5. SITES 600, 601, 602[1]

Shipboard Scientific Party[2]

SITE 600 (HOLE 600)

Date occupied: 23 March 1983

Date departed: 24 March 1983

Time on hole: 20 hr., 32 min.

Position: 18°55.74′S, 116°50.37′W

Water depth (sea level; corrected m, echo-sounding): 3346

Water depth (rig floor; corrected m, echo-sounding): 3356

Bottom felt (m, drill pipe): 3372.3

Penetration (m): Unknown[3]

Number of cores: 1[4]

Total length of cored section (m): Unknown

Total core recovered (m): 5.38

Core recovery (%): 51.7[5]

Oldest sediment cored: Pleistocene

SITE 600 (HOLE 600A)

Date occupied: 24 March 1983

Date departed: 24 March 1983

Time on hole: 3 min.

Position: 18°55.74′S, 116°50.37′W

Water depth (sea level; corrected m, echo-sounding): 3346

Water depth (rig floor; corrected m, echo-sounding): 3356

Bottom felt (m, drill pipe): 3372.0

Penetration (m): Unknown[6]

Number of cores: 0[7]

SITE 600 (HOLE 600B)

Date occupied: 24 March 1983

Date departed: 24 March 1983

Time on hole: 1 min.

Position: 18°55.74′S, 116°50.37′W

Water depth (sea level; corrected m, echo-sounding): 3346

Water depth (rig floor; corrected m, echo-sounding): 3356

Bottom felt (m, drill pipe): 3372.0

Penetration (m): 1.9

Number of cores: 1

Total length of cored section (m): 1.9

Total core recovered (m): 1.9

Core recovery (%): 100

Oldest sediment cored:
Depth sub-bottom (m): 1.9
Nature: Clay-bearing nannofossil ooze
Age: Pleistocene

SITE 600 (HOLE 600C)

Date occupied: 24 March 1983

Date departed: 25 March 1983

Time on hole: 8 hr., 33 min.

Position: 18°55.70′S, 116°50.45′W

Water depth (sea level; corrected m, echo-sounding): 3398

Water depth (rig floor; corrected m, echo-sounding): 3408

Bottom felt (m, drill pipe): 3405.8

Penetration (m): 19.0

Number of cores: 2

Total length of cored section (m): 19.0

Total core recovered (m): 11.80

Core recovery (%): 62.1

Oldest sediment cored:
Depth sub-bottom (m): 11.8
Nature: Clay- and foraminifer-bearing nannofossil ooze
Age: early Pliocene
Measured velocity (km/s): 1.54

Basement:
Depth sub-bottom (m): 19.0
Nature: Lithified sediment with glass chips

SITE 601 (HOLE 601)

Date occupied: 25 March 1983

Date departed: 25 March 1983

Time on hole: 12 hr.

Position: 18°55.22′S, 166°52.11′W

Water depth (sea level; corrected m, echo-sounding): 3433

Water depth (rig floor; corrected m, echo-sounding): 3443

Bottom felt (m, drill pipe): 3447.7

Penetration (m): 20.4

---

[1] Leinen, M., Rea, D. K., et al., *Init. Repts. DSDP*, 92: Washington (U.S. Govt. Printing Office).

[2] Margaret Leinen (Co-Chief Scientist), The University of Rhode Island, Narragansett, Rhode Island; David K. Rea (Co-Chief Scientist), The University of Michigan, Ann Arbor, Michigan; Keir Becker, Scripps Institution of Oceanography, La Jolla, California (present address: University of Miami, Miami, Florida); Jacques J. Boulègue, University of Paris, Paris, France; Jörg Erzinger, Justus-Liebig University, Giessen, Federal Republic of Germany; Joris M. Gieskes, Scripps Institution of Oceanography, La Jolla, California; Marjorie S. Goldfarb, Scripps Institution of Oceanography, La Jolla, California (present address: University of Washington, Seattle, Washington); Michael A. Hobart, Lamont-Doherty Geological Observatory, Palisades, New York; Miriam Kastner, Scripps Institution of Oceanography, La Jolla, California; Stephen Knüttel, Florida State University, Tallahassee, Florida; Mitchell W. Lyle, Oregon State University, Corvallis, Oregon; Tadashi Nishitani, Akita University, Akita, Japan; Robert M. Owen, The University of Michigan, Ann Arbor, Michigan; Julian A. Pearce, The Open University, Milton Keynes, United Kingdom (present address: The University, Newcastle-upon-Tyne, United Kingdom); Karen Romine, The University of Rhode Island, Kingston, Rhode Island (present address: Exxon Production Research Company, Houston, Texas).

[3] 10.4 m were attempted, but HPC barrel sheared on second coring attempt.

[4] Two were attempted, but one sheared off and remains on seafloor.

[5] Of length attempted.

[6] 9.6 m were attempted, but barrel sheared and was not recovered.

[7] Barrel sheared and was not recovered.

Number of cores: 3

Total length of cored section (m): 20.4

Total core recovered (m): 19.45

Core recovery (%): 95.3

Oldest sediment cored:
Depth sub-bottom (m): 20.4
Nature: Foraminifer- and nannofossil-bearing clay
Age: early Pliocene
Measured velocity (km/s): 1.52

SITE 601 (HOLE 601A)

Date occupied: 25 March 1983

Date departed: 25 March 1983

Time on hole: 2 hr., 20 min.

Position: 18°55.22'S, 166°52.11'W

Water depth (sea level; corrected m, echo-sounding): 3433

Water depth (rig floor; corrected m, echo-sounding): 3443

Bottom felt (m, drill pipe): 3448

Penetration (m): 15

Number of cores: 0[8]

SITE 601 (HOLE 601B)

Date occupied: 25 March 1983

Date departed: 26 March 1983

Time on hole: 17 hr., 16 min.

Position: 18°55.22'S, 166°52.11'W

Water depth (sea level; corrected m, echo-sounding): 3433

Water depth (rig floor; corrected m, echo-sounding): 3443

Bottom felt (m, drill pipe): 3448

Penetration (m): 27

Number of cores: 3

Total length of cored section (m): 12.6

Total core recovered (m): 6.75

Core recovery (%): 53.6

Oldest sediment cored:
Depth sub-bottom (m): 24.0
Nature: Foraminifer- and nannofossil-bearing clay
Age: early Pliocene

Basement:
Depth sub-bottom (m): 24.0
Nature: Basalt

SITE 602 (HOLE 602)

Date occupied: 26 March 1983

Date departed: 27 March 1983

Time on hole: 16 hr., 22 min.

Position: 18°54.41'S, 166°54.68'W

Water depth (sea level; corrected m, echo-sounding): 3535

Water depth (rig floor; corrected m, echo-sounding): 3545

Bottom felt (m, drill pipe): 3543.8

[8] Heat flow and *in situ* pore water sampling only.

Penetration (m): 6.2

Number of cores: 1

Total length of cored section (m): 6.2

Total core recovered (m): 6.19

Core recovery (%): 99.8

Oldest sediment cored:
Depth sub-bottom (m): 6.2
Nature: Clay-bearing to clayey nannofossil ooze
Age: Pleistocene

SITE 602 (HOLE 602A)

Date occupied: 27 March 1983

Date departed: 27 March 1983

Time on hole: 2 min.

Position: 18°54.41'S, 166°54.68'W

Water depth (sea level; corrected m, echo-sounding): 3535

Water depth (rig floor; corrected m, echo-sounding): 3545

Bottom felt (m, drill pipe): 3547.3

Penetration (m): 2.3

Number of cores: 1

Total length of cored section (m): 2.3

Total core recovered (m): 2.28

Core recovery (%): 99.1

Oldest sediment cored:
Depth sub-bottom (m): 2.3
Nature: Clay-bearing nannofossil ooze
Age: Pleistocene

SITE 602 (HOLE 602B)

Date occupied: 27 March 1983

Date departed: 27 March 1983

Time on hole: 14 hr., 10 min.

Position: 18°54.41'S, 166°54.68'W

Water depth (sea level; corrected m, echo-sounding): 3535

Water depth (rig floor; corrected m, echo-sounding): 3545

Bottom felt (m, drill pipe): 3548.8

Penetration (m): 4.2

Number of cores: 1

Total length of cored section (m): 4.2

Total core recovered (m): 4.24

Core recovery (%): 101.1

Oldest sediment cored:
Depth sub-bottom (m): 4.24
Nature: Clay-bearing nannofossil ooze
Age: Pleistocene

Principal results, Sites 600 to 602: Sites 600 to 602 were on the youngest (4.5-Ma) crust of the areas surveyed for the Leg 92 East Pacific Rise (EPR) hydrogeology transect. We drilled three sites in order to investigate heat flow, because the site survey revealed that heat flow in the region varied from exceptionally high to very low.

Site 600, the high heat flow end member of these three sites, was drilled on the flanks of an abyssal hill. There were two targets for drilling, each less than 20 m across, which we located by means of transponder navigation. Several holes were drilled at the first heat flow target because of the thin sediment cover and the locally variable heat flow. Core 1 in Hole 600 recovered 5.4 m of Pleistocene nannofossil ooze. Core 2 sheared off upon hitting the basalt basement. Heat flow measured in the hole was approximately 580 mW/m^2. Hole 600A was drilled in a second attempt to recover sediment, but the barrel again sheared off upon hitting basalt. From a third hole, Hole 600B, we recovered 1.9 m of Pleistocene nannofossil ooze. We then moved to the second heat flow target, which lay 170 m west-northwest of Holes 600 to 600B. From Hole 600C we recovered 11.8 m of early Pliocene through Pleistocene clay-bearing to clayey nannofossil ooze that graded to chalk at the bottom of the hole. Some basalt chips were recovered. The sediments became darker and the percentage of clay and RSO (red brown to yellow brown semiopaque oxides) increased downcore. There was some evidence of winnowing and redeposition, but there were no obvious hiatuses in spite of the thinness of the section and the drill site's location on a slope. Interstitial water studies gave no indication of pore water advection at these high heat flow drill sites.

Site 601, the intermediate heat flow end member of the three sites, is in a region 3 km wide in which basement is flat and the sediment is 20 to 25 m deep. Transponder positioning was used, as at Site 600, but the target region was much broader. At Hole 601 we cored 20.4 m of early Pliocene to Pleistocene clay-bearing to clayey nannofossil ooze; the ooze became chalky in the lowest meter. The sediments became darker and the percentage of clay and RSO increased downcore.

Sedimentation rates were 4 and 8 to 11 m/m.y. in the Pleistocene and early Pliocene but were very low during the late Pliocene. Hole 601A was devoted entirely to heat flow measurements (160 mW/m^2) and *in situ* pore water sampling (successful). At Hole 601B we cored the lower part of the sediment section, recovering the sediment/basalt contact in Core 1. Cores 2 and 3 penetrated 3 m into basement and recovered about 1 m of rounded ferrobasalt cobbles with oxidation rims and fresh interiors. Interstitial water studies gave no evidence of pore water advection at Hole 601.

Site 602, the low heat flow end member of the three sites, is in a 4-km-wide trough. Because of the high priority attached to acquiring pore water evidence of downwelling at the site and because the air gun records from the site survey had been interpreted as showing 10 m of sediment, we decided to attempt to recover a core with the variable-length hydraulic piston corer (VLHPC), even though our water gun records showed no sediment. Transponder navigation was used to position the ship. At our first drill location, a 9.6-m VLHPC core attempted from 10 m above basement came up empty. After the ship was offset slightly, an extension core barrel (XCB) was run in to tag basement (Hole 602). The XCB recovered 6.19 m of highly disturbed sediment flow-in which included basalt chips in the core catcher. At Hole 602A we recovered 2.28 m of Pleistocene clay-bearing nannofossil ooze. At Hole 602B the 5-m VLHPC barrel jammed in the bottom of the pipe, so we had to pull out of the hole. When recovered, the core contained 4.24 m of Pleistocene ooze representing at least three penetrations of the extremely thin sediment section; the section was cored repeatedly because the VLHPC bounced as the result of ship motion. At the bases of two of the repeated sections there were two layers of basalt chips. We assume that this is a DSDP first: we recovered one sediment/water interface and three sediment/basalt contacts in the same core.

BACKGROUND AND OBJECTIVES

Sites 600, 601, and 602 were drilled in the youngest of the areas surveyed for the Leg 92 East Pacific Rise (EPR) hydrogeology transect (4.5-Ma crustal age). The area is 310 km east of Site 599 between 116°50′ and 116°55′W, 18°52′ and 19°00′S (Fig. 1). It is bounded on the east by an abyssal hill ridge. The ridge trends about 010° and is highest and broadest (about 100 m high) at the southern margin of the area; it loses elevation and becomes narrower to the north. Along the western margin of the area there is a trough about 100 m deep, the eastern edge of which is a fault scarp. Between the ridge and trough there is a fairly flat plateau with about 20 to 25 m of sediment cover (Fig. 2).

The Ariadne II site surveys located several regions of high heat flow, generally on the slopes of the abyssal hill ridge (Fig. 3). In one of these locations (Fig. 3B), two heat flow measurements exceeded 700 mW/m^2, about three times the theoretical value for crust of this age. The sediment-covered plateau was characterized by moderate heat flow averaging 100 mW/m^2, and the trough had very low heat flow averaging 20 mW/m^2. In addition to the heat flow evidence of advection, the pore water nutrient gradients indicated that advection was taking place near the ridge.

Because this area showed three distinct heat flow regions and might represent both upwelling and downwelling regimes, it was decided that three sites should be drilled, one (Site 600) at the location of highest heat flow, one (Site 602) at the location of lowest heat flow, and one (Site 601) on the sediment-covered, intermediate heat flow plateau. By drilling at these locations we hoped to obtain information that would suggest the constraints on the interactions possible between the sediment and upwelling or downwelling waters.

Because Site 600 is on the side of an abyssal hill ridge and sediment cover is thin (about 10 m, according to the air gun records), we expected the sediment record to be incomplete and/or show evidence of reworking. Nevertheless, we wanted to obtain a complete section of the existing sediment to document any changes in sediment chemistry or mineralogy that might have been caused by hydrothermal alteration. In addition, if the sediment section proved thick enough to make rock drilling with the extended core barrel (XCB) feasible, we wanted to try to recover at least one core of basement rock. Finally, we wished to measure heat flow and to acquire both squeezed and *in situ* pore water samples to try to document advection at the site. Because of the very limited geographical extent of the areas of high heat flow (Fig. 3), we felt that it was important to measure heat flow and collect *in situ* pore water samples at all holes cored. To meet our objectives we planned to drill three holes at this site; we were to recover sediment from two, drilled at the locations of the two high heat flow measurements, and to devote one solely to downhole temperature measurements and *in situ* pore water sampling.

Site 601, which was in the center of the surveyed area (Fig. 1), was drilled to obtain a sediment record unaffected by present-day upwelling or downwelling of pore fluids. We wanted this record for comparison with the records from the nearby sites, where the pore fluids apparently were migrating. In addition, we planned to look for any evidence of prior hydrothermal upwelling at the site to determine whether the plateau had served as a conduit for hydrothermal solutions in the past or whether such activity was restricted to the more thinly covered ridge and trough. Since we anticipated that the site would be unaffected by present or past hydrothermal upwelling or downwelling, we hoped to obtain a sediment record that could be considered representative of young (4.5-Ma) crust for our 19°S (Leg 92) transect; as such the sediment would be examined not only for past ridge-crest hydrothermal activity but also for what it revealed about Pliocene and Pleistocene pelagic sedimentation in

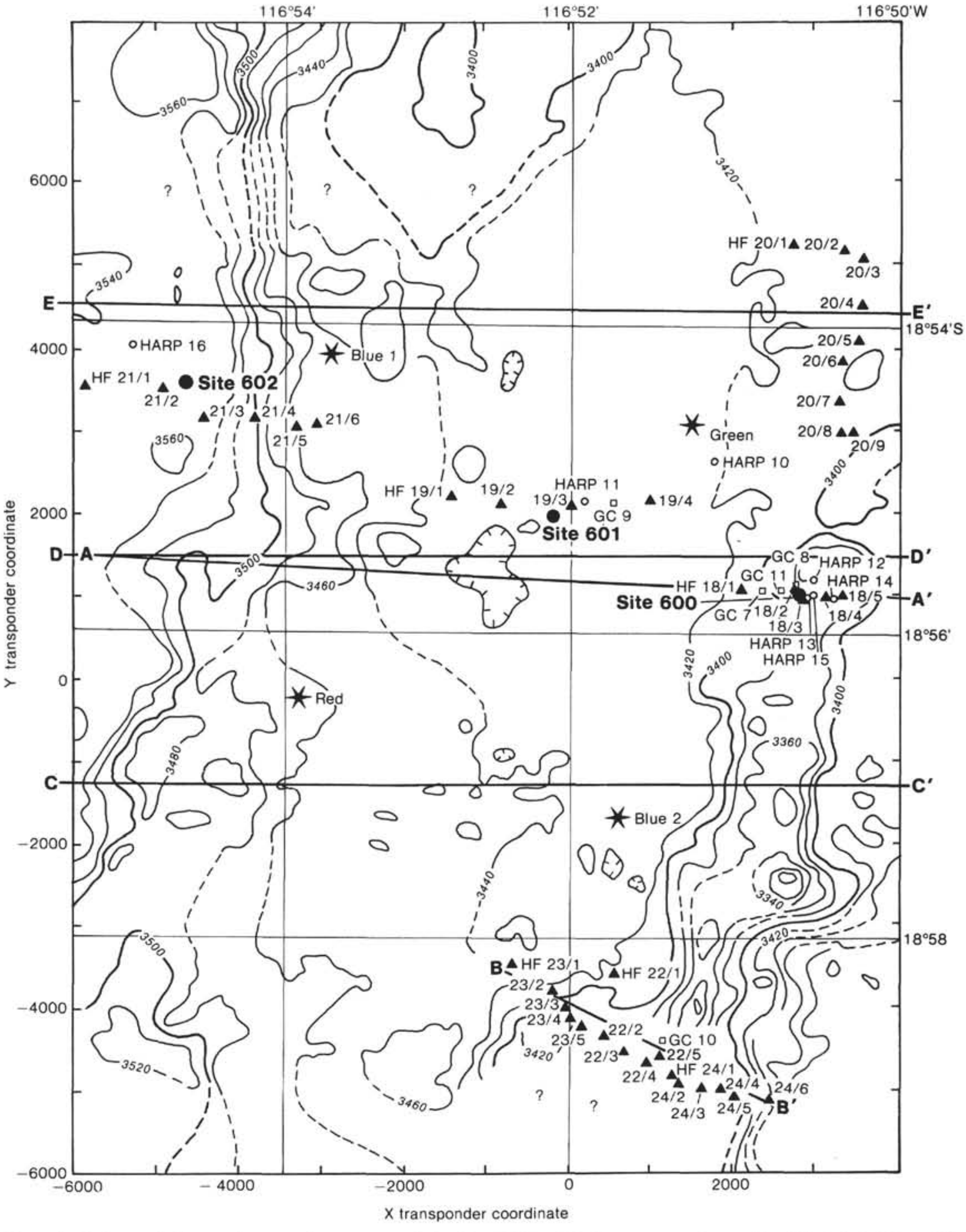


Figure 1. Seabeam bathymetric map of area surveyed for Sites 600 to 602. Contours are in m. Lines labeled A–A′ and B–B′ correspond to heat flow transects shown in Figure 3. Lines labeled C–C′, D–D′, and E–E′ correspond to air gun lines shown in Figure 2. Heat flow (HF) stations (triangles) show penetration/run numbers. HARP, *in situ* pore water harpoon sample (circles); GC, gravity core (squares). Points marked Blue, Red, and Green are locations of transponders used for navigation.

the subtropical south Pacific. We also wished to obtain representative samples of the basalt crust at the site for comparison with crust collected at Sites 597 and 599. Finally, to constrain our models of heat flow and pore water chemistry for this region, which exhibits a large amount of local variation, we planned to collect at least two *in situ* pore water samples and to measure heat flow at two to three depths in the sediment. To meet our objectives we planned to drill three holes; we planned to recover sediment from two and to devote one solely to downhole temperature measurements and *in situ* pore water sampling.

Site 602 is in the trough at the western margin of the area surveyed during Ariadne II. The trough is the locus

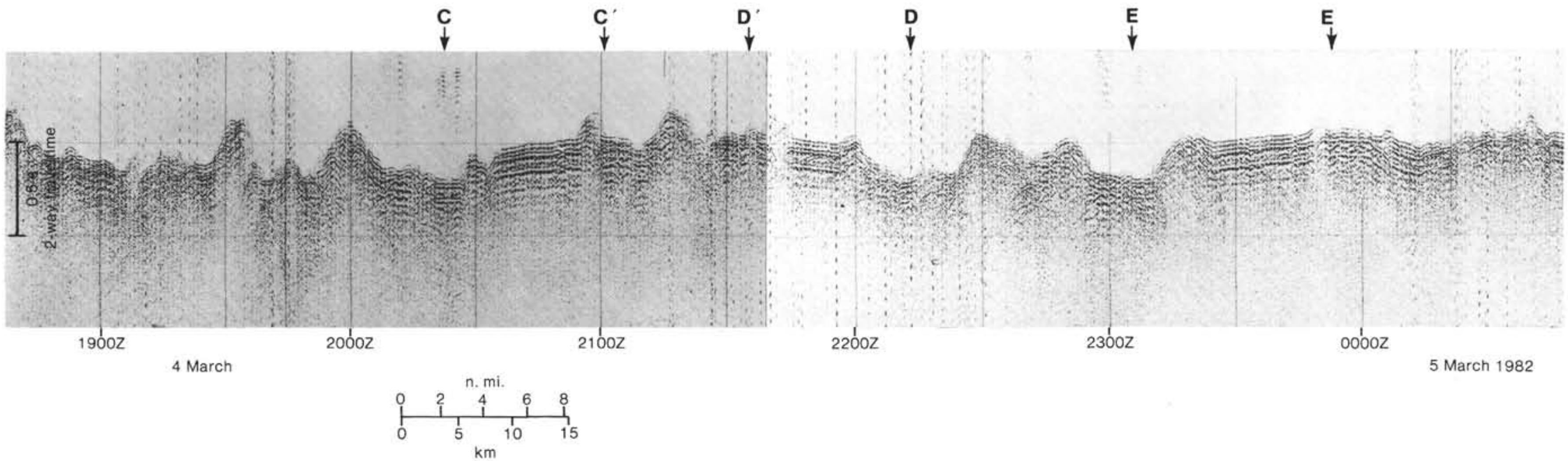


Figure 2. Ariadne II air gun line across area surveyed for Sites 600 to 602. Letters refer to cross sections shown in Figure 1.

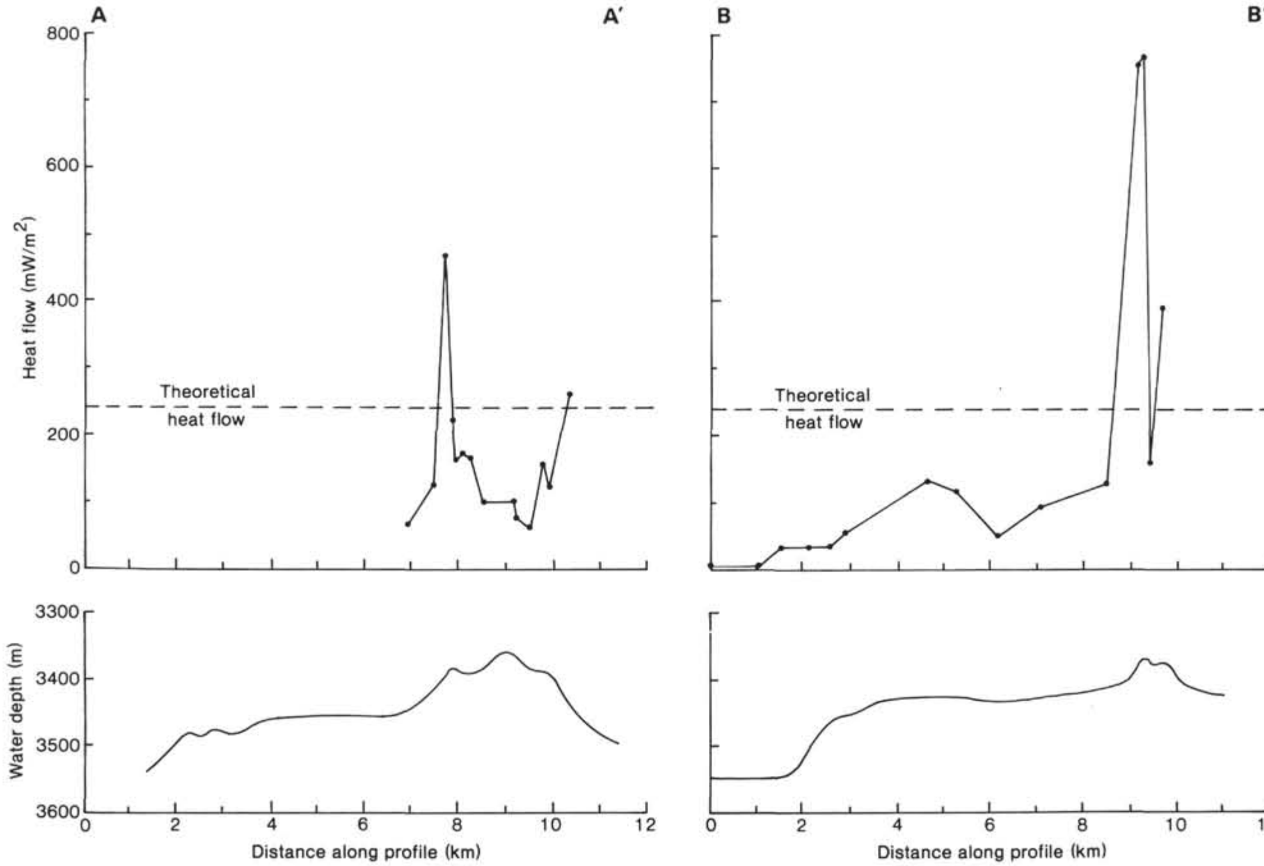


Figure 3. Site survey heat flow profiles in the area surveyed for Sites 600 to 602. Locations are shown in Figure 1. A. Profile A–A′. B. Profile B–B′.

of very low heat flow, which averages 20 mW/m^2 but ranges down to 5 mW/m^2. Because of the high heat flow values at the abyssal hill ridge to the east and the intermediate heat flow values on the plateau between the trough and the ridge, the trough was interpreted as a site of downwelling pore fluids. The sediment cover in the trough was patchy; many areas were bare of sediment, but some were interpreted as having up to 10 m of sediment cover. All of the heat flow probes and *in situ* pore water samplers deployed by the site survey in the low heat flow trough penetrated sediment, however, and did not hit basement. We anticipated drilling Site 602 at one of the two 5-mW/m^2 heat flow stations.

Because of the thin and patchy sediment cover we anticipated that the sediment record might be incomplete and/or show evidence of reworking. Drilling the site had very high priority because of the evidence of downwelling, however; we wanted to obtain a complete sediment section to basement to document any changes in sediment chemistry or mineralogy due to downwelling. Although we did not anticipate that the sediment section would be thick enough to make rock drilling with the XCB feasible, we hoped that the hydraulic piston corer would recover at least a few chips of basalt or basement. To meet our objectives we planned to drill three holes; we planned to recover sediment from two and to devote one to experimental work if the sediment was thick enough to warrant use of the Barnes/Uyeda sampler and the Von Herzen heat flow shoe.

OPERATIONS

Site Survey

The area in which Sites 600 to 602 are located was chosen for more detailed surveys and as a potential site because it met three criteria: the crust was aged 4 to 5 Ma, the basement was generally smooth, and the area of continuous sediment cover was large. The site itself was selected from the Ariadne II survey of the area between 116°45′W and 117°04′W, 18°52′S and 19°05′S (Fig. 4). This survey covers a pair of abyssal hill ridges trending 010°, between which there are a sediment-covered plateau and a trough. A fault scarp trending 010° forms the step between the trough and plateau. These features are clear on a more interpretive map of the Seabeam bathymetry which shows the locations of all the site survey stations (Fig. 1).

Air gun records from the site survey cruise show that the thickness of the sediment on the plateau is fairly uniform (20 to 25 m) except where the sediment is pierced by the abyssal hill ridges. The area that was surveyed in detail (Fig. 1) is bounded on the east by one of the abyssal hill ridges and on the west by the trough. The trough shows patchy sediment cover up to 10 m thick in the air

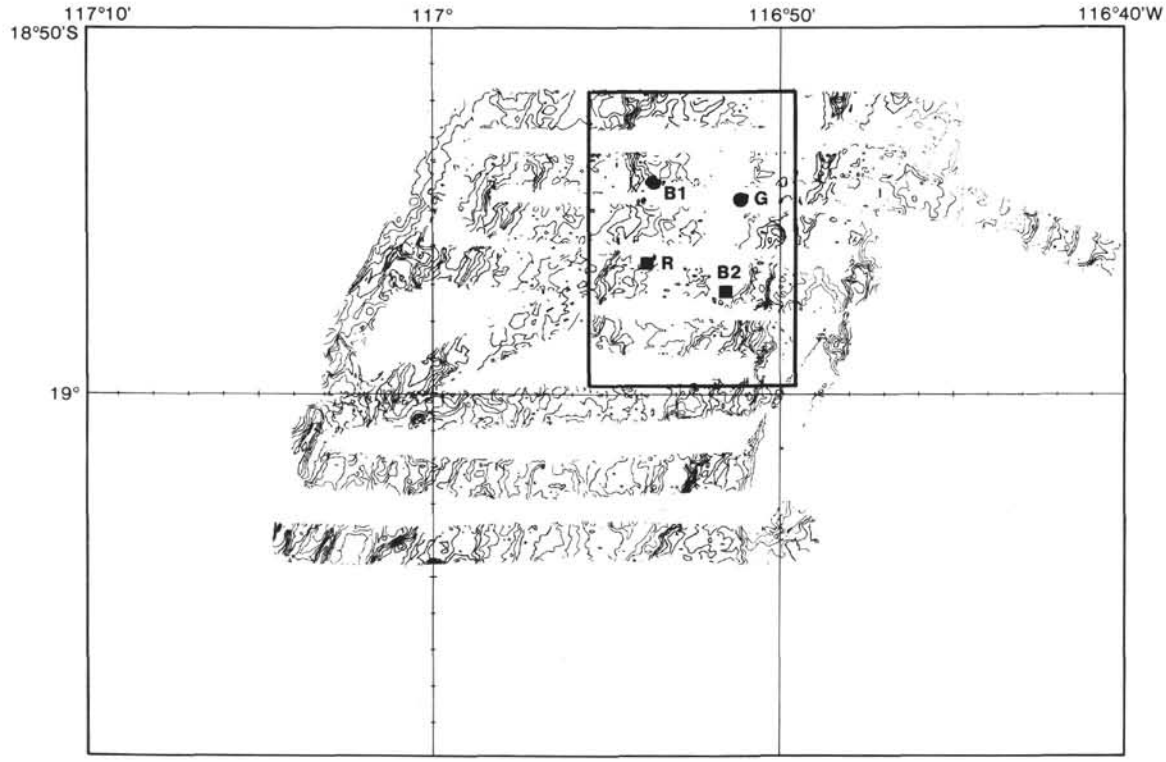


Figure 4. Seabeam swath maps from which bathymetric map in Figure 1 was made. Area of Figure 1 is indicated by the box outlined in black. Lettered locations within the box indicate positions of acoustic transponders used for navigation of site survey stations. Transponders designated R and G were left in the area and were used to position the *Glomar Challenger* over drilling targets chosen from site survey data.

gun records. The sediments are acoustically transparent in the air gun records, but they display internal reflectors in the *Glomar Challenger* water gun records (Fig. 5). The basement reflector is fairly smooth in the air gun records, with a strong bubble pulse. Basement in the water gun records is also quite smooth.

Heat flow measurements from the site survey cruise showed areas of high, intermediate, and low heat flow (Fig. 6). One of the regions of high heat flow (750 mW/m^2) on the northern tip of the abyssal hill ridge also showed pore water evidence of fluid advection through the sediment. This area was chosen as the target for Site 600. Site 601 was located in the intermediate heat flow area (100 mW/m^2), and Site 602 was in the low heat flow area (5 to 20 mW/m^2).

Navigation

Because the drill sites in the surveyed area lay in a straight line, we planned to wait for a satellite fix outside the surveyed area, then steam through the surveyed area on a course of 106° and drop a beacon at each drill site. In this way our sites would be located as accurately as possible if the acoustic transponders left in the area by the site survey were not working. By the time we received the satellite fix, we were almost due south of the low heat flow western (trough) drilling target, however, so we steamed to the second target and dropped only the beacons for the intermediate heat flow (plateau) and high heat flow (ridge) targets. We decided to drop the beacon for the low heat flow target after drilling the first two areas. The beacon for Site 600 was dropped at 2255 hr. on 23 March.

After the ship took position over the beacon, we interrogated the two acoustic transponders as described for Site 597. Both functioned and were used to position the ship within 20 m of site survey heat flow station HF 18/3 (>765 mW/m^2 heat flow).

Operations on Site

Site 600

Since little sediment was anticipated at Site 600 and very little was apparent in the 3.5-kHz records, we decided to wash to basement to determine basement depth before coring. We also wanted to determine pipe depth to basement because the site's slope location made the precision depth recorder (PDR) extremely difficult to interpret. Furthermore, we wanted to make the drilling operation as efficient as possible. We had found at earlier sites that the variable-length hydraulic piston corer (VLHPC) would recover sediment if it was triggered within a meter or two of basement but that the sediment would generally be disturbed and the top portion of the core would be watery. By determining pipe depth to basement before coring the thin sediment section, we would optimize our chances of recovering undisturbed sediment without damaging the core barrel. In addition to recovering sediment from this hole, we wanted, if possible, to run the Von Herzen heat flow shoe at least once (in addition to running it in the dedicated instrumental hole),

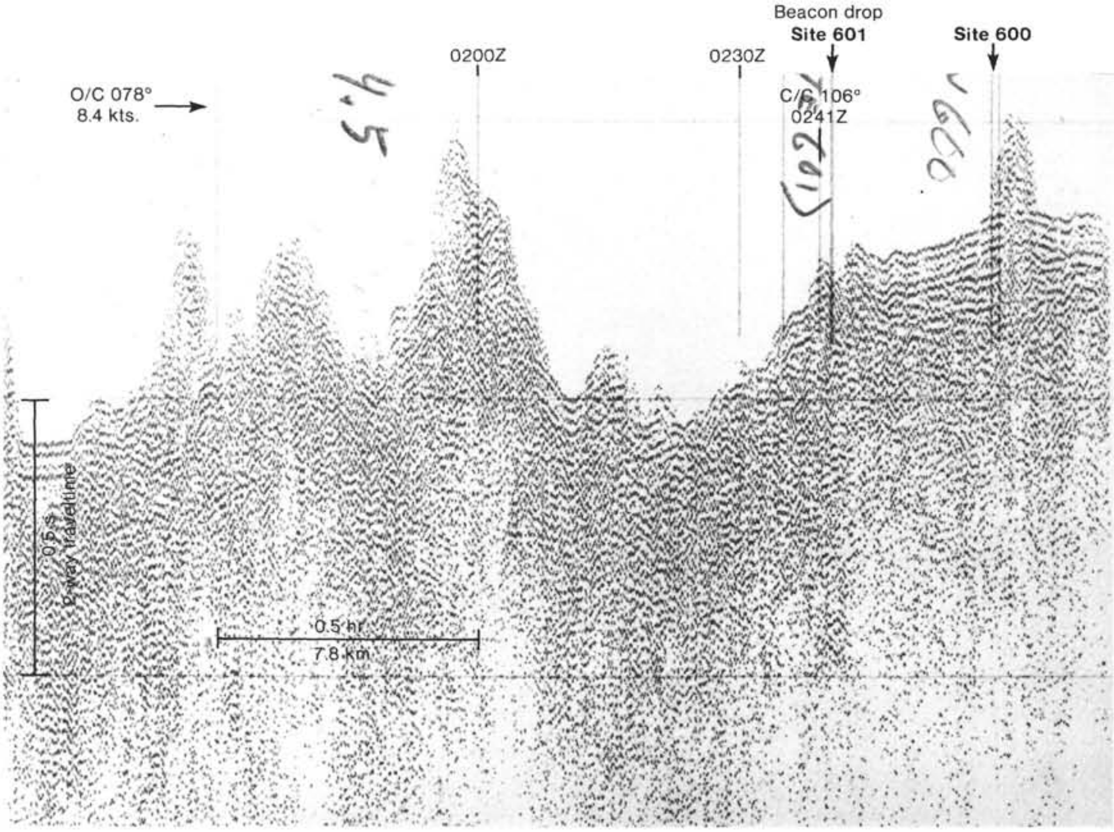


Figure 5. *Glomar Challenger* water gun record of the approach to Sites 600 and 601.

because we knew from the site survey that the heat flow in the area was highly variable over distances as small as tens of meters. Basement was tagged (felt with the drill pipe) at 3380.5 m.

The strongest reflector on the PDR was at 3346 m. A basement depth of 3380.5 m indicated a 35-m sediment section. Although the sediment was thicker than we anticipated, we started coring. After retrieving three empty barrels, Hole 600 was finally spudded at 1236 hr. on 24 March (Table 1). Mud line was at 3372.3 m, a depth that suggested a total sediment thickness of 8.2 m. A Von Herzen heat flow shoe was on the VLHPC for the mud line core and obtained a successful temperature estimate that indicated high heat flow. Since the second core was expected to hit basement, we deployed a 5.0-m core barrel. The corer did not stroke out completely; the core barrel apparently hit basement, and it broke off at the last engaged thread of the inner barrel box connection. Operations at Hole 600 terminated when the pipe was pulled clear of the mud line at 1530 hr. No sediment was recovered in Core 600-2, and since there was little sediment to support the drill string, we assumed that the core barrel sheared because it hit basalt and was sharply deflected to the side.

We then decided to try to core the entire sediment section with a single 9.6-m core barrel. Hole 600A was spudded at 1554 hr. on 24 March. The pipe was pulled clear of the mud line, ending operations at Hole 600A, 3 min. later at 1557 hr., to minimize the risk of breaking off another core barrel. When the core came on deck we found that the lower half of the barrel had sheared off at an inner barrel connection. Shearing at this point suggested that the reason for the shearing was not drill pipe motion but the impact force of the VLHPC. Assuming that the use of three shear pins resulted in excessive penetration velocity, we set a third 9.6-m core with two shear pins, triggered it at 1705 hr., hit basement (Hole 600B), and pulled it clear immediately at 1706 hr. The core was recovered intact with only 1.9 m of sediment. There was no indication of incomplete coring, and we assumed that the difference in recovery between Holes 600 and 600B was due to large variability in sediment thickness.

We offset 170 m west-northwest, using the transponders to position the *Glomar Challenger* over a second surveyed high heat flow station (HF 18/2, 753 mW/m^2, Fig. 6). The offsets from the beacon were 280 ft. north, 340 ft. west of Hole 600. We again washed to basement to determine basement depth. After 50 min. we had 3410 m of pipe out, and we began to suspect that the drill string had deflected off the side of a steep slope; thus, we might be laying the bottom hole assembly (BHA) out on the seafloor. We pulled up and decided to trigger the VLHPC from 3400.8 m. The core barrel come up empty, but there were traces of mud on the flapper of the core catcher. A second core was triggered from 3405.8 m and recovered 9.38 m of sediment; Hole 600C had spudded at 2127 hr. A second core in this hole recovered 2.42 m of sediment. There were fragments of glassy basalt cemented by $CaCO_3$ in the core catcher. (Note: the coring log for Core 600C-2 indicated the pres-

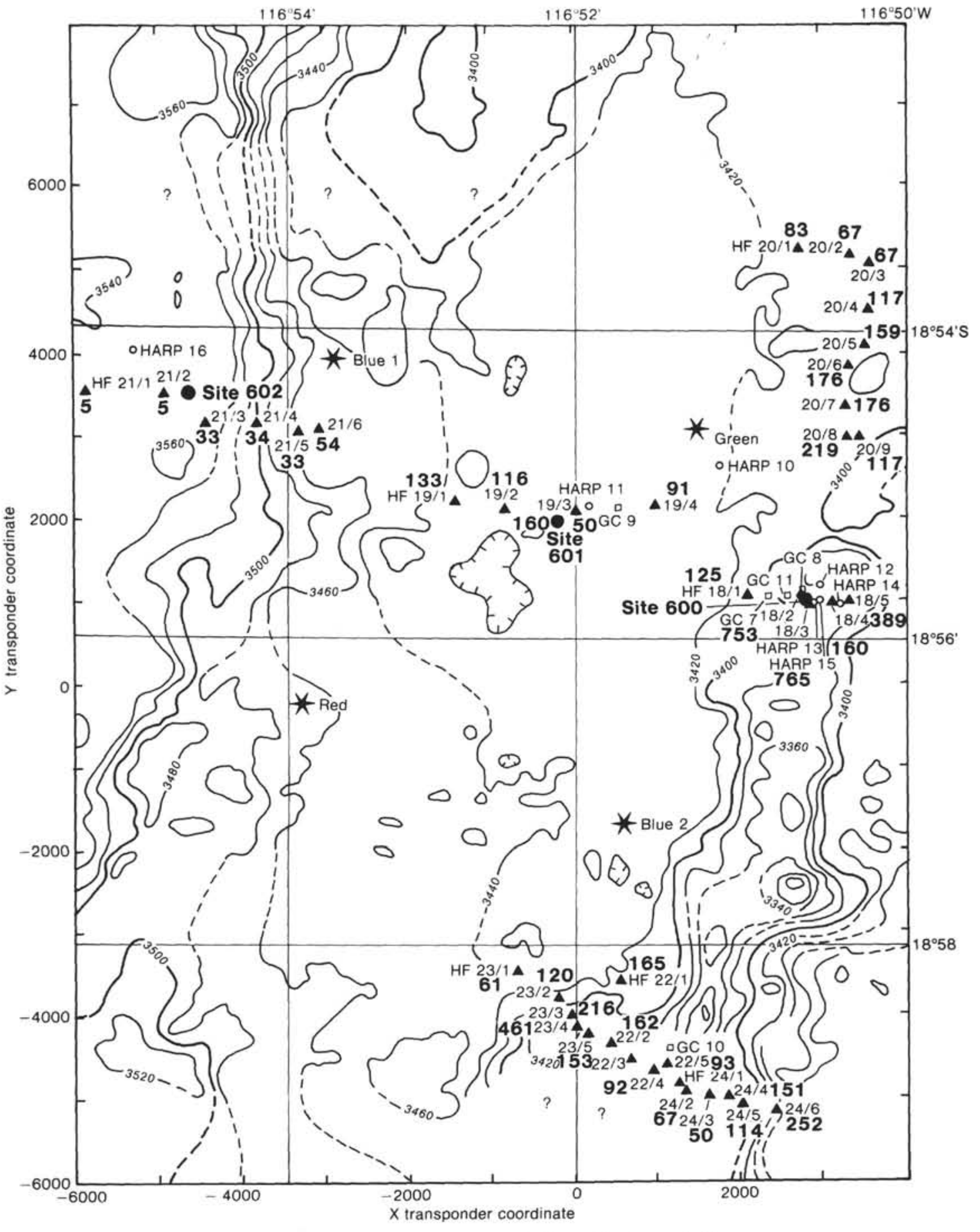


Figure 6. Heat flow values from the site survey in the vicinity of Sites 600, 601, and 602.

ence of sediment in Sections 1 and 5, and Sections 2 to 4 were designated as voids. The sedimentological and paleontological data, however, suggest that the sedimentation record is continuous. It is therefore assumed [unless otherwise proven] that Section 600C-2-5 is actually Section 600C-2-2, and it appears as Section 2 in all Leg 92 records.) Hole 600C terminated with the bit on deck at 0800 hr. on 25 March.

Site 601

The positioning beacon for Site 601 was dropped at 1841 hr. on 23 March as the ship came into the area of Sites 600 to 602. After finishing operations at Hole 600C, we steamed back to Site 601 and took position over the beacon. The original transit across the sediment-covered plateau after dropping the beacon for Site 601 showed that the beacon was located at the edge of the plateau, about 1 km west of the intended target. We therefore used the acoustic transponders left in the area by the site survey to reposition the *Glomar Challenger* over the intended site and to verify its location in the X-Y grid of the site survey transponder network.

Since, as at Site 600, we needed to obtain heat flow measurements in thin sediment cover, we needed exact

Table 1A. Coring summary, Sites 600, 601, and 602.

Core	Date (Mar. 1983)	Time (hr.)	Depth from drill floor (m)	Depth below seafloor (m)	Length cored (m)	Length recovered (m)	Recovery (%)
Hole 600							
1	24	1325	3372.3-3377.7	0-5.4	5.4	5.38	99.6
2	24	1500	3377.7-3382.5	5.4-10.4	Unknown[a]	0	0
Total							51.7
Hole 600A							
1	24	1620	3372.0-3381.6	0-9.6	Unknown[a]	0	0
Hole 600B							
1	24	1725	3372.0-3373.9	0-1.9	1.9	1.9	100
Hole 600C							
1	24	2200	3405.8-3415.2	0-9.4	9.4	9.38	99
2	24	2330	3415.2-3225.0	9.4-19.0	9.6	2.42	25
Total					19.00	11.80	62.1
Hole 601							
1	25	1700	3447.7-3457.5	0-9.8	9.8	9.75	99
2	25	1830	3457.5-3467.1	9.8-19.4	9.6	8.65	90
3	25	1945	3467.1-3468.1	19.4-20.4	1.0	1.05	105
Total					20.4	19.45	95.3
Hole 601B							
Wash			3448.0-3462.4	0-14.4			
1	26	0030	3462.4-3472.0	14.4-24.0	9.6	5.82	61
2	26	0530	3472.0-3473.5	24.0-25.5	1.5	0.75	50
3	26	1045	3473.5-3475.0	25.5-27.0	1.5	0.18	12
Total					12.6	6.75	53.6
Hole 602							
H1[b]	27	0715	3543.8-3550.0	0-6.2	6.2	6.19	99.8
Hole 602A							
1[c]	27	0830	3547.3-3547.6	0-2.3	2.3	2.28	99.1
Hole 602B							
1[d]	27	1700	3548.8-3553.0	0-4.2	4.2	4.24	101.1

[a] VLHPC core barrel sheared off at interbarrel connection.
[b] XCB punch core (basement tagging operation).
[c] 9.6-m VLHPC core barrel.
[d] 5.0-m VLHPC core barrel became stuck in pipe.

Table 1B. Heat flow measurements and pore water samples from Hole 601A.

Station	Total depth of bit (m)	Depth of bit (m)	Depth of probe[a] (m)	Measurement type and number
1	3453.0	5.0	7.0	Heat flow 1
2	3457.0	9.0	11.0	Heat flow 2
3	3463.0	15.0	17.0	Heat flow 3, pore water sample

Note: All measurements were made on 25 March 1983; station 3 was occupied at 2215 hr.
[a] Probe protrudes 2 m in front of bit.

knowledge of basement depth to avoid damaging the heat flow tool. We therefore decided to wash to basement to obtain a depth before coring. We began running into the hole at 0800 hr. on 25 March. We washed to basement, which was at a pipe depth of 3470 m (PDR seafloor depth was 3443.0 m). The drill string was pulled back to attempt a mud line core. The first attempt to spud the hole recovered an empty core, but the flapper core catcher showed traces of mud. Hole 601 was spudded on the second attempt at 1621 hr. on 25 March. Mud line was at 3447.7 m (Table 1). This was the first mud line depth that was not at least 6 m above PDR depth. The hole was cored with the VLHPC. A successful heat flow measurement was made with the Von Herzen heat flow shoe on Core 601-2. Core 601-3 hit hard rock at 3468.1 m. Hole 601 ended with the bit clearing the mud line at 2000 hr. on 25 March.

The next hole (601A) was dedicated to the acquisition of heat flow measurements and pore water samples. Three successful temperature measurements were made and one successful *in situ* pore water sample was taken (Table 1B). The bit cleared the mud line, terminating Hole 601A, at 2225 hr. on 25 March.

A third hole was cored to attempt to recover the sediment/basement contact and to recover a basement core with the XCB. This hole (601B) was spudded with no offset at 2226 hr. and was washed to a depth 8.6 m above basement. The XCB core at the sediment/basement contact recovered 5.82 m of sediment with basalt in the core catcher. Two additional XCB cores were cut before coring was terminated at 3475.0 m (27.0 m below seafloor [BSF]). Hole 601B was terminated with the bit on deck at 1542 hr. on 26 March.

Site 602

The positioning beacon for Site 602 was dropped at 1620 hr. on 26 March after a short transit from Site 601. A brief survey was conducted in an effort to find an area in the trough with sediment thick enough to show up in the 3.5-kHz records. When none of the records clearly showed the presence of sediment, we used the acoustic transponders left in the area by the site survey to reposition the *Glomar Challenger* in the vicinity of the lowest heat flow measurement and to verify the ship's position according to the X-Y coordinates of the site survey transponder network. Our position was offset from the beacon 2990 ft. south and 1600 ft. west.

As at Site 600 and 601, we wanted to obtain heat flow measurements and *in situ* pore water samples if possible; therefore, we needed to know basement depth exactly to avoid damaging the tools. In addition, we were puzzled by the lack of sediment indicated by the PDR, since the site survey air gun records had been interpreted as showing 10 m of sediment. We wanted to determine whether the surface reflector was sediment or rock. We began running in the hole at 1855 hr. on 26 March.

On 0135 hr. on 27 March, just after we picked up the Bowen power sub, the positioning beacon failed. A second beacon was released, and our position was monitored with the acoustic transponders while the beacon was falling to the seafloor. After taking position over the new beacon, we offset the ship 1170 ft. south and 540 ft. west to bring it back to the target site.

The PDR indicated that the depth of the site was 3551 m. While washing down to tag basement, we encountered a hard layer at 3546 m, 5 m above PDR depth. We attempted to acquire one core with the VLHPC from 10.0 m above the 3546-m basement depth. This core was empty. We assumed that there was no sediment, so we steamed back to a position directly over the positioning beacon, looking for a more promising site. After making an offset in a different direction we were still unable to find evidence of sediment. In desperation we offset 1000 ft. due east (toward the base of the trough wall) in hopes that there would be some sediment at the base of the slope. An XCB was placed in the pipe during the basement tagging operation in case the sediment layer was thin. Basement was tagged at 3550 m as the XCB barrel punchcored the overlying sediment. Hole 602 was spudded at 0638 hr. on 27 March, with mud line at 3543.8 m (Table 1). Hole 602 was terminated when the bit cleared the mud line at 0642 hr.

Hole 602A was spudded at 0750 hr. with the VLHPC. The barrel did not stroke out completely; when recovered it contained 2.28 m of sediment, with the core catcher containing basalt chips. Hole 602A was terminated when the bit cleared the mud line 0752 hr. We felt that a 5.0-m core barrel might recover less disturbed sediment than the 9.6-m core barrel, so an additional hole, 602B, was spudded at 0930 hr. The barrel would not pull free from the bottom hole assembly, and we thought it had bent. When the overshot pin sheared, we decided to pull out of the hole. The bit was on deck at 1745 hr. on 27 March. The barrel had not bent; instead, it had been jammed into its seal sleeve by sand. The sand was probably pulled into the seal area because we pulled up on the corer as soon as we triggered it. The core barrel had three layers of basalt chips in it; the corer probably bounced or heaved with ship motion, recoring the sediment veneer three times.

After recovering the final core, we recalled the first transponder. Although the mechanism keeping the transponder at the seafloor released and the transponder rose to the surface, strong winds and rig floor magnafluxing operations prevented us from taking a heading that would bring us closer than 2 km to the transponder until about 0.5 hr. after it had surfaced. Since we could not range on the transponder while it was at the surface, we lost track of it. We began a search pattern for it; the second transponder verified that we were within 400 m of the position at which it had surfaced, but we never found it. We were searching at night, and the transponder's strobe may not have been flashing. The second transponder was recalled. It also surfaced, and we recovered it without difficulty. The transponder was on board at 2330 hr. on 27 March, and the ship got under way for Hole 504B at 2340 hr.

SEDIMENT LITHOLOGY

Site 600

Lithology

The Site 600 sediments are divided by degree of induration into two lithologic units: a clay-bearing to clayey nannofossil ooze and a clayey chalk. Only Hole 600C contains both units (Fig. 7A). In Hole 600C a 10-m lower Pliocene to Pleistocene brownish yellow to dark brown clay-bearing to clayey nannofossil ooze, Unit I, overlies 1.8 m of lower Pliocene, yellowish brown to dark brown, foraminifer-bearing clayey nannofossil chalk, Unit II (Figs. 7A and 7B). Basement was not recovered. Only parts of Unit I were obtained in Holes 600 and 600B. No exact sedimentological and/or paleontological correlations between the sediments of the three holes were made.

As at Sites 597, 598, and 599, the sediments from the holes at Site 600 are composed mainly of various mixtures of calcareous ooze, poorly crystalline smectite, and translucent red brown to yellow brown semiopaque oxides (RSO; Quilty et al., 1976; Bass, 1976). Terrigenous components are rare, with traces to 3% disseminated volcanic glass. Other minor components are palagonite (0 to 2% in Unit I but 3 to >5% in Unit II); micronodules and opaques (0 to 2% each); and phillipsite (0% to traces). Most of the opaque grains seem to be RSO.

The calcareous component is mainly nannofossils, with 2 to 10% foraminifers in Holes 600 and 600B, 5 to 20% in Sections 1 to 3 of Core 600C-1, and 1 to 3% in the rest of Core 600C-1 and the uppermost 55 cm of Section 600C-2-1. Unit II contains 12 to 15% foraminifers. The preservation of the foraminifers is poorer in Unit II than in Unit I.

Silt grain size predominates in both lithologic units.

Unit I (0 to 10.0 m)

In Holes 600 and 600B, Unit I is represented by yellowish brown to brownish yellow clay-bearing nannofossil ooze with 70 to 80% nannofossils, 2 to 10% foraminifers, and 15 to 20% clay minerals and RSO. A very thin, dark crust, presumably manganese oxide, was observed at the surface of Hole 600 while the core was still out on deck. Unfortunately, it was destroyed by normal handling when the core was opened and processed. In Hole 600C, Core 1, Unit I is composed of a similar clay-bearing nannofossil ooze in Sections 1 and 2 and the upper 60 cm of Section 3. In Section 3 at about 62 and 138 cm, rather abrupt but slight changes occur in color and lithology. In each case, the sediment below the color change is a light brown foraminifer- and clay-bearing nannofossil ooze. The sediment above the color change is slightly darker and has fewer foraminifers. The sediments of the first three sections are Pleistocene in age. From Section 4 through the bottom of Unit I (10 m BSF), the $CaCO_3$ content of the sediment gradually decreases, and the amount of clay and RSO gradually increases. The lithology changes from clay-bearing nannofossil ooze to dark brown clayey nannofossil ooze. The clayey ooze comprises about 65% nannofossils, 1 to 3% foraminifers, and 25 to 30% clay and RSO. The age of the sediments from Section 5 downward is early Pliocene. The sediment from Core 1, Section 4 was not zoned but may be late Pliocene, so a hiatus in Section 4 appears likely.

Section 4 contains a dark brown interval of clayey nannofossil ooze between about 38 and 82 cm (4.9 and 5.3 m BSF; Fig. 8). The lower boundary of this sediment is sharp, but its upper boundary is gradational. The dark color is caused by a greater abundance of clay and RSO than in the adjacent sediments below or above. In addition, reworked nannofossil species are common in the interval, and the foraminifer zones suggest the presence of a hiatus within or at the interval's base.

Unit II (10.0 to 11.8 m)

The sediments of Unit II are early Pliocene yellowish brown to dark brown foraminifer-bearing clayey nannofossil chalk. The real thickness of the unit is unknown, since the low recovery in Core 600C-2 indicates that, as at Site 598, a hard layer blocked the coring. The core catcher contained a small limestone fragment. The sediment consists of 50 to 55% nannofossils, 12 to 15% foraminifers (relatively poorly preserved), about 30% clays and RSO, 3 to 5% palagonite, and small amounts of opaque grains and micronodules; it is cemented by $CaCO_3$. Most of the cement must have derived from the *in situ* dissolution of the calcareous ooze.

Discussion

The age of the oldest sediment recovered at this site is early Pliocene, 4.1 to 4.6 Ma. In middle Miocene time (10 to 15 Ma), the carbonate compensation depth (CCD) started deepening to its present depth (Berger and Winterer, 1974; van Andel et al., 1975; Berger, 1981). At present, the CCD in this region is probably at about 3950 to 4050 m (Broecker and Broecker, 1974; Rea and Leinen, this volume). The water depth at Hole 600C is 3406 m, and the site has been above the lysocline throughout its sedimentation history. Preliminary sedimentological and paleoceanographic data obtained on board provide some information about $CaCO_3$ dissolution history, which is a function of the interplay between the subsidence of the crust and the changes in the depth of the lysocline and CCD through time (Rea and Leinen, this volume).

Except for a decrease in sedimentation rate in the late Pliocene, sedimentation rates generally increase with increasing age. Correspondingly, clay and RSO also increase in abundance, until they make up 15 to 30% of the early Pliocene sediment. If we assume hydrothermal origins for the RSO, the input of this hydrothermal component to the sediment was significantly higher during the early Pliocene, when the site was nearer the ridge crest, than during the Pleistocene. The origin of the poorly crystalline smectite is unclear. The most likely precursors are basaltic glass and/or RSO. Diagenesis may be responsible for a small but recognizable increase in the grain size of the RSO in Sections 600C-1-5 through -1-7 and in Core 600C-2.

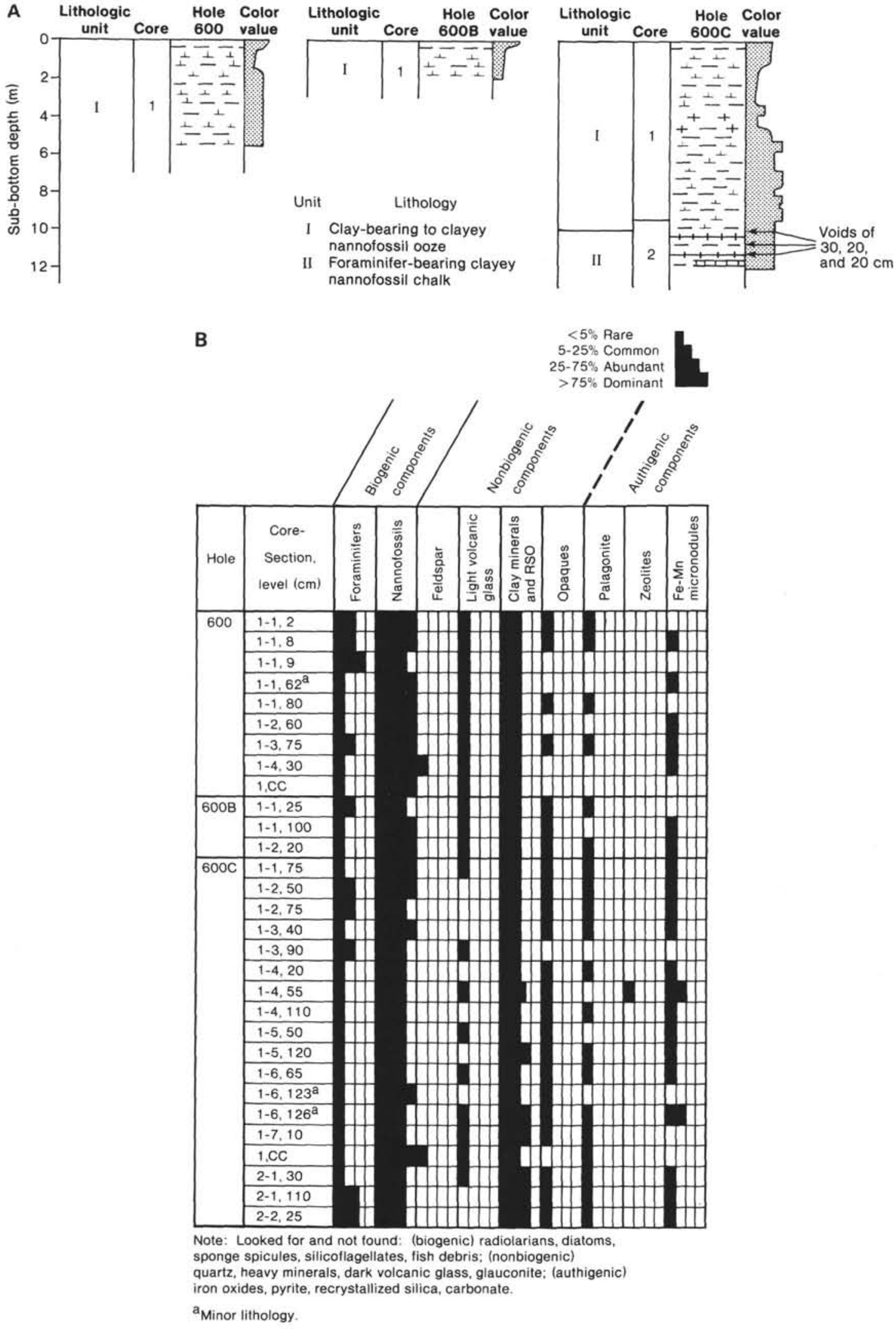


Figure 7. A. Lithologic sections, Holes 600, 600B, and 600C. Color value is an indication of lightness, lighter to the left, from the Munsell soil color charts and core descriptions. B. Smear slide summary, Holes 600, 600B, and 600C.

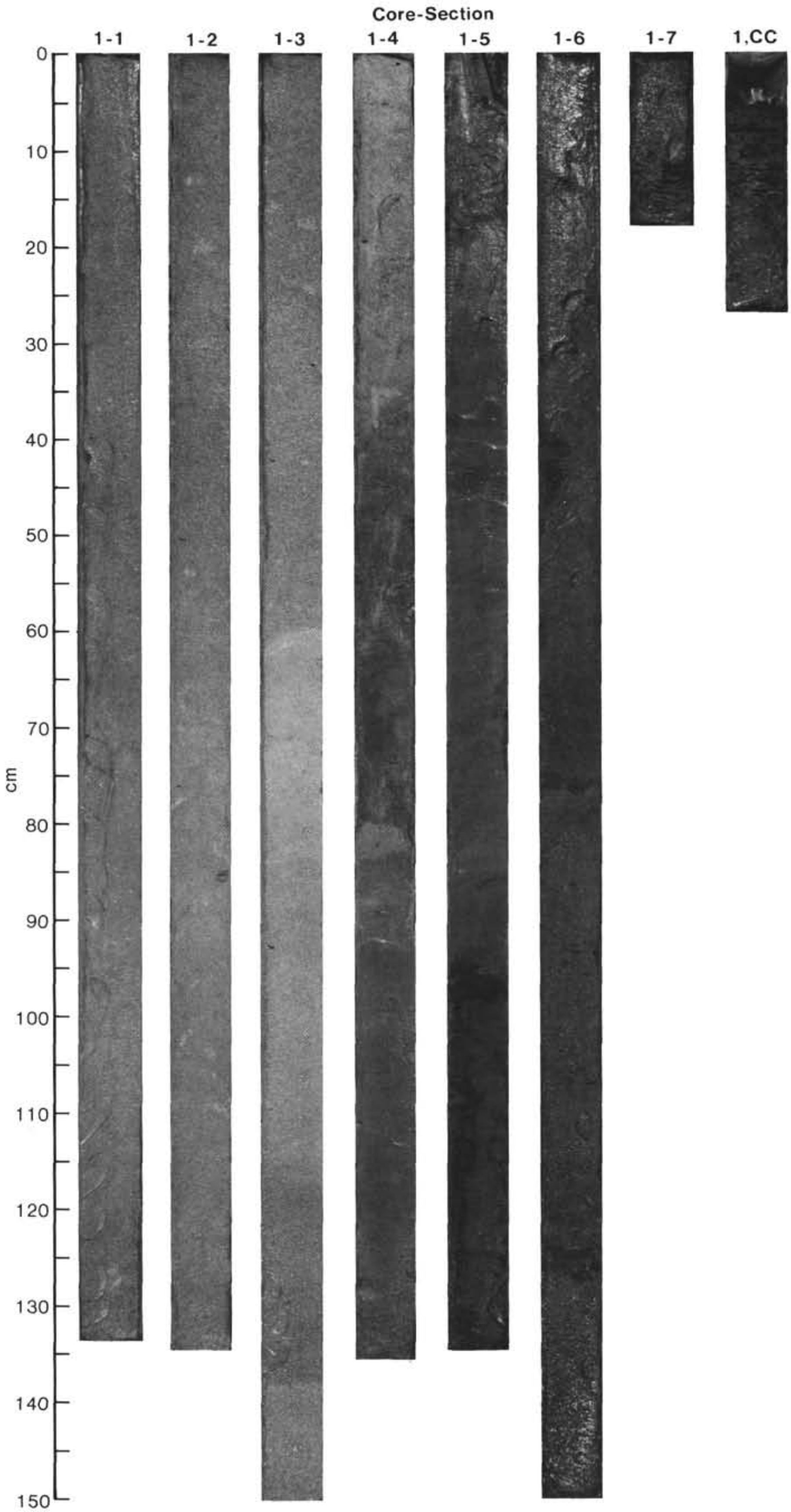


Figure 8. Sediment column, Hole 600C.

Despite the present high heat flow at this site (580 mW/m^2), there is no evidence that chalk is actively forming. There also is no indication that the chalk of Unit II, at the base of this site, is thicker or more extensively indurated than the chalk recovered in Unit II of Site 598, where heat flow is low (87 mW/m^2, about half the theoretically expected value; Sclater et al., 1971). The two chalks are remarkably similar despite a sediment age difference of about 11 m.y. Thus, these chalks may have formed early, by epigenetic or hydrothermal alteration, when each site was close to the ridge crest.

Site 601

Lithology

The sediment column at Site 601 consists of two units (Fig. 9A). Unit I (0 to 20.0 m BSF) is a clay-bearing nannofossil ooze, which grades to clayey nannofossil ooze and foraminifer–nannofossil clay near the basement. The sediments typically contain 2 to 5% foraminifers, occasionally approaching 10% (Core 601-1), 1 to 2% palagonite, and 1 to 2% micronodules and opaque grains (Fig. 9B). The sediment is light brown in most of Core 601-1; it abruptly darkens to brown at the base of Section 601-1-6. The micropaleontological studies suggest that this color change represents a hiatus that spans part or all of the late Pliocene; there is a corresponding hiatus at Site 600.

The lower 10 m of sediment are marked by color banding. Intervals of darker sediment 2 to 20 cm thick, almost all of which have gradational upper and lower contacts, are spaced 20 to 50 cm apart in the section. Because the contacts are gradational, these bands probably represent either carbonate dissolution cycles or hydrothermal events instead of episodes of redeposition.

Unit II (20.0 to 20.4 m BSF) consists of weakly indurated clayey nannofossil chalk to nannofossil claystone. It is similar to the basal sections of Sites 598 and 600, although it contains more clay and is less well lithified.

Holes 601 and 601B are correlated by three distinct color bands that occur in Hole 601 in Section 601-2-5 at 64–75 cm, 85–93 cm, and 110–115 cm. They are found in Hole 601B in Section 601B-1-3 at 36–47 cm, 67–74 cm, and 85–95 cm.

Discussion

Figure 10 correlates the depth of the nannofossil zones and the base of the sediment section in Holes 600C and 601. If all the intervals plotted in a straight line, the changes in sedimentation rate would be perfectly correlated between the two sites, as would be expected in ideal pelagic sediment deposition. A break in slope occurs at about 9 m in Hole 601, during the intervals of the suspected late Pliocene hiatus. Whatever process caused the slowing of sedimentation, it had a more profound effect at Site 601, which lies on a sediment-covered plateau, than at the slightly shallower Site 600, which lies on a ridge.

Site 602

At Site 602, sediments were recovered from three holes (602, 602A, and 602B). In each case the recovery consisted of a single lithologic unit of Pleistocene clay-bearing, and occasionally foraminifer-bearing, to clayey nannofossil ooze (Fig. 11A). Core 602-H1 was collected unintentionally with the XCB in the pipe during the basement tagging operation. The sediments recovered (6.2 m) were totally homogenized and included three zones that were almost entirely water, probably as the result of a combination of pumping as the ship heaved and sediment flow-in. The core was described, but no smear slides were prepared. Portions of this core were sampled and homogenized for use as an analytical standard for interlaboratory comparisons, and the core-catcher sample was sieved for basalt chips.

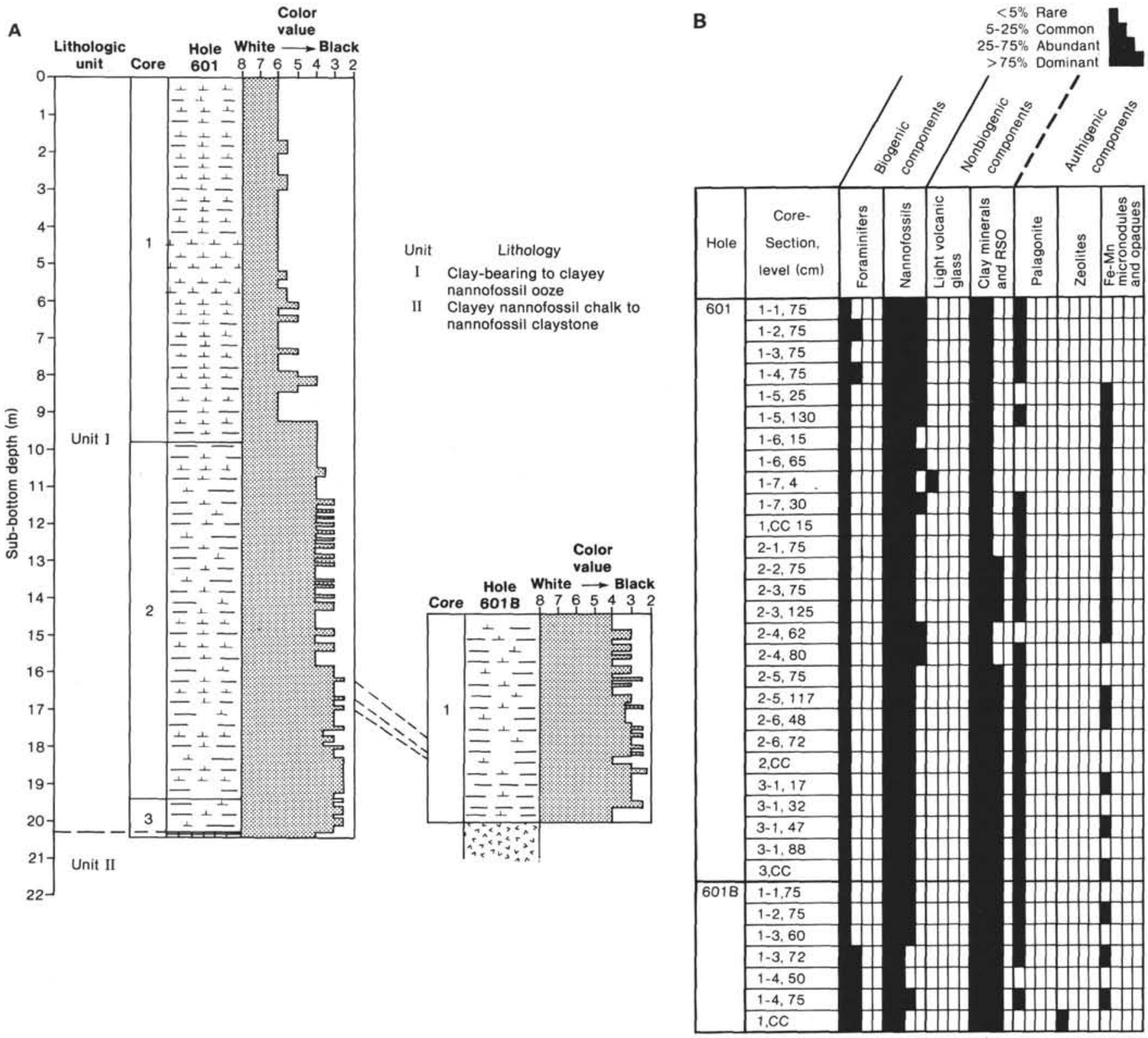
In Hole 602A we recovered 2.3 m of sediment (one core, which had rock chips in the core catcher). Of the sediment recovered at the site, the sediment in this core is considered the most representative of the sediment cover at Site 602.

In Hole 602B, the core (4.2 m) jammed in the bottom of the pipe during recovery, causing the termination of operations at Site 602. Rock chips and/or lithified pieces were noted at four different depth intervals (Fig. 11A), suggesting that ship motion caused the section to be cored repeatedly after the core jammed in the pipe.

Placoliths are the predominant nannofossil recovered at Site 602, and reworked discoasters are common (Fig. 11B). No siliceous microfossils were observed, and the sediments contain almost no continental detritus except for some disseminated volcanic glass.

Lithology

The sediments recovered from Hole 602A are uniform, typically a yellowish brown to dark yellowish brown clay-bearing nannofossil ooze containing 80 to 85% calcareous nannofossils, 10 to 20% clay and RSO, 1 to 3% foraminifers, and trace amounts of zeolites, opaque grains, and volcanic glass. In contrast, the sediments recovered from Hole 602B can be subdivided into three sequences that correspond to the portions of the core that occur above, within, and below the zone where rock chips were observed. Section 602B-1-1 and the upper 40 to 50 cm of Section 602B-1-2 consist of a dark brown to yellowish brown foraminifer- and clay-bearing nannofossil ooze, typically containing 65 to 70% calcareous nannofossils, 15 to 20% clay and RSO, 4 to 15% foraminifers, 2 to 3% palagonite, and trace amounts of opaque grains and volcanic glass. The zone between 50 and 109 cm in Section 602B-1-2 is a dark reddish brown nannofossil clay containing about 55% clay and RSO, 40% calcareous nannofossils, and chips of basalt glass and highly vesicular rock at 61 to 63, 79 to 80, and 104 to 109 cm (Fig. 11A). The foraminifers within this zone are heavily coated with iron–manganese oxyhydroxides; otherwise, the minor lithology of the facies is similar to that of the overlying sediments. X-ray diffraction analyses of carbonate-free residue prepared from the dark reddish brown and the yellowish brown sediment near the volcanic glass in this facies indicated magnetite in the former and palagonite and goethite in the latter. The lowermost facies in Core 602B-1 consists of a brown to dark brown clay-bearing nannofossil ooze containing 80% calcareous nannofossils, 15 to 20% clay and RSO, 4% foraminifers, 1



Note: Looked for and not found: (biogenic) radiolarians, diatoms, sponge spicules, silicoflagellates, fish debris; (nonbiogenic) quartz, feldspars, heavy minerals, dark volcanic glass, glauconite; (authigenic) iron oxides, pyrite, recrystallized silica, carbonate.

Figure 9. A. Lithologic section, Site 601. Dashed lines indicate visual correlations. Color value is an indication of lightness, lighter to the left, from the Munsell soil color charts and core descriptions. B. Smear slide summary, Site 601.

to 2% palagonite, 1% opaque grains, and trace amounts of micronodules and zeolites.

Discussion

The sediments in Hole 602A are similar in composition to lithologic Unit I at Sites 600 and 601. Both of the latter contain a well-defined chalk layer (Unit II), possibly formed by hydrothermal alteration, separating the unlithified sediments from basement. No such layer was observed in any of the cores collected at Site 602, although Section 602B-1-3 did contain two small (about 1.0-cm) pieces of clay-bearing nannofossil chalk. Thus, except for slight $CaCO_3$ dissolution (see Biostratigraphy) and silica dissolution (inferred from the absence of siliceous nannofossils), there is little evidence of postdepositional alteration.

BIOSTRATIGRAPHY

Site 600

Three of the four attempts to core the sediment cover at Site 600 recovered material that was examined for microfossils. Holes 600 and 600B (5.4 and 1.9 m, respectively) contained only Pleistocene sediments; Hole 600C

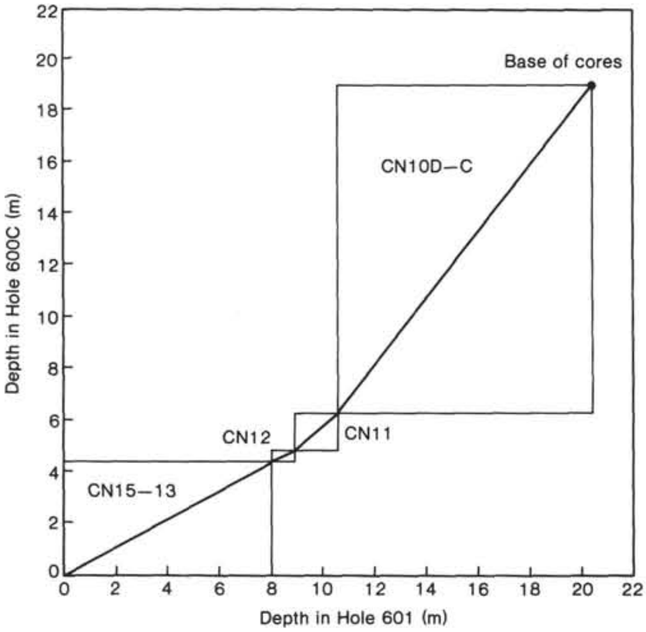


Figure 10. Correlation of nannofossil zones in Holes 600C and 601.

penetrated 19.0 m and recovered 11.8 m of clay-bearing to clayey nannofossil ooze that was dated as early Pliocene to Pleistocene (Figs. 12A and 12B).

In Hole 600C, the sediment to a depth of 4.4 m is Pleistocene in age (Fig. 12B). The few discoasters present are obviously reworked. Upper Pliocene material (nannofossil Zone CN12) occurs between 4.4 and 4.9 m. These sediments lie directly over a highly reworked section from about 4.9 to 5.3 m. The boundaries of the reworked zone at 4.85 and 5.32 m coincide with changes in sediment color in Section 600C-4-1 at 37 and 82 cm. This interval may represent the reworking of lower Pliocene material, slow sedimentation rates within the late Pliocene, and subsequent bioturbation.

The early/late Pliocene boundary is located at approximately 5.4 m BSF. Sample 600C-1-4, 145–150 cm was zoned as CN11 (Okada and Bukry, 1980) by using nannofossils and as N20 (Blow, 1969) by using foraminifers. The remaining 5.8 m of sediment (Sample 600C-1-5, 56–57 cm and lower; approximately 6.2 to 11.8 m BSF) is early Pliocene in age (N19, CN10C). A maximum basal sediment age of 4.6 Ma (Haq, 1984) is suggested by both the nannofossil and foraminifer zonations.

Smear slides examined from Site 600 did not contain siliceous microfossils.

Planktonic Foraminifers

Planktonic foraminifers were generally abundant and moderately well preserved in the sediments from Holes 600 through 600C (Table 2, Fig. 12A). Some reworking of Pliocene material is evident in samples of Pleistocene age.

Samples from Hole 600C indicate the presence of all Pliocene and Pleistocene tropical zones except Zone N21, which marks the late Pliocene (Blow, 1969). From the top of Hole 600C to Section 600C-1-2 (3.0 m BSF), the sediments are Pleistocene in age; specimens of *Globorotalia truncatulinoides*, which marks the base of Zone N22 (Fig. 12A), are common. Between Samples 600C-1-2, 145–150 cm (3.0 m BSF) and 600C-1-4, 145–150 cm (6.0 m BSF), there is a transition from the Pleistocene (Zone N22) to the lower Pliocene (Zone N20). Section 600C-1-4 (6.0 m BSF) contains few specimens of *G. margaritae, Sphaeroidinellopsis paenedehiscens*, and *Pulleniatina primalis* and none of *Globigerina nepenthes;* the extinction of the last of these marks the base of Zone N20. The presence of common specimens of *G. nepenthes* deeper in the section (in Sample 600C-1-5, 145–150 cm; 7.5 m BSF) indicates a zonal age for these lower sediments of N19. *G. nepenthes* also occurs with *S. paenedehiscens, S. seminulina kochi, P. primalis*, and *Globorotalia margaritae* in both Samples 600C-1,CC (9.4 m BSF) and 600C-2,CC (11.8 m BSF), indicating an age within Zone N19 and suggesting a maximum basal sediment age of approximately 5.0 Ma.

Nannofossils

Three holes at Site 600 were examined for calcareous nannofossils; of these, only Hole 600C yielded sediments that could be zoned in any detail (Fig. 12B). Holes 600 and 600B yielded 5.4 and 1.9 m, respectively, of Pleistocene sediment that contained some reworked Pliocene material. Hole 600 showed more reworking than Hole 600B, and both had more reworking than Hole 600C. In assemblage and preservation, Holes 600 and 600B are similar to the Pleistocene interval of Hole 600C.

The sediments down to about 4.4 m BSF (Sample 600C-1-3, 138–139 cm) are within Pleistocene Zones CN13 and CN15 (Okada and Bukry, 1980). A reduction in the abundance of *Pseudoemiliania lacunosa* was noted in Samples 600C-1-1, 4–5 cm and 56–57 cm, which may indicate the reworking of the species after its extinction. The presence of *Emiliania huxleyi* could not be determined, possibly because of its small size. Other species found within the upper 4.4 m of sediment are *Ceratolithus cristatus, Cyclococcolithina leptopora, Gephyrocapsa* spp. (abundant), *Helicopontosphaera carteri*, and *Rhabdosphaera clavigera*. Reworked discoasters are rare to few in abundance. Preservation is good to moderate, decreasing slightly with depth.

The interval between Samples 600C-1-4, 2–3 cm and 77–78 cm (and probably down to 82 cm, where a change in lithology occurs; 4.5 to 5.3 m BSF) is of late early Pliocene to late Pliocene in age. The interval was not given an exact zone assignment because there is much reworking. The samples in the upper half (600C-1-4, 2–3 cm and 24–25 cm), which have abundant discoasters, including *Discoaster tamalis, D. surculus, D. pentaradiatus*, and *D. brouweri*, are most likely of late Pliocene age. However, species from the genus *Gephyrocapsa* may also be present. Lower Pliocene species increase in abundance below a sedimentary contact at approximately 37 cm (4.9 m BSF) that appears to represent a highly reworked interval. Samples 600C-1-4, 56–57 cm and 77–

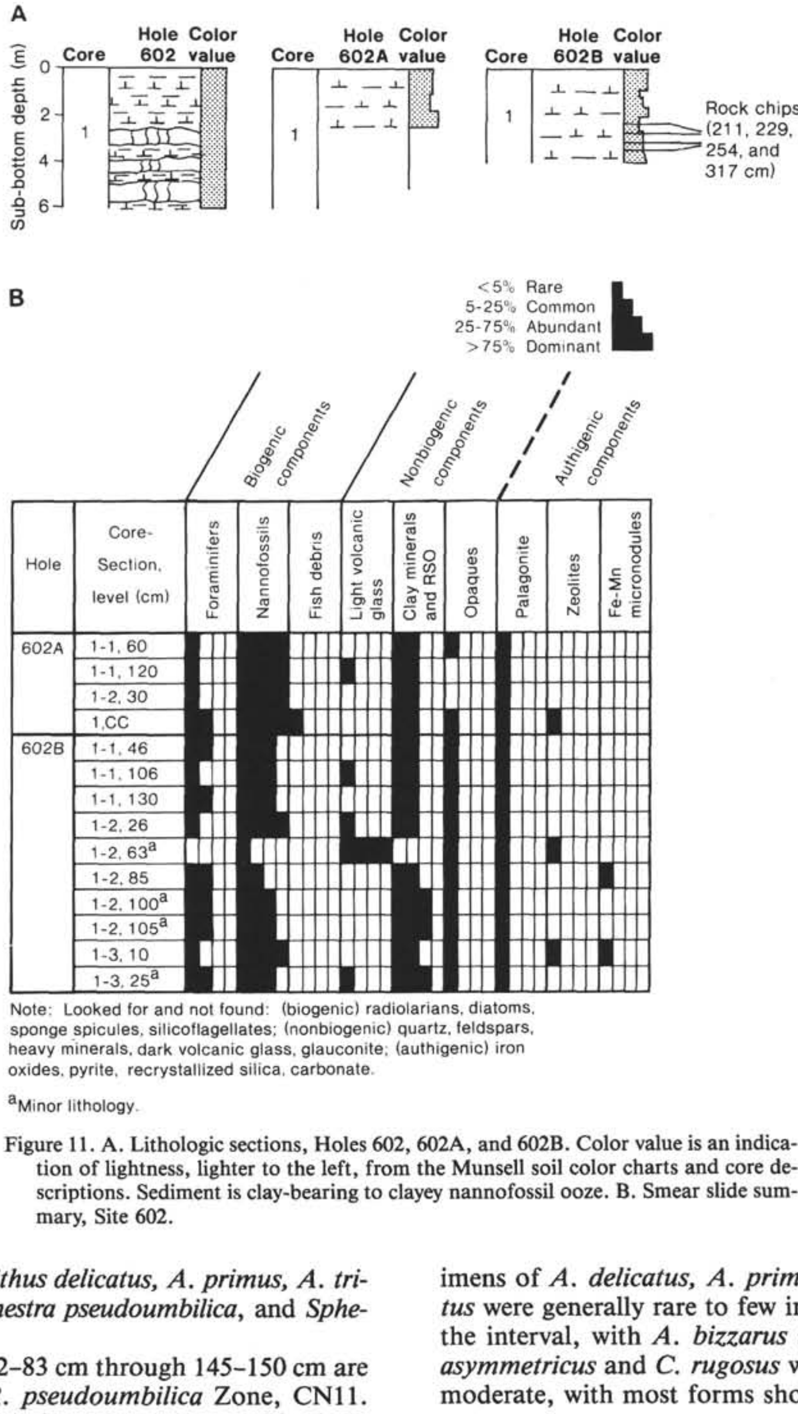


Figure 11. A. Lithologic sections, Holes 602, 602A, and 602B. Color value is an indication of lightness, lighter to the left, from the Munsell soil color charts and core descriptions. Sediment is clay-bearing to clayey nannofossil ooze. B. Smear slide summary, Site 602.

78 cm include *Amaurolithus delicatus, A. primus, A. tricorniculatus, Reticulofenestra pseudoumbilica*, and *Sphenolithus neoabies*.

Samples 600C-1-4, 82–83 cm through 145–150 cm are contained within the *R. pseudoumbilica* Zone, CN11. Zone assignment was based on the presence of both *R. pseudoumbilica* and *Sphenolithus* spp. and the absence of the genus *Amaurolithus*. Other species present include *D. brouweri, D. pentaradiatus, D. surculus, D. tamalis, D. asymmetricus, Ceratolithus rugosus, Cycloccolithina leptopora*, and *C. macintyrei*. Preservation is moderate, with most discoasters and some placoliths showing slight overgrowth.

Samples below 600C-1-5, 56–57 cm (approximately 6.6 m BSF) down to basement are within the upper subzone of the *A. tricorniculatus* Zone, CN10C. Zone assignment was based on the co-occurrence of members of the genus *Amaurolithus* and *Ceratolithus rugosus*. Specimens of *A. delicatus, A. primus*, and *A. tricorniculatus* were generally rare to few in abundance throughout the interval, with *A. bizzarus* sporadically present. *D. asymmetricus* and *C. rugosus* were rare. Preservation is moderate, with most forms showing overgrowth.

Site 601

Hole 601 penetrated 20.4 m of nannofossil ooze, clay-bearing nannofossil ooze, and foraminifer–nannofossil clay, which changed to clayey nannofossil chalk at the base of the section (Core 601-3, 18.44 to 19.44 m BSF). The sediments were dated by the foraminifers and nannofossils as early Pliocene to Pleistocene in age. Between approximately 8.0 and 9.0 m BSF there is an interval that has not been zoned and appears to span the late Pliocene, because it is bounded by samples of Pleistocene and early Pliocene age. The interval is thin for the time it represents, and some upper Pliocene sediment may be

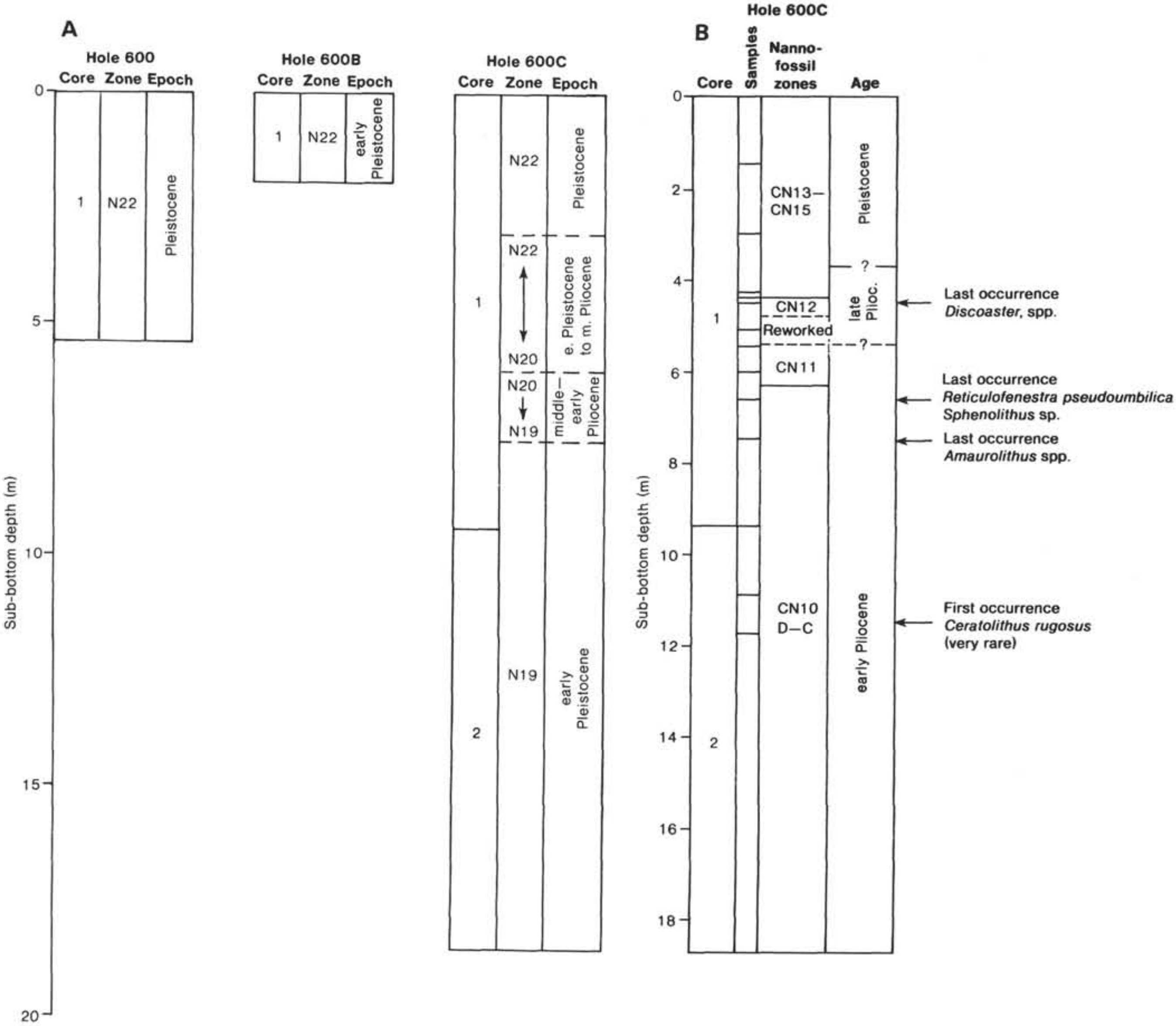


Figure 12. A. Foraminiferal stratigraphy, Site 600. B. Nannofossil stratigraphy, Hole 600C.

missing from the section. The presence of reworked older microfossils and a marked decrease in sedimentation rates within this interval also support this possibility. Reworking of older material as old as early Pliocene was evident in all samples from Hole 601.

Hole 601B was washed to within 9.0 m of basement and cored using the XCB in an effort to recover the sediment/basement contact. This effort was successful; we recovered 6.0 m of clayey nannofossil ooze in contact with basalt. The lower 3.0 m were zoned as early Pliocene (N19 by foraminifers; CN10C by nannofossils), so the maximum biostratigraphic age of the basement is 4.6 Ma (Haq, 1984). The sections from both Holes 601 and 601B contained areas of dark and light banding that allowed a direct lithologic correlation to be made in addition to a correlation based on microfossil zonation.

Smear slides from Site 601 were barren of siliceous microfossils.

Planktonic Foraminifers

Samples from Core 601-1 contained abundant foraminifers that were moderately to moderately well preserved (Table 2). In the samples deeper in the section (Core 601-2 through Sample 601-3,CC) and nearer to basement, foraminifers were somewhat less abundant and more poorly preserved. Samples 601-1-1, 140–150 cm (1.5 m) through 601-1-5, 140–150 cm (7.64 m) are Pleistocene in age (Zone N22; Fig. 13A, Table 2). An assemblage composed of few to common *Globorotalia truncatulinoides*, *Globigerinoides fistulosus*, and *Globorotalia tosaensis* characterizes the Pleistocene in these samples. Reworked Pliocene species are fairly common in the Pleistocene samples as well (e.g., *Pulleniatina primalis, Sphaeroidinellopsis paenedehiscens, G. tumida flexuosa*). Sample 601-1,CC (9.76 m BSF) has a species association that indicates Zone N20 of the latest Pliocene: *G. margari-*

Table 2. Foraminiferal zonation, abundance, and preservation.

Sample (interval in cm)	Zone	Epoch	Abundance	Preservation
Site 600				
600 top	N22	Pleistocene	Abundant	Moderate to good
600-1,CC	N22	Pleistocene	Abundant	Moderate
600B-1,CC	N22	early Pleistocene	Abundant to common	Poor
600C-1-1, 145-150	N22	Pleistocene	Abundant	Moderate to good
600C-1-2, 145-150	N22	early Pleistocene	Abundant	Moderate to good
600C-1-4, 145-150	N20	early Pliocene	Abundant	Moderate to good
600C-1-5, 145-150	N19	early Pliocene	Abundant	Moderate to good
600C-1,CC	N19	early Pliocene	Abundant	Moderate to poor
600C-2,CC	N19	early Pliocene	Common	Moderate to poor
Site 601				
601-1-1, 145-150	N22	Pleistocene	Abundant	Moderate to good
601-1-2, 145-150	N22	Pleistocene	Abundant	Moderate to good
601-1-4, 145-150	N22	early Pleistocene	Abundant	Moderate
601-1-5, 145-150	N22	early Pleistocene	Abundant to common	Moderate
601-1,CC	N20	early Pliocene	Abundant	Moderate
601-2-2, 145-150	N20	early Pliocene	Common	Moderate to poor
601-2-4, 145-150	N19	early Pliocene	Common	Poor
601-2,CC	N19	early Pliocene	Common	Poor
601-3,CC	N19	early Pliocene	Common	Poor
601B-1-2, 145-150	N19	early Plicoene	Few to common	Poor
601B-1,CC	N19	early Pliocene	Few	Poor
Site 602				
602A-1,CC	N22	Pleistocene	Abundant	Good
602B-1-2, 31-33	N22	Pleistocene	Abundant	Good
602B-1-2, 52-54	N22	Pleistocene	Abundant	Moderate
602B-1-2, 91-93	N22	Pleistocene	Abundant	Good
602B-1-2, 112-114	N22	Pleistocene	Abundant	Moderate to good
602B-1,CC	N22	Pleistocene	Abundant	Good

tae, *G. cibaoensis*, and *G. tumida flexuosa* occur without *Globigerina nepenthes*, the extinction of which marks the base of N20. The species association of Section 601-2-2 (12.76 m BSF) is similar to that of Sample 601-1,CC, placing it within Zone N20. A few reworked lower Pliocene species are present. The sample in Section 601-2-4 (15.76 m BSF) has few to common specimens of *G. nepenthes* in association with common specimens of *S. seminulina kochi*, few specimens of *S. paenedehiscens*, and few specimens of *Globorotalia tumida flexuosa*, and it is accordingly placed within Zone N19 of the early Pliocene. The remaining samples (601-2,CC, at 18.44 m; and 601-3,CC, at 19.44 m) are also from lower Pliocene Zone N19.

Both of the two samples examined from Hole 601B indicated an early Pliocene age, Zone N19. Holes 601 and 601B can be correlated by using the lithologic features discussed in the sediment lithology section. The early Pliocene zonal age of the foraminifers in the basal sediment indicate that basement age is no older than about 5.0 Ma.

Nannofossils

Sections 601-1-1 to -1-5 are placed tentatively within the Pleistocene nannofossil Zones CN13 to CN15 (Fig. 13B; Okada and Bukry, 1980). The position of the CN12/CN13 boundary in Hole 601 is uncertain, because the foraminifers date the sediment as Pleistocene at a level at which the nannofossils seem to indicate a late Pliocene age. Discoasters are common to abundant in all samples taken above Sample 601-1,CC, and the genus *Gephyrocapsa* appears to be absent, unless the barless form in the samples represents individuals affected by dissolution. Foraminifer data were therefore used to determine the placement of the Pleistocene/Pliocene boundary. Preservation was moderate. Most discoasters were slightly overgrown, and the placoliths were slightly to moderately etched as the result of dissolution.

No zones were assigned to the samples taken from Section 601C-1-6. The apparent absence of the genus *Gephyrocapsa* and the rare, presumably reworked, occurrence of both *Reticulofenestra pseudoumbilica* and *Sphenolithus* sp. would indicate a late Pliocene age (Zone CN12), however.

Sample 601-1,CC is placed within the *R. pseudoumbilica* Zone, CN11. Zonal assignment was based on the presence of both *R. pseudoumbilica* and *Sphenolithus* sp. in the absence of the genus *Amaurolithus*. Additional species present include *Discoaster brouweri, D. pentaradiatus, D. surculus, D. tamalis, D. asymmetricus, Ceratolithus rugosus, Cyclococcolithina leptopora, C. macintyrei*, and *Helicopontosphaera sellii*. Preservation was moderate, with most forms showing slight overgrowth.

Sediments from Sample 601-2-1, 145-150 cm down to the bottom of the core (i.e., from 11.3 to 19.5 m BSF) and those from Hole 601B from 14.4 to 24.0 m BSF are contained within the upper subzone of the *A. tricorniculatus* Zone, CN10C. The assemblage is similar to the zone above, with *A. tricorniculatus, A. delicatus*, and *A. primus* present. Specimens of *A. bizzarus* and *Ceratolithus rugosus* are rare in the lower portion of the hole (Sample 601B-1,CC). Preservation deteriorates slightly with increasing depth, making some species difficult to identify.

Site 602

A thin section of clay-bearing nannofossil ooze was recovered at Site 602. Microfossils examined from these sediments indicate a Pleistocene age, foraminifer Zone N22 (Fig. 14; Blow, 1969) and nannofossil Zone CN14/15 (Okada and Bukry, 1980). Preservation was good to moderate.

The lithology from Hole 602B indicates that the sediments recovered represent three or four bounces of the core barrel in very thin sediment. The similarity of the sequences assumed to be repeated supports this assumption; similar amounts of reworked Pliocene nannofossils directly overlie each of the basalt chip layers, and the lighter colored layers below each of the basalt chip layers lack reworked material.

Planktonic Foraminifers

Site 602 cored Pleistocene clay-bearing nannofossil ooze. It was not possible to refine zonal age beyond overall Pleistocene with the planktonic foraminifers (Zone N22; Table 2). Reworked Pliocene foraminifers appeared in all samples.

Nannofossils

The nannofossils in all samples examined at Site 602 indicate a Pleistocene age (CN14/15). Preservation was

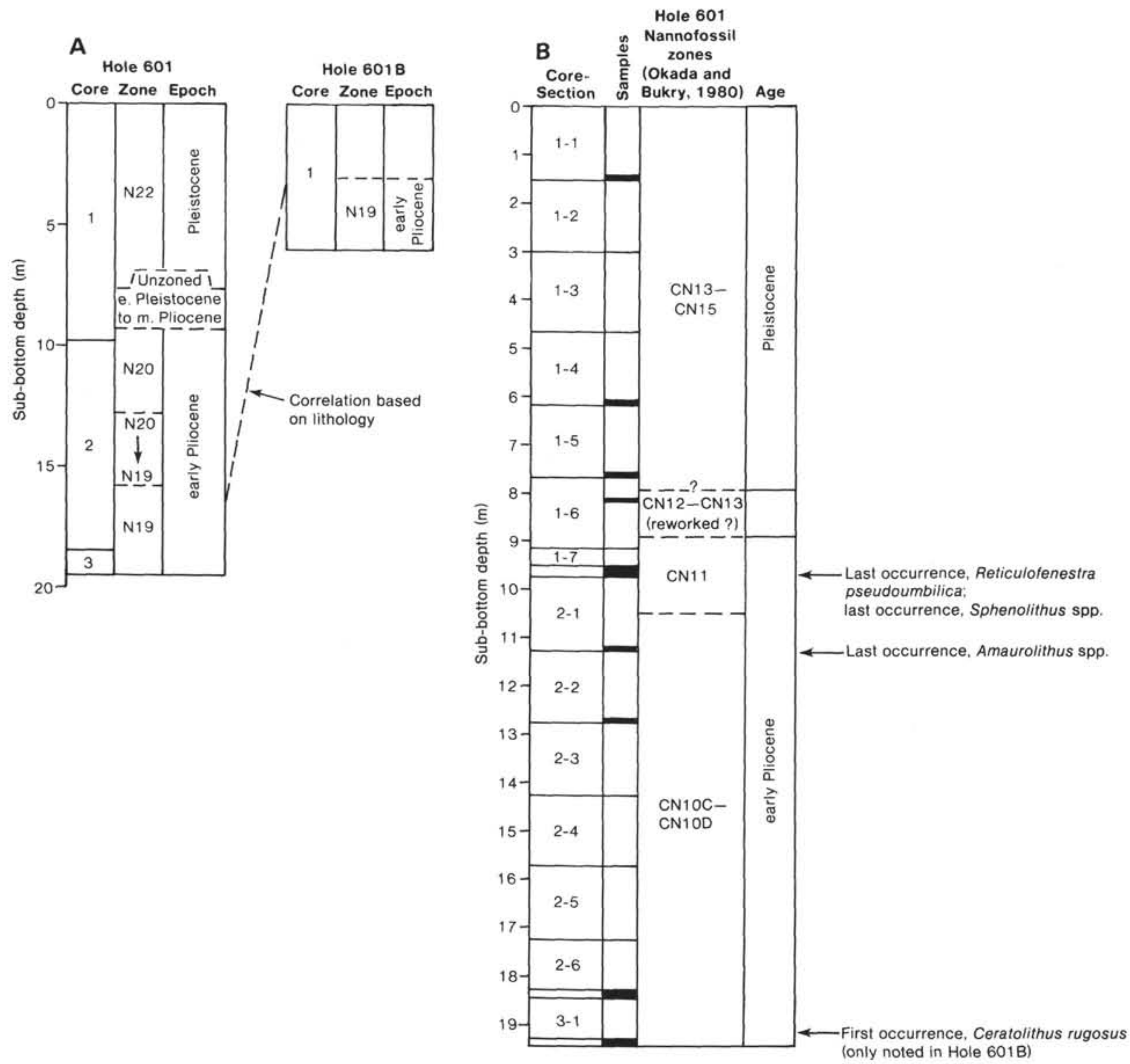


Figure 13. A. Foraminiferal stratigraphy, Site 601. B. Nannofossil stratigraphy, Hole 601.

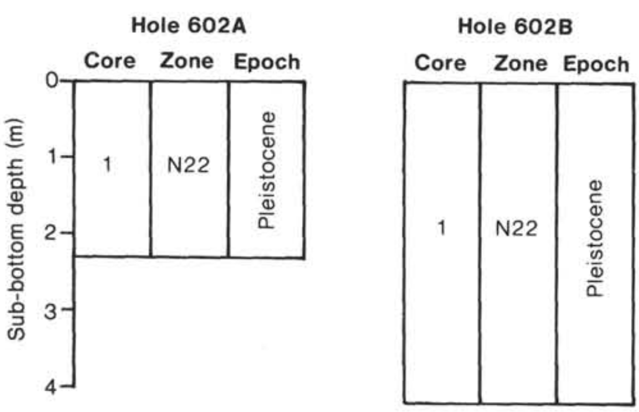


Figure 14. Foraminiferal stratigraphy, Site 602.

moderate to good (Table 3), with some dissolution effects. A typical assemblage consists primarily of *Gephyrocapsa* spp., *Pseudoemiliania lacunosa, Ceratolithus cristatus, Cyclococcolithina leptopora*, and *Rhabdosphaera clavigera*.

The sediment recovered from Hole 602B (4.2 m) represents a repeatedly cored section. Six samples were taken in alternating light and dark layers to detect any age difference in the sediment that might support this assumption. Samples within the darker layers, which were above layers of basalt fragments, were taken close to the fragments. Samples were also taken in the light layers at the top of the core and below each of the basalt chip layers. Although all samples were Pleistocene in age, the amount of reworked Pliocene material did indicate similarity among the lighter layers (few reworked forms present) and among the darker layers (reworked forms common; see Table 3).

Table 3. Major nannofossil groups and their preservation and abundance in samples from Hole 602B.

Core-Section Level (cm) Layer	1-1 3 Light colored	1-2 57 Basalt fragments	1-2 90 Dark colored	1-2 120 Light colored	1-3 17 Basalt fragments	1,CC Light colored
Preservation	Good	Moderate to good	Moderate to good	Moderate	Moderate	Moderate to good
Abundance						
Pseudoemiliania lacunosa	Rare to few	Few	Few	Few	Few	Few to common
Gephyrocapsa spp.	Abundant	Common	Common	Abundant	Common to abundant	Abundant
Rhabdosphaera sp.	Few to common	Present	Rare	Few to common	Rare to few	Few
Reticulofenestra pseudoumbilica	Absent	Few	Few	Present	Few	Absent
Sphenolithus spp.	Absent	Rare to few	Rare	Absent	Rare	Absent
Discoaster spp.	Rare	Few to common	Few to common	Few	Few to common	Rare

SEDIMENTATION RATE

Site 600

At Hole 600C the early Pliocene sedimentation rates were relatively high (14.1 m/m.y.; Table 4; Fig. 15A). These rates decrease by half at approximately 3.7 Ma to 7.5 m/m.y. This rate prevailed about 200,000 yr. just prior to the late Pliocene, when an abrupt order of magnitude decrease to rates less than 0.3 m/m.y. occurred. This decrease may indicate that an upper Pliocene hiatus is associated with the change in sediment color that occurs at approximately 5.3 m BSF (600C-1-4, 82 cm). During the Pleistocene, which follows this period of very low sedimentation rate, the rates increase to approximately 2.5 m/m.y.

Site 601

Rates of sediment accumulation were also calculated for Hole 601 (Table 4; Fig. 15B). Rates of 8.0 to 11.0 m/m.y. in the early Pliocene decreased sharply to 0.6 m/m.y. in the late Pliocene and increased again in the Pleistocene to 4.3 m/m.y. The sharp decrease in rates suggests that a hiatus has removed part of the upper Pliocene. This pattern of sedimentation also appears in Hole 600C (Fig. 15A). This site, like Hole 600C, has been on crust well above the calcite compensation depth throughout its sedimentation history. Changes in the lysocline may be a factor in controlling sedimentation rates; however, the large degree of reworking indicated by the microfossils in the interval of low sedimentation rate suggests a physical rather than a chemical cause for the decreased sedimentation rate in the late Pliocene.

Site 602

An approximate rate of sedimentation at Site 602 was calculated by using the length of the first (and only) core from Hole 602A, 2.3 m, and the depth of the sediment above and the first layer of basalt chips in Core 1 of Hole 602B, or 2.2 m. (The first layer of basalt chips lay at 69 cm in Section 602B-1-2.) All sediments were dated as Pleistocene (0 to 1.6 Ma; Haq, 1984), which gives a minimum calculated rate of 1.4 m/m.y.

PHYSICAL PROPERTIES

Site 600

Wet bulk density, porosity, compressional sonic velocity, formation factor, and thermal conductivity were measured on all six sections from the high heat flow hole, 600C. As at Sites 597 through 599, all the various measurements made on each section were within the same 5- to 10-cm interval. Measurements were made at temperatures of 25 to 26°C. Although the measurements span nearly the complete sedimentary section of about 10 m, they constitute a small sample set, and should be interpreted conservatively.

The measurement results are given in Table 5 and plotted in Figure 16A. The sample means and standard deviations are 1.54 ± 0.05 g/cm^3 for wet bulk density, 69.6 ± 3.5% for porosity, 1.54 ± 0.03 km/s for sonic velocity, 2.45 ± 0.16 for formation factor, and 2.74 ± 0.10 g/cm^3 for grain density. These values are consistent with the values at Sites 597 through 599, except that sonic velocity and formation factor are somewhat higher, possibly because the sediment section is thin. At both previous sites above the CCD (Sites 598 and 599), the highest sonic velocities and high formation factors were measured in the upper 10 m of sediment, where the carbonate content was also highest. As at the previous sites, the variations in wet bulk density and sonic velocity in Hole 600C are correlated with variations in the percentage of calcium carbonate in the sediment (Fig. 16B).

Site 601

Wet bulk density, porosity, compressional sonic velocity, formation factor, and thermal conductivity were measured once per section in the 19.45 m of sediment recovered from Hole 601, in the same 5- to 10-cm interval of each section, at laboratory temperatures of 25 to 26°C.

The measurement results are given in Table 5 and plotted in Figure 17. The sample means and standard deviations are 1.56 ± 0.05 g/cm^3 for wet bulk density, 69.2 ± 3.3% for porosity, 1.52 ± 0.02 km/s for sonic velocity, 2.26 ± 0.14 for formation factor, and 2.75 ± 0.06 g/cm^3 for grain density. These values are consistent with the results at the three previous sites above the CCD (Sites 598 through 600). Like the data for Sites 598 and 599, the measurements at Hole 601 show a downhole increase in porosity and decreases in wet bulk density, sonic velocity, and formation factor. As at Sites 597 to 600, these trends seem to be directly related to the reduction in calcium carbonate with increasing depth.

Site 602

Wet bulk density and porosity were measured once per section in the 4.2 m recovered at Hole 602B; sonic velocity and formation factor were measured every 50

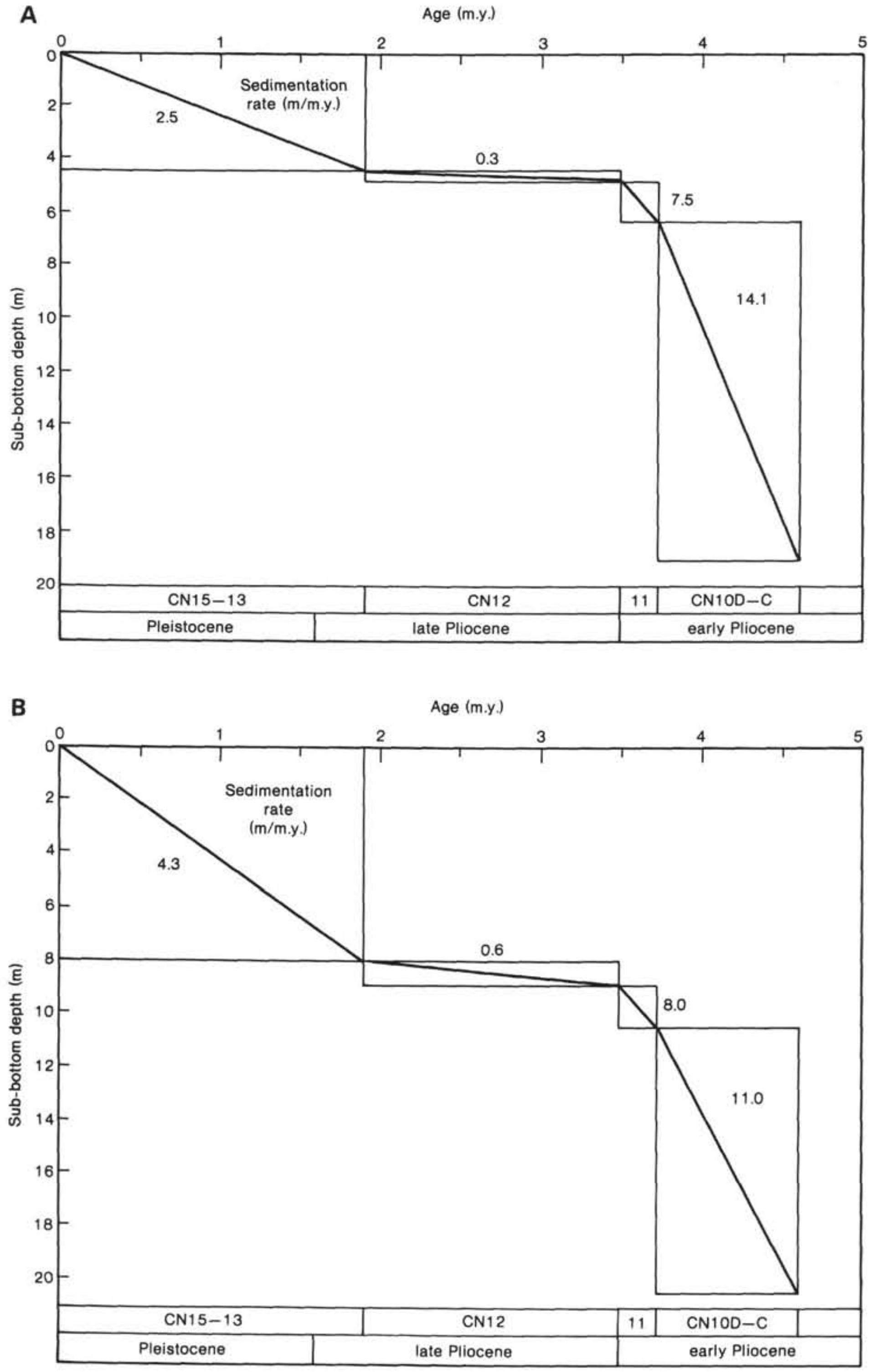


Figure 15. Sedimentation rates. A. Hole 600C. Age assignments from Haq (1984). B. Hole 601.

cm. Because the sediment cover was so thin at Site 602 and because a repeated section was recovered, the data are not plotted, although they are listed in Table 5. The mean values are quite consistent with the values obtained at the adjacent Sites 600 and 601.

IGNEOUS PETROLOGY, HOLE 601B

Hole 601B penetrated 3 m into igneous basement, recovering 0.75 m of basalt fragments in Core 601B-2 and 0.18 m in Core 601B-3. In addition, 12 cm of fragments were recovered below sediment in Sample 601B-1,CC. Only two of the pieces, both from Core 601B-2, could be oriented with respect to the core barrel.

All the rocks recovered consist of slightly rounded fragments of fine-grained gray basalt. Most of the fragments have relatively fresh interiors surrounded by rims up to 2 cm thick that appear to be the result of oxidative alteration. Vesicles occupy up to 10% of the rock by vol-

Table 4. Sedimentation rates, Holes 600C and 601.

Sub-bottom depth (m)	Age (Ma)	Sedimentation rate (m/m.y.)
Hole 600C		
0–4.4	0–1.9	2.5
4.4–4.8	1.9–3.5	0.3
4.8–6.3	3.5–3.7	7.5
6.3–19.0	3.7–4.6	14.1
Hole 601		
0–8.0	0–1.9	4.2
8.0–8.9	1.9–3.5	0.6
8.9–10.5	3.5–3.7	8.0
10.5–20.4	3.7–4.6	11.0

ume; some are partially or completely filled by yellow, brown, or green clays. The outer surfaces of the fragments are coated with iron and manganese oxyhydroxides; blue, green, yellow, and brown clays; and (occasionally) calcite or zeolites. One piece from Core 601B-3 has a vuggy surface with vugs up to 5 mm across filled with spherical clusters of white zeolite crystals. Several pieces have an outer coating of blue clay, possibly saponite; along with palagonite, the blue clay appears to be forming from remnants of glass.

The mineralogy of all the rocks is similar, consisting of plagioclase and clinopyroxene microphenocrysts in a spherulitic to subspherulitic groundmass containing abundant magnetite. Two different textures occur, corresponding to different grain sizes of the groundmass and phenocrysts. The fine-grained rocks are characterized by 5 to 15% microphenocrysts of plagioclase, clinopyroxene, and minor olivine in a virtually opaque groundmass. The microphenocrysts range in size from 0.1 to 0.5 mm for olivine to 0.1 to 1.3 mm for plagioclase and clinopyrox-

Table 5. Sediment physical properties.

Core-Section	Sub-bottom depth (m)	Wet bulk density (g/cm^3)	Corrected for salt: Porosity (%)	Corrected for salt: Grain density (g/cm^3)	Sonic velocity (km/s)	Acoustic impedance (Gg/m^2 · s)	Formation factor
Hole 600C							
1-1	0.77	1.49	70.3	2.60	1.555	2.32	2.39
1-2	2.27	1.55	68.7	2.69	1.582	2.45	2.60
1-3	3.77	1.60	65.7	2.71	1.555	2.49	2.65
1-4	5.27	1.58	67.9	2.74	1.509	2.38	2.46
1-5	6.77	1.57	69.0	2.80	1.529	2.40	2.41
1-6	8.27	1.47	76.1	2.88	1.524	2.24	2.19
Mean		1.54	69.6	2.74	1.542		2.45
Standard deviation		±0.05	±3.5	±0.10	±0.027		±0.16
Hole 601							
1-1	0.77	1.60	67.1	2.77	1.478	2.36	2.54
1-2	2.27	1.57	67.3	2.70	1.538	2.41	2.42
1-3	3.77	1.59	66.9	2.73	1.538	2.45	2.36
1-4	5.41	1.57	65.4	2.61	1.535	2.41	2.21
1-5	5.91	1.63	64.7	2.73	1.540	2.51	2.34
1-6	8.41	1.61	66.7	2.79	1.526	2.46	2.33
2-1	10.57	1.54	69.9	2.72	1.507	2.32	2.19
2-2	12.07	1.54	70.7	2.78	1.525	2.32	2.07
2-3	13.57	1.56	69.8	2.81	1.532	2.39	2.25
2-4	15.07	1.53	70.6	2.74	1.515	2.32	2.15
2-5	16.57	1.52	72.6	2.83	1.507	2.29	2.06
2-6	18.07	1.53	71.5	2.79	1.509	2.31	2.13
3-1	20.27	1.43	76.6	2.76	1.529	2.19	2.32
Mean		1.56	69.2	2.75	1.521		2.26
Standard deviation		±0.05	±3.3	±0.06	±0.018		±0.14
Hole 602B							
1-1	0.2				1.540		2.64
1-1	0.76	1.47	71.3	2.57	1.528		2.21
1-1	1.2				1.542		2.29
1-2	1.75				1.537		2.59
1-2	2.26	1.56	67.7	2.68	1.553		2.49
1-2	2.75				1.484		2.59
1-3	3.30				1.522		2.65
1-3	3.76	1.62	64.7	2.70	1.553		2.70
Mean		1.55	67.9	2.65	1.53		2.52
Standard deviation		±0.08	±3.3	±0.07	±0.02		±0.18

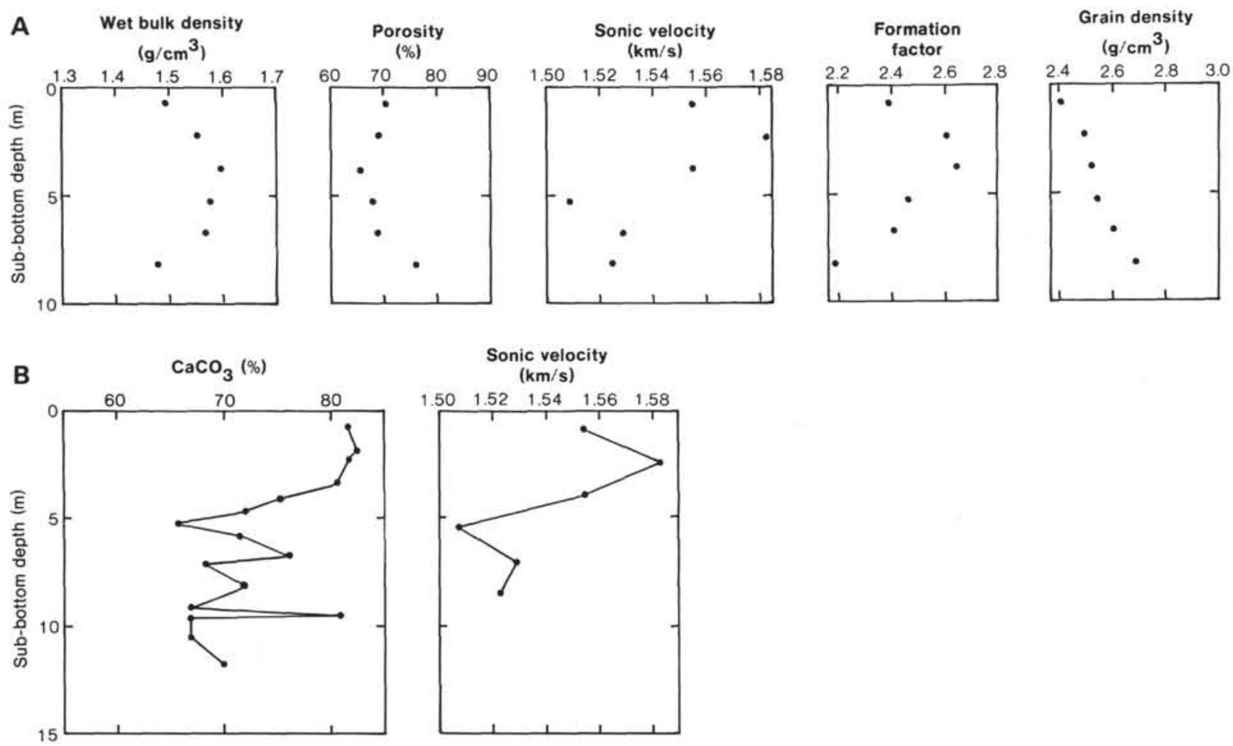


Figure 16. A. Physical properties, Hole 600C. B. Sonic velocity and $CaCO_3$ variations with increasing depth, Hole 600C.

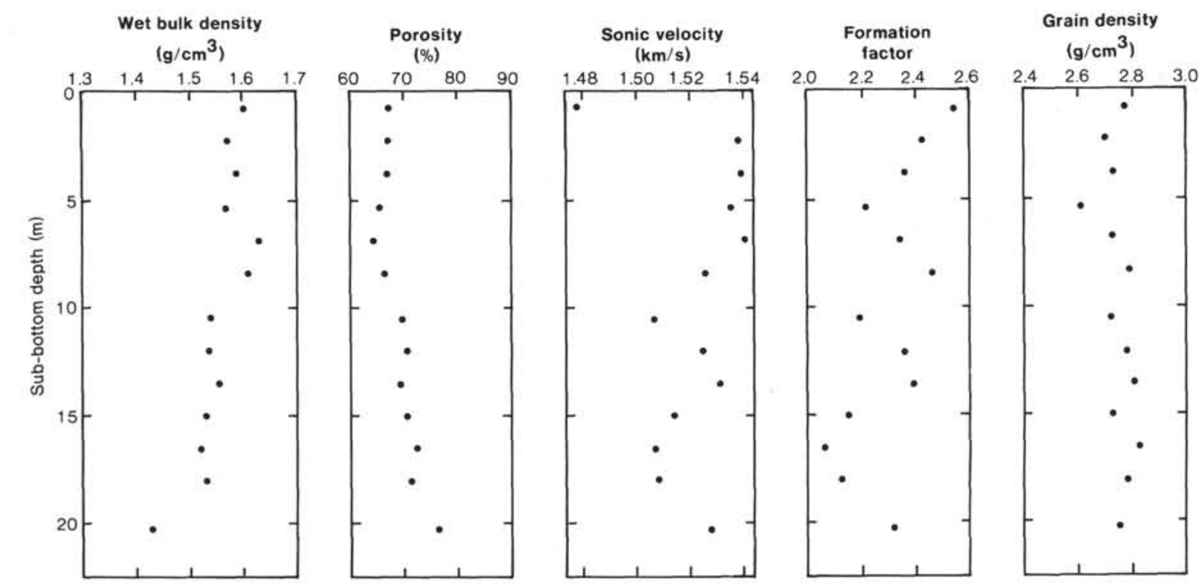


Figure 17. Physical properties, Hole 601.

ene. Olivine occurs as partially altered anhedral to subhedral grains and, occasionally, as skeletal grains. Clinopyroxene also occurs as anhedral to subhedral grains. Pyroxene is present as laths and as stubby and skeletal crystals, and plagioclase and clinopyroxene grains often form clusters. The groundmass of these pieces is almost entirely opaque. It appears to consist of coalesced spherulites, which are made up of crystallites of plagioclase and clinopyroxene and numerous tiny disseminated grains of magnetite.

The coarse-grained rocks contain 7 to 15% microphenocrysts of plagioclase and clinopyroxene, which often form glomerocrysts; the grain sizes of the microphenocrysts range from 0.1 to 1.5 mm. The groundmass typically consists of coalesced fan, sheaf, and subspherical spherulites of plagioclase and clinopyroxene, verging on a mesh texture in the coarser sections of the rocks. The diameter of the coarser spherulites in each piece approaches the length of the smaller microphenocrysts. Magnetite forms 10 to 20% of the groundmass, occurring as disseminated grains up to 0.05 mm across. Yellow glass forms 1 to 5% of the groundmass. In the altered rims of the fragments, the yellow glass is altered to orange and red palagonite, the spherulites may be slightly altered to brown clay, and magnetite is sometimes rimmed by brown and red alteration products.

In terms of petrography, these basalts exhibit the same stages of crystal growth as those that characterize the ferrobasalts from the East Pacific Rise (DSDP Leg 54; Natland, 1980). The opaque spherulitic groundmass closely resembles that described by Natland in samples taken close to the glassy tops of small sheet flows or pillows of ferrobasalt. The coarse-grained pieces, in which the spherulites approach a mesh texture, resemble the coarser interior zones of flows and pillows in the same sequence. The presence of clusters of plagioclase and clinopyroxene microphenocrysts, the abundance of magnetite, the yellow color of the interstitial glass, and the presence of olivine as rare, sometimes skeletal crystals confined to the zone of opaque groundmass are also described by Natland as characteristic of ferrobasalts.

INTERSTITIAL WATER STUDIES

Site 600

Two interstitial water samples were obtained in Hole 600, and six were obtained in Hole 600C (Table 6, Fig. 18A). The sample from 600C-2-6, 0–10 cm was a piece of chalk, which we squeezed after removing the very soft mud surrounding it, which we felt was probably downhole contamination. Only a small amount of water was obtained. We obtained a water sample several days later from Sample 600-2,CC. Although this sample yielded a reasonable value for chlorinity, its salinity (refractive index) reading was distinctly too high. The small squeezer we used to obtain this water sample had been treated with an oily substance that may have caused the aberrant refractive index reading.

There is an indication of an increase in dissolved calcium with increasing depth and, perhaps, a decrease in magnesium (Fig. 18A), but the limited number of data makes it difficult to interpret the profile. The apparent reversal in the calcium and magnesium trends at the greatest depths may be real or may be due to the contamination of the samples by bottom water. For magnesium, the sediment section is not long enough to distinguish a trend from the potential error (±2%), and we conclude that there is probably little change downhole. An *in situ* sample would have been important here, but none was taken because the sediment cover was so thin that there was too great a chance that we would damage the instrument by hitting basalt.

The differences between the nitrate profiles for Holes 600 and 600C (Fig. 18A) are of some interest. Bender et al. (1985) inferred from the site survey pore water profiles that nitrate concentrations were lower in holes affected by the slow upwelling of water from the basement through the sediment column than in holes with no advection or less advection. The two data points for Hole 600, however, suggests that such upwelling waters would have to have nitrate values approximately equal to bottom water. Further, the dissolved ammonia concentrations in Hole 600 are higher than in Hole 600C, and we believe that the source of the ammonia is metabolic activity. Therefore, we do not consider the low nitrate values to be proof of upwelling.

Site 601

Ten samples were obtained at Site 601, including an *in situ* sample at a depth of 17 m (Fig. 18B).

Small increases in dissolved silica occur downhole (Fig. 18B), and dissolved nitrate is virtually constant

Table 6. Interstitital water chemistry, Sites 600 to 602.

Sample (interval in cm)	Sub-bottom depth (m)	pH	Alkalinity (meq dm^{-3})	Ca (mM)	Mg (mM)	K (mM)	Cl (mM)	SO_4 (mM)	NO_3 (μM)	NH_4 (μM)	SiO_2 (μM)	S (‰)
600-1-2, 135–150	2.92	7.76	2.55	10.49	50.3	10.7	552	28.5	38.0	7.0	265	34.6
600-1-3, 135–150	4.42	7.73	2.38	10.38	50.3	10.6	547	29.6	37.2	4.5	258	34.6
600C-1-1, 135–150	1.42	7.66	2.525	10.32	50.9	10.7	552	27.4	41.5	4.0	209	34.6
600C-1-2, 135–150	2.92	7.63	2.56	10.30	50.6	10.9	549	27.4	42	2.5	225	34.6
600C-1-4, 135–150	5.42	7.62	2.75	10.74	48.9	10.4	547	27.1	41	1.0	290	34.4
600C-1-5, 135–150	7.42	7.61	2.76	10.96	48.1	11.1	547	27.6	40.5	1.0	290	34.1
600C-2-6, 0–10	16.95	—	—	10.45	48.2	—	543	28.5	—	10	361	34.1
600C-2,CC	18	—	—	10.67	50.3	—	549	—	60	—	—	38??
601-1-1, 135–150	1.42	7.69	2.62	10.23	52.8	10.5	552	27.5	40.0	3.5	240	34.9
601-1-2, 135–150	2.92	7.68	2.59	10.41	52.3	10.5	557	27.6	39.2	3.5	250	34.9
601-1-4, 135–150	5.92	7.74	2.59	10.11	52.0	11.0	554	27.0	39.5	2.0	265	34.9
601-1-5, 135–150	7.42	7.73	2.69	10.43	51.5	10.8	557	28.5	40.5	2.5	289	34.9
601-2-1, 135–150	10.62	7.67	2.75	10.63	49.9	11.3	557	29.0	39.5	1.5	324	34.9
601-2-2, 135–150	12.12	7.64	2.70	10.87	49.6	11.3	557	27.2	39.5	2.0	313	34.9
601-2-24, 135–150	15.12	7.75	2.65	10.79	50.0	11.6	555	27.4	38	1.0	305	34.9
601-2-5, 135–150	16.62	7.71	2.67	10.98	49.0	11.0	557	27.1	39	2.0	280	34.9
Hole 601A, *in situ*	17.0	—	—	10.87	52.9	10.5	556	29.9	38.5	4.5	207	34.9
601B-1-2, 140–150	17.4	7.63	2.63	10.99	48.6	11.0	555	29.6	37.5	8.0	295	34.9
602A-1-1, 140–150	1.45	7.76	2.64	10.31	50.8	10.6	547	28.9	38.0	5.5	234	34.9
602B-1-1, 140–150	1.45	7.65	2.47	10.11	51.4	10.6	549	29.1	35.0	4.0	238	—
602B-1-2, 140–150	2.95	7.68	2.415	9.99	49.0	11.1	552	28.5	37.1	8.5	249	—
602B-1-3, 140–150	4.15	7.70	2.315	9.83	50.5	11.0	547	29.1	31.5	—	234	—

with increasing depth (Fig. 18B; Table 6). Nitrate production occurs in only the upper few meters of the column, in the same zone where ammonia production is apparent.

The data for calcium and magnesium are plotted in Figure 18B, including data from water samples (indicated by J) squeezed at a slightly higher temperature. Our routine sample squeezing temperature was 16.5°C ± 2°; J samples were squeezed at a temperature about 5°C warmer. The J samples show higher calcium values (which are closer to the *in situ* values) and lower magnesium values. The *in situ* sample indicates that there is no significant downhole change in dissolved potassium (Fig. 18B). The squeezed sample data for potassium suggest that the temperature-of-squeezing effect (defined in Site 597 chapter) gradually increases with depth. If this effect is real, it would also apply to magnesium (not clear for our J values). On this basis we construct two scenarios.

1. If the *in situ* values are real, we may have only a very small change in magnesium with increasing depth (about 1%) and a small increase in calcium (2 to 3%). In this case the changes in dissolved Ca would be due to carbonate dissolution, as at Sites 597 through 599.

2. If the *in situ* values are erroneous because of seawater contamination (which is unlikely, especially in view of the excellent agreement of the nitrate data; however, this is the first time that *in situ* calcium values have been lower than squeezed sample data), the concentration profiles for Mg and Ca would be expected to be similar to those represented by the heavy dashed lines (note error bar). At the base of the hole (about 20 m), this would mean changes of about 6% in Mg and about 6% in Ca. If the changed values in the data from squeezed samples are real, they probably result from exchange with basement.

Site 602

The interstitial water data for Site 602 are reported in Table 6. The repetition of the section at Hole 602B prevents us from constructing pore water profiles.

HEAT FLOW

Site 600

One temperature measurement was made in Hole 600 (Fig. 19A) using the Von Herzen VLHPC temperature tool. No additional temperature measurements were made because the very thin sediment cover made it likely that we might accidentally damage the tool by hitting basalt. This decision proved to be correct (see Operations).

The temperature measurement was made at a depth of 5.2 m. Although there was some disturbance due to ship heave, we were able to develop a fairly good extrapolation to equilibrium temperature. The gradient was calculated by using the bottom water temperature and this one sediment temperature point. The shallowest temperature measurement at the previous sites was generally higher than expected, and it might be at Hole 600 also. If so, the gradient we determined is higher than the true gradient.

The temperature gradient is 579 m°C/m. Thermal conductivity was measured on every section of core recovered from Hole 600, but the data were not reduced at sea. If we assume a value of 1.00 W/m-K, the heat flow is 580 mW/m^2. The heat flow at this site is similar to the high values of 735 and 765 mW/m^2 found nearby during the site survey. Such extreme local variability is characteristic of areas of very high heat flow on the seafloor.

The results from the site survey of this area (Fig. 6) gave a mean value for the region of 160 mW/m^2, with a standard deviation of 170 mW/m^2. The theoretical value is 235 mW/m^2 for crust of 5-Ma age.

Site 601

One temperature measurement was made in Hole 601 (Fig. 19B) using the Von Herzen VLHPC temperature tool. Three temperature measurements were made in the adjacent Hole 601A (Fig. 19C). All of these measurements were made under reasonably undisturbed conditions.

The temperature measurement in Hole 601 was made at a depth of 19.2 m. The gradient, 160 m°C/m, was calculated by using the bottom water temperature and this one sediment temperature point. The three temperature points in Hole 601A are at depths of 7, 11, and 17 m. The gradient defined by the lower two points is 160 m°C/m (Fig. 19C). As at other sites, the upper point is somewhat above this line. The gradient appears to intersect the surface at a point about 1 to 1.5 m above the mud line at Hole 601. This discrepancy may arise because the mud line depth is incorrect; it was assumed to be the same as at Hole 601 (where it was somewhat uncertain), because Hole 601A was offset from Hole 601.

Thermal conductivity was measured on every section of core recovered from Hole 601, but the data were not reduced at sea. If we assume a value of 1.00 W/m-K, the heat flow is 160 mW/m^2 for both Holes 601 and 601A.

The heat flow at this site is quite different from the value of 50 mW/m^2 found nearby during the site survey and is slightly higher than the values of 116 and 133 mW/m^2 that occur slightly to the west (Fig. 6). The variability is somewhat surprising in view of the good agreement between our heat flow values and those found by the site survey party at the previous sites and is not typical of this intermediate heat flow environment.

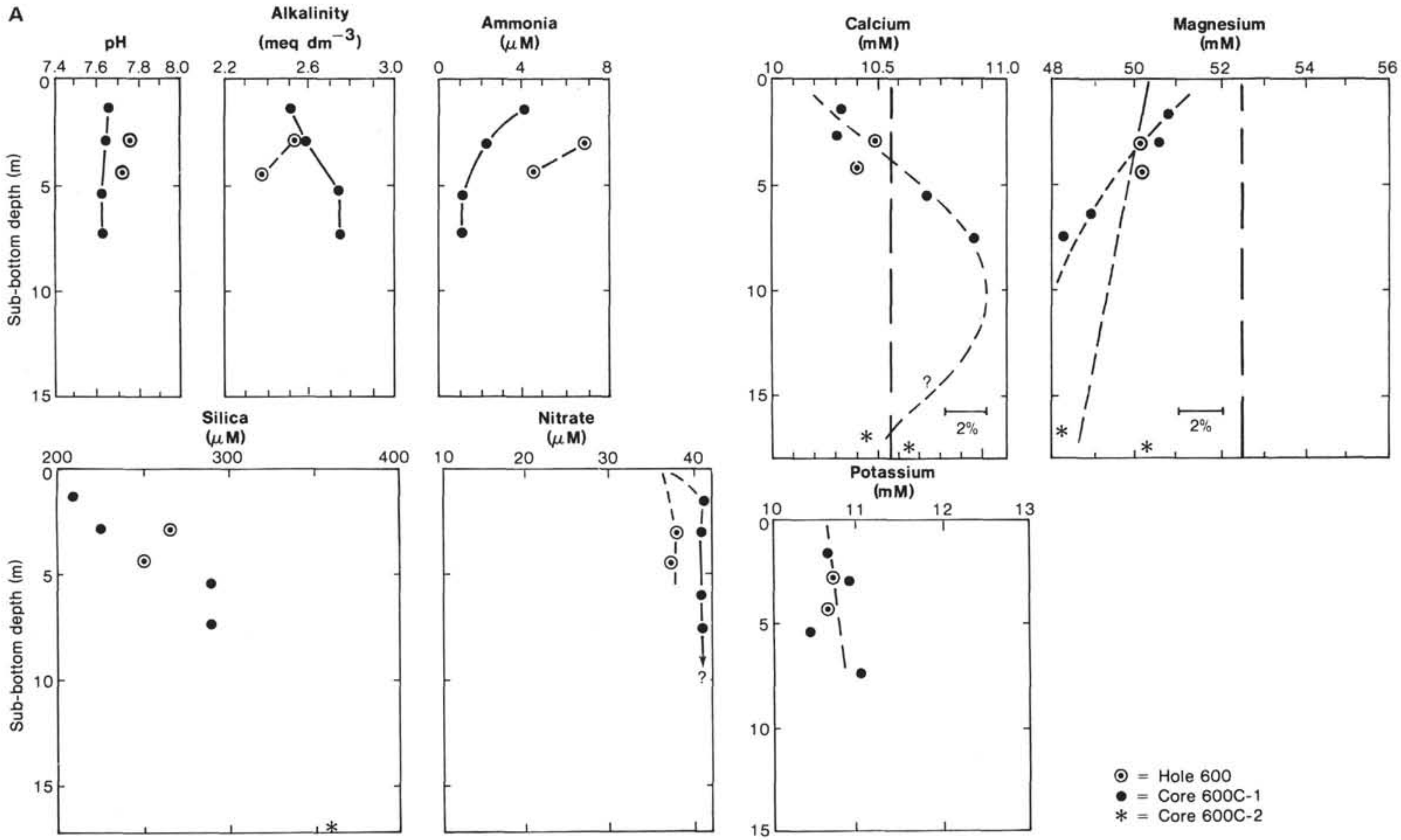
Site 602

No heat flow measurements were attempted at Site 602, since we felt that the chances were great that we would damage the temperature tool while coring the very thin sediments.

SUMMARY AND CONCLUSIONS

Site 600

Site 600 was drilled in very thin sediment cover on the flank of an abyssal hill ridge. Transponder navigation was used to bring the *Glomar Challenger* within the distance of random pipe movement (about 1% of the depth) of the two target locations where measured heat flow


A
pH
7.4 7.6 7.8 8.0
Alkalinity
(meq dm^{-3})
2.2 2.6 3.0
Ammonia
(μM)
0 4 8
Calcium
(mM)
10 10.5 11.0
Magnesium
(mM)
48 50 52 54 56
Sub-bottom depth (m)
0 5 10 15
?
2%
Silica
(μM)
200 300 400
Nitrate
(μM)
10 20 30 40
Potassium
(mM)
10 11 12 13
⊙ = Hole 600
● = Core 600C-1
* = Core 600C-2

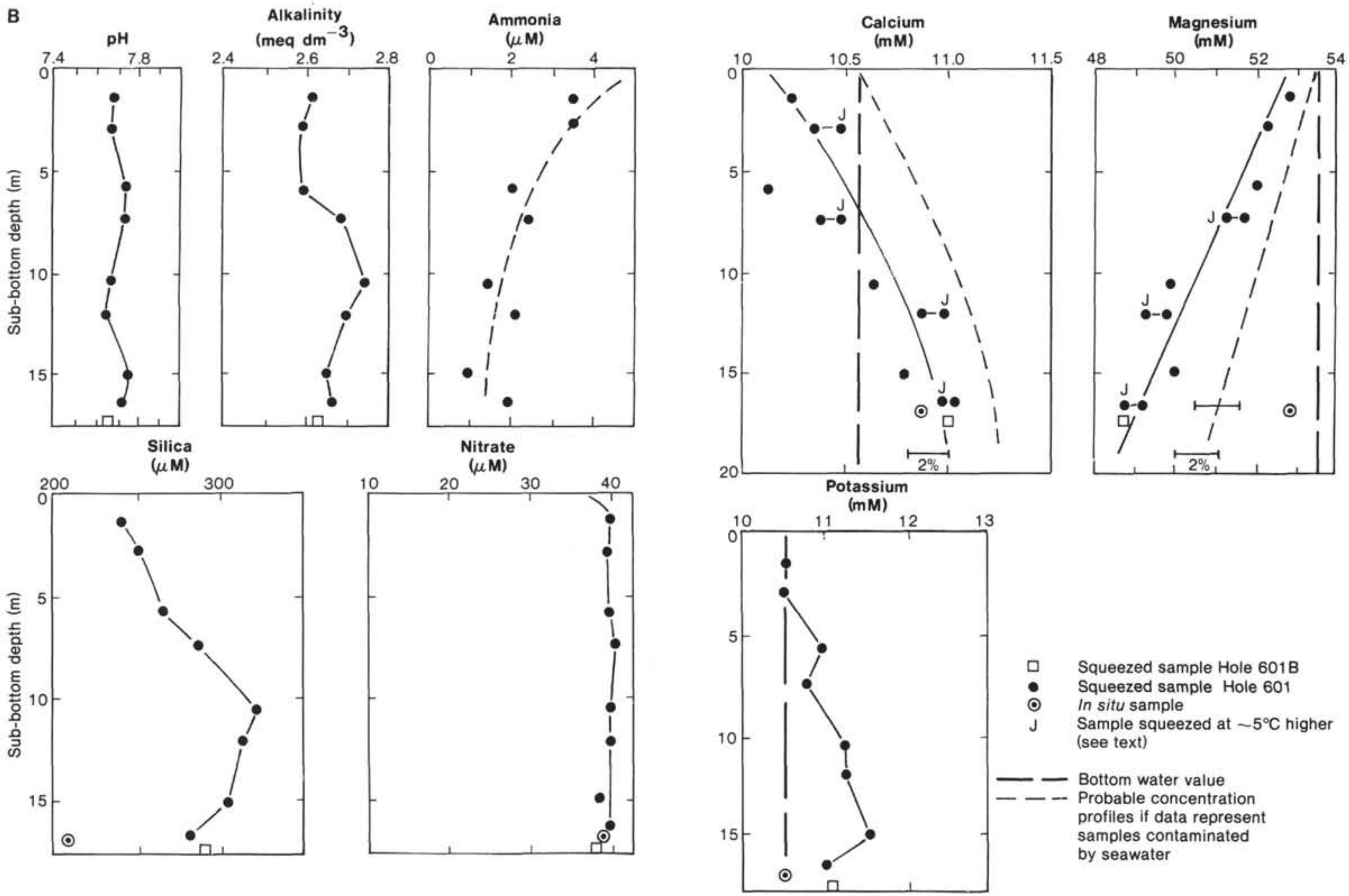


Figure 18. Interstitial water chemistry. A. Site 600. B. Site 601.

exceeded 700 mW/m². Three attempts to core the first area resulted in the recovery of 5.38 m of sediment and the shearing off of a core barrel at Hole 600, the breakage of another barrel at Hole 600A, and the recovery of 1.9 m of sediment at Hole 600B. At the second high heat flow location, Hole 600C, which was 170 m west–northwest of the first target, two VLHPC cores recovered 11.80 m of sediment, the best section acquired from Site 600.

Sediments

We divided the sedimentary section at Site 600 into two units of different degrees of lithification. All the sediments recovered from Holes 600 and 600B and the uppermost 10.0 m from Hole 600C belong to Unit I, a clay-bearing to clayey nannofossil ooze that is yellowish brown to dark brown in color. The components of Unit I include calcareous nannofossils (70 to 80%), foraminifers (2 to 10%), and clay plus RSO, a fraction considered hydrothermal in origin (15 to 25%). Dark-colored bands lower in the unit contain up to 45% hydrothermally derived material.

Unit II is 1.8 m of yellowish brown to dark brown foraminifer-bearing clayey nannofossil chalk. It is composed of 50 to 55% calcareous nannofossils, 12 to 15% foraminifers, 25 to 30% clay plus RSO, and a number of minor and trace components. X-ray diffraction showed the clays to be poorly crystalline smectites. A pebble in the core catcher was composed of clear glass shards cemented by yellowish brown calcite.

The physical properties of the sediments recovered at Hole 600C were measured on every section. Averages are 69.6% for porosity, 2.74 g/cm³ for grain density, 1.54 g/cm³ for wet bulk density, 2.45 for formation factor, and 1.54 km/s for acoustic velocity.

Linear sedimentation rates (LSR) are 2.5 m/m.y. in the Pleistocene, less than 0.3 m/m.y. in the late Pliocene, and 7 to 14 m/m.y. during the early Pliocene. The low-LSR interval of the late Pliocene corresponds to a zone of intensified reworking in Section 600C-1-4 that overlies a sharp contact at 600C-1-4, 82 cm. We presume that this contact represents the base of a lacuna that corresponds to most of the late Pliocene. It may also include some of the Pleistocene. Values of mass accumulation rate (MAR) can be calculated from the LSR and the values of porosity and grain density. The sediment MAR is 0.21 g/(cm² × 10³ yr.) in the Pleistocene. It is very low (0.02 g/[cm² × 10³ yr.]) in the upper Pliocene sediments and increases to 1.02 g/(cm² × 10³ yr.) in the lower Pliocene sediments. Hydrothermal materials constitute a fairly constant 20 to 30% of the sediment recovered at Hole 600C; thus, the hydrothermal MAR reflects that of the total sediment. It ranges from 48 mg/(cm² × 10³ yr.) in Pleistocene sediments to a low of 5 mg/(cm² × 10³ yr.) in the upper Pliocene sediments, increasing downcore to a maximum of 290 mg/(cm² × 10³ yr.).

Experimental Results

One *in situ* temperature measurement was made by using the Von Herzen heat flow shoe on the first VLHPC core barrel at Hole 600. A heat flux of 580 mW/m² was calculated from that single point and the bottom water temperature by using the average thermal conductivity of the sediments recovered from the area during the site survey. Because the VLHPC barrels at Holes 600 and 600A sheared off, we decided against further use of *in situ* temperature sensors and pore water samplers at Site 600.

The analysis of interstitial waters squeezed from the recovered sediments revealed no evidence of pore water advection at either of these high heat flow locations.

This high heat flow site did not provide evidence of either pore water advection within the sediment or the flux of hydrothermal material to the seafloor by advection in the past. Since the hydrothermal component remains a more or less constant percentage of the sediment throughout the sediment column, the rate at which it accumulated, calculated as hydrothermal MAR, depends almost entirely on the LSR of the nannofossil ooze. One implication is that the hydrothermal phases at this site reflect a uniform supply from the ridge axis or from a ridge-flank source; another is that the source of supply is subject to the same influences that cause the nannofossil ooze LSR to vary, especially local episodes of winnowing, nondeposition, and redeposition.

Site 601

Site 601 lies in an area of flat sediments of moderate heat flow. It was drilled to provide a comparison with the high and low heat flow sites (Sites 600 and 602, respectively) that were drilled nearby. In addition, since the latter two sites were being drilled in anomalously thin sediment, Site 601 was chosen to provide a representative sediment column for the interpretation of Pliocene to Recent hydrothermal activity, paleoceanography, and paleoclimate. Three holes were drilled. Hole 601 was cored to a depth of 20.4 m using the VLHPC, and 19.5 m of sediment were recovered. Hole 601A was devoted entirely to instrumental operations (three heat flow determinations and one *in situ* pore water sample). Hole 601B was devoted to coring with the XCB to recover the sediment/basement contact and basement rock. It was washed to 14.4 m and cored to a depth of 27.0 m, with 5.70 m of sediment recovery and 1.05 m of basalt recovery.

Sediments

The sediments recovered from Holes 601 and 601B consist of clay-bearing and clayey nannofossil ooze and foraminifer–nannofossil clay (Unit I; 0 to 20.0 m BSF in Hole 601, 14.4 to 24.0 m BSF in Hole 601B) and clayey nannofossil chalk (Unit II; 20.0 to 20.4 m BSF in Hole 601). The sediments generally contain 2 to 5% foraminifers and 2 to 3% palagonite, micronodules, and opaque minerals. Nannofossils make up about 55 to 70% of the sediment. The remainder consists of clay and RSO.

The color of the sediments changes abruptly from light to medium brown at the base of Section 601-1-6. This color change occurs in an interval that is bounded by samples of Pleistocene and early Pliocene age. The presence of reworked microfossils in the interval, the dis-

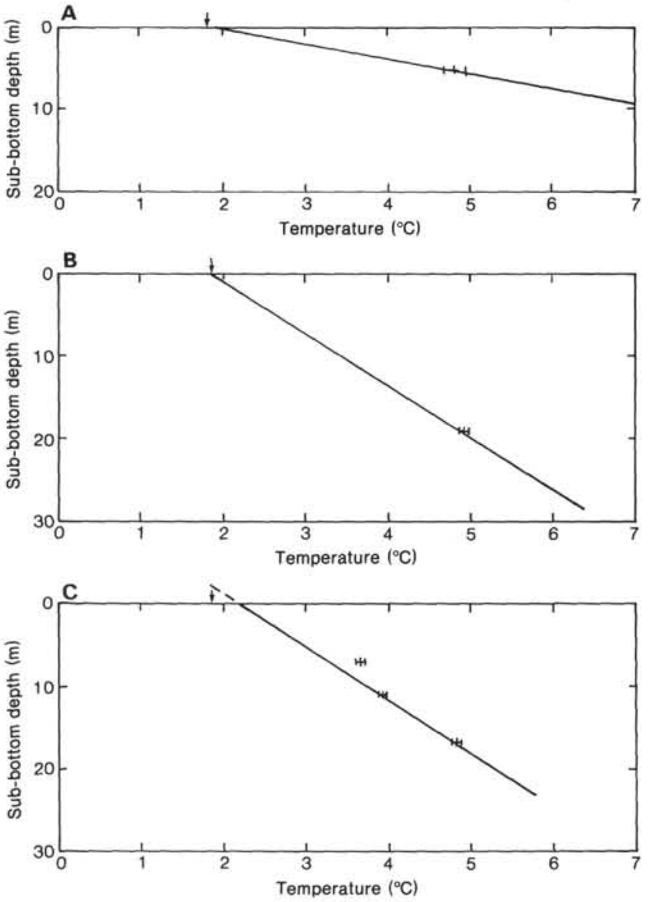


Figure 19. Temperature versus depth, Sites 600 and 601. Lines show temperature gradients. A. Hole 600. The temperature gradient is 579 m°C/m. B. Hole 601. The temperature gradient is 160 m°C/m. C. Hole 601A. The temperature gradient is 160 m°C/m.

continuity of the nannofossil zones, and the very slow sedimentation rate suggest that some upper Pliocene and Pleistocene sediment may be missing.

Foraminifers were moderate to abundant in the Site 601 sediments and became more poorly preserved with increasing depth. A basement age no older than 5.0 Ma was indicated by the foraminifers. Nannofossils were abundant, and some reworking was present throughout the sediment column. Preservation was moderate, with dissolution and overgrowth increasing with increasing depth. The maximum age indicated by the nannofossils was 4.6 Ma.

The upper 8.0 m of sediment were dated as Pleistocene and have a linear sedimentation rate of 4.2 m/m.y. The sediments between 8.0 and 9.0 m in Hole 601 were not zoned but probably represent late Pliocene and possibly Pleistocene sediments; they accumulated at a minimum sedimentation rate of 0.6 m/m.y. The remainder of the sediment column is early Pliocene and has a sedimentation rate of 8.0 to 11.0 m/m.y.

The physical properties of each section of core were measured. The average values are 69.2% for porosity, 1.56 g/cm^3 for wet bulk density, 1.52 km/s for sonic velocity, 2.75 g/cm^3 for grain density, and 2.26 for formation factor. Using the porosity and grain density values in combination with the linear sedimentation rates permits the calculation of total mass accumulation rates: 0.38 g/(cm^2 × 10^3 yr.) for the Pleistocene sediments and 0.67 to 0.82 g/(cm^2 × 10^3 yr.) for the early Pliocene. If the clay plus RSO fraction represents hydrothermal input, the hydrothermal flux averages approximately 37 and 180 to 245 mg/(cm^2 × 10^3 yr.) for the two zoned time intervals.

Igneous Rocks

Hole 601B penetrated 3.12 m into igneous basement, and 1.05 m of basalt cobbles were recovered. The rocks are fragments of relatively fresh gray, vesicular ferrobasalts with slightly oxidized outer rims. The outer surfaces are coated with secondary minerals, commonly Fe and Mn oxides and hydroxides, clays, calcite, or zeolites.

Experimental Studies

In total, nine interstitial water samples from squeezed sediments and one *in situ* water sample from Site 601 were analyzed. The potassium content of the *in situ* sample suggests that at this site, unlike the others, the temperature-of-squeezing effect increases with increasing depth in the core. This observation, if correct, would indicate that the magnesium data are similarly affected and that the small changes in Ca in the pore waters are due to carbonate dissolution, as at Sites 597, 598, and 599.

One temperature measurement was made with the Von Herzen VLHPC heat flow shoe at Hole 601, and three were made in the adjacent Hole 601A. The temperature gradient in both holes was approximately 160 m°C/m (a temperature gradient was found for Hole 601 by using bottom water temperature along with the downhole measurement). The heat flow calculated by using the thermal conductivity of the sediments found during the site survey cruise is 160 mW/m^2; the theoretically expected value for 5-Ma crust is 235 mW/m^2.

Site 602

A very thin sedimentary section was recovered from three holes at Site 602. Since the 3.5- and 12-kHz records failed to show any sediment, an XCB was run in the bit to determine whether any sediment was present as we washed down to determine the depth of basaltic basement. The XCB recovered 6.19 m of watery sediment and flow-in. After it became clear that sediment was present, the VLHPC was used at Hole 602A, and it recovered 2.28 m of sediment, the most representative section acquired at this site. At Hole 602B the core barrel stuck in the bit but recovered 4.24 m of sediment; the section was cored repeatedly as the ship rose and fell on a 2-m swell. The thinness of the sediments and the irregularity of sediment recovery prevented the measurement of heat flow.

The sediment recovered at Hole 602A is yellowish brown to dark yellowish brown clay-bearing to clayey nannofossil ooze. It consists of 80 to 85% calcareous nannofossils, 10 to 20% clay plus RSO (the presumably hydrothermal fraction), and 1 to 3% foraminifers. Zeolites, volcanic glass, and opaque grains occur in minor to trace amounts. The core from Hole 602B recovered chips of basaltic glass and highly vesicular rock fragments in a dark brown nannofossil clay that occurs at three levels, presumably the record of separate punches of the sediment by the stuck core barrel. The section at Site 602, unlike that recovered at most other Leg 92 drill sites, had no indurated basal layer, although there were two chalky 1-cm pieces in Sample 602B-1-3, 17–19 cm.

Biostratigraphic analyses show that all the sediments at Site 602 are Pleistocene in age (foraminifer Zone N22, nannofossil Zone CN14/15). The dark layers that occur in association with the rock chips contain common reworked Pliocene forms; reworking is rare in the sections of the cores that are lighter in color. The linear sedimentation rate for Site 602, a minimum value based on the assumption that the entire Pleistocene was recovered, is 1.4 m/m.y.

In terms of physical properties, the average values for the sediments recovered from Hole 602B are 67.9% for porosity, 2.65 g/cm^3 for grain density, 1.55 g/cm^3 for wet bulk density, 1.53 km/s for acoustic velocity, and 2.52 for formation factor. The minimum mass accumulation rate calculated from the porosity, grain density, and LSR values is 0.12 g/($cm^2 \times 10^3$ yr.) for bulk sediment. The minimum MAR for the hydrothermal component is then about 20 mg/($cm^2 \times 10^3$ yr.) in the light-colored oozes of Site 602 and about 65 mg/($cm^2 \times 10^3$ yr.) in the dark-colored layers of Hole 602B.

No Pliocene sediments were recovered from this 4.5-Ma location, although Pliocene fossils were reworked into the Pleistocene sediments and Pliocene sections were present at adjacent Sites 600 and 601. The absence of a Pliocene section at Site 602 probably indicates that the low trough in which the site is located served to channel current flow and that it remained essentially free of sediment during the Pliocene. Thus, instead of being the site of sediment ponding, this trough appears to be an area of winnowing and nondeposition.

The calculated MAR of the presumed hydrothermal component (20 to 65 mg/[$cm^2 \times 10^3$ yr.]) is about half that at Sites 597, 598, and 600; the low values are probably erroneous and are a consequence of the calculated value of LSR, which is a minimal value.

Operational Results

The coring operations at Site 600 reaffirmed that very thin sediment sections are unsuitable for drilling by the *Glomar Challenger.* Even when we knew the depth of basalt basement from the tagging operation, we lost two VLHPC barrels, and we recovered only partial sections in three of the four successful coring attempts (Cores 600-1, 5.38 m; 600B-1, 1.90 m; and 600C-2, 2.42 m). If the sheared barrels had merely bent we would have had to pull the pipe, which would have meant abandoning the site, given the time restrictions on Leg 92. This situation did arise at Hole 602B.

Transponder navigation works especially well on the *Glomar Challenger*, since the location of the beacon can be included in the transponder net and the dynamic positioning system permits the ship both to maintain station and to make precise offsets in terms of distance and direction. These capabilities reduce the problem of positioning on site determining where you are and deciding where you want to be.

REFERENCES

Bass, M. N., 1976. Rare and unusual minerals and fossils(?) in sediments of Leg 34. *In* Yeats, R. S., Hart, S. R., et al., *Init. Repts. DSDP*, 34: Washington (U.S. Govt. Printing Office), 611–624.

Bender, M. L., Hudson, A., Graham, D. W., Barnes, R. O., Leinen, M., and Kahn, D., 1985. Diagenesis and convection reflected in pore water chemistry on the western flank of the East Pacific Rise, 20 degrees South, *Earth Planet. Sci. Lett.*, 76:71–83.

Berger, W. H., 1981. Paleoceanography: the deep-sea record. *In* Emiliani, C. (Ed.), *The Sea* (Vol. 7): New York (Wiley), 1437–1519.

Berger, W. H., and Winterer, E. L., 1974. Plate stratigraphy and fluctuating carbonate line. *Spec. Publ. Int. Assoc. Sedimentol.*, 1: 11–48.

Blow, W. H., 1969. Late middle Eocene to Recent planktonic foraminiferal biostratigraphy. *In* Brönnimann, P., and Renz, H. H. (Eds.), *Proc. First Int. Conf. Planktonic Microfossils* (Geneva, 1967): Leiden (E. J. Brill), pp. 199–421.

Broecker, W. S., and Broecker, S., 1974. Carbonate dissolution on the western flank of the East Pacific Rise. *In* Hay, W. W. (Ed.), *Studies in Paleoceanography*. Spec. Publ. Soc. Econ. Paleont. Mineral., 20:44–57.

Haq, B. U., 1984. Jurassic to Recent nannofossil biochronology: an update. *In* Haq, B. U. (Ed.), *Nannofossil Biostratigraphy:* Stroudsburg, PA (Hutchinson Ross Publ. Co.), pp. 358–378.

Natland, J. H., 1980. Crystal morphologies of basalts dredged and drilled from the East Pacific Rise near 9°N and the Siqueiros Fracture Zone. *In* Rosendahl, B. R., Hekinian, R., et al., *Init. Repts. DSDP*, 54: Washington (U.S. Govt. Printing Office), 605–633.

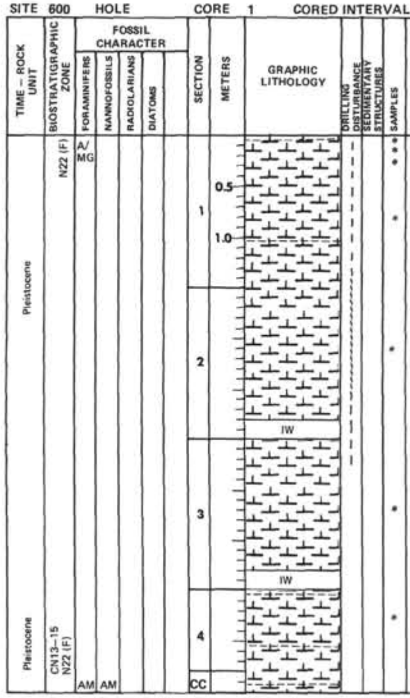
Okada, H., and Bukry, D., 1980. Supplementary modification and introduction of code numbers to the low-latitude coccolith biostratigraphic zonation (Bukry, 1973; 1975). *Mar. Micropaleontol.*, 5:321–325.

Quilty, P. G., Sachs, H., Benson, W. E., Vallier, T. L., and Blechschmidt, G., 1976. Sedimentologic history, Leg 34, Deep Sea Drilling Project. *In* Yeats, R. S., Hart, S. R., et al., *Init. Repts. DSDP*, 34: Washington (U.S. Govt. Printing Office), 779–794.

Sclater, J. G., Anderson, R. N., and Bell, M. L., 1971. Elevation of ridges and evolution of the central eastern Pacific. *J. Geophys. Res.*, 76:7888–7915.

van Andel, T. H., Heath, G. R., and Moore, T. C., 1975. Cenozoic history and paleoceanography of the central equatorial Pacific Ocean. *Mem. Geol. Soc. Am. 143*.

SITE 600 HOLE CORE 1 CORED INTERVAL 0.0–5.4 m



LITHOLOGIC DESCRIPTION

Section 1: CLAY-BEARING NANNO OOZE
0–5 cm: Light yellowish brown (10YR 6/4)
5–8 cm: Light yellowish brown (10YR 6/4)
8–52 cm: Yellowish brown (10YR 5/6)
52–150 cm: Brownish yellow (10YR 6/6)

Section 2: CLAY-BEARING NANNO OOZE
0–140 cm: Light yellowish brown (10YR 6/4)

Section 3: CLAY-BEARING NANNO OOZE
0–140 cm: Light yellowish brown (10YR 6/4)

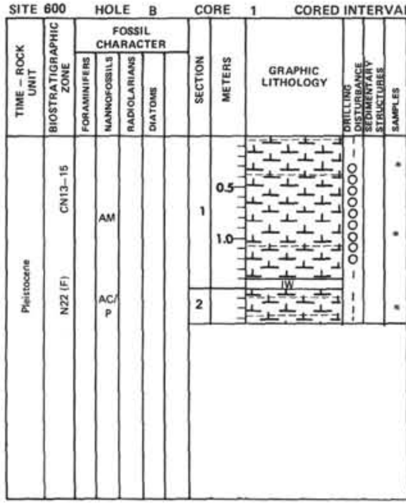
Section 4: CLAY-BEARING NANNO OOZE
0–68 cm: Pale brown (10YR 6/3)

Core Catcher: CLAY-BEARING NANNO OOZE
Light yellowish brown (10YR 6/4)

SMEAR SLIDE SUMMARY (%):

	1, 80	2, 60	4, 30
	D	D	D
Texture:			
Sand	5	–	–
Silt	75–80	40	–
Clay	15–20	60	–
Composition:			
Feldspar	–	–	Tr
Clay	15–20	15	10–15
Volcanic glass	TR	2–3	3
Palagonite	<1	–	–
Micronodules	–	2	1
Foraminifers	~5	2	3–5
Calc. nannofossils	75–80	75	80
Opaques	TR	–	–

SITE 600 HOLE B CORE 1 CORED INTERVAL 0.0–1.9 m



LITHOLOGIC DESCRIPTION

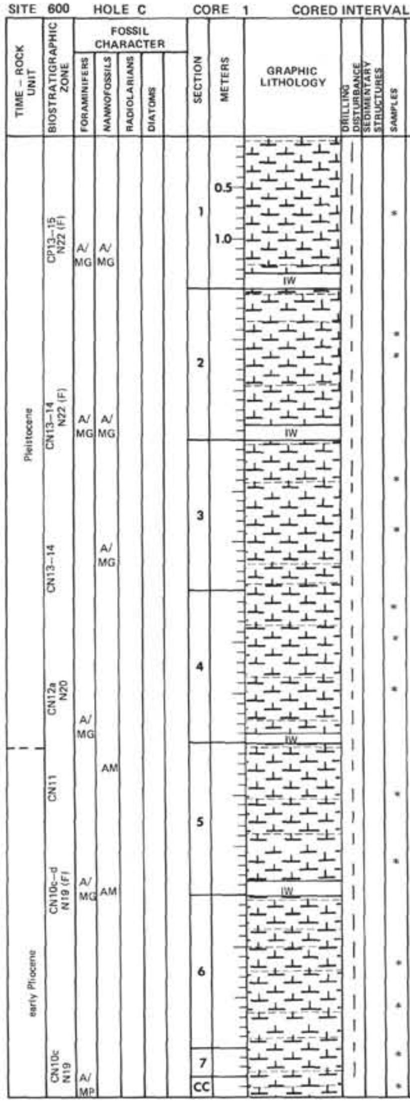
Section 1: CLAY-BEARING NANNO OOZE
0–26 cm: Yellowish brown (10YR 5/4)
26–140 cm: Brownish yellow (10YR 6/6)

Section 2: CLAY-BEARING NANNO OOZE
0–35 cm: Brownish yellow (10YR 6/6)

SMEAR SLIDE SUMMARY (%):

	1, 25	1, 100	2, 20
	D	D	D
Texture:			
Sand	10	5	5
Silt	70	75	80
Clay	20	20	15
Composition:			
Clay	20	20	15
Volcanic glass	5	5	TR
Palagonite	1	>1	5
Micronodules	5	5	1
Foraminifers	8–10	3–5	≥2
Calc. nannofossils	70	75	~80
Opaques	5	~1	5

SITE 600 HOLE C CORE 1 CORED INTERVAL 0.0–9.4 m



LITHOLOGIC DESCRIPTION

Section 1: CLAY-BEARING NANNO OOZE
0–140 cm: Yellowish brown (10YR 5/4)

Section 2: CLAY-BEARING NANNO OOZE
0–65 cm: Brownish yellow (10YR 6/6)
65–140 cm: Brownish yellow (10YR 6/8)

Section 3: FORAM- AND CLAY-BEARING NANNO OOZE
0–58 cm: Brownish yellow (10YR 6/8)
58–113 cm: Light brown (7.5YR 6/4)
113–136 cm: Same as 0–58 cm
126–150 cm: Same as 58–113 cm

Section 4: CLAY-BEARING TO CLAYEY NANNO OOZE
0–5 cm: Light brown (7.5YR 6/4)
5–35 cm: Light brown (7.5YR 5.5/4)
35–85 cm: Dark brown (7.5YR 3/2)
85–136 cm: Brown (7.5YR 4/4)

Section 5: CLAY-BEARING TO CLAYEY NANNO OOZE
0–85 cm: Dark brown (7.5YR 4/4)
85–140 cm: Dark brown (7.5YR 3/2)

Section 6: CLAYEY NANNO OOZE
0–75 cm: Dark brown (7.5YR 3/2)
75–79 cm: Bands
79–123 cm: Same as 0–75 cm
123–127 cm: Bands
127–150 cm: Same as 0–75 cm

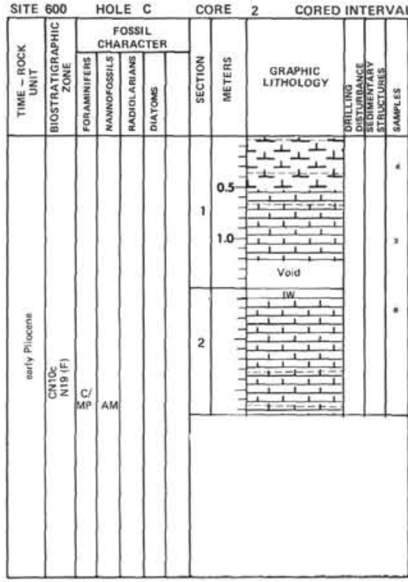
Section 7: CLAYEY NANNO OOZE
Dark brown (7.5YR 3/2)

Core Catcher: CLAY-BEARING TO CLAYEY NANNO OOZE
Dark brown (7.5YR 3/2)

SMEAR SLIDE SUMMARY (%):

	1, 75	3, 90	6, 65
	D	D	
Texture:			
Sand	5	10–15	–
Silt	75	30	–
Clay	20	55	–
Composition:			
Clay	≤20	20	25
Volcanic glass	TR	3	TR
Palagonite	<1	–	–
Micronodules	5	–	3
Foraminifers	5–6	20	2
Calc. nannofossils	75	55	70
Opaques	TR	–	–

SITE 600 HOLE C CORE 2 CORED INTERVAL 9.4–19.0 m



LITHOLOGIC DESCRIPTION

CLAYEY NANNO OOZE

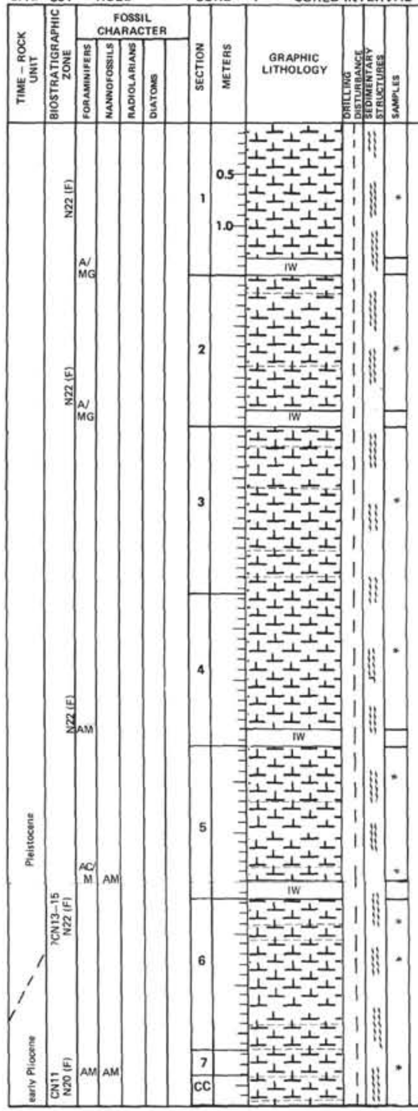
Section 1:
0–57 cm: CLAYEY NANNO OOZE
Dark brown 7.5YR 4/4)
57–130 cm: CLAYEY AND FORAMBEARING NANNOFOSSIL CHALK, yellowish brown (10YR 5/6)

Section 2: CLAYEY AND FORAM-BEARING NANNO CHALK

SMEAR SLIDE SUMMARY (%):

	1, 30	1, 110	2, 25
	D	D	D
Texture:			
Sand	5	15	15
Silt	65	55	55
Clay	30	30	30
Composition:			
Clay	30	30	30
Volcanic glass	5	–	–
Palagonite	~2	>3	~4
Micronodules	1–2	~1	~1
Foraminifers	≤2	~12	~14
Calc. nannofossils	65	55	50–55
Opaques	~2	~2	~2

SITE 601 HOLE CORE 1 CORED INTERVAL 0.0–9.8 m



LITHOLOGIC DESCRIPTION

Section 1: NANNOFOSSIL OOZE TO CLAY-BEARING NANNO OOZE
Light yellowish brown (10YR 6/4)

Section 2: NANNO OOZE TO CLAY-BEARING NANNOFOSSIL OOZE
0–14 cm: 10YR 6/4
14–51 cm: 10YR 5.5/4
51–110 cm: 10YR 6/4
110–135 cm: 10YR 5.5/4

Section 3: CLAY-BEARING NANNOFOSSIL OOZE
* "Section is 164 cm long" *
Light yellowish brown (10YR 6/4)

Section 4: NANNOFOSSIL OOZE
0–65 cm: 10YR 6/4
65–90 cm: 10YR 5.5/4
90–117 cm: 10YR 6/4
117–136 cm: 10YR 5.5/4

Section 5: NANNO OOZE TO CLAY-BEARING NANNO OOZE
0–13 cm: 10YR 5/4
13–39 cm: 10YR 6/3
39–51 cm: 10YR 5/4
51–127 cm: 10YR 6/3
127–136 cm: 10YR 5/4

Section 6: CLAY-BEARING NANNO OOZE
0–38 cm: 10YR 6/3
38–54 cm: 10YR 5/4
54–79 cm: 10YR 4/3
79–96 cm: 10YR 5/4
96–119 cm: 10YR 6/4
119–142 cm: 10YR 6/3
142–150 cm: 10YR 6/4

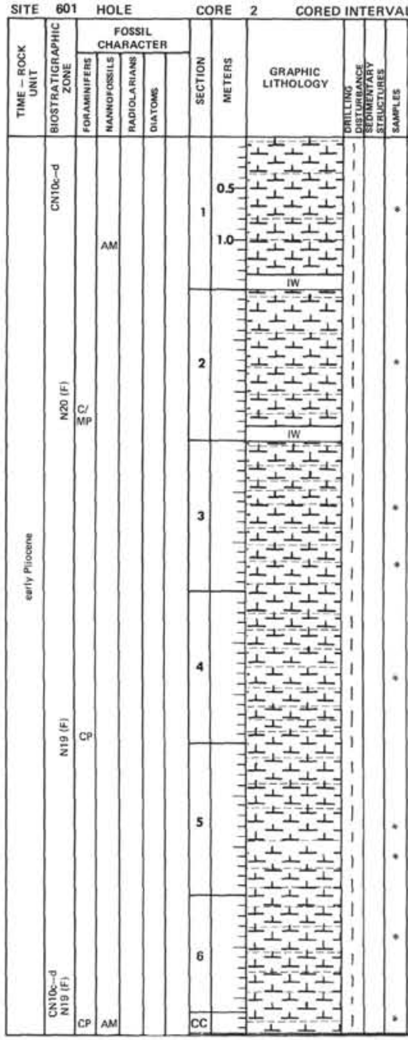
Section 7: CLAY-BEARING NANNO OOZE
10YR 4/3

Core Catcher: CLAY-BEARING TO CLAYEY NANNO OOZE
10YR 4/3

SMEAR SLIDE SUMMARY (%):

	1, 75 D	3, 75 D	5, 130 D
Texture:			
Sand	–	2–3	3
Silt	–	90	85
Clay	–	10	10–15
Composition:			
Clay	10	>10	12
Volcanic glass	TR	TR	–
Palagonite	1	–	1
Micronodules	–	–	TR
Foraminifers	1–3	2	2
Calc. nannofossils	90	90	85
Opaques	TR	TR	TR

SITE 601 HOLE CORE 2 CORED INTERVAL 9.8–19.4 m



LITHOLOGIC DESCRIPTION

Section 1: CLAY-BEARING TO CLAYEY NANNO OOZE
0–69 cm: Brown (10YR 4/3)
69–87 cm: Dark brown (10YR 3.5/3)
87–132 cm: Brown (10YR 4/3)

Section 2: CLAY-BEARING TO CLAYEY NANNO OOZE
Dark bands: Dark brown (10YR 3/3) at 0–17, 28–32, 42–52, 66–77, 84–92, 102–114, and 118–135 cm
Light bands: Brown (10YR 4/3)

Section 3: CLAY-BEARING TO CLAYEY NANNO OOZE
Dark bands: Dark brown (10YR 3/3) at 0–12, 32–39, 70–74, 78–85, 107–118, 129–150 cm
Light bands: Brown (10YR 4/3)

Section 4: CLAY-BEARING NANNO OOZE
Dark bands: Dark brown (7.5YR 3/2) at 49–70 and 90–112 cm
Light bands: Brown (10YR 4/3)

Section 5: CLAYEY NANNO OOZE
Banded: Dark brown (7.5YR 3/2) and very dark brown (7.5YR 3.5/2)

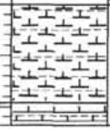
Section 6: CLAYEY NANNO OOZE
Bands: Dark brown (7.5YR 3/2) and reddish brown (5YR 3/2)

Core Catcher: CLAYEY NANNO OOZE
7.5YR 2.5/2

SMEAR SLIDE SUMMARY (%):

	1, 75 D	3, 75	6, 48
Texture:			
Sand	5	–	5
Silt	70	–	65
Clay	25	–	30
Composition:			
Clay	25	25	30
Volcanic glass	–	TR	TR
Palagonite	1–2	<2	2–3
Micronodules	1	–	–
Foraminifers	<2	1–2	~2
Calc. nannofossils	70	70	65
Fish remains	–	TR	–
Opaques	~2	≤2	~1

SITE 601 HOLE CORE 3 CORED INTERVAL 19.4–20.4 m

TIME – ROCK UNIT	BIOSTRATIGRAPHIC ZONE	FORAMINIFERS	NANNOFOSSILS	RADIOLARIANS	DIATOMS	SECTION	METERS	GRAPHIC LITHOLOGY	DRILLING DISTURBANCE	SEDIMENTARY STRUCTURES	SAMPLES
early Pliocene	CN10c–d N19 (F)	CP	CA/M			1	0.5				*
						CC					*

LITHOLOGIC DESCRIPTION

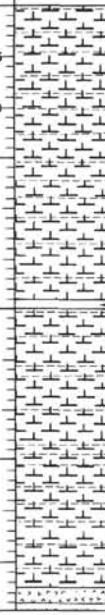
Section 1: CLAYEY *NANNOFOSSIL OOZE, below* 88 cm is a CLAYEY NANNO CHALK
0–11 cm: 7.5YR 3/2
11–23 cm: 7.5YR 3.5/2
23–36 cm: 7.5YR 3/2
36–66 cm: 7.5YR 2/2
66–75 cm: 7.5YR 4/4
75–82 cm: 7.5YR 3/2
82–91 cm: 7.5YR 4/4 grading to 7.5YR 5/6
Slightly indurated grading to indurated

Core Catcher: Breccia of CLAYEY NANNO CHALK 7.5YR 4/4

SMEAR SLIDE SUMMARY (%):

	1, 17	1, 47	1, 88
Texture:			
Sand	5	–	–
Silt	65	–	–
Clay	30	–	–
Composition:			
Clay	30–35	35	40
Volcanic glass	TR	–	TR
Palagonite	>2	>2	2
Micronodules	>1	1–2	–
Foraminifers	3–4	2	5
Calc. nannofossils	65	60	55
Fish remains	–	TR	–
Opaques	3–4	>3	TR

SITE 601 HOLE B CORE 1 CORED INTERVAL 14.4–24.0 m

TIME – ROCK UNIT	BIOSTRATIGRAPHIC ZONE	FORAMINIFERS	NANNOFOSSILS	RADIOLARIANS	DIATOMS	SECTION	METERS	GRAPHIC LITHOLOGY	DRILLING DISTURBANCE	SEDIMENTARY STRUCTURES	SAMPLES
?						1	0.5, 1.0				*
early Pliocene	CN10c–d N19 (F)	FC/P	AM			2					IW
						3					*
early Pliocene	CN10c–d N19 (F)					4					*
		FP	AM			CC					

LITHOLOGIC DESCRIPTION

Section 1: CLAYEY NANNOFOSSIL OOZE
Base color: 10YR 4/3
Dark bands of 7.5YR 3/2 at 45–69, 79–100, 115–120, and 136–140 cm

Section 2: CLAYEY NANNOFOSSIL OOZE
Base color: 7.5YR 4/4
Dark bands of 5YR 2.5/2 to 7.5YR 3/4 at 0–27, 36–40, 45–55, 80–100, and 110–115 cm

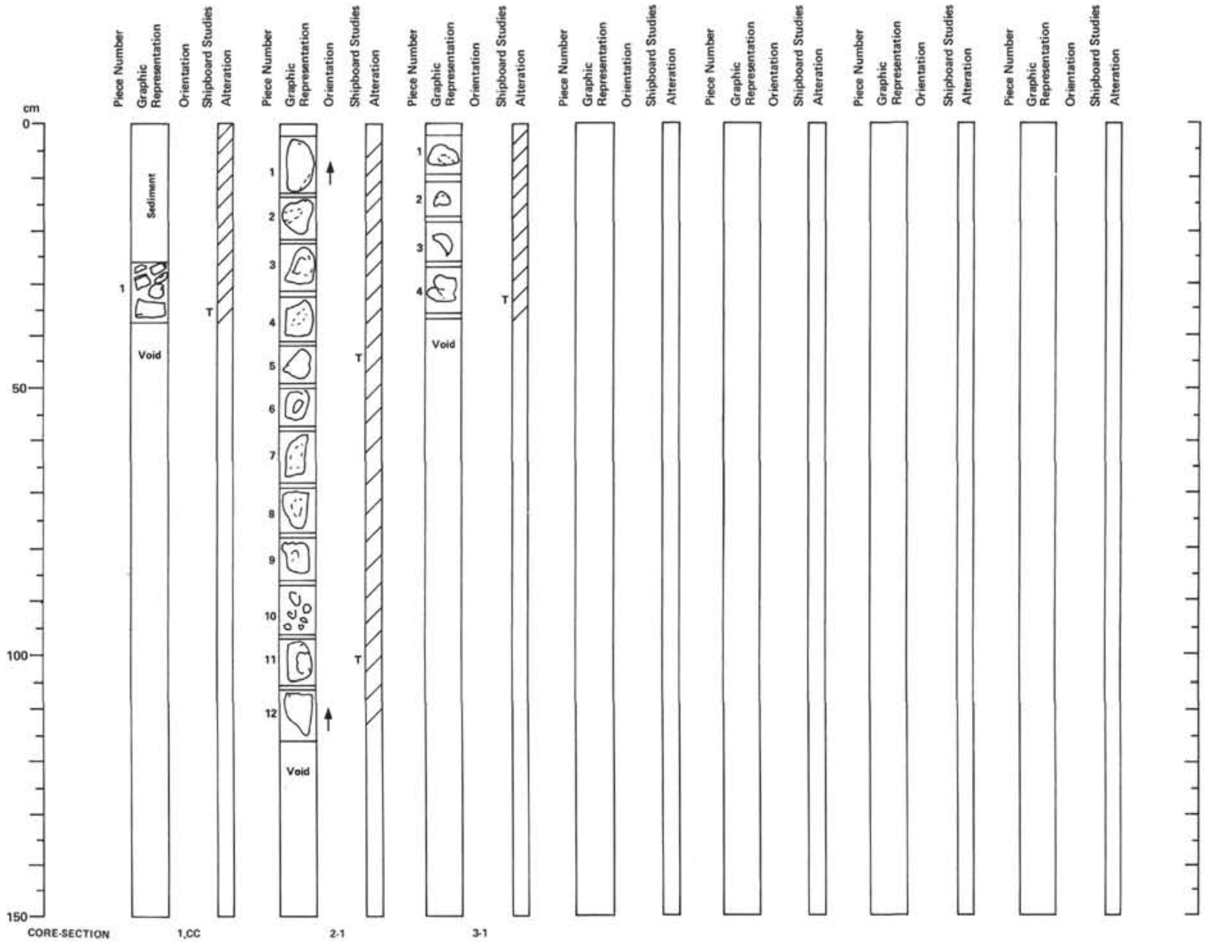
Section 3: CLAYEY NANNOFOSSIL OOZE TO NANNO-FORAM-BEARING CLAY
Base color of 7.5YR 3/4
Dark bands of 5YR 2.5/2–2/2 at 15–25, 37–47, 68–75, 87–91, and 110–137 cm
137–152 cm: 7.5YR 4/4

Section 4: FORAM- AND NANNO-BEARING CLAY
Base color: 7.5YR 3/4 to 4/4
Dark bands of 7.5YR 3/2 to 5YR 2/2 at 0–6, 9–21, 31–41, 81–86, and 102–110 cm

Core Catcher: FORAM- AND NANNO-BEARING CLAY
0–25 cm: 10YR 4/3 partially lithified
25–37 cm: Basalt

SMEAR SLIDE SUMMARY (%):

	1, 75	3, 60	4, 50
Composition:			
Clay	35	35	55
Volcanic glass	TR	TR	TR
Palagonite	1–2	1–2	–
Foraminifers	2–3	2–3	20
Calc. nannofossils	60	60	25
Opaques	TR	TR	–



92-601B-1 Depth: 14.4–24.0 m

Core Catcher

1–25 cm: Sediment

Macroscopic description

Broken gray basalt fragments 2–3 cm across; one 6 cm x 4–5 cm, altered on all outer surfaces. Remnants of glassy rims on 2 pieces are altered to brown palagonite and blue clay (?saponite?); palagonite may also be altered to blue clay. Other surfaces are coated with Fe-oxyhydroxides, green to yellow to brown clays, and some calcite. One fragment has a dark alteration zone 3–4 mm thick on one edge. Vesicles (~5%), partially filled with green, yellow, and brown clays. Mineralogy: plagioclase and clinopyroxene phenocrysts in aphanitic groundmass and some olivine, part of which is altered and pseudomorphed.

Thin section description

33–35 cm (largest piece): Moderately clinopyroxene-plagioclase phyric basalt. Total 7–15% microphenocrysts. Plagioclase in laths, stubby and skeletal crystals 0.05–0.8 mm long makes up 50–70% of microphenocrysts; clinopyroxene in anhedral grains 0.05–1 mm across makes up 30–40%. Minor olivine (5–10%) in anhedral and skeletal grains, 0.1–0.5 mm, partly altered to red iddingsite. Plagioclase and clinopyroxene form clusters as well as isolated grains. Groundmass consists of coelesced spherulites, probably composed of plagioclase and clinopyroxene micro-lites, with abundant disseminated magnetite in grains about 0.005 mm across. Groundmass is opaque except on thin edges of slide, probably due to abundance of magnetite. One empty vesicle 0.5 mm in diameter.

92-601B-2 Depth: 24.0–25.5 m

Section 1:

Macroscopic description

Aphanitic to fine-grained basalt in the form of rounded fragments. Most fragments exhibit concentric zones of weak oxidative alteration and outer coatings of manganese and iron oxyhydroxides and smectite and may have formed a pillow breccia. Visible basalt textures include feldspar crystallites in a matrix of cryptocrystalline material and magnetite; no obvious olivine. Brown smectite and iron oxyhydroxide is common in the oxidative alteration zones. There are 5–10% vesicles partially or completely filled with yellow, green, and brown smectites and zeolite (?phillipsite). Coarser grained patches may represent segregation vesicles. Piece 5 contains blue clay (?saponite) coating, other coatings include Mn/Fe oxyhydroxide, green, yellow-brown, and white smectite and zeolite.

Thin section description

Piece 5, 43–45 cm: Moderately clinopyroxene-plagioclase phyric basalt. 5–15% microphenocrysts of plagioclase (60–80% of microphenocrysts), clinopyroxene (20–30%), and minor olivine (5–10%). Plagioclase in laths, stubby, and skeletal crystals 0.1–1.3 mm long, often forming clusters with anhedral to subhedral clinopyroxene grains 0.2–1.6 mm long. Olivine is anhedral to subhedral, 0.2–0.5 mm grains, usually altered to red iddingsite. Groundmass consists of coelesced spherulites, probably composed of plagioclase and clinopyroxene microlites, and abundant disseminated magnetite in grains about 0.005 mm across. The groundmass is opaque except on thin edges of the slide, probably due to the abundance of magnetite.

Thin section description

Piece 11, 97–99 cm: Moderately clinopyroxene-plagioclase phyric basalt. 10–15% total microphenocrysts, 0.5 to 1.5 mm, of plagioclase (50–60%) and clinopyroxene (40–50%), often in clusters. Plagioclase forms laths, clinopyroxene anhedral grains. Groundmass consists of 75–85% fan, sheaf, and subspherical spherulites up to 0.5 mm across. Spherulite fibers are plagioclase and clinopyroxene. Coelesced coarse spherulites verge on a mesh texture. Abundant disseminated magnetite (10–20%), in grains up to 0.01 mm, and patches of yellow glass (1–5%) make up remainder of groundmass. Center of sample congains 1–2% square to rounded vesicles 0.2–0.5 mm across, usually empty but occasionally lined with glass. Altered rim on piece shows yellow glass altered to red and orange pelagonite and patches of rust colored alteration around magnetite grains. Dark band along interior of altered rim is not altered, but contains unusually abundant magnetite (25%?).

92-601B-3 Depth: 25.5–27.0 m

Section 1:

Macroscopic description

Rounded unoriented fragments of aphanitic to fine-grained gray basalt. Outer surface coated with Fe-Mn oxyhydroxides, blue and brown clays and orange palagonite. Minor remnants of glass may be present with palagonite. Piece 1 has an altered zone up to 2 cm thick surrounding a fresher core. Visible mineralogy consists of plagioclase spherulites, clinopyroxene, and minor olivine, largely altered, in an aphanitic groundmass. Vesicles (1–5%) small, often lined with yellow, green, or brown clay. Piece 4 has a vuggy surface with vugs up to 5 mm lined with white globes of crystals, probably a zeolite. Two fractures extending into Piece 4 have narrow alteration halos. Rare larger coarser grained segregations are associated with vesicles.

Thin section description

Piece 4, 32–34 cm: Moderately clinopyroxene-pyroxene phyric basalt. 7–15% total microphenocrysts. Plagioclase in laths 0.3–1 mm long makes up 65–75% of microphenocrysts, clinopyroxene in anhedral and subhedral grains makes up 25–35%. Clusters of plagioclase and clinopyroxene grains common. Groundmass consists of 80–85% spherulites, 10–15% magnetite, about 5% glass. Spherulites are fan, sheaf, and subspherical, composed probably mostly of plagioclase, plus clinopyroxene. Coarser spherulites grade up toward microphenocryst size, approach mesh texture. Magnetite is disseminated, in grains 0.01–0.05 mm across. Glass is yellow. Altered rim along one edge of piece contains orange-brown pelagonite replacing glass, and possible brown clay replacing spherulites.

SITE 602 HOLE CORE 1 CORED INTERVAL 0.0–6.2 m

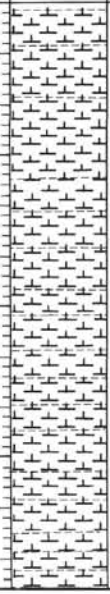
TIME – ROCK UNIT | BIOSTRATIGRAPHIC ZONE | FOSSIL CHARACTER: FORAMINIFERS, NANNOFOSSILS, RADIOLARIANS, DIATOMS | SECTION | METERS | GRAPHIC LITHOLOGY | DRILLING DISTURBANCE | SEDIMENTARY STRUCTURES | SAMPLES | LITHOLOGIC DESCRIPTION

?CN10–15?

AM

Sections: 1, 2, 3, 4

Meters: 0.5, 1.0



Section 1: FORAM- AND CLAY-BEARING NANNO OOZE
0–150 cm: Yellowish brown (10YR 5/4)

Section 2: CLAY-BEARING NANNO OOZE
0–110 cm: Yellowish brown (10YR 5/4)
110–150 cm: Brown 10YR 5/3

Section 3: CLAY-BEARING NANNO OOZE
0–28 cm: Water
28–150 cm: Yellowish brown (10YR 5/4)

Section 4: CLAY-BEARING NANNO OOZE
0–28 cm: Yellowish brown (10YR 5/4)
28–90 cm: Water
90–125 cm: Dark yellowish brown (10YR 3/4)

SITE 602 HOLE A CORE 1 CORED INTERVAL 0.0–2.3 m

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

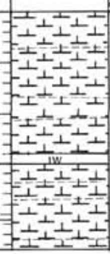
Pleistocene

CN13–15 N22 (F)

AG A/MG

Sections: 1, 2, CC

Meters: 0.5, 1.0



CLAY-BEARING NANNOFOSSIL OOZE

Section 1:
0–96 cm: 10YR 5/6
96–126 cm: 10YR 4/4 grades to 10YR 3/4
126–140 cm: 10YR 4/4

Section 2:
0–12 cm: 7.5YR 4/6
12–63 cm: 10YR 6/4

Core Catcher:
0–10 cm: 10YR 4/4
10–15 cm: 10YR 5/4

SMEAR SLIDE SUMMARY (%):

	1, 60 D	2, 30
Texture		
Sand	2–3	–
Silt	~80	–
Clay	15–20	10–15
Composition:		
Clay	15–20	–
Palagonite	1–2	~1
Foraminifers	<2	1–3
Calc. nannofossils	80	80–85

SITE 602 HOLE B CORE 1 CORED INTERVAL 0.0–4.2 m

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

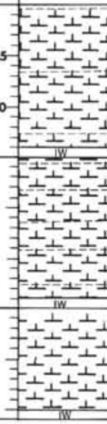
Pleistocene

CN13–15 N22 (F)

A/MG AM

Sections: 1, 2, 3

Meters: 0.5, 1.0



Section 1:
0–83 cm: FORAM- AND CLAY-BEARING NANNO OOZE, brown (7.5YR 5/4)
83–118 cm: CLAY-BEARING TO CLAYEY NANNO OOZE, Dark yellow brown (10YR 3/4)
118–140 cm: CLAY-BEARING NANNO OOZE, dark brown (7.5YR 4/4)

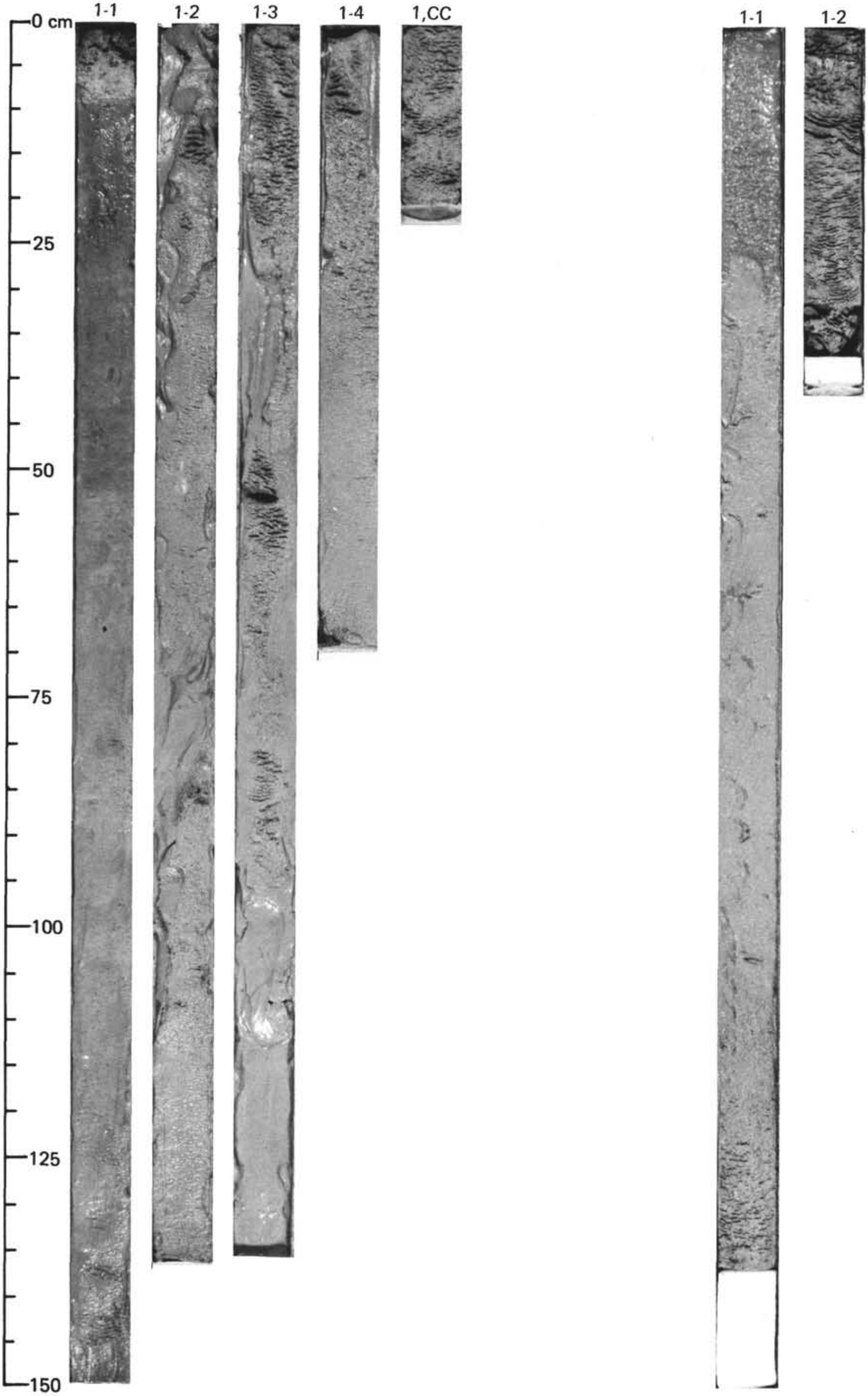
Section 2:
6–40 cm: CLAY-BEARING NANNO OOZE, yellowish brown (10YR 5/4)
50–109 cm: NANNOFOSSIL CLAY, dark olive gray (5YR 3/2)
109–140 cm: CLAY-BEARING NANNO OOZE, dark brown (10YR 4/3)

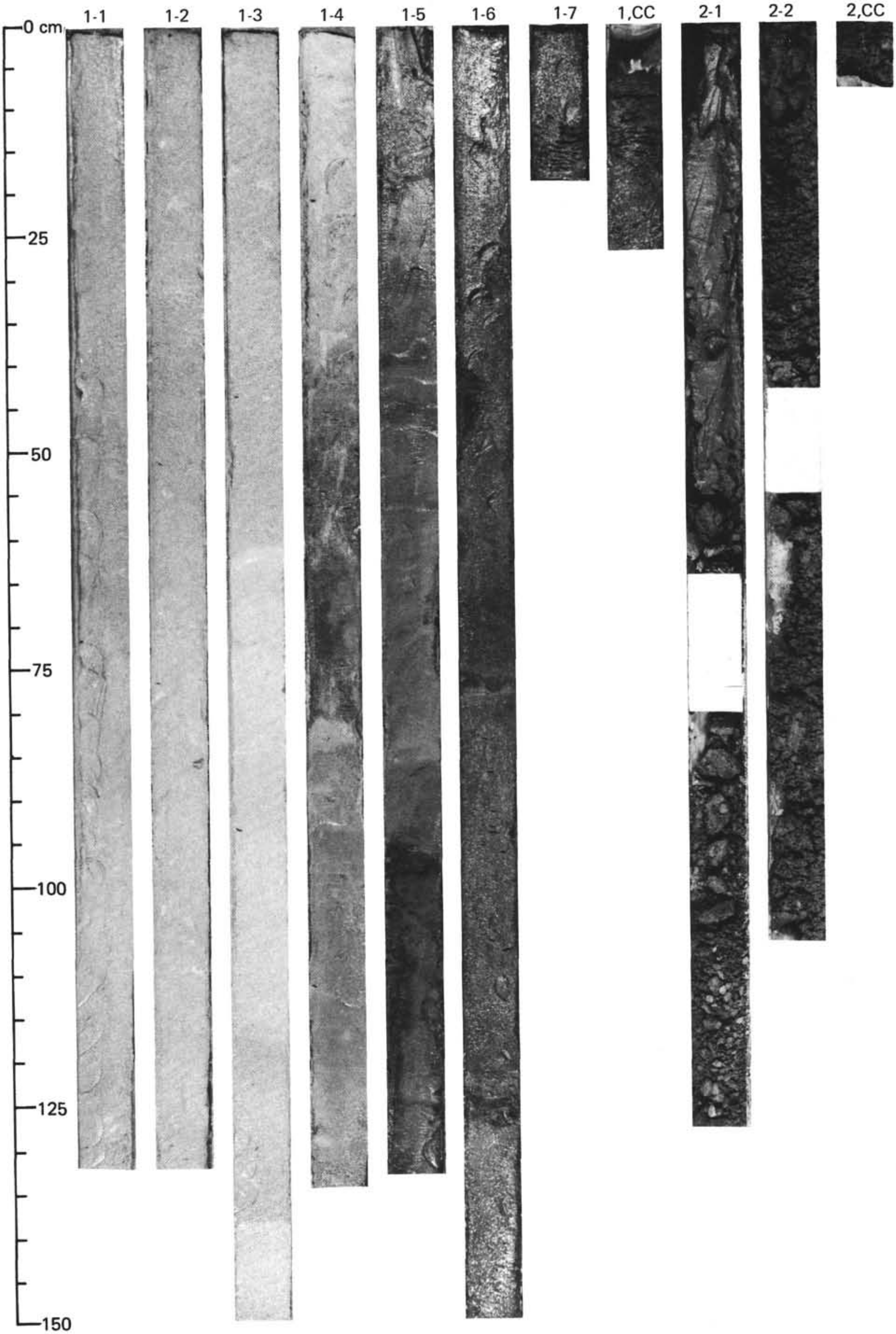
Section 3: CLAY-BEARING NANNO OOZE
0–30 cm: brown to dark brown (10YR 4/3)
30–99 cm: 10YR 4/3 grading to yellow brown (10YR 5/4)

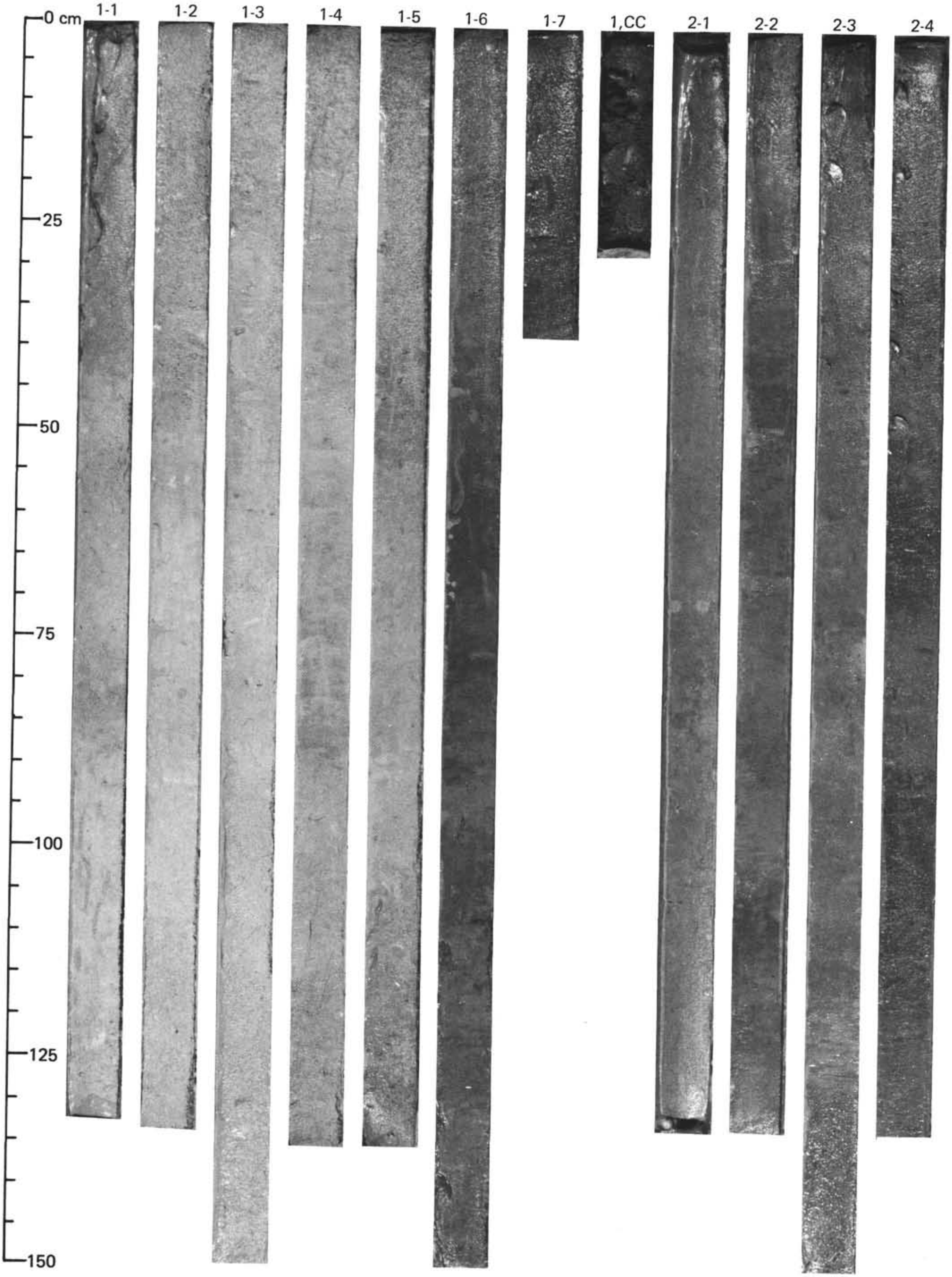
Core Catcher: CLAY-BEARING NANNO OOZE
Yellow brown (10YR 5/4)

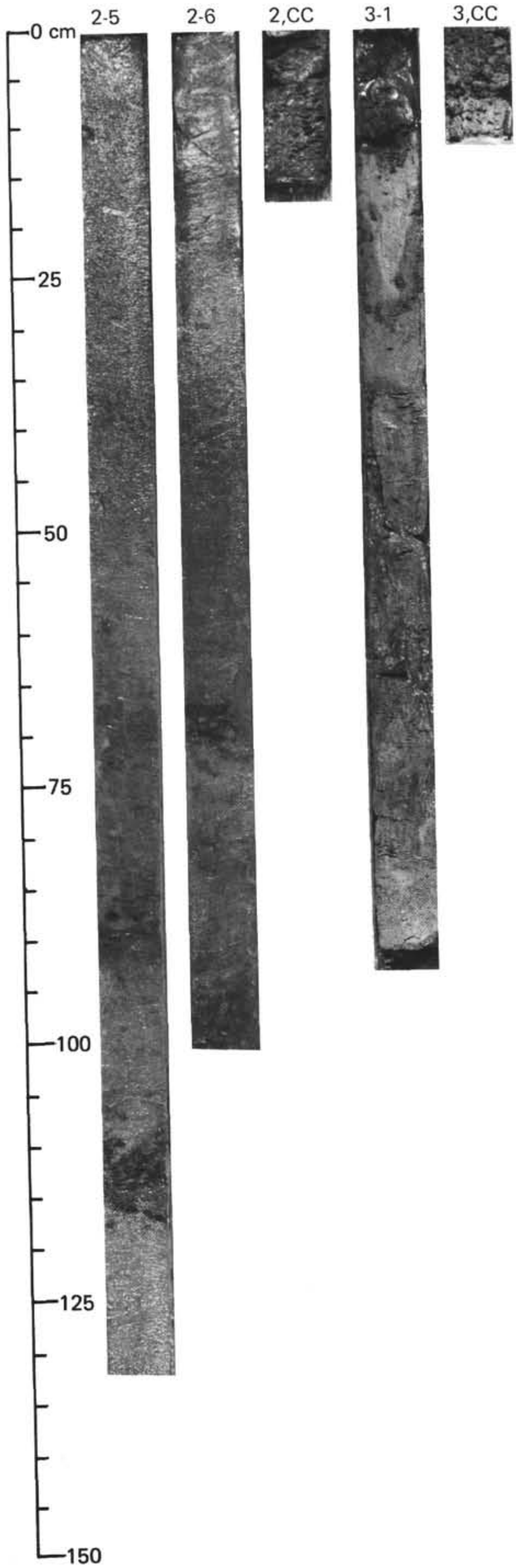
SMEAR SLIDE SUMMARY (%):

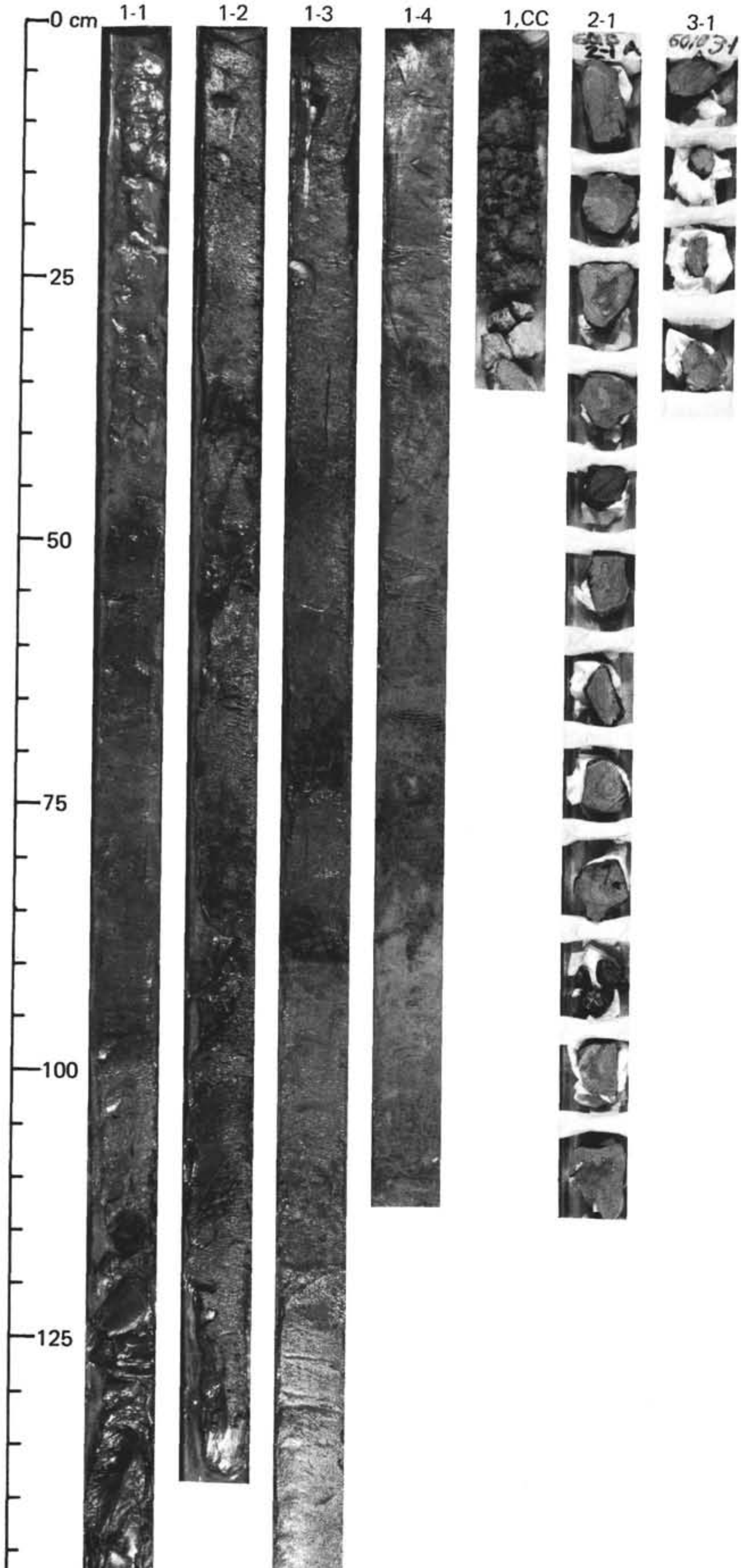
	1, 46 D	2, 26 D	3, 10 D
Texture:			
Sand	15–20	2–3	5
Silt	60–70	80–90	80
Clay	15–20	~10	15
Composition:			
Clay	15–20	>10	15–20
Volcanic glass	–	5	–
Palagonite	~3	1–2	1–2
Micronodules	–	–	TR
Zeolite	–	–	TR
Foraminifers	~15	~2	4
Calc. nannofossils	≤65	85–90	80
Opaques	~1	TR	~1

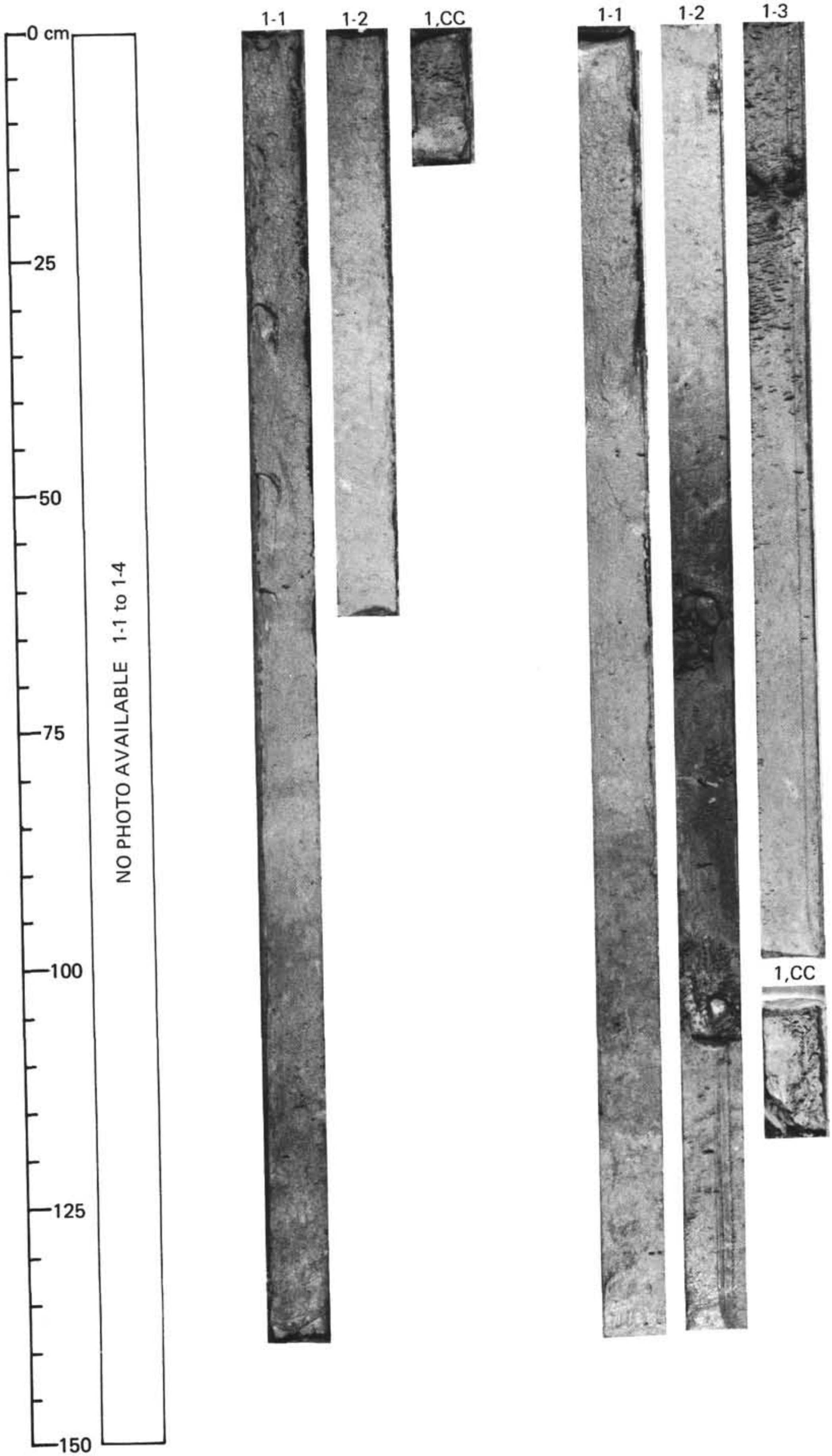

1-1
1-2
1-3
1-4
1,CC
1-1
1-2
0 cm
25
50
75
100
125
150


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


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


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


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


0 cm
25
50
75
100
125
150
NO PHOTO AVAILABLE 1-1 to 1-4
1-1
1-2
1,CC
1-1
1-2
1-3
1,CC