipe. The sand line was raised and lowered several times until the tension increased and pipe stripping continued. The same problem was noticed on the second stand but did not return. No change in tension was noticed when the pipe cleared the mudline and stripping went without problems to the surface.

One possible problem concerning pipe stripping was noted, however. The sand line is not torque balanced and spins when tension is taken on or off. When tension was taken up as the logging wire was lifted from the clamp, the sand line spun quickly for a second or two. All of this spin is transmitted to the logging cable. When tension is released on the sand line, it unspins; but since the logging cable is clamped, it cannot unspin—and all of that spin is built up in the cable, eventually being worked off by spinning the tool at the bottom of the hole. Such a buildup of torque, or spinning of the tool, probably caused the damage observed in the tool when it was recovered. In the future, it is suggested that a swivel be placed between the sand line and the logging cable.

A second concern, also connected with cable spin, relates to safety. When the fork is removed that takes the tension while a stand is being stripped, it could spin off unless it is being held tightly.

At 0003 hours on February 3, the stripping operation was completed, and the cable passed to the drill shack to attach the torpedo splice while the logging sheaves were rehung. After splicing, the tool was again tested. It was noted that one of the horizontal geophones was not operating and the other geophones showed DC offsets and cross talk, indicating some damage to the tool. Since the

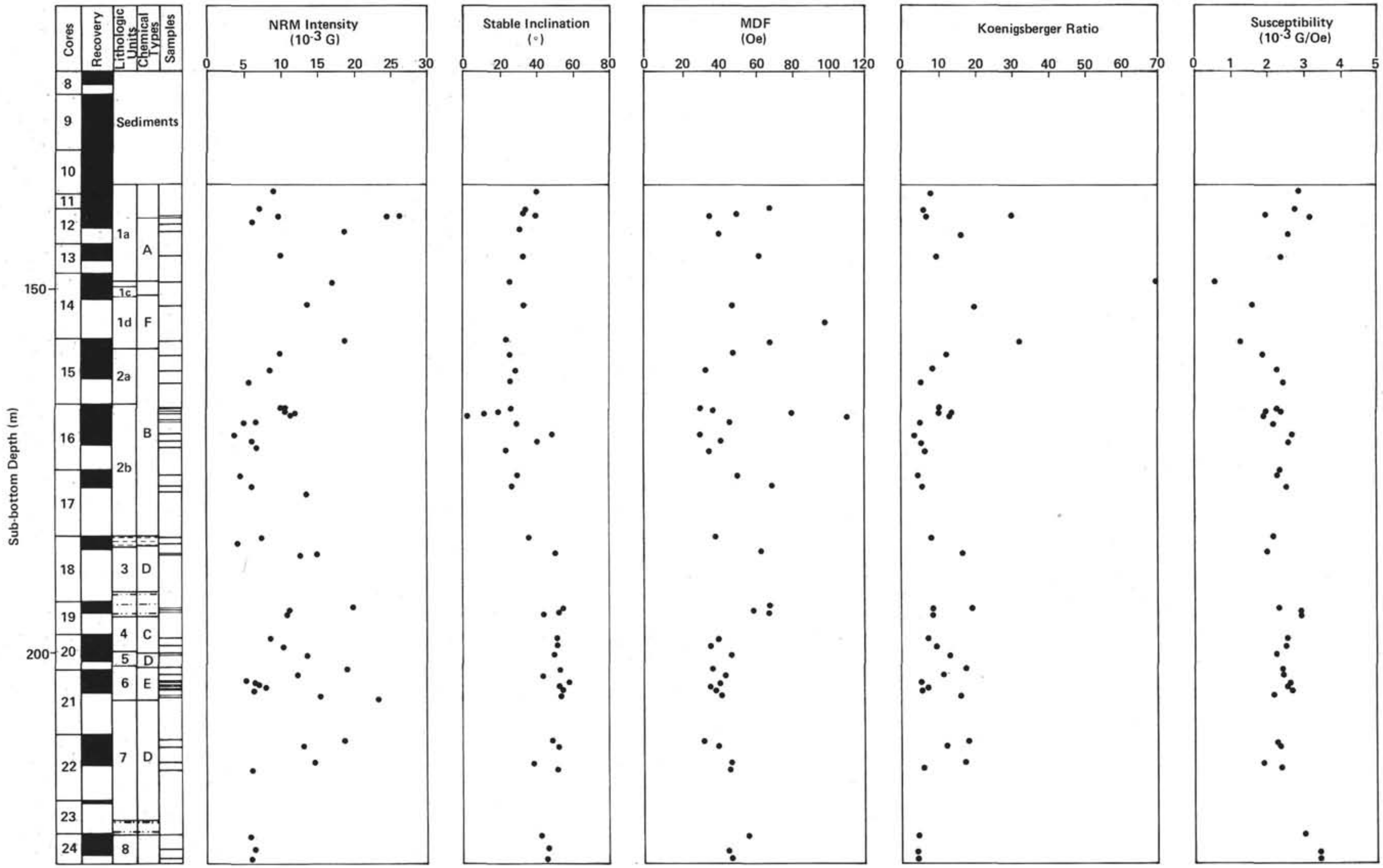


Figure 24. Paleomagnetic properties of basalts plotted against subbottom depth in Hole 482B.

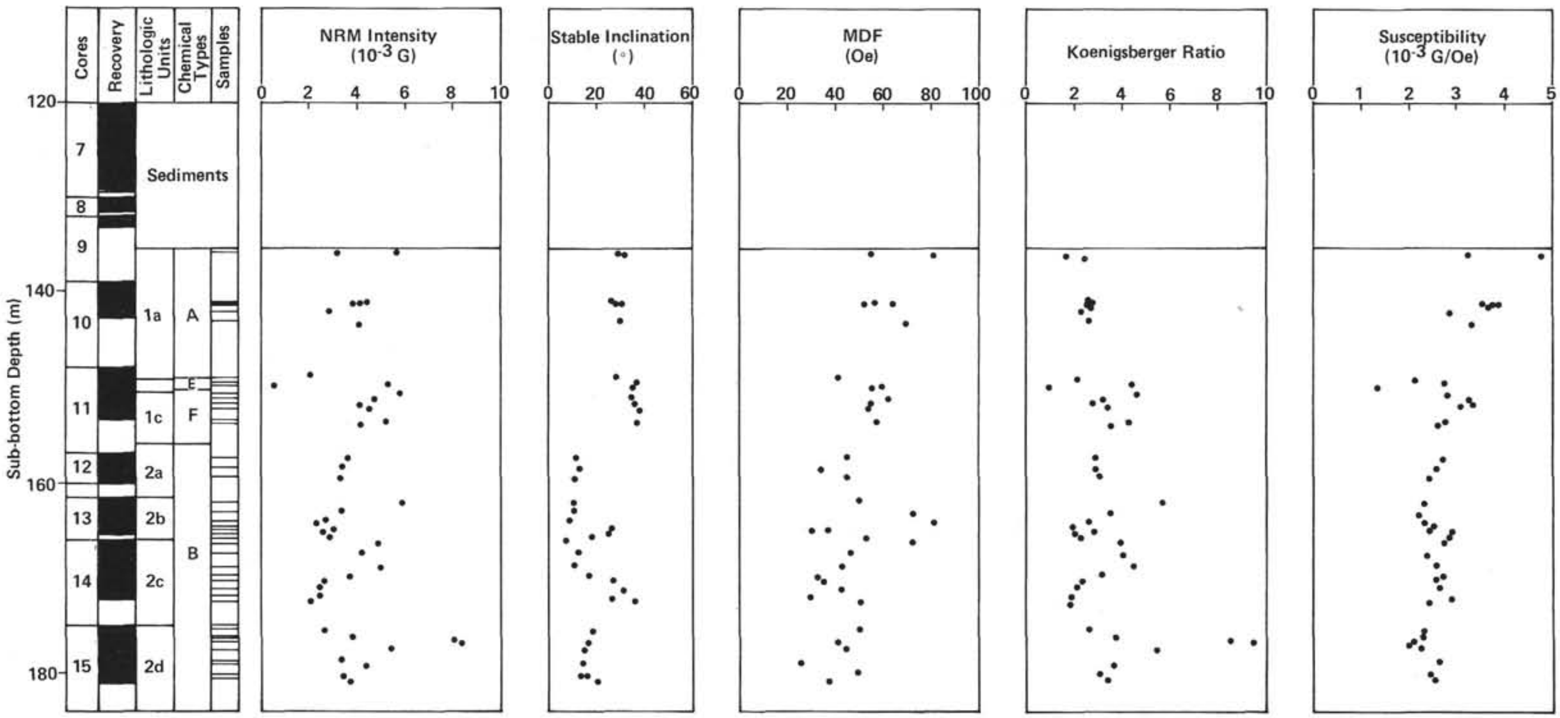


Figure 25. Paleomagnetic properties of basalts plotted against subbottom depth in Hole 482C.

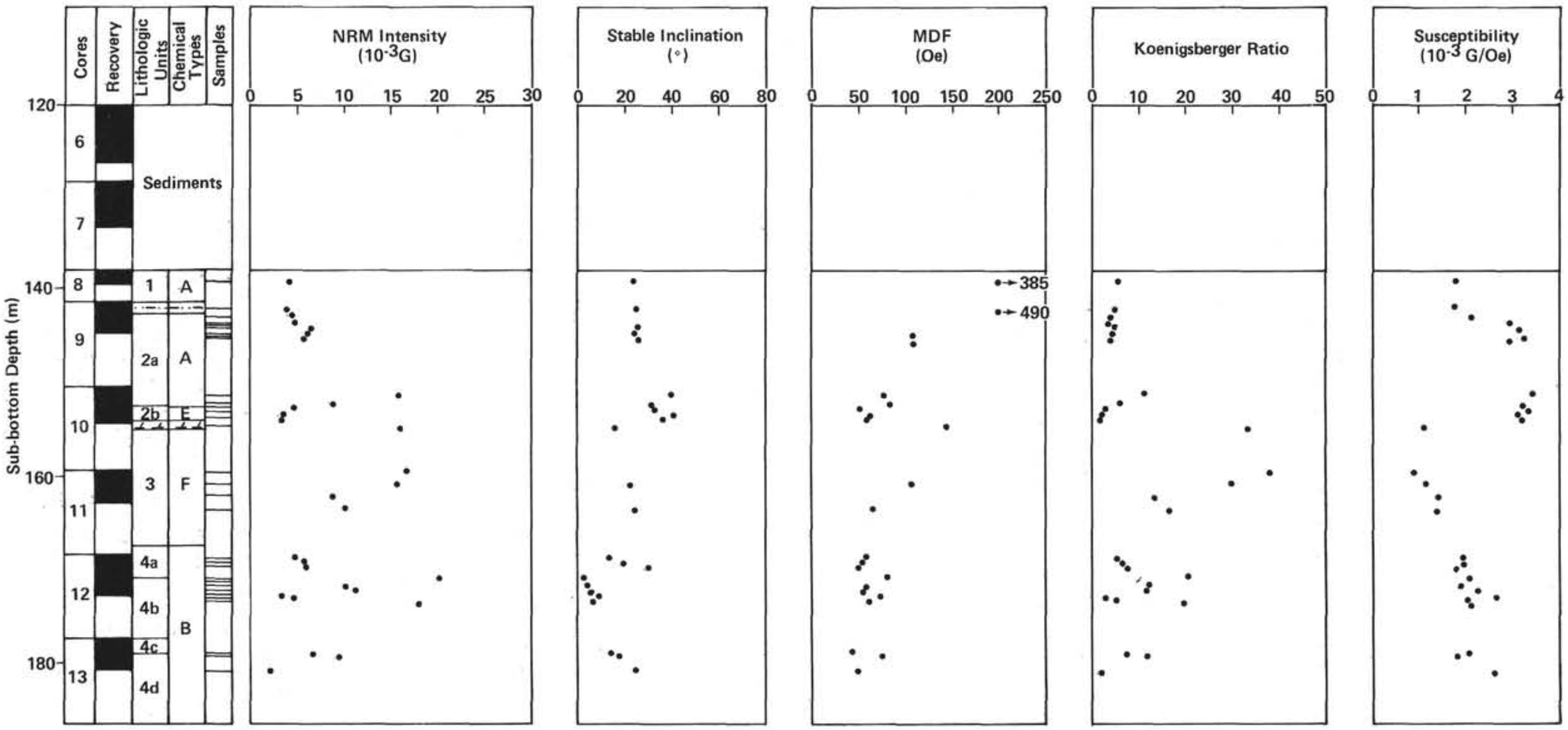


Figure 26. Paleomagnetic properties of basalts plotted against subbottom depth in Hole 482D.

other sensors were operating normally, the operation was continued. At 0245 hours, the tool was returned to the bottom of the hole after lowering about 200 ft. of cable. During the splicing, the ship had drifted about 1000 ft. from the hole, creating some concern that the tool had been pulled from the hole. Our calculations indicated that the tool should have risen less than 150 ft. in the hole with this offset, and, indeed, the seismic and tilt data indicated that the tool was in a vertical attitude. The temperature ($\sim 30°C$) also indicated that the tool was still in the hole. The fact that 200 ft. of cable had to be lowered before the tool again reached bottom did show that we no longer had a straight line from the ship to the bottom of the hole.

At 0330 hours on February 3, the tool was clamped at the bottom of the hole, and the ship started moving away from the hole while the cable was being lowered. About 20 meters of cable had been lowered as slack before starting. To avoid excessive slack on the bottom or in the hole, it was thought best to lay cable at a rate calculated such that the cable would not move at the top of the hole. With Duennebier on the bridge and Blackinton in the logging shack (communicating on voice-powered phones), it was possible to maintain this schedule. It was decided to move away from the hole to the SSW in a direction downwind from the hole and on the axis of the sediment pond, avoiding basalt outcrops on each side. While still in the range of the acoustic beacon, the ship was allowed to drift backward; we made note of the corrections needed to maintain heading and to stay on track. In this way, when the beacon was lost, the ship could still be accurately moved on track. After 23,000 ft. of cable had been payed out, the ship was stopped and another beacon dropped at 0506 hours on February 3. A T-bar was placed on the cable at 0526 hours and tension taken off the drum while waiting for the beacon to settle.

At 0530 hours, the ship was positioning on the new beacon and the cable was cut for re-heading. Special effort was again made to insure long life and integrity of the connector. A cable grip was also installed for use in keelhauling. The cable was ready for keelhauling at 0830 hours, and the operation was performed at 0940 hours after we had corrected some ship positioning problems.

At 0950 hours, the cable was connected to the recording package and the signal monitored. The system was found not to be operating and the problem isolated to a card in the recording package. The pressure case was opened, the card replaced, and the cable re-connected at about 1100 hours. It was obvious at this time that the DC offsets in the geophones were a serious problem in that the recording package would not be able to handle them properly. The package was allowed to run on deck during lunch to watch for changes and then lowered at 1245 hours on February 3. Tension was taken on the recovery rope (1¼-inch polypro) and lowering through the tensioner begun as the ship offset about 3000 ft. from the beacon. Lowering was stopped at about 3500 ft. when a short splice in the rope was encountered that would not pass through the blocks or over the tensioner. The splice marked the point where one strand of the rope changes color from yellow to black. (The purpose of having five different colors is to allow the recovery ship to know how far along the rope they are and which direction is toward the recording package.) The splice was cut out and replaced by a long splice in about 35 minutes; lowering continued at 1350 hours. Another splice was replaced at 1410 hours. When a third splice was encountered at 1550 hours, the rope was slack enough to tie off ahead of the tensioner. The rope was cut and short spliced without going through the tensioner. When the splice was complete, it was noticed that the tension on the rope was very high. The ship was moved ahead to relieve this tension and pay out was continued. The ship had to be moved to keep tension on the rope. In retrospect, high tension should be avoided here to avoid pulling the tool from the hole. Since there was no way to measure tension, we do not know how high it got. The last splice was not replaced since it did not have to pass through the tensioner. In the future, the vendor will be requested to use long rather than short splices.

The end of the recovery rope was removed from the reel at 1725 hours when about half a layer was left. The end was attached to the ½-inch stretch rope and anchor assembly and tension transferred to the stretch rope at 1745 hours. Two kilometers of stretch rope were payed out with three turns around the empty recovery rope spool and through the tensioner. At 1820 hours, the end of the rope was tied off and the ship moved full astern. At 1825 hours, the line was cut at high tension at a distance of about 4½ miles from the hole. The ship then returned to the hole site.

At 2036, with the ship in automatic about 300 ft. north of Hole 482C, an ocean-bottom seismometer and an acoustic transponder were dropped to the bottom. The ocean-bottom seismometer was to be used to compare data from the top of the hole with that obtained from the bottom; the transponder, to aid the recovery ship in keeping station during recovery.

On the morning of February 5th the recovery rope and anchor were sighted next to the *Glomar Challenger*. The ½-inch polypro and buoy were retrieved at 0830. The anchor had been released and one of the timed releases was missing. Inspection of the remaining timer showed that its release bolt had fired as a result of a saltwater leak into the electronics. A small scratch was found under an O-ring.

It was decided to pull the drill string from the re-entry cone at Site 482D and to re-deploy the rope. The extra supplies necessary to do this were on board. A new anchor and release were rigged and the ½-inch polypro was wound on the empty 1¼-inch rope spool. At about 1400 the ship began to move south dragging the 1¼-inch recovery rope with it. After passing about 1 mile south of the location of the beacon placed on February 2nd, the ½-inch polypro was attached to the anchor and deployed. When the end of the ½-inch rope was reached, the ship pulled for about 3 minutes before it was noticed that the rope had become slack, indicating breakage. Approximately 2500 ft. of rope were returned to the deck before the parted end was reached. Re-emplacement was complete at about 1700.

On March 17, 1979, at 0300Z, two explosive bolts were to fire, releasing the ocean-bottom seismometer (OBS) from the bottom to be recovered by the R/V *Kana Keoki*. At 0600 on the same day, the recovery rope for the OBS was to be released from the bottom by explosive bolts. The *Kana Keoki* was then expected to pull in the recovery rope and recording package and complete the experiment.

The emplacement phase of this experiment must be considered a complete success. The scenario written in September was followed almost exactly and with only minor problems. At many points in the emplacement, one small mistake could have caused the loss of everything. That this did not occur is partly the result of luck, but mostly the result of the excellent cooperation and expertise of the ship's personnel and of planning done both at DSDP and the Hawaii Institute of Geophysics. Nearly all the problems encountered were anticipated and planned for.

The emplacement of this package was almost easy. The method used, while perhaps not the only one, can certainly be considered viable by other experimenters wishing to place long-term experiments in deep-ocean drill holes. Indeed, a second system identical to the one in Hole 482C was emplaced on Leg 67.

Recovering the Recording Package

The R/V *Kana Keoki* left Mazatlán on March 16, 1979 at 1900Z for Site 482 at 107°59′W, 22°47′N to attempt recovery of the recording package. The ocean-bottom seismometer was expected to fire its explosive bolts at 1100Z and the downhole anchor to release at 1400Z. Upon arrival at the site at 0520Z, an attempt was made to query the transponder at the top of the hole; no signals were heard, however, and the ship sailed to the expected location of the downhole anchor at 108°02′W, 22°45′S. On route, at least one navigational acoustic beacon left by the *Glomar Challenger* was heard. The AMF transponder signals were heard clearly more than three miles from the anchor, and three passes were made over the site to establish its location within the circle where it had been expected.

It was then decided to try to recover the transponder over the hole since it was of no use if its signals couldn't be heard. After several more attempts to get it to answer us, it was released at 0945Z. The release was successful, and the float surfaced at about 1010Z.

A sonobuoy was dropped at 1030Z near the hole to listen for the OBS bolt firings. One was heard at 1047, and the seismometer surfaced at 1117. The *Kana Keoki* then steamed to the location of the anchor and monitored the AMF transponder on the reflection records. A distinct change in slope of the return signal was seen at 1358Z, indicating that the timer had fired and the float assembly was rising. The transponder was monitored continuously until the buoy was sited at 1543Z. The radio (short antenna) had failed to work, and it is uncertain how long it had been on the surface. The ½-inch polypro was streaming away in one direction and the 1¼-inch polypro in the other. The buoy, transponder, and timer were recovered by throwing a grapple over the rope and hauling them in over the stern.

With the ½-inch rope and anchor assembly secured, the 1¼-inch polypro was threaded over a roller, through a counter/tensionmeter, around a capstan, and into a box on the upper deck. The after-steering was used to keep the ship heading away from the floating rope. Several snarls in the rope were encountered but all were fairly loose and easily cleared. Approximately 7 hours after starting, the last of the polypropylene was hauled on board with the recording package. Time code was verified and checked immediately, indicating that data were still coming up the hole, although the values were not those expected. Further study of the data, obtained by connecting the cable from the sensor package to the test box, showed that while signals were being processed by the sensor package, all seemed to be off scale. Thus, the decision was made to pull the sensor package from the hole and retrieve it. The motor driving the tool clamps was activated, and current drain indicated that the clamps were retracted properly. Wire was hauled for about 60 min. with little change in tension while we maneuvered the ship to keep the wire angle vertical. The splice was reached, indicating that about 3200 meters of wire were left out. Since the splice would not go through the blocks, the cable was clamped at the stern and the splice cut out.

At 0700Z the cable tension was again transferred to the winch and hauling continued. Tension slowly decreased from 2600 lbs. (hanging weight of the wire) to 0 lbs. as the end of the wire was approached; this caused us concern as to whether the sensor package was still attached. At 0800Z, however, the package was brought on board. The outward appearance was normal, with all joints apparently intact and a heavy coating of mud on everything. There appeared to be some sign of heating on the potting around the connectors.

The tool itself was left unopened until return to the Hawaii Institute of Geophysics where it was opened under controlled conditions. The exterior of the tool was only slightly rusted. All connectors appeared to be intact, and the logging cable itself was in good condition. A dark coating (which gave the appearance of having been baked on) was present on the pressure case. Before opening the tool, it was determined that essentially all of the electronics inside were working, and data were present on all three of the seismometer axes. Channels 12–16 could not be selected, however, and all tilt sensors were off scale. Before the hold-down screws on the end cap were removed, it was noticed that the cap could not be pushed down and was tightly pressing on the screws, indicating internal pressure. The end cap was levered down with 2 × 4's and about 50 to 100 lbs. of pressure released. The air inside smelled like warm oil. The sensor package was removed from the pressure case with some difficulty because of the potting compound that had been poured around the tilt meters just before closing the package up. It was immediately obvious that the package had undergone considerable heating. Components and circuit boards that had been green were brown. One of the tilt meters was obviously broken, with small bits of glass spread around the bottom of the package. The other tilt meter was enclosed in potting compound, and it was also broken. Both tilt meters had apparently shattered. The electrolite had boiled off and was probably responsible for the internal pressure.

Later testing has shown that the tilt meters explode at about 140°C. The data taken after the pipe stripping show that both tilt meters were still intact at that point. Therefore, it is likely that both meters exploded as the hole warmed up above 140°C.

Two mechanical problems were also visible. One of the horizontal geophones had shifted in its case, shorting an electrical ground to the instrument case. Shifting of another card in its holder caused shorting of a digital (−5 volt) circuit to the case. Even in this condition the package worked, and it was probably in this state when the real-time data were taken after the pipe stripping. However, when the recording package was placed in the ocean, the short circuit was completed and no more data were transmitted. Real-time data recorded at the time of recovery are apparently reliable. The thermal sensor had a steady value yielding 187°C (uncalibrated). Since this value was well above the range where testing was done (130°C), the package was recalibrated until the value observed at recovery was reached. With a high degree of confidence, we can now say that the bottom of the hole was at a temperature of 150°C ± 5°, which is 50% hotter than the temperature we had expected during deployment and well above the design specifications. We were lucky the instrument worked at all.

HEAT FLOW

One of the reasons Site 482 was selected as a prime drilling target was that the site survey heat-flow measurement predicted basement temperatures of about 100°C. One of the important factors regarding the metamorphism and cooling history of the igneous oceanic crust is the relative importance of convective heat transport by circulating seawater and conductive heat transport by lattice vibrations. Several measurements of temperature in the basalt at depths of a few hundred meters would help answer this question at this site and would allow comparisons with similar studies in the Atlantic (e.g., Leg 37).

In Hole 482C, three temperature measurements were made in the sediment at depths of about 54, 82.5, and 120.5 meters. The Uyeda tool was used and was allowed to free fall to the bottom of the string, which was withdrawn about 5 meters above the hole bottom. Circulation was stopped about 5 minutes before the temperature tool reached bottom to slow its descent. After the tool had latched into the drill string, the string was lowered until weight loss was observed—i.e., the bumper subs were closing. This forced the probe into the sediments, and it was left in place for 20 minutes before the string was withdrawn and the tool recovered with the sand line. Thermistor resistance values were recorded each minute from the time the tool was placed in the core barrel on deck to the time it was opened and switched off. The thermistor resistance values were converted to temperature using the on-board conversion tables, which, however, only went to 50°C. Since some of the measurements were higher than this, the tool was calibrated by immersing it in water, heating the water, and plotting mercury thermometer values against resistance. Next the temperature values were plotted against time in the hole, and they clearly increased while the probe was in the sediment (Fig. 27). The equilibrium temperature was estimated by extrapolating the observed values. Finally, the equilibrium temperatures were plotted against depth in Figure 28 to get a temperature gradient of 63°C/100 meters. This value compares well with the temperature gradient predicted from the surface heat-flow measurement (64.7°C/100 m).

The thermal conductivity of the sediments was estimated by measuring two samples on the shipboard thermal conductivity system. The insulating blocks were used, and an entire 15-cm core section in the liner was placed on end on the block. Thermistor values were read at 0.7 and 1.5 minutes after the heaters were turned on, and the constants provided in the manual were used to get the conductivity.

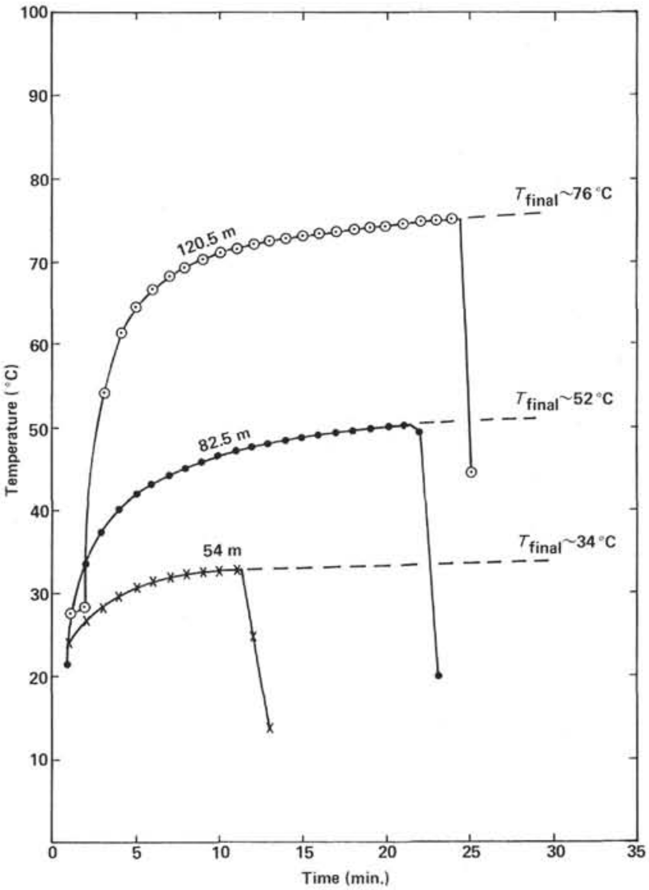


Figure 27. Temperatures measured as a function of time using the Uyeda heat probe at three depths in Hole 482C. (T_{final} is the extrapolated equilibrium temperature for each level in the sediments.)

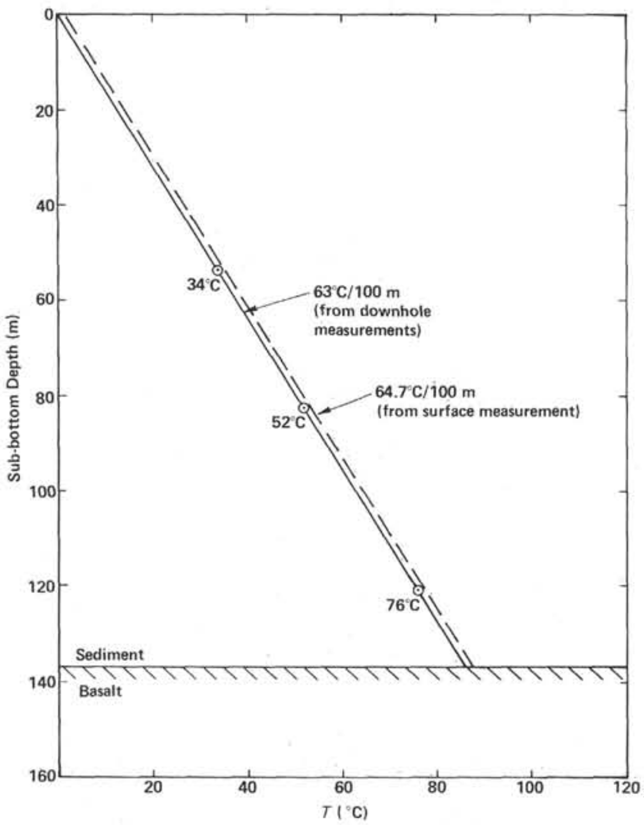


Figure 28. Equilibrium temperatures determined at three levels in Hole 482C, compared to temperature gradient determined from seafloor heat-flow measurements.

The depths and conductivities of the samples are tabulated below.

Core	Sub-bottom Depth (m)	K (mcal/ °C cm s)
Wash core	1.0	1.96
3-4	73.0	2.07
		mean K = 2.0

The temperature gradient is 63°C/100 m and, therefore, the heat flowing through the sediment valley is 12.6 μcal/cm^2 s.

During the site survey, the temperature gradient was found to be 64.7°C/100 m, but the conductivity was found to be 1.83 mcal/°C cm s, using an *in situ* heating method, giving a heat flow of 11.78 μcal/cm^2 s. The agreement is good in view of the experimental error.

Hole 482C was used to emplace the Duennebier downhole seismometer, which also records temperature. A temperature of 150°C $\pm$ 5° was estimated from the thermal sensor included in this instrument package.

On a logging run in this hole, temperature was measured in the water in the hole. The temperature on this run reached about 47°C but seemed to be dependent on the pipe's location. It is suspected either that convective water mixing in the hole kept the values low or that water was flowing down the hole into the basalt.

SUMMARY AND CONCLUSIONS

Seven holes were drilled at Site 482 (Fig. 4), only four of which reached basement. Hole 482 recovered only a mudline core, Hole 482A was drilled to 44 meters, and Hole 482B to 229.0 meters. Hole 482C was a single-bit hole drilled from 44.5 to 186.5 meters for emplacement of the Hawaiian downhole seismometer. The first reentry hole, 482D, was drilled to a depth of 186.5 meters before the pipe became stuck and had to be blown off. Hole 482E recovered no core, being washed to a depth of 48.5 meters while we attempted to set casing for a new re-entry hole. Finding that the casing could not be washed down to full depth in Hole E, we pulled it out and washed down again in Hole F. Hole F was cored from 49 to 56.5 meters, washed from 56.5 to 113.5 meters, and then continuously cored to 145 meters.

The principal holes—482B, C, and D—are about 100 meters apart and lie along a line roughly at right angles to the ridge axis, perpendicular to the axis of the sediment pond in which the site is located; Hole D is closest to the pond axis.

Sediment Lithology

Approximately 137 meters of sediment overlie acoustic basement at Site 482. The sediments are predominately olive gray, clay to silty clay with an average composition of 60-70% clay, 30-35% silt, and 0-5% sand. Biogenic material includes calcareous nannofossils, foraminifers, radiolarians, and diatoms. Rare layers of silty sand with abundant detrital minerals and reworked foraminifers are interpreted as fine-grained turbidites, and some of the clays may also represent mud turbidites. The sandy layers contain abundant quartz and feldspar and lesser quantities of amphibole, mica, zircon, and tourmaline, all of which indicate a continental source. The turbidites were probably derived from sediment previously deposited on the continental shelf and slope of the Mexican mainland. Sands and silty sands are somewhat more abundant in the section cored in Hole D than in the other holes, suggesting that turbidite deposition was greatest along the axis of the sediment pond.

Recovery of the basal sediments above basement was poor, but sediments near the contact show some induration and dehydration. In most holes the top of the basalt is marked by a glassy rind, but no clear evidence of baking was observed in the sediments. Pyrite and dolomite rhombs increase downward in the lower 3.5 meters of sediment, and in Hole C several layers of dolostone occur just above the basement contact.

Precise estimates of sediment ages are difficult to make because no paleontological boundaries were positively identified; however, all of the sediments are late Quaternary. The absence of the radiolarian species *Axoprunum angelinum* indicates an age younger than 410,000 years, the time at which this species became extinct. Nannofossils could fall into either Zone NN21, beginning 250,000 years ago, or Zone NN20, beginning about 440,000 years ago.

Based on a maximum age of less than 410,000 years, the minimum calculated sediment accumulation rate is 334 m/m.y. for the 137 meters of sediment above the basalt. If younger than 250,000 years, the maximum rate is 548 m/m.y. The very high sedimentation rates reflect the proximity of the landmass of mainland Mexico.

Numerous pieces of mudstone and siltstone were recovered within basement and many are indurated or dolomitized. These sediments generally are poorly recovered because they are washed during drilling. In the absence of downhole logs, the drilling record can be used to locate these sedimentary interlayers, which are characterized by a marked increase in drilling rate. Sedimentary layers were inferred where sediments were actually recovered or where suggested by the drilling record. The drilling record was also used to determine probable thicknesses of the sedimentary layers. Layers identified in this way range from 0.5 to 4.0 meters thick and are distributed throughout the entire drilled section (Fig. 29). These sedimentary interlayers correlate closely with boundaries between cooling units, magnetic units, chemical units, and major alteration zones. In a few cases single fragments of sediment were recovered at the tops of cores in intervals where the drilling record indicated no discontinuity in the basalts. These fragments probably slumped into the holes during retrieval of the core barrel.

Basalt Lithology

Basement was cored in Holes 482B, C, D, and F. The deepest penetration was 90 meters in Hole B; Holes C and D each penetrated about 50 meters and Hole F only about 8 meters. Basement recovery averaged about 46% in Hole B, 57% in Hole C, 41% in Hole D, and 40% in Hole F.

Both cooling units and larger lithologic units were recognized in basement (Table 6). Cooling units are defined on the basis of glassy rinds, grain-size changes, and the presence of sedimentary interbeds; lithologic units are defined on the basis of gross lithologic character and phenocryst content and type. Most cooling units are at least 5 meters thick and some exceed 10 meters. They are tentatively interpreted as submarine lava flows because of their thickness, relatively coarse grain size,

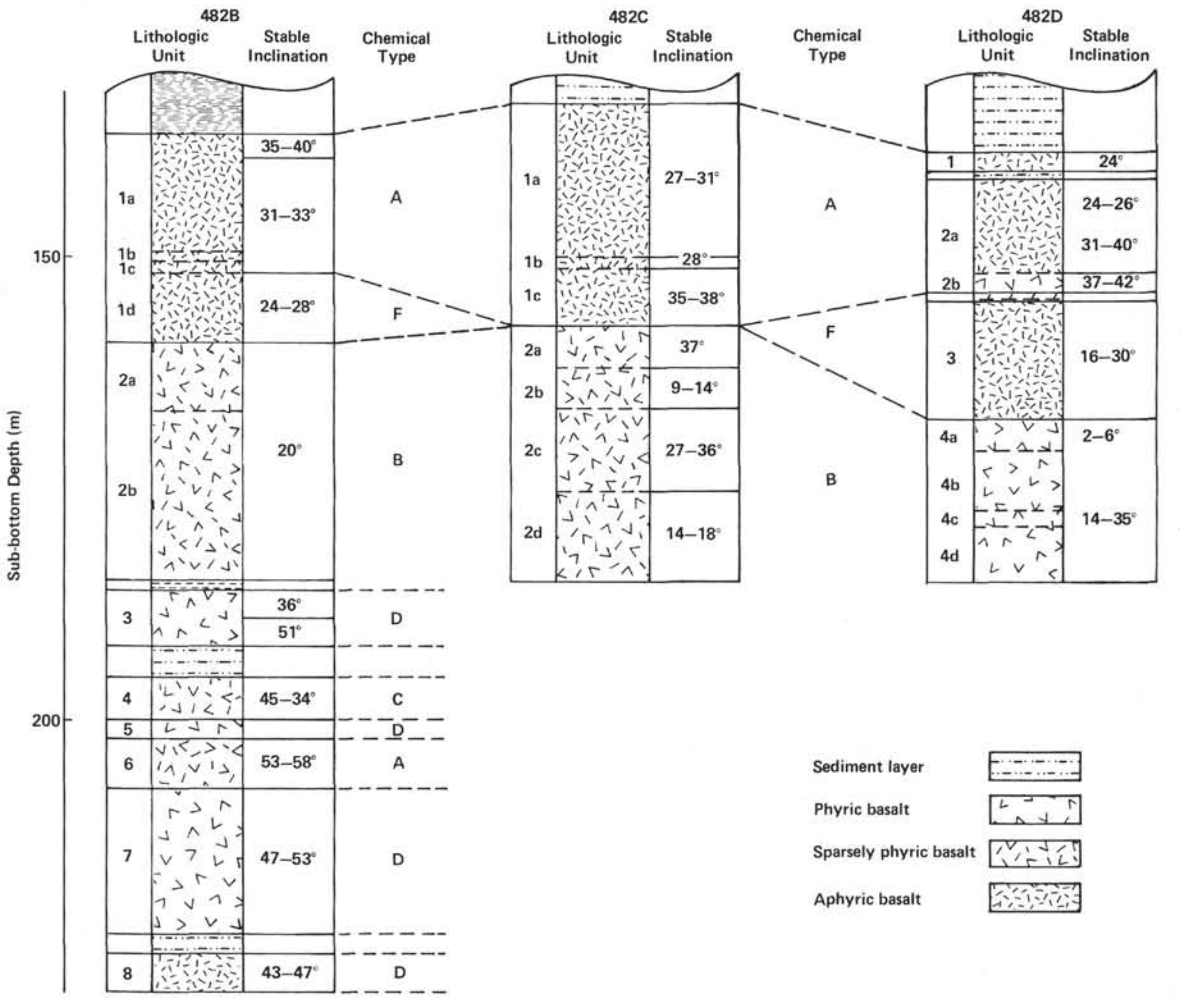


Figure 29. Correlation between lithology, chemistry and paleomagnetic properties in Holes 482B, 482C and 482D.

and lack of obvious intrusive relationships. The relatively coarse-grained nature of the basalts and the presence of interstitial groundmass quartz indicate slow cooling of thick units, but are not considered proof of an intrusive origin. Some thinner cooling units between 0.5 and 1.0 meter thick are present, particularly in Hole D, and these might possibly represent individual pillows. However, we interpret them to be thin flows because glassy rinds are generally thin and flat, and because vesicle zones, characteristic of pillow margins, are absent. Obvious baking of basement sediments was not recognized but many of the sediments interlayered with basalts are indurated and dolomitized.

Petrographically, the basalts can be divided into aphyric and sparsely phyric types. Most aphyric basalts contain very sparse, small phenocrysts of plagioclase, rarely intergrown with clinopyroxene. Sparsely phyric varieties contain up to 5% phenocrysts, chiefly plagioclase with minor amounts of green clinopyroxene and altered olivine. In all the holes, phyric basalts occur in the lower parts of the basement section and are overlain by aphyric varieties. Groundmass textures are generally medium to fine grained, intergranular to subophitic, or coarse grained with a holocrystalline mesostasis.

Plagioclase and well-crystallized clinopyroxene are the most abundant groundmass minerals, with plagioclase being generally more abundant than clinopyroxene. Olivine and titanomagnetite are present in all specimens and range from about 2 to 5% each. The mesostasis is glassy (generally replaced by smectite) in fine-grained rocks; in coarse-grained rocks it consists of tridymite(?), quartz, and apatite needles.

All of the recovered basalts are tholeiites with a composition characteristic of the East Pacific Rise. Fresh basalts have MgO contents generally between 6.5 and 8.5%, TiO_2 between 1.2 and 1.9%, Al_2O_3 between 14 and 17%, CaO between 11 and 13%, and K_2O less than 0.1%. Six chemical types (A–F) were recognized in the four basement holes. Two chemical types are recognized in the aphyric basalts, and these cannot be related by any simple fractionation scheme, making them good candidates for derivatives from separate parental melts. At least some of the phyric rocks may be related by phenocryst accumulation and fractionation (A, E, and D), suggesting at least some high-level crystal fractionation.

The section at Hole 482 is similar to Atlantic Ocean basement in having several magma types (each with a given stratigraphic range), in the existence of two or more liquid compositions, and in the evidence for crystal fractionation and accumulation.

A temperature of about 90°C was estimated for the basement/sediment contact from heat-flow measurements in Hole C, although most of the basalts are not more altered than other oceanic tholeiites. Sparse vesicles and hairline fractures are filled with brown smectite, sometimes accompanied by calcite and sulfide. Groundmass olivine and glassy interstitial material are replaced by smectite and serpentine(?), and calcite in thick cooling units. This type of alteration is characteristic of low-temperature interaction between basalt and seawater. Some deuteric alteration probably took place in the thickest flows. The principal chemical changes associated with this type of alteration are losses of CaO and MgO—and, in some rocks, SiO_2 and increases in H_2O. Only one sample shows enrichment in K_2O.

Higher-temperature hydrothermal(?) alteration was found in the upper part of Section 482C-11-2. Here olivine and clinopyroxene have been partly to completely altered to chlorite and actinolite, possibly with associated zoisite(?) and sphene(?). Chemical trends in these rocks are quite different from those of low-temperature alteration, as indicated by increases in MgO and Na_2O and losses of CaO.

Invariably, the alteration of basalts at Site 482 is most intense just below the sediment/basalt interface and below sediment interlayers in basement. Sulfide-rich veins are abundant in these zones, especially in Hole 482C. These zones of high alteration correlate quite well with chemical, magnetic, and lithologic breaks in the basement section.

Paleomagnetics

Site 482 is located in crust with a probable age between about 250,000 and 400,000 m.y., with a positive surface magnetic anomaly (Brunhes). The expected inclination of the axial geomagnetic dipole is about 40° and the expected range of magnetic inclinations resulting from secular variation is about 23° to 54°.

All but three measured specimens have positive magnetic polarities and these three were probably misoriented in the core before samples were taken. Nearly all the stable magnetic inclinations fall within the range postulated for secular variation, and the average value in Hole 482B is close to the inclination expected from an axial dipole. However, downhole variations in stable inclinations define numerous magnetic units in each hole, many of which correlate with lithologic and chemical units. Generally, inclinations in the upper 50 meters of basement in Hole 482B are lower than those from deeper sections. Many of the downhole magnetic units can be correlated between the basement holes, suggesting that the variation in inclination results from secular variation.

Magnetic intensities in the basalts from Site 482 range from 2.1×10^{-3} G to 2.6×10^{-2} G. The median destructive field is low, ranging from 30 Oe in Hole C to 490 Oe in Hole D in keeping with the relatively coarse grain size of the basalts. Both the intensity and stability of the magnetization increase toward the margins of individual cooling units. The low magnetic stability is similar to other parts of the Pacific basement and may reflect the predominance of massive, relatively coarse-grained cooling units at Site 482.

Physical Properties

The very young sediments drilled at Site 482 show little change in their physical properties with depth. Density increases from about 1.55 g/cm^3 near the top to about 1.80 g/cm^3 near the base, while porosity decreases from about 65% to 50% over the same interval. Only the dolostones near the base of Hole 482B have significantly higher densities and lower porosities. Compressional-wave velocities are typical of weakly consolidated sediments, ranging from about 1.5 to 1.6 km/s, increasing only slightly with depth. Shear strength is extremely low, ranging from about 0.05 to 0.25 tons/ft.^{2} in the upper 70 meters and increasing to about 0.9 tons/ft.^{2} just above the basement.

One of the major reasons for selecting Site 482 for a re-entry hole on the East Pacific Rise was the high seismic velocities measured over the site (V_p = between 4.5 and 5.8 km/s) by refraction profiling. Measured compressional-wave velocities in the basalts range from 5.5 to 6.0 km/s and average about 5.8 km/s, reflecting the very fresh character of the rocks. Comparison with the *in situ* velocities suggests that the upper few hundred meters of basement contain about 7% water-filled cracks or sedimentary interlayers. Basalt densities range from 2.74 to 3.11 g/cm^3 and show a positive correlation with compressional velocities. Both density and velocity decrease with increasing alteration.

Correlation of Lithologic, Chemical, and Magnetic Units

The close spacing of Holes 482B, C, D, and F (Fig. 4) and the relatively high recovery for East Pacific Rise basement provide an unusually good opportunity to compare lithologic, chemical, and magnetic units in a transverse strip of 400,000-year-old oceanic crust about 50 meters thick and 200 meters long. The poor degree of correlation between closely adjacent basement holes at sites drilled in the Atlantic Ocean is generally taken as an argument for faulting and tectonic rotation of rather small crustal elements.

The correlation of lithologic units between holes is excellent (Fig. 29). The upper aphyric unit is about 24 meters thick in Hole 482B, 15 meters thick in Hole 482C, and 12 meters thick in Hole 482D. This is underlain by another aphyric sequence which in turn is underlain by a sequence of sparsely plagioclase phyric basalts in all three holes.

In the aphyric basalts, thick cooling units predominate in the upper part and thin cooling units in the lower part in all three holes. Similarly, the phyric lithologic unit is characterized by thick cooling units in all three holes.

Six chemical types were recognized in the basalts of Hole 482B, designated consecutively downward as A, F, B, C, D, and E. In general, these magma types occur in the same stratigraphic position in Holes 482C and D as in Hole 482B (Fig. 29). The only exceptions are an interval of basalt with E-type composition between groups A and F in Holes 482C and D. In the lower part of Hole 482B, E- and D-type basalts are interlayered.

A fairly close coincidence of chemical and magnetic units is also observed. In Hole 482D, basalts of Chemical Type A compose two magnetic units, only the lower of which occurs in Holes 482C and D. Basalts of F-type composition have similar magnetic inclinations in all three holes (Holes 482B, C, and D), those in C being somewhat higher. Basalts of E-type composition have lower inclinations in Hole 482C than in Hole 482D.

The recognition of discrete, sequential, lithologic, chemical, and magnetic units that correlate well between holes suggests that basement at this site was emplaced as a series of eruptions of different or alternating compositions. The continuity of units over a 200-meter interval and the regular stratigraphic succession argue against emplacement as intrusions. However, some of the basalts of E-type composition intercalated with other compositional groups might possibly be intrusive. If such an intrusive event took place, it might have provided the heat for the relatively high-temperature alteration at two levels in Hole 482C. The interlayered E-type basalts correlate with lithologic changes, sediment interlayers, and zones of more intense alteration in the other holes.

Conclusions

Drilling at Site 482 confirms that the Gulf of California is an area of high sedimentation, with large contributions from the adjacent continental landmasses. At least the upper 90 meters of basement consist of interlayered massive basalts and sediments with no recognizable pillows. The basalts are interpreted as massive flows rather than sills because of the absence of clearly baked contacts and the lateral continuity of lithologic, chemical, and magnetic units. The drilled section is quite different from most basement sections drilled in the Atlantic Ocean and may be characteristic of a young proto-ocean. It seems likely that at some greater depth the volume of sedimentary interbeds should decrease and pillow basalts might be encountered.

Drilling at Site 482 does not support speculations that basalts erupted along fast-spreading ridges are compositionally more uniform than those erupted along slow-spreading ridges. A number of distinct chemical groups can be recognized in the basement basalts and at least two of these probably represent separate parental magmas. Chemical and mineralogical evidence also indicates shallow level crystal fractionation with a range of compositions similar to some Atlantic Ocean sites.

Heat-flow data confirm that crustal rocks near the ridge crest are relatively hot. Despite an estimated basement temperature of 90°C the rocks are relatively fresh, and most observed alteration is the result of low-temperature basalt–seawater interaction. The observed temperature gradients strongly suggest that hydrothermal circulation is occurring in the oceanic crust, and one small area of relatively high-temperature hydrothermally altered basalt was encountered. This probably developed around a fracture or channelway through which hot water was rising.

The magnetic polarities of the basement rocks are in accord with the observed surface anomaly; however, stabilities are low, probably reflecting the relatively coarse-grained nature of most basalts. Measured stable inclinations mostly fall within the range expected for secular variation, but some tilting or rotation of basement sections cannot be ruled out on the basis of magnetic evidence alone. However, the correlation of lithologic, chemical, and magnetic units between holes at this site argues against significant tectonic disruption of the crust.

The expected correlation between high *in situ* seismic velocities and good drilling cannot be adequately evaluated at this site. The massive basalts were fairly easy to drill and recovery was good, but the pipe became stuck in two holes. We believe, however, that this may be the result of collapse of the sediments above basement around the pipe rather than jamming with basalt rubble. If this interpretation is correct, hole stability can be achieved by casing the sedimentary section to basement.

REFERENCES

Bader, R. G., Gerard, R. D., et al., 1970. *Init. Repts. DSDP*, 4: Washington (U.S. Govt. Printing Office).

Bé, A. W. H., 1977. An ecological, zoogeographic and taxonomic review of Recent planktonic foraminifera. *In* Ramsay, A. T. S. (Ed.), *Oceanic Micropaleontology* (Vol. 1): New York (Academic Press), 1-100.

Benson, R. N., 1966. Recent Radiolaria from the Gulf of California [Ph.D. dissert.]. University of Minnesota, Minneapolis.

Boyce, R. E., 1973. Appendix I. Physical property methods. *In* Edgar, N. T., Saunders, J. B., et al., *Init. Repts. DSDP*, 15: Washington (U.S. Govt. Printing Office), 1115-1128.

Boyce, R. E., and Bode G. W., 1972. Carbon and carbonate analyses, Leg 9, Deep Sea Drilling Project. *In* Hayes, J. D., et al., *Init. Repts. DSDP*, 9: Washington (U.S. Govt. Printing Office), 797-816.

Čepek, P., and Wind, F. H., 1979. Neogene and Quaternary calcareous nannoplankton from DSDP Site 397 (northwest African margin). *In* von Rad, U., Ryan, W. B. F., et al., *Init. Repts. DSDP*, 47, Pt. 1: Washington (U.S. Govt. Printing Office), 289-315.

Clague, D. A., and Bunch, T. E., 1976. Formation of ferrobasalt at East Pacific mid-ocean spreading center: *J. Geophys. Res.*, 81: 4247-4256.

Gartner, S., 1977. Calcareous nannofossil biostratigraphy and revised zonation of the Pleistocene. *Mar. Micropaleontol.*, 2:1-25.

Hays, J. D., 1970. Stratigraphy and evolutionary trends of Radiolaria in North Pacific deep sea sediments. *In* Hays, J. D. (Ed.), *Geological Investigations of the North Pacific: Mem. Geol. Soc. Am.*, 126:185-218.

Kling, S. A., 1973. Radiolaria from the eastern North Pacific, Deep Sea Drilling Project, Leg 18. *In* Kulm, L. D., von Huene, R., et al., *Init. Repts. DSDP*, 18: Washington (U.S. Govt. Printing Office), 617-671.

Martini, E., 1971. Standard Tertiary and Quaternary calcareous nannoplankton zonation. *In* Farninacci, A. (Ed.), *Second Planktonic Conf. Proc.:* Rome (Tecnoscienza), 739-785.

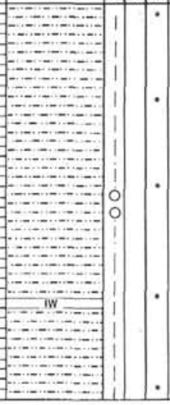
Nigrini, C. A., 1971. Radiolarian zones in the Quaternary of the equatorial Pacific Ocean. *In* Funnell, B. W., and Riedel, W. R. (Eds.), *The Micropaleontology of Oceans:* Oxford (Cambridge University Press) pp. 443-461.

Rosendahl, B. R., Hekinian, R., et al., 1980. *Init. Repts. DSDP*, 54: Washington (U.S. Govt. Printing Office).

Yeats, R. S., Hart, S. R., et al., 1975. *Init. Repts. DSDP*, 34: Washington (U.S. Govt. Printing Office).

SITE 482 HOLE CORE 1 CORED INTERVAL 0.0–4.0 m

TIME – ROCK UNIT	BIOSTRATIGRAPHIC ZONE	FOSSIL CHARACTER: FORAMINIFERS	NANNOFOSSILS	RADIOLARIANS	DIATOMS	SECTION	METERS	GRAPHIC LITHOLOGY	DRILLING DISTURBANCE	SEDIMENTARY STRUCTURES	SAMPLES
LATE QUATERNARY	NN20–21 (N)	RG	CG	RG		1, 2, 3, CC	0.5, 1.0	IW			



LITHOLOGIC DESCRIPTION

5Y 3/2

10Y 4/2

5Y 3/2

Olive gray (5Y 3/2) to grayish olive (10Y 4/2), slightly mottled SILTY CLAY with nannofossils in the base of Section 1 (83–150 cm). H_2O in Section 3 and plant fragments throughout.

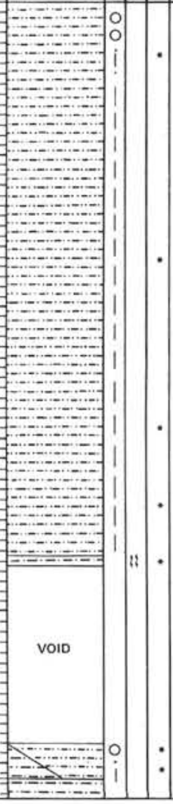
SMEAR SLIDE SUMMARY

	1-11	1-94	2-30	2-140	CC
TEXTURE:					
Sand	3	2	8	10	5
Silt	23	43	27	25	38
Clay	74	55	65	65	57
COMPOSITION:					
Quartz	6	2	4	3	4
Feldspar	3	1	2	1	2
Heavy minerals	9	3	2	1	2
Clay	74	55	65	65	57
Volcanic glass	2	2	2	7	3
Carbonate unspec.	–	1	3	2	4
Foraminifers	4	2	2	2	1
Calc. nannofossils	3	28	7	6	9
Diatoms	3	2	3	6	10
Radiolarians	2	TR	5	4	2
Sponge spicules	TR	–	TR	TR	1
Silicoflagellates	TR	–	TR	TR	TR
Micronodules	3	4	5	3	4

SITE 482 HOLE A CORE 1 CORED INTERVAL 0.0–6.0 m

TIME – ROCK UNIT	BIOSTRATIGRAPHIC ZONE	FORAMINIFERS	NANNOFOSSILS	RADIOLARIANS	DIATOMS	SECTION	METERS
LATE QUATERNARY	NN20–21 (N)	A G FM				1	0.5 1.0
						2	
						3	
						4	
						5	
						6	
		CG	CG	AG		CC	

GRAPHIC LITHOLOGY / DRILLING DISTURBANCE / SEDIMENTARY STRUCTURES / SAMPLES



LITHOLOGIC DESCRIPTION

5Y 3/2

10Y 4/2

Soft olive gray (5Y 3/2) to grayish olive (10Y 4/2) SILTY MUD with a strong H_2S odor. Sediments in Section 4, 90–100 cm are slightly coarser-grained and display moderate bioturbation. Core-Catcher contains olive gray (5Y 3/2) SANDY SILT composed of mica and quartz with minor radiolarians, foraminifera, and lignite.

SMEAR SLIDE SUMMARY

	1-58	2-110	3-120	4-40	4-100	5-140	6-10 (M)
TEXTURE:							
Sand	5	–	10	5	20	15	30
Silt	40	45	40	45	30	25	20
Clay	55	55	50	50	50	60	50
COMPOSITION:							
Quartz	20	20	20	30	20	20	20
Feldspar	10	10	10	15	15	10	15
Mica	–	1	–	–	–	2	1
Heavy minerals	–	–	–	–	1	–	–
Clay	55	55	50	50	50	60	50
Volcanic glass	5	–	5	TR	–	–	–
Glauconite	TR	–	TR	–	1	–	1
Micronodules	5	5	–	TR	–	–	–
Carbonate unspec.	TR	–	TR	TR	10	–	1
Foraminifers	1	–	–	–	–	1	1
Calc. nannofossils	TR	TR	TR	–	–	TR	10
Diatoms	TR	10	5	5	3	5	TR
Radiolarians	TR	TR	–	TR	–	1	–
Sponge spicules	–	TR	TR	–	–	TR	–
Plant debris	–	–	–	–	–	2	–

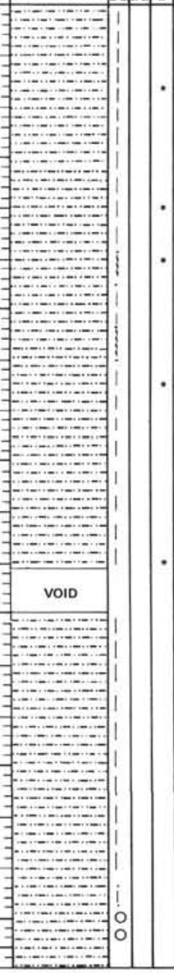
5Y 3/2

5Y 3/2

SITE 482 HOLE A CORE 2 CORED INTERVAL 6.0–15.5 m

TIME – ROCK UNIT	BIOSTRATIGRAPHIC ZONE	FORAMINIFERS	NANNOFOSSILS	RADIOLARIANS	DIATOMS	SECTION	METERS
LATE QUATERNARY	NN20–21 (N)					1	0.5 1.0
						2	
						3	
						4	
						5	
						6	
						7	
		B	CG	FG		CC	

GRAPHIC LITHOLOGY / DRILLING DISTURBANCE / SEDIMENTARY STRUCTURES / SAMPLES



LITHOLOGIC DESCRIPTION

5Y 3/2

Soft olive gray (5Y 3/2) to grayish olive (10Y 4/2) DIATOMACEOUS SILTY CLAY with a strong H_2S odor throughout.

SMEAR SLIDE SUMMARY

	1-80	2-50	2-100	3-75	4-94
TEXTURE:					
Sand	2	5	–	3	5
Silt	38	35	30	27	40
Clay	60	60	70	70	55
COMPOSITION:					
Quartz	15	16	12	15	20
Feldspar	6	6	5	5	15
Mica	1	–	1	–	2
Clay	60	60	70	70	55
Micronodules	2	2	TR	4	TR
Foraminifers	1	TR	1	TR	–
Calc. nannofossils	1	5	TR	TR	–
Diatoms	10	10	10	5	8
Radiolarians	2	TR	1	2	TR
Sponge spicules	TR	–	–	–	–
Silicoflagellates	TR	TR	TR	TR	TR
Plant debris	–	TR	–	TR	–

10Y 4/2

5Y 3/2

10Y 4/2

5Y 3/2

10Y 4/2

5Y 3/2

SITE 482 HOLE A CORE 3 CORED INTERVAL 15.5–25.0 m

TIME – ROCK UNIT: LATE QUATERNARY

BIOSTRATIGRAPHIC ZONE: NN20–21 (N)

FOSSIL CHARACTER: FORAMINIFERS FG, NANNOFOSSILS CG, RADIOLARIANS FG, DIATOMS

SECTION: 1

METERS: 0.5, 1.0

GRAPHIC LITHOLOGY

DRILLING DISTURBANCE / SEDIMENTARY STRUCTURES / SAMPLES

LITHOLOGIC DESCRIPTION

5Y 3/2

Soft olive gray (5Y 3/2) SANDY MUD.

SMEAR SLIDE SUMMARY

	1-75
TEXTURE:	
Sand	15
Silt	45
Clay	40
COMPOSITION:	
Quartz	30
Feldspar	15
Heavy minerals	1
Clay	40
Volcanic glass	2
Micronodules	3
Carbonate unspec.	2
Foraminifers	1
Calc. nannofossils	4
Diatoms	2
Radiolarians	TR
Sponge spicules	TR
Silicoflagellates	TR

SITE 482 HOLE A CORE 4 CORED INTERVAL 25.0–34.5 m

TIME – ROCK UNIT: LATE QUATERNARY

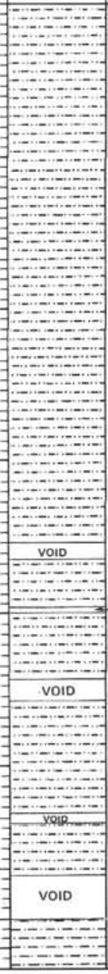
BIOSTRATIGRAPHIC ZONE: NN20–21 (N)

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

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

METERS: 0.5, 1.0

GRAPHIC LITHOLOGY



DRILLING DISTURBANCE / SEDIMENTARY STRUCTURES / SAMPLES

LITHOLOGIC DESCRIPTION

5Y 3/2

IW

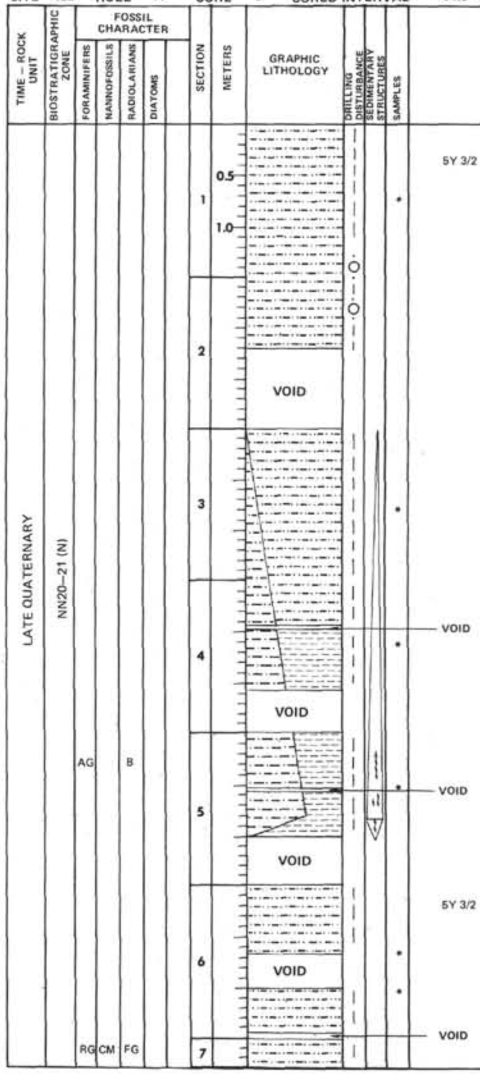
5Y 3/2

Olive gray (5Y 3/2) SILTY CLAY with large foraminifera in Section 1, 30–50 cm. Core-Catcher consists of olive gray (5Y 3/2) SANDY MUD. Sediments soft in Section 1, moderately firm throughout remainder of core.

SMEAR SLIDE SUMMARY

	1-75	2-75	3-75	4-75	5-60	6-100
TEXTURE:						
Sand	2	7	7	6	1	10
Silt	40	43	48	47	30	40
Clay	58	50	45	47	69	50
COMPOSITION:						
Quartz	12	20	20	20	15	30
Feldspar	5	5	7	10	8	13
Heavy minerals	1	2	–	2	–	–
Clay	58	50	45	47	69	50
Volcanic glass	–	–	3	1	TR	–
Micronodules	4	5	4	4	1	1
Carbonate unspec.	4	2	2	3	–	TR
Foraminifers	2	3	5	2	1	3
Calc. nannofossils	7	7	8	7	4	3
Diatoms	7	4	5	4	TR	TR
Radiolarians	TR	1	TR	–	–	–
Sponge spicules	TR	1	1	TR	5	–
Silicoflagellates	TR	TR	TR	TR	–	–
Plant debris	–	–	–	–	TR	–

SITE 482 HOLE A CORE 5 CORED INTERVAL 34.5–44.0 m



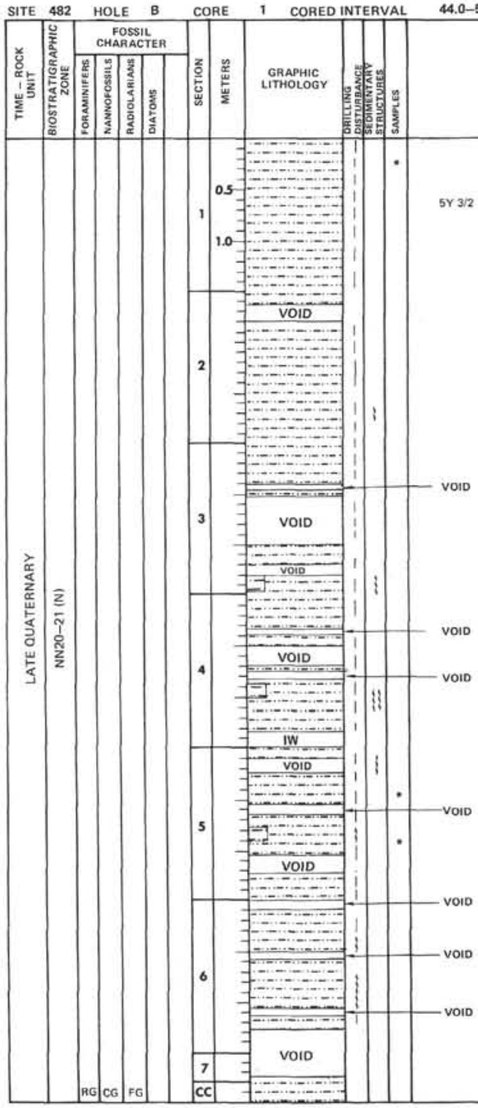
LITHOLOGIC DESCRIPTION

Olive gray (5Y 3/2) SILTY CLAY becoming increasingly coarse-grained with depth from the top of Section 3–Section 5, 70 cm, where the sediments consist of a mix of clay and SANDY MUD. Below this interval, which may represent the boundary between two turbidite sequences, the sediments revert to fine-grained SILTY CLAY. The sediments contain numerous foraminifera between 60–105 cm in Section 4 and occasional black streaks in Section 6, while Section 5 shows evidence of bioturbation. The sediments are increasingly firm with depth to Section 4, 60 cm, then soft to the base of the turbidite(?) at Section 5, 70 cm, and then firm again in the underlying silty clays.

SMEAR SLIDE SUMMARY

	1-75	3-75	4-60	5-50	6-67	6-105
TEXTURE:						
Sand	5	–	–	–	–	–
Silt	35	40	13	10	36	30
Clay	70	59	87	90	64	70
COMPOSITION:						
Quartz	15	20	2	2	10	1
Feldspar	7	9	–	–	–	–
Heavy minerals	2	1	1	1	–	1
Clay	69	59	77	86	64	70
Pyrite	–	–	–	–	–	1
Micronodules	–	–	–	–	1	–
Carbonate unspec.	2	4	5	1	–	–
Foraminifers	1	3	4	3	–	TR
Calc. nannofossil	1	4	10	4	5	TR
Diatoms	2	–	–	–	10	20
Radiolarians	–	–	–	–	2	–
Sponge spicules	–	–	–	TR	10	7
Plant debris	–	–	–	TR	–	–

SITE 482 HOLE B CORE 1 CORED INTERVAL 44.0–53.5 m



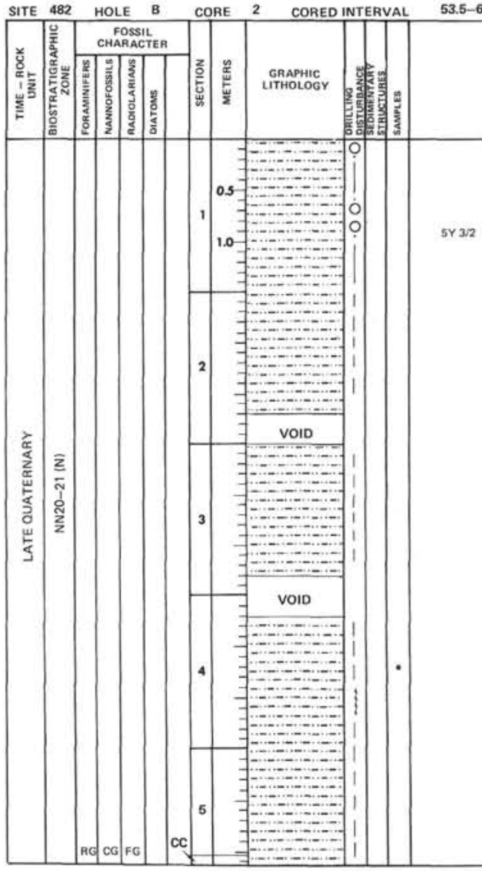
LITHOLOGIC DESCRIPTION

Olive gray (5Y 3/2) SILTY CLAY with cm-wide burrows filled with SANDY MUD near the base of Section 3 and at 90 cm in Sections 4 and 5. Small cracks due to gas expansion are present at 35 cm and between 130–150 cm in Section 5 and throughout Section 6. Section 5 also contains black streaks of lignite at 40 cm. The sediments are soft and mottled in the upper 45 cm of Section 1 and firm throughout the remainder of the core.

SMEAR SLIDE SUMMARY

	1-22	5-43	5-90 (M)
TEXTURE:			
Sand	2	1	10
Silt	38	25	20
Clay	60	74	70
COMPOSITION:			
Quartz	15	8	20
Feldspar	3	2	5
Mica	TR	–	–
Clay	60	74	70
Volcanic galss	TR	–	–
Micronodules	TR	–	4
Carbonate unspec.	–	TR	1
Foraminifers	TR	TR	–
Calc. nannofossils	7	5	TR
Diatoms	5	–	–
Sponge spicules	5	10	–

SITE 482 HOLE B CORE 2 CORED INTERVAL 53.5–63.0 m



LITHOLOGIC DESCRIPTION

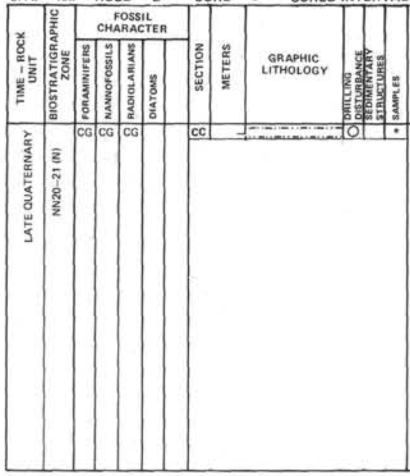
5Y 3/2

Olive gray (5Y 3/2) SILTY CLAY. Sediments are strongly disturbed throughout Section 1 and adjacent to liner in Section 2, but relatively firm in Section 4. Small cracks due to gas expansion are present at 90 cm in Section 4.

SMEAR SLIDE SUMMARY

	4-75
TEXTURE:	
Sand	–
Silt	25
Clay	75
COMPOSITION	
Quartz	8
Feldspar	2
Clay	75
Micronodules	1
Calc. nannofossils	6
Diatoms	2
Radiolarians	1
Sponge spicules	5

SITE 482 HOLE B CORE 3 CORED INTERVAL 63.0–72.5 m



LITHOLOGIC DESCRIPTION

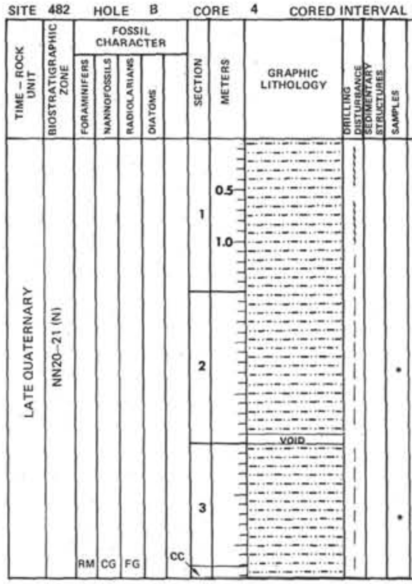
5Y 3/2

Olive gray (5Y 3/2) SILTY CLAY.

SMEAR SLIDE SUMMARY

	CC-10
TEXTURE:	
Sand	2
Silt	34
Clay	63
COMPOSITION:	
Quartz	10
Feldspar	8
Heavy minerals	1
Clay	60
Volcanic glass	2
Micronodules	2
Carbonate unspec.	3
Foraminifers	1
Calc. nannofossils	3
Diatoms	4
Radiolarians	1
Sponge spicules	2
Silicoflagellates	4

SITE 482 HOLE B CORE 4 CORED INTERVAL 72.5–82.0 m



LITHOLOGIC DESCRIPTION

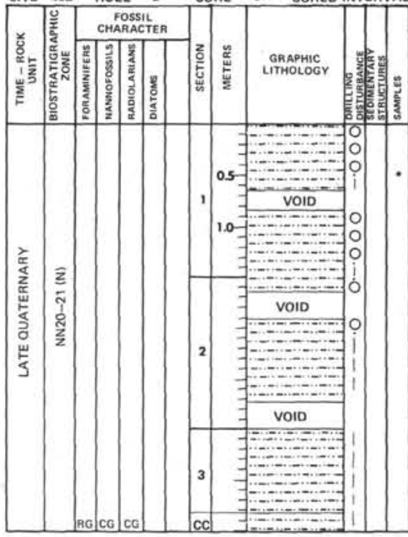
5Y 3/2

Soft olive gray (5Y 3/2) SILTY CLAY. Sediments have a petroliferous odor but show no fluorescence. Upper 110 cm of Section 1 strongly disturbed.

SMEAR SLIDE SUMMARY

	2-75	3-75
TEXTURE:		
Sand	2	5
Silt	21	35
Clay	57	60
COMPOSITION:		
Quartz	15	25
Feldspar	5	5
Mica	–	TR
Heavy minerals	3	–
Clay	57	60
Volcanic glass	–	TR
Glauconite	–	TR
Micronodules	4	4
Zeolite	–	TR
Carbonate unspec.	2	–
Foraminifers	3	TR
Calc. nannofossils	9	5
Diatoms	1	1
Radiolarians	TR	–
Sponge spicules	1	TR

SITE 482 HOLE B CORE 5 CORED INTERVAL 82.0–91.5 m



LITHOLOGIC DESCRIPTION

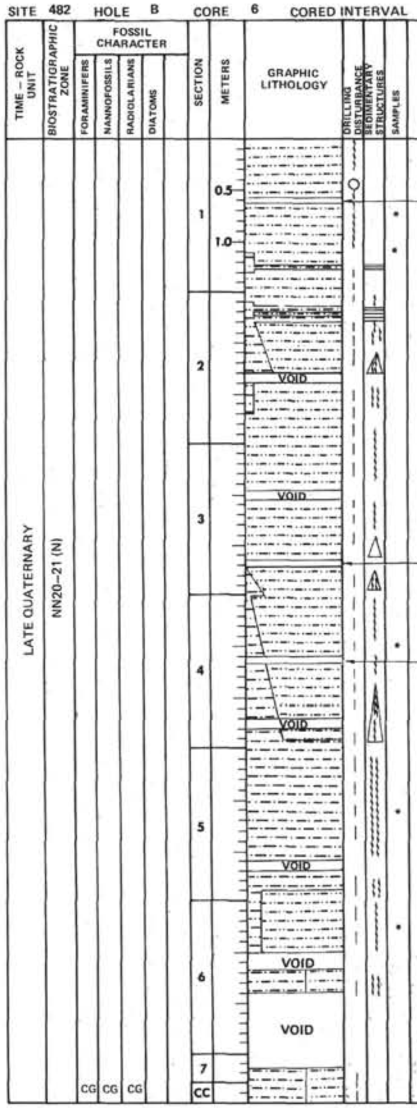
5Y 3/2

Soft olive gray (5Y 3/2) NANNOFOSSIL-bearing SILTY CLAY with a high gas content. Sediments strongly disturbed in Section 1, but more indurated in Section 2 between 55–120 cm.

SMEAR SLIDE SUMMARY

	1-50
TEXTURE:	
Sand	5
Silt	35
Clay	60
COMPOSITION:	
Quartz	10
Feldspar	9
Mica	TR
Clay	60
Volcanic glass	TR
Micronoculdes	5
Zeolite	TR
Foraminifers	TR
Calc. nannofossils	15
Diatoms	TR
Radiolarians	TR

SITE 482 HOLE B CORE 6 CORED INTERVAL 91.5–101.0 m



LITHOLOGIC DESCRIPTION

5Y 3/2

VOID

VOID

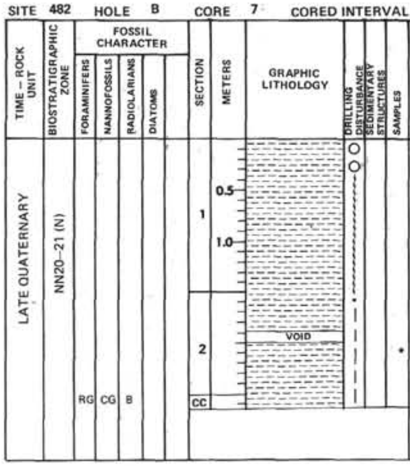
VOID

Olive gray (5Y 3/2) SILTY CLAY with thin (0.5 cm) layers of olive gray (5Y 3/2) SANDY MUD in Section 1 at 125 cm and in Section 2 at 15 and 25 cm. The ratio of sand and silt to clay increases from Section 3, 120 cm to Section 5, 140 cm, below which the sediments revert abruptly to SILTY CLAY, *suggesting a very fine-grained turbidite sequence.* The sediments are soft in Section 1, somewhat more firm in Section 2 and slightly indurated below the contact at 140 cm in Section 5. Bioturbation is present throughout the Section, but is particularly developed in Section 2 and the base of Sections 3, 4, and 5 where it is marked by an increase in sand and silt content.

SMEAR SLIDE SUMMARY

	1-75	1-121 (M)	4-50 (M)	5-60	6-30
TEXTURE:					
Sand	10	30	60	25	5
Silt	40	15	29	20	28
Clay	50	55	11	55	72
COMPOSITION:					
Quartz	16	75	32	5	2
Feldspar	8	10	3	20	8
Heavy minerals	1	1	2	–	–
Clay	60	–	11	55	72
Volcanic glass	TR	–	4	–	–
Glauconite	TR	TR	–	TR	–
Micronodules	5	1	7	1	1
Zeolite	TR	–	–	–	–
Carbonate unspec.	–	3	12	–	TR
Foraminifers	TR	TR	15	10	TR
Calc. nannofossils	10	7	5	10	10
Diatoms	TR	TR	3	2	
Radiolarians	–	–	5	TR	5
Sponge spicules	–	–	TR	TR	
Silicoflagellates	–	–	1	–	–

SITE 482 HOLE B CORE 7 CORED INTERVAL 101.0–110.5 m



LITHOLOGIC DESCRIPTION

5Y 3/2
10Y 4/2

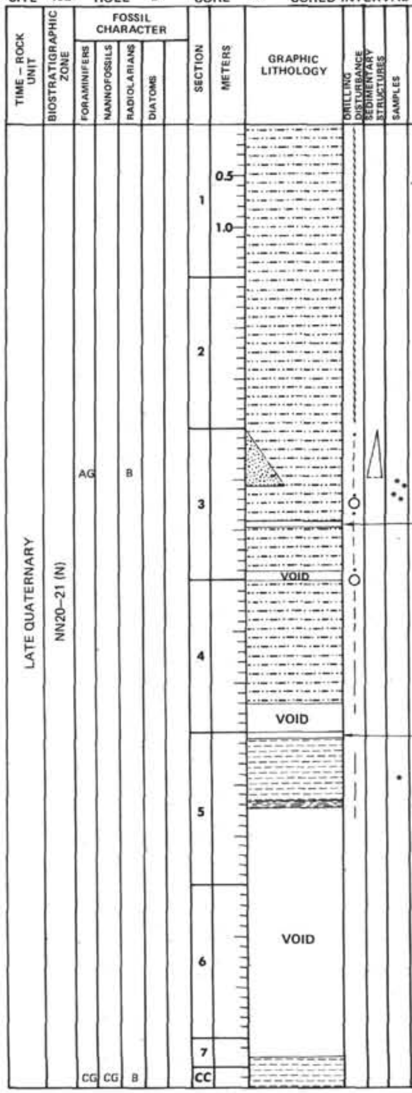
5Y 3/2

Olive gray (5Y 3/2) to grayish olive (10Y 4/2) CLAY. Sediments strongly disturbed at top of Section 1, moderately firm toward base of Section 2.

SMEAR SLIDE SUMMARY

	2-60
TEXTURE:	
Sand	–
Silt	15
Clay	85
COMPOSITION:	
Quartz	5
Feldspar	–
Clay	85
Volcanic glass	TR
Micronodules	5
Carbonate unspec.	5
Calc. nannofossils	1
Radiolarians	
Sponge spicules	TR

SITE 482 HOLE B CORE 8 CORED INTERVAL 110.5–120.0 m



5Y 3/2

VOID

IW

5Y 3/2

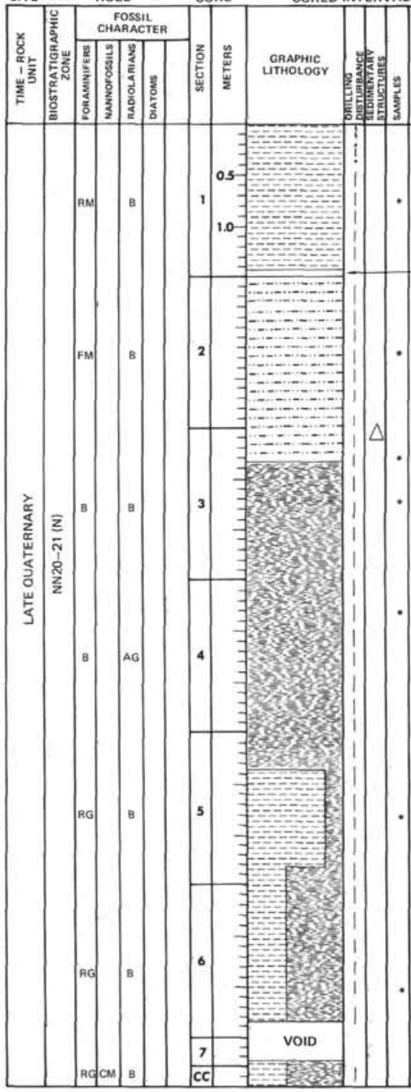
LITHOLOGIC DESCRIPTION

Olive gray (5Y 3/2) SILTY CLAY with SANDY SILT in the top of Section 3 and CLAY below Section 4. The sediments are strongly disturbed in Sections 1 and 2, become increasingly firm with depth in Sections 3 and 4 and are fissile in Section 5.

SMEAR SLIDE SUMMARY

	3-52	3-52 (M)	3-71	3-79	5-44
TEXTURE:					
Sand	30	7	2	–	–
Silt	40	30	40	30	12
Clay	30	63	58	70	88
COMPOSITION:					
Quartz	50	5	5	5	–
Feldspar	13	15	18	10	–
Mica	2	1	–	–	1
Heavy minerals	TR	–	1	–	TR
Clay	20	63	58	70	88
Pyrite	–	4	5	–	–
Micronodules	–	–	2	3	1
Carbonate unspec.	–	–	TR	–	–
Foraminifers	5	5	1	–	–
Calc. nannofossils	10	7	10	12	10
Radiolarians	–	–	–	TR	–

SITE 482 HOLE B CORE 9 CORED INTERVAL 120.0–129.5 m



5Y 3/2

VOID

LITHOLOGIC DESCRIPTION

Section 1–Section 3, 35 cm: Firm olive gray CLAY and SILTY CLAY.

Section 3, 35 cm–Core-Catcher: Very stiff, olive gray SHALE mixed with CLAY below Section 5, 35 cm. Sediments display a petroliferous odor but no UV fluorescence. Presence of radiolarian and diatoms and absence of foraminifera and quartz sand in residue >44 μm indicates that sediments are eupelagic. Silty clay and clay to shale transitions marked by pronounced dehydration gradients are present in Sections 3 and 5.

SMEAR SLIDE SUMMARY

	1-75	2-75	3-30	3-75	4-35	5-80	6-105
TEXTURE:							
Sand	–	–	–	–	–	–	–
Silt	20	25	36	35	26	30	15
Clay	80	75	64	65	74	70	85
COMPOSITION:							
Quartz	5	15	20	15	1	15	5
Feldspar	5	5	10	10	–	5	–
Mica	–	–	–	–	–	TR	–
Heavy minerals	TR	–	2	TR	–	–	TR
Clay	80	75	64	65	74	70	85
Palagonite	3	3	–	2	–	–	1
Glauconite	–	–	–	–	TR	TR	TR
Pyrite	–	–	–	2	TR	TR	TR
Micronodules	1	1	1	–	1	–	–
Zeolite	–	–	–	–	–	–	TR
Carbonate unspec.	TR	–	–	–	–	2	TR
Foraminifers	–	–	TR	TR	TR	TR	TR
Calc. nannofossils	6	2	3	6	7	5	8
Diatoms	–	–	–	TR	10	TR	1
Radiolarians	–	–	–	–	6	–	TR
Sponge spicules	–	–	–	–	2	–	–
Silicoflagellates	–	–	–	–	TR	–	–
Fish remains	–	–	–	–	–	TR	–
Plant debris	–	–	–	–	–	TR	–

SITE 482 HOLE B CORE 10 CORED INTERVAL 129.5–137.0 m

TIME – ROCK UNIT	BIOSTRATIGRAPHIC ZONE	FORAMINIFERS	NANNOFOSSILS	RADIOLARIANS	DIATOMS	SECTION	METERS	GRAPHIC LITHOLOGY
LATE QUATERNARY	NN20–21 (N)	RG		RG		1	0.5, 1.0	
								VOID
		CG		FG		2		
		CG		RG		3		
		CG		B		4		
								VOID
		B		B		5		
		B		B		6		
			CM					
						7		
						CC		

LITHOLOGIC DESCRIPTION

VOID

5Y 3/2

Section 1–Section 4, 90 cm: Olive gray CLAY, strongly brecciated by drilling Sections 1 and 2 but relatively firm in Sections 3 and 4.

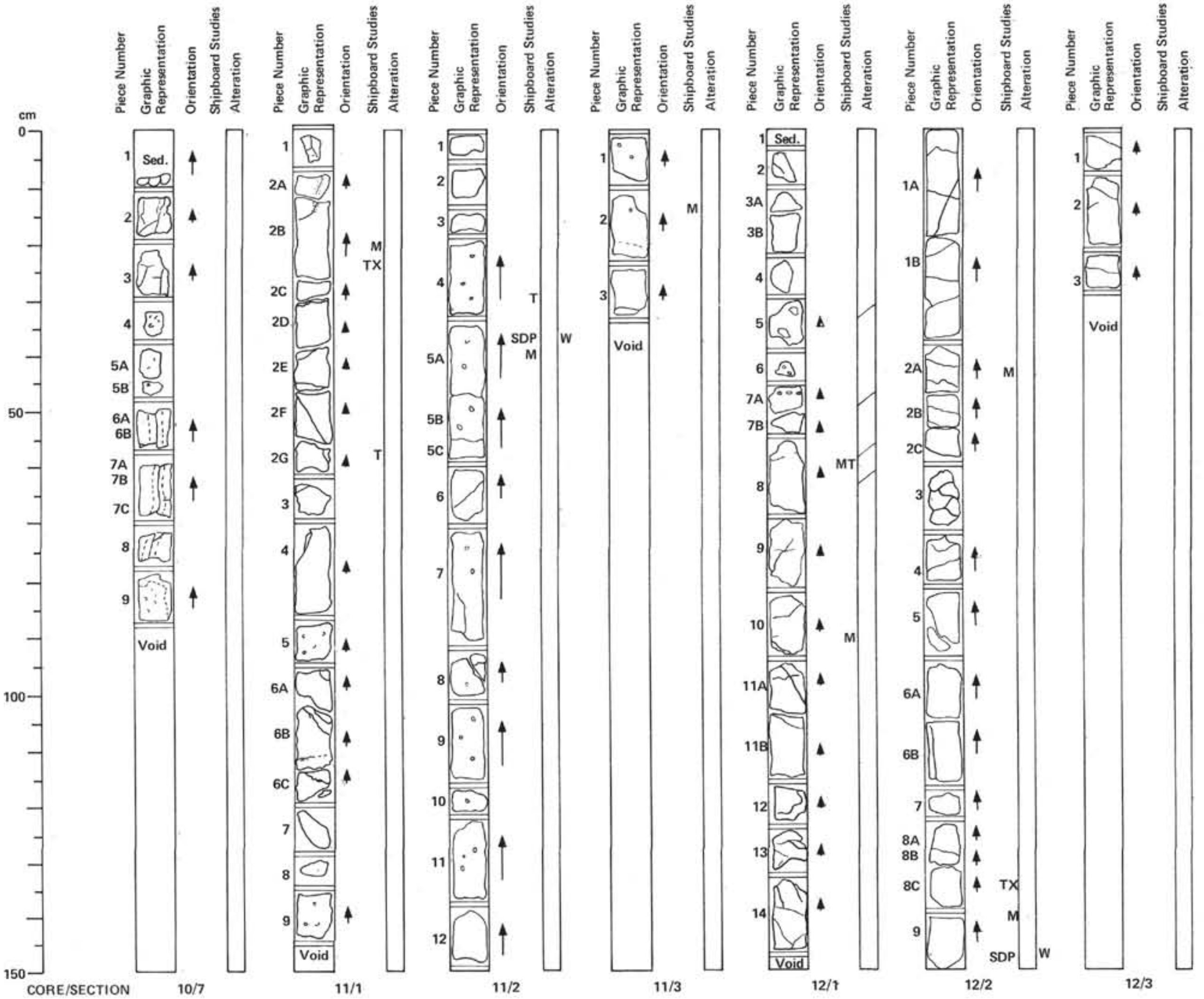
Section 4, 90 cm–Section 7, 5 cm: Firm, olive gray SHALE.

Section 7, 5 cm–Core-Catcher: BASALT.

SMEAR SLIDE SUMMARY

	1-120	3-92	4-114	5-22 (M)	5-58	5-100	5-129	6-20	6-81	6-144
TEXTURE:										
Sand	–	–	–	–	–	–	1	–	–	–
Silt	15	20	15	90	20	35	34	25	30	35
Clay	85	80	85	10	80	65	65	75	70	65
COMPOSITION:										
Quartz	3	8	1	2	10	10	20	8	8	10
Feldspar	1	3	1	1	4	7	4	3	2	5
Mica	TR	TR	TR	–	–	TR	1	–	–	TR
Heavy minerals	–	TR	1	–	–	1	1	–	TR	TR
Clay	85	80	85	10	80	65	65	75	70	65
Palagonite	–	TR	1	–	1	TR	–	1	1	–
Pyrite	TR	TR	1	2	2	5	–	5	6	6
Zeolite	–	–	–	–	–	3	2	1	1	1
Carbonate unspec.	TR	TR	TR	85	–	–	–	TR	TR	1
Foraminifers	TR	TR	–	–	–	TR	TR	–	TR	1
Calc. nannofossils	6	6	10	–	2	12	7	7	12	10
Diatoms	3	–	TR	–	–	–	TR	–	TR	1
Radiolarians	2	–	–	–	–	–	–	–	–	–
Sponge spicules	–	–	TR	–	–	–	–	–	–	–
Fish remains	TR	–	–	–	–	–	–	–	–	–
Plant debris	–	–	–	–	TR	–	–	–	–	–

VOID



HOLE 482B, CORE 10

Visual Description

Dark gray, generally aphyric, massive basalt; color becomes lighter and grain size larger toward base of core. Plagioclase phenocrysts 1–2%, 1–2 mm in upper 20 cm, absent elsewhere. Groundmass aphanitic to fine-grained. Vesicles <1%, 0.5–8 mm, round to irregular, filled with carbonate, zeolite(?) and smectite. Veinlets occur in some pieces, 0.5–1.5 mm wide, filled with carbonate and pyrite, bordered by alteration halos 1.5–10 mm wide. Minor disseminated pyrite in groundmass, particularly in alteration halos.

Thin Section Description

Location: Section 7, 14–16 cm

Texture: Aphyric, fine-grained, intersetal to quench; abrupt change in grain size in slide.

Groundmass: Olivine 1%, 0.05–0.1 mm, subhedral, altered to smectite; plagioclase 5%, 0.2–1 mm, subhedral laths, fresh; augite 1–2%, 0.1–0.4 mm, subhedral to anhedral, sometimes intergrown with plagioclase, fresh; magnetite 3–4%, minute granules; interstitial material 85–90%, cryptocrystalline.

Vesicles: 1%, 0.05–0.25 mm, round, filled with brown smectite.

Veins and Fractures: Veins 1–2 mm wide, filled with smectite, carbonate, and pyrite; surrounded by narrow alteration halos.

Alteration: Olivine completely altered to smectite; augite and plagioclase partly altered; interstitial material mostly fresh.

HOLE 482B, CORE 11

Visual Description

Medium to dark gray, aphyric, massive basalt. Groundmass fine- to medium-grained. Vesicles 1–3%, 0.5–3 mm, round, filled with smectite, carbonate and minor zeolite(?). Veinlets scattered irregularly throughout, 0.5–1 mm wide, filled with carbonate, smectite and minor pyrite. Minor pyrite disseminated in groundmass.

Thin Section Description

Location: Section 1, 23–25 cm

Texture: Aphyric, fine-grained, intergranular

Groundmass: Olivine 1–2%, <0.3 mm, subhedral, altered to smectite; plagioclase 55%, 0.2–0.5 mm, euhedral to subhedral laths, fresh; augite 40%, 0.2–0.4 mm, anhedral, fresh; magnetite 3%, 0.01–0.05 mm, subhedral.

Vesicles: 1–2%, 1–2 mm, round, filled with smectite and calcite.

Alteration: Olivine completely altered to smectite or calcite; some small interstitial patches of smectite probably represent altered interstitial material.

Location: Section 1, 56–59 cm

Texture: Aphyric, fine-grained, intersertal to intergranular

Groundmass: Olivine 3–5%, 0.3 mm, subhedral, replaced with smectite; plagioclase 45%, 0.2–0.5 mm, euhedral to subhedral laths, fresh; augite 35%, 0.2–0.4 mm, anhedral, $2V_z$ ~45°, fresh; magnetite 2–3%, 0.05–0.2 mm, euhedral to subhedral; interstitial material 10–12%, irregularly distributed, partly replaced by smectite.

Vesicles: 2%, 1–2 mm, round, filled with brown smectite and minor calcite.

Veins and Fractures: 1–2 mm wide, filled with calcite with minor smectite and pyrite.

Alteration: Olivine and most interstitial material replaced by yellowish-brown smectite.

Location: Section 2, 35–37 cm

Texture: Aphyric, fine-grained, intersertal to intergranular.

Groundmass: Olivine 2–3%, 0.3 mm, subhedral, replaced by smectite; plagioclase 45%, 0.2–0.5 mm, anhedral to subhedral laths; augite 40%, 0.2–0.4 mm, anhedral, $2V_z$ ~45°, fresh; magnetite 2–3%, 0.01–0.05 mm, subhedral; interstitial material 10%, cryptocrystalline.

Vesicles: 1–3%, 1–3 mm, round, filled with brown smectite, minor carbonate and traces of silica(?).

Alteration: Olivine replaced by brown smectite and calcite; interstitial material partly replaced by brown smectite.

HOLE 482B, CORE 12

Visual Description

Section 1, 0–5 cm: Olive gray, indurated, silty clay with uniform grain size; no baking or alteration.

Section 1, 5 cm–base of core: Medium to dark gray, aphyric, massive basalt. Single plagioclase phenocryst, 2.5 mm long, euhedral. Groundmass fine-grained, fresh. Vesicles generally <1%, 0.2–2 mm, round, filled with carbonate, smectite and minor pyrite; large vesicles up to 2 cm occur in Section 1, 40–50 cm. Veins scattered irregularly through core, generally <1 mm, filled with carbonate and minor pyrite. Some irregular patches of smectite and pyrite occur in Section 1.

Thin Section Description

Location: Section 1, 60–62 cm

Texture: Aphyric, fine-grained, intersertal to intergranular.

Groundmass: Olivine 3–5%, <0.3 mm, subhedral to euhedral, replaced by smectite; plagioclase 35%, 0.1–0.6 mm, subhedral laths, fresh; augite 45%, 0.2–0.4 mm, anhedral, $2V_z$ ~45°, some subophitic patches, fresh; magnetite 3–4%, 0.05–0.2 mm, granular to acicular, mostly in interstitial patches; interstitial material 10–15%, cryptocrystalline.

Vesicles: <1%, <1 mm, round, filled with brown smectite and minor calcite.

Alteration: Olivine and some interstitial material replaced by brown smectite.

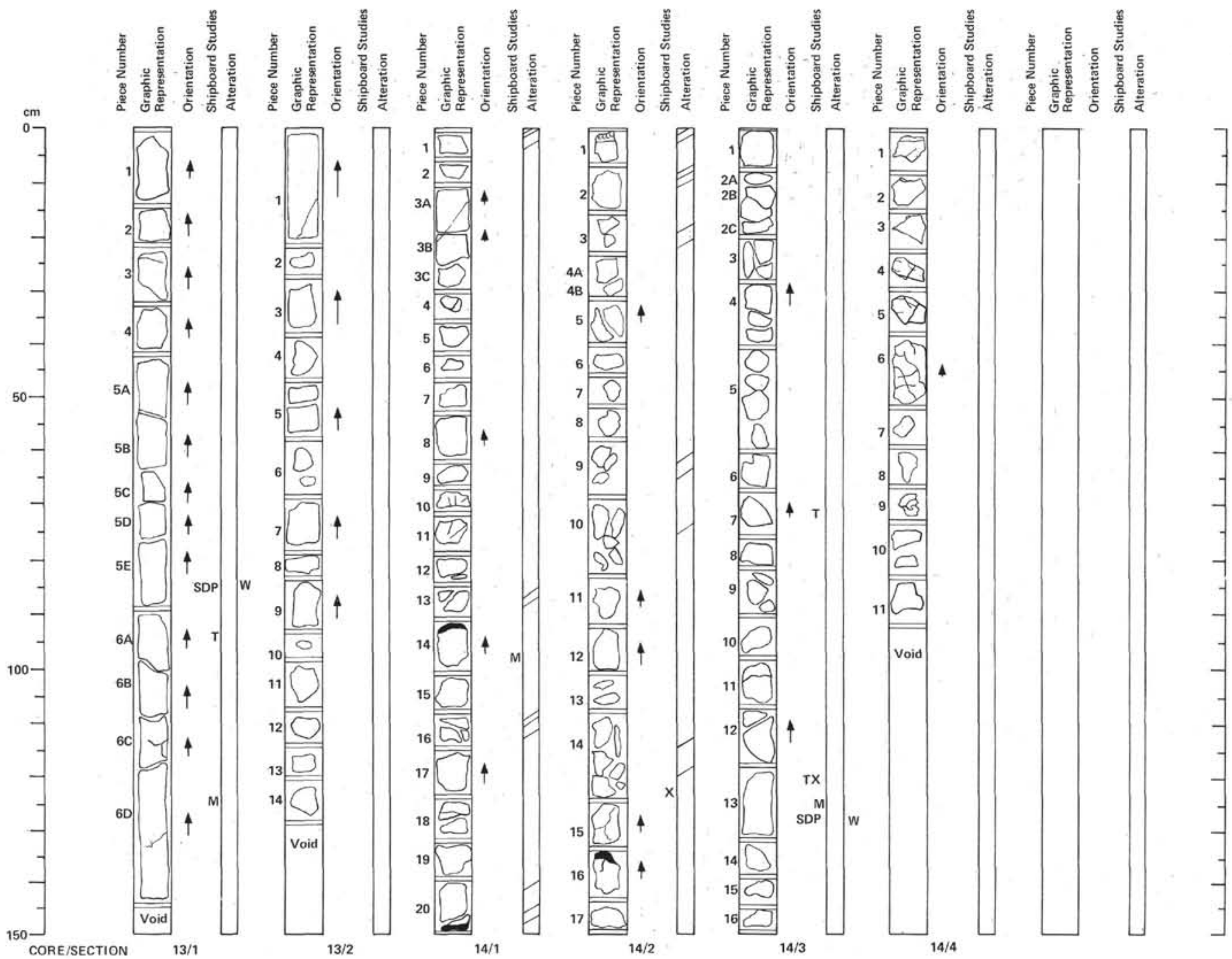
Location: Section 2, 135–137 cm

Texture: Aphyric, fine-grained, intergranular to intersertal.

Groundmass: Olivine 3–4%, 0.2–0.3 mm, subhedral to euhedral; plagioclase 45%, 0.2–1.5 mm, subhedral laths, fresh; augite 35%, 0.1–0.5 mm, $2V_z$ ~45°, anhedral, fresh; magnetite 3–4%, 0.05–0.1 mm, square to acicular, mostly in interstitial patches; interstitial material 10–12%, cryptocrystalline, partly replaced by smectite.

Vesicles: <1%, <0.2 mm, round, filled with brown smectite and minor carbonate.

Alteration: Olivine and some interstitial material replaced by dark brown smectite.



HOLE 482B, CORE 13

Visual Description

Medium gray, aphyric, massive basalt. Groundmass fine-grained, equigranular, very fresh. Very fine-grained cooling unit boundary occurs in Section 2, 40 cm. Vesicles <1%, ≤0.5 mm, spherical, filled with carbonate and smectite. Sparse veinlets 1 mm wide, filled with carbonate and minor pyrite. Minor pyrite disseminated in groundmass.

Thin Section Description

Location: Section 1, 93–95 cm

Texture: Aphyric, fine-grained, intergranular to intersertal.

Phenocrysts: Plagioclase trace, 1–2 mm, subhedral, slightly corroded.

Groundmass: Olivine 3–4%, 0.1–0.3 mm, subhedral; plagioclase 45%, 0.2–1.5 mm, subhedral laths, fresh; augite 35%, 0.1–0.5 mm, anhedral, $2V_z$ ~45°; magnetite 5%, 0.05–0.2 mm, square to lath-shaped cyrstals, mostly in interstitial patches; interstitial material 10–12%, cryptocrystalline, partly altered to smectite.

Vesicles: 1%, 0.5 mm, rimmed with brown smectite and filled with carbonate.

Alteration: Olivine completely altered to brown smectite; interstitial material partly altered.

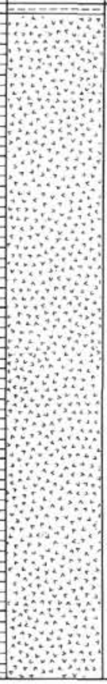
HOLE 482B, CORE 14

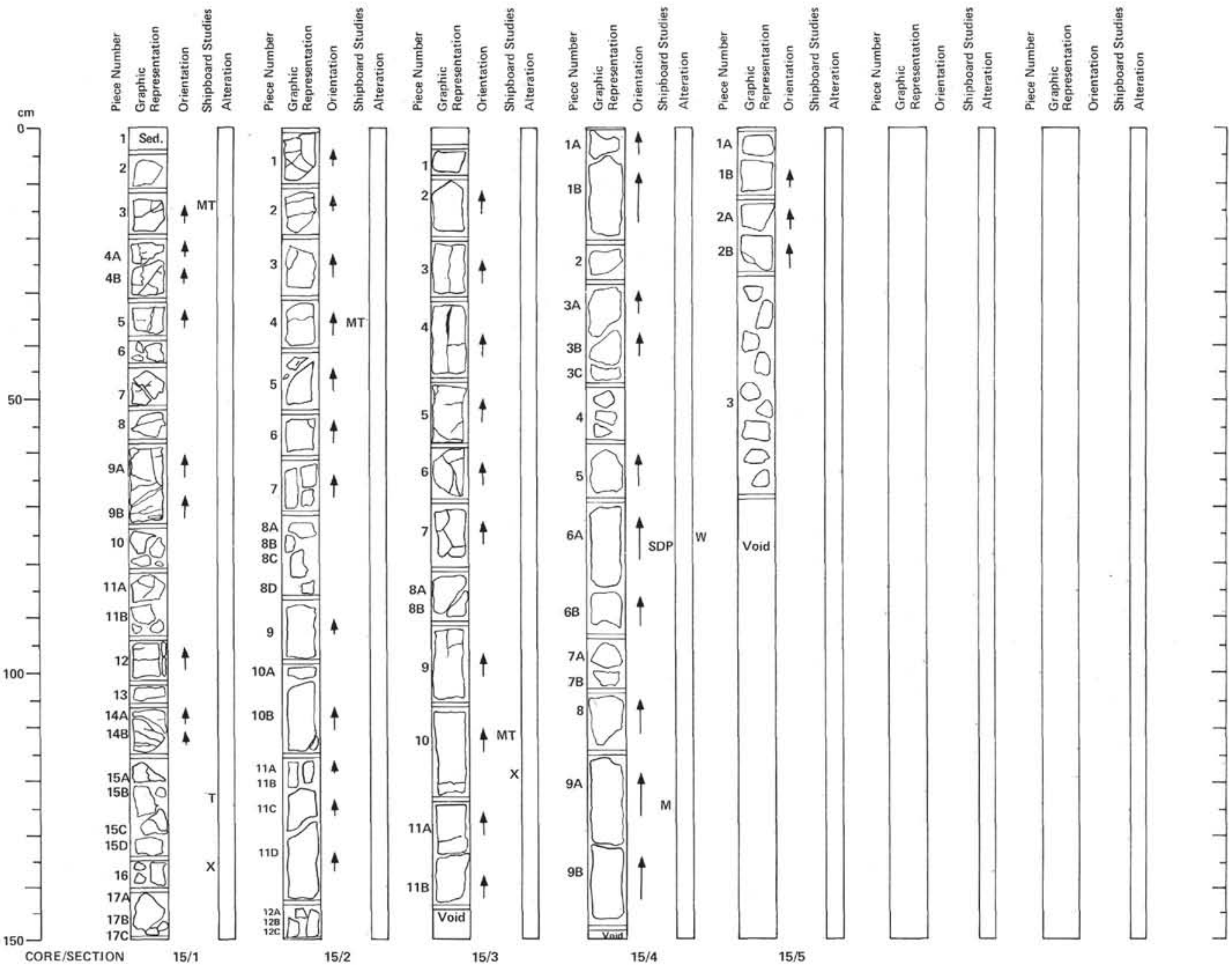
Visual Description

Section 1, 0–90 cm: Medium gray, generally aphyric, massive basalt. Sparse glomerophyric clusters of plagioclase and clinopyroxene 2–5 mm across occur between 55 and 90 cm. Groundmass fine to medium-grained; color becomes darker and grain size smaller between 50 and 90 cm. Vesicles absent, small vug at 4 cm, filled with pyrite. Groundmass generally fresh, minor smectite at 89 cm.

Section 1, 90 cm–base of core: Medium to dark gray or greenish-gray, aphyric basalt. Groundmass fine-grained to glassy; glass selvedges occur at 92 cm in Section 1 and at 2 cm and 134 cm in Section 2; acicular plagioclase crystals ≤1 mm often visible in groundmass; some mottling in Section 3. Vesicles absent. Veinlets scattered throughout, 1–2 mm vein in Section 4, 70 cm filled with smectite.

SITE 482 HOLE B CORE 15 CORED INTERVAL 157.0–166.0 m

TIME – ROCK UNIT	BIOSTRATIGRAPHIC ZONE	FOSSIL CHARACTER: FORAMINIFERS	NANNOFOSSILS	RADIOLARIANS	DIATOMS	SECTION	METERS	GRAPHIC LITHOLOGY	DRILLING DISTURBANCE	SEDIMENTARY STRUCTURES	SAMPLES	LITHOLOGIC DESCRIPTION
LATE QUATERNARY						1	0.5 1.0					5Y 3/2 **Section 1, 0–4 cm:** Olive gray SILTY CLAY. **Section 1, 4 cm–Section 5, 67 cm:** BASALT (see separate petrographic description).
						2						
						3						
						4						
						5						



HOLE 482B, CORE 15

Visual Description

Section 1, 0–5 cm: Olive gray mudstone, probably fallen in from sedimentary section.

Section 1, 5–115 cm: Medium gray, aphyric, massive basalt. Groundmass medium- to fine-grained, generally fresh. Vesicles < 1%, ≤1 mm, spherical, filled with smectite and carbonate. Fractures and veinlets sparse, ≤ 1 mm wide, irregular, filled with blue-green smectite, carbonate and zeolite(?).

Section 1, 115–base of core: Light to medium gray, sparsely phyric, massive basalt. Plagioclase phenocrysts 1–3%, 1–5 mm, euhedral fresh. Groundmass medium-grained, somewhat finer-grained near top of unit, fresh. Vesicles ≤ 1%, < 2 mm, spherical, filled with dark green to bluish-green smectite. Fractures and veinlets sparse, 1–2 mm wide, coated or filled with smectite, carbonate, zeolite(?) and minor pyrite.

Thin Section Description

Location: Section 1, 15–17 cm

Texture: Aphyric, fine-grained, intersertal to quench.

Groundmass: Olivine 10–15%, 0.2–0.5 mm, subhedral to euhedral, $2V_z$ ~90°, partly altered to smectite; plagioclase, 45%, 0.2–0.8 mm, subhedral laths, fresh; augite 25–30%, 0.2–0.5 mm, poorly crystallized, radiating clusters, $2V_z$ ~50°; magnetite 7–8%, 0.05–0.1 mm, subhedral, mostly in interstitial patches; glassy mesostasis 5–7%, dark interstitial material, partly replaced by smectite.

Vesicles: <1%, 0.1–0.3 mm, round, filled with brown smectite.

Alteration: Olivine and interstitial material partly replaced by brown smectite.

Location: Section 1, 123–125 cm

Texture: Sparsely phyric, quench.

Phenocrysts: Plagioclase 5–6%, 0.5–2 mm, subhedral, strongly zoned, usually in glomerophyric clusters with augite; augite 2–3%, 0.2–0.5 mm, anhedral, usually intergrown with plagioclase, $2V_z$ ~ 45°

Groundmass: Olivine 2–3%, 0.1–0.3 mm, subhedral, altered to smectite; plagioclase 10–15%, 0.2–0.5 mm, acicular; magnetite 3–4%, minute granules; quench matrix 80–85%, incipiently crystallized to clinopyroxene, minor replacement by smectite.

Alteration: Olivine and minor matrix material replaced by yellowish-brown smectite.

Location: Section 2, 34–40 cm

Texture: Sparsely phyric, intersertal to quench

Phenocrysts: Plagioclase 3%, 0.5–2 mm, subhedral, sometimes in small glomerophyric clusters.

Groundmass: Olivine 5%, 0.2–0.5 mm, euhedral to subhedral, altered to smectite; plagioclase 40%, 0.2–0.5 mm, subhedral laths, fresh; augite 45–50%, ≤0.2 mm, usually in poorly crystallized sheaves; magnetite 3–5%, minute granules; glass 5%, mostly devitrified or replaced by smectite, in interstitial patches.

Vesicles: <1%, 0.3–0.5 mm, round, filled with brown smectite.

Alteration: Olivine and minor interstitial material replaced by smectite.

Location: Section 3, 115–117 cm

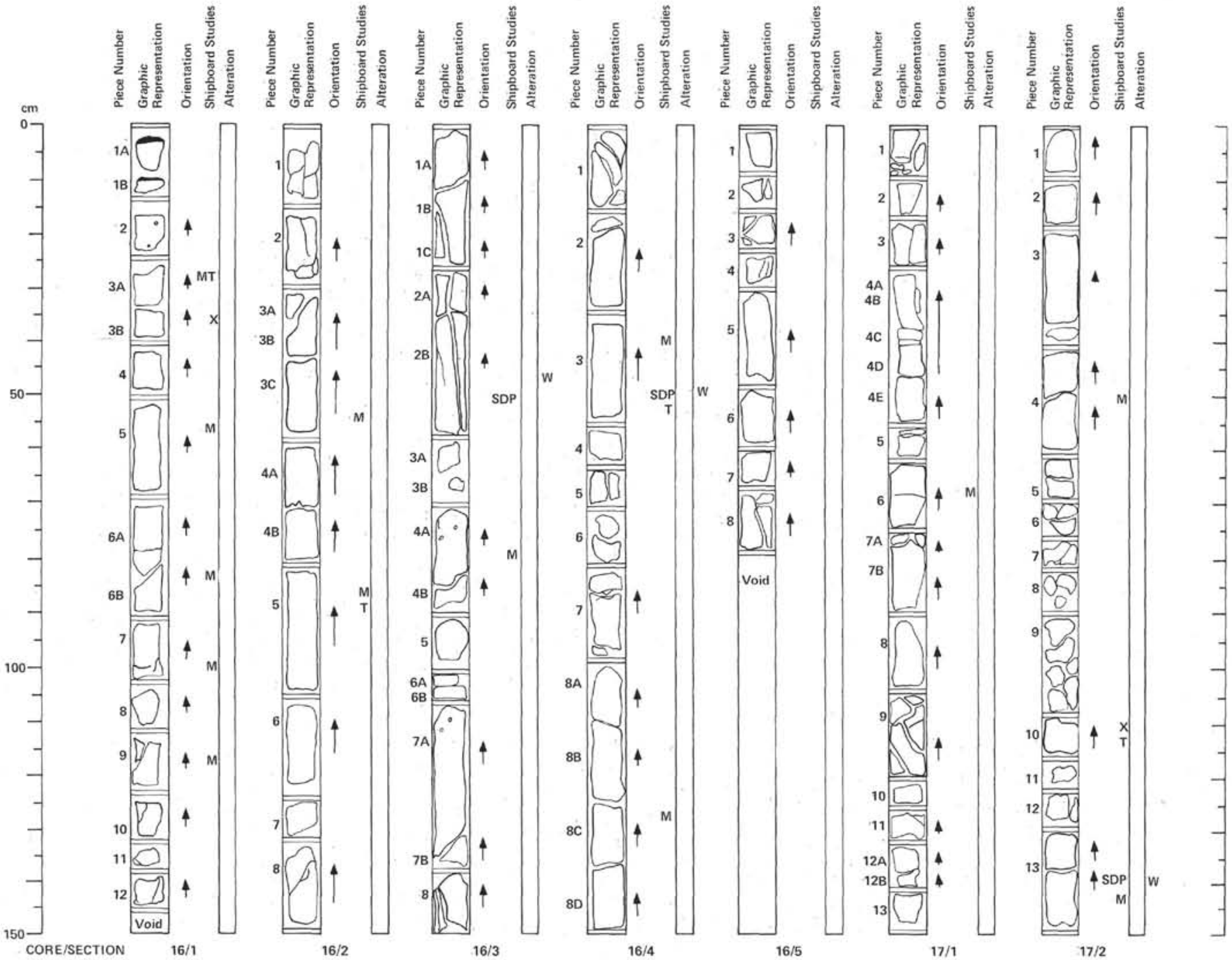
Texture: Sparsely phyric, medium-grained, intersertal to subophitic

Phenocrysts: 1–2%, 1–2 mm, subhedral laths, some clusters to 3 mm, fresh.

Groundmass: Olivine 5%, 0.2–0.6 mm, subhedral to euhedral, altered to smectite; plagioclase 55%, 0.3–1 mm, subhedral laths, fresh; clinopyroxene 30%, 0.3–0.5 mm, anhedral, fresh, $2V_z$ ~ 45°; interstitial material 5%, devitrified glass, partly replaced by smectite.

Vesicles: 1%, 0.2–0.5 mm, round, filled with brown smectite.

Alteration: Olivine and minor glass replaced by brown smectite.



HOLE 482B, CORE 16

Visual Description

Light to medium gray, sparsely phyric, massive basalt. Plagioclase phenocrysts 3–5%, 1–4 mm, euhedral, fresh; rare glomerocrysts of plagioclase and minor clinopyroxene(?), <5 mm. Groundmass medium-grained to glassy; glass selvedges in Section 1, 3 and 11 cm; glass partly altered to smectite, rock otherwise fresh, except for rare patches of smectite alteration. Vesicles 1–3%, < 1 mm, spherical, filled with smectite. Fractures and veinlets sparse, spherical, filled with smectite. Fractures and veinlets sparse, hairline to 1 mm, coated or filled with smectite and minor carbonate.

Thin Section Description

Location: Section 1, 27–30 cm

Texture: Very sparsely phyric, fine-grained, intersertal to intergranular.

Phenocrysts: Plagioclase 1%, 1–2 mm, subhedral, some glomerophyric clots to 3 mm.

Groundmass: Olivine 5%, 0.2–0.5 mm, euhedral to subhedral, altered to smectite; plagioclase 50%, 0.2–1 mm, subhedral laths, fresh; augite 30%, 0.1–0.3 mm, anhedral, fresh, $2V_z$ ~45°; magnetite 5%, 0.05–0.5 mm, subhedral crystals, some laths, mostly in interstitial areas; interstitial material 10%, cryptocrystalline, partly replaced by smectite.

Vesicles: 1%, 0.2–0.4 mm, round, filled with brown smectite.

Alteration: Olivine and some interstitial material replaced by brown smectite.

Location: Section 2, 88–91 cm

Texture: Very sparsely phyric, medium-grained, intergranular to subophitic.

Phenocrysts: Plagioclase 1%, 1–2 mm, subhedral laths, fresh, some glomerophyric clusters to 3 mm.

Groundmass: Olivine 5%, 0.4–0.8 mm, subhedral to euhedral, altered to smectite; plagioclase 60%, 0.5–1 mm, subhedral, fresh; augite 30%, 0.5–1 mm, fresh, $2V_z$ ~45°; magnetite 3–5%, 0.1–0.4 mm, subhedral, mostly in interstitial areas; interstitial material 1–2%, cryptocrystalline material with traces of quartz, partly altered to smectite.

Alteration: Olivine and minor interstitial material replaced by greenish-brown smectite.

Location: Section 4, 54–55 cm

Texture: Aphyric, medium-grained, intergranular to subophitic

Groundmass: Olivine 5%, 0.3–0.6 mm, subhedral, replaced by smectite; plagioclase 60%, 0.5–2 mm, subhedral laths, some strongly zoned, fresh; augite 30%, 0.5–1 mm, anhedral, fresh, $2V_z$ ~45°; magnetite 3–5%, 0.1–0.5 mm, subhedral; interstitial material 1–2%, cryptocrystalline with traces of quartz, mostly replaced by smectite.

Vesicles: <1%, 0.4–0.8 mm, round, filled with smectite.

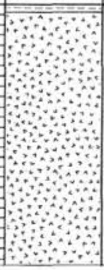
Alteration: Olivine replaced by greenish-brown smectite; interstitial material partly replaced by smectite and minor carbonate.

HOLE 482B, CORE 17

Visual Description

Light to medium gray, sparsely phyric, massive basalt. Plagioclase phenocrysts 1–3%, 1–4 mm, euhedral, fresh; rare glomerophyric clots of plagioclase and clinopyroxene(?) to 5 mm. Groundmass medium-grained, uniform, generally fresh. Vesicles < 1%, < 1 mm, spherical, filled with smectite. Fractures and veinlets sparse, < 1 mm, coated or filled with green smectite and minor carbonate.

SITE 482 HOLE B CORE 18 CORED INTERVAL 184.0–193.0 m

TIME – ROCK UNIT	BIOSTRATIGRAPHIC ZONE	FOSSIL CHARACTER: FORAMINIFERS	NANNOFOSSILS	RADIOLARIANS	DIATOMS	SECTION	METERS	GRAPHIC LITHOLOGY	DRILLING DISTURBANCE	SEDIMENTARY STRUCTURES	SAMPLES
LATE QUATERNARY	NN20–21 (N)		CG			1	0.5, 1.0				*
						2					

LITHOLOGIC DESCRIPTION

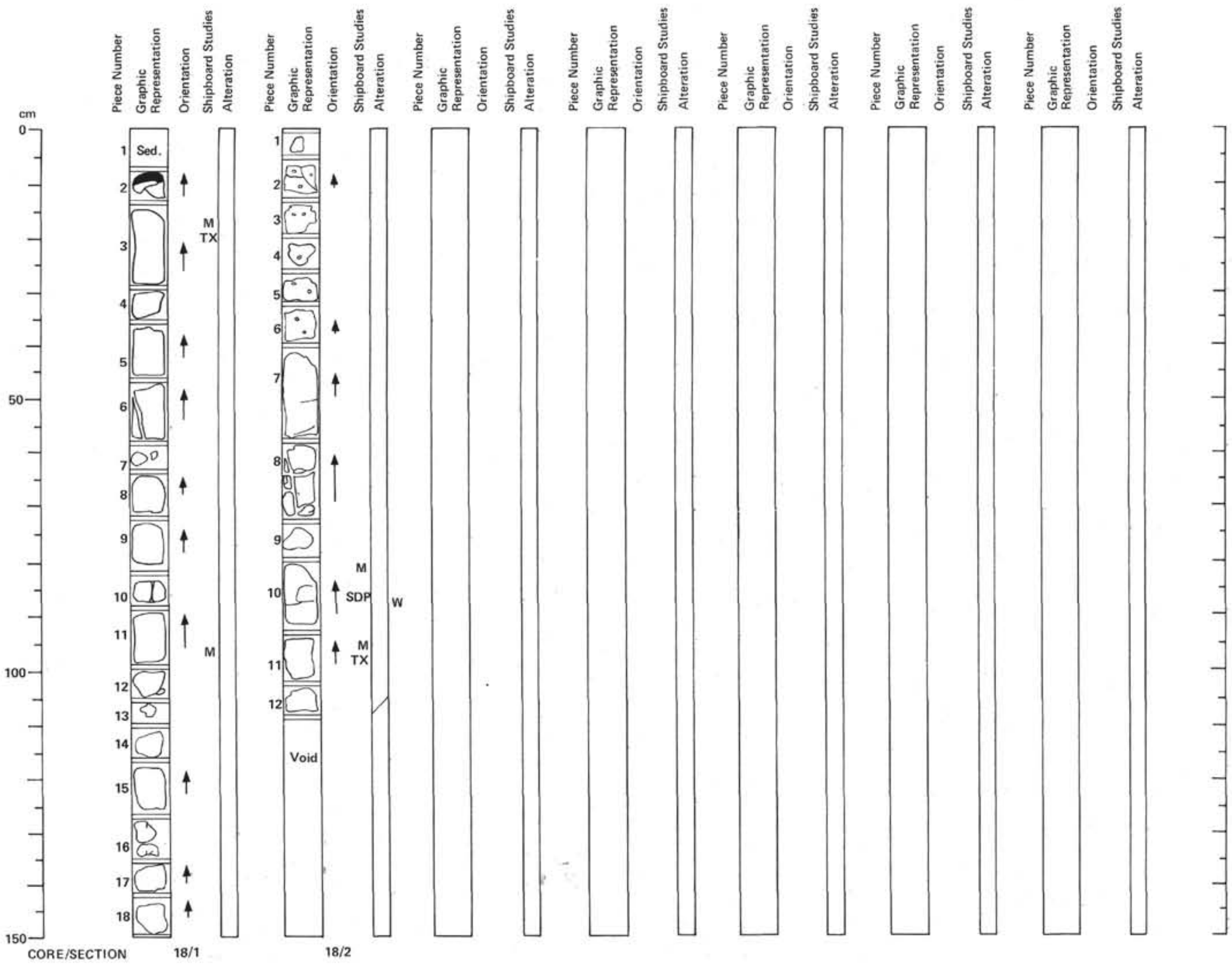
5Y 2/1

Section 1, 0–5 cm: Indurated (baked?) NANNOFOSSIL-bearing CLAY.

Section 1, 5 cm–Section 2, 108 cm: BASALT (see separate petrographic description).

SMEAR SLIDE SUMMARY

	1-4
TEXTURE:	
Sand	0
Silt	20
Clay	80
COMPOSITION:	
Quartz	3
Feldspar	2
Clay	80
Palagonite	TR
Pyrite	TR
Micronodules	TR
Carbonate unspec.	TR
Calc. nannofossils	15



HOLE 482B, CORE 18

Visual Description

Section 1, 0–8 cm: Yellowish-gray, indurated silty claystone.

Section 1, 8 cm–base of core: Medium to dark gray, sparsely phyric, massive basalt. Plagioclase phenocrysts 1–3%, 1–2 mm, euhedral, fresh. Groundmass medium-grained to glassy; glass selvedge in Section 1, 9 cm; grain size increases gradually downward from chilled margin; glassy margin partly altered to smectite and coated with pyrite, groundmass otherwise quite fresh. Vesicles 0.5–3%, most abundant in upper part of Section 2, 0.1–1.5 mm, spherical, filled with smectite. Veinlets sparse, <1 mm, filled with smectite and carbonate.

Thin Section Description

Location: Section 2, 99–101 cm

Texture: Very sparsely phyric, fine- to medium-grained, intergranular.

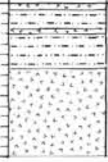
Phenocrysts: Plagioclase <1%; 1–2 mm, subhedral laths, fresh.

Groundmass: Olivine 2–3%, 0.2–0.3 mm, subhedral, replaced by smectite; plagioclase 50%, 0.2–0.6 mm, subhedral, fresh; augite 30%, 0.1–0.3 mm, anhedral, fresh, $2V_z$ ~45°; magnetite 3%, 0.05–0.1 mm, skeletal crystals; interstitial material 10–12%, replaced by brownish-green smectite.

Vesicles: <1%, 0.3–0.5 mm, round, filled with smectite.

Alteration: Olivine and interstitial material replaced by greenish-brown smectite.

SITE 482 HOLE B CORE 19 CORED INTERVAL 193.0–197.5 m

TIME – ROCK UNIT	BIOSTRATIGRAPHIC ZONE	FORAMINIFERS	NANNOFOSSILS	RADIOLARIANS	DIATOMS	SECTION	METERS	GRAPHIC LITHOLOGY	DRILLING DISTURBANCE	SEDIMENTARY STRUCTURES	SAMPLES
LATE QUATERNARY	NN20–21 (N)	CG	CG / RG	B		1	0.5 / 1.0				

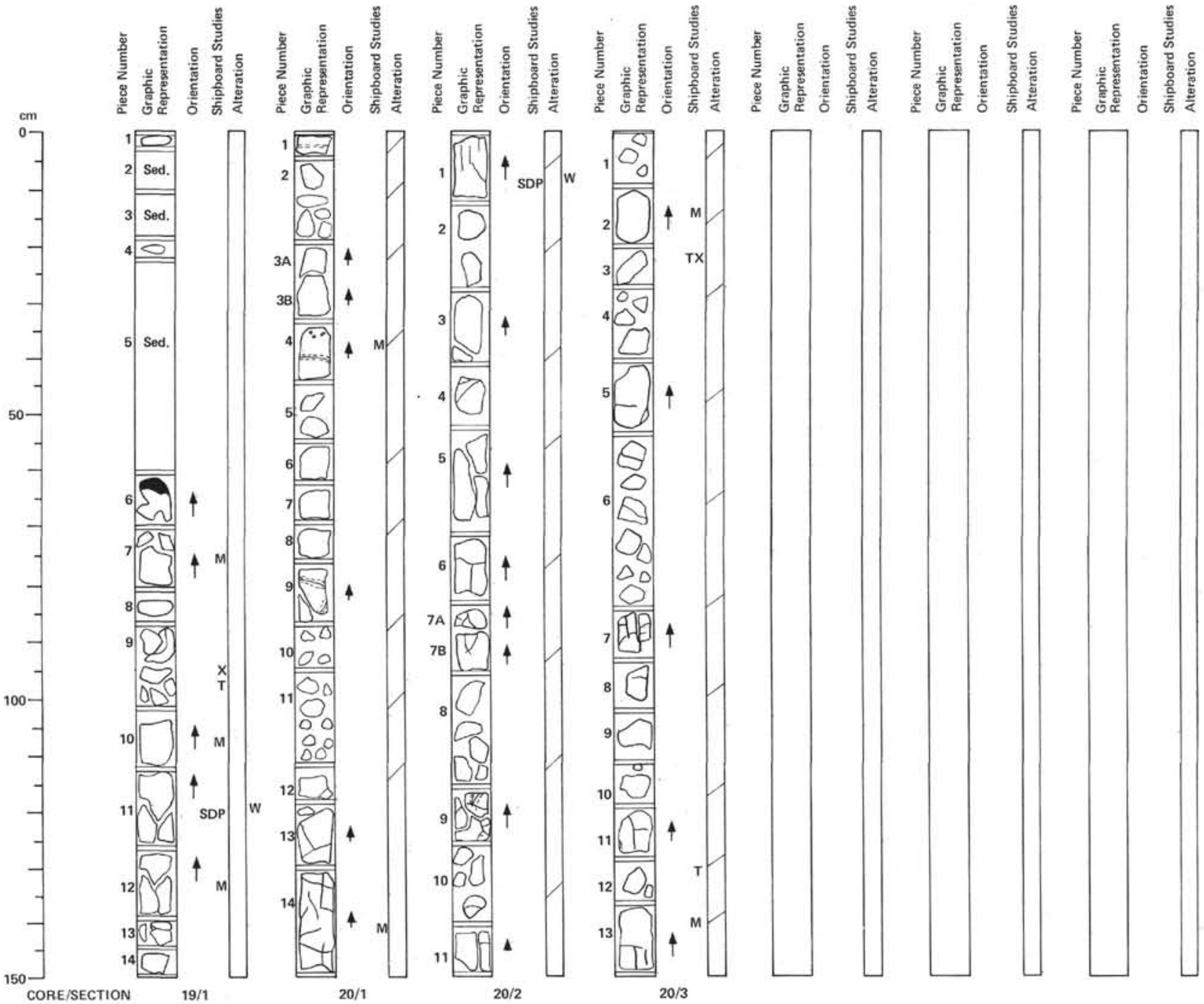
LITHOLOGIC DESCRIPTION

5Y 3/2
N1, N2
5Y 3/2
5YR 2/1

Section 1, 2–3 cm: BASALT.
Section 1, 5–10 cm: Very firm to hard olive gray (5Y 3/2) SILTY CLAY.
Section 1, 10–22 cm: Firm (baked?), grayish black (N2) to black (N1) MUDSTONE displaying conchoidal fractures.
Section 1, 22–25 cm: BASALT.
Section 1, 25–61 cm: Firm olive gray (5Y 3/2) MUDSTONE with a thin (3 cm) brownish black (5YR 2/1) baked(?) layer overlying basalt.
Section 1, 61–150 cm: BASALT (see separate petrographic description).

SMEAR SLIDE SUMMARY

	1-10	1-15	1-34	1-50	1-60
TEXTURE:					
Sand	–	–	–	–	TR
Silt	30	30	35	30	40
Clay	70	70	63	70	60
COMPOSITION:					
Quartz	20	10	20	10	25
Feldspar	10	7	9	–	10
Mica	–	–	–	TR	–
Heavy minerals	TR	TR	TR	TR	–
Clay	70	70	63	70	60
Palagonite	–	–	–	3	–
Pyrite	–	TR	1	1	–
Micronodules	TR	TR	1	1	–
Zeolite	–	10	1	5	15
Carbonate unspec.	TR	TR	–	–	–
Foraminifers	TR	–	–	–	–
Calc. nannofossils*	1	–	5	10	–



HOLE 482B, CORE 19

Visual Description

Section 1, 0–5 cm: Dark gray, glassy, aphyric basalt; probably a piece that has fallen into the hole.

Section 1, 5–60 cm: Olive gray to grayish-black, very firm mudstone and silty mudstone, probably baked. Small basalt fragment at 20–23 cm.

Section 1, 60 cm–base of core: Dark gray, sparsely phyric, massive basalt. Plagioclase phenocrysts 3–5%, 1–3 mm, euhedral, fresh. Groundmass fine-grained to glassy; glass selvedge at 60 cm, Section 1, with grain size increasing gradually toward lower parts of core; glass selvedge partly altered to smectite, groundmass otherwise quite fresh. Vesicles absent. Veinlets sparse, <0.5 mm, most filled with carbonate, those in glass selvedge coated with pyrite.

Thin Section Description

Location: Section 1, 96–100 cm

Texture: Aphyric, fine-grained, intersertal.

Groundmass: Plagioclase 50%, 0.1–2 mm, subhedral laths, partly replaced by smectite; augite 20%, 0.2–0.4 mm, anhedral, $2V_z \sim 45°$, partly replaced by smectite; interstitial material 25%, mostly glassy, mostly replaced by smectite, minor interstitial quartz and apatite.

Alteration: Extensive replacement of plagioclase, augite and interstitial material by greenish-brown smectite.

HOLE 482B, CORE 20

Visual Description

Medium to dark gray, fine- to medium-grained, very sparsely phyric, massive basalt. Plagioclase phenocrysts 1–2%, 2–5 mm, euhedral, fresh; some glomerocrysts of plagioclase to 5 mm. Groundmass mostly medium-grained, fine-grained zones probably mark cooling unit boundaries; groundmass often mottled, possibly due to alteration of interstitial glass. Vesicles 1–2%, <1 mm, filled with dark green smectite. Fractures abundant in some pieces, hairline to 1 mm, lined with smectite, pyrite and rare carbonate, often slickensided.

Thin Section Description

Location: Section 1, 62–64 cm

Texture: Sparsely phyric, very fine-grained, intersertal to quench.

Phenocrysts: Plagioclase 1–2%, 1–3 mm, subhedral, highly zoned, some glomerophyric clots, fresh.

Groundmass: Olivine 2%, 0.3–1 mm, subhedral, replaced by smectite; plagioclase 25%, 0.5–0.8 mm, subhedral laths, fresh; augite 20%, 0.2–0.5 mm, anhedral, fresh, intergrown with plagioclase; magnetite 2%, minute granules in matrix; cryptocrystalline mesostasis 50%, poorly crystallized clinopyroxene, mostly fresh.

Vesicles: <1%, 0.2–0.3 mm, round, filled with smectite and carbonate.

Veins and Fractures: 1 hairline fracture, filled with smectite and pyrite.

Alteration: Olivine replaced by brown smectite.

Location: Section 3, 25–26 cm

Texture: Very sparsely phyric, fine-grained, intersertal to intergranular.

Phenocrysts: Plagioclase 1%, 1–4 mm, subhedral, highly zoned, fresh.

Groundmass: *Olivine 3–5%, 0.2–0.8 mm*, subhedral, *replaced by smectite*; plagioclase 60%, 0.5–1 mm, subhedral laths, slight replacement by smectite; augite 20%, 0.2–0.8 mm, anhedral, $2V_z \sim 45°$, slightly altered to smectite; magnetite 5%, 0.05–0.2 mm, subhedral, some laths, mostly in interstitial patches; cryptocrystalline mesostasis 10%, partly replaced by smectite.

Alteration: Olivine and some interstitial material replaced by greenish-brown smectite.

Location: Section 3, 135–136 cm

Texture: Sparsely to moderately phyric, quench.

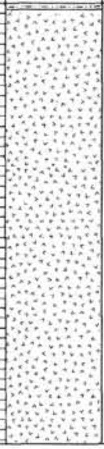
Phenocrysts: Olivine <1%, 1.0–1.5 mm, euhedral to subhedral, replaced by smectite; plagioclase 3–5%, 1-% mm, subhedral, some glomerophyric clots with augite; augite 1%, 0.3–0.5 mm, anhedral, intergrown with plagioclase.

Groundmass: Olivine 3%, 0.1–0.4 mm, euhedral to subhedral, replaced by smectite; plagioclase 10%, 0.1–0.5 mm, euhedral to skeletal, fresh; augite 10%, 0.2–0.5 mm, euhedral, intergrown with plagioclase; magnetite 1–2%, minute granules, in interstitial patches; microcrystalline mesostasis 75%, poorly crystallized clinopyroxene in radiating sheaves.

Vesicles: 1–2%, 0.2–0.8 mm, round to irregular, filled with smectite and minor calcite.

Alteration: Olivine and very minor matrix material replaced by yellowish-brown smectite.

SITE 482 HOLE B CORE 21 CORED INTERVAL 202.0–211.0 m

TIME-ROCK UNIT	BIOSTRATIGRAPHIC ZONE	FOSSIL CHARACTER: FORAMINIFERS	NANNOFOSSILS	RADIOLARIANS	DIATOMS	SECTION	METERS	GRAPHIC LITHOLOGY	DRILLING DISTURBANCE	SEDIMENTARY STRUCTURES	SAMPLES
LATE QUATERNARY			B			1	0.5, 1.0				*
						2					
						3					

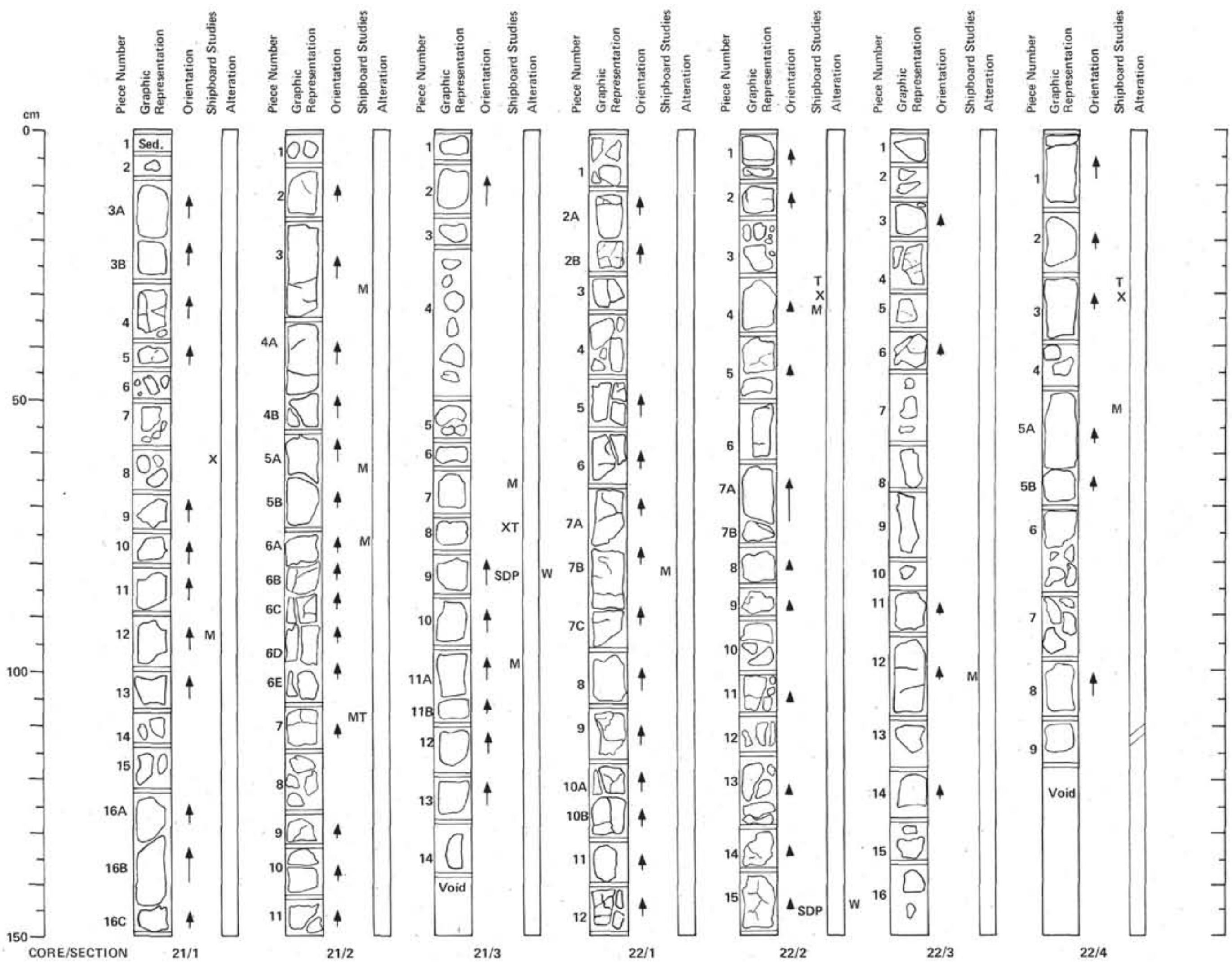
LITHOLOGIC DESCRIPTION

5Y 2/1

Section 1, 0–5 cm: Firm, olive black SILTY CLAY.
Section 1, 5 cm–Section 3, 137 cm: BASALT.

SMEAR SLIDE SUMMARY

	1-2
TEXTURE:	
Sand	–
Silt	25
Clay	75
COMPOSITION:	
Quartz	20
Feldspar	5
Mica	TR
Clay	75
Carbonate unspec.	TR
Calc. nannofossils	TR



HOLE 482B, CORE 21

Visual Description

Section 1, 0–5 cm: Olive black, silty clay, firm.

Section 1, 0 cm–Section 3, 50 cm: Medium gray, sparsely phyric, massive basalt. Plagioclase phenocrysts 1–2%, 2–5 mm, euhedral, fresh. Groundmass fine- to medium-grained, finest-grained in Section 1, fresh. Vesicles 1–3%, most abundant in Section 2, < 0.5 mm, round to irregular, filled with green smectite. Fractures and veinlets common, hairline to 2 mm, lined and filled with smectite, carbonate, and pyrite with minor silica(?).

Section 3, 50 cm–base of core: Dark gray, sparsely to moderately phyric, massive basalt. Plagioclase phenocrysts 3–8%, 1–4 mm, euhedral, fresh; clinopyroxene phenocrysts <1%, 1–2 mm, subhedral, fresh. Groundmass fine- to very fine-grained, increasing in grain size downward, fresh. Vesicles <1%, 0.5 mm, spherical, filled with dark green smectite. Fractures sparse, hairline to 1 mm, lined with smectite.

Thin Section Description

Location: Section 2, 113–114 cm

Texture: Sparsely phyric, medium-grained, intergranular to intersertal.

Phenocrysts: Olivine < 1%, <2.5 mm, euhedral, replaced by smectite and carbonate; plagioclase 1–2%, 2–4 mm, subhedral, zoned, fresh; augite <1%, 1–1.5 mm, anhedral, fresh, $2V_z$ –45°.

Groundmass: *Olivine 1–2%, 0.2–0.3 mm, subhedral, replaced by smectite*; plagioclase 55%, 0.5–1 mm, subhedral, fresh; augite 35%, 0.5–1 mm, anhedral, fresh; magnetite 5%, 0.1–0.4 mm, subhedral to anhedral; cryptocrystalline mesostasis 5%.

Alteration: Olivine replaced by brown smectite and carbonate; interstitial material mostly fresh, minor replacement by smectite.

Location: Section 3, 76–77 cm

Texture: Moderately phyric, medium-grained, intergranular to intersertal

Phenocrysts: Olivine 1%, 1–1.5 mm, subhedral, replaced by smectite and calcite; plagioclase 5–8%, 1–4 mm, subhedral, often in glomerophyric clusters, fresh; augite <1%, 1–2 mm, anhedral, often in clusters, fresh.

Groundmass: Olivine 3%, 0.2–0.5 mm; euhedral to subhedral, replaced by smectite and carbonate; plagioclase 55%, 0.1–1 mm, subhedral, fresh; augite 20%, 0.2–0.5 mm, anhedral, fresh, $2V_z$ ~45°; magnetite 5%, 0.05–0.1 mm, subhedral; cryptocrystalline mesostasis 5%, slightly altered to smectite.

Vesicles: < 1%, 0.4–0.8 mm, round, filled with smectite and minor carbonate.

Alteration: Olivine and minor interstitial material replaced by brown smectite.

HOLE 482B, CORE 22

Visual Description

Medium gray, sparsely to moderately phyric, massive basalt. Plagioclase phenocrysts 5–10%, 1–5 mm, euhedral, fresh; clinopyroxene phenocrysts <1%, 1–2 mm, green, anhedral, fresh, often intergrown with plagioclase in glomerophyric clusters; olivine microphenocrysts 1–2%, < 1 mm, anhedral, slightly altered to smectite, usually in localized patches. Groundmass fine- to medium-grained, coarsest-grained in middle part of core, fresh. Vesicles 1–2%, 0.2–0.4 mm, spherical, filled with smectite. Fractures sparse, mostly hairline, coated with green smectite, carbonate, minor pyrite and minor silica(?), sometimes slickensided.

Thin Section Description

Location: Section 2, 32–34 cm

Texture: Moderately phyric, fine-grined, intergranular to intersertal.

Phenocrysts: Plagioclase 5–8%, 1–2 mm, subhedral, some glomerophyric clots to 3 mm.

Groundmass: Olivine 3–5%, 0.2–0.4 mm, subhedral, replaced by smectite; plagioclase 50%, 0.2–1 mm, subhedral, fresh; augite 30%, 0.2–0.4 mm, fresh, $2V_z$ ~45°; magnetite 3–5%, 0.05–0.2 mm, subhedral; cryptocrystalline mesostasis 5%, partly replaced by smectite.

Vesicles: <1%, <0.5 mm, round, filled with smectite.

Alteration: Olivine and some interstitial *material replaced by smectite.*

Location: Section 4, 34–36 cm

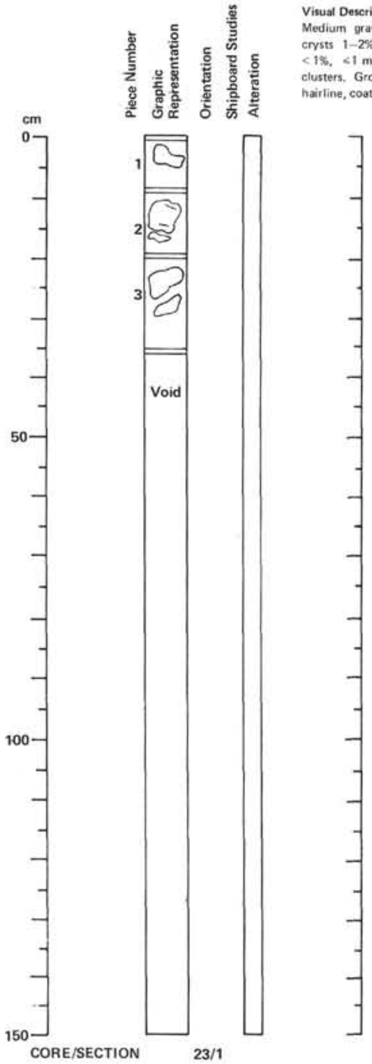
Texture: Moderately phyric, fine-grained, intergranular to intersertal

Phenocrysts: Olivine 1–2%, 1–4.5 mm; euhedral; mostly replaced by smectite; plagioclase 7%, 1–4 mm, subhedral, fresh, often in glomerophyric clusters; augite 1%, 1–3 mm, subhedral, fresh, $2V_z$ ~45°.

Groundmass: Olivine 3–5%, 0.2–0.8 mm, subhedral; replaced by smectite; plagioclase 50%, 0.2–1 mm, subhedral, fresh; augite 25%, 0.2–0.6 mm, anhedral, fresh, $2V_z$ ~45°; magnetite 2–3%, 0.05–0.1 mm, anhedral, some laths; cryptocrystalline mesostasis 5–8%, partly altered to smectite.

Vesicles: 1%, 0.2–0.4 mm, round, filled with smectite.

Alteration: Most olivine and most interstitial material altered to brown smectite.

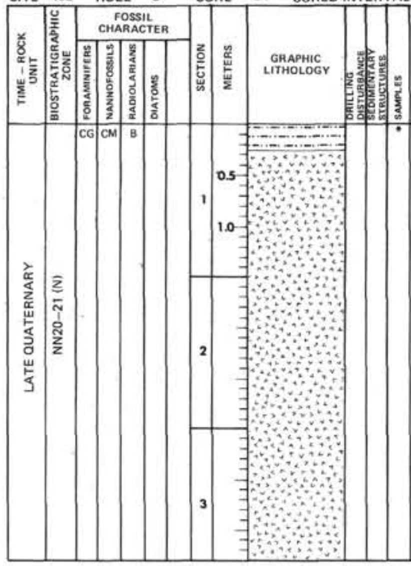


HOLE 482B, CORE 23

Visual Description

Medium gray, sparsely phyric, massive(?) basalt. Plagioclase phenocrysts 1–2%, 1–2 mm, euhedral, fresh; clinopyroxene phenocrysts < 1%, <1 mm, anhedral, intergrown with plagioclase in glomerophyric clusters. Groundmass fine-grained, uniform, fresh. Fractures sparse, hairline, coated with smectite.

SITE 482 HOLE B CORE 24 CORED INTERVAL 224.5–229.0 m



LITHOLOGIC DESCRIPTION

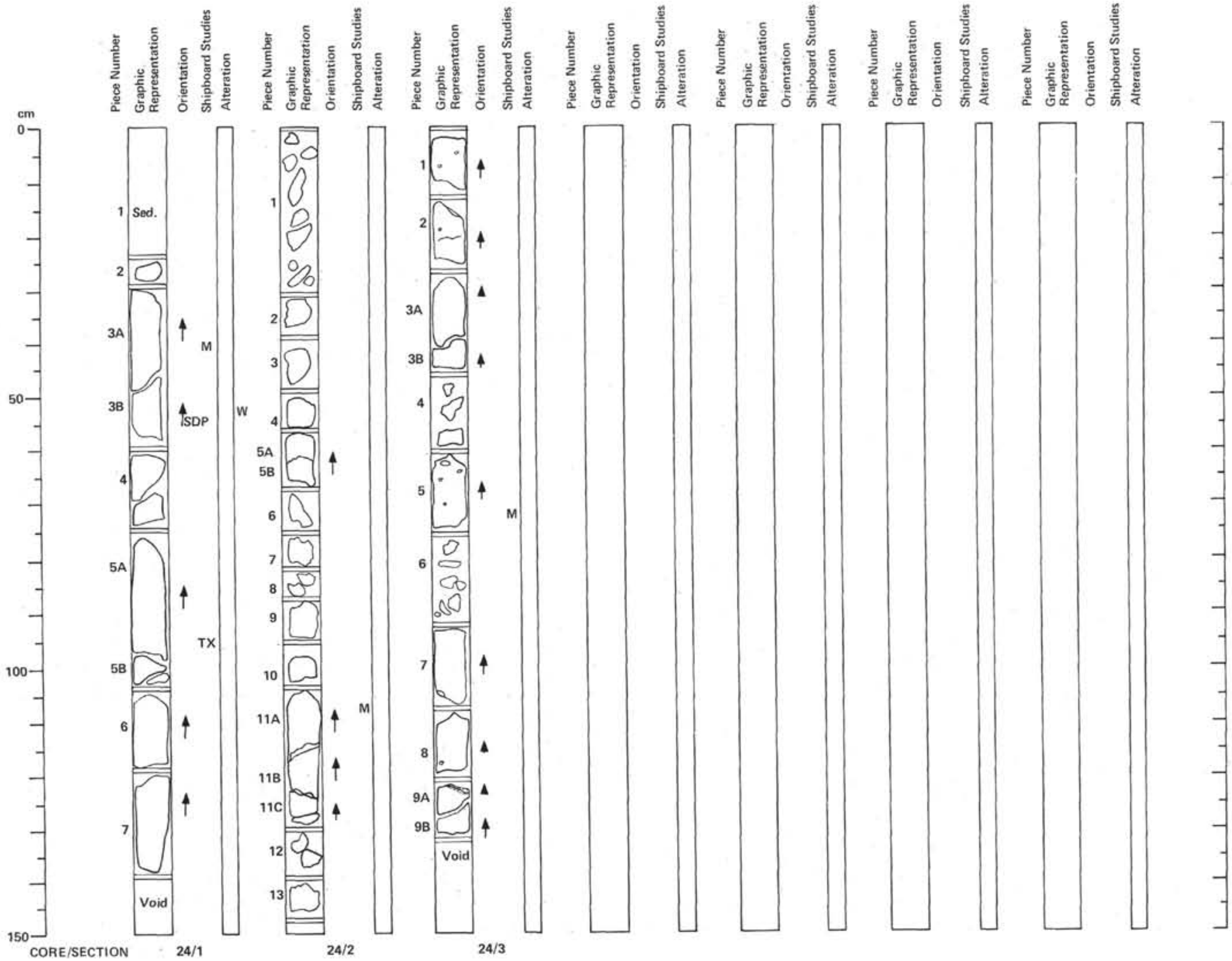
5Y 2/1

Section 1, 0–14 cm: Firm to hard (baked?) olive black NANNOFOSSIL-bearing SILTY CLAY displaying conchoidal fractures.

Section 1, 14 cm–Section 3, 130 cm: BASALT.

SMEAR SLIDE SUMMARY

	1-1
TEXTURE:	
Sand	–
Silt	35
Clay	65
COMPOSITION:	
Quartz	18
Feldspar	5
Clay	65
Zeolite	TR
Carbonate unspec.	TR
Foraminifers	TR
Calc. nannofossils	12



HOLE 482B, CORE 24

Visual Description

Section 1, 0–25 cm: Olive black, firm, silty clay

Section 1, 25 cm–base of core: Dark gray, *aphyric*, massive basalt. Rock is fine- to medium-grained with acicular plagioclase crystals visible in groundmass, generally fresh. Vesicles 1–5%, decreasing in abundance near top of core, < 0.5 mm, spherical, filled with green smectite and minor carbonate; a few large vesicles up to 5 mm occur in Section 2, 95–150 cm. Fractures and veins sparse, randomly distributed, hairline to 2 mm, coated or filled with smectite; some veins have narrow alteration halos 1–2 mm wide.

Thin Section Description

Location: Section 1, 93–95 cm

Texture: Aphyric, fine-grained, intergranular to subophitic

Groundmass: Olivine 5%, 0.3–0.9 mm, subhedral, replaced by smectite; plagioclase 50%, 0.5–1.5 mm, subhedral, fresh; augite 35%, 0.2–0.5 mm, anhedral, fresh, $2V_z \sim 45°$; magnetite 2–3%, 0.05–0.1 mm, subhedral; *cryptocrystalline mesostasis* 5%, *partly replaced by brown* smectite.

Vesicles: 2%, 1–1.5 mm, round, filled with brown smectite.

Alteration: Olivine and some interstitial material replaced by brown smectite.

SITE 482 HOLE C CORE 1 CORED INTERVAL 44.5–54.0 m

TIME – ROCK UNIT	BIOSTRATIGRAPHIC ZONE	FOSSIL CHARACTER	SECTION	METERS	GRAPHIC LITHOLOGY	LITHOLOGIC DESCRIPTION
LATE QUATERNARY	NN20–21 (N)	CG (nannofossils)	1, 2, 3	0.5, 1.0	VOID, OG, PP, PP, VOID	VOID; 5Y 3/2; VOID; VOID

Firm, homogeneous olive gray SILTY CLAY.

SMEAR SLIDE SUMMARY

	1-75
TEXTURE:	
Sand	10
Silt	30
Clay	60
COMPOSITION:	
Quartz	20
Feldspar	5
Mica	1
Heavy minerals	1
Clay	60
Foraminifers	4
Calc. nannofossils	3
Diatoms	2
Radiolarians	3
Sponge spicules	1

SITE 482 HOLE C CORE 2 CORED INTERVAL 54.0–63.5 m

TIME – ROCK UNIT	BIOSTRATIGRAPHIC ZONE	FOSSIL CHARACTER	SECTION	METERS	GRAPHIC LITHOLOGY	LITHOLOGIC DESCRIPTION
LATE QUATERNARY	NN20–21 (N)	CG (nannofossils)	1, 2, 3	0.5, 1.0	OG, PP, PP	5Y 3/2; VOID

Firm, homogeneous olive gray SILTY CLAY.

SMEAR SLIDE SUMMARY

	2-85
TEXTURE:	
Sand	5
Silt	40
Clay	55
COMPOSITION:	
Quartz	20
Feldspar	5
Clay	55
Micronodules	1
Carbonate unspec.	TR
Calc. nannofossils	10
Diatoms	5
Radiolarians	1
Sponge spicules	3

SITE 482 HOLE C CORE 3 CORED INTERVAL 63.5–73.0 m

TIME – ROCK UNIT	BIOSTRATIGRAPHIC ZONE	FOSSIL CHARACTER	SECTION	METERS	GRAPHIC LITHOLOGY	LITHOLOGIC DESCRIPTION
LATE QUATERNARY	NN20–21 (N)	FG (nannofossils)	1, 2, 3, 4, 5, 6, 7, CC	0.5, 1.0	VOID, OG, PP, PP	5Y 2/1; 5Y 3/2; 5Y 2/1; 5Y 3/2; 5Y 2/1; 5Y 3/2

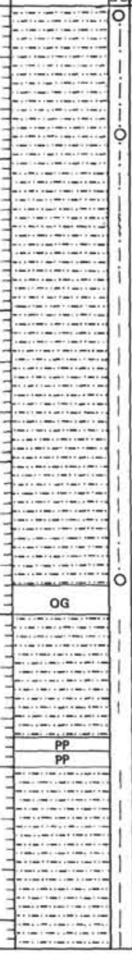
Olive gray SILTY CLAY containing burrows filled with olive black SAND. Sediments soft in Section 1 but become increasingly firm with depth.

SMEAR SLIDE SUMMARY

	1-13 (M)
TEXTURE:	
Sand	90
Silt	10
Clay	1
COMPOSITION:	
Quartz	80
Feldspar	14
Mica	1
Heavy minerals	2
Clay	1
Calc. nannofossils	TR

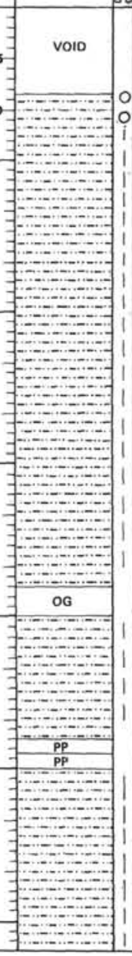
SITE 482 HOLE C CORE 4 CORED INTERVAL 73.0–82.5 m

TIME – ROCK UNIT	BIOSTRATIGRAPHIC ZONE	FORAMINIFERS	NANNOFOSSILS	RADIOLARIANS	DIATOMS	SECTION	METERS	GRAPHIC LITHOLOGY	DRILLING DISTURBANCE	SEDIMENTARY STRUCTURES	SAMPLES	LITHOLOGIC DESCRIPTION
LATE QUATERNARY	NN20–21 (N)					1, 2, 3, 4, 5, 6, 7	0.5, 1.0					5Y 3/2 Soft, homogeneous olive gray SILTY CLAY. Sediments in Section 7 show evidence of local compaction due to drilling(?).



SITE 482 HOLE C CORE 5 CORED INTERVAL 82.5–92.0 m

TIME – ROCK UNIT	BIOSTRATIGRAPHIC ZONE	FORAMINIFERS	NANNOFOSSILS	RADIOLARIANS	DIATOMS	SECTION	METERS	GRAPHIC LITHOLOGY	DRILLING DISTURBANCE	SEDIMENTARY STRUCTURES	SAMPLES	LITHOLOGIC DESCRIPTION
LATE QUATERNARY	NN20–21 (N)					1, 2, 3, 4, 5, 6, 7	0.5, 1.0					Homogeneous, olive gray SILTY CLAY. Sediments soft in Section 1, but relatively firm in Sections 2 through 7. 5Y 3/2



SITE 482 HOLE C CORE 6 CORED INTERVAL 111.0–120.5 m

TIME – ROCK UNIT: LATE QUATERNARY

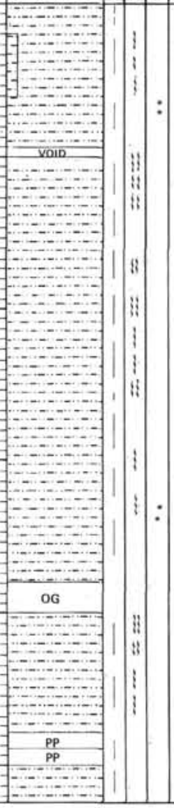
BIOSTRATIGRAPHIC ZONE: NN20–21 (N)

FOSSIL CHARACTER (FORAMINIFERS, NANNOFOSSILS, RADIOLARIANS, DIATOMS): FG, CG, CG, CG, B, CG

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

METERS: 0.5, 1.0

GRAPHIC LITHOLOGY



DRILLING DISTURBANCE / SEDIMENTARY STRUCTURES / SAMPLES

LITHOLOGIC DESCRIPTION

5Y 3/2

Olive gray NANNOFOSSIL-bearing SILTY CLAY containing irregular burrows filled with olive black SNADY MUD and SILTY SAND. Sediments soft in Sections 1–4, firm in Sections 5 and 6. Burrows well-preserved in Sections 2–4.

5Y 2/1

5Y 3/2

5Y 2/1

5Y 3/2

5Y 2/1

SMEAR SLIDE SUMMARY

	1-90 (M)	1-105	4-43	4-51 (M)
TEXTURE:				
Sand	30	10	10	55
Silt	20	31	32	35
Clay	50	59	58	10
COMPOSITION:				
Quartz	35	15	14	60
Feldspar	12	5	6	20
Mica	TR	TR	TR	–
Heavy minerals	–	–	1	5
Clay	50	59	58	10
Pyrite	1	2	2	–
Carbonate unspec.	–	–	3	–
Foraminifers	1	5	6	5
Calc. nannofossils	1	12	10	–
Diatoms	–	1	–	–
Radiolarians	TR	1	–	–
Sponge spicules	–	TR	–	–

SITE 482 HOLE C CORE 7 CORED INTERVAL 120.5–130.0 m

TIME – ROCK UNIT: LATE QUATERNARY

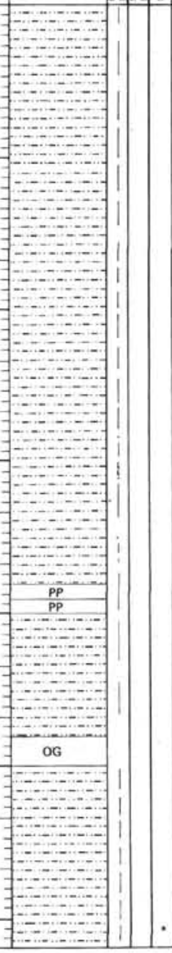
BIOSTRATIGRAPHIC ZONE: NN20–21 (N)

FOSSIL CHARACTER (FORAMINIFERS, NANNOFOSSILS, RADIOLARIANS, DIATOMS): CG, CG

SECTION: 1, 2, 3, 4, 5, 6, 7

METERS: 0.5, 1.0

GRAPHIC LITHOLOGY



DRILLING DISTURBANCE / SEDIMENTARY STRUCTURES / SAMPLES

LITHOLOGIC DESCRIPTION

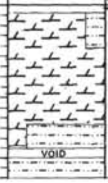
5Y 2/1

Homogeneous, olive black SILTY CLAY. Sediments range from firm in the upper sections of the core, to sub-fissile in Section 3, 50–80 cm and Sections 5–7.

SMEAR SLIDE SUMMARY

	7-15
TEXTURE:	
Sand	–
Silt	30
Clay	70
COMPOSITION:	
Quartz	20
Feldspar	5
Mica	TR
Clay	70
Foraminifers	TR
Calc. nannofossils	5

SITE 482 HOLE C CORE 8 CORED INTERVAL 130.0–132.0 m

TIME-ROCK UNIT	BIOSTRATIGRAPHIC ZONE	FORAMINIFERS	NANNOFOSSILS	RADIOLARIANS	DIATOMS	SECTION	METERS	GRAPHIC LITHOLOGY	DRILLING DISTURBANCE	SEDIMENTARY STRUCTURES	SAMPLES
LATE QUATERNARY		B	B, B	B		1, 2	0.5, 1.0	 VOID			

LITHOLOGIC DESCRIPTION

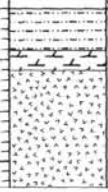
VOID
5Y 2/1
N5
5Y 2/1

Section 1, 5–117 cm: DOLOMITE mixed with MUDSTONE and SILTY CLAY near the top of the section (5–45 cm).
Section 1, 117 cm–Section 2, 20 cm: Hard, olive black mudstone mixed with dolomite near the base of Section 1 (117–140 cm).

SMEAR SLIDE/THIN SECTION SUMMARY

	1-40	1-64	1-70	1-124	2-15
TEXTURE:					
Sand	–	–	–	–	–
Silt	90	100	100	22	100
Clay	10	–	–	78	–
COMPOSITION:					
Quartz	2	–	2	5	1
Feldspar	1	–	–	10	–
Heavy minerals	1	–	–	3	1
Clay	10	–	–	–	78
Pyrite	–	–	–	1	–
Zeolite	–	–	–	3	–
Carbonate unspec.	86	100	98	78	98

SITE 482 HOLE C CORE 9 CORED INTERVAL 132.0–139.0 m

TIME-ROCK UNIT	BIOSTRATIGRAPHIC ZONE	FORAMINIFERS	NANNOFOSSILS	RADIOLARIANS	DIATOMS	SECTION	METERS	GRAPHIC LITHOLOGY	DRILLING DISTURBANCE	SEDIMENTARY STRUCTURES	SAMPLES
LATE QUATERNARY	NN20–21 (N)	B	AG	B		1, 2	0.5, 1.0				

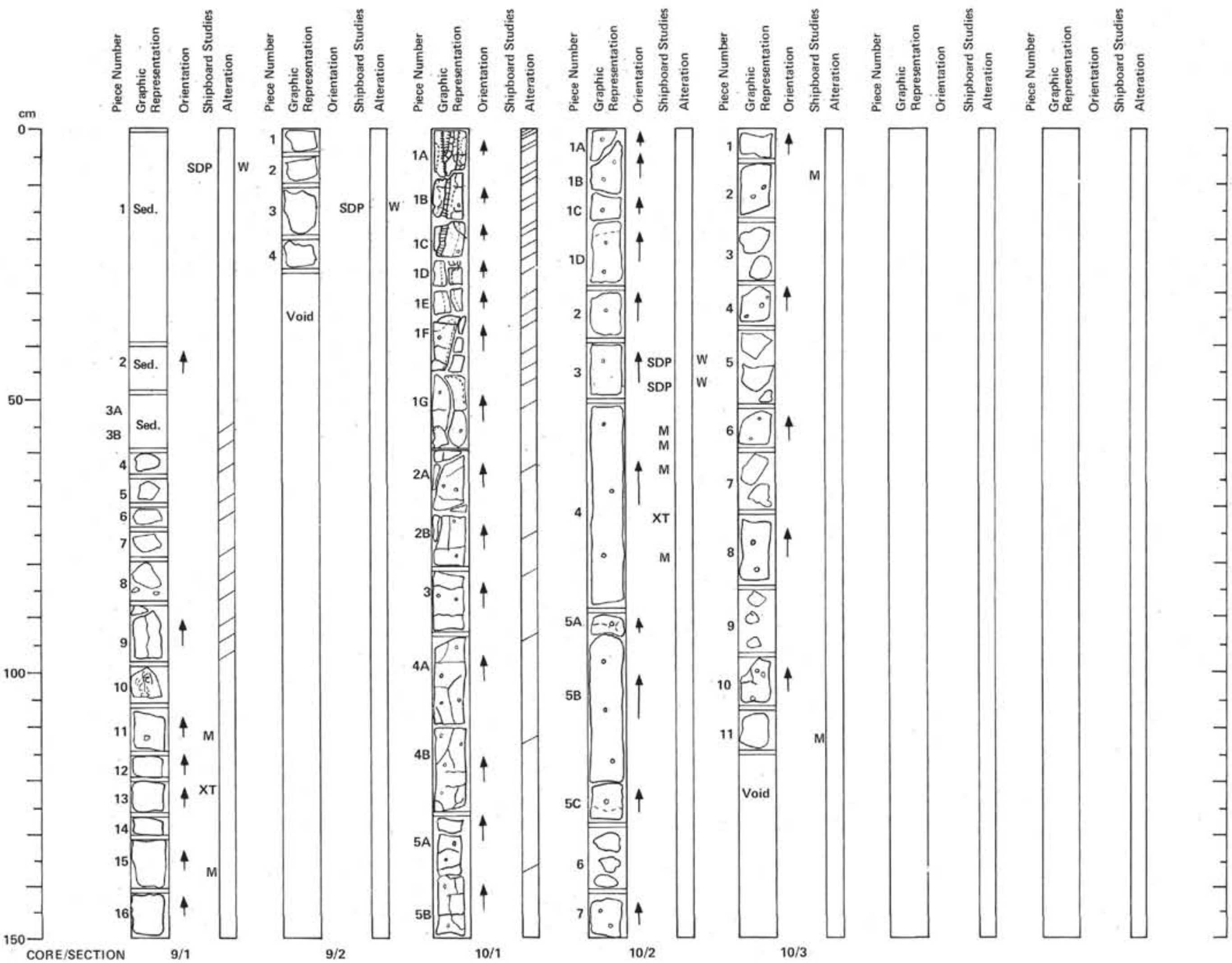
LITHOLOGIC DESCRIPTION

5Y 2/1

Section 1, 0–40 cm: Fine-grained, well indurated, olive-black CLAY and SILTY CLAY overlying a thin indurated layer of granular DOLOMITE (50–59 cm).
Section 1, 59 cm–Section 2, 26 cm: BASALT.

SMEAR SLIDE/THIN SECTION SUMMARY

	1-26	1-32	1-38	1-45	1-52
TEXTURE:					
Sand	–	10	–	5	5
Silt	20	30	100	80	95
Clay	80	60	–	15	–
COMPOSITION:					
Quartz	5	17	–	30	4
Feldspar	2	10	–	5	TR
Heavy minerals	1	2	–	–	–
Clay	80	60	–	15	–
Pyrite	TR	TR	–	2	1
Zeolite	3	–	–	–	–
Carbonate unspec.	–	10	100	50	95
Foraminifers	–	1	–	–	–
Calc. nannofossils	10	–	–	–	–



HOLE 482C, CORE 9

Visual Description

Section 1, 0–58 cm: Well indurated, olive-black silty clay from 0–40 cm grading into light gray granular dolomite below.

Section 1, 58 cm–base of core: Medium to dark gray, aphyric, massive basalt. Sparse plagioclase microphenocrysts <1%; <1 mm. Groundmass fine-grained, partly altered along veins. Vesicles 1%, < 2 mm, spherical, filled with green smectite. Veins and fractures common, especially at top of basalt, hairline to 5 mm, filled with carbonate, pyrite, and minor smectite; sulfide decreases downward; some veins have narrow alteration halos. Pyrite disseminated in groundmass, particularly near veins.

Thin Section Description

Location: Section 1, 121–123 cm

Texture: Aphyric, fine- to medium-grained, intergranular to subophitic.

Groundmass: Olivine(?) 1%, subhedral clots of smectite, 0.2–0.5 mm; plagioclase 45%, <1 mm, subhedral to euhedral, fresh; clinopyroxene 40%, <0.5 mm, anhedral, partly intergrown with plagioclase, $2V_z$ ~40°, fresh; magnetite 3–5%, <0.2 mm, subhedral to anhedral, mostly in interstitial patches; interstitial material 10%, mostly smectite with lesser feldspar(?) and opal(?) (colorless, isotropic material with high negative relief).

Vesicles: 1%, <0.5 mm, round, filled with smectite and minor carbonate.

Alteration: Olivine(?) and some interstitial material replaced by greenish-brown smectite.

HOLE 482C, CORE 10

Visual Description

Gray, medium-grained, aphyric, massive basalt; moderately altered in upper part. Vesicles 1–3%, 0.5–3 mm, subspherical, irregularly distributed, filled with green smectite, pyrite, and some calcite. Veins and fractures common, subvertical, 0.3–0.8 mm wide, filled or lined with pyrite, calcite, zeolite(?), and some smectite, opal and barite; large vein in upper 60 cm which splits a pre-existing segregation vein and has a prominent alteration halo with bleached rock on either side; fractures decrease in number downward. Pyrite disseminated in groundmass, particularly near veins.

Thin Section Description

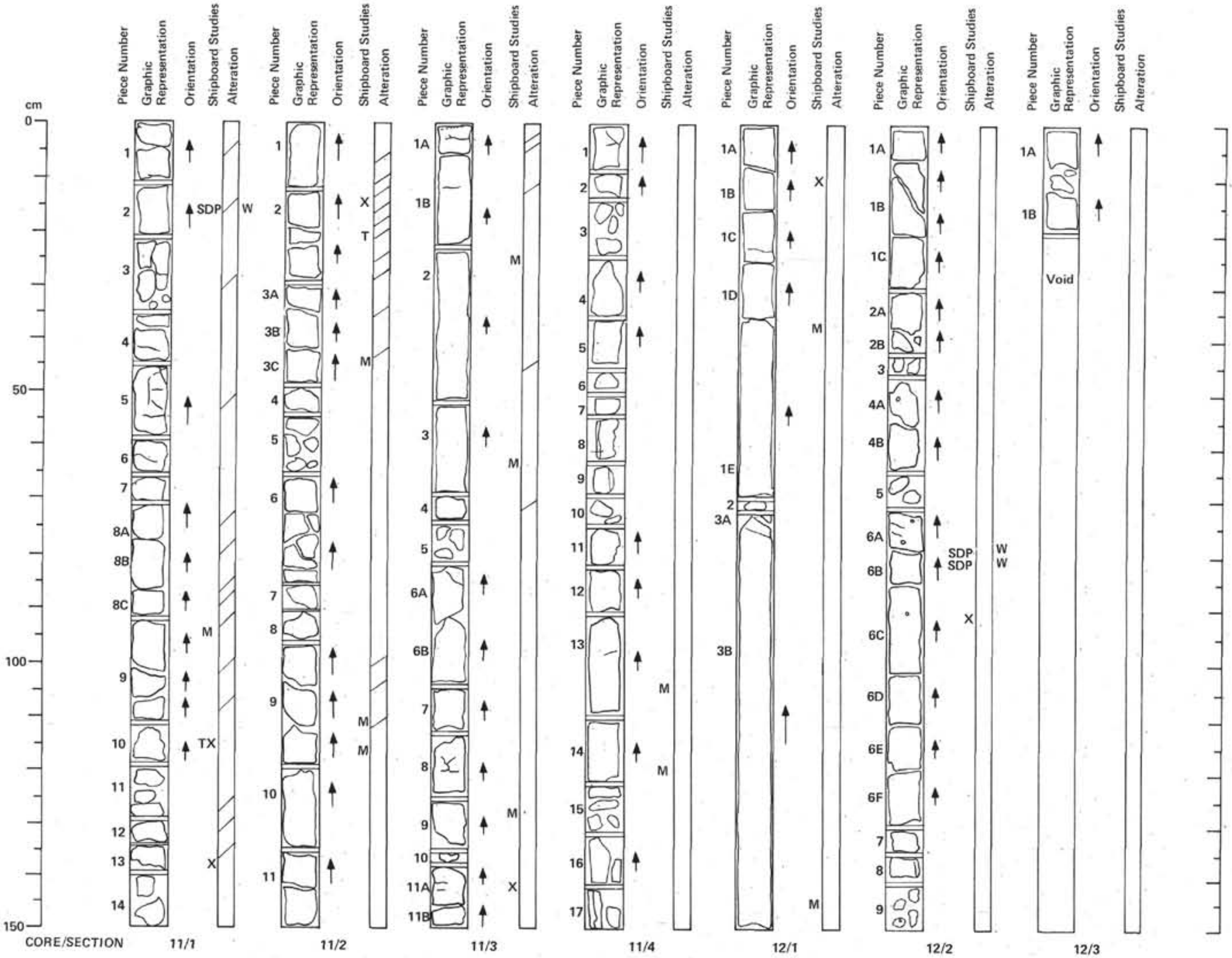
Location: Section 2, 75–76 cm

Texture: Aphyric, medium-grained, intergranular to subophitic.

Groundmass: Olivine 2–3%, < 0.4 mm, subhedral to anhedral, completely replaced by smectite; plagioclase 40–45%, < 1.5 mm, euhedral to subhedral, fresh; clinopyroxene 40%, 0.2–0.7 mm, anhedral, often partly intergrown with plagioclase, $2V_z$ ~ 40°, fresh; magnetite 3–5%, <0.2 mm subhedral to anhedral, mostly in interstitial patches; interstitial material 10–15%, mostly smectite with minor feldspar(?), apatite and traces of green amphibole(?).

Vesicles: 1–5%, irregularly distributed, 1–2 mm, round, open or partly filled with smectite.

Alteration: Olivine replaced by smectite and minor carbonate; interstitial material replaced by smectite.



HOLE 482C, CORE 11

Visual Description

Gray, medium-grained, aphyric, massive basalt. Vesicles <2%, <1 mm, spherical, filled with smectite. Fractures and veinlets sparse, hairline to 0.5 mm, filled or lined with calcite and smectite. Groundmass has patchy replacement by smectite, particularly adjacent to fractures. Section 2, 20–23 cm shows intense replacement by chlorite, carbonate and sulphides.

Thin Section Description

Location: Section 1, 115–117 cm

Texture: Aphyric, medium-grained, intergranular to subophitic.

Groundmass: Olivine(?) 1–2%, < 0.5 mm, subhedral, completely replaced by smectite; plagioclase 55%, <1 mm, subhedral laths, fresh; clinopyroxene 30–35%, <0.5 mm, anhedral, partly intergrown with plagioclase, $2V_z$ ~ 40°; magnetite 2%, 0.05–0.1 mm, subhedral, mostly in interstitial patches; interstitial material 10%, replaced by yellow-brown smectite, minor apatite.

Alteration: Olivine and some interstitial material replaced by smectite.

Location: Section 2, 21–24 cm

Texture: Aphyric, medium-grained, intergranular to subophitic, highly altered.

Groundmass: Olivine(?) 2%, 0.2–0.8 mm, possible pseudomorphs of smectite; plagioclase 50%, 0.3–1.2 mm, subhedral laths, partly replaced by smectite; clinopyroxene 35%, 0.5–1 mm, anhedral, partly replaced by smectite, celadonite(?), actinolite and clinozoisite(?); opaques 2–3%, mostly pyrite; interstitial material 10%, altered to smectite.

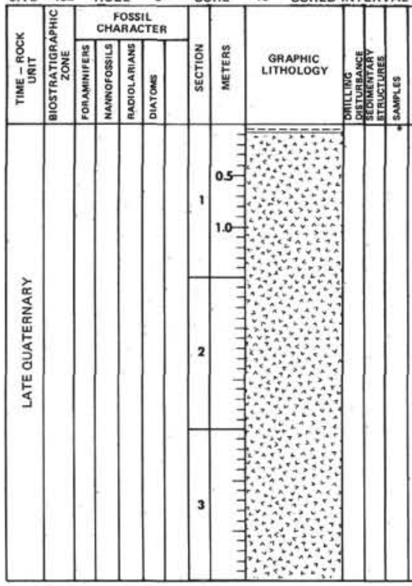
Alteration: *Olivine(?) to smectite; clinopyroxene to smectite, actinolite, clinozoisite(?) and smectite; some sphene(?) in interstitial areas; unknown secondary mineral, 1 grain, colorless, uniaxial (–), high positive relief, low birefringence.*

HOLE 482C, CORE 12

Visual Description

Gray, sparsely phyric, massive basalt. Plagioclase phenocrysts 5%, 1–5 mm, euhedral, fresh. Groundmass fine-grained with grain size increasing slightly downward, generally fresh. Vesicles 1–2%, < 2 mm, spherical, filled with smectite and minor zeolite(?). Veinlets and fractures sparse, < 2 mm wide, filled with smectite and minor pyrite.

SITE 482 HOLE C CORE 13 CORED INTERVAL 161.5–166.0 m

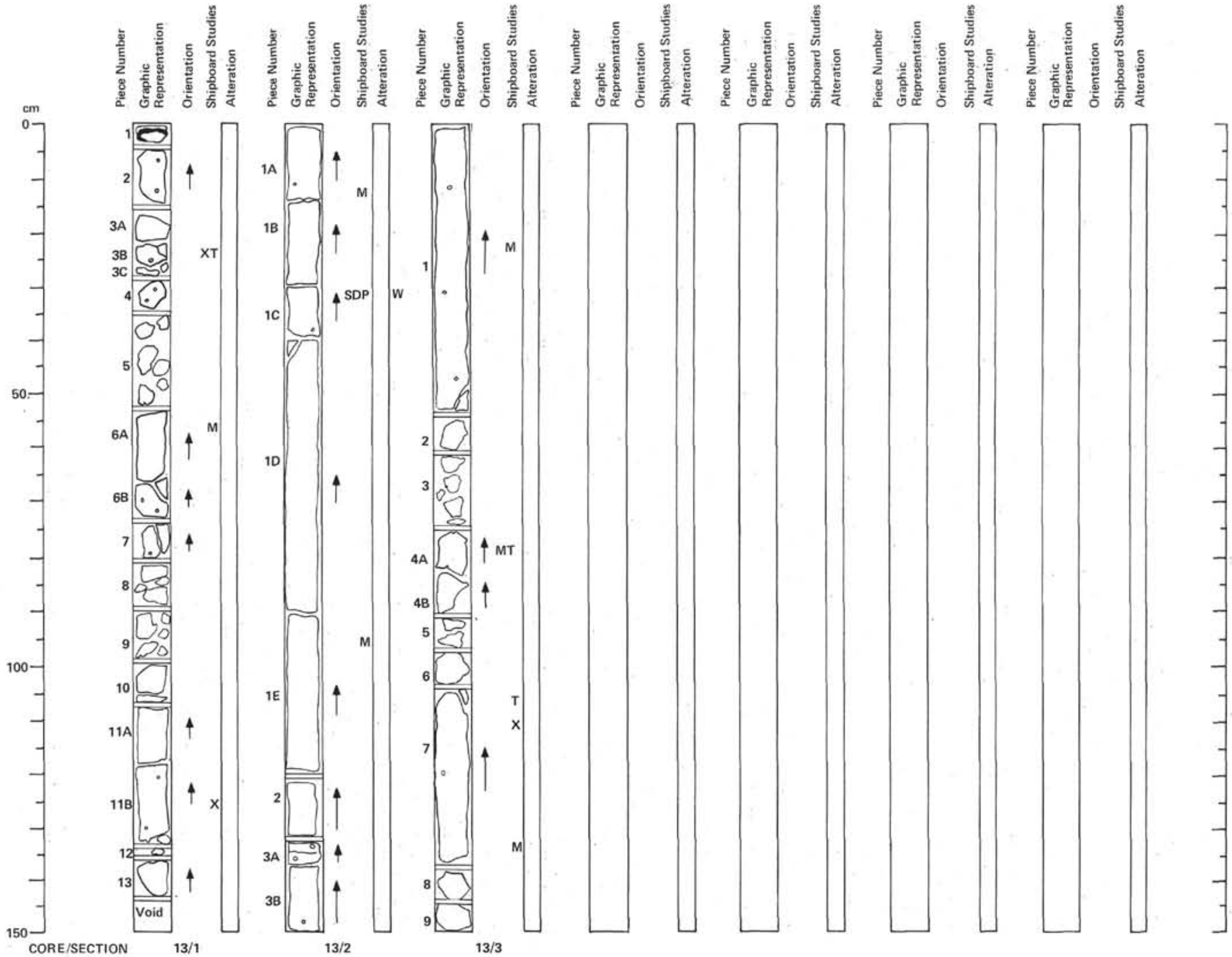


LITHOLOGIC DESCRIPTION

Section 1, 0–1 cm: Dark brown CLAYSTONE coating devitrified glass along the margin of a basalt pillow.
Section 1, 1 cm–Section 3, 150 cm: BASALT.

SMEAR SLIDE SUMMARY

	1-2
TEXTURE:	
Sand	–
Silt	20
Clay	80
COMPOSITION:	
Clay	80
Pyrite	5
Zeolites	15



HOLE 482C, CORE 13

Visual Description

Section 1, 0–1 cm: Dark brown, indurated, foraminifer-rich mudstone.

Section 1, 1 cm–base of core: Medium gray, sparsely phyric, massive basalt. Plagioclase phenocrysts 1–3%, 1–4 mm, euhedral, fresh. Groundmass fine- to medium-grained, grain size increases slightly downward; glass selvedge present in Section 1, 2 cm. Groundmass generally fresh with minor disseminated pyrite. Vesicles 1–5%, most abundant near top of core, 0.5–2 mm, spherical, filled with green smectite and rare pyrite. Fractures and veinlets sparse, hairline to 1 mm wide, filled with smectite and minor pyrite.

Thin Section Description

Location: Section 1, 22–24 cm

Texture: Very sparsely phyric, medium-grained, intersertal to subophitic.

Phenocrysts: Plagioclase <1%, 2–4 mm, subhedral laths, fresh.

Groundmass: Olivine 2–3%, 0.1–0.2 mm, subhedral, completely replaced by smectite; plagioclase 50%, 0.2–1 mm, subhedral laths fresh; clinopyroxene 30–35%, 0.1–0.4 mm, anhedral, fresh $2V_z$ ~40°; interstitial material 10–15%, glassy, partly replaced by smectite; magnetite 3–5%, 0.02–0.04 mm, subhedral.

Vesicles: 1–2%, 0.5–2 mm, round, filled with smectite and minor carbonate.

Alteration: Olivine and interstitial altered to smectite.

Location: Section 3, 106–107 cm

Texture: Very sparsely phyric, coarse-grained, intersertal to subophitic.

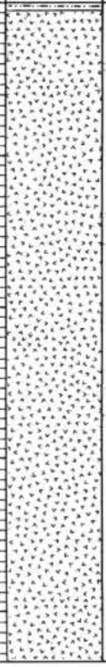
Phenocrysts: Plagioclase <1%, 1–1.5 mm, subhedral, zoned with glassy inclusions, fresh.

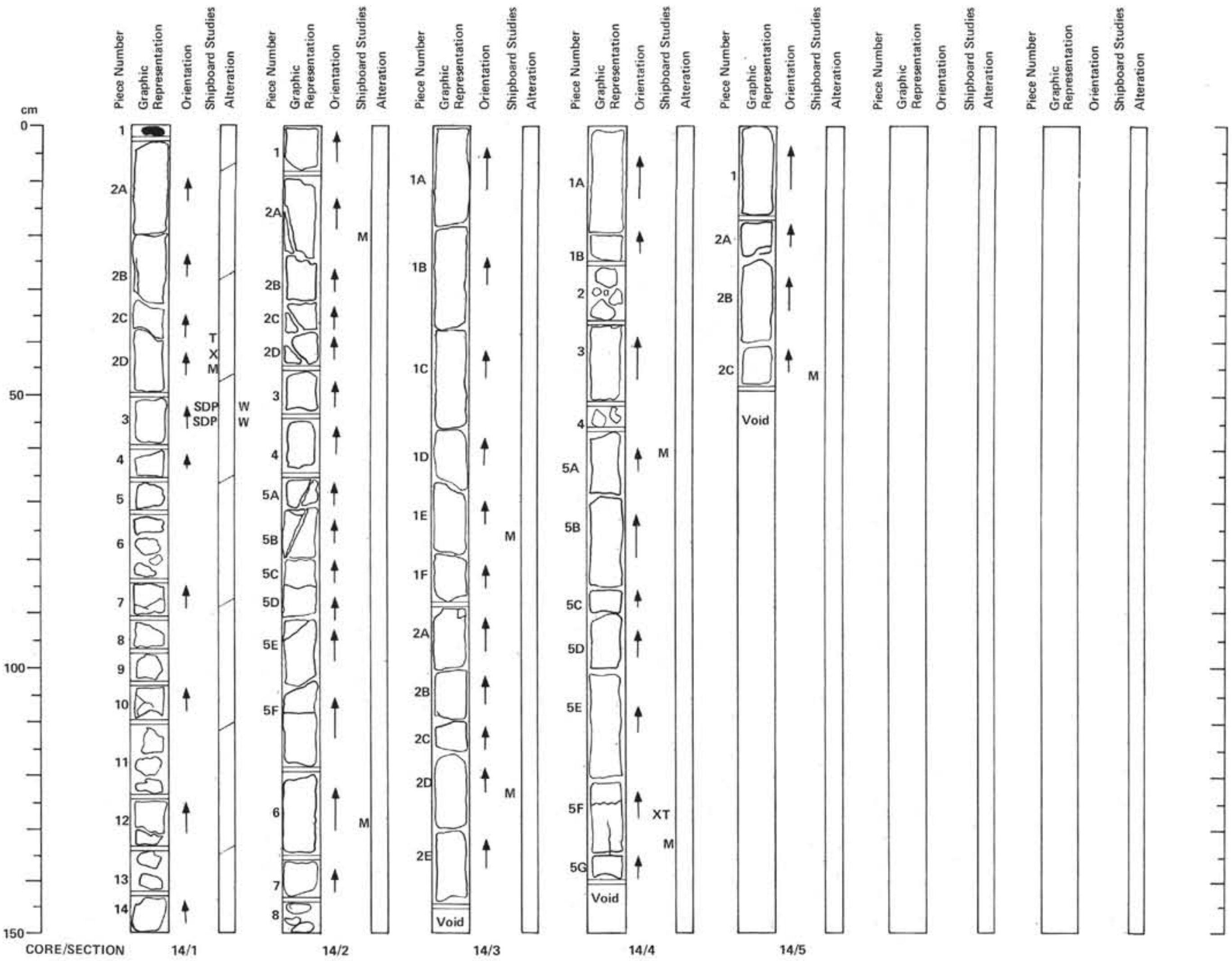
Groundmass: Olivine 2–3%, 0.2–0.4 mm, subhedral, replaced by smectite; plagioclase 50%, 0.2–1.2 mm, subhedral, fresh; clinopyroxene, 35–40%, 0.2–0.8 mm, anhedral, $2V_z$ ~ 40°; magnetite 5%, 0.1–0.4 mm, subhedral; interstitial material 5%, mostly glassy material with minor quartz and apatite, partly replaced by smectite.

Vesicles: <1%, 0.1–0.2 mm, round, filled with smectite.

Alteration: Olivine and some interstitial material replaced by smectite; some clinopyroxene marginally replaced by smectite.

SITE 482 HOLE C CORE 14 CORED INTERVAL 166.0–175.0 m

TIME – ROCK UNIT	BIOSTRATIGRAPHIC ZONE	FORAMINIFERS	NANNOFOSSILS	RADIOLARIANS	DIATOMS	SECTION	METERS	GRAPHIC LITHOLOGY	DRILLING DISTURBANCE	SEDIMENTARY STRUCTURES	SAMPLES	LITHOLOGIC DESCRIPTION
LATE QUATERNARY						1	0.5 1.0					**Section 1, 0–1 cm:** Brown indurated MUDSTONE coating devitrified glass along the margin of a basalt micropillow. **Section 1, 1 cm–Section 5, 47 cm:** BASALT.
						2						
						3						
						4						
						5						



HOLE 482C, CORE 14

Visual Description

Section 1, 0–1 cm: Brown, indurated mudstone.

Section 1, 1 cm–base of core: Gray, aphyric to sparsely phyric, massive basalt. Plagioclase phenocrysts 0–3%, 1–3 mm, euhedral to subhedral; fresh, occasionally in glomerophyric clots. Groundmass fine- to medium-grained; glass selvedge in Section 1, 2 cm, glass partly palagonitized. Groundmass generally fresh but with some mottling and yellow staining. Vesicles <1%, <0.5 mm, spherical filled with smectite. Fractures and veinlets very sparse, hairline to 1 mm wide, coated or filled with smectite and calcite, often slickensided.

Thin Section Description

Location: Section 1, 37–39 cm

Texture: Aphyric, coarse-grained, intersertal to subophitic.

Groundmass: *Olivine 2%, 0.2–0.5 mm, subhedral, replaced by smectite;* plagioclase 55%, 0.2–1 mm, subhedral, fresh; clinopyroxene 30%, 0.1–0.4 mm, anhedral, fresh; magnetite 4%, 0.1–0.3 mm, subhedral; interstitial material 10%, mostly microcrystalline material with some quartz and apatite, partly replaced by smectite.

Vesicles: <1%, 0.5 mm, round, filled with smectite.

Alteration: Olivine and some interstitial material altered to smectite.

Location: Section 4, 122–127 cm

Texture: Very sparsely phyric, medium-grained, intersertal to subophitic.

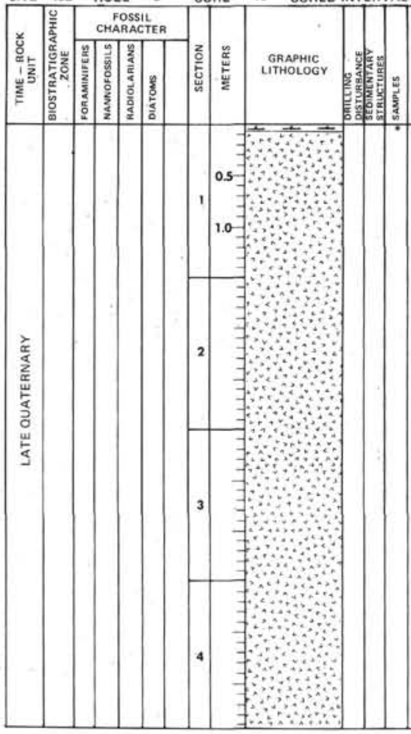
Phenocrysts: Plagioclase <1%, 1–3 mm, subhedral, fresh.

Groundmass: Olivine 2–3%, 0.2–0.5 mm, subhedral, altered to smectite; plagioclase 50–55%, 0.3–1 mm, subhedral, fresh; clinopyroxene 35–40%, 0.2–0.8 mm, anhedral, fresh, $2V_z$ ~40°; magnetite 2–3%, 0.05–0.02 mm, anhedral; interstitial material 5%, mostly cryptocrystalline material with minor quartz and apatite, partly replaced by smectite.

Vesicles: < 1%, 0.2–0.5 mm, round, filled with smectite.

Alteration: Olivine and some interstitial material altered to smectite.

SITE 482 HOLE C CORE 15 CORED INTERVAL 175.0–184.0 m

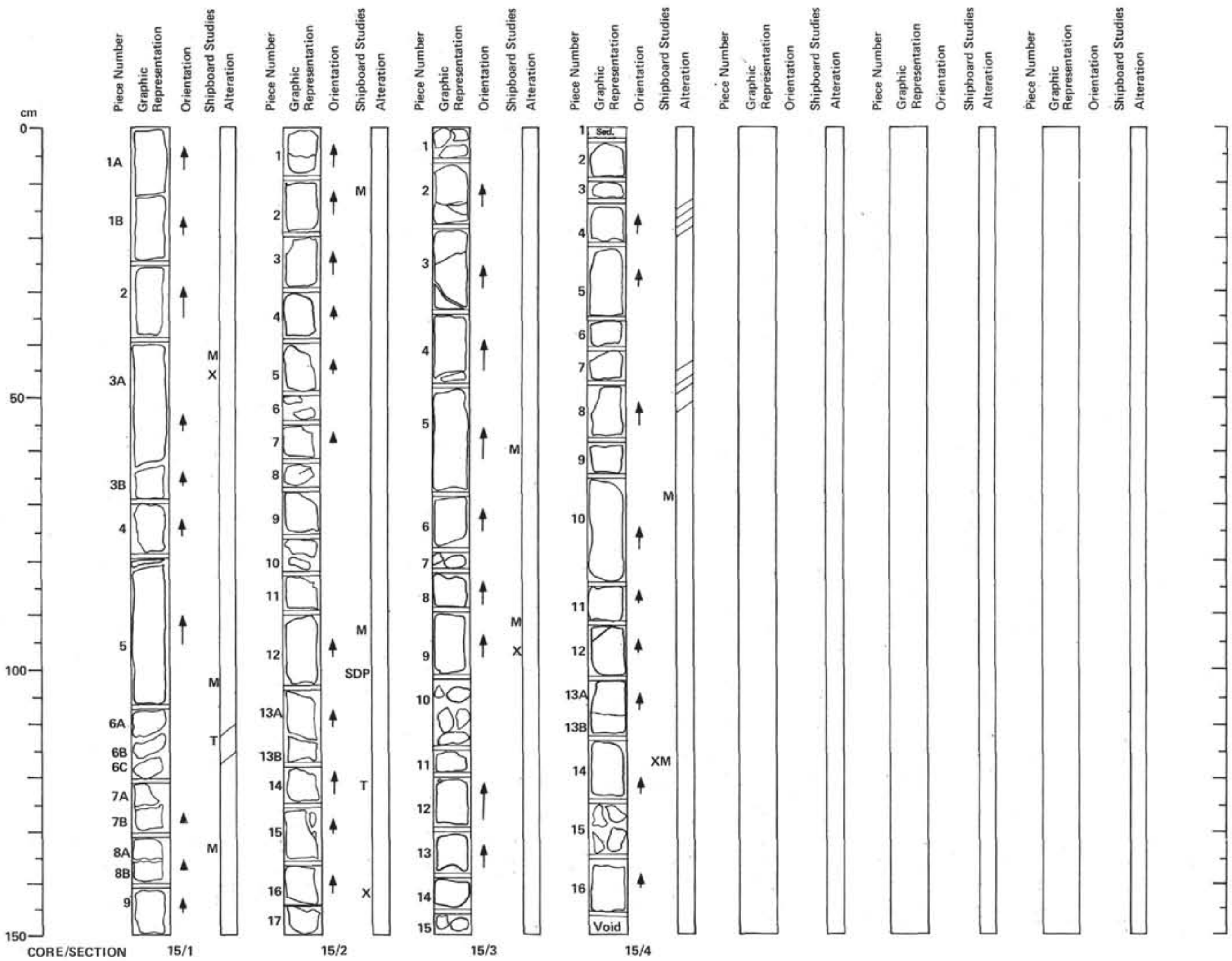


LITHOLOGIC DESCRIPTION

Section 1, 0–1 cm: DOLOMITE.
Section 1, 1 cm–Section 4, 145 cm: BASALT.

SMEAR SLIDE SUMMARY

	1-1
TEXTURE:	
Sand	–
Silt	100
Clay	–
COMPOSITION:	
Carbonate unspec.	100



HOLE 482C, CORE 15

Visual Description

Section 1, 0–1 cm: Light gray dolomite.

Section 1, 1 cm–base of core: Medium gray, sparsely phyric, massive basalt. Plagioclase phenocrysts 3–5%, 1–4 mm, euhedral, fresh, usually in clots with clinopyroxene. Clinopyroxene phenocrysts 1–3%, 0.5–1 mm, anhedral, fresh, intergrown with plagioclase. Olivine microphenocrysts 1%, < 1 mm, altered to smectite. Groundmass fine- to medium-grained, grain size increases slightly downward, generally fresh, but some smectite alteration. Vesicles < 1%, < 0.5 mm spherical, filled with smectite. Fractures and veinlets sparse, hairline to 1 mm, coated and filled with smectite.

Thin Section Description

Location: Section 1, 103–105 cm

Texture: Sparsely phyric, fine-grained, intergranular to quench.

Phenocrysts: Olivine 1%, 0.3–0.5 mm, subhedral, replaced by smectite; plagioclase 3–5%, 0.5–1 mm, subhedral laths, fresh; clinopyroxene 1–2%, 0.2–0.4 mm, subophitic clots, $2V_z$ ~40°.

Groundmass: Olivine 1–3%, 0.1–0.2 mm, subhedral, replaced by smectite; plagioclase 50%, 0.1–0.3 mm, subhedral, fresh; clinopyroxene 30–40%, 0.05–0.15 mm, anhedral to granular, fresh; magnetite 3–4%, 0.02–0.05 mm, subhedral; interstitial material 5–15%, cryptocrystalline, partly altered to smectite.

Vesicles: <1%, 0.1–0.3 mm, round, filled with smectite.

Alteration: Olivine and some interstitial material altered to smectite.

Location: Section 2, 119–121 cm

Texture: Sparsely phyric, medium-grained, intergranular to subophitic.

Phenocrysts: Plagioclase 1–2%, 1–2 mm, subhedral, fresh; clinopyroxene < 1%, 0.5–0.8 mm, anhedral, intergrown with plagioclase, $2V_z$ ~40°.

Groundmass: Olivine 2–3%, 0.4–0.6 mm, subhedral, replaced by smectite; plagioclase 50%, 0.1–0.5 mm, subhedral, fresh; clino0-pyroxene 30–35%, 0.1–0.4 mm, anhedral, fresh, $2V_z$ ~40°; magnetite 2–3%, 0.05–0I2 mm, anhedral; interstitial material 10%, partly replaced by smectite.

Vesicles: 1%, 0.1–0.5 mm, round, filled with smectite and minro carbonate.

Alteration: Olivine and some interstitial material replaced by smectite.

SITE 482 HOLE D CORE 1 CORED INTERVAL 71.5–81.0 m

TIME – ROCK UNIT: LATE QUATERNARY

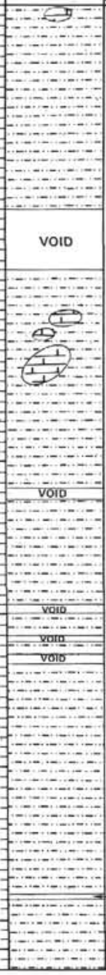
BIOSTRATIGRAPHIC ZONE: NN20–21 (N)

FOSSIL CHARACTER (NANNOFOSSILS): CG, CG, FG, CM

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

METERS: 0.5, 1.0

GRAPHIC LITHOLOGY



DRILLING DISTURBANCE / SEDIMENTARY STRUCTURES / SAMPLES

VOID

LITHOLOGIC DESCRIPTION

5Y 3/2

Soft, homogeneous, olive gray SILTY CLAY with hard carbonate concretions of the same color near the top of Sections 1 and 3 and a strong petroliferous odor throughout. Detrital mineral content decreases between Sections 2 and 3.

SMEAR SLIDE SUMMARY

	1-10	2-130	3-34	3-48	3-52 (M)	3-70	7-33
TEXTURE:							
Sand	–	–	–	–	–	–	–
Silt	47	39	15	21	100	22	33
Clay	53	61	85	79	–	78	67
COMPOSITION:							
Quartz	12	15	7	7	5	6	8
Feldspar	11	4	1	1	12	1	2
Mica	TR	–	–	TR	–	–	–
Heavy minerals	1	–	–	TR	–	–	–
Clay	53	61	85	79	–	78	67
Pyrite	–	3	TR	1	TR	TR	TR
Carbonate unspec.	4	2	–	TR	83	–	4
Foraminifers	–	–	TR	–	–	TR	–
Calc. nannofossils	5	6	3	4	–	5	3
Diatoms	2	1	–	1	–	2	5
Radiolarians	5	3	1	2	TR	3	5
Sponge spicules	10	5	3	5	–	5	6

SITE 482 HOLE D CORE 2 CORED INTERVAL 81.0–90.5 m

TIME – ROCK UNIT: LATE QUATERNARY

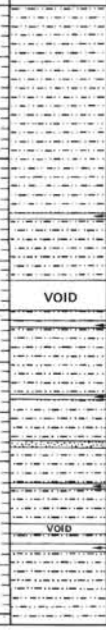
BIOSTRATIGRAPHIC ZONE: NN20–21 (N)

FOSSIL CHARACTER: FORAMINIFERS AG, NANNOFOSSILS FM, CG, RADIOLARIANS B

SECTION: 1, 2, 3, 4, 5

METERS: 0.5, 1.0

GRAPHIC LITHOLOGY



DRILLING DISTURBANCE / SEDIMENTARY STRUCTURES / SAMPLES

VOID

VOID

VOID

VOID

VOID

LITHOLOGIC DESCRIPTION

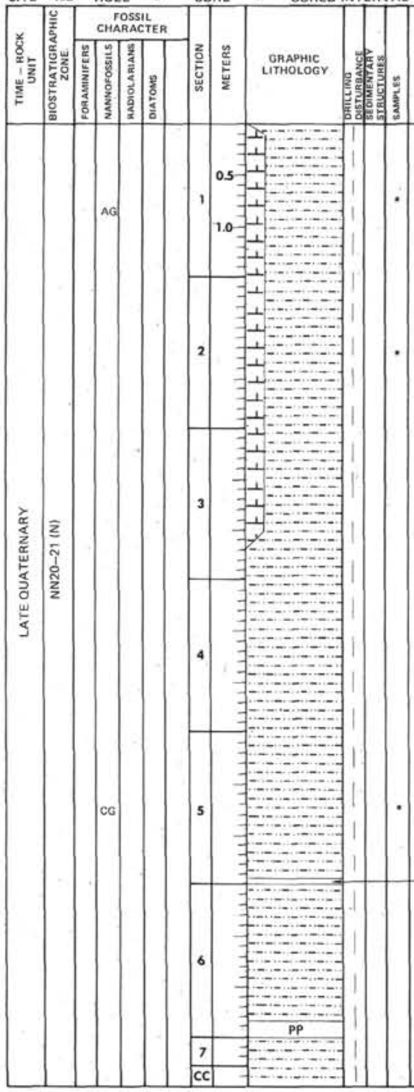
5Y 3/2

SILTY CLAY, grading with depth near the top of Section 1 to soft, olive gray NANNOFOSSIL-bearing SILTY CLAY. This gradually reverts near the top of Section 3 to soft SILTY CLAY with occasional layers of SANDY SILT.

SMEAR SLIDE SUMMARY

	1-56	2-118	3-131 (M)
TEXTURE:			
Sand	–	TR	50
Silt	25	40	45
Clay	75	60	5
COMPOSITION:			
Quartz	1	20	32
Feldspar	3	7	32
Mica	–	TR	–
Heavy minerals	–	TR	–
Clay	75	60	5
Pyrite	5	2	5
Carbonate unspec.	1	1	15
Foraminifers	TR	–	10
Calc. nannofossils	15	8	1
Diatoms	TR	2	–
Radiolarians	1	–	–
Sponge spicules	TR	–	–

SITE 482 HOLE D CORE 3 CORED INTERVAL 90.5–100.0 m



LITHOLOGIC DESCRIPTION

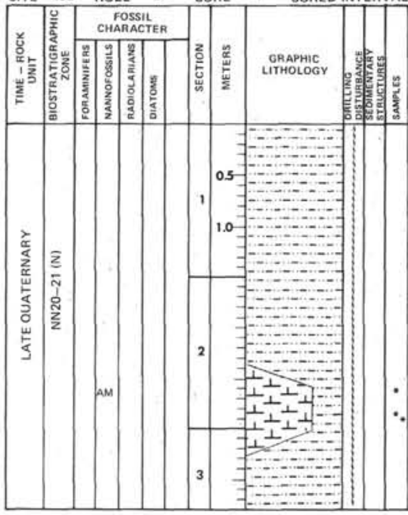
5Y 3/2

Fine-grained SILTY CLAY, grading with depth near the top of Section 1 to firm, homogeneous, olive gray NANNOFOSSIL-bearing SILTY CLAY. This gradually reverts near the middle of Section 3 to fine-grained SILTY CLAY.

SMEAR SLIDE SUMMARY

	1-75	2-75	5-75
TEXTURE:			
Sand	–	–	–
Silt	36	36	35
Clay	64	64	65
COMPOSITION:			
Quartz	7	7	5
Feldspar	2	2	14
Mica	TR	–	TR
Heavy minerals	TR	–	1
Clay	64	64	65
Pyrite	TR	1	–
Carbonate unspec.	2	2	3
Foraminifers	–	TR	TR
Calc. nannofossils	25	25	15
Diatoms	TR	–	–
Radiolarians	TR	–	–

SITE 482 HOLE D CORE 4 CORED INTERVAL 100.0–109.5 m



LITHOLOGIC DESCRIPTION

5Y 3/2

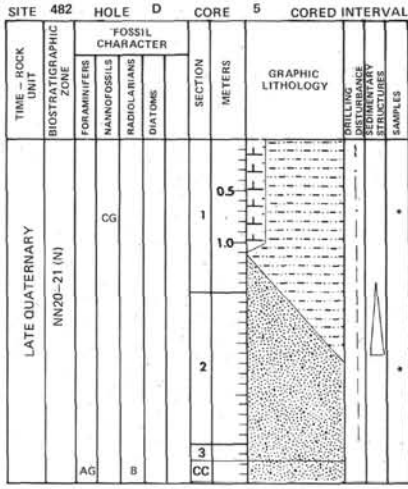
5Y 4/1

Olive gray SILTY CLAY with an interval of MUDDY NANNOFOSSIL OOZE near the base of Section 2.

SMEAR SLIDE SUMMARY

	2-117	2-140	2-144
TEXTURE:			
Sand	–	–	–
Silt	82	81	81
Clay	18	18	18
COMPOSITION:			
Quartz	TR	TR	5
Feldspar	TR	TR	20
Heavy minerals	2	TR	–
Clay	18	18	18
Pyrite	–	–	3
Micronodules	–	–	3
Carbonate unspec.	5	6	30
Foraminifers	–	TR	TR
Calc. nannofossils	75	75	20
Diatoms	TR	TR	TR
Radiolarians	–	TR	–

SITE 482 HOLE D CORE 5 CORED INTERVAL 109.5–119.0 m



LITHOLOGIC DESCRIPTION

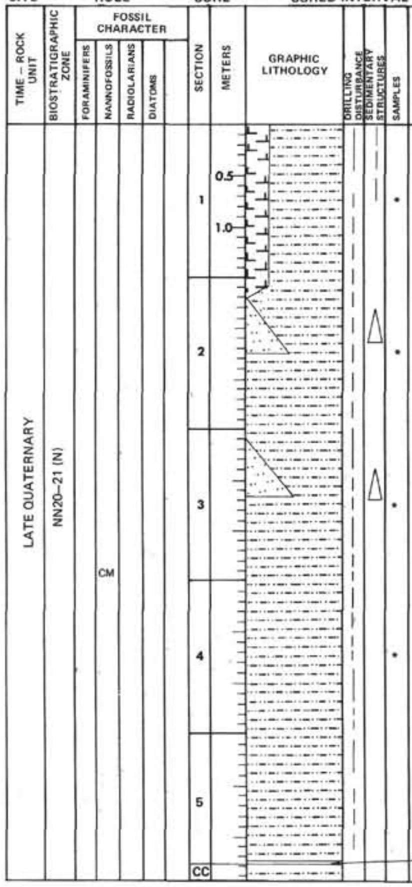
5Y 3/2

NANNOFOSSIL-bearing SILTY CLAY underlain by a firm SILTY CLAY which grades downward into olive gray SILTY SAND.

SMEAR SLIDE SUMMARY

	1-75	2-75
TEXTURE:		
Sand	–	60
Silt	56	30
Clay	44	10
COMPOSITION:		
Quartz	8	50
Feldspar	20	25
Mica	TR	–
Heavy minerals	–	1
Clay	44	10
Pyrite	1	5
Zeolite	TR	–
Carbonate unspec.	1	4
Foraminifers	TR	2
Calc. nannofossils	25	3
Diatoms	1	–

SITE 482 HOLE D CORE 6 CORED INTERVAL 119.0–128.5 m



LITHOLOGIC DESCRIPTION

5Y 2/1

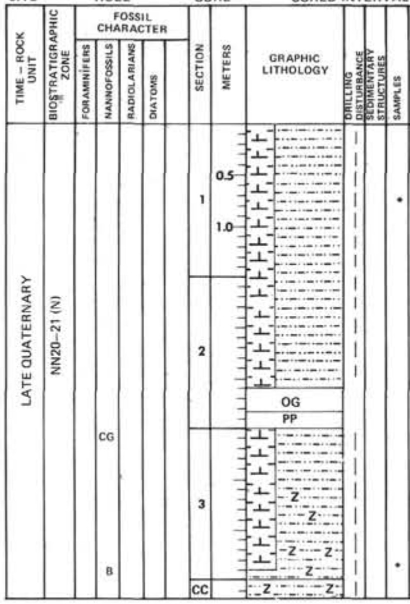
Firm, olive black NANNOFOSSIL-bearing SILTY CLAY grading downward to a firm, olive black, coarse-grained SILTY CLAY displaying turbidite cycles in the tops of Sections 2 and 3, a tendency toward fissile parting and a strong petroliferous odor.

PP

SMEAR SLIDE SUMMARY

	1-75	2-75	3-75	4-75
TEXTURE:				
Sand	–	10	10	1
Silt	39	37	34	38
Clay	61	53	56	61
COMPOSITION:				
Quartz	5	10	20	15
Feldspar	4	20	15	5
Heavy minerals	–	5	TR	1
Clay	61	53	56	61
Pyrite	1	2	1	5
Zeolite	TR	TR	–	5
Carbonate unspec.	1	3	5	1
Foraminifers	TR	TR	–	TR
Calc. nannofossils	25	7	3	7
Diatoms	3	TR	TR	–

SITE 482 HOLE D CORE 7 CORED INTERVAL 128.5–138.0 m



LITHOLOGIC DESCRIPTION

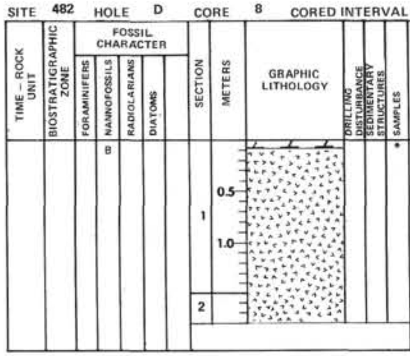
5Y 2/1
5YR 2/1
5Y 2/1
5YR 2/1

Olive black to brownish black MUDDY NANNOFOSSIL OOZE underlain by a thin layer of SILTY CLAY containing corroded calcareous nannofossils (Section 3, 140 cm–CC). Zeolites are increasingly common toward the base of the core. Undisturbed pieces found intermittently throughout the core indicate that prior to drilling, the sediments were very firm and displayed a tendency toward fissile parting and a strong petroliferous odor.

SMEAR SLIDE SUMMARY

	1-75	3-140
TEXTURE:		
Sand	–	–
Silt	46	51
Clay	54	49
COMPOSITION:		
Quartz	3	15
Feldspar	2	8
Heavy minerals	–	TR
Clay	54	49
Pyrite	10	5
Zeolite	1	20
Carbonate unspec.	TR	3
Calc. nannofossils	30	–

SITE 482 HOLE D CORE 8 CORED INTERVAL 138.0–141.5 m



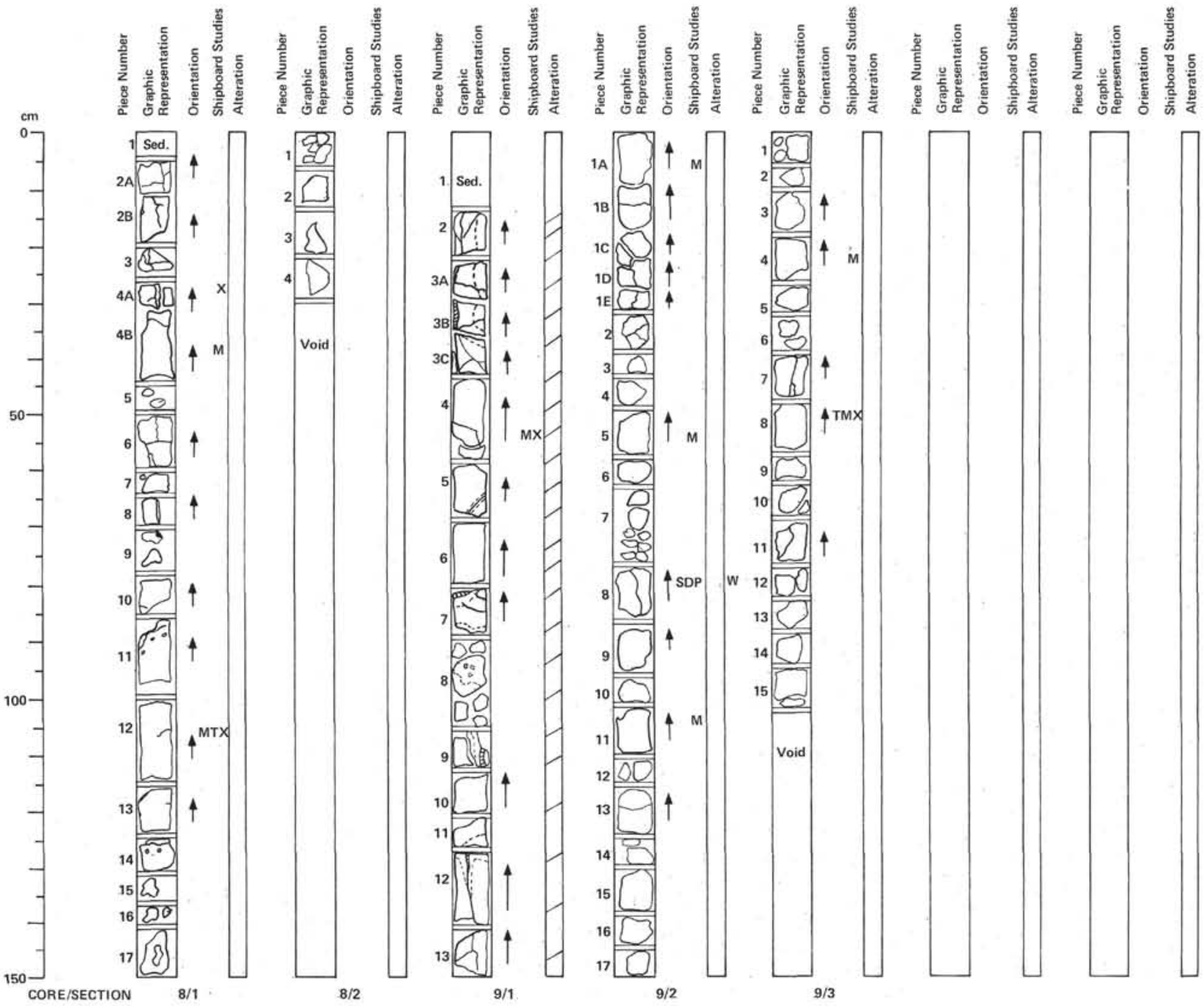
LITHOLOGIC DESCRIPTION

10Y 4/2

Section 1, 0–2 cm: Grayish olive DOLOMITE overlying BASALT. Dolomite display conchoidal fracturing and basalts display pervasive alteration along contact.

SMEAR SLIDE SUMMARY

	1-2
TEXTURE:	
Sand	–
Silt	100
Clay	–
COMPOSITION:	
Calcite	20
Dolomite	80



HOLE 482D, CORE 8

Visual Description

Section 1, 0–2 cm: Grayish-olive, indurated mudstone

Section 1, 2 cm–base of core: Medium gray, very sparsely phyric massive basalt. Plagioclase phenocrysts <1%, 1–2 mm, euhedral laths, fresh. Groundmass fine- to medium-grained, increasing in grain size downward, generally fresh. Vesicles <1%, <1 mm, spherical, filled with calcite and pyrite. Fractures and veinlets common, hairline to 2 mm wide, decreasing in width downward, filled with smectite, calcite and minor pyrite, often with faint alteration halos.

Thin Section Description

Location: Section 1, 30–31 cm

Texture: Very sparsely phyric, fine- to medium-grained, intersertal to intergranular, subvariolitic.

Phenocrysts: Plagioclase 1%, 0.5–1 mm, subhedral laths, fresh.

Groundmass Olivine(?) 1%, 0.1–0.3 mm, possible pseudomorphs of carbonate and pyrite; plagioclase 55%, 0.2–0.5 mm, subhedral laths, fresh; clinopyroxene 30%, 0.05–0.3 mm, anhedral to granular, often poorly crystallized, fresh, $2V_z$ ~30–35°; opaques 5%, mostly pyrite, 0.05–0.2 mm, anhedral, often associated with carbonate; interstitial material 10%, devitrified glass and poorly crystallized clinopyroxene, partly replaced by carbonate and pyrite.

Vesicles: < 1%, 0.2–0.5 mm, round, filled with carbonate and pyrite; some poorly developed segregation vesicles.

Alteration: Olivine(?) and some groundmass material replaced by carbonate and pyrite.

Location: Section 1, 111–113 cm

Texture: Aphyric, fine- to medium-grained, intersertal to subophitic, slightly ophimottled.

Groundmass: Olivine 3–4%, 0.1–0.2 mm, subhedral, completely replaced by smectite and minor carbonate; plagioclase 50%, 0.3–1 mm, subhedral laths, fresh; clinopyroxene 30%, 0.1–0.3 mm, anhedral, fresh, $2V_z$ ~ 40°; magnetite 3%, 0.01–0.08 mm, euhedral to subhedral, mostly in interstitial patches; interstitial material 10–15%, cryptocrystalline, partly replaced by smectite.

Vesicles: 2%, 0.5 mm, round, many with segregation lenses, filled with smectite and carbonate.

Alteration: Olivine and some interstitial material altered to smectite.

HOLE 482D, CORE 9

Visual Description

Section 1, 0–15 cm: Dark yellowish-brown to olive black, indurated mudstone and 1 piece of black chert.

Section 1, 15 cm–base of core: Medium gray, aphyric to very sparsely phyric, massive basalt. Plagioclase phenocrysts < 1%, 1–2 mm, euhedral, fresh, irregularly distributed. Groundmass medium-grained, relatively fresh. Vesicles 1–2%, < 1 mm, decreasing in size and abundant downward, round, filled with greenish-brown smectite, calcite and minor pyrite. Veins and fractures common, hairline to 2 mm wide, filled with blue smectite, calcite, zeolite(?), and minor pyrite, usually surrounded by alteration halos in which pyrite is disseminated in the groundmass.

Thin Section Description

Location: Section 1, 57–58 cm

Texture: Very sparsely phyric, medium-grained, intersertal to subophitic.

Phenocrysts: Plagioclase 1%, 1–1.5 mm, euhedral, fresh.

Groundmass: Olivine 3%, 0.1–0.3 mm, subhedral, completely replaced by smectite; plagioclase 50%, 0.2–0.7 mm, subhedral laths, fresh; clinopyroxene 35–40%, 0.1–0.3 mm, anhedral, fresh, $2V_z$ ~ 40°; magnetite 3%, 0.05–0.1 mm, subhedral; interstitial material 5–10%, glassy, partly replaced by smectite.

Vesicles: 1%, 0.2–1 mm, round, filled with olive green smectite.

Alteration: Olivine and some interstitial material replaced by smectite.

Location: Section 3, 49–50 cm

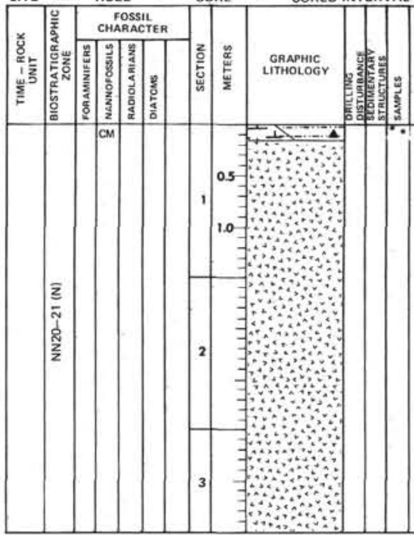
Texture: Aphyric, fine-grained, intersertal to intergranular.

Groundmass: Olivine 2–3%, 0.2–0.5 mm, subhedral, replaced by smectite; plagioclase 45%, 0.2–0.5 mm, subhedral laths, fresh; clinopyroxene 35%, 0.1–0.3 mm, anhedral, fresh, $2V_z$ ~40°; magnetite 3%, 0.02–0.1 mm, subhedral, mostly in interstitial patches; interstitial material 15%, glassy to cryptocrystalline, mostly replaced by smectite.

Vesicles: <1%, <0.5 mm, round, filled with smectite.

Alteration: Olivine and most interstitial material replaced by smectite.

SITE 482 HOLE D CORE 9 CORED INTERVAL 141.5–150.5 m



LITHOLOGIC DESCRIPTION

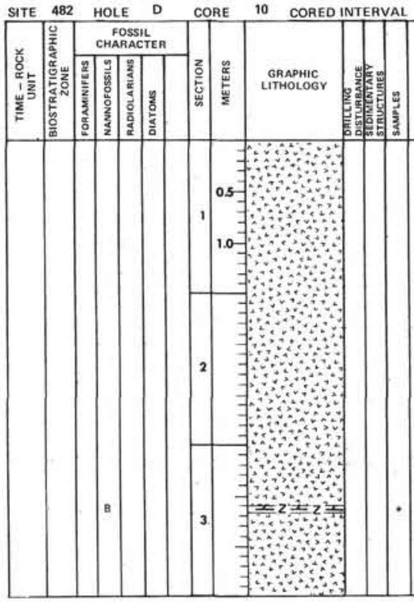
10YR 2/2
5YR 2/1
N1

Firm, dusky yellow brown and olive black NANNOFOSSIL-bearing SILTY CLAY and MUDDY NANNOFOSSIL OOZE. The clay contains a piece or vein of hard grayish black chert composed of amorphous white silica with inclusions of pyrite.

SMEAR SLIDE SUMMARY

	1-1	1-10
TEXTURE:		
Sand	–	–
Silt	51	54
Clay	49	46
COMPOSITION:		
Quartz	10	3
Feldspar	5	TR
Mica	TR	–
Heavy minerals	TR	–
Clay	49	46
Carbonate unspec.	20	3
Calc. nannofossils	16	48

SITE 482 HOLE D CORE 10 CORED INTERVAL 150.5–159.5 m



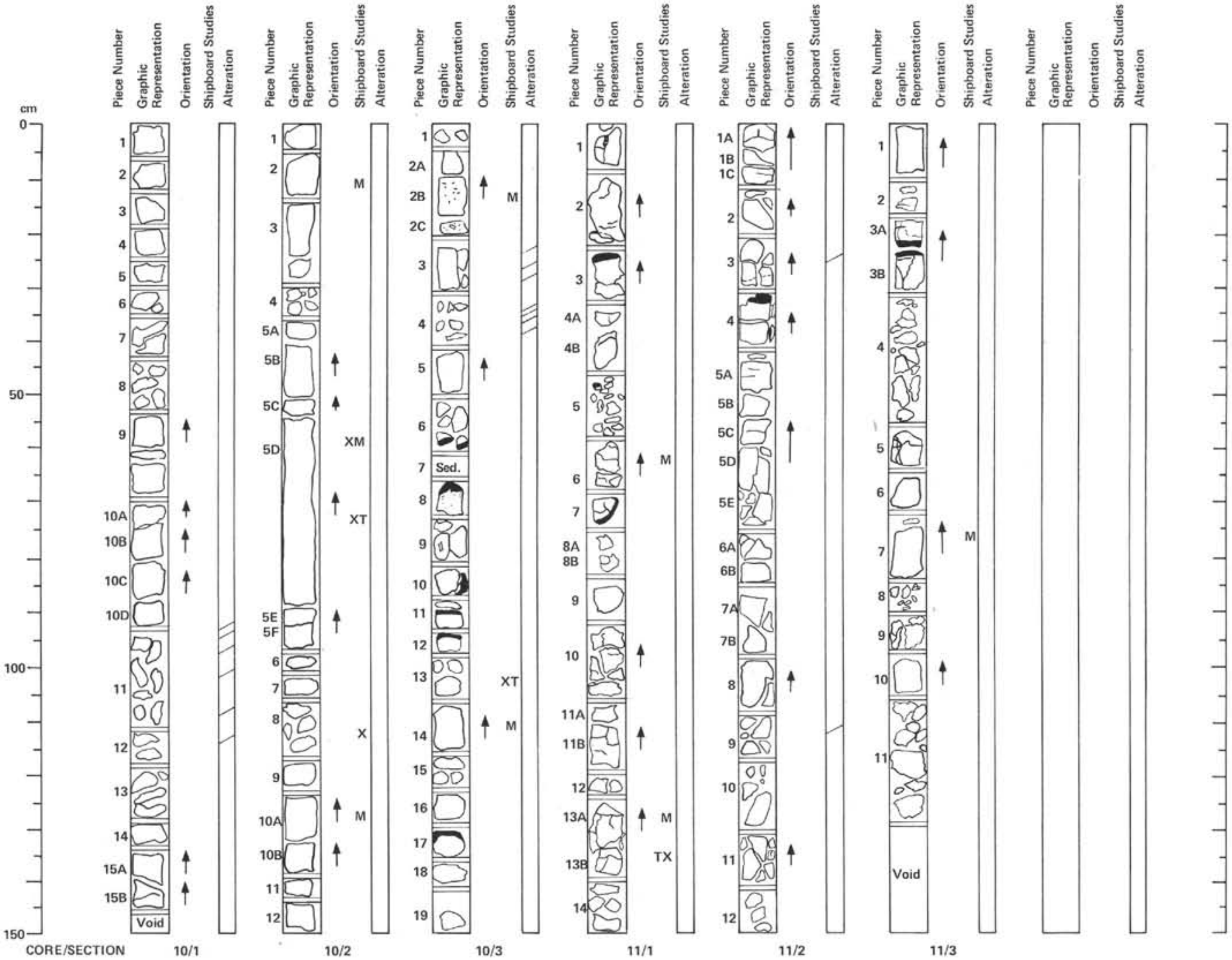
LITHOLOGIC DESCRIPTION

5Y 2/1

Section 3, 60–65 cm: Firm, olive-black ZEOLITIC DOLOMITE overlain and underlain by BASALT with glassy chill margins.

SMEAR SLIDE SUMMARY

	3-63
TEXTURE:	
Sand	–
Silt	100
Clay	–
COMPOSITION:	
Quartz	5
Zeolite	55
Dolomite	45



HOLE 482D, CORE 10

Visual Description

Section 1, 0 cm–Section 3, 60 cm: Medium gray, aphyric to very sparsely phyric, massive basalt. Plagioclase microphenocrysts <1%, < 4 mm, euhedral, fresh. Groundmass fine- to medium-grained, slightly mottled; glass selvedge in Section 3, 59 cm; grain size decreases gradually downward in Section 3. Fractures and veinlets sparse, hairline to 1 mm wide, filled with smectite, calcite and minor pyrite.

Section 3, 60–65 cm: Olive black, firm, dolomitic mudstone.

Section 3, 65 cm–base of core: Dark gray, sparsely phyric, pillowed(?) basalt. Plagioclase phenocrysts 1%, 1–2 mm, euhedral, intergrown with clinopyroxene. Groundmass fine-grained to glassy; glass selvedges at 66, 89, 93, and 130 cm; grain size increases gradually away from selvedges. Glass selvedges partly altered to smectite and often coated with pyrite.

Thin Section Description

Location: Section 2, 70–72 cm

Texture: Very sparsely phyric, medium-grained, intersertal to intergranular.

Phenocrysts: Olivine < 1%, 2–4 mm, subhedral, partly replaced by smectite; plagioclase < 1%, 1 mm, subhedral, fresh, in small clots with olivine.

Groundmass: Olivine 2–3%, 0.1–0.5 mm, subhedral, replaced by smectite; plagioclase 50%, 0.2–1 mm, subhedral laths, fresh; clinopyroxene 35%, 0.1–0.3 mm, anhedral, fresh, $2V_z$ ~35–40°; magnetite 3%, 0.03–0.1 mm, subhedral, mostly in interstitial patches; interstitial material 10%, microcrystalline feldspar, clinopyroxene, silica and apatite, partly replaced by smectite.

Vesicles: <1%, 0.2–0.5 mm, round, filled with smectite.

Alteration: Olivine and interstitial material partly replaced by smectite.

Location: Section 3, 17–19 cm

Texture: Very sparsely phyric, fine-grained, intergranular.

Phenocrysts: Olivine < 1%, < 1 mm, subhedral, replaced by smectite; plagioclase <1%, 0.5–1 mm, subhedral, fresh.

Groundmass: Olivine(?) 1%, 0.1–0.2 mm, subhedral pseudomorphs of smectite; plagioclase 50%, 0.2–0.5 mm, subhedral laths, fresh; clinopyroxene 40%, 0.1–0.2 mm, anhedral, fresh, $2V_z$ ~40°; magnetite 2–3%, 0.05–0.1 mm, subhedral to anhedral; interstitial material 5%, cryptocrystalline material with some apatite, replaced by smectite.

Vesicles: 1%, 0.3 mm, round, filled with smectite.

Alteration: Olivine and interstitial material replaced by smectite, minor opal(?) in groundmass.

Location: Section 3, 101–103 cm

Texture: Moderately phyric, quench

Phenocrysts: Olive 5%, 0.3–0.5 mm, subhedral to euhedral, completely replaced by smectite; plagioclase 15%, 0.5–1.5 mm, seriate, subhedral laths and acicular crystals, fresh.

Groundmass: Olivine 1%, 0.05–0.1 mm, subhedral, replaced by smectite; plagioclase 5–10%, 0.2–0.5 mm, acicular, fresh; magnetite 2–3% minute granules in groundmass; interstitial material 70–75%, quench mixture of clinopyroxene, magnetite and plagioclase, mostly fresh.

Vesicles: 1–2%, 0.5–1 mm, round to irregular, open or filled with smectite.

Alteration: Olivine and some groundmass material replaced by smectite.

HOLE 482D, CORE 11

Visual Description

Dark gray, aphyric, pillowed(?) basalt. Basalt is fine-grained to glassy, often mottled; glass selvedges occur in Section 1, 25 and 74 cm, Section 2, 32 cm, and Section 3, 24 cm; grain size fairly uniform but decreases gradually toward glass selvedges. Veinlets and fractures sparse, hairline to 1 mm wide, filled with smectite, calcite, and minor pyrite.

Thin Section Description

Location: Section 1, 133–135 cm

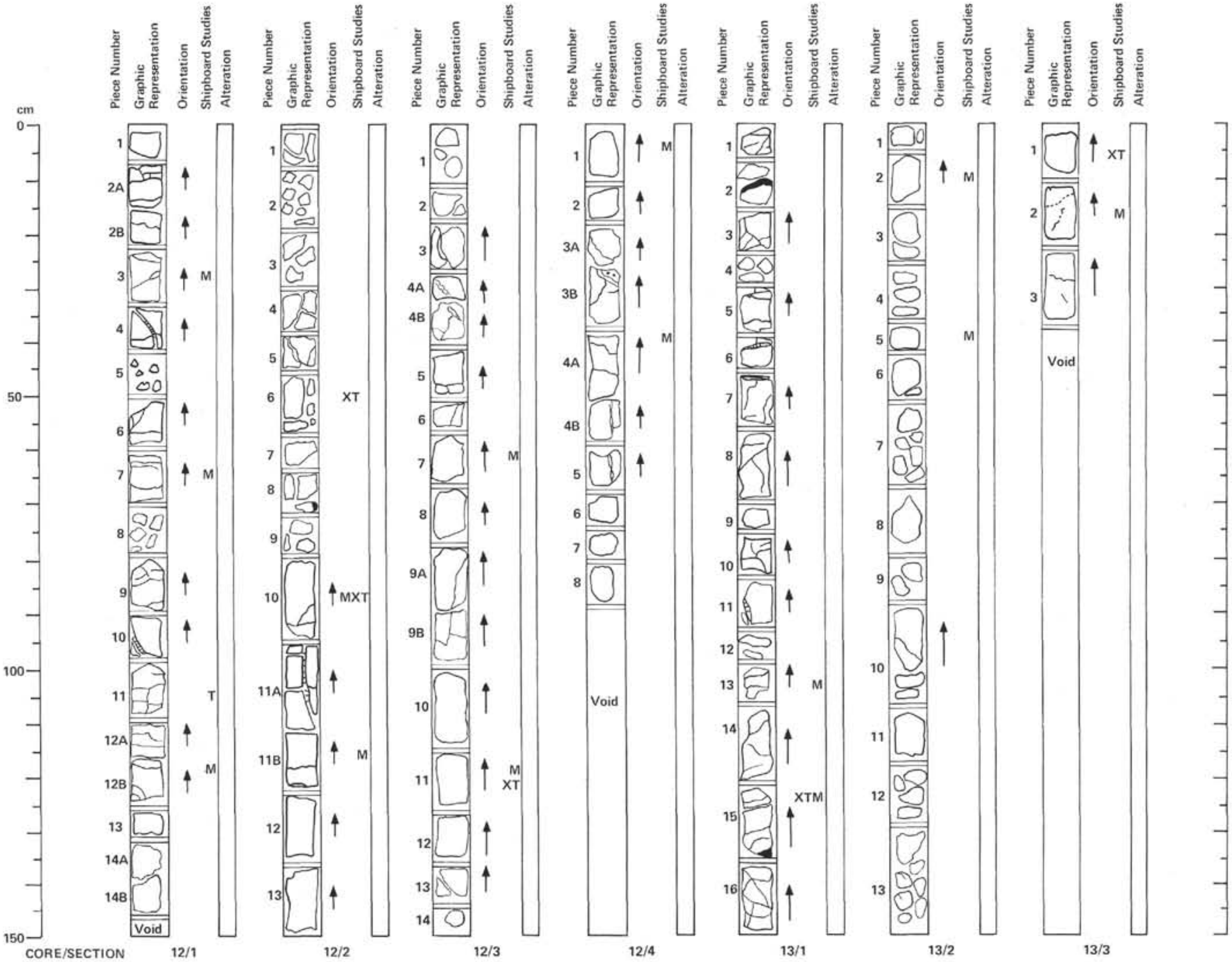
Texture: Sparsely phyric, quench to intersertal

Phenocrysts: Olivine 1%, 0.5 mm, subhedral, partly replaced by smectite, $2V_z$ ~88°; plagioclase 10%, 0.5–2 mm, seriate, subhedral laths, fresh.

Groundmass: Olivine 2%, 0.2–0.4 mm, subhedral, partly replaced by smectite; plagioclase 45%, 0.2–0.5 mm, subhedral, fresh; clinopyroxene 30%, 0.05–0.2 mm, poorly crystallized sheaves and granules, fresh; magnetite 2%, minute granules in interstitial patches; interstitial material 10%, glassy to cryptocrystalline, partly replaced by smectite.

Vesicles: <1%, 0.2–0.3 mm, round, filled with smectite.

Alteration: Some olivine and interstitial material replaced by smectite.



HOLE 482D, CORE 12

Visual Description

Section 1, 0–130 cm: Medium gray, aphyric to very sparsely phyric, massive basalt. Plagioclase microphenocrysts < 1%, 1–1.5 mm, euhedral, fresh. Groundmass fine- to medium-grained, decreasing in grain size downward. Vesicles <1%, <1 mm, spherical, filled with green smectite. Veins and fractures sparse, hairline to 1 mm, filled and coated with smectite, calcite, zeolite(?) and minor pyrite.

Section 1, 130 cm–base of core: Medium gray, sparsely phyric, massive basalt. Plagioclase phenocrysts 1–2%, 1–4 mm, euhedral, fresh. Groundmass fine- to medium-grained with glass selvedge in Section 2, 71 cm; groundmass generally fresh. Vesicles 1%, <1.5 mm, spherical to irregular, filled with green smectite and minor calcite. Fractures irregularly distributed, hairline to 4 mm wide, filled with smectite, calcite, zeolite(?) and minor pyrite; alteration halos around some veins have disseminated pyrite.

Thin Section Description

Location: Section 1, 107–109 cm

Texture: Sparsely phyric, medium-grained, intersertal to subophitic.

Phenocrysts: Plagioclase 5%, 0.5–3 mm, subhedral, fresh.

Groundmass: Olivine 5–7%, 0.1–0.5 mm, subhedral, partly replaced by smectite, $2V_z \sim 88°$; plagioclase 45%, 0.2–0.5 mm, subhedral, fresh; clinopyroxene 35%, 0.2–0.3 mm, anhedral, fresh, $2V_z \sim 40°$; magnetite 3%, minute granules, mostly in interstitial patches; interstitial material 5%, cryptocrystalline, partly replaced by smectite.

Vesicles: 1%, 0.2–0.3 mm, round, rimmed with smectite and filled with carbonate.

Alteration: Some olivine and interstitial material replaced by smectite.

Location: Section 2, 49–50 cm

Texture: Moderately phyric, quench

Phenocrysts: Olivine 2–3%, <0.5 mm, euhedral to subhedral, altered to smectite; plagioclase 5%, 0.5–1 mm, subhedral laths, fresh; clinopyroxene 2–3%, 0.3–0.6 mm, anhedral, fresh, either as single crystals or in clots intergrown with plagioclase, $2V_z \sim 35°$.

Groundmass: Quenched groundmass 90%, consists of fine magnetite grains in poorly crystallized mixture of clinopyroxene and plagioclase in radiating sheaves; some small glassy patches partly replaced by smectite.

Vesicles: < 1%, < 0.5 mm, round to irregular, filled with smectite.

Alteration: Olivine and some interstitial material replaced by smectite.

Location: Section 2, 80–84 cm

Texture: Sparsely phyric, fine-grained, intersertal to quench

Phenocrysts: Plagioclase 3%, 0.5–1.5 mm, subhedral to euhedral, zoned, fresh.

Groundmass: Olivine 2%, 0.1–0.3 mm, subhedral, replaced by smectite; plagioclase 45%, 0.1–0.5 mm, anhedral, often in poorly crystallized sheaves, fresh, $2V_z \sim 40°$; magnetite 2%, minute crystals in interstitial patches; interstitial material 10–15%, glassy, partly replaced by smectite.

Vesicles: 1%, 0.1–0.3 mm, round, filled with smectite

Alteration: Olivine and some interstitial material replaced by smectite.

Location: Section 3, 116–117 cm

Texture: Very sparsely phyric, medium-grained, intersertal to subophitic

Phenocrysts: Plagioclase 1%, 1–1.5 mm, subhedral, fresh.

Groundmass: Olivine 3%, 0.1–0.6 mm, subhedral, replaced by smectite; plagioclase 50%, 0.2–0.6 mm, subhedral laths, fresh; clinopyroxene 40%, 0.1–0.4 mm, anhedral, fresh, $2V_z \sim 40°$; magnetite 1–2%, 0.02–0.1 mm, euhedral to subhedral, in interstitial patches; interstitial material 5–8%, cryptocrystalline with minor apatite, partly replaced by smectite.

Vesicles: 1%, < 0.3 mm, round, filled with smectite

Alteration: Olivine and some interstitial material replaced by smectite.

HOLE 482D, CORE 13

Visual Description

Medium- to dark-gray, sparsely phyric, massive basalt. Plagioclase phenocrysts 1%, 1–4 mm, euhedral, fresh. Groundmass fine- to medium-grained, variable, weakly to moderately altered; glass selvedge in Section 1, 12 cm. Vesicles <1%, <1 mm, spherical, filled with green smectite. Fractures and veinlets common, hairline to 1 mm wide, lined or filled with smectite and zeolite(?) with rare calcite and pyrite. Some alteration halos along veins.

Thin Section Description

Location: Section 1, 123–125 cm

Texture: Sparsely phyric, fine-grained, intersertal to subophitic.

Phenocrysts: Plagioclase 2–4%, 0.5–3 mm, subhedral to euhedral, often in clusters, some zoned, fresh.

Groundmass: Olivine 3–5%, 0.1–0.3 mm, subhedral, replaced by smectite and carbonate; plagioclase 45%, 0.2–0.5 mm, subhedral laths, fresh; clinopyroxene 40%, 0.1–0.4 mm, anhedral, fresh, $2V_z \sim 40°$; magnetite 2%, minute granules in interstitial patches; interstitial material 5%, cryptocrystalline material, partly replaced by smectite and carbonate.

Alteration: Olivine and some interstitial material replaced by smectite and carbonate.

Location: Section 3, 8–9 cm

Texture: Very sparsely phyric, fine-grained, intersertal to intergranular

Phenocrysts: Plagioclase 1%, 0.5–1 mm, subhedral, fresh, usually in clusters.

Groundmass: Olivine 2–3%, 0.1–0.3 mm, subhedral, replaced by smectite; plagioclase 50%, 0.2–0.5 mm, subhedral laths, fresh; clinopyroxene 40%, 0.1–0.3 mm, anhedral, fresh, $2V_z \sim 40°$; magnetite 2%, < 0.05 mm, euhedral to subhedral, usually in interstitial patches; interstitial material 5%, cryptocrytalline material, partly replaced by smectite.

Vesicles: < 1%, 0.1 mm, round, filled with smectite

Alteration: Olivine and some interstitial material replaced by smectite.

Location: Section CC

Texture: Sparsely phyric, quench

Phenocrysts: Olivine < 1%, 0.4–0.7 mm, euhedral, replaced by smectite; plagioclase 3–4%, 0.5–1.5 mm, subhedral laths, fresh.

Groundmass: Olivine 2%, 0.05–0.1 mm, subhedral, replaced by smectite; plagioclase 5–10%, acicular crystals, < 0.4 mm, fresh; glass 80–85%, brown, incipiently crystallized with sheaf structure, usually fresh.

Vesicles: 1%, 0.2–0.3 mm, round, filled with smectite

Veins and Fractures: Rare, 0.2 mm wide, filled with smectite

Alteration: Olivine and minor glass altered to smectite.

SITE 482 HOLE F CORE 2 CORED INTERVAL 113.5–123.0 m

TIME – ROCK UNIT	BIOSTRATIGRAPHIC ZONE	FORAMINIFERS	NANNOFOSSILS	RADIOLARIANS	DIATOMS	SECTION	METERS
LATE QUATERNARY	NN20–21 (N)		FM			1	0.5, 1.0
		CM		CG		2	
		B		AG		3	
						CC	

GRAPHIC LITHOLOGY

DRILLING DISTURBANCE | SEDIMENTARY STRUCTURES | SAMPLES

LITHOLOGIC DESCRIPTION

10YR 2/2

VOID

Site 482F, Core 1, 49.0–56.5 m: NO RECOVERY.

Dusky yellow brown SILTY CLAY containing small (mm) agglomerates of sponge spicules and up to 15% calcareous nannofossils. Sediments stiff in Sections 1 and 2, increasingly fissile toward the base of Section 3.

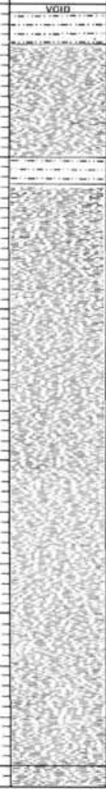
SMEAR SLIDE SUMMARY

	1-82 (M)	3-50
TEXTURE:		
Sand	1	1
Silt	45	29
Clay	55	70
COMPOSITION:		
Quartz	15	8
Feldspar	TR	3
Mica	–	TR
Heavy minerals	TR	TR
Clay	55	70
Pyrite	TR	1
Carbonate unspec.	–	1
Foraminifers	–	TR
Calc. nannofossils	5	15
Sponge spicules	25	–

SITE 482 HOLE F CORE 3 CORED INTERVAL 123.0–132.5 m

TIME – ROCK UNIT	BIOSTRATIGRAPHIC ZONE	FORAMINIFERS	NANNOFOSSILS	RADIOLARIANS	DIATOMS	SECTION	METERS
LATE QUATERNARY	NN20–21 (N)		CG			1	0.5, 1.0
		B		B			
						2	
						3	
			CG			4	
			B			5	
						CC	

GRAPHIC LITHOLOGY



DRILLING DISTURBANCE | SEDIMENTARY STRUCTURES | SAMPLES

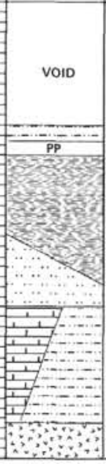
LITHOLOGIC DESCRIPTION

10YR 2/2

Dusky yellow brown SILTY CLAY. Sediments firm to hard with well-developed fissile parting throughout most of the core.

SITE 482 HOLE F CORE 4 CORED INTERVAL 132.0–142.0 m

TIME – ROCK UNIT	BIOSTRATIGRAPHIC ZONE	FOSSIL CHARACTER: FORAMINIFERS	NANNOFOSSILS	RADIOLARIANS	DIATOMS	SECTION	METERS	GRAPHIC LITHOLOGY	DRILLING DISTURBANCE	SEDIMENTARY STRUCTURES	SAMPLES
LATE QUATERNARY	NN20–21 (N)		CM			1	0.5 1.0	VOID, PP			
			CM			2					
			CM, CM, CM			3					*, •*



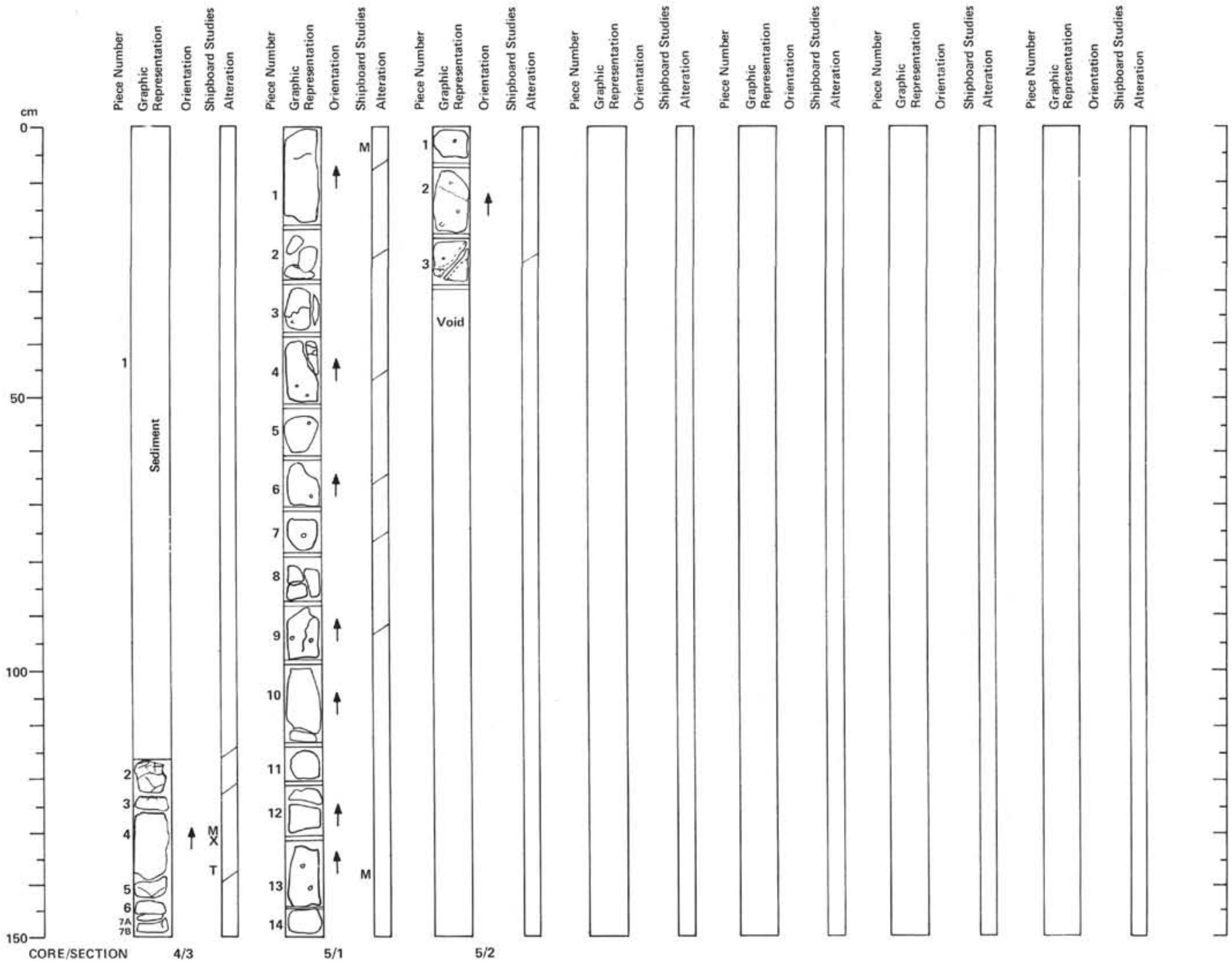
LITHOLOGIC DESCRIPTION

5Y 2/1

Very firm to hard, olive black fissile SHALE *and* SILTY CLAY grading with depth to SILTSTONE and then NANNOFOSSIL CHALK mixed with hard SILTY CLAY over BASALT.

SMEAR SLIDE SUMMARY

	3-25	3-110	3-115
TEXTURE:			
Sand	–	–	–
Silt	68	45	30
Clay	32	55	70
COMPOSITION:			
Quartz	10	20	15
Feldspar	2	5	5
Mica	–	–	TR
Heavy minerals	1	–	TR
Clay	32	55	70
Pyrite	4	1	2
Zeolite	1	2	1
Carbonate unspec.	–	1	TR
Foraminifers	–	1	TR
Calc. nannofossils	50	15	7
Diatoms	TR	TR	–



HOLE 482F, CORE 4

Visual Description

Light gray, very sparsely phyric, massive basalt. Plagioclase phenocrysts 1%, 1–2 mm, euhedral, fresh, intergrown with minor clinopyroxene. Groundmass fine-grained, relatively fresh. Vesicles 1–2%, <1 mm, spherical, filled with smectite.

Thin Section Description

Location: Section 3, 134–136 cm

Texture: Aphyric, fine-grained, intergranular

Groundmass: Olivine(?) 1%, 0.05–0.1 mm, subhedral pseudomorphs of smectite; plagioclase 55%, 0.1–0.4 mm, subhedral laths, fresh; clinopyroxene 35%, 0.1–0.3 mm, anhedral, fresh, $2V_z \sim 40°$; magnetite 5%, 0.05–0.1 mm, subhedral; interstitial material 5%, cryptocrystalline with minor apatite, replaced by smectite and carbonate.

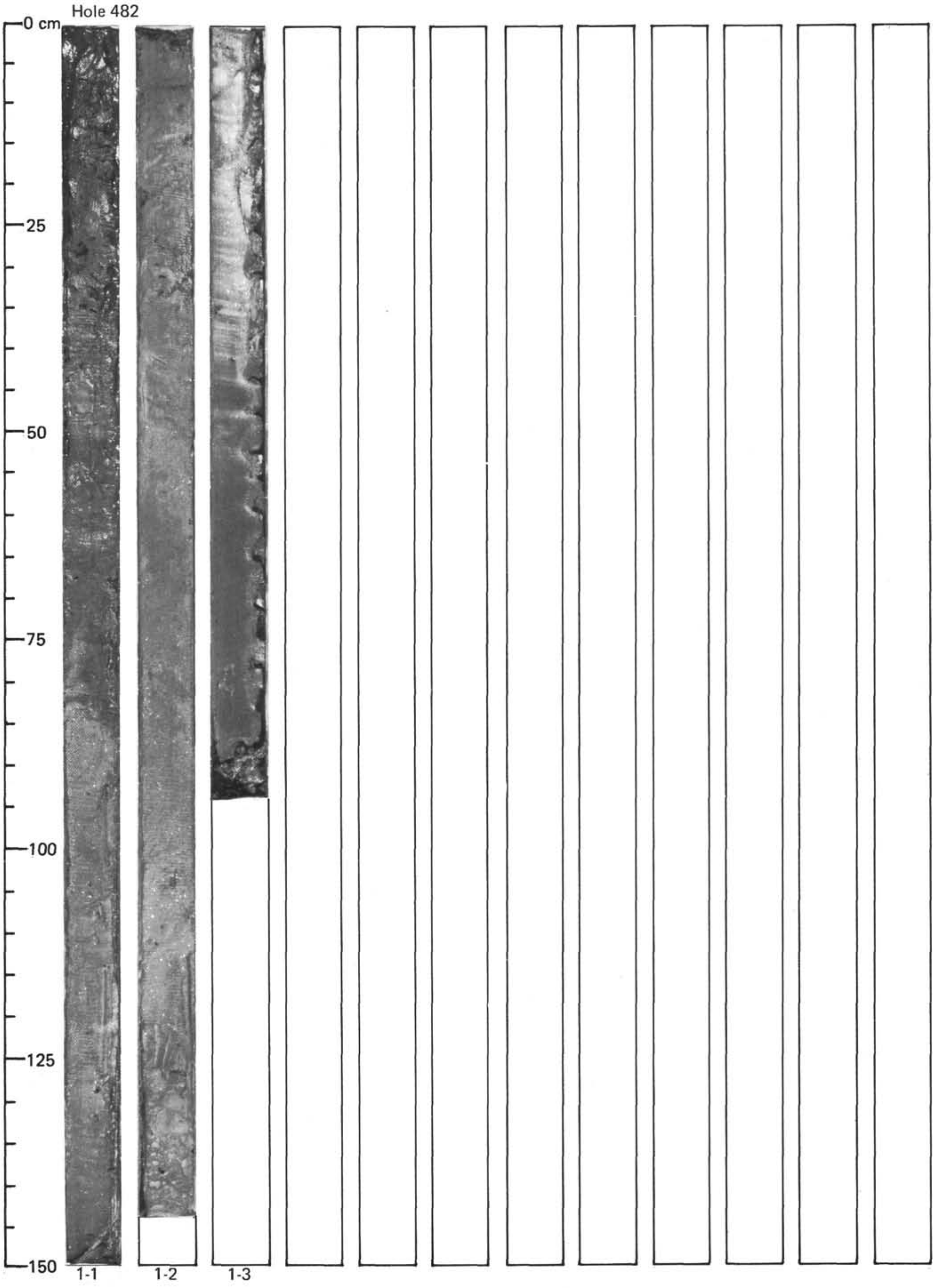
Vesicles: 1–2%, < 0.5 mm, round, rimmed with smectite and filled with carbonate

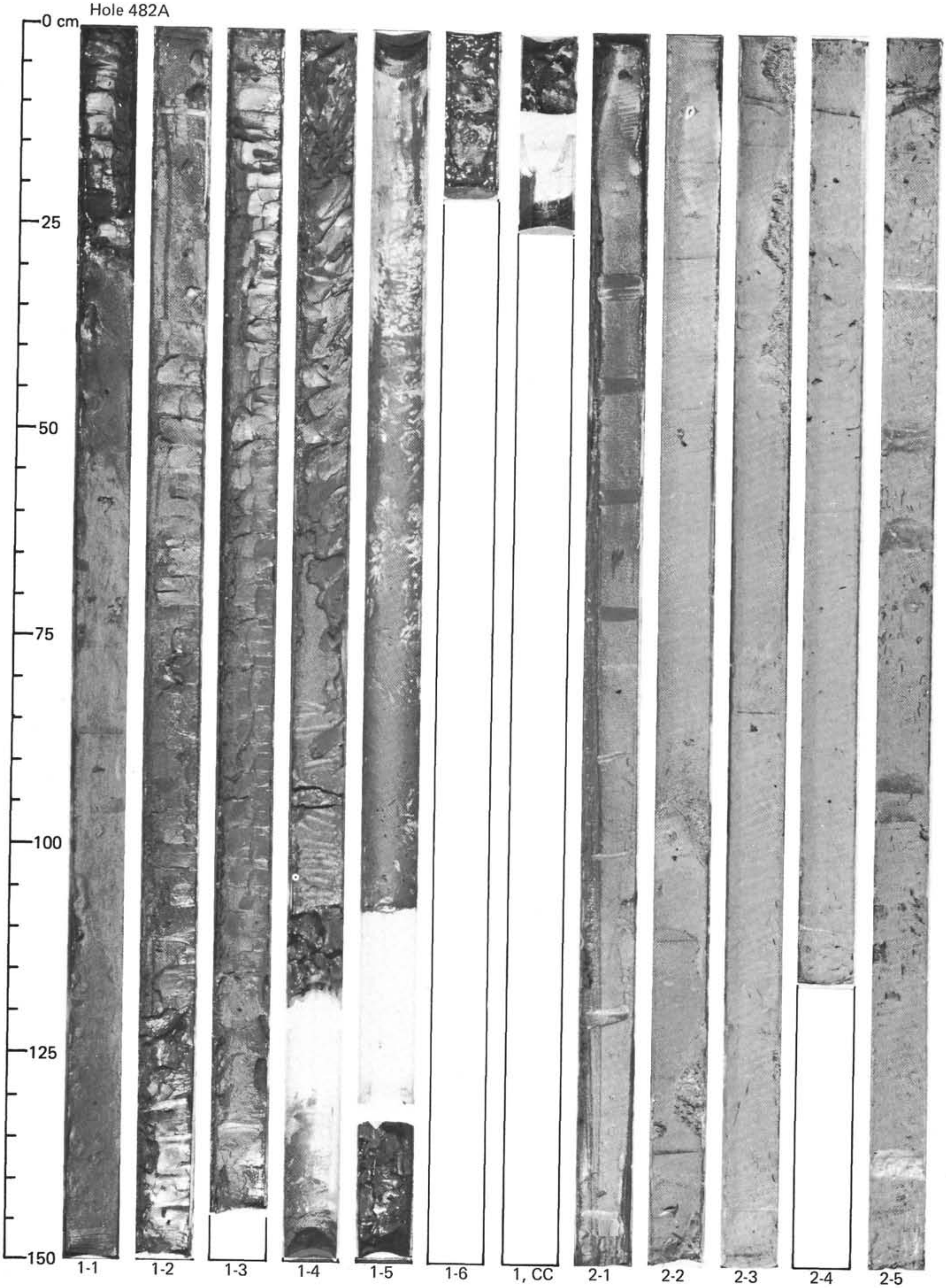
Alteration: Olivine(?) and most interstitial material replaced by smectite and carbonate.

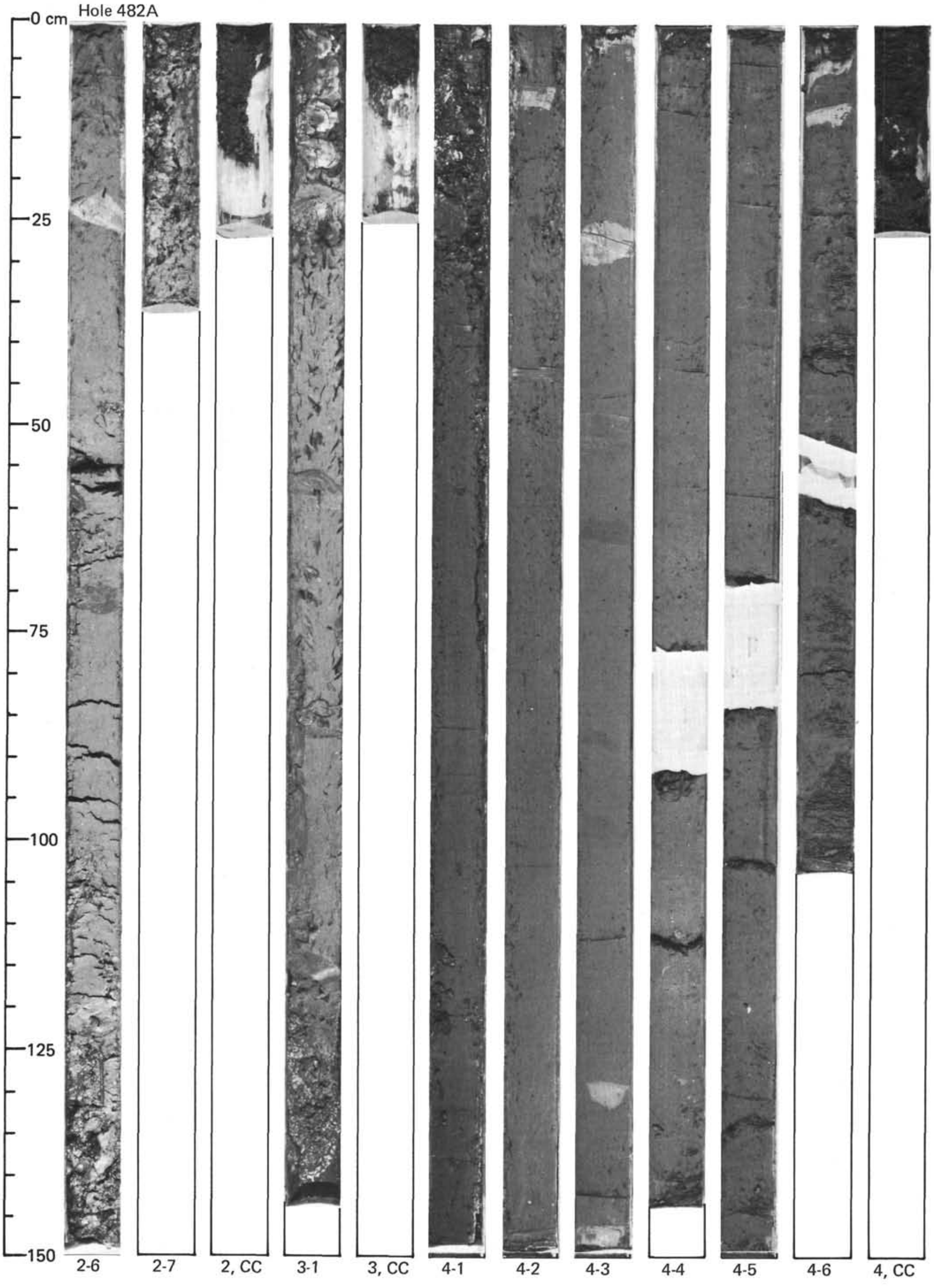
HOLE 482F, CORE 5

Visual Description

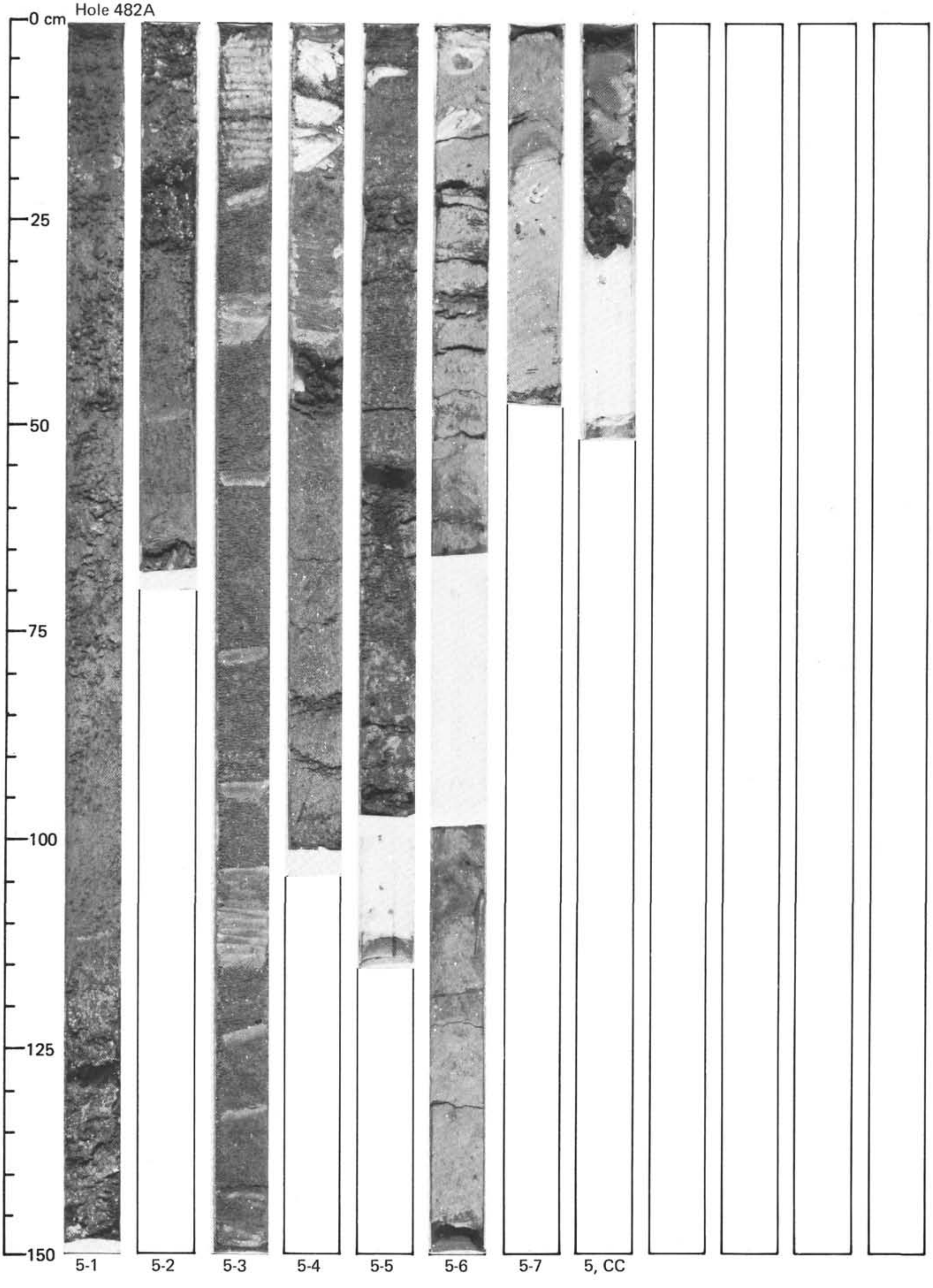
Light gray, very sparsely phyric, massive basalt. Plagioclase phenocrysts 1%, 1–2 mm, euhedral, fresh, intergrown with minor clinopyroxene. Groundmass fine- to medium-grained, relatively fresh. Vesicles 1–2%, < 1 mm, spherical, filled with smectite and calcite. Veins and fractures common, hairline to 1 mm wide, filled or lined with smectite and pyrite; some veins have alteration halos with disseminated pyrite.

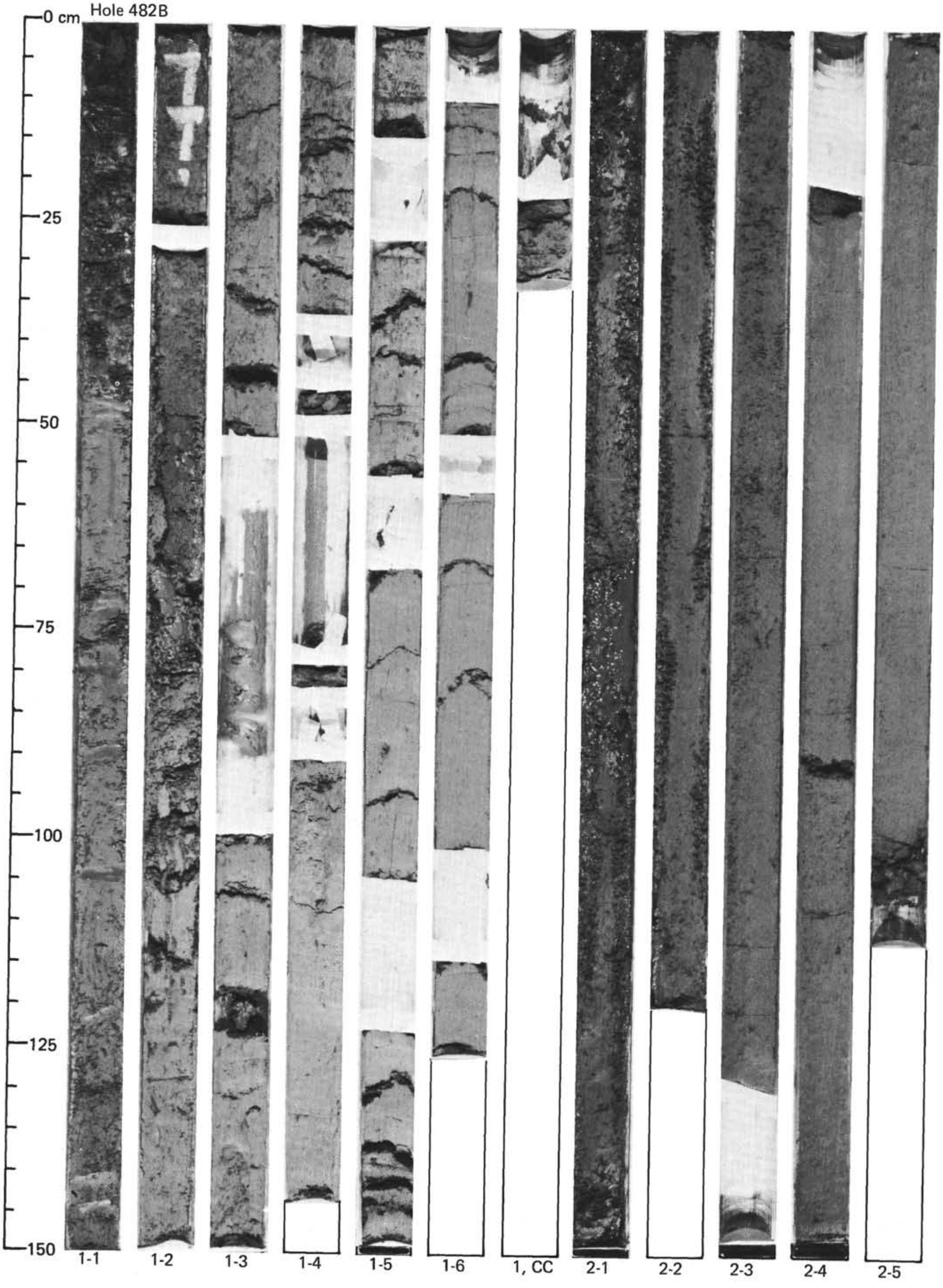

Hole 482
0 cm
25
50
75
100
125
150
1-1
1-2
1-3

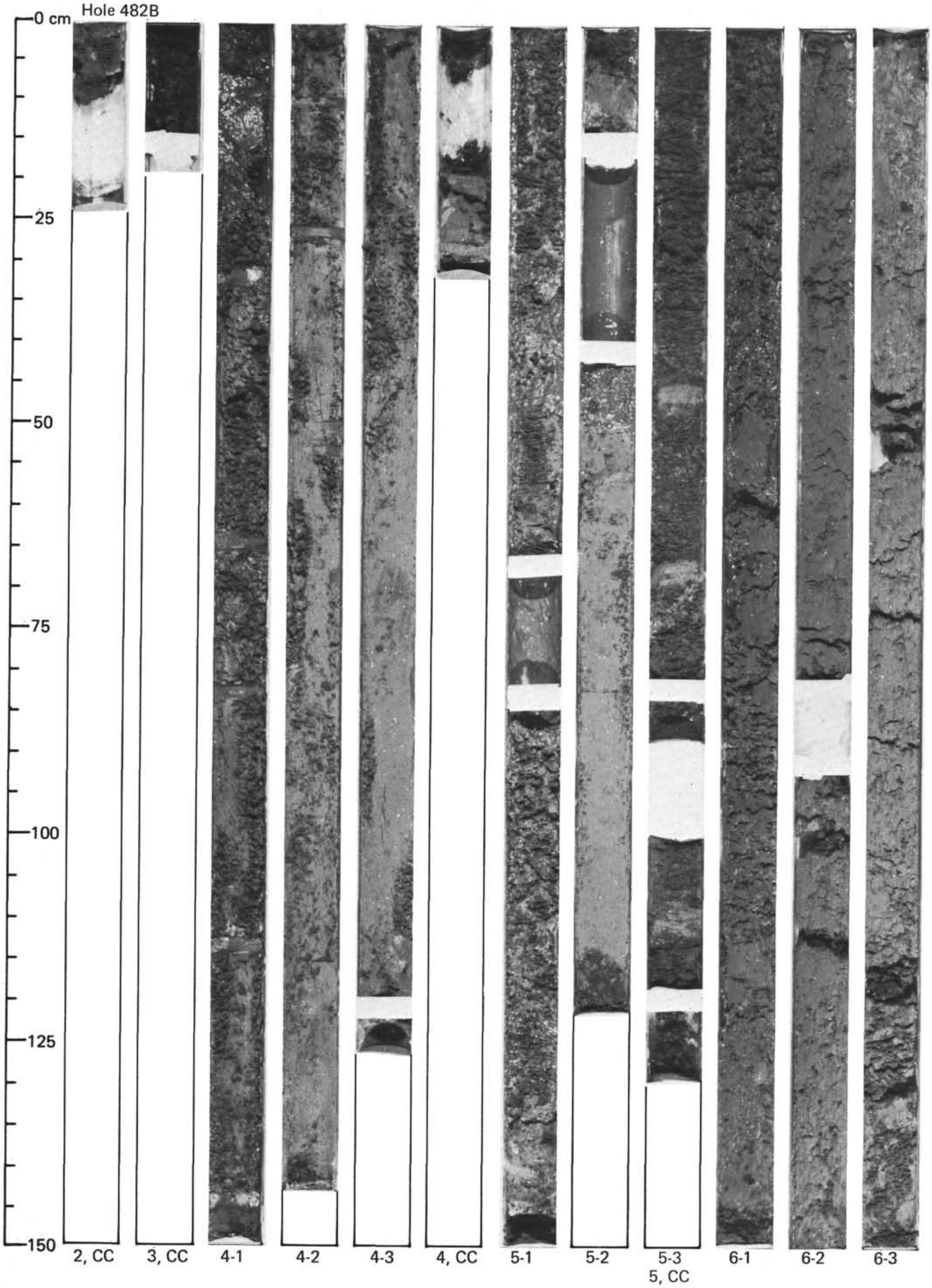

Hole 482A
0 cm
25
50
75
100
125
150
1-1
1-2
1-3
1-4
1-5
1-6
1, CC
2-1
2-2
2-3
2-4
2-5

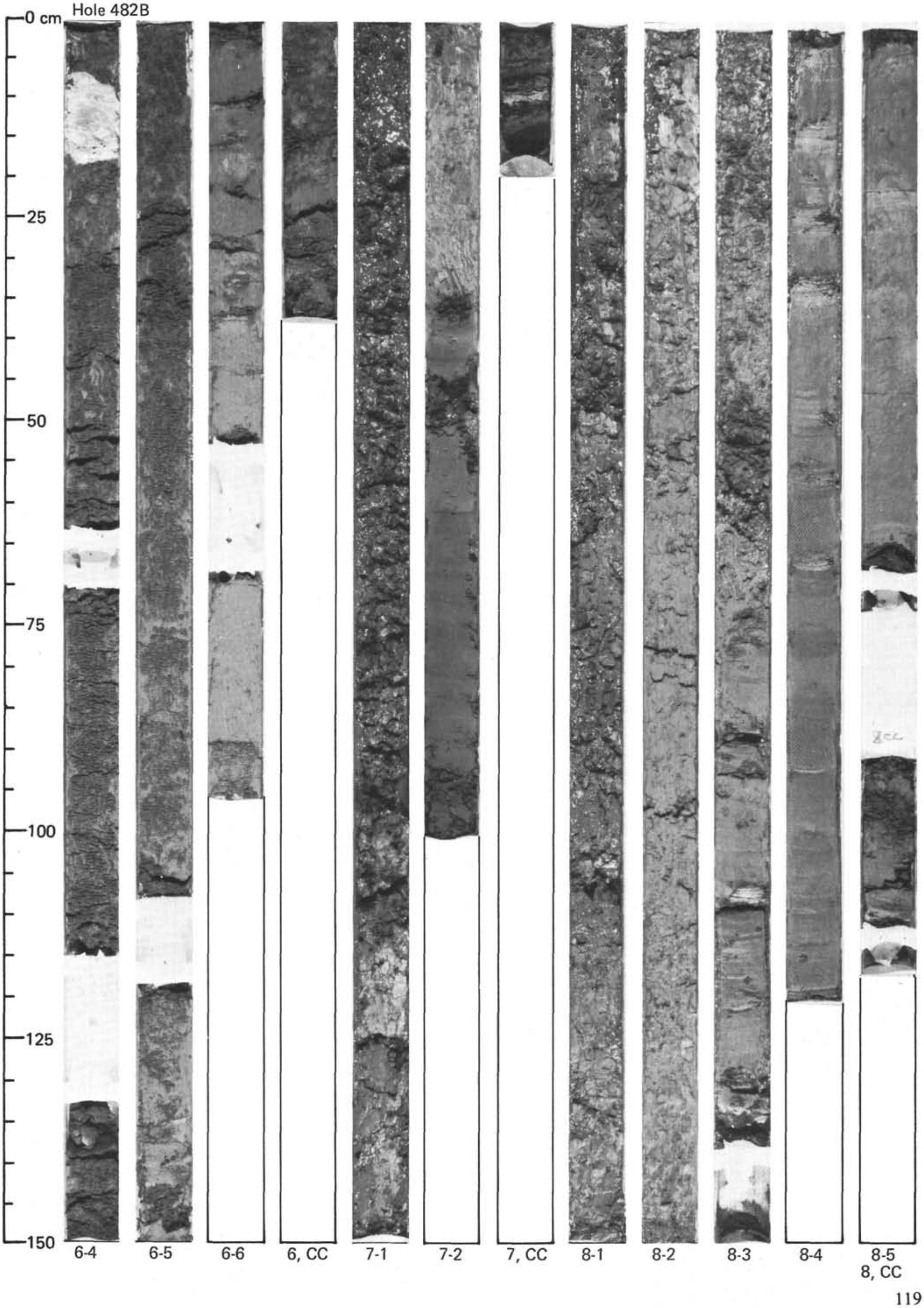


Hole 482A
0 cm
25
50
75
100
125
150
2-6
2-7
2, CC
3-1
3, CC
4-1
4-2
4-3
4-4
4-5
4-6
4, CC

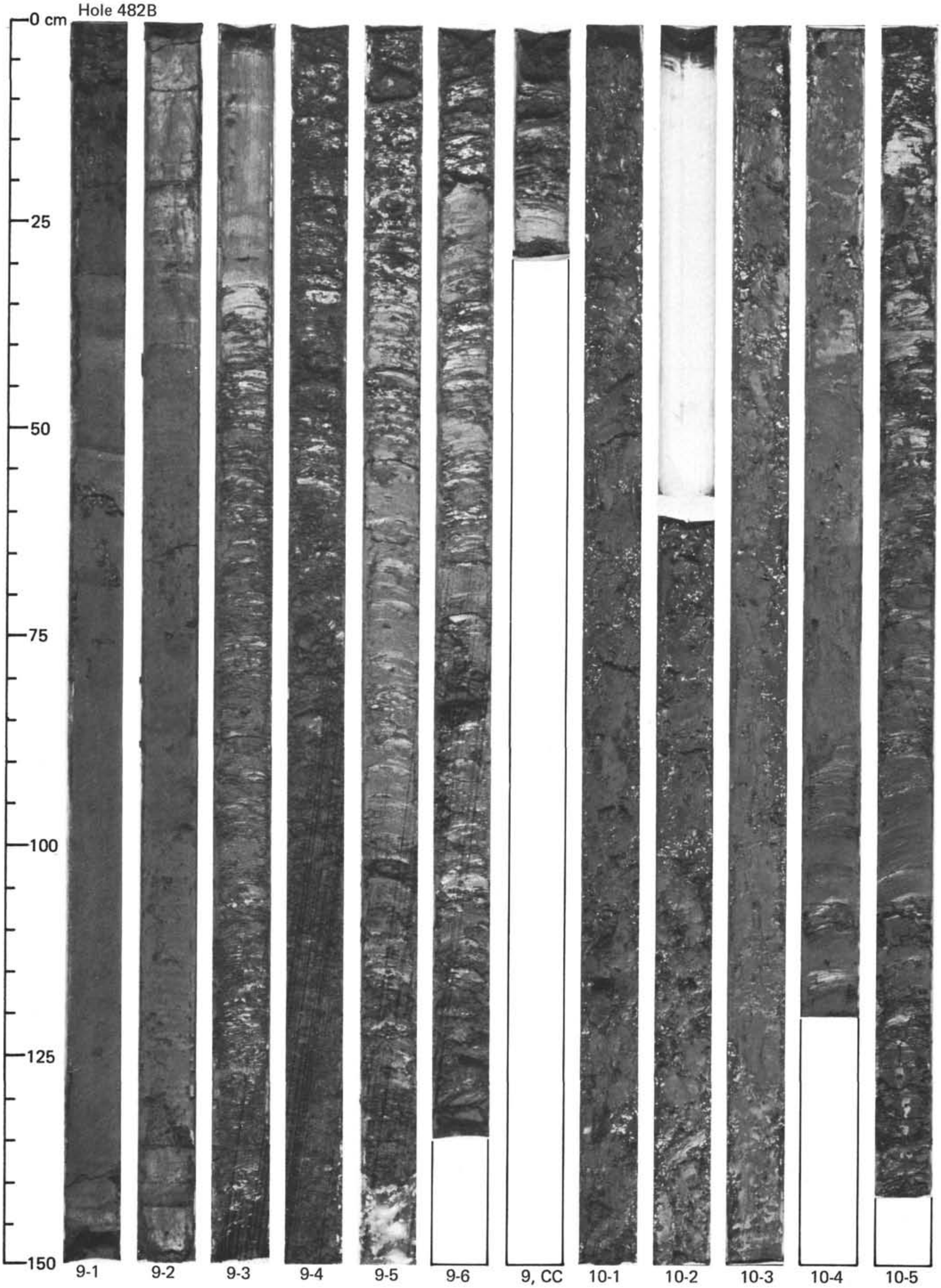

Hole 482A
0 cm
25
50
75
100
125
150
5-1
5-2
5-3
5-4
5-5
5-6
5-7
5, CC

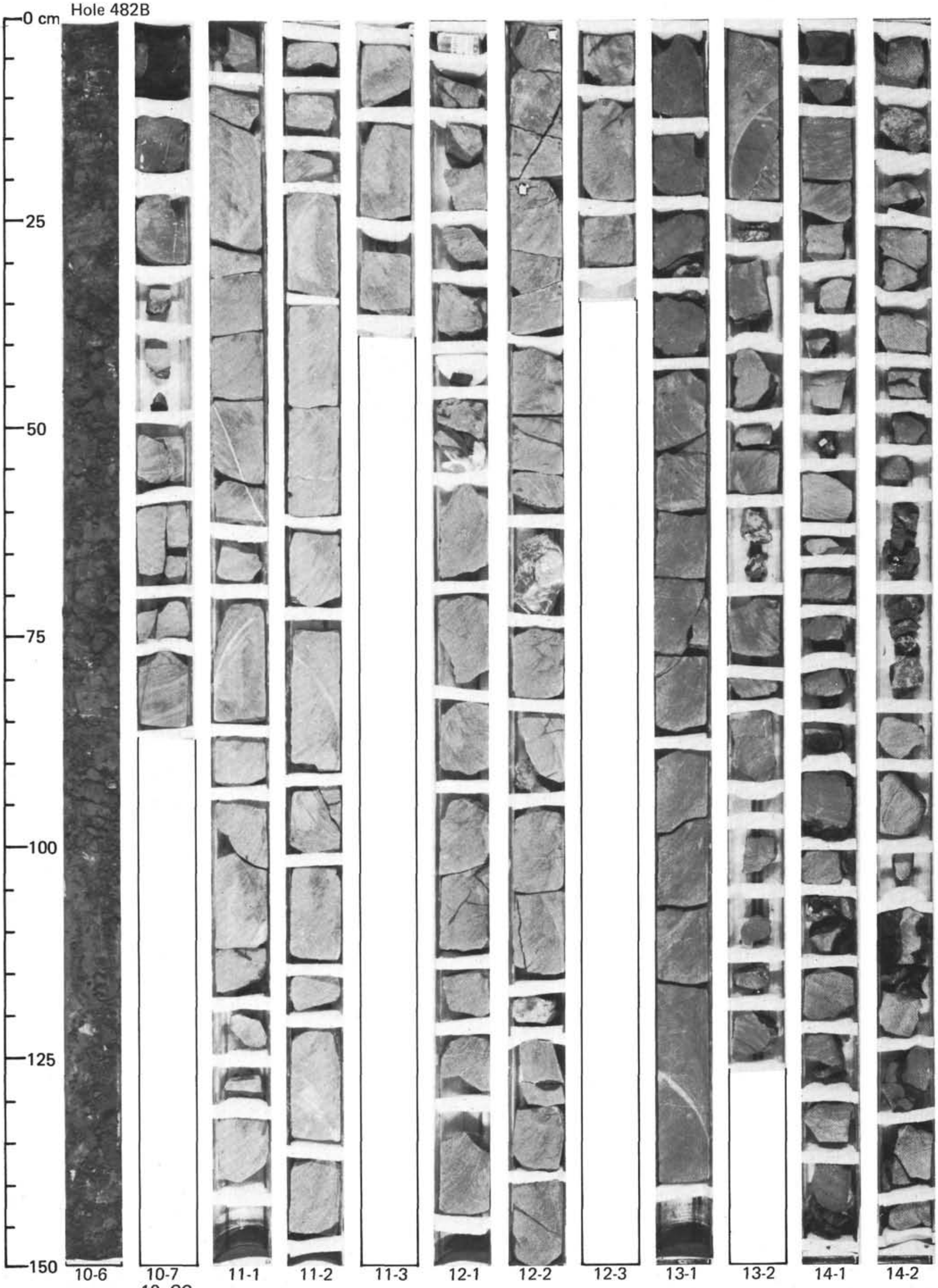

Hole 482B
0 cm
25
50
75
100
125
150
1-1
1-2
1-3
1-4
1-5
1-6
1, CC
2-1
2-2
2-3
2-4
2-5

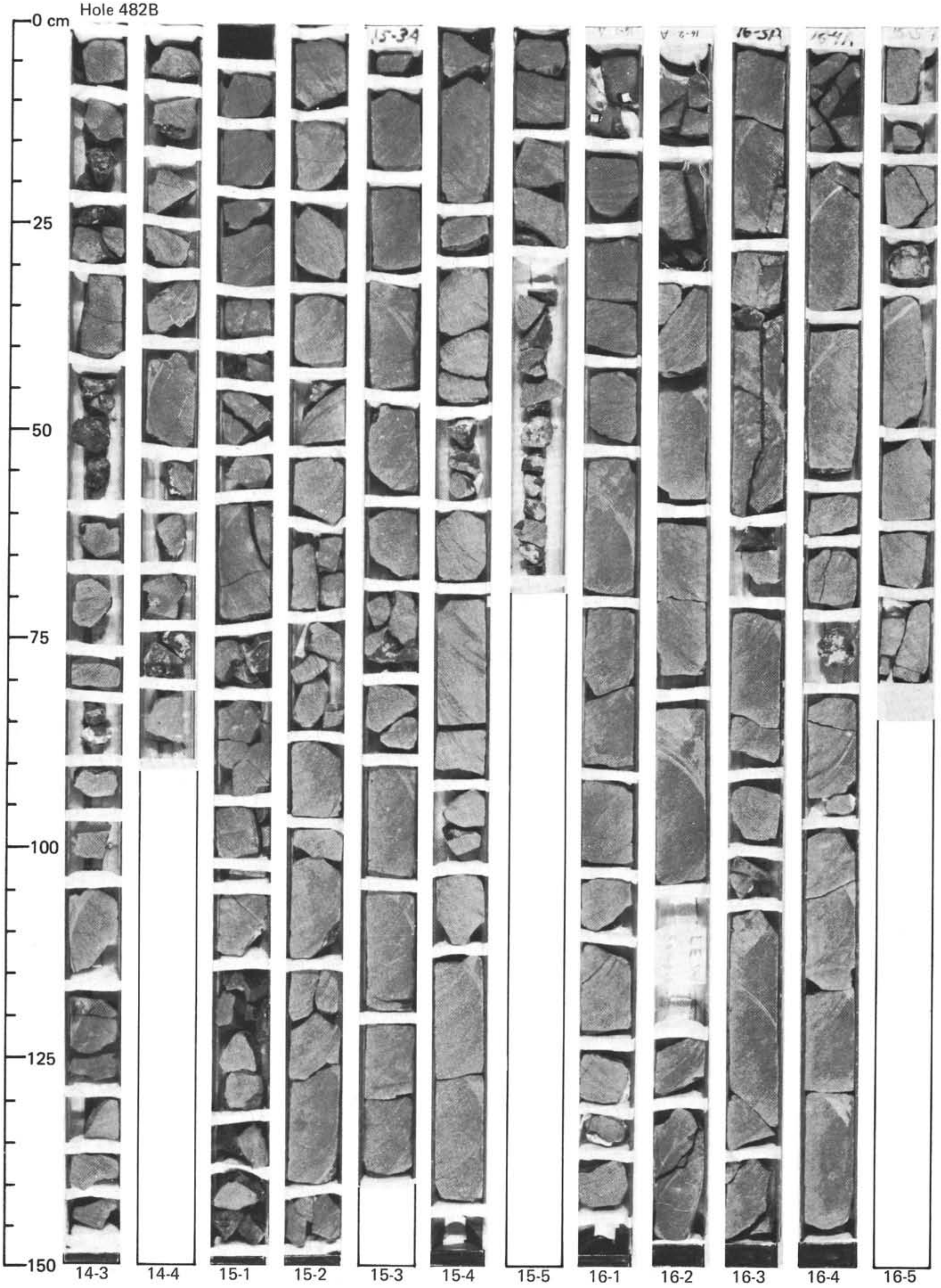

Hole 482B
0 cm
25
50
75
100
125
150
2, CC
3, CC
4-1
4-2
4-3
4, CC
5-1
5-2
5-3
5, CC
6-1
6-2
6-3

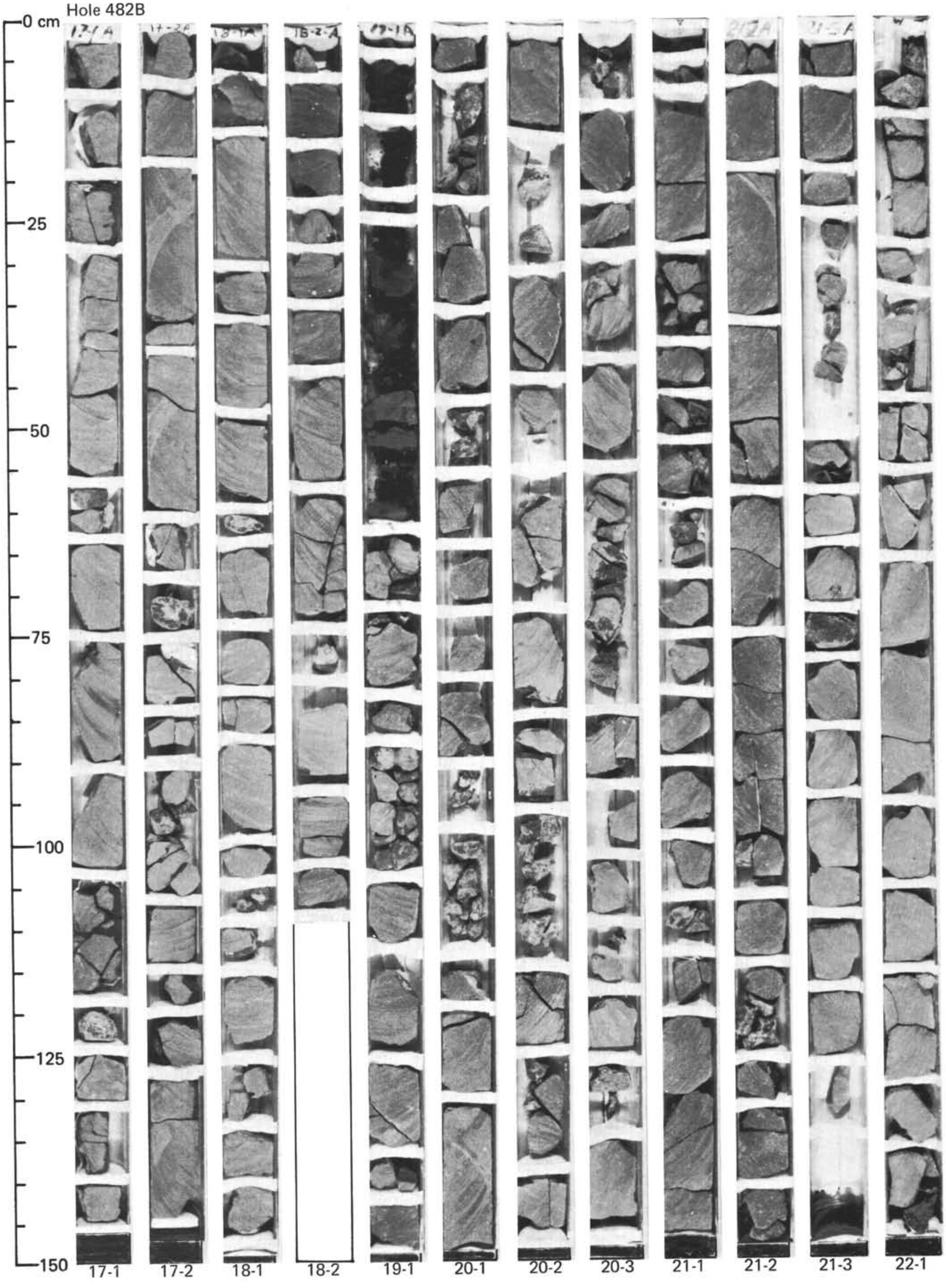


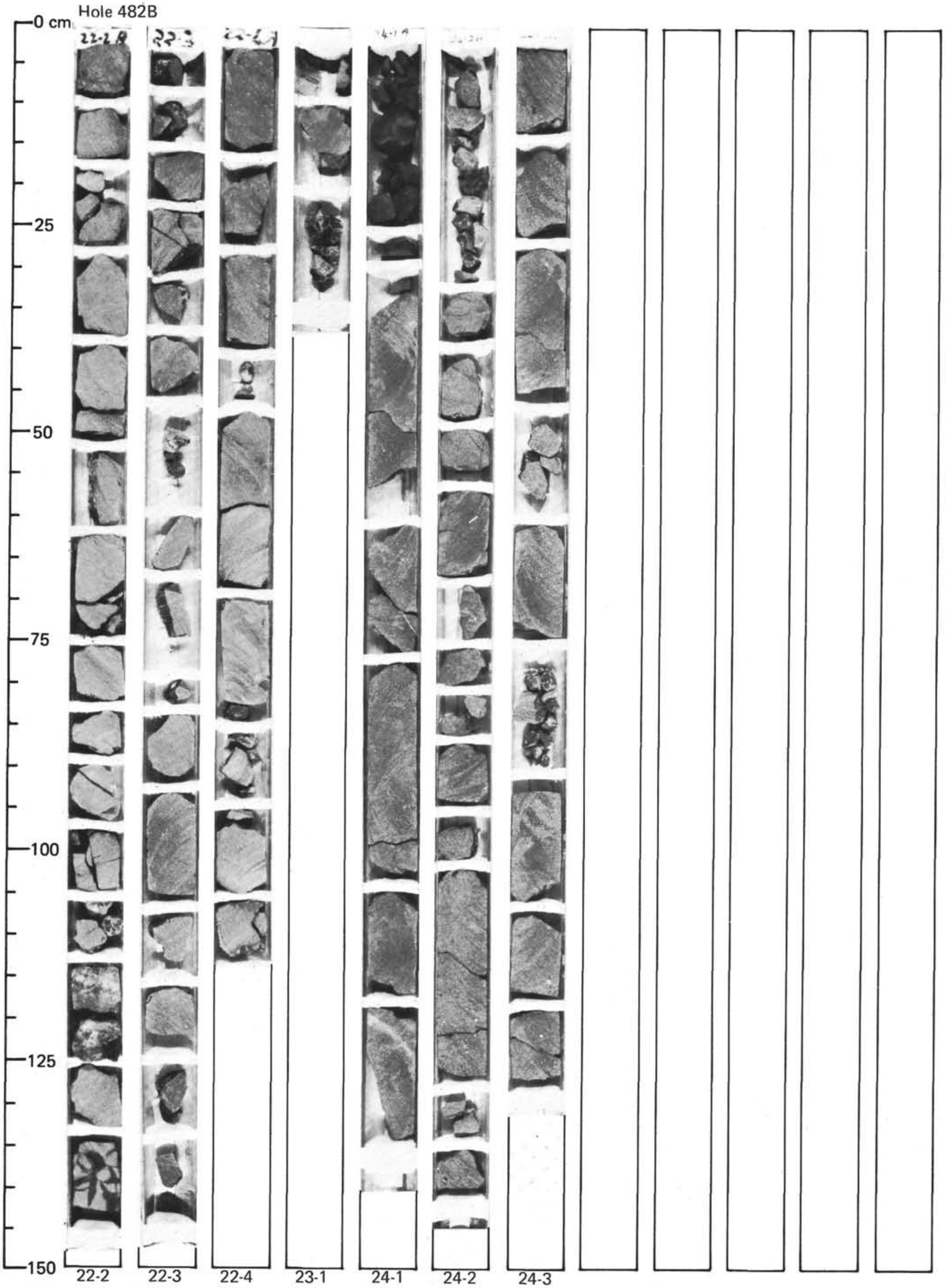
0 cm
Hole 482B
25
50
75
100
125
150
6-4
6-5
6-6
6, CC
7-1
7-2
7, CC
8-1
8-2
8-3
8-4
8-5
8, CC

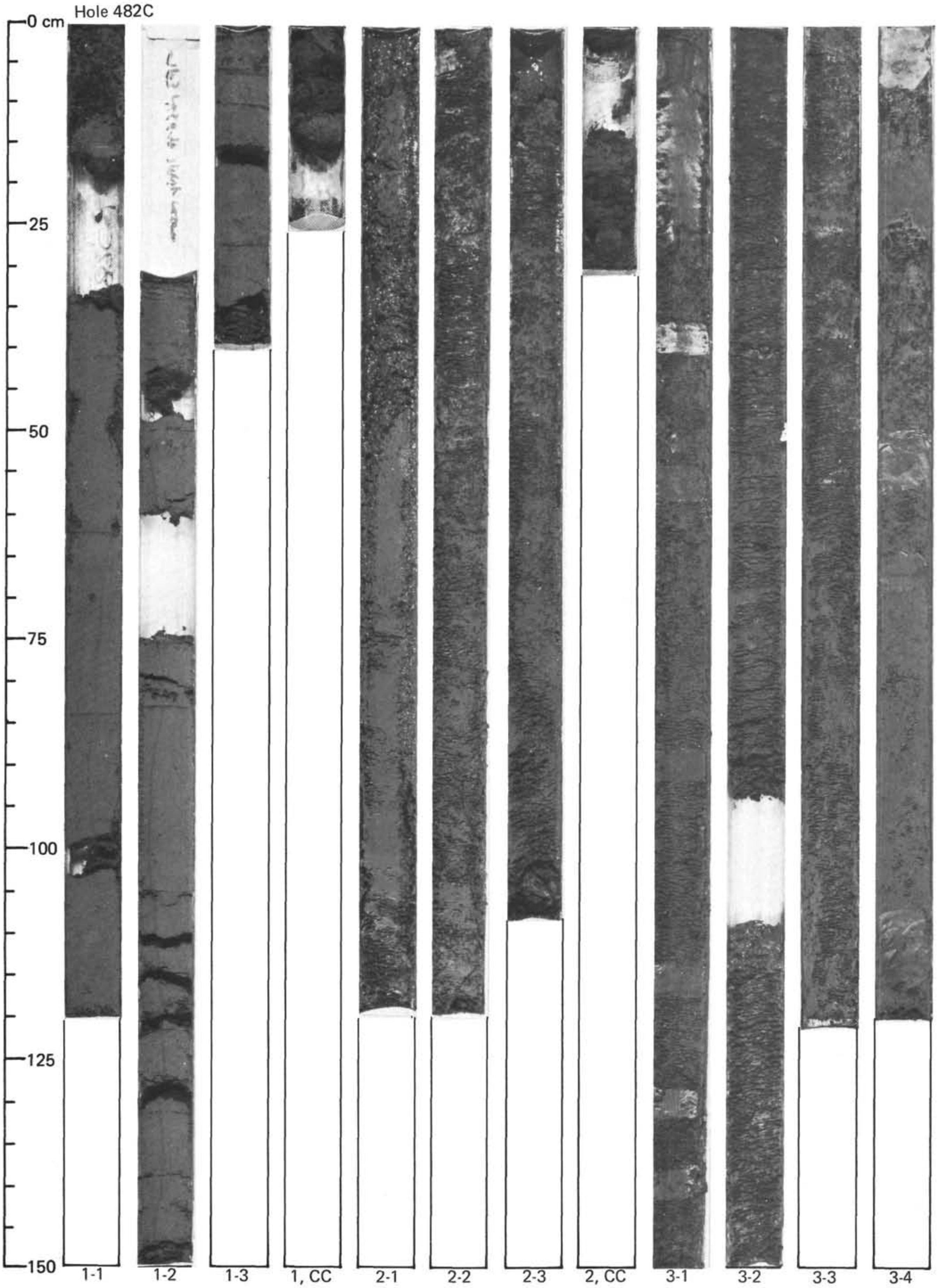

Hole 482B
0 cm
25
50
75
100
125
150
9-1
9-2
9-3
9-4
9-5
9-6
9, CC
10-1
10-2
10-3
10-4
10-5

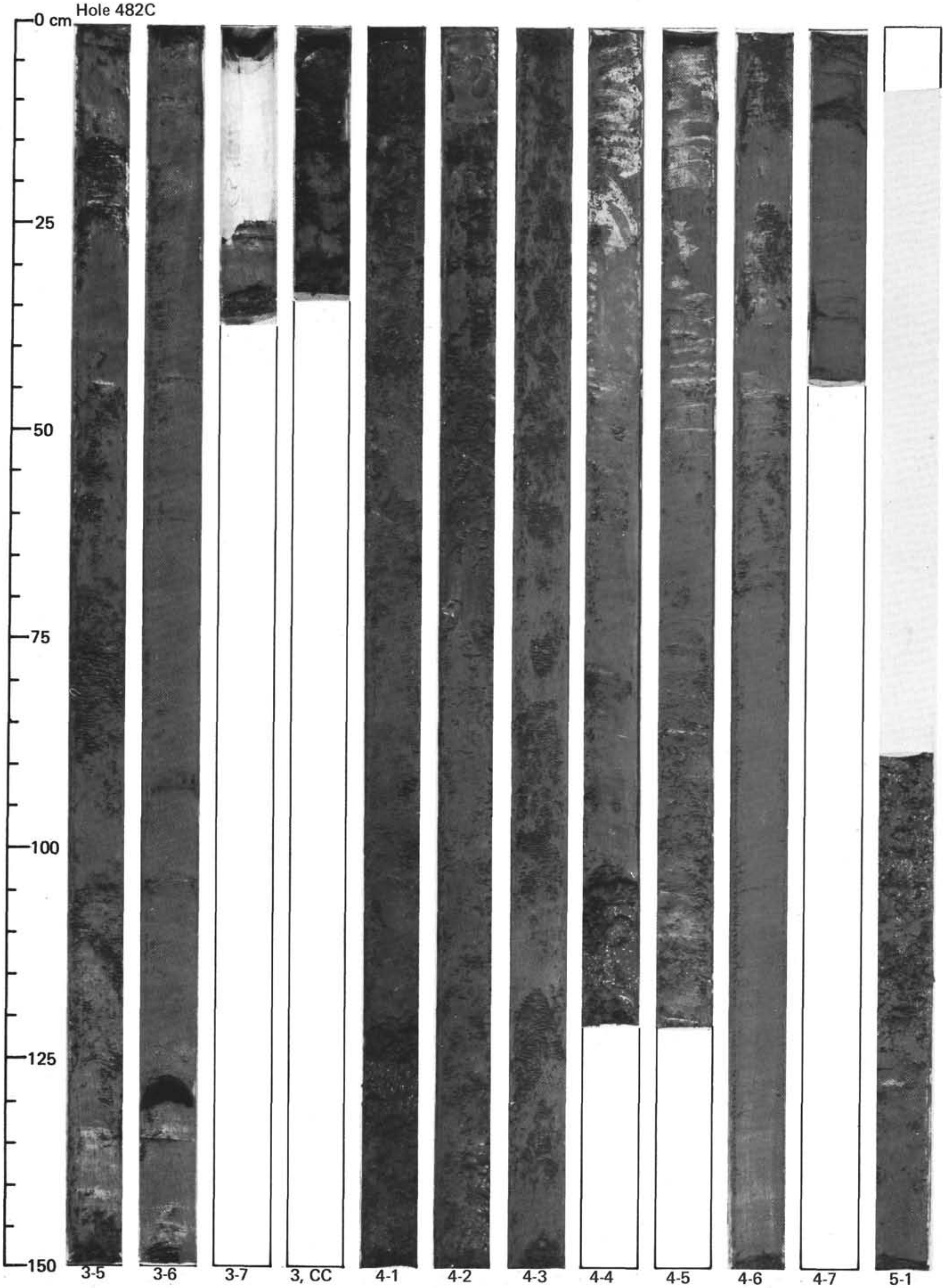

Hole 482B
0 cm
25
50
75
100
125
150
10-6
10-7
10, CC
11-1
11-2
11-3
12-1
12-2
12-3
13-1
13-2
14-1
14-2

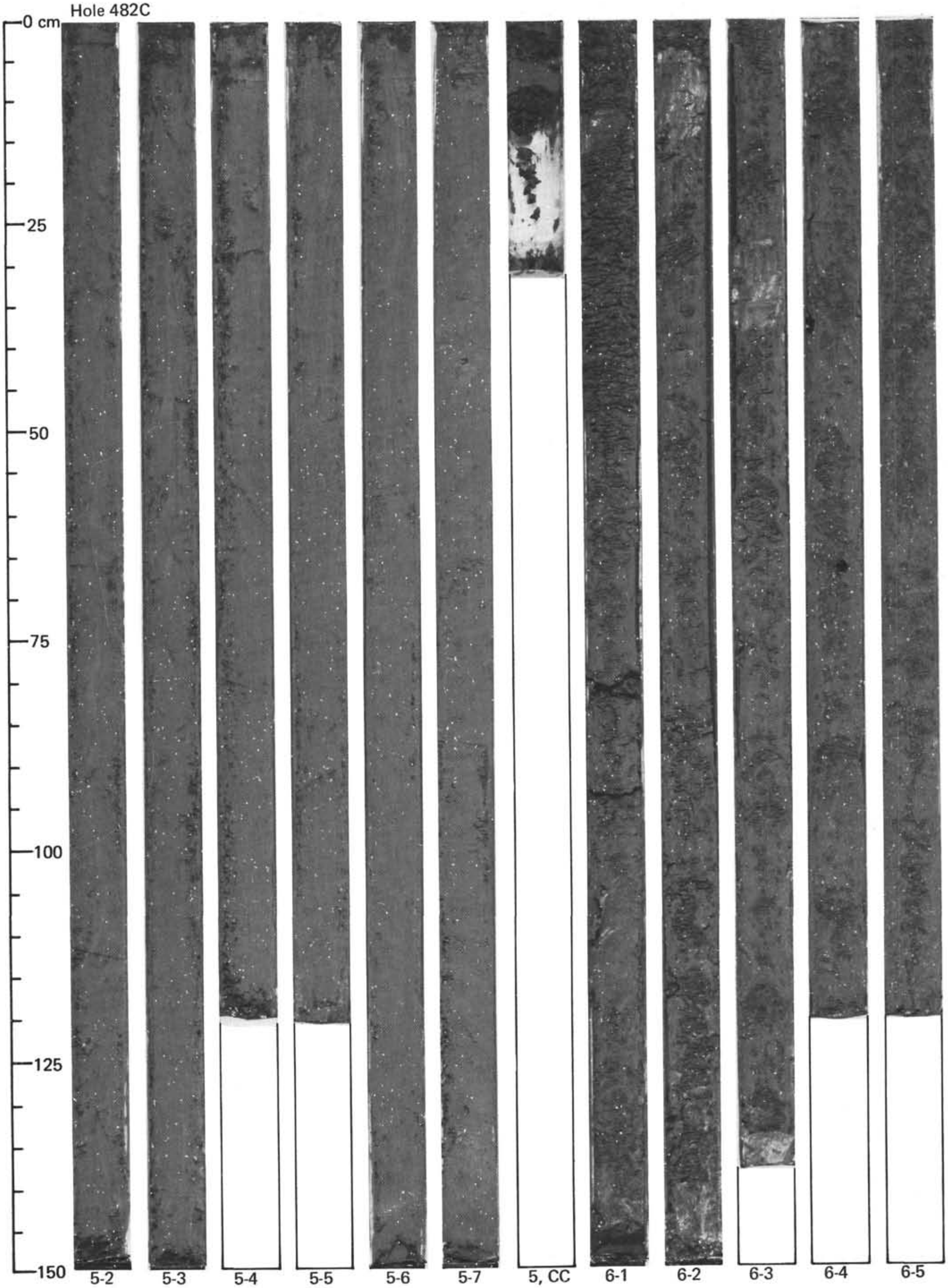

Hole 482B
0 cm
25
50
75
100
125
150
14-3
14-4
15-1
15-2
15-3
15-4
15-5
16-1
16-2
16-3
16-4
16-5

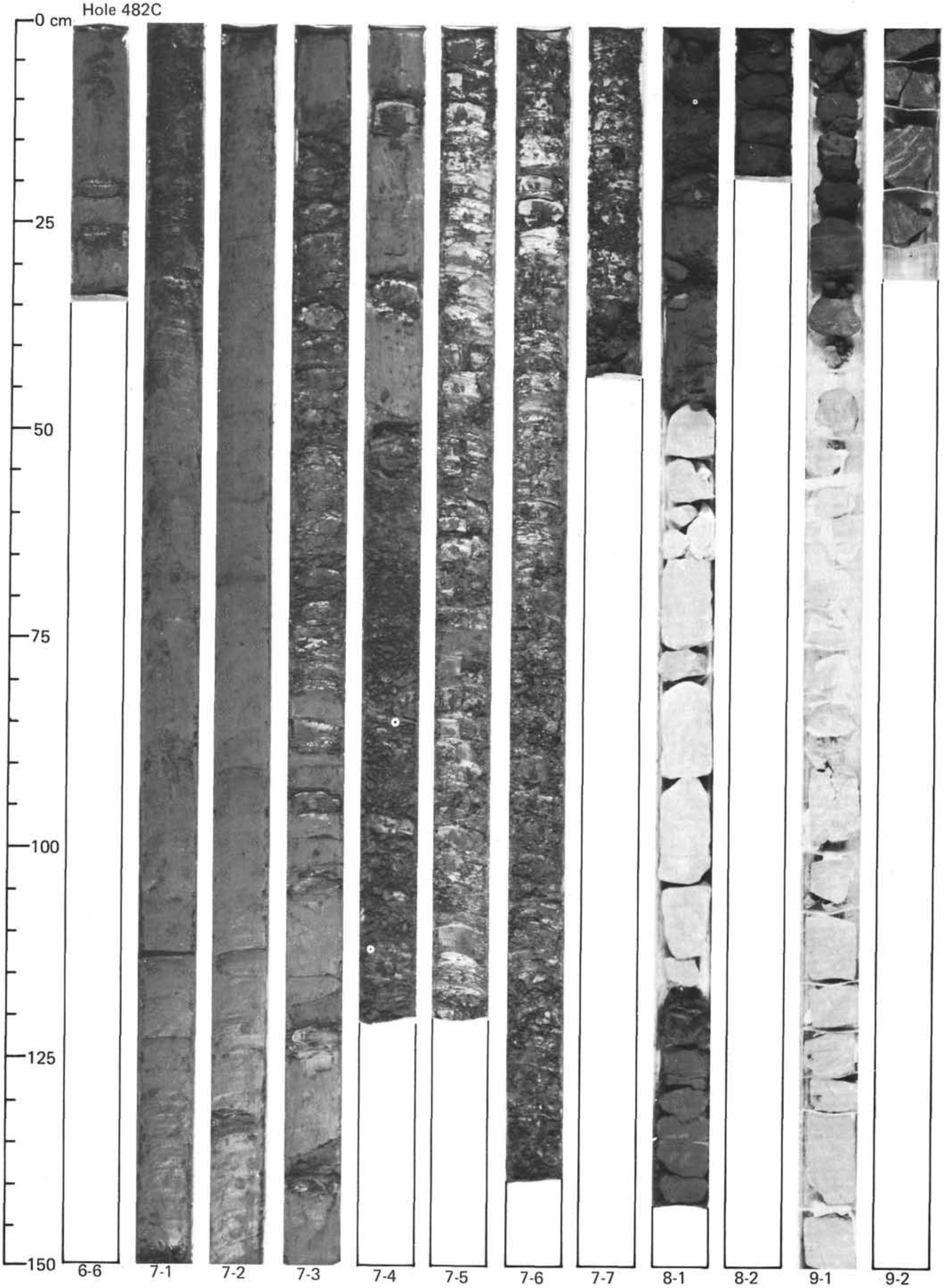

Hole 482B
0 cm
25
50
75
100
125
150
17-1
17-2
18-1
18-2
19-1
20-1
20-2
20-3
21-1
21-2
21-3
22-1

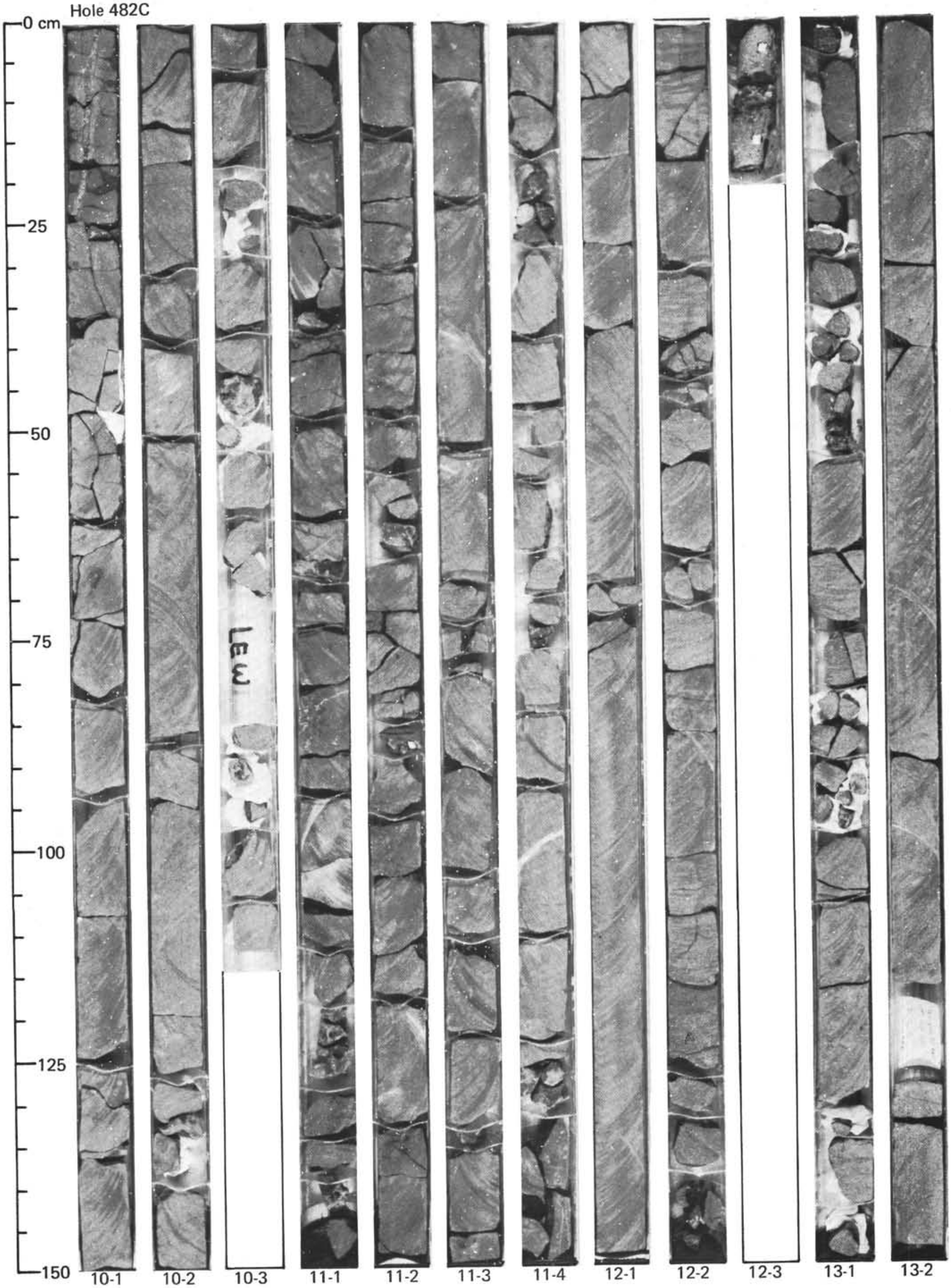

Hole 482B
0 cm
25
50
75
100
125
150
22-2
22-3
22-4
23-1
24-1
24-2
24-3

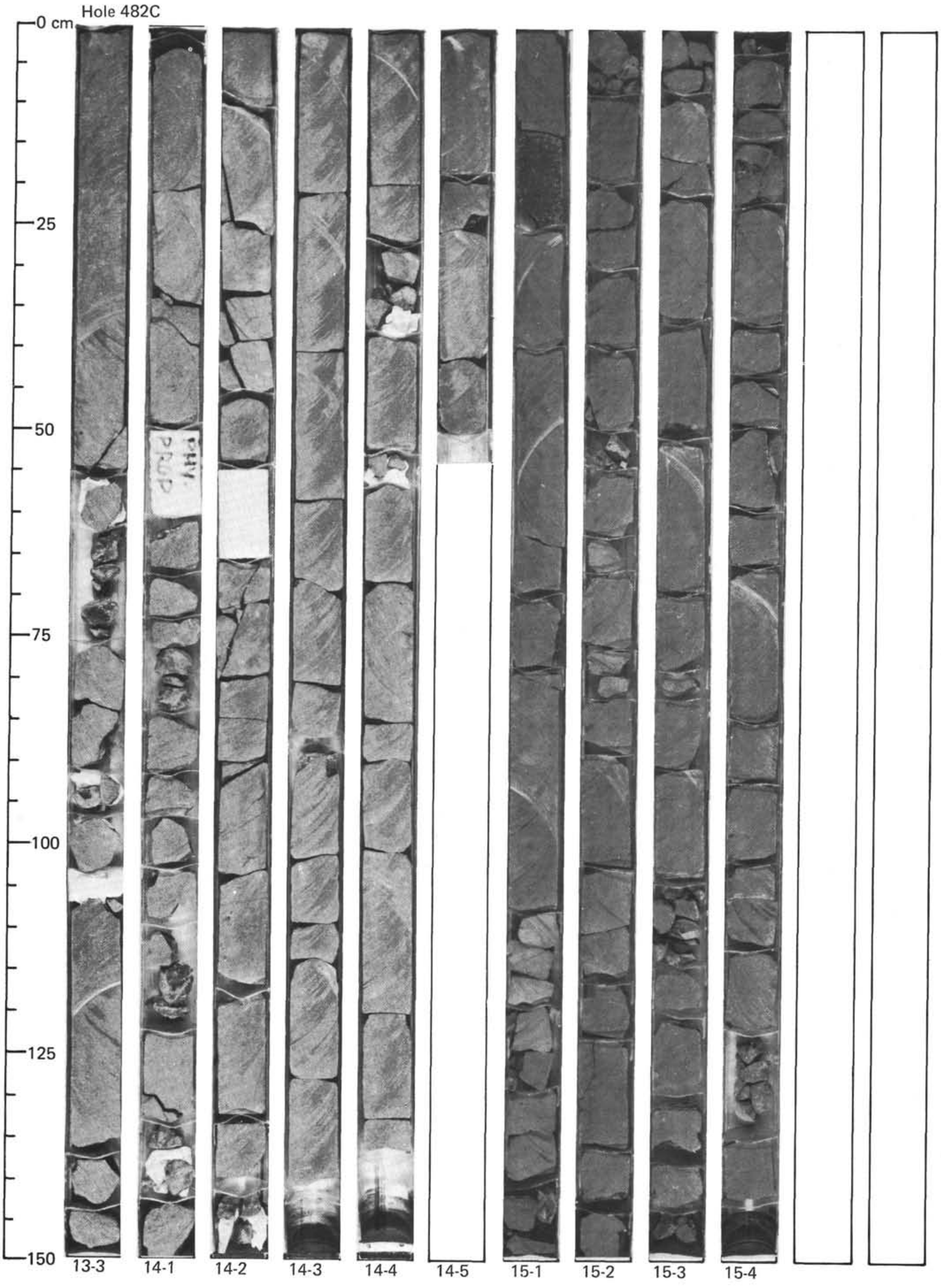

0 cm
Hole 482C
25
50
75
100
125
150
1-1
1-2
1-3
1, CC
2-1
2-2
2-3
2, CC
3-1
3-2
3-3
3-4

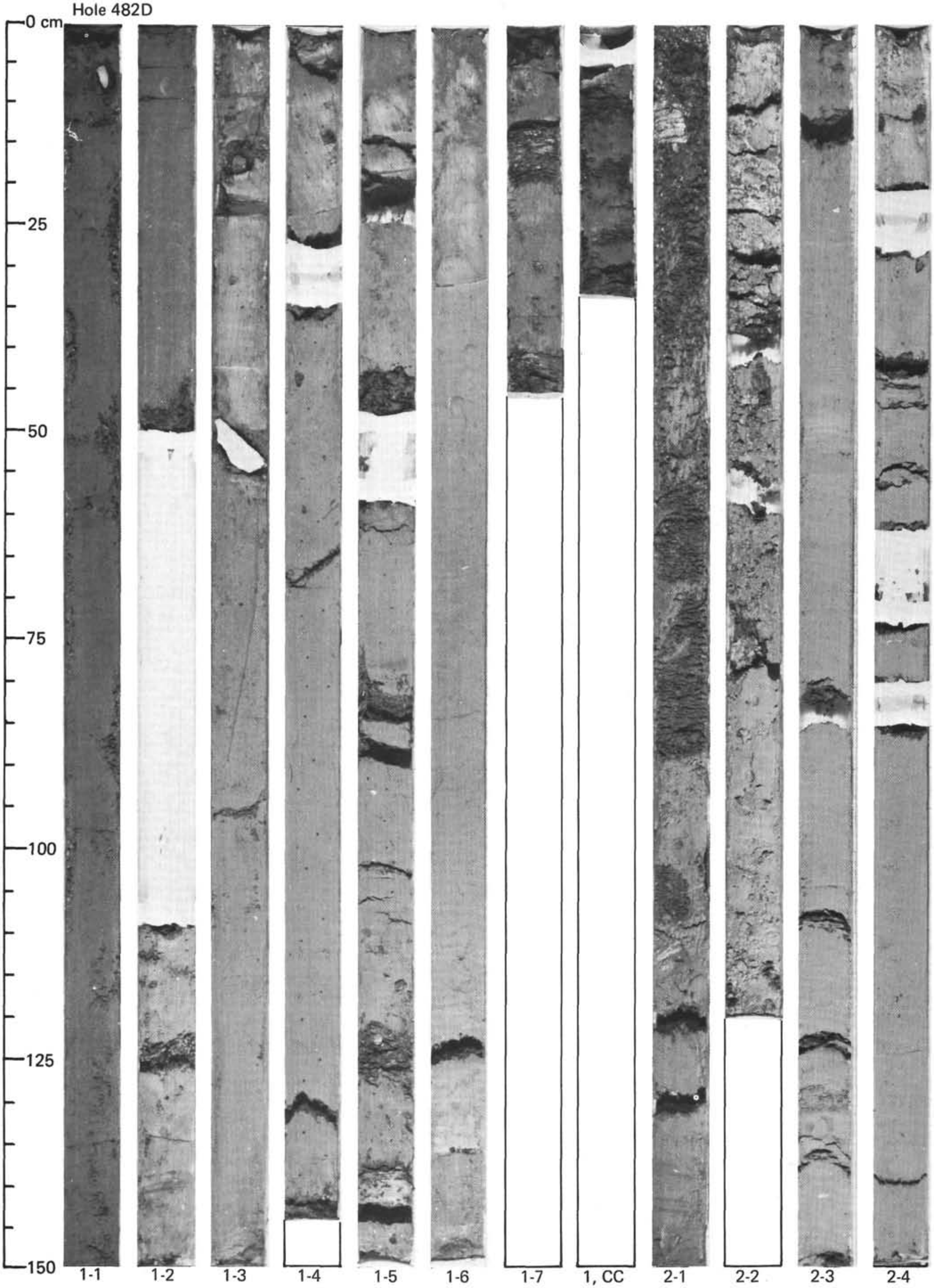

Hole 482C
0 cm
25
50
75
100
125
150
3-5
3-6
3-7
3, CC
4-1
4-2
4-3
4-4
4-5
4-6
4-7
5-1

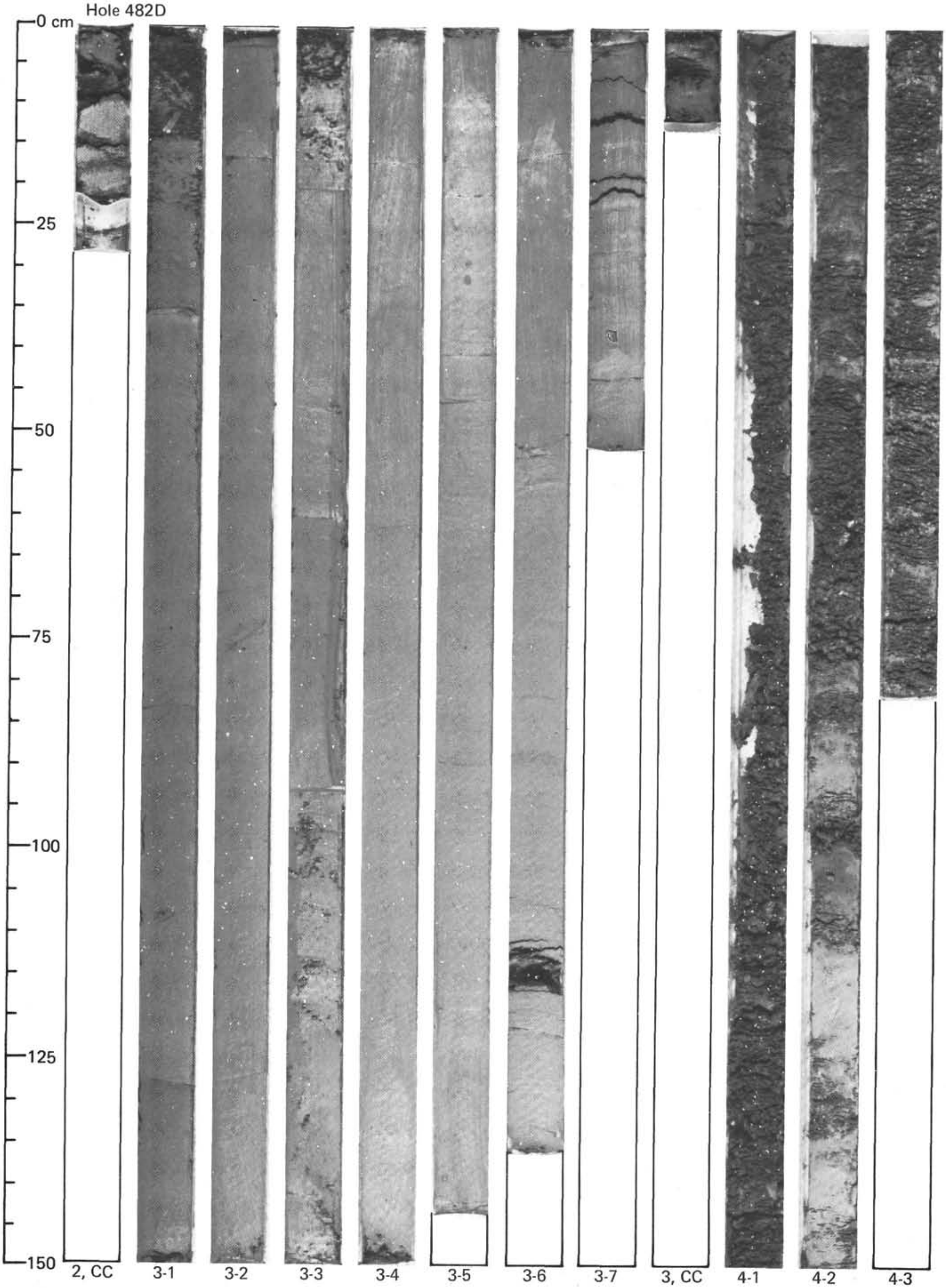

Hole 482C
0 cm
25
50
75
100
125
150
5-2
5-3
5-4
5-5
5-6
5-7
5, CC
6-1
6-2
6-3
6-4
6-5

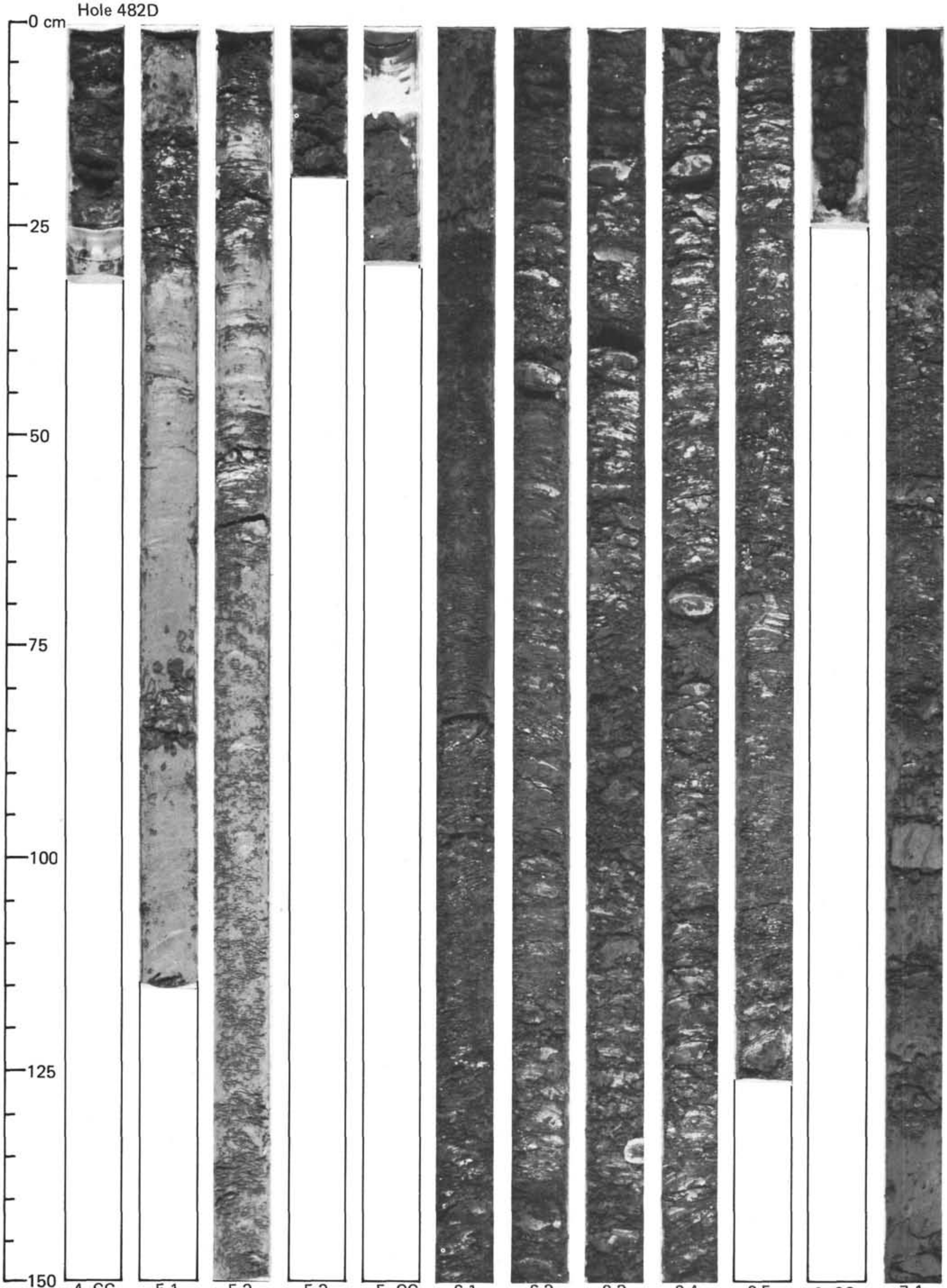

Hole 482C
0 cm
25
50
75
100
125
150
6-6
7-1
7-2
7-3
7-4
7-5
7-6
7-7
8-1
8-2
9-1
9-2

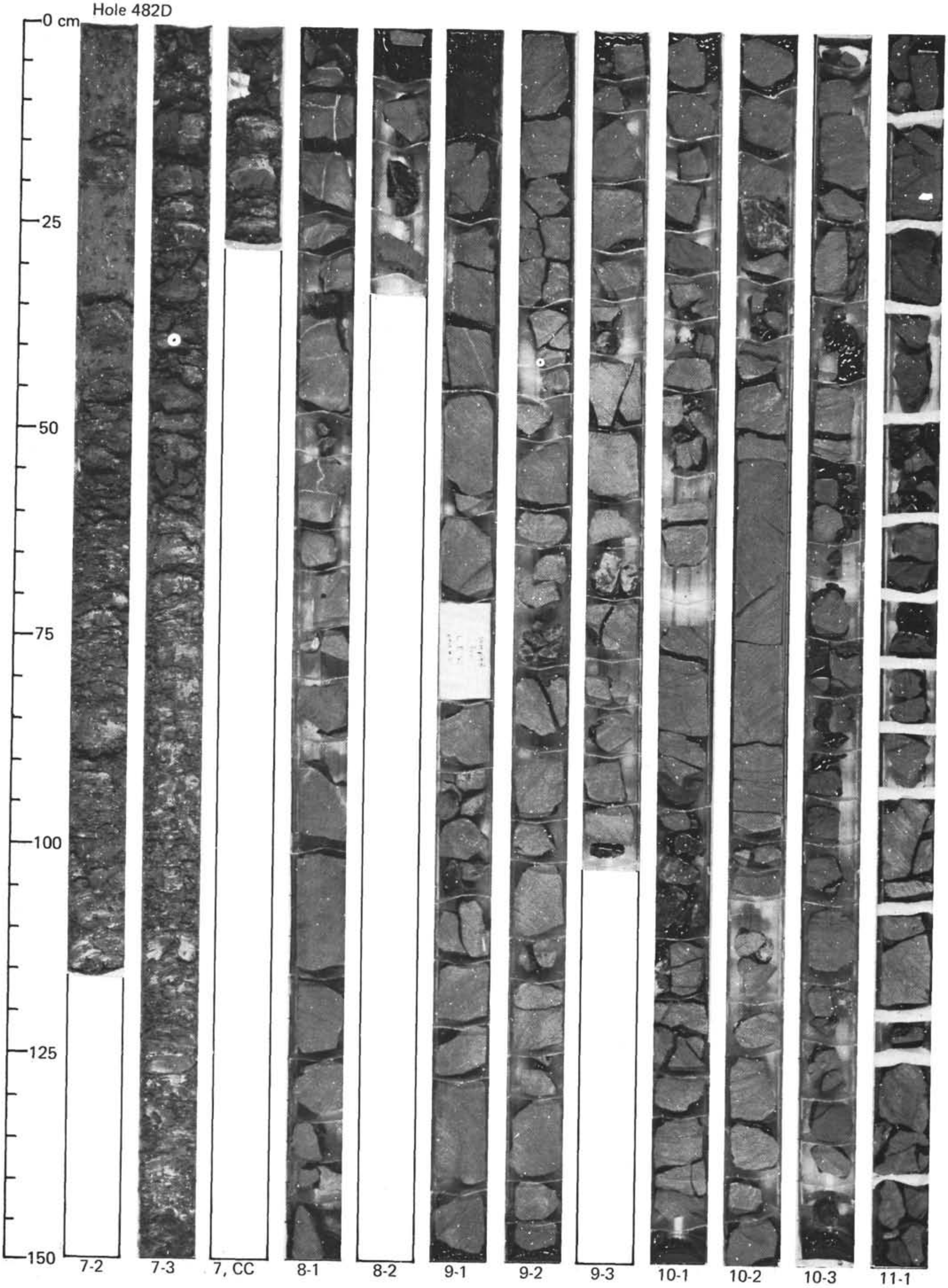

Hole 482C
0 cm
25
50
75
100
125
150
LEW
10-1
10-2
10-3
11-1
11-2
11-3
11-4
12-1
12-2
12-3
13-1
13-2

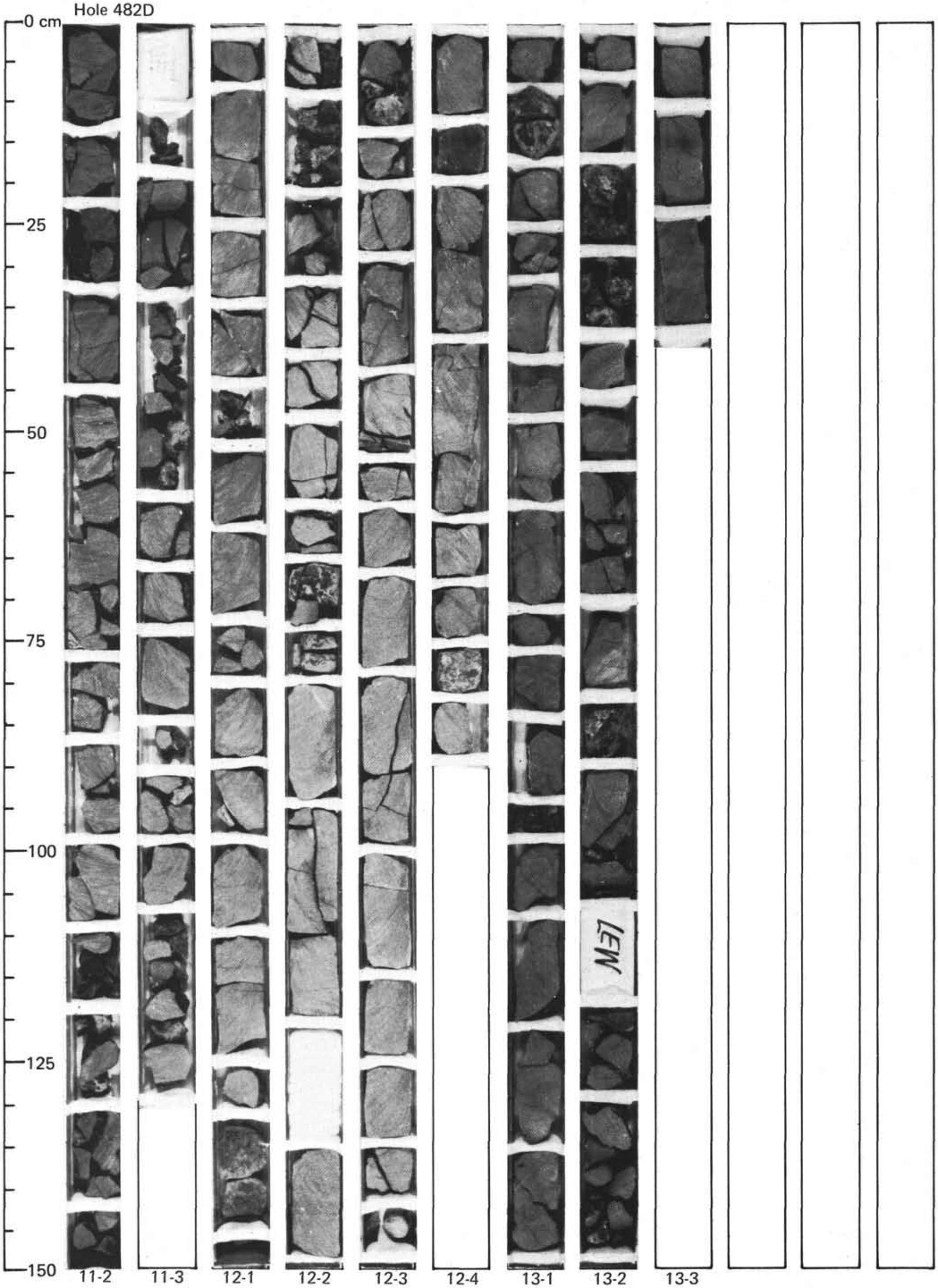

Hole 482C
0 cm
25
50
75
100
125
150
PHY PROP
13-3
14-1
14-2
14-3
14-4
14-5
15-1
15-2
15-3
15-4

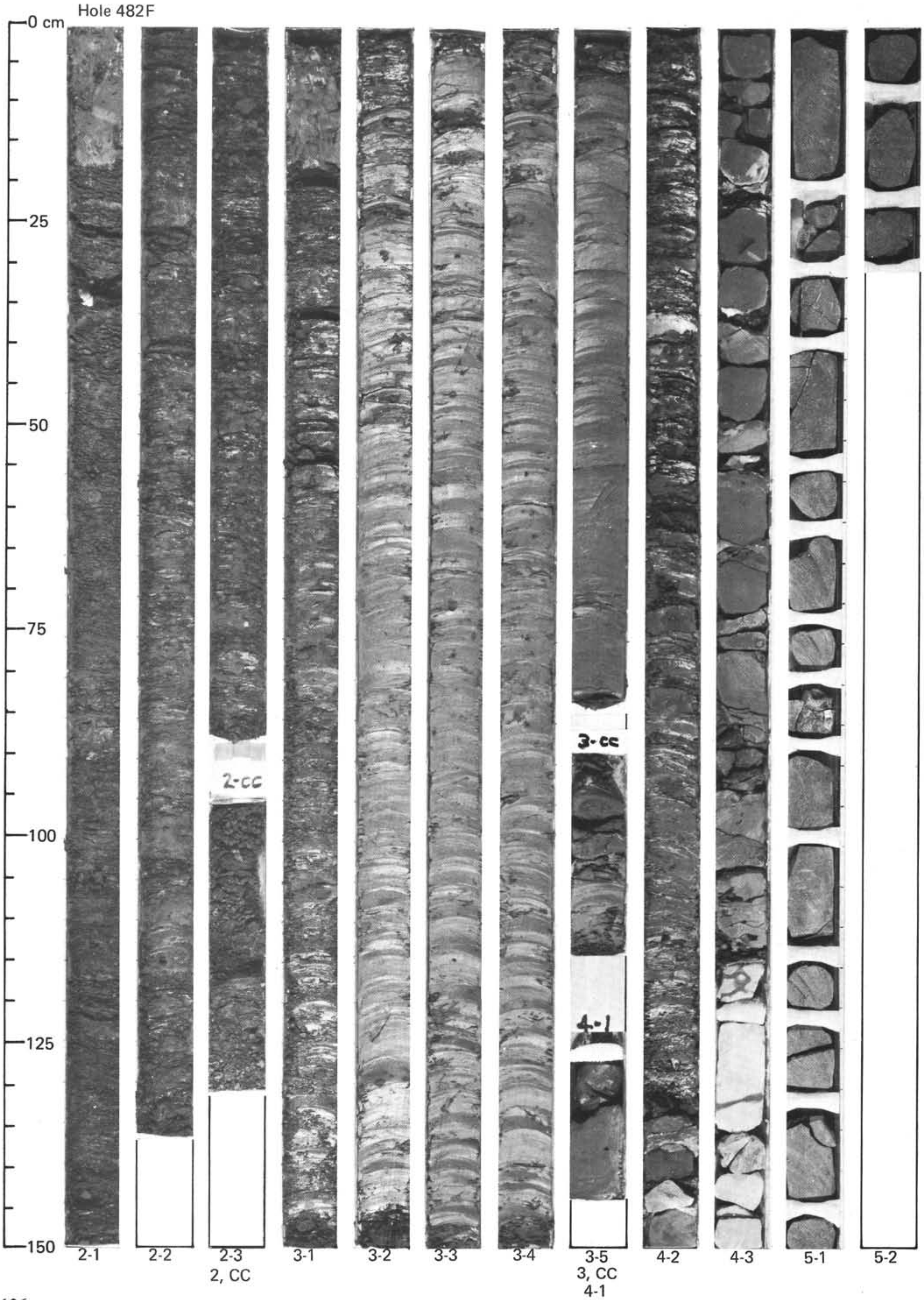

Hole 482D
0 cm
25
50
75
100
125
150
1-1
1-2
1-3
1-4
1-5
1-6
1-7
1, CC
2-1
2-2
2-3
2-4


Hole 482D
0 cm
25
50
75
100
125
150
2, CC
3-1
3-2
3-3
3-4
3-5
3-6
3-7
3, CC
4-1
4-2
4-3


Hole 482D
0 cm
25
50
75
100
125
150
4, CC
5-1
5-2
5-3
5, CC
6-1
6-2
6-3
6-4
6-5
6, CC
7-1


Hole 482D
0 cm
25
50
75
100
125
150
7-2
7-3
7, CC
8-1
8-2
9-1
9-2
9-3
10-1
10-2
10-3
11-1


Hole 482D
0 cm
25
50
75
100
125
150
11-2
11-3
12-1
12-2
12-3
12-4
13-1
13-2
13-3


Hole 482F
0 cm
25
50
75
100
125
150
2-cc
3-cc
4-1
2-1
2-2
2-3
2, CC
3-1
3-2
3-3
3-4
3-5
3, CC
4-1
4-2
4-3
5-1
5-2