2. SITE 462: NAURU BASIN, WESTERN PACIFIC OCEAN, DEEP SEA DRILLING PROJECT LEG 61[1]

Shipboard Scientific Party[2]

HOLE 462

Date occupied: 1550Z 28 May 1978

Date departed: 0700Z 8 June 1978

Time on hole: 10 days, 14 hours, 12 min.

Position (latitude; longitude): 7°14.25′N; 165°01.83′E

Water depth (sea level; corrected m, echo sounding): 5181

Water depth (rig floor; corrected m, echo sounding): 5191

Bottom felt (m, drillpipe): 5189

Penetration (m): 617.0

Number of cores: 69

Total length of cored section (m): 616.5

Total core recovered (m): 376.8

Core recovery (%): 61

Oldest sediment cored:
Depth sub-bottom (m): 599
Nature: Brown clay, chert
Age: Cenomanian
Measured velocity (km/s): 2.5

Basement:
Depth sub-bottom (m): 617.0
Nature: Basaltic sill
Velocity range (km/s): 4–5.9

Principal results: Hole 462 (7°14.25′N, 165°01.83′E) was drilled as a re-entry pilot hole from 28 May to 8 June at a water depth of 5181 corrected meters. Total length of continuously cored section was 616.5 meters. Total core recovered was 376.8 meters. Core recovery was 61%. The section is divided into units. Unit I extends from 0.5 to 297 meters: calcareous and radiolarian oozes and chalks, mainly of turbidite origin, containing shallow-bank to reef skeletal debris of Eocene age, and planktonic microfossils as old as Late Cretaceous, in deeper-water strata of Oligocene age; at 50 meters depth, several meters of late Miocene–Pliocene ooze is rich in air-borne volcanic ash; age of Unit I ranges from Pleistocene to early Oligocene or late Eocene. Unit II extends from 297 to 447 meters: cherts, chalks and limestones of early Oligocene or late Eocene to middle Maestrichtian age. Unit III extends from 447 to 560 meters; volcanogenic and zeolitic sandstone, mudstone, and limestone of Maestrichtian to Cenomanian age, containing locally abundant shallow-bank skeletal debris of Maestrichtian to Campanian age. Unit IV extends from 560 to 617 meters (total depth): hyaloclastic mudstone layers, one of which contains undatable fish teeth and radiolarians intercalated with seven altered basalt and diabase sills. Total basalt recovery was approximately 35 meters from six sills 0.5 to 9 meters thick, and one sill at least 30 meters thick which was not fully penetrated at 617 meters. This deepest sill is diabase and displays granophyre facies. All sedimentary units are characterized by abundant contributions of sediment transported and redeposited at Site 462.

Six Uyeda-temperature-probe runs were made, three good, two questionable, and one without usable results. Based on these data and shipboard porosity and conductivity measurements, a geothermal gradient was plotted that gave a surface value of 1.1 HFU, which is consistent with other measurements in the area.

Six logging runs were made: (1) temperature and natural gamma, which was successful; (2) sonic and gamma, which failed; (3) induction and gamma, which succeeded; (4) sonic, which failed; (5) density, gamma, and temperature, which succeeded; and (6) guard, neutron, and gamma, which failed. Failures were due to hole conditions, particularly in the Eocene chert section.

The vessel moved 1553 feet to re-entry Hole 462A, on a bearing of 16.6° from Hole 462.

HOLE 462A

Date occupied: 0305Z 9 June 1978

Date departed: 0524Z 27 July 1978

Time on hole: 47 days, 2 hours, 19 min.[3]

Position (latitude; longitude): 07°14.50′N; 165°01.90′E

Water depth (sea level; corrected m, echo sounding): 5177

Water depth (rig floor; corrected m, echo sounding): 5187

Bottom felt (m, drill pipe): 5186

Penetration (m): 1068.5

Number of cores: 92

Total length of cored section (m): 629.0

Total core recovered (m): 348.7

Core recovery (%): 55.5

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[1] *Initial Reports of the Deep Sea Drilling Project*, Volume 61.

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[3] Includes Majuro port call and steaming between 462A and Majuro and return.

Oldest sediment cored:

Depth Sub-bottom (m): 994

Nature: Brown-red clay, volcaniclastic sandstone and siltstone

Age: Barremian

Measured velocity (km/s): 2.93

Basement:

Depth sub-bottom (m): 1068.5

Nature: Basaltic sill

Velocity range (km/s): 5.40–6.25

Principal results: Hole 462A was a multiple re-entry hole programmed to penetrate and sample Mesozoic sediments and the underlying oceanic crust of anomaly M-26. The upper 617 meters of Hole 462A virtually duplicated Hole 462. From 617 meters down to the total depth of 1068.5 meters, the drill penetrated an igneous complex of single and multiple diabase sills and extrusives. A few datable horizons were cored. The deepest of these, taken in Core 80 at a sub-bottom depth of 994 meters, contained a bathyal fauna of radiolarians, fish debris, and agglutinate foraminifers.

Also obtained in Hole 462A were (1) neutron and gamma-ray logs in the pipe and bottom-hole assembly, and (2) a sonic log in the open hole. Difficulties prevented further logging.

BACKGROUND AND OBJECTIVES

Introduction

Our goal at Site 462 was to study the paleontologic, sedimentary, petrologic, tectonic, and magnetic histories of that area through Recent to Late Jurassic time by drilling a deep re-entry site into the Nauru Basin west of the Ralik Chain of the Marshall Islands (Fig. 1). This area formed at a fast-spreading Pacific Plate boundary 145 to 155 m.y. ago, in the Late Jurassic (Fig. 2). Cores from this locale would allow us to better understand biostratigraphic evolution and sedimentary processes in a Mesozoic open-ocean environment, the petrologic nature of fast-spreading oceanic crust, the tectonic history of the Late Jurassic Pacific Plate, and the nature of the Jurassic magnetic quiet zone.

Sedimentological and Paleoenvironmental Objectives

The basement, or plate, age at Holes 462 and 462A in the Nauru Basin should be approximately 145 to 155 m.y., giving us an opportunity to core sediments possibly as old as Oxfordian. The section there should therefore encompass these stratigraphic intervals: late Barremian–Aptian–early Albian, and Cenomanian–Turonian, occupied by organic-carbon-rich "black shales" or sapropels, cored at many DSDP sites. These black-shale sections are thought to be the result of the development of a widespread and thick oxygen-minimum layer in the world ocean during relatively short and well-defined times (Schlanger and Jenkyns, 1976).

Sedimentological, geochemical, and paleontological studies of strata deposited during the above-mentioned stages at Holes 462 and 462A would enable us to compare the effects of an oxygen-minimum buildup in a relatively closed basin such as the Atlantic Ocean and Tethys Sea, where terrestrial carbonaceous input was high, with effects in a relatively open basin such as the Pacific, where terrestrial carbonaceous input presumably was low. The Nauru Basin sediments should contain a clear record of a deep-water oxygen-minimum event—one without the complicating factor of a heavy terrestrial organic-carbon overprint.

Geochemical and isotopic studies of Holes 462 and 462A material should resolve some of the questions posed concerning the correlation of oxygen-minimum expansions and global climatic changes. Further, since the development of oxygen minima may be linked to variations in upper-water-layer fertility, the fossil record at Holes 462 and 462A, which should contain information on the range and extension of new groups, will help in establishing such a linkage. Recovery of a complete fossiliferous section down to the Oxfordian will in itself be valuable in refining zonations and deciphering paleoenvironmental events.

The Cenozoic section at this site may, according to the site surveys, consist of interbedded pelagic sediments and turbidites. It is in a deep basin surrounded by atolls of the Marshalls and volcanic islands of the Caroline chain (Fig. 1). Further, *Kana Keoki* seismic records (Fig. 3) and the detailed bathymetric chart (Fig. 4) show levees and channels indicative of probable distal turbidite regimes. Therefore, we should be able to identify events such as the onset and cessation of volcanism that built the edifices in the Marshalls and eastern Carolines. Turbidite-debris analysis should also give us information on reef build-up and, probably, island emergence in the area, as was done in the Line Islands area on Leg 33 (Schlanger, Jackson, et al., 1976).

Petrologic Objectives

It has been a top priority to obtain relatively deep sections from oceanic crust formed at both slow- and fast-spreading ridges. Three DSDP Legs (51, 52, 53) involved drilling such sites on 110-m.y.-old, slow-spreading crust in the western Atlantic Ocean. The Nauru Basin site was meant to sample fast-spreading, Mesozoic-age crust. The Nauru Basin formed at 4.7 cm/yr, half-rate, and is an area of smooth oceanic crust, characterized by a well-defined magnetic-lineation pattern.

The results from Atlantic Ocean drilling indicate that the construction of upper Layer 2 is largely by extrusives, with many pillow lava sequences separated by abundant glass-lined fragments. Is this also true for fast-spreading crust? This is an especially interesting question in the Nauru Basin, because the seismic-profile records show many smooth layers that may be indicative of significant intrusive activity.

Almost all of the Atlantic Ocean samples show alteration of basalts by cold water, and abundant production of smectite. Very few high-temperature-metamorphosed samples have been recovered. Much relatively fresh glass was recovered from one of the deep sites on the 110 m.y. old Atlantic crust. Is this also typical of fast-spreading crust, indicating a similar distribution of ridge-crest isotherms and hydrothermal-circulation history? Magnetic-anomaly patterns, although subdued in amplitude, in the Nauru Basin are remarkably well defined, indicating that alteration has had little affect on the magnetic-anomaly source layer.

Tectonic Objectives

The history of horizontal motion of the Pacific Plate back through the Early Cretaceous is relatively well

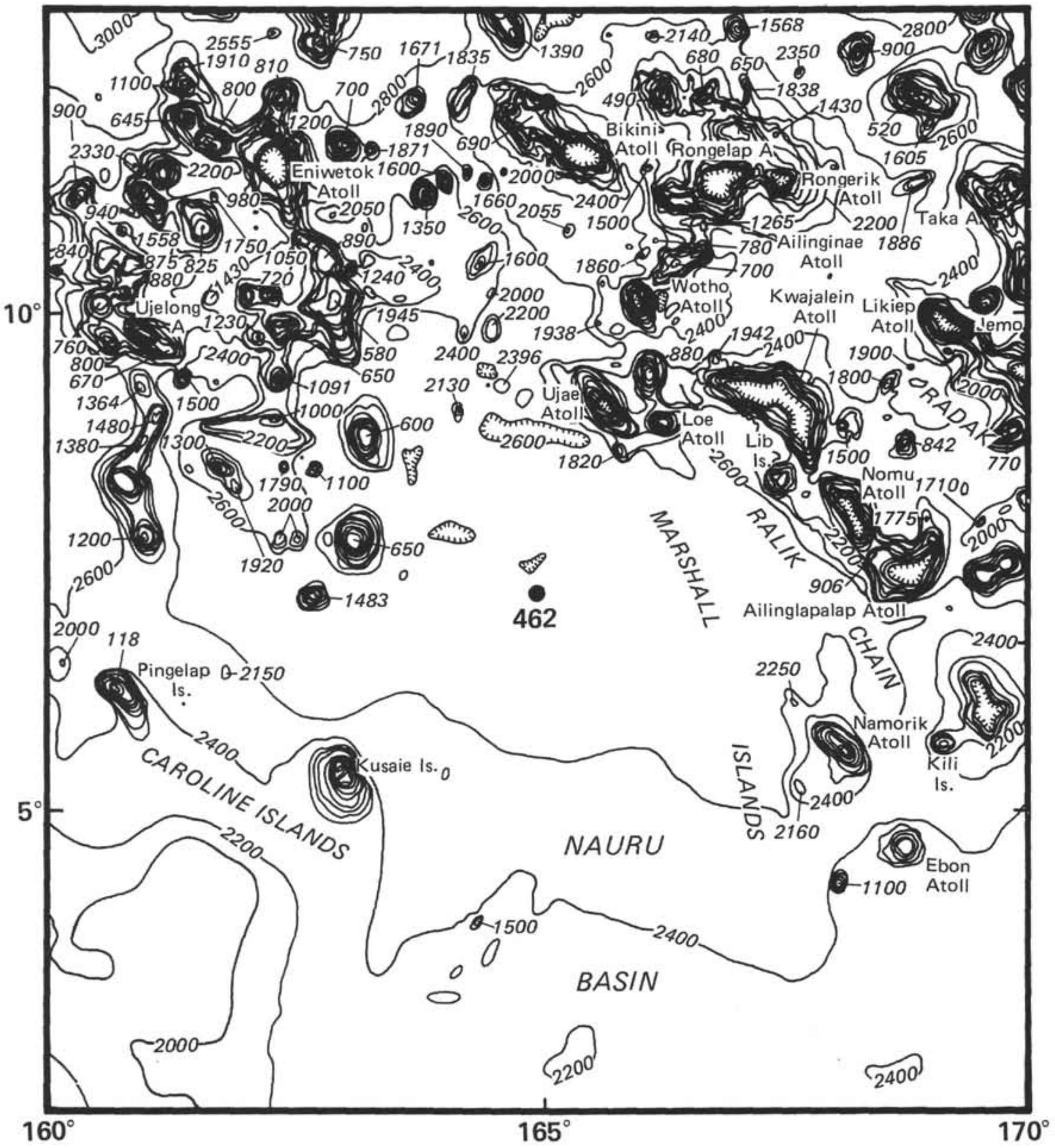


Figure 1. Regional bathymetric setting of Site 462 in the Nauru Basin, fringed to the north, east, and west by seamounts, guyots, and the Marshall and eastern Caroline Islands.

known from studied magnetic-lineation patterns, magnetic studies of seamounts, and facies studies of sediments. The preceding Jurassic history is relatively unknown, because no Jurassic seamounts have been reported, magnetic-lineation information is very limited, and no sediments of unequivocal Jurassic age have been recovered from the western Pacific. Tentative studies of Jurassic magnetic-lineation patterns suggest a more-equatorial paleolatitude for the Late Jurassic Nauru Basin than the Early Cretaceous Central Pacific Basin just to the east (Fig. 2). This raises the possibility that in the Late Jurassic the Pacific Plate was initially moving south, or at least had a dominant counterclockwise rotational component. Sometime in the Late Jurassic or Early Cretaceous, this retrograde motion reversed, perhaps by rebounding off eastern Gondwanaland, and the Pacific Plate began the steady northward motion that persists today.

Studies of Mesozoic sedimentary facies coupled with paleomagnetic studies of the sedimentary and volcanic rocks of the Nauru Basin should confirm or deny the above hypothesis. An equatorial sedimentary sequence at the base of the Nauru Basin section, overlain by higher-latitude sediments, in turn overlain by a second equatorial sequence, would support the retrograde-motion hypothesis. Paleomagnetic-inclination information should reveal the corresponding history of latitudinal motion, although nothing can be inferred concerning rotation of the Mesozoic Pacific Plate from the relative paleomagnetic declinations.

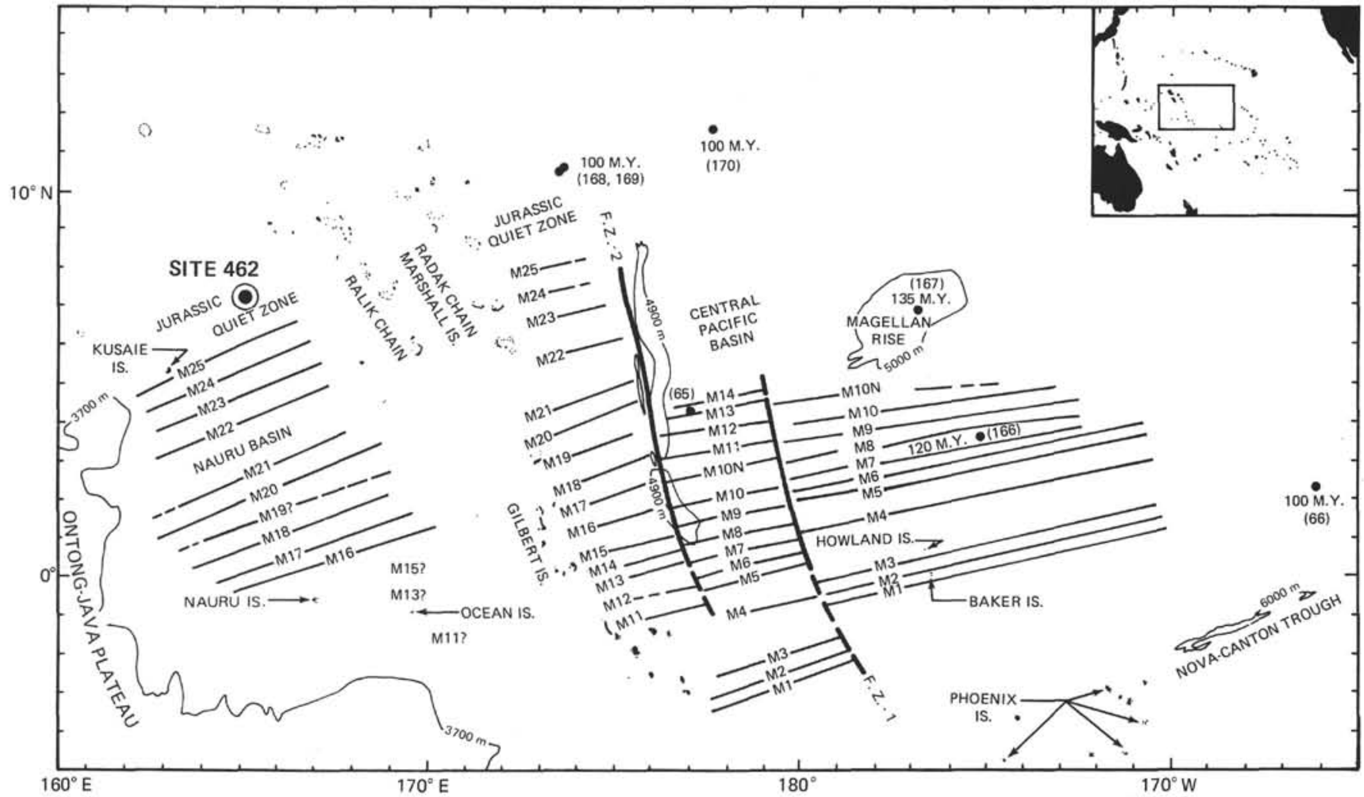


Figure 2. Mesozoic magnetic-lineation patterns of the Nauru and Central Pacific Basins, showing the location of Site 462 in the Jurassic quiet zone (from Larson, 1976).

Magnetic Objectives

Studies of the remanent-paleomagnetic-inclination information should contribute to our understanding of the Mesozoic tectonic evolution of the Pacific Plate, as described above. In addition, paleomagnetic and rock-magnetic studies of Jurassic sedimentary and volcanic rocks should be of great interest in understanding the history of the Earth's magnetic field at that time.

The M-sequence of magnetic anomalies is always bounded on its old (Jurassic) end by an "envelope" of anomaly amplitudes that taper down from "normal" values at about 145 m.y. to very small anomalies by 155 m.y. This latter portion of the record, nominally from 153 to 160 m.y., is called the Jurassic magnetic quiet zone (Fig. 2) and was the target of our drilling program in the northern Nauru Basin. In this area, very small but coherent magnetic anomalies (M26, M27, M28) imply remanent magnetizations nearly an order of magnitude lower than Lower Cretaceous magnetic anomalies. Obtaining a significant Jurassic volcanic section should test the hypothesis that these low-amplitude anomalies result from fluctuations of the Jurassic dipole-field intensity, field reversals during a time of generally low magnetic intensity, local variations in petrology, or a large increase in reversal frequency.

Site Survey Results

A detailed survey of the vicinity surrounding Site 462 was conducted from the Hawaii Institute of Geophysics vessel *Kana Keoki* from 9 April to 17 April 1977. Bathymetric relief is less than 150 meters (Fig. 4), and is dominated by two turbidity-current channels in the southwestern region of the survey. The transition between discrete, leveed channels and an extremely flat turbidite plain occurs near the center of the survey. Site 462 is about 10 km east of the southeastern leveed-channel system, on a very flat turbidite plain characterized by many flat-lying internal reflectors that comprise an upper and lower sedimentary sequence. A further seismic characteristic of the Nauru Basin is an unusual lack of refracted arrivals observed on sonobuoy stations (Larson, 1976; Houtz, 1976). However, many of the normal-incident reflections also produce prominent wide-angle reflections on air gun-sonobuoy (ASPER) seismic records. Wide-angle reflection solutions from seven ASPER measurements were averaged to characterize the average thickness and velocity of the sediments in the area. The upper sedimentary sequence consists of the material between the sea floor and the reflector at 7.3 seconds on Figure 3. This material has an average interval velocity of 1.68 km/s and an average layer thickness of 417 meters; it is probably Cenozoic. The lower sequence is the lower-frequency set of flat-lying reflectors between 7.3 and 7.6 seconds. The base of this sequence is harder to pick than the upper unit, but the average interval velocity of this material is 3.59 km/s, and the average layer thickness is 534 meters. It is probably much more lithified Mesozoic sediments, and may contain interbedded volcanic units. The scientific objec-

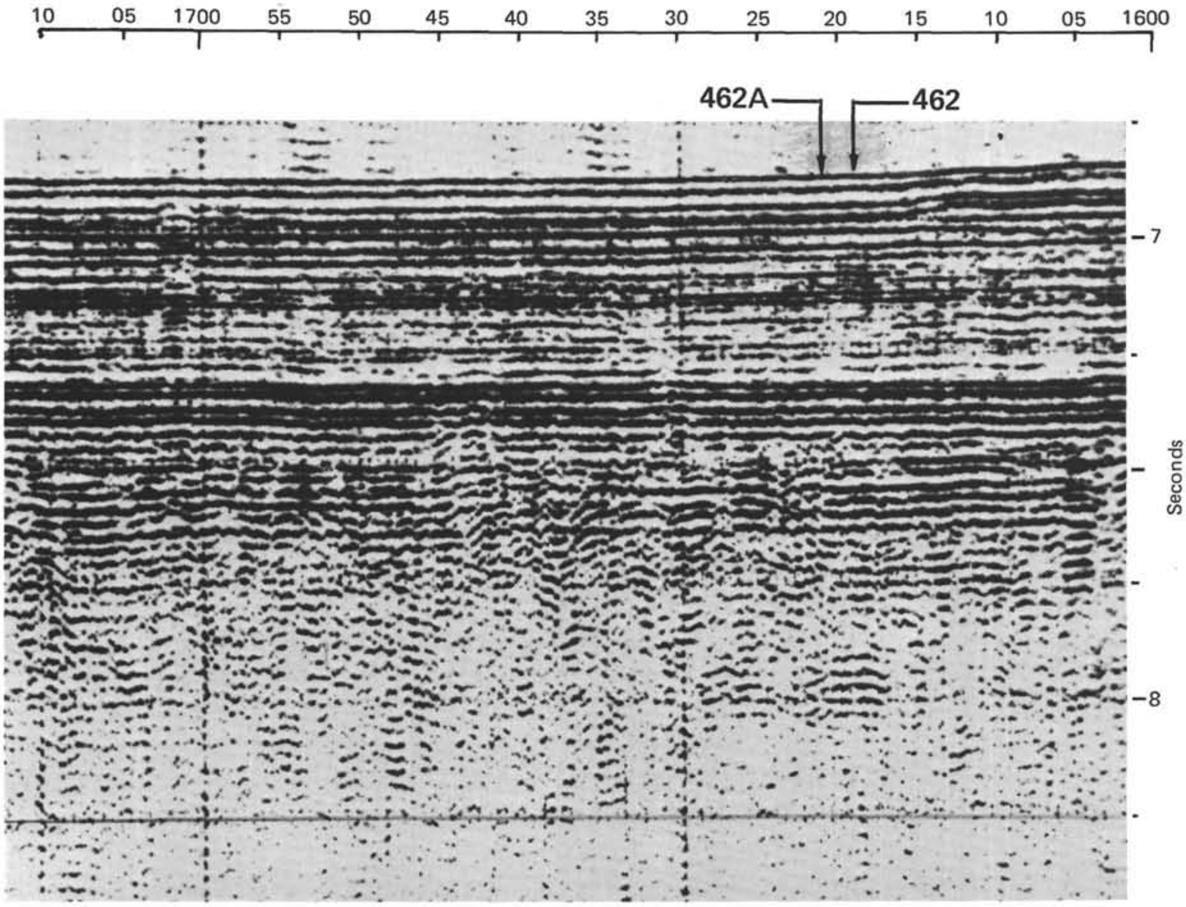


Figure 3. Seismic-reflection profile made by *Kana Keoki* on 11 April 1977, during her site survey of the area. East is to the left and west to the right. Holes 462 and 462A are slightly south of this profile.

tives of this site were mainly concerned with the lower sedimentary sequence and the basement beneath it; however, we hoped that the upper sedimentary unit would provide a soft bed in which to spud the bottom-hole assembly and the re-entry cone and casing.

Core MP-1 is a piston core recovered by the *Kana Keoki* about 17 km north-northwest of Site 462. Two lithologies are present in the core. The uppermost 2 meters is pelagic clay, and the remainder is calcareous ooze. The clay is moderate brown, slightly mottled grayish-orange at a few intervals, with 12 to 20% radiolarian remains. Other components are a trace to a few per cent of volcanic glass (light and dark), globular golden-brown palagonite, zeolite, pyroxene, diatoms, radiolarians, sponge spicules, and silicoflagellates. The calcareous ooze in the remainder of the core is all very pale-orange. At several intervals are suggestions of horizontal bedding, but only in the lowest part of the core (113–150 cm, Section 7) is the lamination sufficiently distinctive to record on the visual core description. There are a few black specks, possibly pyrite, in mid-core.

The core below Section 1 and part of Section 2 is a sequence of turbiditic layers, in which the size fractions increase downward along with the planktonic-foraminifer content. In Sections 3 and 4, the washed residues are relatively rich in small manganese nodules (between 200 and 44 μm). Foraminifers are present only in the 150- to 44-μm fraction. Assemblages are very mixed, including species characteristic of the Pliocene, late Miocene, and rarely the middle Miocene. The most abundant forms belong to the biserial genus *Streptochilus* (Brönnimann and Resig, 1971). Few diatoms, rare sponge spicules, and fish debris are also present.

The upper 111 cm in Section 7 are very similar to the upper part of the core. Radiolarians are still the dominant forms of the washed residues; however, planktonic foraminifers are common to abundant, and present also in the fraction larger than 150 μm. A few benthic foraminifers also occur. The highly reworked planktonic-foraminifer assemblages contain forms of the following ages: early Pliocene; late, middle, and early Miocene; and late Oligocene. The Quaternary species *Globorotalia truncatulinoides* is recorded for the first time. From 112 to 150 cm in Section 7, the turbidites become coarser, and the foraminifer content represents about 50% of the washed residues. The reworked planktonic assemblages also include forms of middle Eocene and Late Cretaceous ages, along with the other intervals mentioned above. Still, the most abundant assemblages belong to the late Miocene and early Pliocene. Along with the increasing size fractions, benthic foraminifers

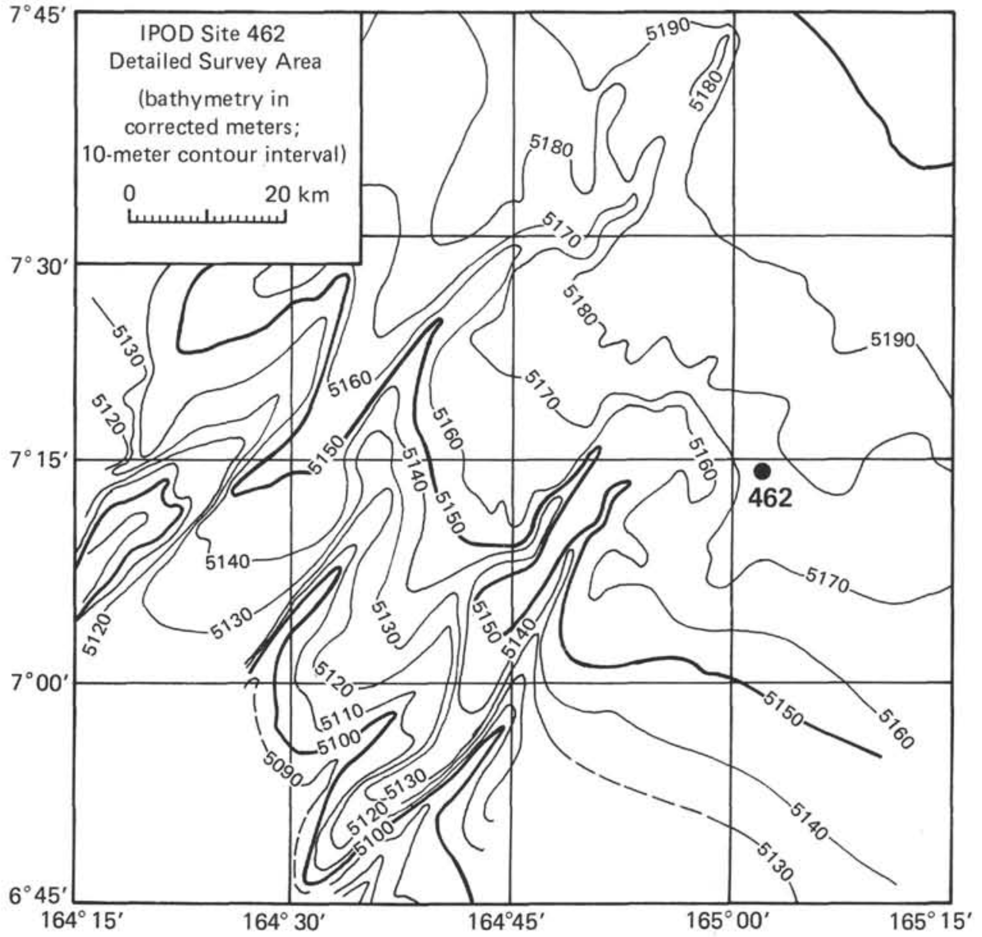


Figure 4. Detailed bathymetric chart of the Site 462 area, based on *Kana Keoki* survey that outlines the channel-and-levee system that channels sediment to this area from the Ontong-Java Plateau.

become more frequent and diversified. They possibly belong to the upper bathyal zone, and on the basis of the good preservation, they are probably Quaternary in age. Ostracodes, echinoid fragments, and sclerites are also recorded in this part of the section, along with volcanic glass(?).

It seems exceptionally unlikely that all of this is one calcareous turbidite, because the overall grain size suggests a distal setting, which the thickness belies. Probably there are several turbidites whose tops and bottoms cannot be detected. The sequence was of coarser flows followed by finer ones, perhaps related to slight changes in the turbidite processes in the leveed distributary channels shown in the detailed bathymetric chart of the site area. Presumably the distant source was the Ontong–Java Plateau during the middle or late Quaternary.

Four ocean-bottom seismometers were deployed within a kilometer of each other near the center of the detailed survey area. Two 150-km-long explosion refraction lines were run, one parallel and one perpendicular to the magnetic lineations. For the purposes of drilling, the principal results of this study are as follows: (1) depth to velocities greater than 5.0 km/s range between 5.9 and 6.2 km; (2) depth to velocities greater than 6.0 km/s range between 8.4 and 9.9 km; (3) sediment thickness ranges between 700 and 1000 meters; (4) Layer 2 is abnormally thick. For an expanded discussion of this study, see Wipperman et al. (this volume).

The Site 462 survey is located in the Jurassic magnetic quiet zone and centered on Late Jurassic magnetic anomalies M26, M27, and M28 (Fig. 5). The anomalies in this survey area are of very low amplitude (~ 80 gammas), but they are strongly lineated parallel to the Late Jurassic magnetic anomalies to the south (M20–M25; see Fig. 2). There are no volcanic peaks or fracture-zone offsets within the area, and the amplitudes and cross-sectional shapes of the anomalies are all very uniform. The time scale used to model the anomalies in Figure 5 was derived by Cande et al. (1978), to match a similar set of anomalies in the Japanese Jurassic quiet zone. The extremely low amplitudes require a magnetization intensity of ± 0.002 emu/cm^3 for a 500-meter-thick layer, which is a value 5 to 10 times smaller than magnetizations used to match other Cenozoic and Mesozoic magnetic sequences. A skewness parameter of $\theta = -160°$ was used in the model, which corresponds to a paleolatitude of 20 to 30°S. This value is not well determined, because the very low magnetization intensity and relatively great depth of the model results only in small changes in the shapes of the model profiles with changes

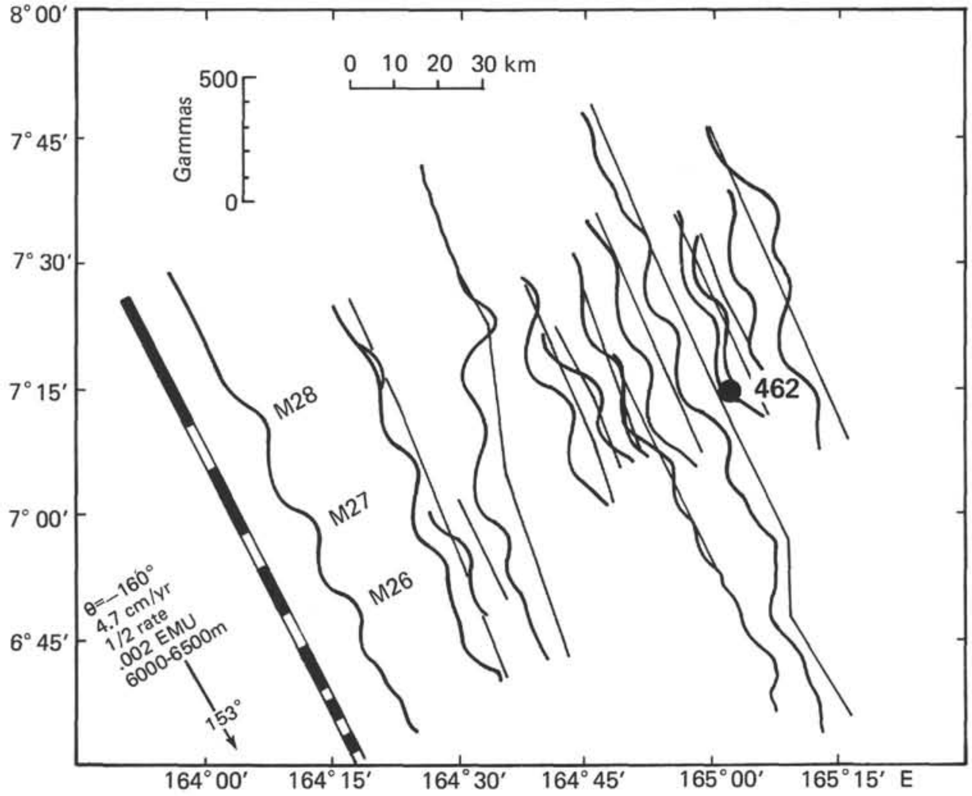


Figure 5. Cross-strike magnetic-anomaly profiles across anomalies M26, M27, and M28, in the Jurassic quiet zone of the northern Nauru Basin. Data are from the *Kana Keoki* survey and a model profile based on the revised Late Jurassic magnetic time scale of Cande et al. (1978).

in θ. Skewness measurements on Late Jurassic anomalies M20 to M25 from the Japanese, Hawaiian, and Phoenix lineations suggest that this is approximately the correct value for the Nauru Basin (S. C. Cande, pers. comm., 1977). A further consequence of not knowing exactly the skewness value for anomalies M26, M27, and M28 is that the locations of the model block boundaries are not well fixed. Site 462 is very close to the normal/reversed transition that forms the older boundary of magnetic anomaly M26, and our inexact knowledge of the location of that boundary makes it impossible to predict the polarity of volcanic basement at Site 462. This location was chosen deliberately in the hope that the transition zone might be sampled. This would allow a test of the hypothesis that the low-amplitude anomalies result from field reversals during a time of low intensity, which would be supported by the recovery of basalts with similar magnetic inclinations, but opposite polarities. The alternate hypothesis is that the anomalies result from fluctuations of the dipole or non-dipole field during a uniform polarity interval, which would be supported if basalts with varying magnetic inclinations that all have the same polarity were recovered.

OPERATIONS

We profiled from Guam to Site 462 in 6 days, 13.3 hours, via Heezen Guyot, a 27-km diversion from a rhumb-line track that allowed a crossing of this alternate shallow-water site (Fig. 6) on the northern edge of the Nauru Basin. Our approach to Site 462 was from the northwest, generally on course 115° that took us over the northern and presumably oldest part of the Nauru Basin (Fig. 7). This track shows a very flat sea floor about 5150 meters deep, and crossings of magnetic anomalies M29, M28, and M27 (Figure 5) that should be mid- to Late Jurassic in age (Cande et al., 1978). At 1025Z on 28 May, we changed course to 153° and slowed to 6 knots to make our approach down a previous *Kana Keoki* track to the site.

This track took us across at least one channel-and-levee system that feeds sediments to the Nauru Basin from the Ontong–Java Plateau to the southwest. This system is well outlined in the detailed bathymetry of the site-survey area (Fig. 4), and on our 3.5-kHz records, which show the channel floored with reflective, probably somewhat winnowed sediment that sits between levees of relatively transparent, unlayered material. Profiles of the 3.5-kHz records away from the modern channel-and-levee systems show many flat-lying reflectors in the upper several tens of meters of section. Site 462 is on this type of 3.5-kHz profile, southeast of the main channel-and-levee system outlined by the site survey. The sediment distributary system has channeled the carbonate-rich turbidites into this area; they are interbedded with radiolarian oozes in the 300 to 400-meter thick section of uppermost sediments. This section corresponds to the upper 0.4 to 0.5 seconds of relatively high-frequency reflectors apparent on seismic-reflection profiles (Figs. 3 and 8). Our objectives lay generally below the middle Eocene chert layer that shows clearly

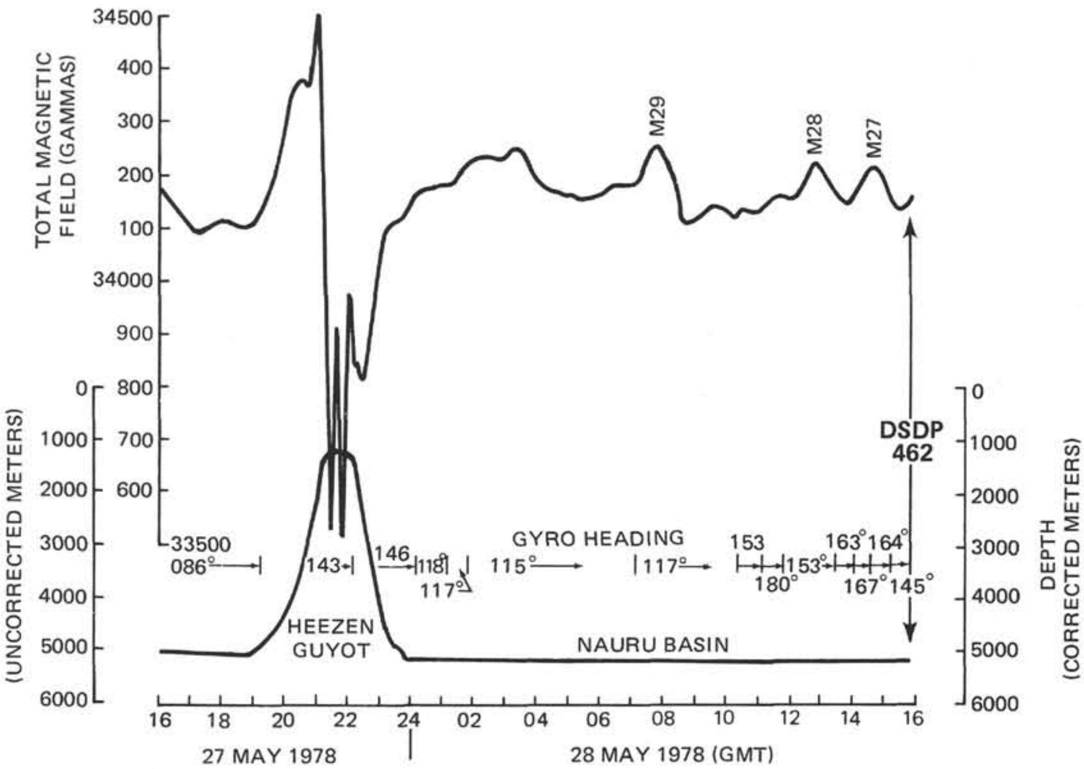


Figure 6. Bathymetric and magnetic profiles made by *Glomar Challenger*, Leg 61, on the approach to Site 462 across Heezen Guyot and the northern Nauru Basin.

at 7.3 seconds on the *Kana Keoki* profile (Fig. 3) in the relatively low-frequency, flat-lying reflectors that correspond to Mesozoic sedimentary and igneous rocks.

A number of well-timed satellite fixes and precise maneuvering of the vessel allowed us to navigate exactly to the planned drop site. At 1550Z on 28 May, we launched the beacon for Site 462 in 5152 (uncorrected) meters of water (5191 m corrected to the rig floor). We turned, retrieved our running gear, positioned ourselves over the beacon with a 200-foot offset to the west, and began running in pipe at about 1745Z on 28 May.

Since this was to be a re-entry site, we measured the water depth as precisely as possible by measuring the drill string as it was run in, and then we took a punch core from 5189.5 to 5199 meters. No weight indication of contact was noted, but the core barrel was retrieved almost completely filled with sediment. One joint of drill pipe was set back and the punch-core procedure was repeated. No core was recovered, but some sediment was found in the core catcher and coating the lowest 0.5 meters of the core liner. Water depth from the rig floor was set at 5189.0 meters.

A jetting test was then conducted to determine the length of the re-entry conductor casing string to be set. With the exception of a fairly resistant stratum at 45 to 47 meters sub-bottom, the bit was washed easily through the soft ooze to 86 meters, with only minimal pumping. This depth was considered to be in excess of the length of casing required to provide adequate support for the re-entry cone. The bit then was pulled clear of the mud line, the inner core barrel was tripped, and continuous coring was begun at 5199 meters.

We continuously cored the upper 314 meters of the section in the first 33 cores, with few problems and generally high recovery percentages (Table 1). Cores 9 and 15 were nearly all lost, because the core catcher sock carried away and jammed in the check valve on Core 9, and was inadvertently left out on Core 15. Six attempts to measure sediment temperature at the bottom of the hole, and thus construct a very accurate "base-level" heat-flow measurement for oceanic crust, were made at 133.5, 181.0, 219.0, 257.0, 295.0, and 314.0 meters. Measurements were limited to this interval because soft sediments above 133.5 meters would not bear the weight of the lower drill collars, and hard chert stringers below 314.5 meters might bend the temperature probe and cause us to lose the hole. The first three measurements were obviously successful, but the latter three have peculiar-looking equilibration curves and occasional bad readings that indicate instrument malfunction.

The first cherts, of late Eocene age, were found in Core 34 from 314.0 to 323.5 meters, but heavy cherts and slow drilling were not encountered until Core 40, from 371.0 to 380.5 meters. We believe that this level correlates with the top of the B_1 seismic reflector, because the interval velocity of 1.7 km/s for the overlying sediment yields 380 meters of section corresponding to the 0.46 seconds of two-way travel time on the profiler records above B_1.

Recovery was uniformly poor from Cores 40 to 46 (371.0–437.5 m), below which the Eocene and possibly Paleocene chert sequence gave way to volcanogenic turbidites, limestone, and conglomerate of probable Cretaceous (late Campanian–early Maestrichtian) age. We

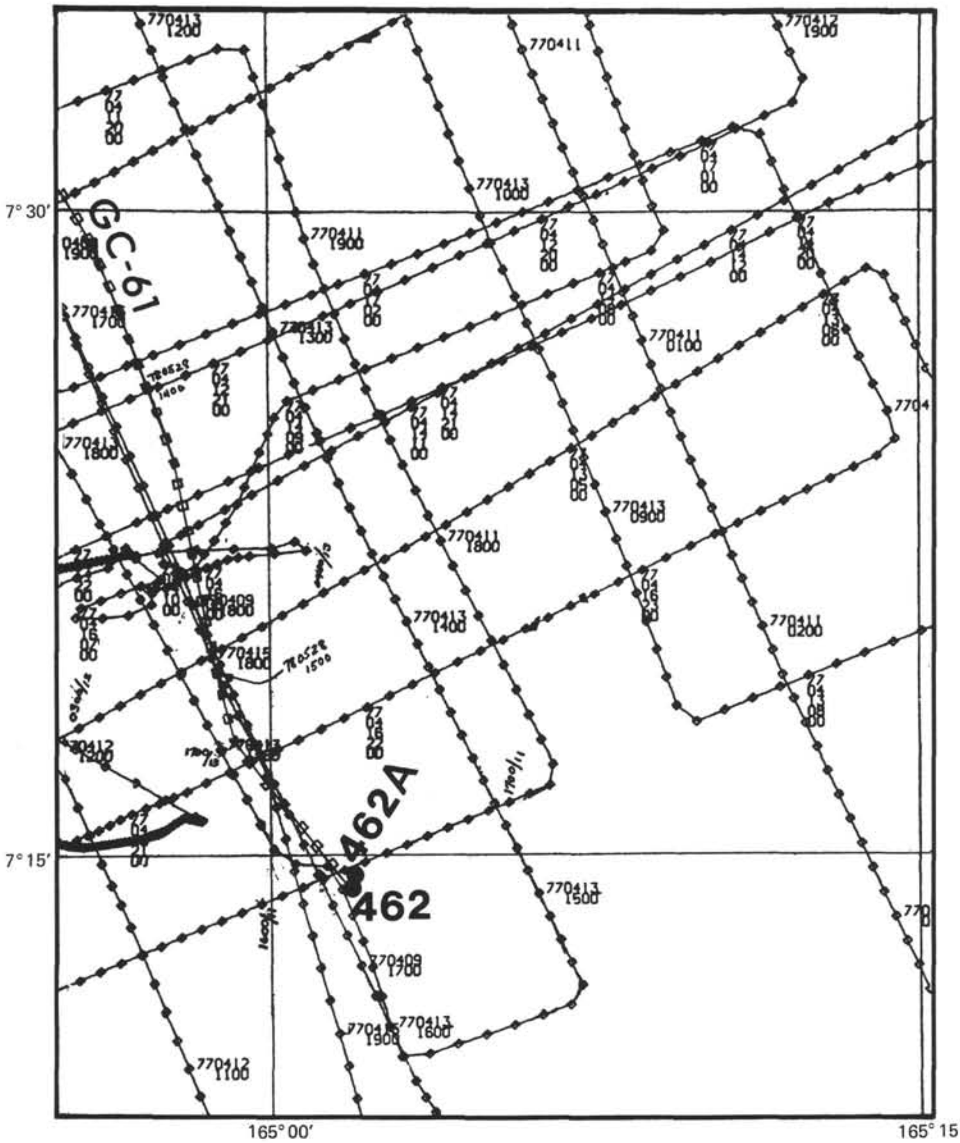


Figure 7. Chart of Site 462 area, showing *Kana Keoki* and *Glomar Challenger* Leg 61 tracks.

tried hard-formation core catchers and very slow penetration with minimum pump pressure, but these modifications did not improve recovery until the major cherts disappeared at about Core 47.

Cores 48 to 60 are a Late Cretaceous sequence of claystones, limestones, volcaniclastics, conglomerates, and very minor cherts that cored and recovered well. They were re-cored on the re-entry hole, because they are too lithified to wash ahead without a center bit in place. After retrieving Core 53, we found the bit partially plugged and had to run an extended core barrel to dislodge the obstruction.

Cores 60 to 69 contain a series of Cenomanian or younger basaltic sills, with some thermally altered claystones in Core 64. In general, we had good recovery but a very slow rate of penetration in the basalt sequence. Often, penetration rates dropped to 1 m/hr, probably because of the density of the basalts, and possibly because of bit damage suffered during the chert drilling. Sometimes cores were pulled before a full 9 meters of penetration, because of the slow rate of penetration. Often we discovered a piece of basalt jammed in the core catcher of these cores and the plastic core liner collapsed above it. Although the bit was still cutting full-gauge core, we decided to terminate the hole at Core 69 because the rate of penetration was very slow, and because we had decided to stay in this area and attempt to penetrate the sill with the re-entry hole.

On 5 June 1978, we attempted to shoot three on-site sonobuoys with the 120-in^3 air gun tethered to floats. Only the third buoy was successful. All buoys were Select International (Aquatronics) sonobuoys (model SB76-1), and were rigged and deployed in accordance with procedures developed on *Vema* 3405. The first buoy failed because of a bad hydrophone or faulty electronics in the buoy. No reasonable transmitted signal was received. The second buoy sank because of the addition of too much ballast weight and a poorly secured flotation collar. The third buoy was successful in that it yielded a high signal-to-noise level, but no wide-angle-

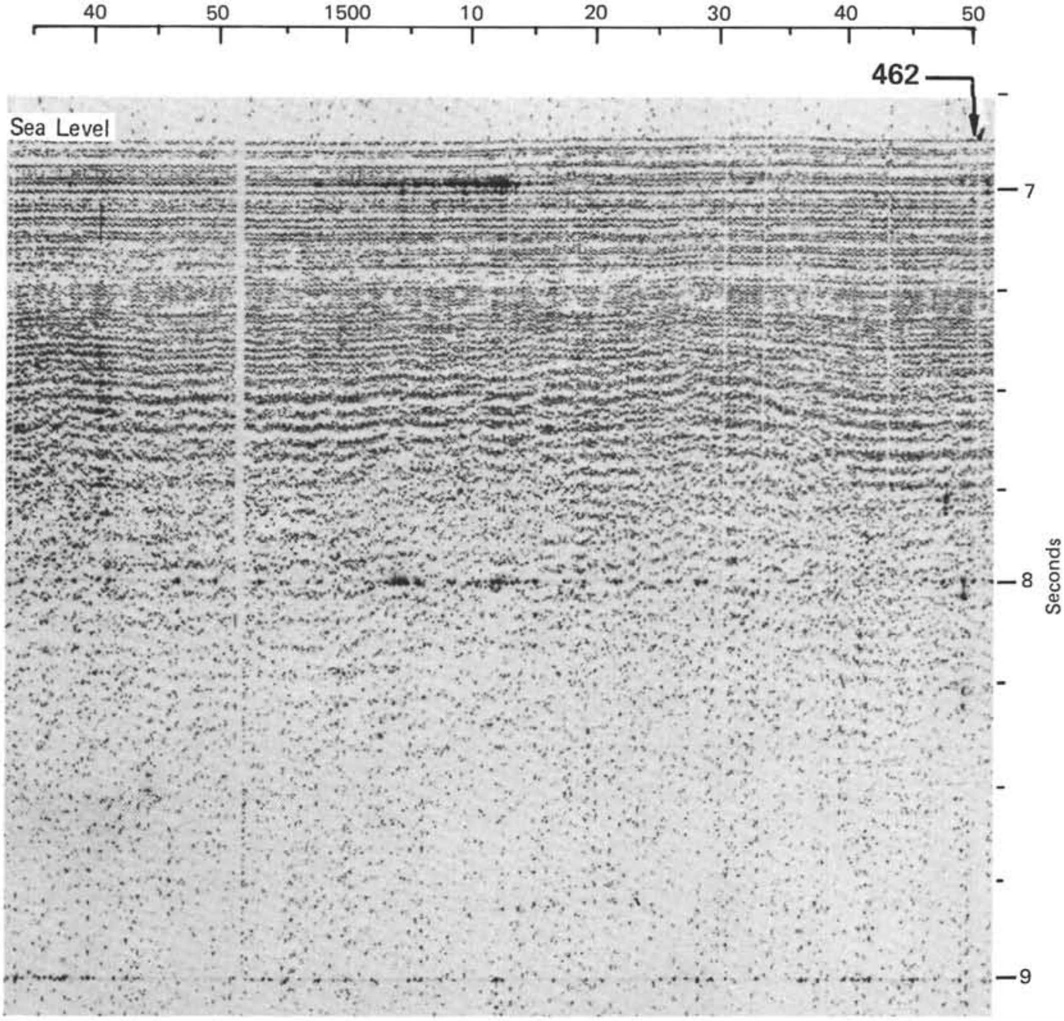


Figure 8. Seismic-reflection profile made by *Glomar Challenger* during Leg 61, on her approach to Site 462 across the northern Nauru Basin.

reflection information was received, because the experiment was cut off after only about an hour of recording, owing to a shift in the wind.

After Core 69, we released the bit and pumped freshwater mud into the upper part of the hole, in preparation for logging operations. The hole was logged with Gearhart-Owen Corp. equipment which allows real-time display of the logging data via their computer and laser camera system. We first attempted the temperature log, but met a bridge at 5338 meters. We pulled out the tool, ran in two stands of pipe to knock out the bridge, and then re-ran the temperature log, this time in the density tool, with the gamma-ray source removed. We successfully logged temperature going down the hole, and natural gamma radiation coming up. We obtained a maximum temperature of 15.4°C with 5796 meters of logging cable out.

We next attempted to run the sonic and natural gamma-ray log, which failed because we could not get the tool down past the chert sequence. The run was terminated when the sonic log shorted out, probably because of an open connection generated by banging the sonde on the chert ledges.

We then hooked up the induction (electrical-conductivity) log with the natural gamma-ray log and worked our way to the bottom of the hole. We successfully logged conductivity up the hole, but the lower 200 meters of logging cable was snarled when retrieved from the pipe. The depth during logging is probably reasonably accurate, and it is likely that the tool floated at a point on the way up the hole. It required several hours to re-terminate the logging cable.

In a second attempt to obtain a velocity log, we hooked up the backup sonic tool and again could not get down through the chert sequence. This is probably due to two things: first, the hole is 3 to 4° off vertical, and, second, the sonde is not rigid, so that when the tip of the sonde encounters a chert ledge, the sonde bends and hangs up instead of running by.

Next we ran what proved to be our most successful log: density (gamma-ray back-scatter), natural gamma-ray, and temperature. We had some problem working past the cherts, but got the tool well down into the basalt sequence. There we measured a maximum temperature of 17°C and successfully logged up the hole, the density and natural gamma-ray logs doing a beauti-

Table 1. Coring summary, Site 462.

Core No.	Date (1978)	Time	Depth from Drill Floor (m) Top Bottom	Depth below Sea Floor (m) Top Bottom	Length Cored (m)	Length Recovered (m)	Recovery (%)
Hole 462							
1	May 29	2025	5189.5–5199.0	0.5–10.0	9.5	9.3	98
2	30	0328	5199.0–5208.5	10.0–19.5	9.5	5.0	53
3	30	0445	5208.5–5218.0	19.5–29.0	9.5	8.4	88
4	30	0605	5218.0–5227.5	29.0–38.5	9.5	7.6	80
5	30	0735	5227.5–5237.0	38.5–48.0	9.5	9.8	100+
6	30	0854	5237.0–5246.5	48.0–57.5	9.5	8.8	93
7	30	1020	5246.5–5256.0	57.5–67.0	9.5	8.6	91
8	30	1144	5256.0–5265.5	67.0–76.5	9.5	5.7	60
9	30	1310	5265.5–5275.0	76.5–86.0	9.5	0.1	1
10	30	1435	5275.0–5284.5	86.0–95.5	9.5	8.6	91
11	30	1556	5284.5–5294.0	95.5–105.0	9.5	5.6	59
12	30	1722	5294.0–5303.5	105.0–114.5	9.5	9.2	97
13	30	1912	5303.5–5313.0	114.5–124.0	9.5	9.3	98
14	30	2050	5313.0–5322.5	124.0–133.5	9.5	9.0	95
15	31	0037	5322.5–5332.0	133.5–143.0	9.5	0.7	7
16	31	0216	5332.0–5341.5	143.0–152.5	9.5	7.1	75
17	31	0350	5341.5–5351.0	152.5–162.0	9.5	9.7	100+
18	31	0530	5351.0–5360.5	162.0–171.5	9.5	9.4	99
19	31	0700	5360.5–5370.0	171.5–181.0	9.5	8.0	84
20	31	1015	5370.0–5379.5	181.0–190.5	9.5	6.9	73
21	31	1155	5379.5–5389.0	190.5–200.0	9.5	9.0	95
22	31	1330	5389.0–5398.5	200.0–209.5	9.5	9.5	100
23	31	1500	5398.5–5408.0	209.5–219.0	9.5	8.9	94
24	31	1835	5408.0–5417.5	219.0–228.5	9.5	6.9	73
25	31	2015	5417.5–5427.0	228.5–238.0	9.5	9.5	99
26	31	2200	5427.0–5436.5	238.0–247.5	9.5	7.9	83
27	31	2332	5436.5–5446.0	247.5–257.0	9.5	9.9	100+
28	June 1	0255	5446.0–5455.5	257.0–266.5	9.5	9.7	100+
29	1	0420	5455.5–5465.0	266.5–276.0	9.5	9.2	97
30	1	0545	5465.0–5474.5	276.0–285.5	9.5	3.8	40
31	1	0720	5474.5–5484.0	285.5–295.0	9.5	3.2	34
32	1	1050	5484.0–5493.5	295.0–304.5	9.5	5.3	56
33	1	1228	5493.5–5503.0	304.5–314.0	9.5	2.8	29
34	1	1645	5503.0–5512.5	314.0–323.5	9.5	1.2	13
35	1	1825	5512.5–5522.0	323.5–333.0	9.5	0.5	5
36	1	2020	5522.0–5531.5	333.0–342.5	9.5	5.3	56
37	1	2215	5531.5–5541.0	342.5–352.0	9.5	9.0	95
38	1	2353	5541.0–5550.5	352.0–361.5	9.5	7.3	77
39	2	0133	5550.5–5560.0	361.5–371.0	9.5	6.7	71
40	2	0310	5560.0–5569.5	371.0–380.5	9.5	0.1	1
41	2	0440	5569.5–5579.0	380.5–390.0	9.5	0.3	3
42	2	0640	5579.0–5588.5	390.0–399.5	9.5	0.7	7
43	2	0835	5588.5–5598.0	399.5–409.0	9.5	0.4	4
44	2	1040	5598.0–5607.5	409.0–418.5	9.5	0.8	8
45	2	1235	5607.5–5617.0	418.5–428.0	9.5	0.3	3
46	2	1428	5617.0–5626.5	428.0–437.5	9.5	0.1	1
47	2	1723	5626.5–5636.0	437.5–447.0	9.5	0.1	1
48	2	1918	5636.0–5645.5	447.0–456.5	9.5	2.8	29
49	2	2100	5645.5–5655.0	456.5–466.0	9.5	7.8	82
50	2	2255	5655.0–5664.5	466.0–475.5	9.5	9.8	100+
51	3	0025	5664.5–5674.0	475.5–485.0	9.5	5.0	53
52	3	0234	5674.0–5683.5	485.0–494.5	9.5	5.4	57
53	3	0545	5683.5–5693.0	494.5–504.0	9.5	2.8	29
54	3	1230	5693.0–5702.5	504.0–513.5	9.5	4.7	49
55	3	1445	5702.5–5711.5	513.5–522.5	9.0	7.0	78
56	3	1645	5711.5–5720.5	522.5–531.5	9.0	2.4	27
57	3	1900	5720.5–5729.5	531.5–540.5	9.0	4.4	49
58	3	2100	5729.5–5738.5	540.5–549.5	9.0	6.8	76
59	3	2315	5738.5–5747.5	549.5–558.5	9.0	3.3	37
60	4	0425	5747.5–5756.5	558.5–567.5	9.0	4.2	47
61	4	1127	5756.5–5765.5	567.5–576.5	9.0	2.4	27
62	4	1550	5765.5–5768.5	576.5–579.5	3.0	2.4	80
63	4	2046	5768.5–5774.5	579.5–585.5	6.0	4.1	68
64	5	0053	5774.5–5783.5	585.5–594.5	9.0	5.7	63
65	5	0400	5783.5–5788.0	594.5–599.0	4.5	3.2	71
66	5	0942	5788.0–5795.0	599.0–606.0	7.0	7.5	100+
67	5	1410	5795.0–5798.0	606.0–609.0	3.0	2.5	83
68	5	2010	5798.0–5803.0	609.0–614.0	5.0	5.8	100+
69	6	0005	5803.0–5806.0	614.0–617.0	3.0	1.6	53
				Totals	616.5	376.8	61
Hole 462A							
1	9	1740	5264.5–5274.0	78.5–88.0	9.5	9.7	100+
(washed) 2	9	2040	5435.5–5445.0	249.5–259.0	9.5	8.3	87
(washed) H1	9	2345	5445.0–5559.0	259.0–373.0	—	—	—
(washed) H2	10	0230	5559.0–5587.5	373.0–401.5	—	—	—
3	10	0435	5587.5–5597.0	401.5–411.0	9.5	0.4	4
4	10	0650	5597.0–5606.5	411.0–420.5	9.5	0.7	7
5	10	0845	5606.5–5616.0	420.5–430.0	9.5	0.2	2
6	10	1030	5616.0–5625.5	430.0–439.5	9.5	0.1	1
7	10	1255	5625.5–5635.0	439.5–449.0	9.5	1.4	15
(washed) H3	10	1600	5635.0–5673.0	449.0–487.0	—	—	—
8	10	1825	5673.0–5682.5	487.0–496.5	9.5	4.6	48
(washed) H4	11	0135	5682.5–5701.5	496.5–515.5	—	—	—
9	11	0550	5701.5–5711.0	515.5–525.0	9.5	7.8	82
Hole 462A (Cont.)							
10	11	0740	5711.0–5720.5	525.0–534.5	9.5	4.8	51
11	11	0930	5720.5–5730.0	534.5–544.0	9.5	2.0	21
12	11	1155	5730.0–5739.5	544.0–553.5	9.5	2.1	22
13	11	1405	5739.5–5749.0	553.5–563.0	9.5	3.2	34
14	11	1722	5749.0–5752.5	563.0–566.5	3.5	1.8	51
15	11	2052	5752.5–5758.0	566.5–572.0	5.5	1.6	29
16	12	0010	5758.0–5760.0	572.0–574.0	2.0	1.8	90
17	12	0810	5760.0–5762.0	574.0–576.0	2.0	2.3	100+
18	12	1525	5762.0–5764.0	576.0–578.0	2.0	2.3	100+
19	12	2020	5764.0–5767.0	578.0–581.0	3.0	2.7	90
20	13	1645	5767.0–5772.0	581.0–586.0	5.0	2.9	58
	14	(first re-entry completed)					
21	14	2315	5772.0–5774.0	586.0–588.0	2.0	1.8	90
22	15	0545	5774.0–5783.0	588.0–597.0	9.0	7.3	81
23	15	0935	5783.0–5792.0	597.0–606.0	9.0	4.6	51
24	15	1420	5792.0–5801.0	606.0–615.0	9.0	4.6	51
25	15	2010	5801.0–5810.0	615.0–624.0	9.0	0.9	10
26	16	0520	5810.0–5812.0	624.0–626.0	2.0	0.0	0
B1	16	1630	—	—	—	1.5	—
	17	(second re-entry completed)					
27	18	0105	5812.0–5816.0	626.0–630.0	4.0	3.7	93
28	18	0825	5816.0–5822.0	630.0–636.0	6.0	5.9	98
29	18	1750	5822.0–5831.0	636.0–645.0	9.0	7.1	79
30	19	0315	5831.0–5840.0	645.0–654.0	9.0	8.4	93
31	19	0630	5840.0–5841.5	654.0–655.5	1.5	0.9	60
32	19	1000	5841.5–5849.0	655.5–663.0	7.5	2.4	32
33	19	1558	5849.0–5858.0	663.0–672.0	9.0	0.1	1
34	19	1920	5858.0–5867.0	672.0–681.0	9.0	0.0	0
35	19	2135	5867.0–5871.0	681.0–685.0	4.0	tr	0
36	20	0240	5871.0–5876.0	685.0–690.0	5.0	0.3	6
37	20	0647	5876.0–5877.0	690.0–691.0	1.0	0.0	0
B2	20	1935	—	—	—	0.7	—
	21	(third re-entry completed)					
38	21	2113	5877.0–5878.0	691.0–692.0	1.0	2.6	260
39	22	0450	5878.0–5888.0	692.0–702.0	10.0	5.5	55
40	22	0830	5888.0–5897.0	702.0–711.0	9.0	2.0	22
41	22	1410	5897.0–5906.0	711.0–720.0	9.0	9.4	100+
42	22	1618	5906.0–5909.0	720.0–723.0	3.0	2.6	87
43	22	1818	5909.0–5915.0	723.0–729.0	6.0	3.8	63
44	22	2240	5915.0–5919.0	729.0–733.0	4.0	3.0	75
45	23	0300	5919.0–5924.0	733.0–738.0	5.0	3.7	74
46	23	1030	5924.0–5933.0	738.0–747.0	9.0	6.5	72
47	23	1736	5933.0–5942.0	747.0–756.0	9.0	4.1	46
48	24	0130	5942.0–5951.0	756.0–765.0	9.0	6.7	74
49	24	0555	5951.0–5960.0	765.0–774.0	9.0	4.3	48
50	24	1150	5960.0–5964.5	774.0–778.5	4.5	8.2	182
51	24	1921	5964.5–5973.5	778.5–787.5	9.0	5.4	60
	25	(fourth re-entry completed)					
52	26	0310	5973.5–5978.0	787.5–792.0	4.5	4.4	98
53	26	0835	5978.0–5983.5	792.0–797.5	5.5	2.8	51
54	26	1150	5983.5–5987.0	797.5–801.0	3.5	2.1	60
55	26	1715	5987.0–5992.5	801.0–806.5	5.5	2.2	40
56	27	0255	5992.5–6001.5	806.5–815.5	9.0	3.2	36
57	27	0831	6001.5–6010.5	815.5–824.5	9.0	1.5	17
58	27	1254	6010.5–6019.5	824.5–833.5	9.0	5.4	60
59	27	2245	6019.5–6028.5	833.5–842.5	9.0	8.7	97
60	28	0434	6028.5–6037.5	842.5–851.5	9.0	5.0	56
61	28	0940	6037.5–6046.5	851.5–860.5	9.0	7.5	83
62	28	1525	6046.5–6050.5	860.5–864.5	4.0	4.1	100+
63	28	1849	6050.5–6055.5	864.5–869.5	5.0	2.3	46
64	29	1145	6055.5–6062.5	869.5–876.5	7.0	7.5	100+
	30	(fifth re-entry completed)					
65	30	1710	6062.5–6069.0	876.5–883.0	6.5	4.2	65
66	30	2340	6069.0–6078.0	883.0–892.0	9.0	8.9	99
67	July 1	0515	6078.0–6087.0	892.0–901.0	9.0	9.8	100+
68	1	1256	6087.0–6096.0	901.0–910.0	9.0	7.9	88
69	1	1940	6096.0–6105.0	910.0–919.0	9.0	3.3	37
70	2	0227	6105.0–6114.0	919.0–928.0	9.0	4.6	51
71	2	0550	6114.0–6117.0	928.0–931.0	3.0	0.5	17
72	2	0950	6117.0–6123.0	931.0–937.0	6.0	3.6	60
73	2	1450	6123.0–6132.0	937.0–946.0	9.0	3.1	34
74	3	0845	6132.0–6139.0	946.0–953.0	7.0	7.2	100+
X1	4	1115	6139.0–6139.0	953.0–953.0	NA	0.4	NA
75	19	2200	6139.0–6144.0	953.0–958.0	5.0	6.8	100+
76	20	0900	6144.0–6153.0	958.0–967.0	9.0	0.5	06
77	20	1612	6153.0–6162.0	967.0–976.0	9.0	4.0	44
78	21	0017	6162.0–6171.0	976.0–985.0	9.0	3.6	40
79	21	0615	6171.0–6180.0	985.0–994.0	9.0	6.8	76
80	21	1112	6180.0–6184.0	994.0–998.0	4.0	4.3	100+
81	21	1515	6184.0–6189.0	998.0–1003.0	5.0	3.5	70
	22	(sixth re-entry completed)					
82	22	2350	6189.0–6190.0	1003.5–1004.0	1.0	0.5	50
83	23	0645	6190.0–6191.5	1004.0–1005.5	1.5	0.08	05
84	23	1325	6191.5–6200.5	1005.5–1014.5	9.0	7.5	83
85	23	2007	6200.5–6209.5	1014.5–1023.5	9.0	5.4	60
86	24	0300	6209.5–6212.0	1023.5–1026.0	2.5	0	0
87	24	0850	6212.0–6218.5	1026.0–1032.5	6.5	3.0	46
88	24	1558	6218.5–6222.5	1032.5–1036.5	4.0	4.3	100+
89	24	2020	6222.5–6227.5	1036.5–1041.5	5.0	3.5	70
90	25	0735	6227.5–6236.5	1041.5–1050.5	9.0	6.1	70
91	25	0735	6236.5–6245.5	1050.5–1059.5	9.0	0.02	0
92	25	1115	6245.5–6254.5	1059.5–1068.5	9.0	0.02	0
				Totals	629.0	348.72	55.4

ful job of outlining the basalt sills with included sediment beds, and the overlying chert–chalk sequence.

Our final log was a combination of electrical conductivity for hard rocks (guard or Lateralog), porosity (neutron back-scatter), and natural gamma-ray, which we could not get to work past the chert sequence. We then retrieved the log, pulled the bottom-hole assembly out of the hole, and began to move the 1553 feet to Hole 462A while the drill string was brought on deck.

A total of 376.8 meters of core were taken from Hole 462, for a recovery rate of 61%.

Hole 462 was drilled as the pilot hole for re-entry Hole 462A. Throughout drilling at Holes 462 and 462A, the weather was generally excellent and never hampered our operations. Trade winds of 10 to 20 knots from the east-northeast were experienced, accompanied by mild squalls that intensified at night but very seldom required alteration of our heading. The sea state was generally 2 or 3, and the vessel rolled no more than one or two degrees.

Hole 462 was drilled to 616.5 meters sub-bottom and logged. The vessel was then offset 473 meters on a bearing of 16.6° from Hole 462 and prepared to launch the re-entry system from Hole 462A. The re-entry assembly consisted of a 16-foot-diameter re-entry cone with mudskirt, 73 meters of 16-inch-diameter conductor casing, and a bottom-hole assembly 74.5 meters long. The cone was keelhauled under the ship, and the remainder of the re-entry assembly was lowered into place through the moon pool. The assembly was lowered to the mudline and washed in very easily with 5 to 10 strokes per minute of pumping. At a point that appears to be 3 meters above complete wash-in, the assembly took up weight and would not penetrate further with 40 strokes per minute of pumping and 30,000 pounds of weight on the bit. Either a hard layer was encountered at 72 meters sub-bottom, or the mudskirt actually was on the bottom and the mudline is 3 meters shallower than estimated. The pinger attached to the mudskirt was still transmitting, indicating that the former may have been the case; however, the pinger may have been jostled up to a level even with the mudskirt during the launching, so that it was transmitting from exactly on the sea floor. It seems unlikely that a hard layer, which was not present at Hole 462, was encountered so close to the mudskirt-on-bottom level at this location. Even if the mudskirt were off the bottom by 3 meters, the cone probably would sink in by that amount in a few days.

After unlatching the bottom-hole assembly, the hole was drilled and spot cored to 400 meters sub-bottom. The chert, chalk, and limestone interval was re-cored continuously in an unsuccessful attempt to recover more carbonate sediments. The hole was then spot cored from 449 to 515 meters (Table 1), where continuous coring was begun in Late Cretaceous claystones and limestones. After Core 8, 10 stands of pipe were laid back in order to raise the bottom-hole assembly above the chert zone and ream out that level of the hole. The cherts cored easily and did not seem to present any hole problems at this point.

At 565 meters, in Core 14, the top of the basaltic sill encountered at 560 meters in Hole 462 was reached. The upper part of the sill cored very slowly, with penetration rates of less than 1 m/hr. The pipe was round-tripped after Core 20, at 586 meters, in order to change the bit and add more drill collars for additional drilling weight in the bottom-hole assembly. The bit, type F94CK, was in good shape, although 17 teeth were broken out of the drive rows. The other teeth had not suffered much wear, and all the bearings were still sealed.

A new bottom-hole assembly was made up, with three additional drill collars in the lower part of the assembly and a new F94CK bit. No trouble occurred until the sonar scanning tool was run in, which shorted out soon after it started to scan. It was retrieved and found to have a cracked plastic lead housing. That was repaired, and the tool was run in to 165 meters, where it jammed because of a backed-out set screw. On the third attempt, the cone was successfully re-entered and the bit was easily run down to the bottom of the hole.

Operations went well until after Core 25, at 624 meters sub-bottom. The core barrel for Core 26 would not seat, and repeated runs of an extended core barrel did not remove the obstruction. After running an extended barrel twice, a regular barrel was pumped down and a 2-meter interval was cut. The core barrel contained nothing, so we were then certain that there was a bit obstruction. On retrieving the bit, 10 broken drive teeth were found, but the bit was otherwise in good shape. We decided to run a type F99CK hard-rock bit on the next re-entry. It will cut well, and last a long time in basalt, but will not make much penetration in claystone.

The drill string was run in in record time, but the sonar scanning tool malfunctioned on its way down the pipe. The tool was retrieved, repaired, and run in, and we made a stab at the cone, using a new display scope for the sonar scanning tool on the bridge. This scope has a number of problems: (1) it does not hold an image long enough; (2) it seems to be miscalibrated; and (3) the mud-line image cannot be attenuated, leading to a confusing display when in the vicinity of the cone. This scope was replaced with the original scope.

On retrieval, the sonar tool jammed in the pipe at 650 meters below the sea surface. The logging cable parted at the weak-link joint that is also the cable termination. A conventional core barrel with new tungsten-carbide dogs was made up and run in as a fishing tool. A connection was made to the top of the sonar tool on the first try, but the shear-pin connection to the overshot parted on attempted retrieval. Considerable working of the sand-line tension on the second try proved successful, and the pipe was cleared of obstructions.

On lowering two stands of pipe, we determined that our stab missed the cone, probably because of the new display scope. The original display scope in place, we easily re-entered and ran in to the bottom of the hole.

The F99CK bit penetrated no faster than a F94CK in the basaltic sill, but cut beautiful cores, with individual sections 1 to 2 meters in length. Penetration was about 1 m/hr. A new beacon (13.5 kHz) was dropped during the cutting of Core 29, because the original one was losing its signal strength. The new one had very small offsets relative to this hole. Cores 27 and 31 were recovered early, because erratic pump pressure indicated that the cored basalt was unseating the core barrel. Core 32 cut very quickly and contained basalt underlain by volcaniclastic sediments. Cores 33, 34, and 35 also drilled quickly, presumably through the same sequence, although only traces of the formation were recovered. Basalt was encountered again in Core 36. Core 37 also drilled with hard-rock characteristics, but no core was recovered. The string was rotated for 1 hour after Core 37, but no penetration was noted. Pump pressure was slightly erratic, but not too unusual; torque and bit weight were satisfactory, but the lack of recovery and penetration induced us to pull the string to inspect the bottom-hole assembly. Also, the pump pressure tended to go up when the bit weight was slacked off, indicating that the core barrel may not have been seated.

The drill string was retrieved, and all hardware was found to be in good condition. The F99CK bit was in excellent condition after 39 rotating hours. All teeth were intact, and the bearings were sealed. Basalt cobbles were found above the bit and flapper valve, which had prevented the core barrel from seating and blocked the coring process. Although we were uncertain of the next formation to be encountered, we ran another new F99CK hard-rock bit, because the first one performed so well.

The pipe was run in for re-entry #3 without incident. After scanning for less than 1 hour, an apparently good stab was made, accompanied by audible clanging from the in-the-pipe hydrophone. However, a slight loss of weight and more-than-normal total-weight fluctuations indicated that the cone may have been missed. The pipe was pulled up above the level of the cone, and a second stab was made. All signs then indicated a successful stab, and running in of several stands of pipe verified it.

We began coring with Core 38, which cut very slowly, after which the coring rate increased to 2 to 3 m/hr. Cores 39 to 51 were taken through a basalt sequence with extrusive characteristics increasing downwards. Cores 40 to 43 contained volcaniclastic siltstones and claystones. Very few problems were encountered in this coring sequence. The core diameter reduced, until Core 51 measured 5.4 to 5.6 cm in diameter and had a rather "lumpy" appearance. Because the bit had 48 hours on it at that point, we decided on a round trip for bit replacement.

Recovery of the F99CK bit showed one significantly but not dangerously loose cone. The other three cones were all tight, and the teeth were mainly intact, although there was quite a bit of tooth wear. Since the teeth held up better on these bits, we decided to run another F99CK (button-tooth) bit for re-entry #4.

The drill string was run in for re-entry #4 without incident, and an apparently successful stab was made after only a half hour of scanning. Running in several more stands verified a successful stab, and the drilling assembly was run in to the bottom of the hole to start cutting Core 52. Core 53 required a second wire-line run, because the overshot shear pin sheared on the first one. Core 54 was pulled early because of a drop in pump pressure, indicating that the core barrel was coming unlatched. Core 57 recovered only 1.5 meters of a 9.0-meter core, because of a jammed core liner and jammed core barrel. Core 59 was run experimentally without a core liner, and 97% of the core was recovered. Coring with liners again resulted in a jammed liner-catcher combination on Core 62, which was pulled early because of a drop in pump pressure, indicating unlatching of the core barrel. Decreasing core diameter and 53 hours of bit life induced us to execute a round trip for a new bit after Core 64. This bit suffered similar but more extensive wear than the previous F99CK. One cone was becoming dangerously loose, while the other three remained sealed. More teeth were broken, and about 3/16 of an inch of "shirttail wear" was noted.

Seven deviation surveys were made between Cores 49 and 63, all but the last showing large (5–10°) deviations, although the measurements may be unreliable (the replicate measurement does not match the first one, and is not 180° across the bull's-eye from it). The survey at Core 63, 865 meters, showed an apparently reliable measurement of only 1.3°. During re-entry #5, another survey was made at 801 meters, approximately in the middle of the previous large, but erratic ones. A reliable 1.5° deviation proved that the previous results were due to a malfunctioning survey instrument.

In an attempt to make hole faster, we decided to use an F94CK (chisel-tooth) bit on re-entry #5. The drill collars were magnifluxed for crack detection, and the lowest one was demagnetized during this pipe run-in. The pipe was run in without incident, and an apparently good stab was made, with only 15 minutes of scanning. The drilling assembly went down the hole easily, with only a minor hang-up on a previously encountered basalt ledge at 5791 meters. On picking up the Bowen power sub, the bearings in the supporting swivel failed, requiring three additional hours to change the swivel out for its spare. Because of many previously jammed core liners, we began this coring sequence at Core 65, without using liners. This increased recovery, lowered the cutting and wire-line time, and lowered the danger of the core barrel unlatching and allowing basalt fragments to accumulate in the bit sub. These cores cut considerably faster than previously, possibly because of the chisel tooth bit, although the formation was more rubbly and less dense than before. This rubble reduced recovery from Cores 69 to 73, and caused the drill string to torque up somewhat. A round trip was decided on during Core 74, at 953 meters, because of slow penetration and drill-string torquing. The bit had been used only for 40 hours, but core diameters were hard to measure in the rubble sequence.

The bit was recovered with only three cones attached, the fourth one apparently having been left in the hole. One of the remaining cones was locked, and the other two were dangerously loose. Most of the teeth were worn off these cones as the result of drilling on the lost cone. The bottom of the hole was 3/16 to 1/4 of an inch undersized. Recovery for Core 74 was 103%, consisting of 7.2 meters of sill-type basalt cut in about 30- to 50-cm lengths. Core diameter was uniform at 5.1 to 5.4 cm. Heavy scratch marks were observed on the lowest 6 meters of the bottom drill collar, indicating that the lost cone was bypassed at some point. Probably at least Core 74 was drilled with only three cones, after the lost cone had been bypassed.

A junk basket consisting of a drill-collar-sized pipe (concave junk mill), with teeth and tungsten carbide at the bottom, was rigged to fish for the missing cone. Two sets of dogs that completely close the core barrel were rigged above the junk mill. These dogs were blocked open with 4-in.-diameter PVC pipe glued to a piece of plywood, to allow the EDO scanning tool access through the bit. This assembly should have over-cored the basalt rubble and loose cone at the bottom of the hole, then recovered the cone after the PVC pipe and plywood were crushed during the coring.

The pipe was run in without incident, the EDO-scanning tool worked normally, and the re-entry was made after about 15 minutes of scanning. The drilling assembly was run to the bottom of the hole, and the drill string was rotated with about 12,000 pounds of weight for about 20 minutes. No drill-string torquing or bouncing was observed. The hole was reamed and flushed with mud, and the drill string was round-tripped.

The drill string was pulled up, and the PVC pipe–plywood arrangement had not been crushed, allowing the core dogs to close. A few basalt cobbles were wedged beneath the dogs, but the cone was not recovered. Small sections of polished surfaces on the bottom of the teeth, groove marks on the outside of the junk mill, and several chunks torn out of the teeth all indicated that the cone probably was still in the hole, although not necessarily on the bottom or in one piece. A second junk basket was made up, similar to the first one, but with a shorter piece of PVC pipe to block open the core dogs. In order for the dogs to close with this arrangement, it was only necessary that the PVC pipe be pushed up the bit sub 2½ inches.

The fishing assembly was made up and run in without incident. Re-entry was temporarily hampered by a minor electronic console malfunction, which was quickly cured, and the re-entry was made in the usual short time, without further incident. The drill string was run to the bottom of the hole and rotated for 2 hours with 12,000 pounds of weight on the junk mill. The drill string first rotated smoothly, then exhibited moderate torquing, then ran smoothly again. After drilling, weighted drilling mud was pumped into the hole, and the circulation was reversed in an attempt to pick up any loose fragments on the bottom of the hole. The weighted mud was then flushed out of the hole, and the drill string was retrieved.

The junk mill was brought on deck, and all the core dogs but one had been torn or milled out of the core catcher. The last dog was badly milled, apparently from coring a solid piece of basalt for too long a time. The junk mill teeth were dulled, but it was not obvious that the missing cone was encountered at the bottom of the hole. We decided to run down a regular drilling assembly with a F99CK button-tooth bit, to determine if we could drill ahead. This assembly was made up and run into the re-entry cone, where re-entry was made to a new 16-kHz beacon dropped in the meantime. Re-entry took about 2 hours, because new beacon offsets were determined.

The drilling assembly was run in to the bottom of the hole, where mud was pumped, and about 2 meters of fill were encountered. Repeated attempts to rotate the bit on bottom with 5000 to 12,000 pounds of drilling weight resulted in moderate bouncing and serious torquing of the drill string. The drill string stalled several times, and no apparent progress was made down the hole. After stalling, the drill string could be freed by lifting it about 3 meters to open the bumper subs, indicating that the obstruction was on the bottom. After 45 minutes of drilling with no apparent progress, we decided to retrieve the drill string before the present bit was too badly damaged.

The drill string was pulled out of the hole and up to the rig floor. The core barrel was empty, and the bit cones were badly gouged and scarred. Twenty-five inserts were broken off. The bit-cone bearings were in good condition. We decided to run back in the hole with the concave junk mill blocked open with PVC pipe. A permanent magnet was run in after re-entry as a back-up junk catcher. This magnet seated about 10 cm above the core dogs and was intended to retain bit-cone fragments passing through the core dogs. The magnet was an old tool, and not very powerful.

The drill string was run in, and re-entry was made with no problems. The drilling assembly was then run to the bottom of the hole, and the junk mill was rotated on bottom with about 5000 pounds or less drilling weight, for 5 to 10 minutes. Minor torquing was experienced at first, then the drill string turned smoothly.

The overshot was then run in, and the magnet was retrieved. The magnet collected only pipe scale. An attempt was made to re-energize the magnet by wrapping the magnifluxing cable around it and exposing it to about 10,000 amp-turns of magnetic flux. No appreciable difference in magnetic attraction was noted.

The Servco junk mill was then turned on bottom for another 10 minutes of light weight, and the drill string was retrieved; we discovered that all the core dogs had been torn from the junk mill after only 15 minutes of rotation. Nothing was recovered from the hole.

About the time this junk mill was brought on deck, the chief engineer reported that the #2 bow thruster had salt water flooded in the lube oil. Something in the system had failed to seal and repairs had to be made ashore. A crane is necessary to move the "ear muffs" that seal the thruster tunnels while the thrusters are being worked on. This could be done in Majuro, and we could maintain our position in the calm weather to finish one more round trip.

Only enough time remained to make one more round trip into the hole. It was decided to run the natural gamma-ray-neutron back-scatter logs in the pipe, and to conduct a junk run. We decided to run the Homco junk mill, which is similar to the Servco model, except that it has free-rotating core dogs and no way to land a core barrel with a magnet attached. Its core dogs are propped open with a wooden "sandwich" that also serves as a landing pad for the EDO scanning tool.

The drill string was run in without problems. Reentry took about 2 hours and was hampered by the lack of #2 bow thruster. The drilling assembly was run to the bottom of the hole, and the logging tool was run in through the pipe. The logging run was conducted coming up the hole, with a total expenditure of time for logging of about 5 hours.

The junk mill was then set down on bottom with about 10,000 pounds of drilling weight and rotated slowly for 1 to 2 minutes. The drill string was pulled out of the hole for the last time, and we had recovered two cobbles of basalt and got all the core dogs back intact, but the bit cone was not retrieved. The free-rotating core-dog assembly was less free-rotating than when it was lowered, because of sand-sized grit in the moving parts. The ship was got under way and run due west for 2 miles, where a sonobuoy was deployed, the ship was turned to head due east, and a run was made across Site 462. The sonobuoy malfunctioned, probably because of the hydrophone tangling in the magnetometer cable, but a good quality, normal-incidence seismic profile was obtained across the site. The ship then continued due east across the northern Nauru Basin, profiling at about 6 knots. All geophysical running gear and the electronics lab watch were secured when we came abeam of Ailinglapalap Atoll, about 300 km west of Majuro. The ship was docked at Majuro Atoll on the morning of 11 July 1978 for repairs to the bow thruster and crew exchange.

Because a freighter was occupying the only available space at Majuro wharf, the ship was anchored out, and work was begun on the bow thruster. This required a harbor tugboat and divers to manipulate into place the "ear muffs" that seal the thruster tunnel. Since the weather was calm, the work proceeded smoothly. After sealing and pumping out the thruster tunnel, the cause of the leak was determined to be hold-down bolts (studs) that had loosened from vibration. All 12 bolts were changed, but the gear box itself was not replaced. Thruster repair consumed 3 days, during which the ship could not be moved without endangering the sealed thruster tunnel. On July 12, during this period, the crew change was accomplished via a charter aircraft, a local freighter acting as a ferry, and a school bus. During the morning of July 14, thruster repair was completed, and the ship moved to the wharf to take on fresh water for drilling mud. About 40,000 gallons of fresh water was pumped on in about 20 hours. At approximately 0630 on July 15, we sailed from Majuro to re-occupy Site 462. The ship's party included eight people who departed the vessel in Majuro when the Site 462 work was completed. A corresponding eight of the Leg 62 crew waited on Majuro during this period. This ship track back to Site 462 was between Ailinglapalap and Namu Atolls, a deviation from a rhumb line track of about 25 km, which allowed a different crossing of the archipelagic apron of the western Marshalls.

The ship proceeded without incident across the northern Nauru Basin to Site 462. Fifteen minutes after starting to listen for a beacon, the 16-kHz instrument signal was received at a range of 12,000 feet off the port bow. The ship's course was altered, the running gear was retrieved, and the ship was positioned on site.

A junk grinder modified under the supervision of Mr. Arkie Slayton of the Midway Fishing Tool Co. was run in on a short bottom-hole assembly. This junk grinder consisted of a concave grinding surface built up from an existing "clover leaf" grinder. The 2½-in. throat for the scanning tool was designed to be filled with a center bit modified with tungsten-carbide chips on the head. The drill string was run in, and the re-entry stab was made after 2 hours of scanning. The scanning tool was retrieved, and two verification stands were run in. The logging sheaves were rigged down, and the drill string was run to the bottom of the hole. No bridges or filled sections were encountered. The grinder first took up weight at 6139 meters, the total depth of the hole.

The junk grinder was turned with 10,000 to 15,000 pounds of weight for about an hour. There was no bouncing, but severe torquing was observed, requiring us to lift the grinder off bottom when the drill string stalled out. Often the junk became wedged on the side of the grinder and "followed the grinder up the hole." After about an hour of this procedure, the torquing smoothed out, and more weight was applied to the grinder. The grinder was rotated another half hour, and the bottom of the hole was declared junk-free. The drill string was pulled out of the hole and retrieved to the ship. The grinder and center bit were recovered intact, the center bit being worn badly in the grinding process. The main surface of the grinder was still in good condition. Obvious milled surfaces and traces of PVC pipe were observed on the grinder.

The bottom-hole assembly was re-rigged with an F99CK button-tooth basalt bit and run in to a point above the re-entry cone. The scanning tool was run down, but would not fall to the bottom of the pipe. It was retrieved, and we discovered a backed-out screw that was jamming it in the pipe. The screw was torqued down, and the scanning tool was run to the bottom of the pipe. An electronic malfunction occurred immediately after beginning to scan, so the tool was retrieved. Two leads in the logging tool head were found to be shorted out because of a water leak. The logging-tool head was repaired, and the scanning tool was run down the pipe for the third time.

The scanning tool was run down the pipe, and scanning was conducted for 2 hours prior to a successful stab. The target on the scanning scope was very poor, because of the pipe dope coating the transducer head, discovered upon retrieval of the tool. This resulted from applying pipe dope to the interior pipe joint (the "box") instead of the exterior pipe joint (the "pin"), when running in pipe.

The pipe was run to the bottom of the hole, and drilling commenced at 953.0 meters. Moderate torquing was observed for the first 3.5 hours of drilling, then the torque level smoothed out. Mainly intrusive, sill-type basalts were recovered in Cores 75 to 79, from 953 to 994 meters, although the core catcher of Core 79 contained brown claystone. Recovery of Core 76 was poor, because of a core-dog jam, and Core 80 was retrieved early because of slow progress, found to be caused by a jammed core liner. Core 80 contained 3 meters of gray volcaniclastic siltstone, overlying 1 meter of basalt. Core 81, from 998 to 1003 meters, contained fractured, sill-type basalt.

The drill string was pulled out of the hole to change the bit after Core 81 and 35 hours of bit life. This decision was based on the need to work with a new, multipurpose bit in the time remaining before the logging program commenced; the general feeling was that it would be safe to change the bit at that point. On retrieval, the bit was discovered to have three loose cones—one dangerously loose—and a small piece of the cone body containing four inserts was missing from one cone. This piece may have been knocked off on reentry, and may have been the cause of the torquing during the initial coring. Alternatively, the torquing could have resulted from milling of junk in the hole that remained after the junk-grinder run.

The bottom-hole assembly was re-rigged with an F94CK chisel-tooth, multi-purpose bit and run in to a point above the re-entry cone. The core was successfully stabbed after scanning for 1 hour to a much improved target over the previous re-entry. The drill string was run to the bottom of the hole, and coring was begun with Core 82. Core 82 was retrieved early, because of very slow penetration; it was found to contain 1 meter of basalt and 3 meters of cuttings. Apparently, either the flapper valve was jammed open or the spring was broken, so the center bit was run down twice in an attempt to clear the jam. Core 83 was another short core, to see if the flapper valve had been cleared. Only one small piece of basalt was retrieved after cutting a 1.5-meter core, but the core barrel appeared to have seated, so we proceeded with coring full-length cores. Coring appeared normal until Core 91, although Core 86 had no recovery for no apparent reason. Cores 91 and 92 recovered only a 2-cm fragment of basalt each in the core catcher. The fragment in Core 92 was rotated sideways, giving the impression of extra space somewhere in the bit assembly, so we decided to trip out of the hole at that point with 37 hours of wear on the bit. Coring had been slow and continuous from Core 85 to 91, but Core 92 had drilled very quickly. When the bit was recovered on deck, all four cores were found intact with the bearings sealed; however, all the drive-teeth inserts were worn off the middle of all the cones. The flapper-valve spring was broken, which may account for some of our earlier problems with an open flapper valve.

The used bit was removed from the pipe, and a special landing sub was installed for the scanning tool, which also allows logging tools to pass easily through the end of the pipe. The pipe was run in to the re-entry cone, the scanning tool was run down the pipe, and the stab was made after 15 minutes of scanning. The scanning tool was retrieved, the end of the drill string was run down to the bottom of the re-entry-cone casing, and the sonic-velocity and gamma-ray caliper tool was run down the pipe. This tool was run to the bottom of the hole without encountering any ledges, and the tool was retrieved up the hole while logging. The tool worked normally, and an excellent velocity log was obtained.

The tool was retrieved up the pipe and lost near the top of the pipe, apparently because it was two-blocked against the line wiper at the rig floor. We felt that the tool probably had fallen back to the bottom of the hole, so a guard tool was rigged to be run carefully down the hole. The guard tool encountered the velocity tool at 132 meters; on retrieval, it was found to have been jammed there because the caliper was open.

The five stands of pipe that had been laid down to retrieve the velocity tool were put back into the drill string, and the scanning tool was run down the pipe for re-entry. When the scanning tool reached the bottom of the pipe, it would not present a target or a bottom echo, so it was retrieved and found to have a water leak. An alternate scanning tool was run down the pipe, the target was scanned for about 1 hour, and the stab was made. On retrieving the scanning tool after the fifteenth successful re-entry at Hole 462A, a broken strand of armor wire was found on the logging cable at about 5000 meters. This jammed and balled up against the line wiper, requiring about 250 meters of loose wire to be cut off. The logging cable was no longer usable for logging or re-entries, so the scanning tool was retrieved, and the drill string was pulled out of the hole. At 0524 (local), 27 July, the ship departed the site and sailed due east toward Majuro. At 1400 (local), 29 July, *Glomar Challenger* rendezvoused with a small craft at the entrance to Majuro Lagoon, where a transfer of 10 people on and 10 people off the ship was accomplished. This terminated Leg 61.

SEDIMENT LITHOLOGY

Introduction

The stratigraphy of sediments and sedimentary rocks recovered from the Nauru Basin is as follows:

Unit I	0–297 meters	Calcareous and radiolarian oozes and chalks, mainly of turbidite origin, of late Eocene and younger age.
Unit II	297–447 meters	Cherts, chalks, and limestones, presumably the diagenetically advanced Eocene to Maestrichtian equivalents of Unit I, above.
Unit III	447–996.5 meters	Volcanogenic and zeolitic sandstones, mudstones, and limestones (the lowest within sills and flows), of Maestrichtian to Barremian age.

For the purpose of this report, the section can be divided into these three units. All units are characterized by abundant contributions of sediment transported to the site and redeposited. In brief, Unit I is ooze above about 220 meters, and mainly chalk below that depth.

The contact between Units I and II is placed at the first cherty rock recovered, a piece of porcellanite near the top of Core 32. Unit II is chalk, with sparse porcellanite and chert above Core 41, but Cores 42 through 47 were slow to drill, and recovery of chert and limestone was poor. Unit III has a upper section of redeposited volcaniclastic siltstones, sandstones, and breccias, interbedded with marls, limestones, and chalks. It was recovered as high as 447 meters, but may extend up to 440 meters (by interpretation of the density log through an uncovered interval). The section below about 487 meters, dominated by zeolitic mudstones and claystones, contains but minor amounts of limestone or volcanic sandstone. Basalt intrudes the zeolitic mudstone at 561 meters, but layers of mudstone lie between sills as deep as 599 meters. Whether these Cretaceous zeolitic sedimentary rocks continue deeper could not be determined at this site.

Two holes (462, 462A) were drilled; a graphic summary of their stratigraphy to a depth of 617 meters is given in Figure 9.

Hole 462

In Hole 462 the following units are recognized:

Unit I: Calcareous and Radiolarian Oozes and Chalks (0–297 m)

The sea floor of the Nauru Basin lies at 5181 meters Precision Depth Recorder, (PDR) at this site, well below the CCD. At these depths, we expected and found brown pelagic clay at the top of the piston core taken during the 1977 site survey, as well as in the top 2 meters of Core 1. The clay, like most of the oozes and clays well into the section, is rich in radiolarians, perhaps owing to the proximity of this site to the equatorial belt of high productivity during much of the Cenozoic. The first several cores were moderately to strongly disturbed by the coring process, so that our inferences of the rhythmically bedded *in situ* appearance and redeposited origin of the bulk of the Neogene are based on (1) alternations of solution-prone and solution-resistant lithologies where least disturbed by drilling, the homogeneous disturbed portions combining the alternating lithologies; (2) abundant carbonate detritus reworked from sediments with microfossils as old as Late Cretaceous; (3) comparison with obvious turbidites from deeper levels, where recovery of preserved primary sedimentary structures improved; (4) the regional setting, a nearly flat-floored basin with leveed channels, sloping gently up to the southwest, where at about 400 km distance is the eroded edge of the Ontong–Java Plateau; and (5) continuous, "turbidite-appearing" reflectors on the site-survey seismic-reflection profiles.

The beds, colored in various shades of brown, contain abundant clay and radiolarians, and range from siliceous pelagic clays through radiolarian-rich clays to radiolarian oozes. Diatom remains and spicules of siliceous sponges are common locally, and trace amounts of phosphatic fish debris and opaline silicoflagellates may be present.

The layers of calcareous ooze are mainly composed of nannofossils, perhaps resulting from more-active dissolution of foraminifers in the source area or in the present basin of deposition. At many levels, however, foraminifer content is sufficiently high to give the ooze a sandy appearance and feel. A few per cent of radiolarians are present in many of the carbonate-rich layers. The ooze is very pale-orange to white; none of the cores displayed the pastel greens, blues, and purples common in freshly opened piston and DSDP cores in areas of present-day particle-by-particle pelagic carbonate sedimentation: such colors bleach rapidly as the original micro-environment of reducing pore waters is destroyed. This supports the overwhelming evidence discovered by the paleontologists that virtually all of the carbonate grains were redeposited.

The repetitions of carbonate and non-carbonate beds are on a scale from less than 0.1 meter to more than 8 meters. The percentage of $CaCO_3$ in a bed about 1.2 meters thick in Core 16 is shown in Figure 10. Obviously, the thicker carbonates are not single turbidites, and probably most of the thinner ones are not; if they were, the volumes of individual density flows would have been enormous. Slight mottling, indistinct horizontal bedding in some units, and alternations of foraminifer-rich and foraminifer-poor layers suggest that the carbonate-bearing parts of Unit I represent repeated influxes of sediment, whereas at other times such processes were infrequent or nil. Perhaps the difference could be related to changes in tectonism or bottom currents in the source area, but more likely there were changes in the levee heights, locations, and pathways along the distributary channels fed from the Ontong–Java Plateau.

Toward the tops of the better-sampled carbonate units, the nannofossil ooze grades upwards into siliceous pelagic clay. Commonly, the siliceous, dominantly radiolarian component of a sequence of turbidites is sufficiently great that the succession is nannofossil ooze through radiolarian ooze to pelagic clay. Most of the radiolarian tests are fragmented and size-sorted. Perhaps these grains, with a high ratio of surface area to volume, are fractions of turbidites even more distal than the carbonate part. The pelagic clay represents the background sedimentation in the region. It may also in part represent a solution facies of the tops of the oozes.

Below about 250 meters, the recovered carbonate sediment becomes sufficiently lithified to earn the name chalk. The density log suggests that the transition is between about 228 and 241 meters; however, the hole is washed out in this area, so the density log is probably not reliable. In the lower part of Unit I and the upper part of Unit II, the appearance of several split cores is of pieces of chalk a few centimeters thick, separated by intervals of ooze-like soft sediment. This has been common at other DSDP sites in carbonate sections. The up-

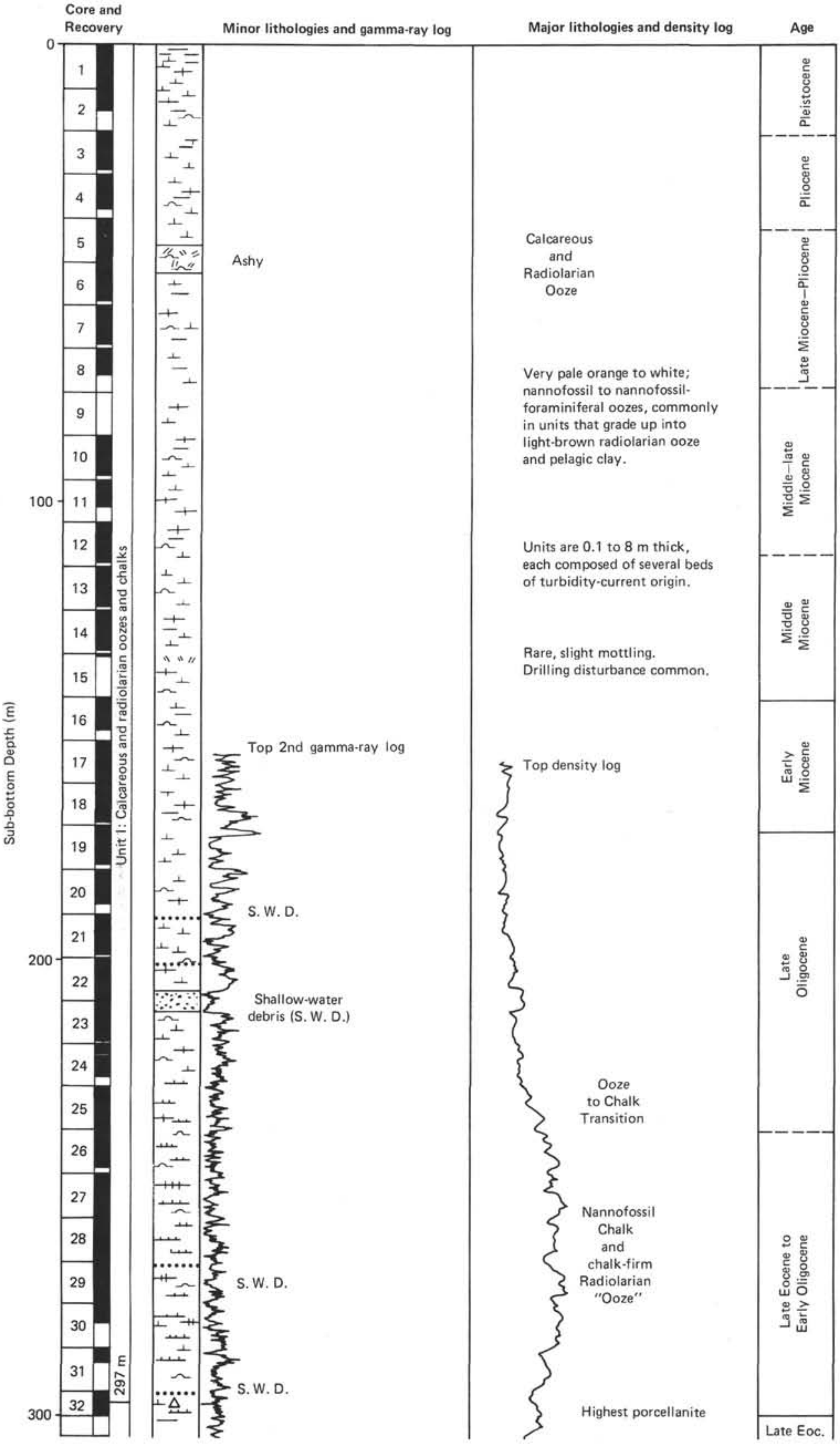


Figure 9. Lithologic summary, Site 462.

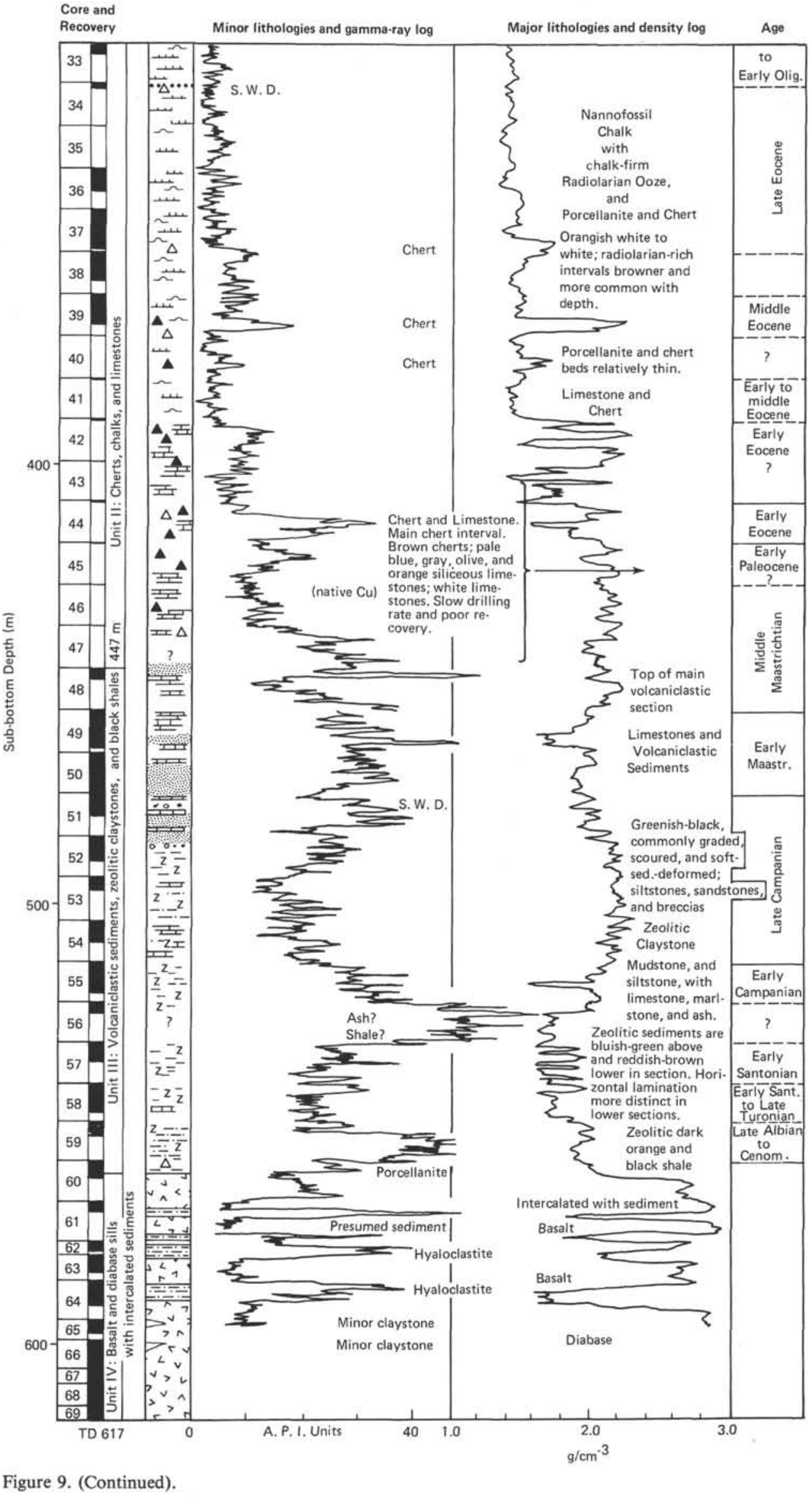


Figure 9. (Continued).

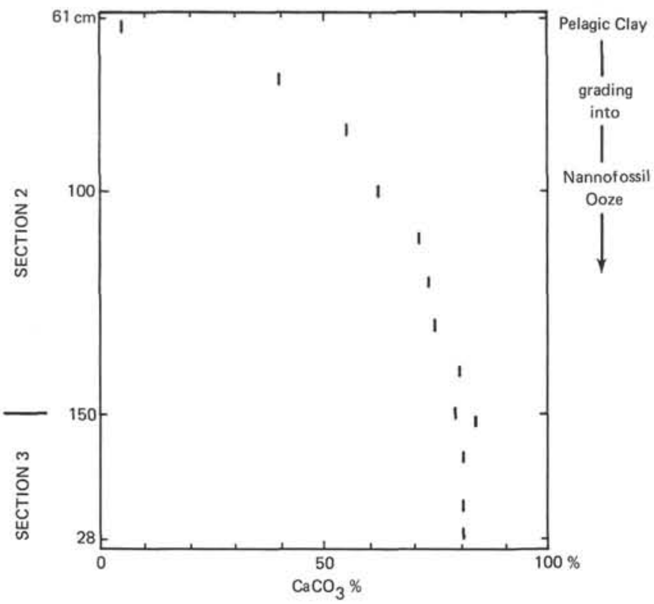


Figure 10. $CaCO_3$ content of a 1.2-meter-thick turbidite interval in Core 16, Site 462 (J. Rutherford, analyst).

permost part may indeed represent a transitional interval, with layers of ooze interbedded with layers in which differences in texture or composition have allowed diagenesis to proceed to the chalk stage. The alternative explanation, which the density log suggests, certainly is the correct one farther down in the section, where small relict lumps of chalk as well as flakes of rusty scale from the drill pipe can be seen in the "soft" intervals. The larger, biscuit-like pieces of chalk represent sediment cored when the driller released the brake momentarily, whereas the sediment between the large pieces is chalk ground up by the bit, wetted with water circulated through the string of drill pipe, and then pressed up into the core barrel.

Sedimentary rock without a common name may be present in Unit I below about 200 meters, and is typical of much of Unit II. The rock is the siliceous equivalent of chalk, composed dominantly of radiolarians, with clay and sponge spicules, but so firm that the term ooze seems inappropriate. It behaves like chalk under a spatula or fingernail, and small lumps resist disintegration during modest washing. Yet certainly the rock is too friable to deserve the names porcellanite or chert. We have called it a very firm radiolarian ooze for lack of anything more appropriate.

Against this general background of turbidite oozes and chalks, two less common but significant lithologic contributions are found in Unit I, ash and shallow-water, sand-sized material. The ash is found in Cores 4, 5, and 6, and also was indicated by a modest increase in the drilling rate at the bottom of Core 5. By inspection of the first-run gamma-ray log, the principal ashy interval is between 44 and 50 meters.

Where the ashy component is contained in radiolarian ooze it is brown, whereas it is greenish-gray in carbonate ooze. Yellow-brown glass, glass partly altered and crowded with opaque dust, feldspar, pyroxene, and some amphibole are the components from volcanic activity nearby. The volcanism records the early late Miocene to Pliocene growth of Kusaie Island, the easternmost and apparently youngest of the Caroline Island Chain. Kusaie is the closest island to Site 462, lying about 260 km to the southwest.

Sands of shallow-water origin characterize parts of Cores 21, 22, 29, 32, and 34 and are thickest at about 210 meters depth. According to the gamma-ray and density logs, the principal interval lies at 207 to 212 meters depth. The carbonate component of the coarse fraction is a mixture of chalky-lustered, recrystallized, highly abraded fragments of large foraminifers, mollusks, echinoid spines, calcareous red algae, bryozoans, and, rarely, corals. Rare fragments of white to pale-yellow calcite spar are also present. Individual fragments range from 1 to 4 mm in diameter. Identified large foraminifers include nummulitids and discoclyclinids. The former include these genera, in decreasing order of abundance: *Nummulites, Heterostegina, Operculina, Spiroclypeus, Cycloclypeus*, and *Assilina;* the discoclyclinids are mainly represented by *Asterocyclina*. Also present is a primitive species of *Miogypsinoides*. Cores 22 and 32 are especially rich, containing, among other large foraminifers, alveolinids, *Cycloclypeus*, and lepidocyclinids.

This assemblage is Eocene in age, but also contains Paleocene and Cretaceous redeposited elements. The assemblage indicates an origin in a reef to shallow-bank environment. In thin section, intensely recrystallized and strongly calcite-cemented rock fragments containing the above-listed fossil elements are seen. This indicates that lithified reef rock, as well as individual skeletal fragments, of Eocene age were transported into the deeper-water Oligocene facies. A similar event took place during Oligocene time in the Line Islands (Winterer, Ewing, et al., 1973; see Premoli Silva and Brusa, this volume).

Volcanic grains make another component of the sand. They include lithic grains which are commonly vesicular and are opaque to transmitted light at their greatest thickness, as well as vitric and crystal (pyroxene) grains. Like the lime sand, they are detrital in origin. Probably they are the record of times in the Oligocene when the Marshall Islands were above sea level. Foraminifers of probable Eocene age and volcanic rock from the tops and submarine slopes of the islands were being eroded. The Ralak Chain of the Marshalls lies about 230 to 400 km to the northeast and east of the site, and the unnamed group of the Marshalls (containing Enewetak Atoll and numerous closer atolls, seamounts, and guyots) is the same distance to the northwest; Enewetak Atoll is known to have been emergent in the Oligocene.

Unit II: Cherts, Chalks, and Limestones (297–447 m)

As noted in the introduction, the top of Unit II arbitrarily is placed at the level of the highest recovered cherty rock within the chalk and firm radiolarian "ooze." These principal lithologies persist down to about 390 meters, but with a general increase in the proportion of the radiolarian intervals to the nannofossil-chalk intervals between about 330 and 390 meters. The highest recovered porcellanite, from 297 meters, does not show on the logs (hole washed out), but intervals at 349 to 353, 367 to 370, and 376 to 378 meters show above the top of the main interval at 390 meters depth. The 367- to 370-meter interval showed the highest density, and chert sampled in Core 39,CC, at about 368 meters, may be a principal seismic reflector.

At Site 462, two different sequences of silica diagenesis and formation of authigenic silicates can be recognized, which reflect two different types of particle sources. The dominantly biogenic silica supply in the Cenozoic sequence led to chert formation in Cores 32 to 47, at burial depths exceeding 300 meters. Preliminary examination shows that diagenesis of the Cretaceous volcaniclastic sediments led to the formation of zeolites and authigenic clay minerals.

Dissolution of biogenic opal in the radiolarian and radiolarian-nannofossil oozes increases with depth: diatoms are preserved only above Core 20, whereas below that level opal is limited to varying amounts of remaining radiolarians and sponge spicules. No alteration of biogenic opal-A to opal-CT (low-temperature cristobalite/tridymite) has been noted in non-silicified sediments, contrary to evidence from other sites, where alteration in individual skeletons was observed.

Porcellanites occur only sporadically in Cores 32, 34, 40, 44, and 47, the majority of pieces recovered being quartzose cherts. Intercalated radiolarian oozes and calcareous turbidites are interpreted as host rocks.

Carbonate diagenesis, like silica diagenesis, had advanced in the lower part of Unit II. Limestones and siliceous limestones are the only other lithologies recovered with the chert from the main cherty interval between 390 and 450 meters. The more-siliceous limestones are colored pale tints of blue, grayish-yellow, light olive-gray, and very pale orange; the limestones are more nearly white. Nannofossils are common in the limestones, but the origin of most carbonate is not discernable in the shipboard smear slides scraped from the limestones. Some of the rhombs may have been sparry cement, and the various spindles and tiny irregular grains probably represent skeletal remains in various stages of dissolution or overgrowth. A very thin vein of native copper is present on a high-angle hair-line joint within Core 46.

Unit III: Greenish-Black Volcaniclastic Sediments, Brownish-Red Zeolitic Claystones, and Black Shales (447–559 m)

Unit III is separated from Unit II by the down-hole disappearance of major chert and the appearance of volcaniclastic material; its boundary with Unit IV is at the sediment/basalt contact. Unit III embraces the time interval between late Campanian/early Maestrichtian and Cenomanian. The top of the unit comprises light-olive-gray to pale-yellow nannofossil chalks and limestones, locally mottled; associated lithologies are dark-gray to olive-gray nannofossil marls and claystones which are horizontally laminated at some levels. These sediments, which contain considerable percentages of unspecified carbonate, traces of volcanogenic grains, very sparse radiolarians, and sponge spicules, are interpreted as a pelagic product in which the amount of redeposition has been modest.

Interbedded and intermixed with these host lithologies are a series of greenish-gray to greenish-black volcaniclastic sediments. These deposits are perhaps the most striking feature of this unit and display a range of sedimentary structures: tabular and trough cross-lamination, horizontal and parallel lamination, angular and scoop-shaped scours and pebbly mudstone conglomerates whose clasts range up to 2 cm in length. Prominent vertical burrows are present in one cross- and horizontally laminated calcareous volcaniclastic level at the top of the unit (Core 48, Section 1): these organo-sedimentary features may be escape structures, the result of rapid and premature burial of the organism concerned (see Moberly and Jenkyns, this volume). This mixed calcareous volcaniclastic level is one of the few in the unit which contains a notable admixture of planktonic foraminifers. Grading is obvious in many of the volcaniclastic sediments, and one bed, attaining a thickness of 2.55 meters, fines upwards from a dark-greenish-gray, granular base to a greenish-gray, burrow-mottled, clay-rich nannofossil limestone (Core 51, Sections 1-3). Slump structures, both within the scale of the core itself and, apparently, extending over several tens of centimeters, characterize particularly the basal levels of the volcaniclastic sediments; inclined bedding, up to 30° from the horizontal, is present locally. A range of other styles of soft-sediment deformation (phacoidal structures) are also present, commonly involving horizontally and cross-laminated horizons. The basal part of the volcaniclastic section comprises a matrix-rich volcanic breccia (wackestone), where sparse altered mafic clasts are enveloped in bluish-gray clay. Volcanic glass, heavy minerals, radiolarians, sponge spicules, fish remains, and clay constitute the fine fraction.

Associated with these volcaniclastic sediments are a variety of shallow-water skeletal grains. In Core 48-2, of Maestrichtian age, the coarse-grained carbonate components are a poorly sorted mixture of chalky and abraded tests of large benthic foraminifers (including *Pseudorbitoides, Vaughnina*, and *Asterorbus*), subangular chips of mollusk shells, short segments of echinoid spines, and rare bryozoans. Small chips of white to yellow calcite spar are present, and some of the fossil remains show calcite cement adhering to their surfaces, suggesting that rock fragments as well as uncemented skeletal grains were redeposited within the upper levels of the volcaniclastic sequence.

In Core 51-3, of late Campanian age, the coarse-grained carbonate components are a poorly sorted mixture of small (< 1 mm) unidentifiable calcite fragments, large foraminifers, echinoid spines (rare), fragments of white to yellow calcite spar, and mollusk shells. Many of the large foraminifers are relatively well preserved, but most, like the echinoid spines, are thickly coated with clear to white and yellow, subhedral calcite crystals. There is a striking contrast between well-preserved (slightly chalky), large foraminifers and calcite-coated forms that appear to have been broken out of a well-cemented rock. Identified large benthic foraminifers include *Vaughnina* sp., *Pseudorbitoides* sp., and amphisteginids. In Core 52, rudistid fragments were found.

These shallow-water fossils of Maestrichtian to late Campanian age indicate that banks within the photic zone existed during the Late Cretaceous, probably in the Marshall Islands, as noted above. The presence of calcite-cemented material mixed with the individual foraminifer tests suggests that these banks may have emerged and that subsequently fragments of these diagenetically mature limestones mixed with co-existing reef and forereef material in the turbidites.

The volcaniclastic sediments, with their associated fauna, are clearly redeposited, and, because many of them display features typical of Bouma sequences, they readily may be interpreted as turbidites. The matrix-rich volcanic breccias probably were formed by deposition from a plastic, mobile mass, possibly some kind of debris flow. It is possible that the original texture was more granular initially, and considerable *in situ* devitrification of glass to clay minerals has taken place. All these volcaniclastic sediments presumably reflect synchronous volcanism nearby.

Below the volcaniclastic sediments are light-olive-gray claystones to limestones that typically occur in sequences that are calcareous and laminated at the base and pass upwards into more-clay-rich, burrowed tops. Above this burrowed level, zeolitic claystones, usually consisting of pale-bluish-green and pale-brown layers (2–3 cm thick), are typically developed. The olive-gray limestones to claystones here are interpreted as redeposited material, and the zeolitic claystones are interpreted as the product of background pelagic sedimentation. Farther down the section, the thickness of the zeolitic claystones gradually increases, and colors of grayish-red and reddish-brown dominate over the pale-bluish-green hues. Olive-green claystones die away downward, until the pale-reddish-brown zeolitic claystones to siltstones, locally evincing faint horizontal lamination, become the dominant lithology. Traces of radiolarians, sponge spicules, fish teeth, and nannofossils constitute the fauna and flora. Occasionally, beds of greenish-gray, horizontally laminated volcaniclastics are interbedded (Core 57, Section 3, and core catcher). Near the base of the section, green mottles and calcite veins occur, and horizontal lamination is common; a nannofossil marlstone is recorded from Core 58, Section 4. Core 59, also zeolitic mudstone (with nannofossils in Section 1), is dominantly reddish- to light-brown, but contains horizontal, millimeter-scale laminae colored dark yellowish-orange, moderate brown, and grayish-green. Most striking perhaps are interbedded reddish-brown and greenish-brown horizontal laminae, and a distinct black horizon. Zeolitic mudstone, containing a piece of moderate-brown, impure quartz chert, is in contact with basalt.

The zeolitic mudstones presumably represent the alteration products of fine-grained volcanic material which has undergone modest redeposition; the former presence of siliceous organisms, tentatively identified in smear slides, is supported by the presence of chert: an isolated nodule was recovered from the Cretaceous volcanogenic sequence 40 cm above basalt in Core 60. This chert is isotropic under crossed nicols (opal-CT?), and shows a sound velocity (5.292 km/s) higher than, for instance, a porcellanite from Core 47 (4.290 km/s).

The grayish-brown to black sediments, dated at about the Cenomanian/Turonian boundary, are intriguing, in that similarly colored, coeval, but organic-rich sediments are recorded from a variety of locations within the major ocean basins and in pelagic sections on land. These sediments, however, are not organic-rich (0.11% organic carbon maximum), and they apparently owe their color to enrichment in iron and manganese oxy-hydroxides.

Unit IV: Basalt and Diabase with Sedimentary Intercalations

Unit IV is dominantly basalt and diabase, but it provided samples from four major sedimentary intercalations (63-1, 6–62 cm; 64-1, 30 cm through 64-3, 42 cm; 65-1, 0–20 cm; and 66-1, 0–16 cm), here grouped as part of sedimentary Unit III. The first, stratigraphically highest of these horizons is a grayish-black to black, waxy claystone with relict hyaloclastite texture, containing abundant zeolites and fragments of dark material which is iron- and manganese-rich. Chemical analysis (XRF) of the material reveals a composition very similar to that of the enclosing sill, except for an elevated Mg content. The second and thickest of these sedimentary intervals comprises greenish-black claystones to hyaloclastic siltstones, horizontally and cross-laminated. The component particles are chiefly altered volcanic glass, set in a matrix of clay that probably resulted from terminal devitrification of an igneous precursor. The material at 65-1, 0–20 cm is essentially identical to this; that at 66-1, 0–16 cm, however, is grayish-red and grayish-blue-green hyaloclastic claystones containing some fish debris.

The sediments above-described are presumably rafts caught up during emplacement of the basic sill; they are therefore likely to have undergone some thermal metamorphism. The stratigraphically highest intercalation, with its black, waxy character, is part and parcel of the dark Cenomanian sediments that lie above the sill. The grayish-red and grayish-blue-green hyaloclastic sediments probably formed as a by-product of extrusion of the Lower Cretaceous flows discovered in Hole 462A. Redeposition has clearly operated during formation of the cross- and horizontally laminated, greenish-black siltstones that constitute the two central intercalations.

According to interpretation of the density and gamma-ray logs, the top of the basalt is at 561 meters. Sedimentary intercalations logged at 570 to 571.5 and 575 to 576 meters were not recovered in Core 61, nor was the bottom of the intercalation at 578 to 581.5 meters recovered in Core 62, but its base is the hyaloclastite recovered in the top of Core 63. Most of the intercalation logged between 586 and 590.5 meters was recovered in Core 64. Logs were not started deep enough to identify clearly the actual depth of sediments recovered at the tops of Cores 65 and 66 within the diabase sill. It is possible that these pieces fell into the hole between periods of coring, and were thereby available for collection at the tops of the next cores, but the size of the pieces and bit-cut marks indicate that they are in place.

Hole 462A

The first part of this text is a comparison of sediments and sedimentary rocks recovered from the upper part of Hole 462A with those of Units I, II, and III recovered from Hole 462. The second part is a description and summary analysis of the Mesozoic section recovered below the total depth of Hole 462.

To assign a particular lithology to a certain depth, the datum used for the purpose of comparing Hole 462 and 462A is the length of the string of drill pipe plus the bottom-hole assembly hanging from the derrick floor, not in-hole depths below the sea floor. The reason for this is that the sea floor at Hole 462A is listed as 3 meters less than at Hole 462 (actually, probably less than 3 meters, considering that the holes are merely about 500 meters apart on a turbidite-formed abyssal plain, and that the PDR readings are rounded-off upward. Thus, on Figure 9 the cores from Hole 462 are plotted 3 meters deeper than the sub-bottom depths of cores from Hole 462A.

We have followed the general DSDP convention in spacing or "hanging" the actual meters recovered from the top of the listed cored interval for a regular core. For washed cores H2, H3, and H4, the *in situ* location of the pieces of rock recovered from the washed interval is unknown, except that the largest hard pieces probably represent the hardest beds wherever they were penetrated in that interval, and that the softer sediment probably was almost totally washed away by the water pumped down the hole. Washed core H1, however, was almost certainly obtained between 363.5 and 371 meters. Finally, the bit core (B1) probably is the rock unrecovered by Core 26.

Unit I: Calcareous and Radiolarian Oozes and Chalks (at least 78.5-259 m sub-bottom)

This unit extends from the sea floor to 297 meters in Hole 462. In 462A, Core 1 sampled the upper, or ooze, part of the unit, and Core 2 sampled the lower, or chalk, part. As in Hole 462, the ooze is present as alternating intervals of nannofossil, nannofossil-foraminifer, foraminifer, nannofossil-radiolarian, and radiolarian ooze. The carbonate oozes, which predominate and show no sedimentary structures, are very pale orange to white, whereas the siliceous oozes are browner and show slight to moderate mottling in some parts. Each of the carbonate intervals presumably is made of numerous turbidites, as deduced for the previous hole.

Chalk recovered in Core 2 resembles chalk cored at similar depths in Hole 462, shortly below the ooze-to-chalk transition. It is very pale orange, with faint evidence of burrowing in some parts. The chalk contains several 1- to 6-cm intervals of dark-yellowish-brown, firm, nannofossil-bearing radiolarian ooze, which is faintly laminated and burrowed. Sediment in Core 2 is virtually identical with sediment of similar depth, age, and diagenetic stage from the first hole.

Unit II: Cherts, Chalks, and Limestones (at least in the interval 363.5 to 441 m)

Washing, rather than coring, down across the equivalent depth in Hole 462A of the unit boundaries of Hole 462 precluded recovery of the highest cherty stringers marking the arbitrary top of Unit II, or the highest volcaniclastic sediments marking the arbitrary top of Unit III.

Foraminifer-nannofossil chalk is the dominant lithology of Core H1; this washed core spanned depths from 259 and 373 meters before the core barrel was pulled, but the recovery probably was between 363.5 and 371 meters, according to the drillers' interpretation of pump pressures and drilling rates. The chalk is very pale orange to white, and most was badly disturbed by drilling. Firm, calcareous radiolarian ooze (whose lithology, like that of the chalk, is described more fully in the report for Hole 462) is present in the chalk as burrowed, grayish-orange layers, of millimeter- to centimeter-scale. A piece of porcellanite jammed in the core catcher may be from the equivalent of the cherty interval at about 370 meters in Hole 462.

Washed Core H2 and regular Cores 3 through 7 recovered a meager total of 4.2 meters of cherts and limestones of the 76 meters penetrated. The true proportion of these rocks, or of any other types of sediment in the section, is therefore unknown. The cherty rocks include light-gray, greenish-gray, and light- to moderate-yellowish-brown porcellanites, and light-gray to light-olive-gray, siliceous limestones, as well as quartzose cherts in more varied and generally deeper shades, such as grayish-orange and grayish-orange-pink, pale olive-gray, and moderate- to dusky yellowish-brown. Zeolitic limestones, and two thin beds of claystone, are the only other represented lithologies.

Unit III: Volcanogenic and Zeolitic Sandstones, Mudstones, and Limestones (about 450 m, to within igneous rocks of Unit IV)

The upper part of Unit III, as recovered from spot cores and washed cores, comprises pinkish-white through pale-brownish-gray to pale-yellowish-brown limestone, locally clay rich and nannofossil-bearing. Pale-blue-green nannofossil marlstones are also present. A pale-yellowish-brown chert is recorded from one core (H3-3). Faint horizontal lamination is present at some levels; burrow mottling is more common. Interbedded with these sediments in washed core H3 are beds of cross- and horizontally laminated, greenish-gray, volcaniclastic sandstones, containing detrital carbonate. Disturbed ripple bedding is present in some of these volcaniclastic layers.

The volcaniclastic components decrease downward in Cores 8 and H4, and the host rock is mostly medium-brownish-gray through light-olive-gray limestone and clay-rich nannofossil limestone. Increasingly, however, thin couplets of pale- to grayish-blue-green and grayish-brown, zeolitic volcanic claystones make their appearance. Varicolored claystones (medium gray, grayish-brown, pale yellowish-brown, pale blue-green) dominate in the lower parts of the unit. Increasingly also, the content of recognizable zeolites increases in the lower reaches of these claystones. Particularly notable is the presence at 462A-9-5 of native copper in several parts of the core. This occurrence is at a level considerably below that in Hole 462, and, unlike that example, is not in sub-vertical veinlets. Rather, the copper occurs in tiny strands surrounded by haloes or apparently bedded levels of blue-green zeolitic claystone which themselves are set in a brownish-red matrix. This latter color dominates through most of Core 10, and the lithology concerned, which locally carries *Chondrites* burrows, contains thin, grayish-blue-green interbeds of claystone and cross- and horizontally laminated volcaniclastic siltstone. Thicker layers of greenish-gray volcaniclastic siltstone to sandstone show graded units and horizontal and ripple bedding, locally evincing signs of soft-sediment deformation. Fucoid burrows are not uncommon. At some levels (see Core 11), the claystones are less obviously zeolitic; radiolarians, grossly recrystallized into siliceous globules, are common at certain horizons in Cores 12 and 13, typically being better preserved in the grayish-blue zones than in the light-brown claystones.

At the base of the sedimentary section, the varicolored claystones darken to brownish-black and black with light-brown smears. Faint lamination is present throughout these darker lithologies, and in Core 14-1 the laminae dip at approximately 20°. Resting directly on basalt is a piece of black chert.

As in Hole 462, sediments are also intercalated within the basalt. These sediments are chiefly gray, hyaloclastic siltstones and sandstones, locally showing grading, cross- and parallel lamination, and soft-sediment deformation. Pebbly conglomerates occur at some levels. A thin, quartzose radiolarian claystone, reddish-brown in color, is stuck to chilled basalt in Section 20-2. Several features of note are present in these intra-basalt sediments. First are distinct contact-metamorphic aureoles at 32-1 and 41-7, where sediments below the basalt contain spherical, magnetic porphyroblasts of millimeter scale. The coalescence of these spherules shows clearly that they have grown in place; they decrease in size but increase in number below the sediment/basalt contact, giving the appearance of inverse grading. The second important feature is the presence of abundant plant remains, apparently coated by a patina of pyrite in Section 40-1; these remains occur in a laminated sediment deformed into a phacoidal structure whose bedding dips some 5 to 10°. A sample of this core, dated as probable Aptian–Albian, contains approximately 0.25% organic carbon. Similar organic-rich sediments containing terrestrial plants occur in coeval sediments in other oceans.

Following a port call at Majuro, drilling was resumed on 19 July. At 993 meters below the sea floor, beneath 428 meters of almost continuous diabase, we recovered 239 cm of volcaniclastic sediment at 79-6, 80-1, and 80-2. The uppermost part of this unit, at 79-6, is grayish-red (5R 4/2), and the lower parts, in Core 80, are various shades of dark gray (N3 and N4) and brownish-black (5YR 2/1 and rarely 5YR 4/1). Sandy and rarely pebbly siltstone occurs above 42.5 cm in Section 80-1. This unit exhibits trough, parallel, and cross-laminations, and three obvious instances of normal graded bedding with fairly sharp basal contacts. Between 42.5 and 62.5 cm in Section 80-1 is a conglomerate layer. The matrix of this unit is the same kind of sandy siltstone described above. The clasts are angular, oriented parallel to bedding, and average 5 to 8 mm. The largest clast, at 55 cm, measures about 20 × 5 mm. Rarely, basalt pebbles occur as clasts, but no carbonate material was observed. The coarsest material in this layer occurs near the middle, at 51 to 56 cm, the grain size grading both up and down to coarse sand. Underlying the conglomerate is 117 cm of generally homogeneous sandy siltstone containing rare coarser and fine laminae. A second conglomerate, also containing angular clasts, occurs between 59 and 65 cm in Section 80-2. The clasts average about 5 mm, and range up to 15 mm. Boundaries of this unit are rather abrupt. The lowest unit in this sequence is 46 cm of sandy siltstone containing faint parallel lamination at 1- to 2-cm intervals. At the base of this unit is a 1- to 2-cm interval of lighter-gray material, and on one corner of the lowest piece (80-2, 101 cm) is a small amount of black glass. These sediments consists almost entirely (95%+) of very angular, clear to olive-colored grains altered to smectite, with trace amounts of glass, feldspar, and opaque minerals. No carbonate grains were observed. One thin layer (80-1, 18 cm) contains a Barremian radiolarian assemblage, plus fish debris and agglutinate foraminifers.

The graded beds, parallel and cross-laminations, homogeneous intervals, and the thin pelagic layer suggest that all five intervals of the Bouma turbidite sequence may be present here. The siliceous sediments, the redeposited shallow-water grains, the volcaniclastic deposits, and the organic-rich horizons are discussed elsewhere in this volume.

INORGANIC GEOCHEMISTRY

Interstitial pore water was squeezed from 11 sediment samples taken at regular intervals down to a depth of 445 meters, 16 meters above the top of the sill complex. These water samples were analyzed for *p*H, alkalinity, Ca^{2+}, Mg^{2+}, and Cl^- by standard DSDP methods, previously described. The results are shown in Table 2.

The variations of Ca^{2+} and Mg^{2+} with depth (Fig. 11), and *p*H, alkalinity, Cl^-, and salinity with depth (Fig. 12), show two major zones related to the major lithological units separated by the chert-rich layer concentrated between 365 and 448 meters sub-bottom. Unfortunately, recovery was too low within the chert zone to allow taking of interstitial-water samples. The sediments above the chert, basically turbidite flows, range downward from calcareous and radiolarian oozes into chalks between 220 and 255 meters sub-bottom. The increase in alkalinity and drop in *p*H above 365 meters suggest a very broad sulfate-reduction zone in the section above the cherts, related to the origin of the sediments and to the present environment. Deep-water

Table 2. Summary of shipboard geochemical data, Leg 61.

Sample	Core No.	Section No.	Interval (cm)	Sub-bottom Depth (m)	*p*H	Alkalinity (meq/l)	Salinity (‰)	Calcium (mM/l)	Magnesium (mM/l)	Chlorinity (‰)
IAPSO (standard sea water)					7.88	2.54	35.8	10.55	53.99	19.34
SSW (surface sea water)					8.27	2.31	34.6	10.15	52.09	18.78
1	1	6	144-150	9.44-9.5	7.55	2.94	35.3	10.47	52.42	19.68
2	5	4	140-150	44.4-44.5	7.54	2.95	36.1	11.63	52.08	19.94
3	10	4	140-150	91.9-92.0	7.42	3.44	36.0	12.20	50.57	19.61
4	16	3	140-150	147.4-147.5	7.25	3.77	35.2	13.79	48.69	19.34
5	20	4	140-150	186.9-187.0	7.22	3.97	35.4	14.82	47.89	19.58
6	26	4	140-150	243.9-244.0	7.21	3.87	35.4	15.73	47.10	19.64
7	30	2	140-150	278.9-279.0	7.23	4.18	35.5	16.59	46.53	19.51
8	36	3	140-150	337.4-337.5	7.21	4.13	35.6	17.51	45.67	19.61
9	48	1	90-100	448.4-448.5	7.33	0.72	35.7	55.04	10.67	19.61
10	54	2	140-150	506.9-507.0	7.54	0.39	35.6	57.05	9.66	19.81
11	58	3	140-150	544.4-544.5	7.58	0.88	34.2	58.01	10.70	19.14

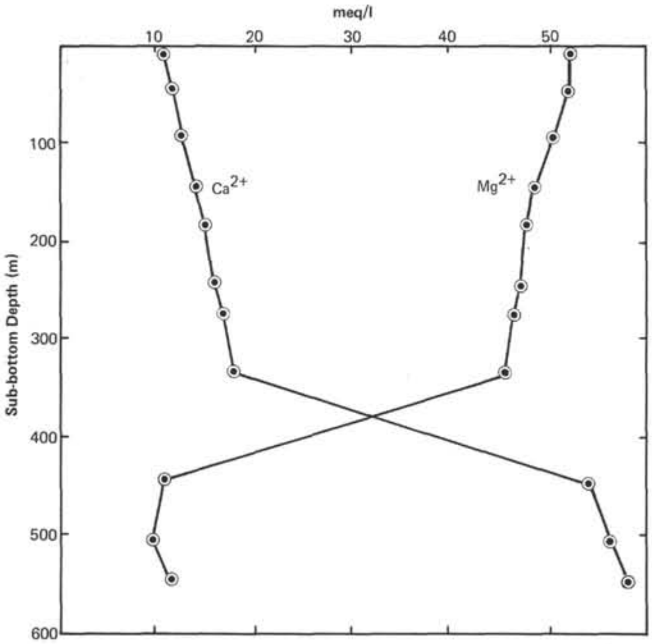


Figure 11. Variation of calcium and magnesium concentrations with depth.

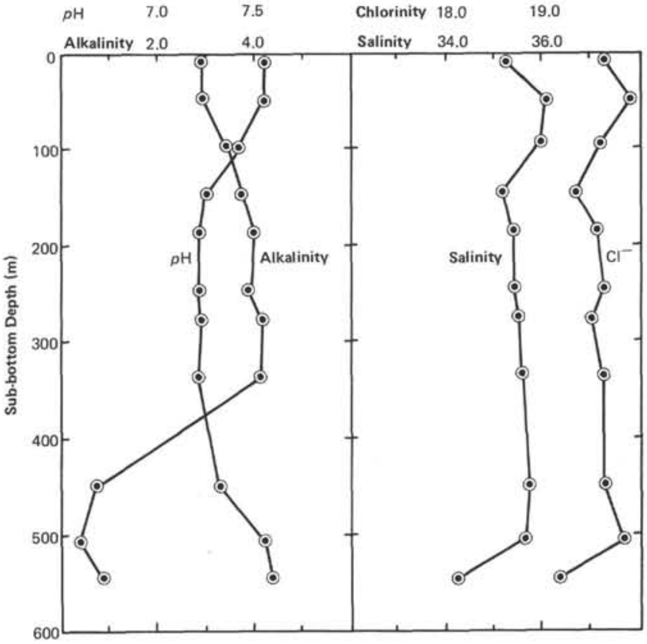


Figure 12. Variation of alkalinity, *p*H, salinity, and chlorinity with depth.

pelagic sediments generally show either a continuous drop in alkalinity or a slight increase in the uppermost 50 to 200 meters in higher-productivity areas, because most of the organic matter is broken down during its descent through the water column.

The vertical anomaly in alkalinity and *p*H values at Site 462 can be explained best by the relatively high organic content of the turbidites, which originated in much shallower water and were transported into deep water. In deep water, the high hydrostatic pressure and low temperature would greatly slow the biochemical transformations responsible for this increase in alkalinity and decrease in *p*H (i.e., the oxidation of organic matter into CO_2, coupled with the reduction of the anion of a strong acid $[SO_4^{2-}]$ to the anion of a weak acid $[HS^-]$), and would increase the time and depth at which these changes occur. Also the depth of the alkalinity maximum corresponds to the zone of highest sedimentation rate ($\simeq 2$ cm/1000 yr) in Hole 462.

The slow increase in calcium and decrease in magnesium at nearly a 1:1 ratio (Fig. 13) is typical of the diagenetic changes in biogenic oozes involving recrystallization accompanied by replacement of calcium by magnesium.

Below the chert layers the measured parameters strongly affected by diagenetic changes are quite different from those above the chert, reflecting both the nature of the chert layer and the sediments below it. The increase in *p*H, decrease in alkalinity, and the high calcium and low magnesium are probably due to low organic content and the formation of clays from the volcaniclastic sediments, with solution of calcium and replacement by magnesium. The sharp gradients across the chert zone imply that this layer has porosity low enough either to block diffusion or to be very rate-limiting. Silicate diagenesis also can cause a decrease in CO_2 and a rise in *p*H.

The effect of the sill upon the gradients is difficult to assess, but circulation of interstitial water through the basalt may be responsible for the lower chlorinity and salinity in Core 58 (16 m above the sill), and also the high manganese content of the basal claystones.

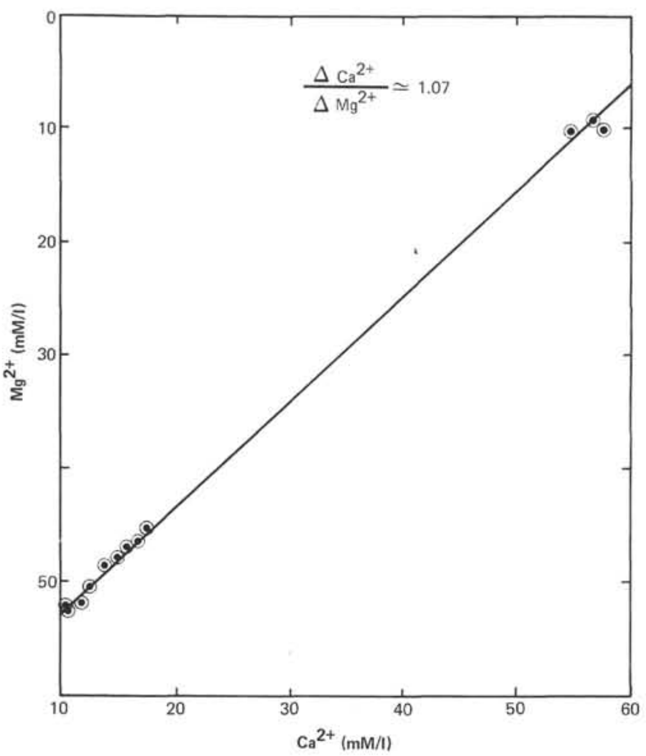


Figure 13. Co-variation of calcium and magnesium.

Calcium carbonate was determined with the carbonate bomb. These data are in Table 3.

Table 3. Hole 462 calcium carbonate data determined aboard ship by the carbonate-bomb technique.

Sample (interval in cm)	% $CaCO_3$
462-12-4, 16-19	24
12-4, 75-77	88
16-1, 26-28	~2
16-2, 63-65	5
16-2, 74-76	40
16-2, 85-87	56
16-2, 99-101	62
16-2, 109-111	71
16-2, 119-121	73
16-2, 129-131	74
16-2, 139-141	80
16-2, 148-150	79
16-3, 1-3	83
16-3, 8-10	81
16-3, 25-27	81
16-3, 19-21	81
23-2, 58-60	90
24-2, 134-136	78
24,CC,CC	63
25-1, 90-92	89
26-2, 97-99	92
28-1, 34-36	91
33-1, 130-132	86
44-1, 42-44	24
48-1, 113-115	50
48-2, 57-59	62
53-1, 25-28	67

BIOSTRATIGRAPHY

Summary

Modern sediments at Site 462 deposited at a water depth of 5181 meters consist of red clays with manganese nodules. The washed residue of the $>63\text{-}\mu m$ size fraction is limited to a few radiolarians, sponge spicules, and fish debris. The sediments are characterized by a lack of carbonates.

In Core 1, 3 meters of red clay were recovered. They are underlain by apparently homogeneous, white nannofossil-foraminifer ooze which yielded heavily mixed but well preserved planktonic-foraminifer assemblages, with forms at least as old as the late Miocene. Microscopic analysis reveals that the "homogeneous" oozes are finely graded, and ultimately can be subdivided into different units, the largest planktonic foraminifers occurring at the bottoms of the turbiditic sequences. In the upper part of the "pelagic" turbidite, planktonic foraminifers are present only in the smaller fraction (150-63 μm), or even absent.

These patterns were already described from piston core MP1, taken by the *Kana Keoki* near Site 462 during the site survey.

The alternation of red clay with carbonate-rich and earlier of radiolarian "pelagic" turbidites represents the main feature of the lithologic succession recovered at Site 462, at least down to Core 39, at a depth of 370 meters sub-bottom.

By analogy with the modern situation, it is assumed that the indigenous pelagic sediments at this site are the red clays and that the fine- and coarse-grained calcareous components are allochthonous and were carried downslope by turbidity and/or bottom currents from shallower areas well above the CCD, possibly even above the lysocline. As mentioned above, the turbidites contain a suite of Pleistocene through Miocene planktonic foraminifers, forms as old as the Cretaceous occasionally being represented. In some cases, the reworked forms are more abundant than those of the most recent age, completely masking the biostratigraphic signal. This sedimentary model is also confirmed by the presence of scattered coarser graded layers, described as volcaniclastic sandstones rich in shallow-water larger foraminifers, red algae, coral, and mollusk fragments, and more rarely lithic materials. These coarser layers surely originated in water shallower than that from which "pelagic" turbidites came—perhaps from a reef around a volcanic island. The age and composition of the two types of reworked materials are plotted against depth in Figure 14.

Because of the heterogeneity of sedimentation at Site 462, for each sample the occurrence, abundance, and preservation of the main fossil groups (foraminifers, calcareous nannoplankton, and radiolarians from the >63-μm washed residues obtained during the cruise) are plotted against sub-bottom depth, age, zonal assignment, and $CaCO_3$ content (Figs. 15–17). Moreover, the relative abundance of the minor fossil groups and the inorganic materials in the residues was estimated for all Mesozoic samples, as shown in Figure 17.

The primary observations resulting from those plots are (1) the negative correlation between foraminifer-and radiolarian-abundance curves; (2) the positive correlation between the amount of volcanic material and foraminifers; (3) the uniform distribution of the calcareous nannoplankton, compared to the spotty presence of both foraminifers and radiolarians during the Cenozoic; whereas (4) in the Cretaceous the abundance of calcareous nannoplankton fluctuates together with the other fossil groups in response to sediment type; and (5) the increased abundance of deep-water biogenic components in the Cretaceous section.

Calcareous Nannofossils

Age determinations of Cenozoic nannofossil assemblages from Holes 462 and 462A are based on the zonal schemes of Martini (1971) and Bukry (1973, 1975). The Mesozoic biostratigraphic scheme is a slightly modified version of Thierstein's (1976). Estimates of absolute time for the biostratigraphic units are shown in Tables 4 through 6 and follow those by Berggren and Van Couvering (1974), Hardenbohl and Berggren (1978), and van Hinte (1976). Zonal assignments of cores, the abundance of nannofossils, and the state of preservation (i.e. etching and overgrowth) are shown in Figures 15 through 17. The precise positions of the examined samples and their estimated ages are indicated on the core-description sheets.

The Cenozoic, and at least parts of the Cretaceous, carbonate record at this site are largely allochthonous. Evidence for turbidite deposition is found in the scarcity of isolated nannoliths on smear slides through most of the Cenozoic sequence. The sediments often consist of fine radiolarian sands, nannoliths being preserved only within the radiolarian tests. Dissolution and overgrowth features persist throughout the sequence. Reworking of older specimens is observed throughout the Cenozoic. The abundance of reworked taxa decreases with increasing age difference compared to the autochthonous assemblage. Mixing of fossils from adjacent zones abounds and leads to uncertainty in delineating zonal boundaries, particularly in the Oligocene and late Miocene to Pleistocene.

No neritic taxa have been observed in any of the assemblages, with the exception of *Braarudosphaera* sp. in Cores 55 and A9, of early Campanian age.

The abundance and preservation of calcareous nannofossils in sediments below 520 meters sub-bottom deteriorate, making accurate dating extremely difficult. An age range of late Albian to latest Cenomanian for sediments overlying the highest sill complex is based on the presence of rare to few *Cruciellipsis chiastia, Eiffellithus turriseiffelii*, and *Cylindralithus* spp.; early Turonian species are missing. Rare, poorly preserved *Lithraphidites alatus* make a Cenomanian age very likely.

An isolated, poorly preserved nannofossil assemblage was found in a thin layer of claystone intercalated in basalt sills in Core 40, Section 1, 92 cm. This assemblage consists of *Watznaueria barnesae* (99%), *Lithastrinus floralis* (rare), *Rucinolithus irregularis*, and several long-ranging Early Cretaceous species (Late Aptian to earliest Albian), possibly indicating a restricted environment of original deposition.

All other sediment samples from within the basaltic complex were barren, or of Campanian age, indicating down-hole contamination.

In the lower part of Hole 462A, at 993 meters below the sea floor, beneath 428 meters of almost continuous diabase, 239 cm of volcaniclastic sediment was recovered from 462A-79-6 to 462A-80-2. Twenty samples (Table 7) of this sediment were studied for calcareous nannofossils, but all were barren. The samples selected above, below, and from the radiolarian layer (Fig. 18), and from pebbles (claystone) in the sediment, also brought negative results.

After both re-entries (#12 and #13) the next cores contained cuttings in which Late Cretaceous nannofossils were recovered in (Cores 76 and 82). These occurrences represent down-hole contamination from the Cretaceous layers overlying the basalt.

Foraminifers

The type of sedimentation strongly biases the biostratigraphic signal, particularly that based on planktonic foraminifers. Frequently the age of the sequence was established on the basis of calcareous nannofossils or radiolarians, rather than planktonic foraminifers, which are distributed sporadically through the stratigraphic column (Figs. 14–17). The zonal scheme based on planktonic foraminifers used in the present report is shown in Tables 4 through 6 and is based mainly on correlational zonal schemes by Berggren and Van Couvering (1974) and Hardenbol and Berggren (1978) for the Cenozoic, and van Hinte (1976), Sigal (1977), and Premoli Silva and Boersma (1977) for the Mesozoic.

Cores 1 through 3 are attributed to the Pleistocene. Few of the studied samples contain a Pleistocene fauna (e.g., 462-2,CC. The planktonic foraminifers in these samples are well preserved and well developed. Among the most important and common forms are *Pulleniatina finalis, P. obliquiloculata, Truncorotalia truncatulinoides, Globorotalia tumida, Sphaeroidinella dehiscens dehiscens, and Streptochilus tokelauae.* This assemblage is attributed to Zone N22 (early Pleistocene).

The major component of the reworked faunas is a very rich assemblage of Miocene age (N17, N13–N12, N8). Pliocene elements are poorly represented, as are older faunas, which also include some Late Cretaceous forms.

It is worthwhile to mention the abundance of biserial heterohelicids belonging to the genus *Streptochilus*, represented by all the species described to date by Brönnimann and Resig (1971), some of which are reworked.

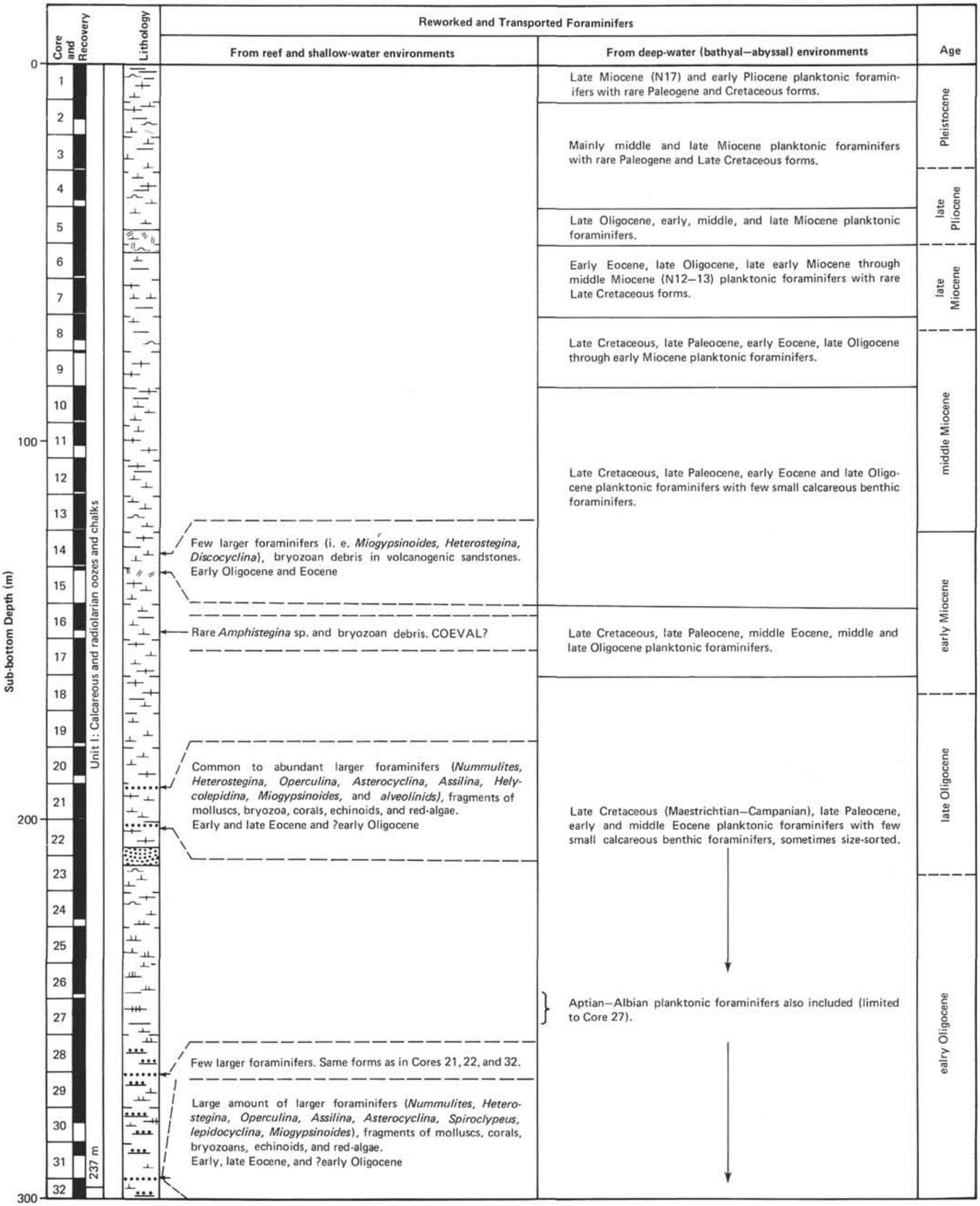
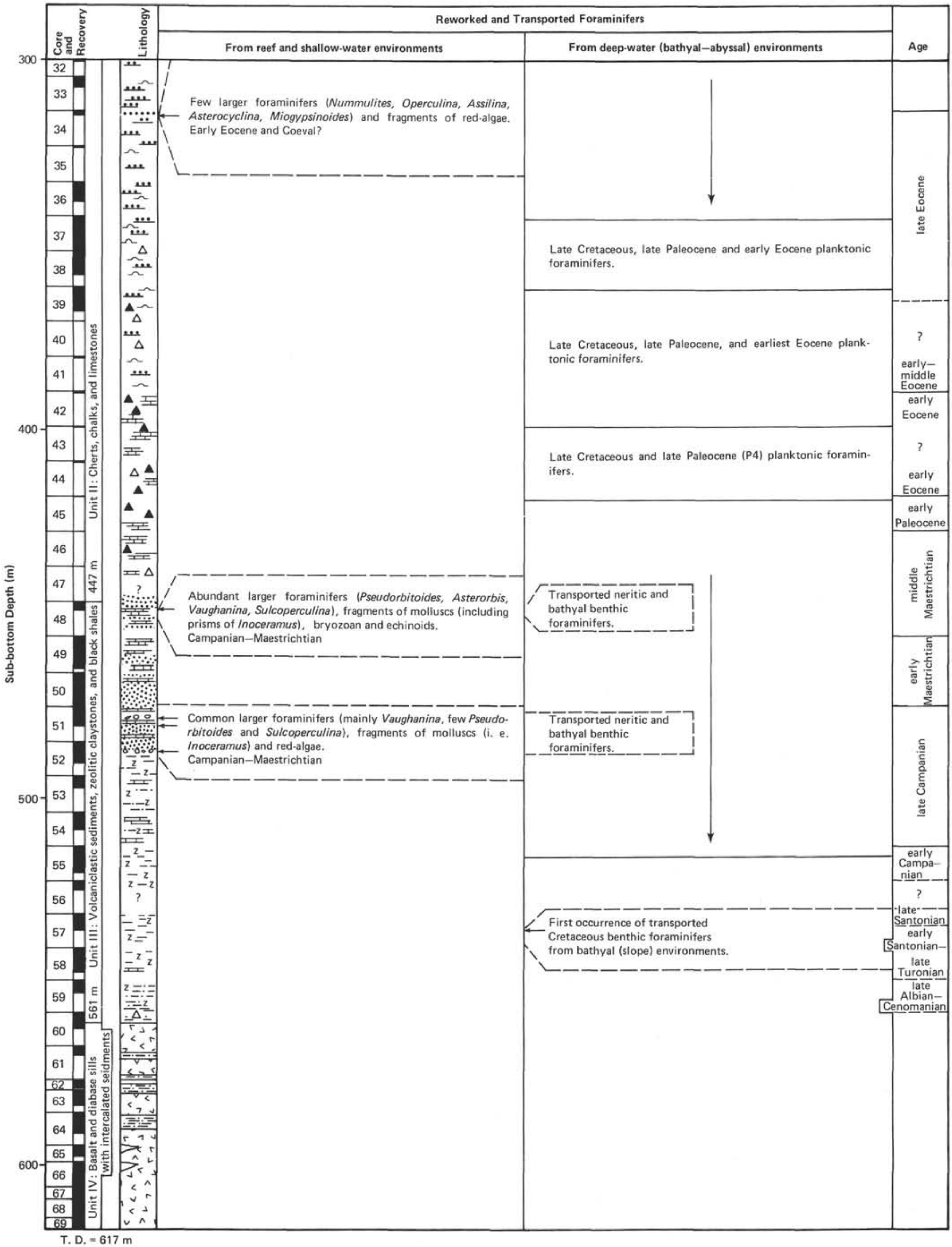


Figure 14. Distribution at Site 462 of foraminifers reworked and transported from reef and shallow-water environments and from deep-water (bathyal and abyssal) environments.



Few larger foraminifers (*Nummulites, Operculina, Assilina, Asterocyclina, Miogypsinoides*) and fragments of red-algae. Early Eocene and Coeval?

Late Cretaceous, late Paleocene and early Eocene planktonic foraminifers.

Late Cretaceous, late Paleocene, and earliest Eocene planktonic foraminifers.

Late Cretaceous and late Paleocene (P4) planktonic foraminifers.

Abundant larger foraminifers (*Pseudorbitoides, Asterorbis, Vaughanina, Sulcoperculina*), fragments of molluscs (including prisms of *Inoceramus*), bryozoan and echinoids. Campanian–Maestrichtian

Transported neritic and bathyal benthic foraminifers.

Common larger foraminifers (mainly *Vaughanina*, few *Pseudorbitoides* and *Sulcoperculina*), fragments of molluscs (i. e. *Inoceramus*) and red-algae. Campanian–Maestrichtian

Transported neritic and bathyal benthic foraminifers.

First occurrence of transported Cretaceous benthic foraminifers from bathyal (slope) environments.

Figure 14. (Continued).

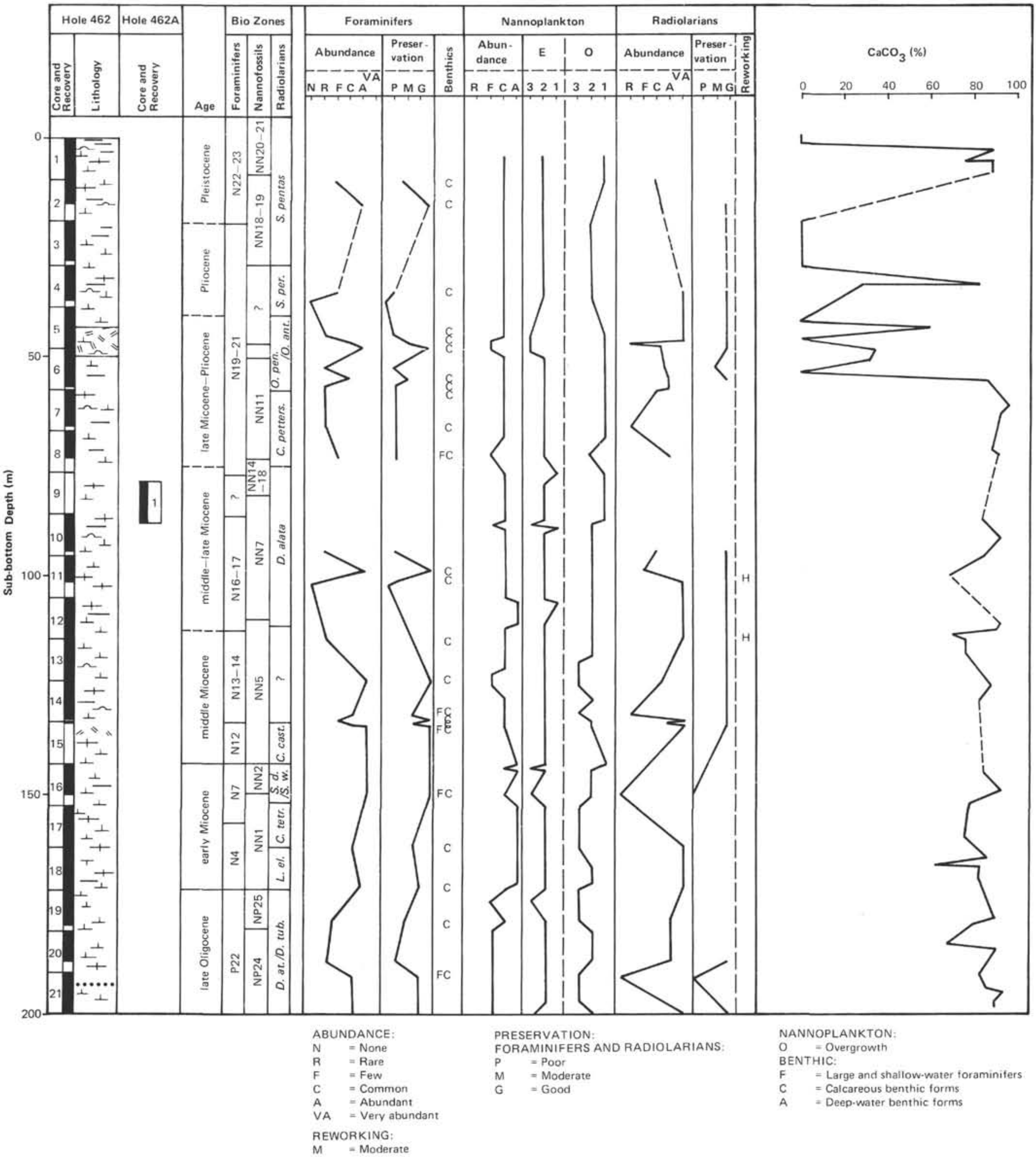


Figure 15. Oligocene to Pleistocene biostratigraphy at Site 462.

Core 4 is very poor in planktonic foraminifers, while Core 5 yielded a relatively rich assemblage, among which *Globorotalia tumida, Pulleniatina obliqueloculata, P. finalis*, sphaeroidinellids, *globorotalia tosaensis, Streptochilus tokelauae*, and *Globigerinoides fistulosus* are the most common and important species. This assemblage is attributed to Zone PL6 (late Pliocene). As in the cores above, the major reworked faunal components belong to the Miocene; however, elements of late Oligocene assemblages increase in importance.

Cores 6 through 8 yield rich planktonic-foraminifer faunas attributable primarily to late Miocene Zones N17 and N16; however, few forms of early Pliocene age, such as well-developed specimens of the guide form

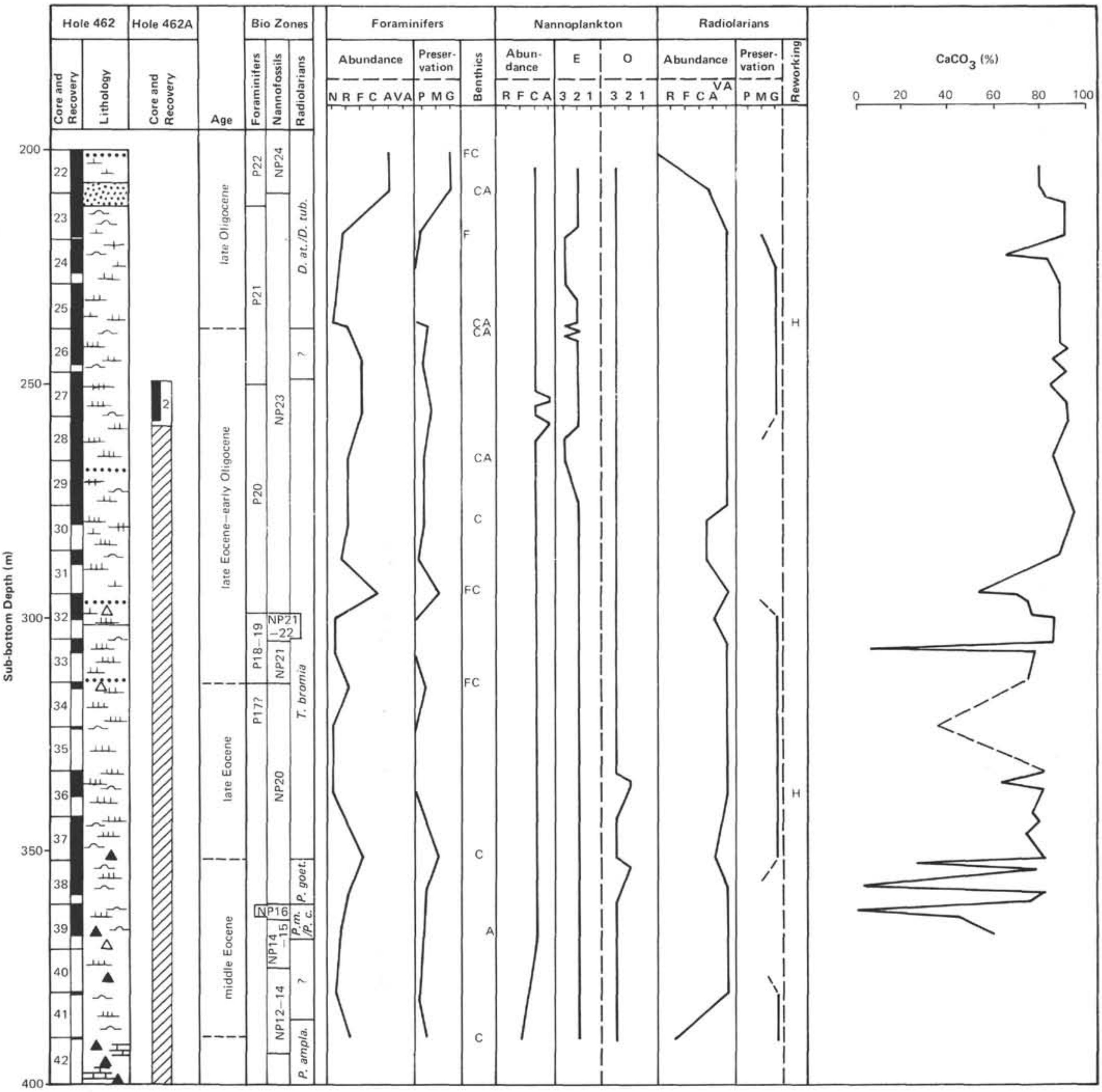


Figure 16. Eocene to Oligocene biostratigraphy at Site 462.

Globorotalia margaritae, and of late Pliocene to Pleistocene age, such as *Streptochilus tokelauae*, among others, indicate that those cores are at least Pliocene. In fact, the Pleistocene forms are here interpreted as downhole contaminants. If further studies prove that they are instead *in situ*, then the base of the Pleistocene should be placed at the base of Core 8, at about 73 meters subbottom. In this last case, not only the late Miocene faunas, but also the early Pliocene assemblages must be considered reworked.

Core 9 had no recovery. The occurrence of *Globorotalia juanai* and primitive *Pulleniatina* at 462-12-5, 47–48 cm, dates the interval from Core 10 to Core 12, Section 5, to the late Miocene Zones N17 and N16 (middle part). *Globigerinoides ruber* and well-developed *Globigerina nepenthes* are sometimes associated with the above-mentioned species, and their occurrence is consistent with the zonal attribution. In this interval, however, late Miocene faunas are overwhelmed by middle Miocene (Zones N12 and N13) assemblages, which are particularly abundant at the bottom of the coarser graded layers (coarse foraminifer sands). Very large specimens of *Globotruncana contusa* (late Maestrichtian) and the highest shallow-water skeletal debris are

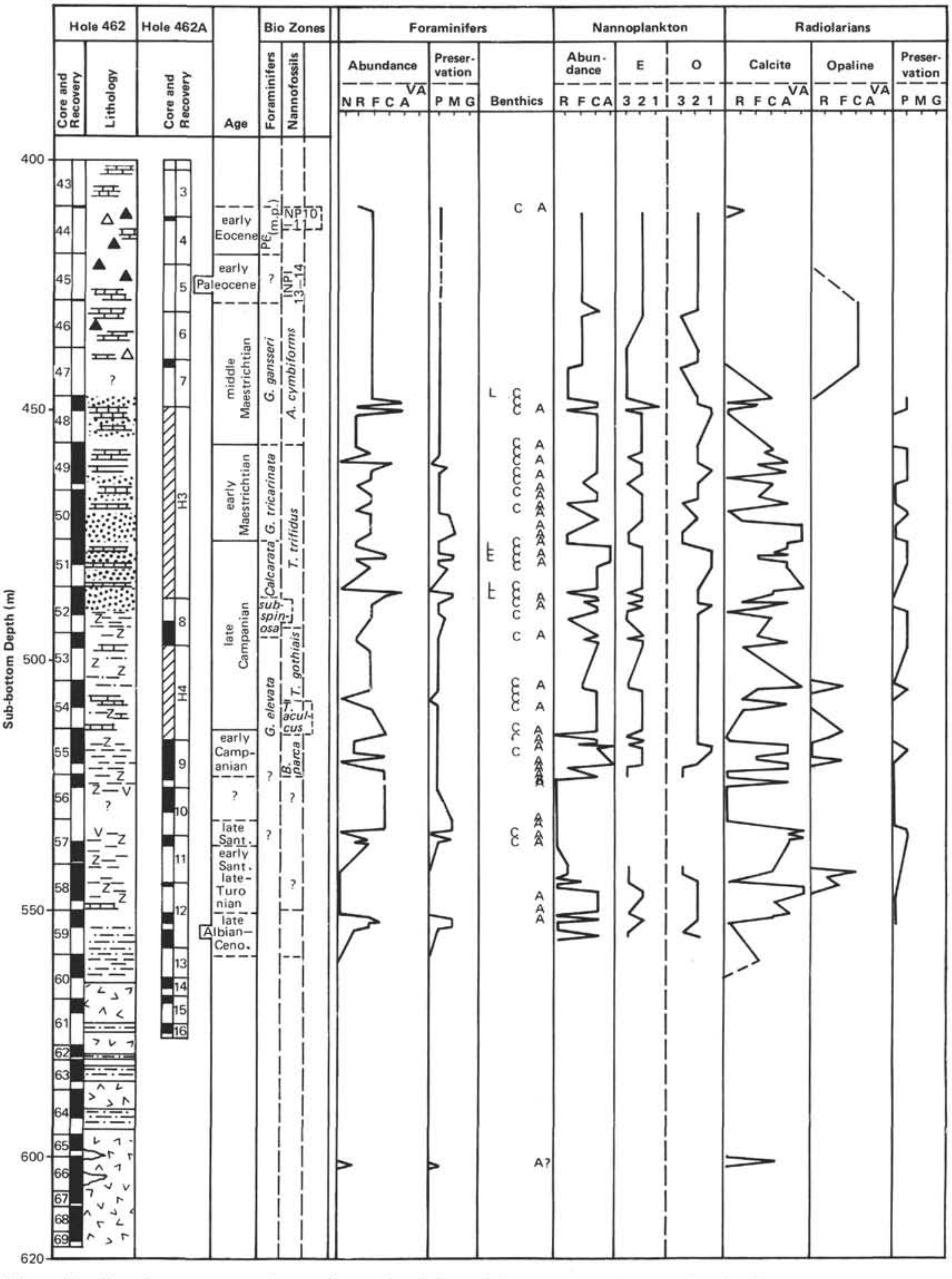


Figure 17. Abundance, preservation, and associated data of Cretaceous to Eocene microfossils.

also reworked in the same layers (Core 11, Section 3; Core 13, Section 5). The lower part of the late Miocene Zone N16 and the middle Miocene Zones N15 and N14 seem to be missing at Site 462.

Core 12, Section 6, to Core 15,CC are attributed to the middle Miocene Zones N13 and N12 on the occurrence of primitive *Globigerina nepenthes*, common forms transitional to *G. nepenthes*, and *Sphaeroidinellopsis subdehiscens*. Again, the bulk of the planktonic-foraminifer faunas consists of older assemblages of the early middle Miocene (Zones N11 and N10) and late early Miocene (Zones N8 and N7). *Globigerinatella insueta* occurs commonly in those layers. In Core 14, Section 5, 79–81 cm and Core 15,CC, relatively large amounts of shallow-water debris are recorded.

Cores 16 and 17, Section 1, are attributed to the early Miocene Zone N7, based on the occurrence of *Globigerinita glutinata, Hastigerina siphonifera*, and the first

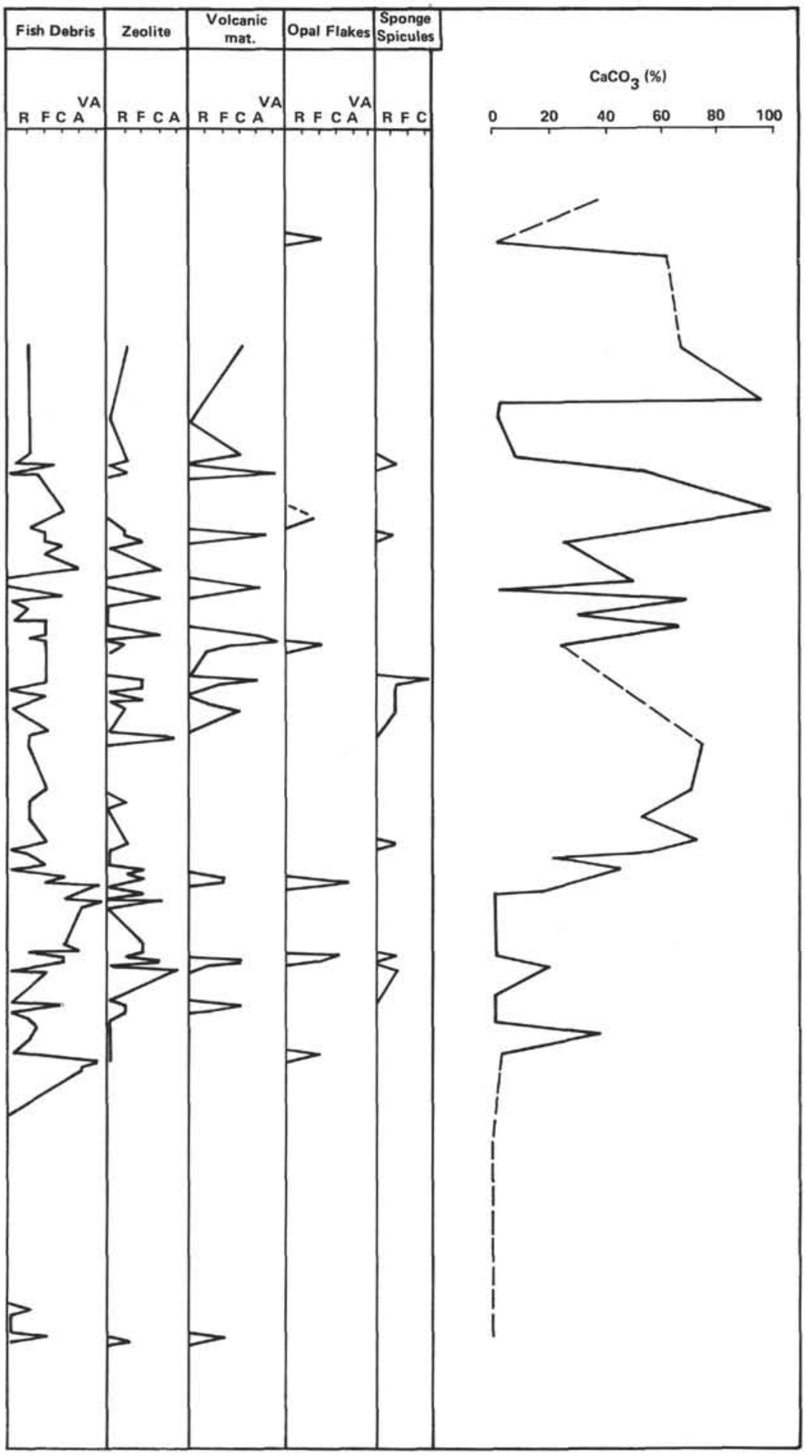


Figure 17. (Continued).

Sphaeroidinellopsis in Core 17, Section 1, 6-8 cm. As above, the dominant planktonic-foraminifer faunas belong to older zones, such as the lower part of Zone N4 (*Globorotalia kugleri* Zone), then latest Oligocene in age, associated with undifferentiated Oligocene forms.

Although Core 15 had very poor recovery, a new discontinuity in the planktonic-foraminifer record must be hypothesized between Cores 15 and 16.

The absence of Miocene forms in Core 17, Section 3 through Core 18,CC, which yield rich planktonic-foraminifer faunas attributable to Zone N4, allowed us to locate the Miocene/Oligocene boundary within Core 17. Faunas attributable to the early Miocene Zones N6 and N5 appear to be missing at Site 462.

Core 19 through Core 23, Section 2, are attributed to the late Oligocene Zone P22 (*Globigerina angulisutu-*

Table 4. Neogene biostratigraphy.

m.y.	Age		Planktonic Foraminifers			Calcareous Nannofossils		Radiolarians	
0	Pleistocene	Late	N23		Core 1	NN21	Core 1, Sections 1-6	*Lamprocyrtis haysi*	Core 1-Core 3,CC
						NN20			
			- - ? - -						
1		Early	N22		Core 2	NN19	Core 1,CC Core 5,CC	*Pterocanium prismatium*	
2	Pliocene	Late	N21	PL6	Core 4-Core 8	NN18	— — ? — —		
				PL5		NN17			
				PL4		NN16		*Spongaster pentas*	
3			N20	PL3		NN15			
		Early	N19	PL2					
4				PL1	— — ? — —	NN14			
						NN13			
			N18			NN12		*Stichocorys peregrina*	Core 4, Section 2-Core 5, Section 1
5	Miocene	Late	N17						
6						NN11	Core 6-Core 8		
7					Core 10, Section 1				
8								*Ommatartus penultimus*	Core 5, Section 2-Core 6, Section 5
9			N16		Core 12, Section 5			*Ommatartus antepenultimus*	
10					— — ? — —	NN10	— — — —		
			N15					*Cannartus petterssoni*	Core 7, Section 1-Core 8, Section 4 Core 1A, Section 1-Core 1A,CC
11		Middle				NN9			
			N14						
12			N13		Core 12, Section 6-Core 14,CC, Core 1A	NN8			
			N12		Core 15	NN7	Core 10-Core 12, Section 1 Core 1A		
13			N11		— — ? — —	NN6		*Dorcadospyris alata*	Core 8,CC-Core 12, Section 4
			N10			NN5	Core 12-Core 15		
			N9					*Calocycletta costata*	Core 15, Section 1-Core 15,CC
14			N8						
		Early	N7			NN4			
15					— — ? — —				
16					Core 16-Core 17, Section 1				
17					— — ? — —				
18			N6			NN3		*Stichocorys wolffii*	Core 16, Section 2
19			N5			NN2	Core 16, Section 1	*Stichocorys delmontensis*	
20									
21			N4		— — ? — —	NN1	Core 16,CC-Core 18		
22					Core 17, Section 3-Core 18			*Cyrtocapsella tetrapera*	Core 17, Section 1-Core 17, Section 6
23								*Lychnocanoma*	Core 18, Section 2
24	Oligocene						— — — —		

Table 4. Neogene biostratigraphy.

Table 5. Paleogene biostratigraphy.

m.y.	Age		Planktonic Foraminifers		Calcareous Nannofossils		Radiolarians	
25	Oligocene	Late	*G. ciperoensis* P22	Core 19–Core 23, Section 2	NP25	Core 19, Section 2–Core 19, Section 6	*D. elongata*	Core 18, Section 6
26 27 28 29			*'Gr.' opima opima* P21	Core 23, Section 3–Core 27, Section 2	NP24	Core 19,CC–Core 22	*Dorcadospyris ateuchus*	Core 19, Section 2–Core 25,CC
30			*G. ampliapertura* P20	Core 27, Section 3–Core 32, Section 3	NP23	Core 23–Core 32, Section 2 Core 2A		
							Theocyrtis tuberosa	Core 2A, Section 1–Core 2A,CC
35		Early	*Cassigerinella chipolensis/ pseudohastigerina micra* P19–P18	Core 32, Section 4–Core 33	NP22	Core 32,CC–Core 33		
					NP21			
							Thyrsocyrtis bromia	Core 27, Section 2–Core 37,CC
	Eocene	Late	*T. cerroazulensis*	Core 34	NP20	Core 34–Core 38		
			Globigerinatheka semiinvoluta		NP19			
					NP18			
40		Middle	*Truncorotaloides rohri*		NP17		*Podocyrtis goetheana*	Core 38, Section 1–Core 38,CC
			Orbulinoides beckmanni		NP16	Core 39, Section 1	*Podocyrtis chalara*	Core 39, Section 2–Core 39, Section 5
							Podocyrtis mitra	
45			*Morozovella lehneri*				*Podocyrtis ampla*	Core 41,CC
			Globigerinatheka subconglobata		NP15	Core 39, Section 3–Core 39,CC	*Thyrsocyrtis triacantha*	
			Hantkenina aragonensis		NP14		*T. mongolfieri*	
							T. cryptocephala	
50		Early	*Acarinina pentacamerata*		NP13	Core 41–Core 42	*Phormocyrtis striata*	
			Morozovella aragonensis		NP12		*Buryella clinata*	
			M. formosa					
			M. subbotinae		NP11	Core 44, Section 1 Core 5A,CC		
			M. edgari		NP10			
55	Paleocene	Late	*Morozovella velascoensis*		NP9			
			Planorotalites pseudomenardii		NP8 NP7 NP6			
			M. pusilla pusilla		NP5			
			M. angulata		NP4	Core 45,CC		
60		Early	*M. uncinata*		NP3			
			"M." trinidadensis					
			Subbotina pseudobulloides		NP2			
65			*"P." eugubina*		NP1			

Table 6. Cretaceous biostratigraphy.

m.y.			Planktonic Foraminifers	Calcareous Nannoplankton	Radiolarians	Hole 462	Hole 462A
65	Maastrichtian		*A. mayaroensis*	*M. mura*	*Theocapsoma comys*		
			G. contusa	*L. quadratus*			
			Globotruncana gansseri	*A. cymbiformis*		46,CC-48,CC	7-1-7,CC
			G. tricarinata	*T. trifidus*		49-1-50,CC	H3-1-H3-3
70	Campanian		*G. calcarata*		*Amphipyndax enesseffi*	51-1-52-2	H3,CC-8-1
			G. subspinosa			52-2-52,CC	8-1-9,CC
			Globotruncana elevata	*T. gothicus*		53-1-54-3	
				T. aculeus		54-3-54,CC	
75				*B. parca*		55-1-55,CC	
	Santonian		▨	*M. furcatus*	*Artostrobium urna*		
			Dicarinella asymetrica				
80			*Dicarinella concavata*			57-1-57,CC	
	Coniacian						
85	Turonian		*Marginotruncana schneegansi*	*M. staurophora*	*Dictyomitra somphedia*		
			Praeglobotruncana helvetica				
90			*Whiteinella aprica*	*G. obliquum*			
	Cenomanian		*Whiteinella baltica*	*L. alatus*		59-1	12-1-13-1
95			*Rotalipora cushmani*				
			R. reicheli				
			Rotalipora brotzeni				
100	Albian	VRAC	*Planomalina buxtorfi*	*E. turriseiffeli*			
		Sup.	*Ticinella breggiensis*	*P. cretacea*			
		M	*Ticinella primula*		*Acaeniotyle umbilicata*		
105			*Hedbergella planispira*				
		in	*Ticinella bejaouensis*	*P. angustus*			
	Aptian		*Hedbergella trocoidea*				
110			*G. lloides algerianus*				
			G. lloides ferreolensis				
			Schackoina cabri				
			Globigerinelloides maridalensis/G. blowi	*C. litterarius*			
			G. lloides gottisi/G. lloides duboisi				
			Hedbergella similis				
115	Barremian		*Hedbergella sigali*	*M. hoschulzii*	*Eucyrtis tenuis*		43-1-43-3 80-1
120							

Table 7. Hole 462A samples from Cores 79 and 80 in which Cretaceous calcareous nannoplankton were not found.

79-6, 0–1	80-1, 15,8	80-1, 17,7	80-1, 18,9
79-6, 8	80-1, 16,1	80-1, 17,9	80-1, 80 (pebble)
80-1, 1	80-1, 16,5	80-1, 18	80-1, 120–122
80-1, 15	80-1, 17	80-1, 18,1	80-2, 60 (pebble)
80-1, 15,6	80-1, 17,4	80-1, 18,3	80-2, 110–112

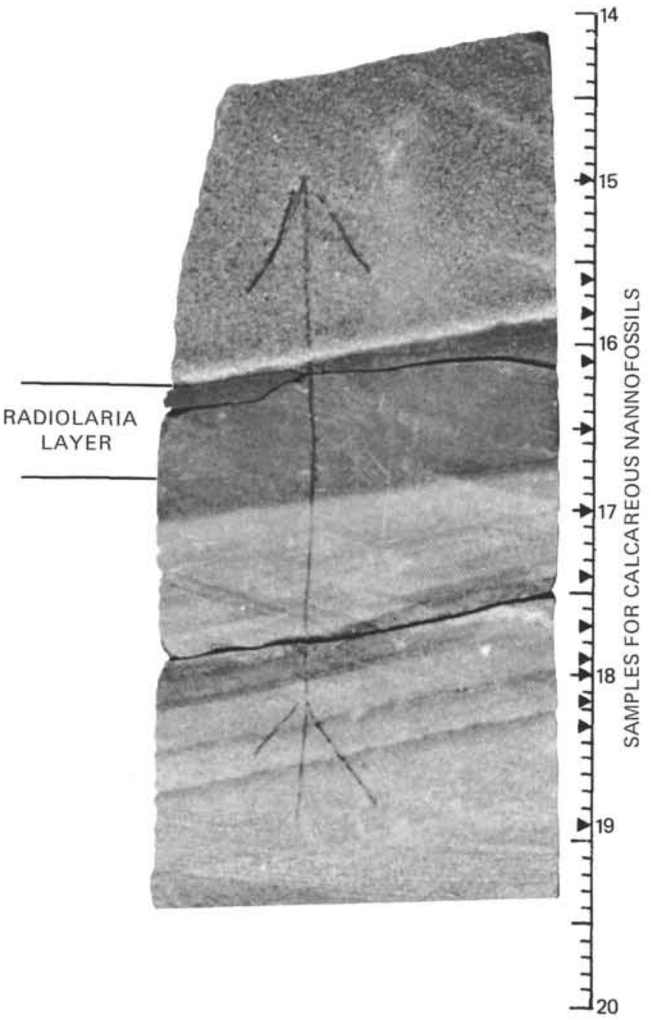


Figure 18. Sample 462A-80-1, 14–19.3 cm, with the position of the radiolarian layer and positions of the samples studied for calcareous nannofossils.

ralis Zone) on the occurrence of *Globoquadrina praedehiscens* and common well-developed *Globorotalia siakensis* and related forms in Core 23, Section 3, 98–100 cm. In agreement with the inferred age, rare *Globigerinoides primordius* and *Globorotalia mendacis* are first recorded in Core 22,CC and in Core 22, Section 1, 69–72 cm, respectively. The coarser layers are very rich in planktonic foraminifers from early to late Oligocene Zones P19 through P21. *Cassigerinella* and *Chiliguembelina* are the dominant forms of the finest fractions (< 150 µm). Two of the largest shallow-water assemblages are recorded in the coarsest layers in Core 21, Section 1, 1–3 cm and Core 22, Section 1, 69–71 cm, whereas few skeletal remains occur in Core 23.

The lower part of Core 23 (Section 3 to CC) still yield large planktonic-foraminifer assemblages similar to those of the upper part, except for the absence of *Globoquadrina praedehiscens*. The occurrence of *Globorotalia opima opima, G. siakensis* associated with well-developed *Globoquadrina baroemoenensis*, and less common forms close to *Globoquadrina altipsira* does indicate that part of Core 23 may belong to the late Oligocene Zone P21 (*Globorotalia opima opima* Zone). Large numbers of forms belonging to older Oligocene zones (P19 and P20) occur in the same interval.

Below Core 23, layers yielding large planktonic-foraminifer faunas decrease downward, replaced mainly by radiolarian-rich layers, or by minor amounts of pelagic-clay layers totally devoid of planktonic foraminifers. Taking into account that heavy reworking from older levels still occurs, the zonal boundaries must be considered only tentative: the boundary between Zones P21 and P20 is arbitrarily located within Core 27.

Well-developed *Globoquadrina baroemoenensis* are recorded in some samples from Cores 28 and 29, and from the upper part of Core 32. According to Blow (1969), this taxon appears within Zone P20 (*"Globigerina" ampliapertura* Zone); however, on the basis of personal observation of deep-sea drilling material by one of the authors (IPS), specimens attributable to *G. baroemoenensis* occur at the base of Zone P20. Then Core 32, Section 3, 113–115 cm, which contains the mentioned taxon, is datable approximately to the P19/P20 zonal boundary, while the overlying cores are attributed to Zone P20. *Catapsydrax unicavus, Turborotalia ampliapertura, Tenuitella gemma, Globorotalia opima nana, Globoquadrina galavisi, Cassigerinella chipolensis*, and *Chiloguembelina* spp. are the most important forms identified in this interval. Late Eocene and early Oligocene planktonic-foraminifer assemblages are reworked in the same layers.

From Core 32 to the top of the Mesozoic, between Cores 45 and 46, planktonic foraminifers correlative with nannofossil zones are very rare and limited to a few levels, partly because of the poor recovery in some cores, and mainly because they are absent. Core 34 yielded some planktonic foraminifers, including *Subbotina linaperta, S. angiporoides, Catapsydrax* sp., *Chiloguembelina* spp., and representatives of the *Turborotalia cerroazulensis* lineage, along with a rare shallow-water assemblage. An attribution to Zone P17 (latest Eocene) is suggested, which agrees with the age inferred from calcareous nannofossils and radiolarians.

Acarinina nitida, "Globorotalia" guatemalensis, Morozovella acuta, M. gracilis, "Morozovella" edgari, "M." aequa, "M." wilcoxensis and *Subbotina* sp., characterizing Zone P6 (*"M." edgari* Subzone), of earliest Eocene age, occur in Core 44 and are not considered reworked. Few other planktonic assemblages were found in this interval (in Cores 37 and 42), but they are clearly reworked (Fig. 14).

Core 45, which according to the nannofossils is early Paleocene in age, has only 45 cm of recovery, most of which is chert. No planktonic foraminifers were found.

The main feature which differentiates the Mesozoic from the Cenozoic is that the reworking from older levels ceased, although the sedimentary patterns remain more or less constant. In the Mesozoic, the presence of carbonates, even still allochthonous in a deep basin well below the CCD, is related more to penecontemporaneous transport.

Planktonic foraminifers are still largely size-sorted, and rather commonly the assemblages are composed only of small-sized individuals. As in the Cenozoic, rich planktonic-foraminifer assemblages are associated with the volcaniclastic layers, which also contain shallow-water debris.

Samples yielding planktonic foraminifers are scarce and spotty, the main lithology being zeolitic clay.

From Core 46 through Core 48, few to abundant planktonic foraminiferal assemblages were recorded. The preservation is rather poor, and the assemblages are mainly recrystallized. The occurrence of *Globotruncana gansseri, Abathomphalus intermedia*, and *G. aegyptiaca*, along with *G. elevata, Pseudoguembelina costulata, Psg. excolata*, and *G. arca*, characterizes the *Globotruncana gansseri* Zone, of middle Maestrichtian age. It is within Core 48 that the youngest Mesozoic volcaniclastic layer occurs.

Cores 49 and 50 are assigned to the early Maestrichtian *Globotruncana tricarinata* Zone. The assemblages are rich and are moderately well preserved. This zone is mainly distinguished on the basis of its negative character: it corresponds to the interval between the extinction of *Globotruncana calcarata* (lower boundary) and the appearance of *G. gansseri* (upper boundary). Both markers are present below and above Cores 49 and 50. *Globotruncana stuartiformis, G. tricarinata, G. fornicata, G. arca*, and *Rugotruncana subpenneyi, Schackoina multispinata* are among the most characteristic forms.

In Core 51 and Core 52, Section 1, *Globotruncana calcarata* occurs; consequently, this interval is assigned to the *Globotruncana calcarata* Zone (total range zone), corresponding to the latest Campanian. Besides the zonal marker, the planktonic-foraminifer assemblage comprises *G. plummerae, G. fornicata, G. elevata, Rug. subpenneyi, G. subspinosa, G. bulloides*, and *Psg. costulata*. It is within this interval that a second layer of shallow-water debris occurs.

In the remaining part of Core 52, *G. calcarata* is absent; however, on the presence of *G. subspinosa* we attribute this interval to the *Globotruncana subspinosa* Zone of the late Campanian. Among the most important forms, *G. tricarinata, G. arca, G. bulloides, G. fornicata*, and *G. lapparenti*, along with *Heterohelix pulchra, H. globulosa, Psg. costulata, Pseudotextularia elegans*, and *Globigerinelloides alvarezi*, are recorded. The samples containing non-size-sorted planktonic-foraminifer assemblages decrease downward, while levels yielding only small forms (150–63 μm) increase.

In Cores 53 and 54, only two samples (Core 54, Section 1, 39–45 cm; and Core 54, Section 3, 3–7 cm) still contain large-sized globotruncanids in their residues; all others are dominated primarily by small-sized heterohelicids and hedbergellids. On the occurrence of *G. arca, G. stuartiformis, G. elevata, G. fornicata, Globigerinelloides volutus*, and *Psg. costulata*, the upper and middle part of the *Globotruncana elevata* Zone is recognized and assigned to the late Campanian. The occurrences of *Globigerinelloides asper* and heterohelicids close to *Ventilabrella*, without *Psg. costulata*, in Core 55 suggest the lower part of the *Globotruncana elevata* Zone, attributed to the early Campanian. Planktonic foraminifers in Core 55 are mainly small-sized forms, except for the few specimens of *G. elevata*.

Below Core 55, planktonic foraminifers are recorded only in two samples for Core 57 (Section 3, 53–55 cm and 100–102 cm). The assemblages are poor and of small sizes, and cannot be attributed to a definite zone. *Archaeoglobigerina bosquensis, Marginotruncana pseudolinneiana, "G." cachensis, Rugoglobigerina pilula, R.* spp. aff. *R. bulbosa, Dicarinella* sp., *Hedbergella flandrini*, and *Heterohelix reussi* are recorded from Santonian or older levels. Lacking better markers, we attribute this assemblage tentatively to the early Santonian.

There are no planktonic foraminifers recorded below Core 57.

Smaller benthic foraminifers recovered from sediments of Hole 462 constitute two groups: (1) autochthonous agglutinated species indicative of abyssal benthic environments greater than 4000 meters, and (2) allochthonous calcareous and agglutinated species from neritic and bathyal environments. With the exception of the Cretaceous brown zeolitic claystone just above the basalt in Core 60, resedimentation and vertical sorting exert a strong influence on the recovery and preservation of the biogenic components throughout the cored sequence. This influence is seen in the sporadic distribution and small size of the allochthonous benthic species recovered from sediments in Core 5 to Core 57.

The autochthonous assemblage is characteristic of the reddish-brown zeolitic claystone typical of Cores 56 to 60 and found between turbidites in the younger cores. Species of *Hyperammina, Haplophragmoides, Praecystammina, Paratrochamminoides*(?),*Glomospira*, and *Ammodiscus*, among others, usually are associated with fish debris and recrystallized radiolarians (Figs. 15–17). Members of this assemblage, along with manganese-coated cyclamminids occur in the reddish-brown clays interbedded in the "pelagic" turbidites of the Miocene through Eocene sediments of Cores 5 to 39. The deep-water foraminifer assemblage is most characteristic of benthic environments between 5000 to 6000 meters, such as those previously reported from Mesozoic sediments in the western Pacific during Leg 20, and in the Indian Ocean during Leg 27.

Allochthonous species first appear in Core 57, as shown in Table 4. They reappear in Core 55 and are found sporadically thereafter throughout the Cretaceous sequence to Core 46. The assemblages typically consist of small, size-sorted, calcareous benthic species of *Praebulimina, Gavelinella, Gyroidinoides, Stilostomella, Allomorphina, Ellipsonodosaria*, and *Pleurostomella*, which indicate bathyal source areas above 2500 meters. These assemblages are distinct from those of neritic or reef environments that are restricted to the coarse, graded turbiditic material of the Cretaceous and Cenozoic cores, as shown in Figure 14. The allochthonous bathyal assemblage continues into the Cenozoic until Core 1, with species of *Bulimina, Stilostomella, Osangularia, Cibicidoides, Melonis, Laticarinina*, and *Gyroidina*, among others.

Coarse bioclastic debris of shallow-water origin and a number of isolated specimens of larger foraminifers were recovered at Site 462 from Cenozoic and Mesozoic layers. They are among the major components of the larger-size fraction of the volcaniclastic turbiditic sandstones. As the grain-size decreases, pieces of larger foraminifers still are found, but mainly they are replaced by planktonic foraminifers (globotruncanids, etc.).

As shown in Figure 14, the composition of shallow-water material is not constant throughout the cored interval. Instead, the age of the transported material becomes progressively older and roughly approximates the age of the cored material.

The largest amount of shallow-water debris occurs in Core 32, Section 1, 5–8 cm. The major biogenic components of this layer are still the larger foraminifers, among which nummulitids, discocyclinids, and miogypsinids are the dominant forms. Species composition is very similar to that mentioned for the upper layers.

A minor amount of shallow-water debris of limited diversity is recorded in Core 34, tentatively attributed to the latest Eocene. The faunal assemblages are constituted by several *Nummulites*, poorly preserved *Heterostegina, Miogyspinoides ubaghsi, Polylepidina*, and *Assilina leymeriei*.

A large amount of larger foraminifers is recorded in Core 48, Section 2, 78–81 cm (middle Maestrichtian, *Globotruncana gansseri* Zone), accompanied by fragments of various mollusks. Foraminifers belong to the Late Cretaceous genera *Pseudorbitoides, Asterorbis, Vaughanina, Sulcoperculina*, and *Lepidorbitoides*. Their range is Campanian to Maestrichtian, so that similar ages for the shallow-water forms and the pelagic faunas cannot be ruled out.

The rather rich shallow-water assemblages from Core 51, Section 3, 44–47 cm and Core 52, Section 1, 98–101 cm (latest Campanian, *G. calcarata* Zone) are less diverse than those of mid-Maestrichtian age and lack representatives of *Asterorbis* and *Lepidorbitoides*. Moreover, they are dominated by relatively large specimens of *Vaughanina*, whereas specimens of *Pseudorbitoides* and *Sulcoperculina* are scarce. The age of these assemblages is not in conflict with that of the associated planktonic foraminifers and calcareous nannofossils.

The Cenozoic sequence of Hole 462A was only spot cored in an attempt to have better recovery than at Hole 462.

The first core, A1, was cored at 80 meters sub-bottom to cover the gap of Core 462-9. It yielded few to common, moderately well preserved planktonic foraminifers belonging to the middle Miocene, possibly to the top of Zone N13. The assemblages are commonly size-sorted, with an enrichment of small forms like *Globigerinita glutinata, Globigerina druryi, G. quinqueloba*, and *Cassigerinella chipolensis*. Species are few in comparison with Core 462-10 which in part overlaps it.

Core A2 was recovered at 249.5 meters sub-bottom. Core A2,CC contains common planktonic foraminifers, among which the most important species are *Turborotalia pseudoampliapertura, T. ampliapertura, Gq. baroemoenensis, G. nana, Chiloguembelina* sp., *Psh. naguewichiensis, Tenuitella munda*, and *T. gemma*. They are assigned to Zones P19 to P18, of early Oligocene age. It is noteworthy that in the same sample abundant reworked Eocene through Cretaceous planktonic assemblages occur with large amounts of volcanic glass and rock fragments, which are recorded at the same depth in Hole 462 (Cores 27 and 28).

Washed Core H1, covering more than 100 meters, yielded very rare planktonic foraminifers in the residues, which are dominated by radiolarians and sponge spicules, except for H1,CC, in which *Subbotina angiporoides, Catapsydrax unicavus, Gq. tripartita, Cassigerinella chipolensis, Chiloguembelina* sp., and *Tenuitella gemma* were identified. A similar assemblage was recorded in Cores 27 through 32 of Hole 462.

Washed Core H2 (373.0–401.5 m) and Cores A3, A4, and A5 contain chert and limestone, but few planktonic foraminifers were detected, except for Core A5,CC, in which, from the mixture of different lithologies, three heavily recrystallized planktonics and rare deep-water agglutinated foraminifers were found.

Core A6,CC recovered 7 cm of chert and limestone, but no foraminifers were found.

Core A7 contains rare planktonic foraminifers that give a middle Maestrichtian age. Preservation in the cross-laminated zeolitic calcarenite is poor, and specimens are recrystallized and fragmented. Species include *Globotruncana gansseri, G. arca*, and *Pseudoguembelina excolata*, which characterize the *Globotruncana gansseri* Zone.

In washed Core H3 (449–487 m), Sections 1 to 3 contain an early Maestrichtian assemblage with species such as *Globotruncana aegyptiaca, G. gagnebini, G. caliciformis, G. stuartiformis*, and *Globotruncanella havanensis*, among others. This interval is assigned to the *Globotruncana tricarinata* Zone and correlated with Cores 49 and 50 of Hole 462.

Sample H3,CC belongs to the *Globotruncana calcarata* Zone, based on the presence of the zone marker in addition to *G. subspinosa, G. bulloides, G. arca*, and *Globotruncanella havanensis*. The base of washed Core H3 thus correlates with Core 51 and Core 52, Section 1, 98–101 cm, of Hole 462.

The *G. calcarata* Zone extends into Core 8, Section 1, 35–40 cm, below which the marker species was not recovered. Planktonic foraminifers in Core 8, Sections 2 and 3 are rare to few and poorly preserved. The meager fauna, which contains *Globotruncana arca, G. caliciformis, G. stuartiformis, Pseudoguembelina costulata*, and *Heterohelix pulchra*, with others, is tentatively placed in the late Campanian *Globotruncana subspinosa* Zone.

Washed Core H4 (496.5–515.5 m) contains poorly preserved planktonic foraminifers associated with recrystallized radiolarians, zeolite, and pyrite. The assemblage that includes *Globotruncana stuartiformis, G. arca, G. fornicata, Pseudoguembelina costulata, Heterohelix pulchra, H. punctulata*, rugoglobigerinids, and *Globigerinelloides alvarezi* is placed in the late Campanian *Globotruncana elevata* Zone. Correlation is thus made with Cores 53, 54, and portions of 55 at Hole 462.

Elements of the *Globotruncana elevata* Zone continue downward into the grayish-brown claystone of Core 9; however, the fauna is much reduced, and preservation deteriorates. Recovered species include *Globotruncana fornicata, Pseudoguembelina costulata, Heterohelix pulchra*, and *Hedbergella holmdelensis*.

Below Core 9, planktonic foraminifers were not recovered, with the exception of displaced greenish claystone at the top of basalt in Core 21. The moderately well-preserved fauna contains common planktonic foraminifers and the only larger foraminifers from Hole 462A. The assemblage is assigned to the *Globotruncana calcarata* Zone on the basis of *G. calcarata, G. caliciformis, G. fornicata, G. stuartiformis*, and others. The sample correlates in age and biogenic and lithologic components with those of Cores 51 and 52 of Hole 462 and provides evidence of an important paleontological horizon that was missed during the discontinuous coring of the Late Cretaceous section in Hole 462A.

Two distinct assemblages representing autochthonous abyssal foraminifers and allochthonous bathyal and neritic species were recovered from Hole 462A. Abyssal foraminifers made up the assemblages recovered from Cores 10 to 13, Section 1, with the exception of an influx of rare allochthonous calcareous species displaced from bathyal environments in Core 12, Section 1.

Below this interval, from Core 13, Section 2, to Core 14, Section 1, above the first basalt sill, the samples are barren of foraminifers, and biogenic material consists of fish debris, recrystallized radiolarians and rare fibrous organic material in Core 14, Section 1, 29–32 cm.

Allochthonous calcareous benthic species appear in Core 9, Section 5, and continue in increasing abundance up to Core 1, whereas abyssal species become sporadic and were not recovered in Cores 1 or 2. This is closely similar in age and faunal content to assemblages from Hole 462. For example, the appearance of consistently occurring allochthonous benthic species within Core 9 of Hole 462A correlates with a similar pattern in Core 55 of Hole 462. Further, the first influx of calcareous benthics forms in Core 12 of Hole 462A is close to a similar occurrence in Core 57 of Hole 462.

Deep-water agglutinated foraminifers again appear in the dark-gray volcaniclastic claystone, siltstone, and sandstone interbedded with basalt in Cores 40, 42, 43, and 46. Assemblages consist of poorly preserved, rare specimens of largely primitive species associated with radiolarians, fish debris, sponge spicules, and carbonized plant material. Abyssal water depths analogous to those earlier alluded to are suggested by these associated biogenic components, as is their similarity to those in younger sediments in Hole 462A, especially in regard to their co-occurrence in the autochthonous, thin, red-brown claystone units. Poorly preserved radiolarians are more common in the interbedded sediments and were recovered from Cores 40 through 44 and 46; fish debris occurs in Cores 42 and 44. Material was noticed in carbonized-plant sediments from Cores 40, 42, and 46. A thin (1 cm) bed of red-brown claystone in Core 80, Section 1, 15.8–16.5 cm, contains an autochthonous assemblage with rare deep-water agglutinated foraminifers associated with radiolarians and fish debris.

Radiolarians

Radiolarians are present throughout the cores of Hole 462, although their state of preservation is variable, so that they are sometimes useless for biostratigraphic identification.

From Cores 1 to 22, the abundance of radiolarians shown in Figure 17 compares only irregularly to that of the other biogenic components. Only three absences of radiolarians were recorded in Cores 16, 20, and 22.

From Cores 23 to 40, radiolarians are usually the most abundant biogenic component, and their preservation is almost always good.

From Cores 41 to 60, the abundance of radiolarians varies considerably, but generally they are less abundant than above (Figs. 15–17). Moreover, their state of preservation is poor at best, in most cases so poor that only general outlines are seen. Commonly they are calcified, the test being filled with and/or replaced by calcite and zeolite.

Only some general remarks on the Cenozoic radiolarian assemblages are made here. The radiolarians from Hole 462 and the ages are given in Figure 14 with the core and biostratigraphic-age determinations.

In Cores 1 to 8, even though radiolarians were abundant (except in Core 1), it has not been possible so far to give a more-precise age than upper Miocene to Quaternary.

The radiolarian assemblages in several samples (e.g., those of the core catchers of Cores 11, 12, 25, and 36) show two states of preservation (recorded as "good" or "moderate"; Figs. 15–17) which correspond to the reworking processes.

No identifiable radiolarians were recorded in the lowermost Cenozoic.

Identification of radiolarians from the Cretaceous interval is nearly impossible, because the tests are replaced by zeolite and calcite in large crystals that distort the specimens. Moreover, the general outlines are sometimes hardly recognizable.

However, Core 51 provided somewhat better-preserved specimens (pseudoaulophacids, *Dictyomitra torquata, D. duodecimcostata*) that give a Late Cretaceous (Campanian) age.

Radiolarians are abundant and well preserved in the Neogene cores of Hole 462A (Cores 1 and 2). They are absent in the Paleogene (Cores 3 to 6), and rare to common but always poorly preserved in the Mesozoic sediments (Cores 7 to 46).

In Core 1, the radiolarians are from the *Dorcadospyris alata* Zone through the *Cannartus petterssoni* Zone. In Core 2, the age is difficult to determine with confidence on the basis of information given by Sample 2,CC, in which numerous Eocene radiolarians (*Cycladophora turris, Podocyrtis chalara, Theocampe mongolfieri, Lithocyclia aristotelis* group, *Thyrsocyrtis triacantha*) belonging to different zones are mixed with some Oligocene radiolarians (*Lychnocanium bipes, Dorcadospyris forcipata*). The possibility of contamination cannot be excluded.

In some of the Mesozoic cores, because of the poor preservation of the radiolarians (replaced by calcite and zeolite) and their distortion, only a few vague, high-level taxa can be identified. However, in Cores 43 and 46 some identifications were attempted. In both cores, the radiolarian zone could be the *Eucyrtis tenuis* Zone, but it seems more likely that in Core 43 it is the top of the zone, and that Core 46 is somewhat older. Radiolarians from the *E. tenuis* Zone again appear in the red-brown claystone of Core 80, Section 1, 15.8–16.5 cm. Rare, poorly preserved (hence undated) radiolarians were also recovered from Core 79.

SEDIMENTATION RATES

Average sedimentation rates for Hole 462 vary from a high of about 2 cm/10^3yr in the Late Cretaceous, late Oligocene, and middle Miocene turbidites to a low of less than 0.2 cm/10^3yr in the early Late Cretaceous red clays. The rates are shown in Figure 19. The time scales used are those by Berggren and Van Couvering (1974) for the Neogene, Hardenbol and Berggren (1978) for the Paleogene, and van Hinte (1976) for the Cretaceous. Unconformities are found in the latest Cretaceous, late Paleocene, Eocene, and Miocene. Additional, smaller unconformities may be present, but biostratigraphic resolution does not allow their definite characterization.

IGNEOUS PETROLOGY

The igneous rocks will be discussed in four parts: Part A, by R. Batiza, which discusses Hole 462 and Hole 462A to Core 74, with his interpretations; Part B, by S. Shcheka, which discusses Hole 462 and Hole 462A down to Core 74, with his interpretation; Part C, by H. Tokuyama, which discusses Hole 462 and Hole 462A down to Core 74, with his interpretations; Part D, by K. Seifert, T. Vallier, and K. Windom, which discusses all igneous data on Cores 75 to 92 of Hole 462A.

All parts are based on data which were collected jointly.

Part A (by R. Batiza)

Introduction

About 33.7 meters of basaltic rock was recovered from Hole 462, and about 450 meters from Hole 462A. Details of the petrology, mineralogy, alteration history, chemical composition, and petrogenesis are discussed elsewhere in this volume. The purpose of this section is to discuss briefly the stratigraphy, mineralogy, and megascopic character of these basaltic rocks.

Rock Fragments Recovered in Core 21

Several cores of Tertiary sediments contain volcanic detritus. Core 21 (late Oligocene) contains especially abundant and large fragments of igneous rock together with large reef foraminifers.

Thin-section observations of about 20 rock fragments separated from Section 1 of Core 21 revealed the following:

1) *Mineral fragments*. Fragments of olivine, lavender colored (high-Ti) augite, and colorless augite were identified. Some of these fragments have tiny amounts of volcanic glass and/or crystalline volcanic materials adhering to their surfaces.

2) *Rock fragments*. A wide variety of rock fragments are contained in this sediment. The most common are fragments of pumice composed of pale-brown glass with abundant stretched or spherical vesicles. Next most abundant are fragments of highly altered hyalopilitic and intersertal-textured basalt. The most interesting fragments observed, however, are holocrystalline rock fragments which contain, among other things, amphibole and potassium feldspar. These are almost certainly some type of alkalic differentiated rock. We can tentatively conclude from these observations that the source of these fragments was petrologically diverse. The pumice fragments are probably calc-alkaline and may have had a source different from that of the other fragments. Both sub-alkaline and alkaline rocks in the source area of the non-pumice fragments may be inferred on the basis of the types of augite found; on the other hand, each kind of rock or mineral fragment may have had a distinct source.

Sill-Complex Igneous Units

Logging of Hole 462 revealed the presence of five major igneous units separated by sedimentary units of variable thickness. Figure 20 shows that the uppermost igneous unit has been divided into five smaller igneous units, and that the third (counting downward) unit has been divided into three smaller units. Several criteria were employed either singly or in combination as bases for these subdivisions:

1) Megascopically observed grain-size fining or coarsening trends in the cores.

2) Significant mineralogic variations based on thin-section observation. This may be a difference in the

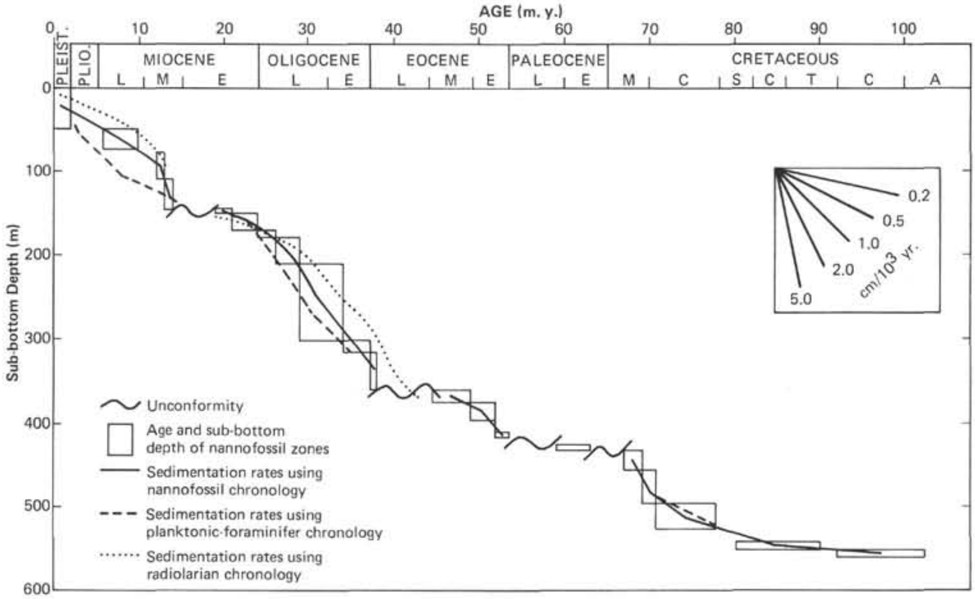


Figure 19. Sedimentation rates for Holes 462 and 462A.

number and kinds of phases present, or a difference in the relative proportions of phases.

3) Chemical differences between rocks with similar textures.

4) The presence of chilled margins.

5) The presence of fine-grained border zones.

6) The presence of *in situ* sedimentary horizons.

7) Sediment horizons inferred from logs.

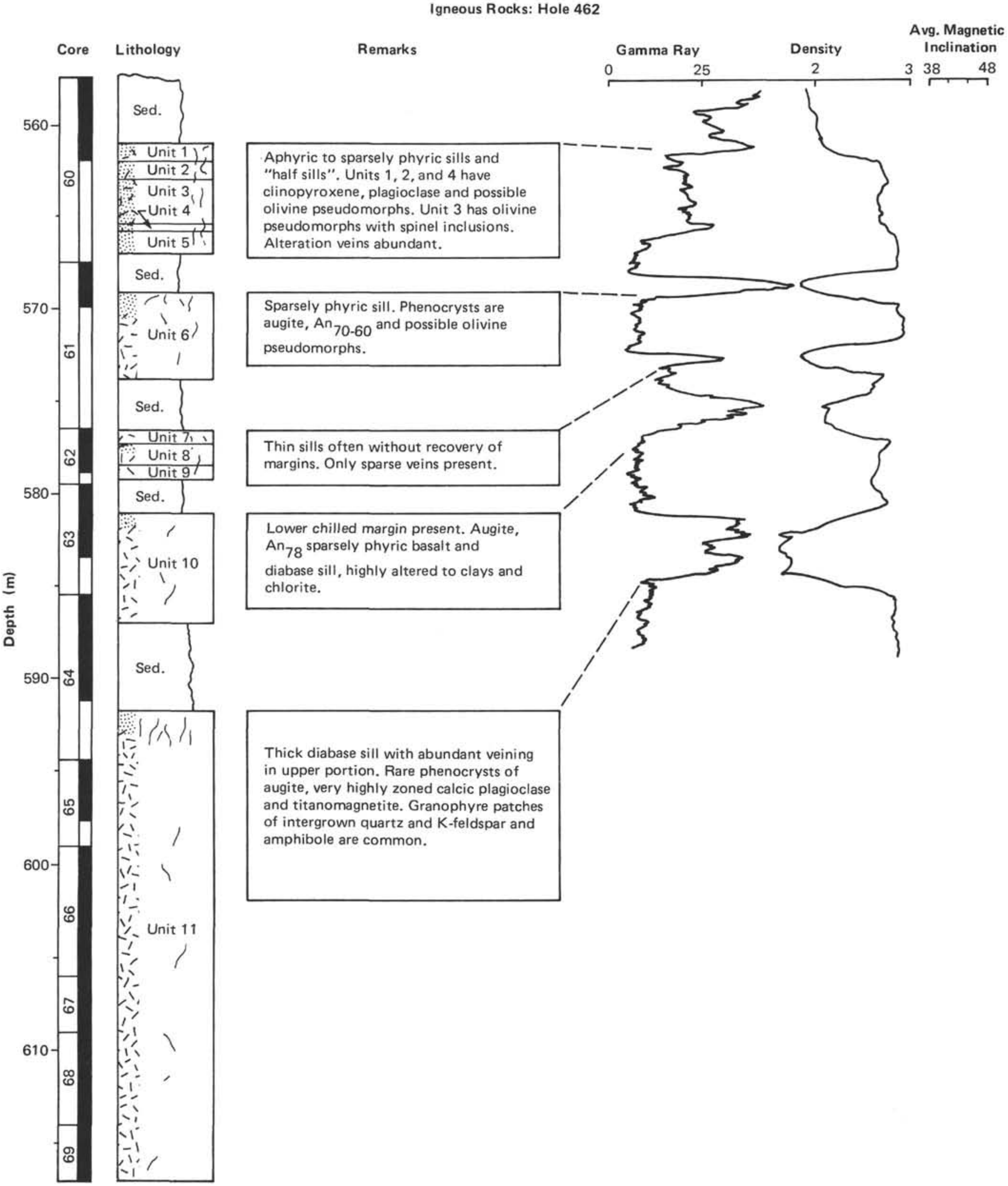
Table 8 is a brief summary of the criteria used to distinguish each contact.

Summary of Petrography

The rocks of Units 1 through 10 are either aphyric or sparsely phyric. They usually have a few phenocrysts of clear to light-brown augite ($2V \sim 50\text{–}60°$), zoned bytownite to labradorite, and occasionally olivine pseudomorphs (usually green smectite after olivine). Augite is also often replaced by smectite, so that positive identification of olivine pseudomorphs is difficult. The textures of the rocks vary from variolitic to diabasic, all intermediate textures being represented. These textural differences are, of course, related to differences of cooling rate and degree of supercooling and are related to position within the cooling units. In the finer-grained rocks, the phenocrysts are set in an altered matrix of glass, quench- or granular-textured augite, skeletal plagioclase laths, microlites and crystallites, and titanomagnetite. Some of the diabases have interstitial patches of brown or green smectite which resemble diktytaxitic cavities. These may be either clay-filled cavities or replaced glassy patches.

The upper portions of Unit 2 are petrographically indistinguishable from Units 1 to 10. However, beginning at the top of Core 65, patches of distinctive granophyre-facies mineralogy appear. These patches increase in abundance downward, but in a very irregular manner. Some deep horizons, for example, are relatively fine-grained and have no granophyric patches. These patches usually consist of intergrown quartz and feldspar micropegmatite. Many patches include a colorless acicular prismatic phase which is probably apatite. In addition to these patches, many of the rocks of Unit 2 contain subhedral quartz crystals as a separate phase, and also amphibole. The amphibole is brown with green rims, and has the following optical properties: Brown portions: $2V_\alpha = 50\text{–}60°$, $\delta = 0.020 \pm 0.005$, $Z = 0\text{–}23°$, absorption $> \beta > \alpha$, dispersion $r > \nu$. Crystals are pleochroic, equant euhedral to anhedral; α = straw yellow to colorless, β = light brown and γ = medium honey brown. The green amphibole differs from the brown amphibole only in color and crystal form. Color is: α = straw yellow to green, β = pale yellow-green to apple green,γ = deep emerald green, and the crystals are often fibrous. All transitions between fibrous green and more-equant brown amphibole are observed, and green commonly rims brown amphibole. In addition, rims of chlorite needles oriented normal to amphibole crystal faces are commonly observed around green amphibole. These observations suggest that green amphibole is either a reaction product of brown amphibole, or that the color and form difference is the result of continuously varying physical and chemical properties in the rocks during the period of amphibole (and perhaps chlorite) growth. The optical properties of the amphibole suggest that it is a hornblende; it is observed as matted, fibrous patches in the rock, and as replacement and reaction rims of clinopyroxene.

In addition to these granophyric patches, Unit 2 also differs from the other rocks in the abundance of opaque phenocrysts. Tables 9 and 10 show that there are no systematic mineralogic changes through the unit, although the lowest portions of Unit 2 in Hole 462 have veins with euhedral magnetite and chalcopyrite. Rhythmic lavering is not observed on any scale.



Igneous Rocks: Hole 462

Aphyric to sparsely phyric sills and "half sills". Units 1, 2, and 4 have clinopyroxene, plagioclase and possible olivine pseudomorphs. Unit 3 has olivine pseudomorphs with spinel inclusions. Alteration veins abundant.

Sparsely phyric sill. Phenocrysts are augite, $An_{70\text{-}60}$ and possible olivine pseudomorphs.

Thin sills often without recovery of margins. Only sparse veins present.

Lower chilled margin present. Augite, An_{78} sparsely phyric basalt and diabase sill, highly altered to clays and chlorite.

Thick diabase sill with abundant veining in upper portion. Rare phenocrysts of augite, very highly zoned calcic plagioclase and titanomagnetite. Granophyre patches of intergrown quartz and K-feldspar and amphibole are common.

Figure 20. Igneous rocks, Hole 462.

Table 8. Igneous units.

Contact	Criteria Used (see text)	Criteria in Which No Difference Was Observed (see text)	Remarks
Unit 1/Unit 2	1, 5	2, 3, 4, 6, 7,	Bottom margin of Unit 1 not observed
Unit 2/Unit 3	1, 5	2, 3, 4, 6, 7	Bottom margin of Unit 2 not observed
Unit 3/Unit 4	1, 2, 5	3, 4, 6, 7	Unit 3 is fine-grained throughout; contact is sharp
Unit 4/Unit 5	1	2, 3, 4, 5, 6, 7	Contact is sharp
Unit 5/Unit 6	1, 5, 7	2, 3, 4, 6	
Unit 6/Unit 7	1, 5, 6, 7	2, 3, 4	
Unit 7/Unit 8	1, 3, 5	2, 4, 6, 7	Bottom marginal zone of Unit 7 not observed
Unit 8/Unit 9	1, 5	2, 3, 4, 6, 7	Bottom margin zone of Unit 8 not observed
Unit 9/Unit 10	1, 5, 6, 7	2, 3, 4	
Unit 10/Unit 11	1, 2, 3, 4, 5, 6, 7	—	

Mode of Intrusion

There can be little doubt that the igneous units penetrated by Hole 462 are sills. Where chilled margins were recovered, they are sub-horizontal. When recovery permits (as in Unit 10), orderly and symmetrically decreasing grain-size variations are observed approaching the margins. These observations, together with the total lack of characteristic pillow-lava features, gives strong support to this conclusion. However, the presence of volcaniclastic-sediment interlayers between sills may indicate that the sill-producing magmatic episode was associated with contemporaneous extrusive activity nearby. The importance of multiple igneous intrusion versus intrusion into sediments or along sediment/sediment or sediment/sill bedding planes is more difficult to establish. This is primarily because of poor recovery in crucial intervals, mainly in Cores 60, 61, and 62. The observed grain-size variations in the recovered rocks are consistent with sequential multiple or composite intrusion of Units 2 and 3 into a unit consisting (prior to intrusion) of Units 1 and 4. Similarly, Unit 8 could have been multiply intruded into an igneous unit consisting of Units 7 and 9. Alternatively, Unit 9 could have been intruded into the Unit 7 sediment or Unit 8 sediment bedding plane.

Major-Element Chemistry

Batiza et al., (this volume) gives the results of shipboard chemical analyses using X-ray-fluorescence (XRF) methods. Loss on ignition was determined gravimetrically. These data permit a few generalizations:

1) Whole-rock chemistry appears to be a function of grain size. Rocks with variolitic or hyalopilitic textures have higher MgO, Al_2O_3, and K_2O; lower TiO_2, FeO*, MnO, and CaO contents; and lower FeO*/MgO, CaO/Al_2O_3, and TiO_2/FeO* ratios than holocrystalline rocks. This is probably because of a combination of two factors: (a) replacement of glass by smectite and chlorite, and (b) a coincidentally greater degree of fractionation in the holocrystalline rocks (Fig. 20). The composition of the smectite will be important in evaluating the relative importance of each of these or other factors.

2) The holocrystalline rocks are mineralogically and chemically very similar to mid-ocean-ridge tholeiite, but they are moderately to badly altered. Alteration has produced slight changes in the whole-rock major-element chemistry.

Table 9. Petrographic characteristics of igneous rocks, Hole 462.

Unit	Thickness (m)	No. of Thin Sections	Types of Phenocrysts[a]	Total % of Phenocrysts	Alteration[b]	Textures[c]
1	1	3	1, 2, An_{70-65}	2–10	1, 2, 3, 5, 6	V, H, I
2	1	2	1, 2, An_{68}	4	1, 2, 3, 5, 6	H, E
3	2.5	6	1, 3, An_{80-70}	2–10	2, 3, 4, 5, 6	V, H
4	0.14	1	1, 2, An_{65}	3	2, 3, 4	I
5	1	0	Aphyric	—	—	E
6	4.7	2	1, 3, An_{70-60}	1	3, 4, 7	D
7	1.3	1	2, An_{80-50}	1	3, 4	D
8	0.62	1	1, 2, An_{74}	1	2, 3, 4	V
9	1.2	0	—	—	2, 3, 7	I, E, D
10	6	6	1, An_{78}	0–4	2, 3, 4	V, H, I, E, D
11	25 (minimum)	21	1, 4, An_{80-27}	0–5	2, 3, 4, 7	D

[a] Phenocrysts: 1 = augite; 2 = possible olivine pseudomorphs; 3 = olivine pseudomorphs with spinel inclusions, 4 = titanomagnetite.

[b] Alteration: 1 = calcite; 2 = chlorite; 3 = green clay; 4 = brown clay; 5 = zeolite; 6 = iron and manganese oxides and hydroxides; 7 = pyrite.

[c] Textures: V = variolitic; H = hyalopilitic; I = intersertal; E = equigranular; D = diabasic.

Table 10. Modal analyses, Hole 462.

Sample	Unit	Plagioclase	Augite	Titano-magnetite	Chlorite	Green and/or Brown Clay	Amphibole	Quartz	Total No. of Points
462-61-2, 53–56 cm	6	37	34	8	12	7	—	—	580
63-3, 119–122 cm	10	34	17	9	39	Tr	—	—	584
64-3, 79–81 cm	11	41	11	7	40	Tr	—	—	500
65-2, 27–30 cm	11	42	28	6	5	5	12	1	695
66-4, 12–14 cm	11	35	27	9	30	Tr	—	—	589
68-2, 37–39 cm	11	41	29	8	1	Tr	17	3	538
68-2, 49–51 cm	11	34	28	6	Tr	Tr	28	4	465
69-1, 36–38 cm	11	42	16	8	7	Tr	16	11	471

Within the set of holocrystalline rocks, the following elemental trends are observed: P_2O_5, SiO_2, MnO, and CaO remain about constant; Al_2O_3 decreases; and TiO_2 increases with higher FeO*/MgO ratio. FeO* and TiO_2 co-vary, but the variation trend is slightly different than that observed in typical oceanic-crust volcanic suites. It is possible that such a trend results from a combination of fractionation and alteration. Crude stratigraphic-chemical variation is observed in Hole 462, but is probably due simply to the fact that Unit 11 shows the widest compositional variation.

Alteration

Veining and alteration are moderate to heavy in all the rocks of Hole 462. Veins are monomineralic and polymineralic and contain:(1) green smectite;(2) brown smectite; (3) mixed smectite and chlorite (celadonite); (4) mixed smectite and Mn/Fe oxides and hydroxides; (5) mixed smectite and calcite; (6) mixed smectite, calcite, pyrite, zeolite; and many other assemblages. The relative replacement/emplacement sequences of these minerals based on textural relationships are highly variable, and in some cases at least two generations of a given phase are clearly visible. The following secondary minerals have been identified optically in the rocks of Hole 462:

Brown smectite (Al, Mg-rich)	Calcite
Green smectite (Fe-rich)	Mn/Fe hydroxides and oxides
Red smectite (very Fe-rich)	Pyrite
Yellow smectite (Fe-rich)	Chalcopyrite
Chlorite	Magnetite
Disordered hydromica (?)	Amphibole (two kinds)
Chalcedony	Zeolites (at least two or three kinds)
Quartz	

At least two major types of post-solidification alteration probably have affected the rocks: (1) sea-water alteration, which resulted in precipitation of smectites, calcite, zeolite, sulfides, SiO_2, and Mn/Fe hydroxides, and (2) late-magmatic or deuteric processes which have resulted in the production of micropegmatite, amphibole, and possibly chlorite, quartz, and Fe-oxide mineralization.

Hole 462A

Figure 21 shows the stratigraphy and mineralogy of the basaltic rocks from Hole 462A

Physical Characteristics and Mode of Emplacement of the Igneous Units

The igneous section drilled in Hole 462A has been subdivided into units (Fig. 22). These units were distinguished on the basis of differences in any one or a combination of physical, textural, or lithologic attributes, as were those of Hole 462. The units of Figure 22 contain one or more of five kinds of igneous units: (1) single basalt sills, (2) compound or multiple basalt sills, (3) basalt flows or groups of flows, (4) hyaloclastite/hyaloclastite breccia, and (5) possibly a pillow lava unit. The criteria which have been used to distinguish each of these igneous units are discussed in turn below.

Single sills have been recognized by the same characteristics as were used for the rocks of Hole 462: (1) glassy margins or fine-grained marginal zones with subhorizontal attitude, and (2) orderly coarsening-inward grain-size variations, coarse-grained interiors, and diabasic texture. Units 6, 12, 13, 21, and 25 (Fig. 22) are some examples of single basalt sills. Their thickness ranges from a few tens of centimeters to over 50 meters. In some cores, baked sediment and glass contacts were recovered, but in most (as with Hole 462) the glassy sill margins were not recovered. In the latter case, however, narrow, fine-grained marginal zones were recognized. The sill units exhibit a narrow range of mineralogical and chemical variations, and the thicker ones (>5–10 m) invariably contain patchy granophyric intergrowths.

Multiple sills are more difficult to distinguish with certainty. In some cases (e.g., Units 33 and 34) where fine-grained to glassy apophyses are present, multiple intrusion, at least on a small scale, can be demonstrated. On larger scales, multiple intrusion has been inferred from the alternation of fine-grained and coarser-grained units (as in Units 31 and 33) which lack glassy margins in drill cores where recovery was very high. In such cores, abrupt changes in grain size near horizontal or near-horizontal contacts are observed. These observations support the interpretation that these units represent multiply intruded sills, although we recognize that such features also may be developed within single extrusive bodies.

At least two types of multiple intrusions can be recognized in the rocks of Hole 462A. The first type occurs in the upper portions of the section (e.g., Units 1–5) and is characterized by subtle grain-size variations, but distinct mineralogic differences between the individual units. This type of multiple intrusion may represent the sequential emplacement of one magma batch in a series of several smaller batches, each of which has undergone a different degree of fractionation (perhaps flow differentiation).

The second type of multiple intrusion occurs in the lower portions of the igneous section. This type is characterized by greater differences in grain-size and an absence of mineralogical differences among the various grain-size domains. Units of this type are associated with units of obvious extrusive character and may in fact be portions of thick flows. In this case, the grain-size variations could be due to turbulent flow during cooling, heterogeneous distribution of volatile components, complex isotherm distributions, or other factors.

Flows have the following characteristics: (1) variable but small thickness (0.3–2.0 m) of units; (2) thick (up to 4 cm) glassy margins on upper and lower contacts; (3) fine grain size throughout, but a patchy appearance which results from mixed textures; (4) variable attitude of glassy margins (dips of glassy margins range from horizontal to vertical; contorted shapes, often with reentrant surfaces are common); (5) ubiquitous cooling cracks normal to glassy surfaces, and numerous cracks

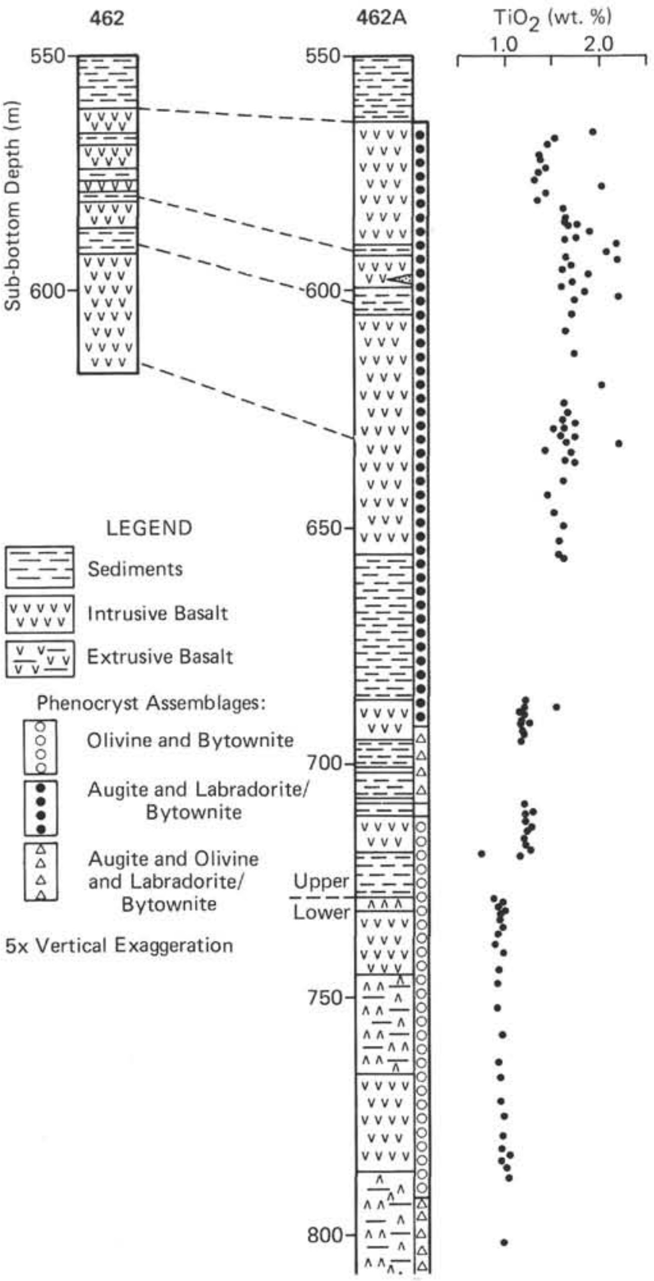


Figure 21. Stratigraphy and mineralogy of basaltic rocks, Holes 462 and 462A.

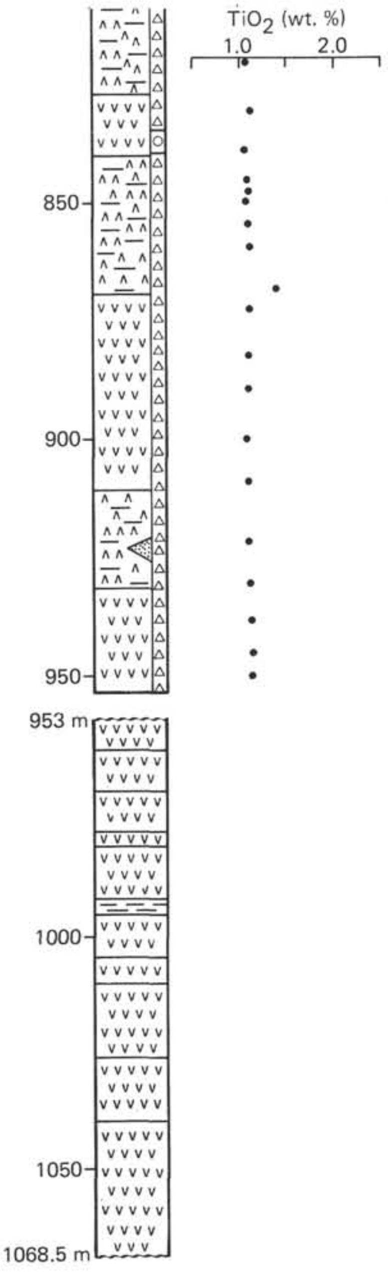


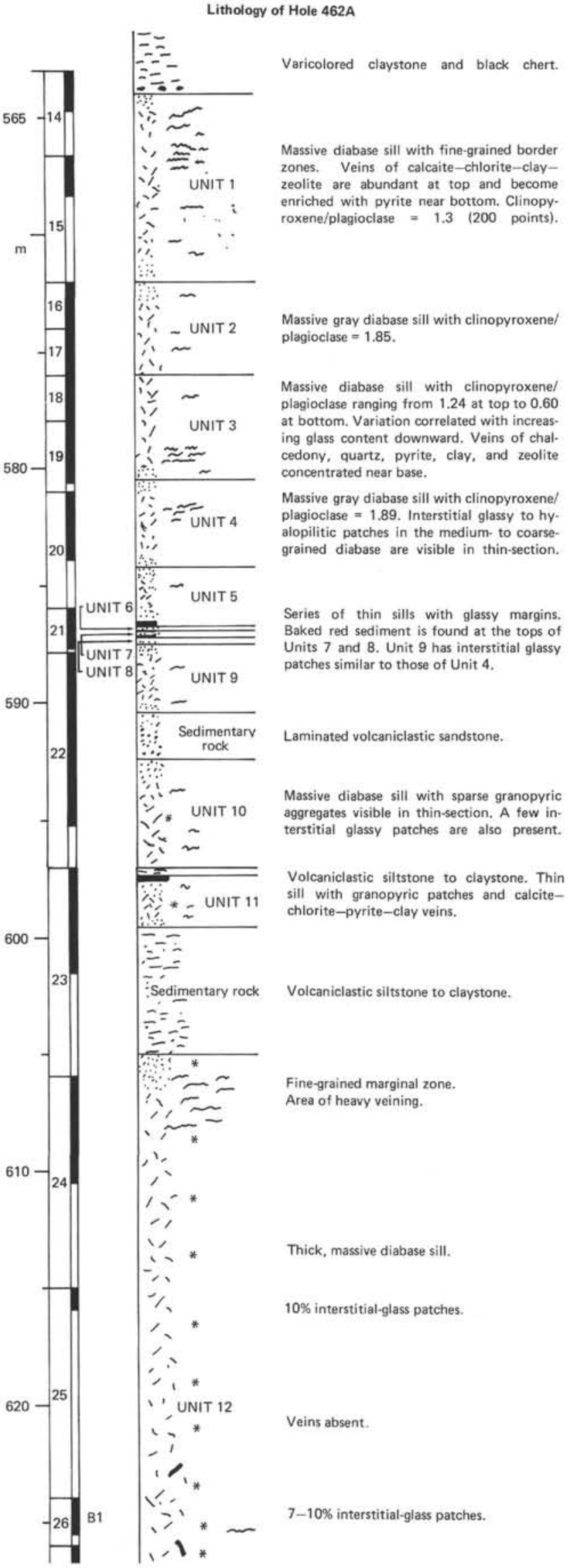
Figure 21. (Continued).

in the interior, crystalline portions of units (these interior cracks do not display preferred orientation); (6) inclusions and thin apophyses of fine-grained material in coarser-grained basalt, suggesting turbulent flow and mixing within cooling units.

These characteristics strongly suggest that these units (e.g., Units 23, 26, and 29) are either extrusive or were intruded into very soft, water-rich sediment, but the almost total lack of sediment inclusions or infolded sediment pockets suggests that these units were likely extruded directly onto the sea floor. However, these units have none of the characteristics of pillow lava. They lack (1) radial cooling fractures, (2) concentric structures, (3) regular, curved surfaces, (4) interior hollows or vugs, and (5) inter-pillow matrix material.

The mode of extrusion of these flows could be either (1) slabby pahoehoe type, or (2) a series of shingled, lobate, and narrow advancing flow fronts similar to pillow lava, but extruded more rapidly. The formation of pillow forms in this case might be inhibited by rapid extrusion rate, as at fast-spreading ridge crests. Hollows apparently have formed between flows or lobes of single flows in the Hole 462A rocks. These vugs are now filled with aggregates of euhedral, inward-pointing phillipsite crystals.

Hyaloclastite and *hyaloclastite breccia* units are abundant in the upper part of Hole 462A, but are rare in



Varicolored claystone and black chert.

Massive diabase sill with fine-grained border zones. Veins of calcaite–chlorite–clay–zeolite are abundant at top and become enriched with pyrite near bottom. Clinopyroxene/plagioclase = 1.3 (200 points).

Massive gray diabase sill with clinopyroxene/plagioclase = 1.85.

Massive diabase sill with clinopyroxene/plagioclase ranging from 1.24 at top to 0.60 at bottom. Variation correlated with increasing glass content downward. Veins of chalcedony, quartz, pyrite, clay, and zeolite concentrated near base.

Massive gray diabase sill with clinopyroxene/plagioclase = 1.89. Interstitial glassy to hyalopilitic patches in the medium- to coarse-grained diabase are visible in thin-section.

Series of thin sills with glassy margins. Baked red sediment is found at the tops of Units 7 and 8. Unit 9 has interstitial glassy patches similar to those of Unit 4.

Laminated volcaniclastic sandstone.

Massive diabase sill with sparse granopyric aggregates visible in thin-section. A few interstitial glassy patches are also present.

Volcaniclastic siltstone to claystone. Thin sill with granopyric patches and calcite–chlorite–pyrite–clay veins.

Volcaniclastic siltstone to claystone.

Fine-grained marginal zone.
Area of heavy veining.

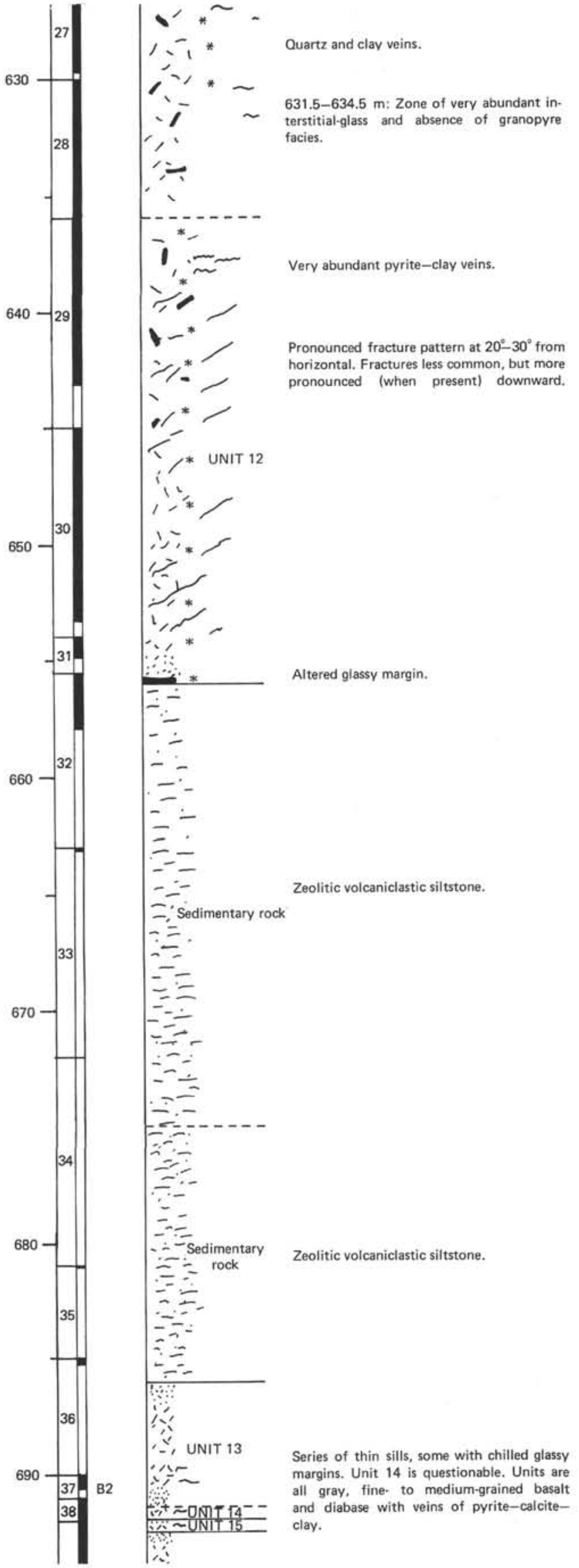
Thick, massive diabase sill.

10% interstitial-glass patches.

Veins absent.

7–10% interstitial-glass patches.

Figure 22. Summary of core data and igneous-rock units.



Quartz and clay veins.

631.5–634.5 m: Zone of very abundant interstitial-glass and absence of granopyre facies.

Very abundant pyrite–clay veins.

Pronounced fracture pattern at 20°–30° from horizontal. Fractures less common, but more pronounced (when present) downward.

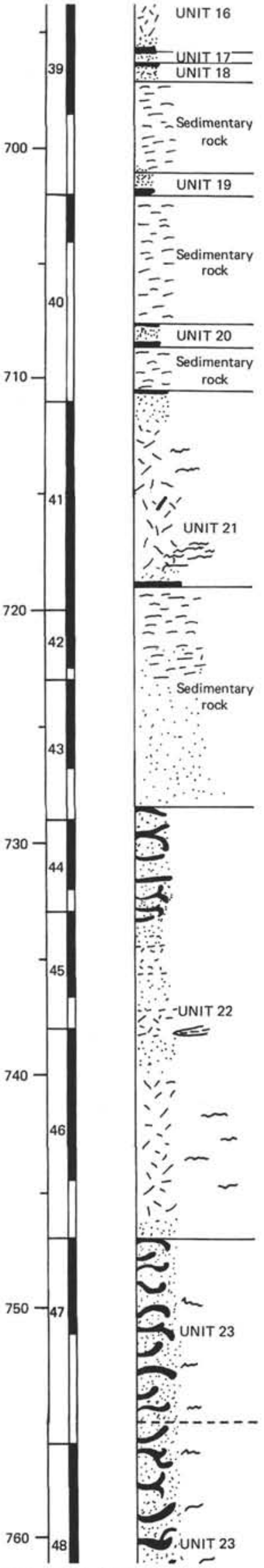
Altered glassy margin.

Zeolitic volcaniclastic siltstone.

Zeolitic volcaniclastic siltstone.

Series of thin sills, some with chilled glassy margins. Unit 14 is questionable. Units are all gray, fine- to medium-grained basalt and diabase with veins of pyrite–calcite–clay.

Figure 22. (Continued).



Sediment horizon inferred from drilling rate.

Thin diabase sill.

Sediment layer inferred from drilling rate.

Thin sill with glassy margins.

Laminated claystone containing pyritized plant remains.

Massive diabase sill with calcite–chlorite–pyrite–clay veins.

Dark-green claystone, cross- and horizontally-laminated claystone.

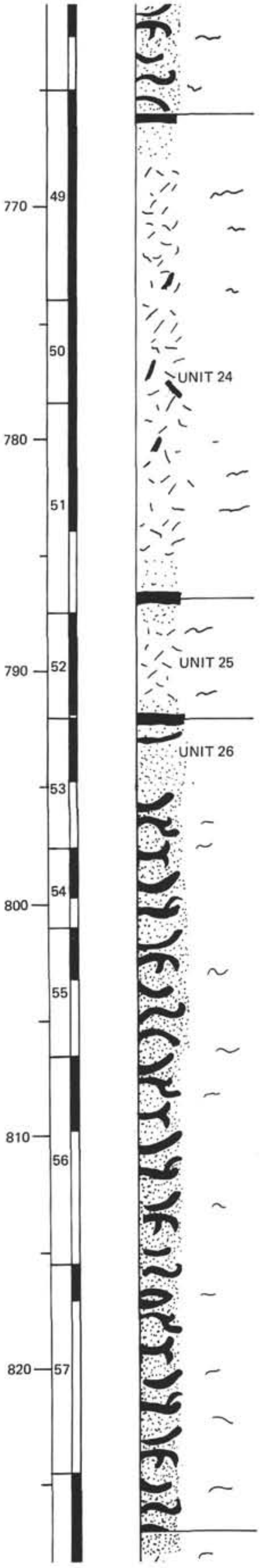
Volcaniclastic sandstone and siltstone with grading and soft-sediment deformation.

Topmost portion of unit consists of very thin units of fine-grained basalt with subhorizontal to subvertical glassy margins. These units lack characteristic features of pillow lava, but probably represent extrusions. Lower portion of this unit consists of alternating fine- and medium-grained basalt without glassy margins, which may be a series of multiple intrusions. Zeolite is very abundant in glassy areas.

Chlorite–pyrite veins.

Massive series of extrusive units (at least 19 individual units ranging from 2–30 m). Zeolites (phillipsite), pyrite, and clay are common as veins and pods, often associated with glassy portions.

Figure 22. (Continued).

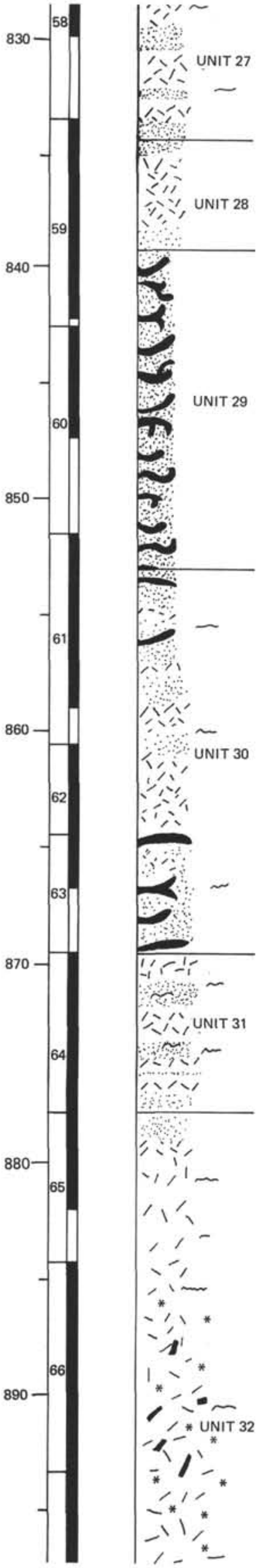


Medium-dark-gray, massive diabase sill with chilled margins, coarse-grained interior, and granophyric patches.

Diabase sill with pyrite–clay–zeolite veins.

Identical to Unit 23 in all its characteristics. This unit consists of at least 17 individual units.

Figure 22. (Continued).



Alternating fine- and medium-grained units which lack glassy margins. Possibly multiple intrusions.

Massive diabase sill.

This series of extrusives consists of at least 16 individual units ranging in thickness from 1–0.3 m. Alteration is similar to that of previous units of this type.

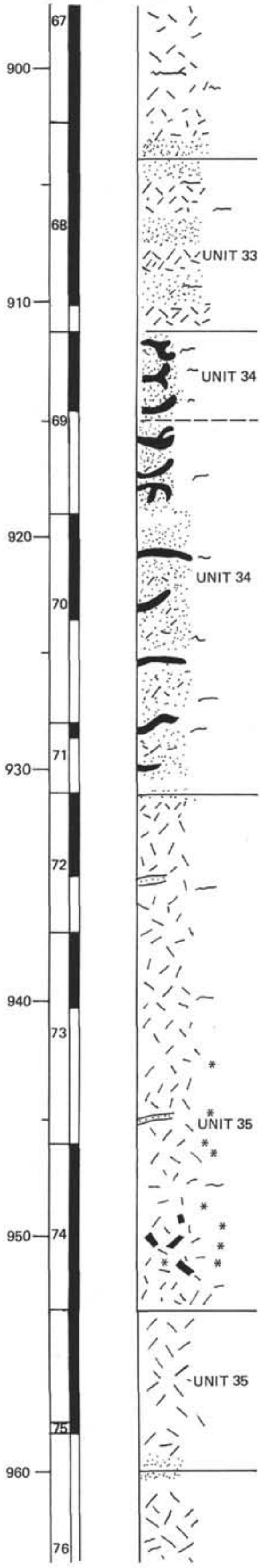
Chlorite–Pyrite–Zeolite veins

Flows of slightly greater thickness than those of previous units, together with alternating units of fine- and medium-grain size. These could be either multiply intruded sills or portions of thick flows.

Alternating fine- and coarse-grained units without glassy margins. May be multiply intruded upper border zone of thick sill below.

Thick dolerite sill with granophyric facies in central portion. Veins are of chalcedony–pyrite–chlorite–clay–calcaite, and also a white, flaky phylosilicate.

Figure 22. (Continued).



Alternating fine- and medium-grained basalt units. May be lower border facies of Unit 32.

Thin flows of basalt, grading downward into thicker flows with minor amounts of intercalated hyaloclastite and hyaloclastite breccia. Veins of chalcedony, calcite, pyrite, and green clay.

Massive medium-grained diabase, very slightly altered. Subophitic texture.

Fine-grained diabase with some alteration and a subophitic texture.

Figure 22. (Continued).

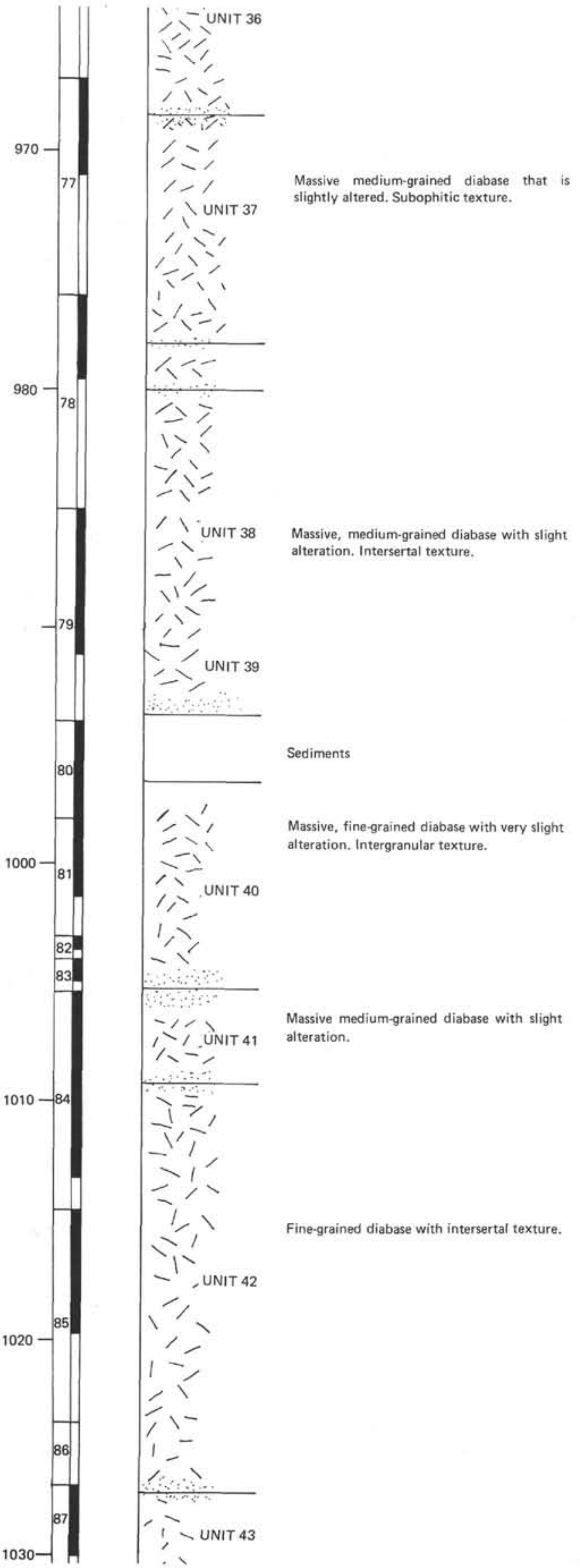


Figure 22. (Continued).

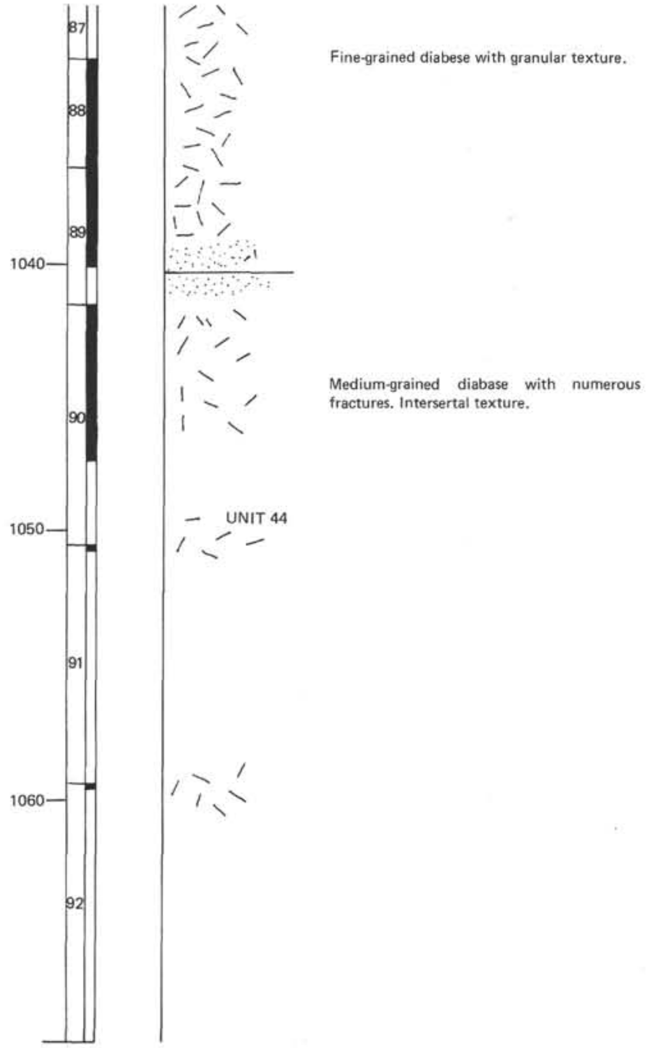


Figure 22. (Continued).

the lower portions. These units will be described elsewhere (Moberly and Jenkyns, this volume). These units are important because they contain deep-water benthic-foraminifer tests (Sliter, this volume), among other things. In addition, the presence of hyaloclastites supports the suggestion that at least part of the major Nauru Basin volcanic episode was extrusive.

A single occurrence of possible *pillow lava* is found at the base of Core 71 (Unit 34). These possible pillows have radial cracks, concentric and curved internal structures, and interior clay-filled vugs, and their grain size increases inward from the margins. They lack glassy margins and have instead altered basalt margins of micro-intrusion breccia. One pillow is about 20 cm across, and the other about 8; they do not have all of the characteristics of typical pillows, but they may nevertheless be genuine pillows, and in this they are unique among the rocks recovered from Hole 462A.

Summary of Petrographic Data

The igneous rocks of Hole 462A are petrographically very similar to those of 462, and will not be discussed in detail, but a few features which are found only in Hole

462A will be discussed briefly. The granophyre facies in the thick sills of Hole 462A is not confined to the thick sills in which the granophyre fluid was presumably produced, as was the case in Hole 462. Instead, this low-viscosity, SiO_2-rich fluid apparently permeated neighboring units. This evidenced by the occurrence of quartz and quartz-feldspar-apatite intergrowths in thin sills adjacent to the thick, granophyre-producing sills (e.g., Unit 12, Figure 22). The mineralogy of the sills of Hole 462A is almost identical to that of the Hole 462 sills, but some textural variations are observed. For example, coarser-grained rocks containing interstitial, polygonal patches of glassy to variolitic rock are more common in the Hole 462A sills. These patches are probably the result of decompression freezing in the latter stages of the sill's solidification.

Glassy rocks are much more common in Hole 462A than in Hole 462. They display typical vitrophyric to variolitic textures. In some cases, fresh relict olivine phenocrysts are preserved within fresh glass. These glassy rocks are most common and abundant in the extrusive units, which also display a great variety of unusual fine-grained textures. Of particular interest is spinifex-like quench texture developed in groundmass clinopyroxene, which is common in rocks of Units 22 and 23 (Batiza et al., this volume).

A few generalizations about the mineralogy of Hole 462A rocks can be made:

1) The basalts are all aphyric or sparsely phyric.

2) Several phenocryst assemblages are observed: (a) olivine (with spinel inclusions) + bytownite; (b) olivine + clinopyroxene + labradorite or bytownite; (c) clinopyroxene + labradorite.

3) These assemblages are distributed more or less systematically through the section and are to some extent reflected in the chemical compositions of the basalts.

Figure 21 shows that, on simple inspection, units of petrographic group (b) appear symmetrically disposed about a group of units of type (a) between about 710 and 790 meters sub-bottom.

Correlation between Holes 462A and 462

Figure 21 shows that some correlations can be made between Holes 462 and 462A. There is little doubt, for example, that the Unit 11 of Hole 462 (Fig. 20) is the same thick sill encountered in the upper part of Hole 462A (Unit 12). In addition, some of the sediment horizons encountered at similar sub-bottom depths in both holes may be continuous between the holes. It is clear, however, that most of the thin sills of Hole 462 do not extend laterally to Hole 462A. Many of the thinner sediment horizons also appear to pinch out.

This pattern suggests significant three-dimensional lithologic heterogeneity on a scale of less than 500 meters (the distance between the holes). However, since the chemical compositions of the uppermost basalts in each hole are very similar, it is probable that they are closely related temporally. They even may have been fed by the same major conduit.

Part B (by S. Shcheka)

Rock Fragments Recovered in Cores 462-4 to 462-21 and Their Petrologic Significance

Thin-sections and smear-slide observations of about 50 rock and mineral fragments taken from these cores revealed the following:

1) Scoriaceous, glassy, alkaline basalts with perfectly shaped crystals of olivine and titanaugite. In all fragments, the pale-brown glass is very fresh, and no alteration was observed. Small (0.1-0.5 mm) inclusions of titanaugite dolerite in the glass probably belong to the early subvolcanic phase of a single volcano.

2) K-feldspar (probably anorthoclase) dolerites with titanaugite, kaersutite, magnetite, and needles of apatite—and a mineral, replaced by calcite, which was probably nepheline.

3) Magnetite-plagioclase-kaersutite-titanaugite dolerites. Coarse Ti-augite phenocrysts are strongly zoned and colored (pinkish-brown) in contact with the groundmass.

4) Plagioclase glassy basalts. The glass is fresh, the clinopyroxene is homogeneous, and the plagioclase laths show flow alignment.

5) Coarse (> 1 mm) fragments of colorless crystals of olivine ($2V_\gamma \approx 80°$), orthopyroxene ($2V_\gamma \approx 80°$), and pale-grass-green diopside ($2V_\gamma \approx 60°$). The diopside looks like chrome diopside. Fine inclusions (0.1 mm) of translucent spinel octahedrons are commonly observed in the olivine. Being included in glass, these crystals show distinct optical zonation and alteration rims, i.e., they were unstable in the original basalt melt. All five features are characteristic of phases which belong to lherzolite inclusions in alkaline basalt. The large size and high magnesium content (according to optical properties) of these crystals are not features characteristic of basalt phenocrysts.

These results show that the petrologic assemblage of fragments could belong to a stage of edifice-building in which alkaline eruptions alternate with tholeiite eruptions (Hawaiian type). Absence of the slightest signs of metamorphism and weathering in minerals, especially in glass, and the sharp-edged debris are evidence for the formation of such an edifice near Site 462. The vesicular, trachytic textures of the rocks—in addition to the subvolcanic facies in glassy lavas, combined with the features listed above—are in clear agreement with subaerial explosive eruptions. Consistency of debris composition and texture, along with a considerable age interval (Oligocene–Pleistocene) allow us to suppose that a long-standing volcano of Hawaiian type is near Site 462 (probably on the west side of the Marshall Islands, because of its proximity). Alkali-basalt volcanoes with deep-seated inclusions are commonly located on continental crust—rarely on oceanic islands of the Hawaiian type—but are unknown in oceanic rift zones. These occurrences are correlated with the nature and thickness of the crust in these regions and suggest the possible existence of thick crustal blocks in the Nauru Basin. This correlation is linked to the wider problem of the origin of oceanic alkali-basalt magma, which has an important bearing on the reconstruction of oceanic-crust evolution and deserves to be investigated on future DSDP legs.

Chemical Results, Holes 462 and 462A

METHODS

More than 100 samples of volcanic rock from Holes 462 and 462A have been analyzed aboard ship using (XRF) techniques. The Siemens (FRG) XRF spectrometer allowed determination of nine elements: Si, Ti, Al, Fe, Mn, Mg, Ca, P, and K. We will confine this discussion to a brief decription of sample-preparation procedure.

First, all samples are rinsed in distilled water and dried at 110°C for about 10 minutes to remove sea-water impurities. Next, the dried sample is crushed in a piston-cylinder "Abish"-type mortar, using a 20,000 lb/in.^{2} hydraulic press, then ground in an agate mortar for 5 to 10 minutes. A quantity of this powder is then heated for at least 6 hours at 110°C to remove non-structural water. Unfortunately, this heating step also partly disturbs the crystal structures of low-temperature minerals such as clays, zeolite, and chlorite. About 700 mg of dried powder are then calcinated at 1050°C for determination of weight loss on ignition (LOI).

An aliquot of calcinated powder is then fused in a Rh-Au-Pt crucible (OPR-3) with $Li_2B_4O_7 + La_2O_3$ flux (3.4 and 0.6 g, respectively for 2 hours. The glass discs which are thus produced are used for the analyses. Element values are calculated by comparing sample-intensity ratios to a set of standard rocks of known chemical composition. These standards are BR, GA, GH, DRN, MAR, DTS, BCR-1, and PCC-1. Precision and accuracy of the analyses are better than 1% for the major elements of fresh samples (LOI $\leq 2\%$). Volatile-rich samples may lose some alkali elements during fusion, as determined from experimental petrologic work.

Results and Discussion

Alteration

To interpret the chemistry of oceanic basalt magma, one must consider the conditions under which submarine eruptions take place. During oceanic basalt emplacement, the magma consolidates either in direct contact with sea water or in contact with water-saturated rocks. In Holes 462 and 462A, for example, the water content of sedimentary rocks is more than 20% at depths of up to 500 meters below the sea floor. Very rapid quenching, even for moderately deep intrusives in such sediments, and sea-water-rock chemical reactions are two important consequences of eruption under these conditions. As a result, the chemical compositions of submarine lavas on freezing may differ greatly from the composition of the original primary magma. In the following discussion, we attempt to describe the specific chemical changes which have resulted from submarine emplacement in the rocks of Holes 462 and 462A. Unfortunately, detailed shipboard mineralogic studies are not possible; thus this discussion will be limited to several short comments. Shore-based laboratory mineralogical studies to be carried out later will add greatly to our understanding of the chemical effects of alteration.

Abundant and diverse products of alteration are represented in the recovered rock samples (Fig. 23). Throughout the drilled interval, olivine has been converted to iddingsite, volcanic glasses are palagonitized, and rocks are cut by numerous veins of chlorite, clay minerals and pyrite. Calcite, opal-quartz, and zeolites are also found. It is important to note that higher-temperature secondary minerals such as epidote, albite, actinolite, and adularia, which are invariably encountered in ancient continental basalts, are absent in these rocks. This demonstrates conclusively that the alteration occured at low temperatures (< 150°C).

Following the classification of metasomatic rock facies of Korzhinskiy (1957), the volcanic rocks of Holes 462 and 462A can be divided into three groups: (1) facies of near-neutral hydrothermal conditions, resulting in hydration of olivine and glass; (2) facies of acidic hydrothermal conditions, resulting in production of aluminous chlorite, quartz, and pyrite; (3) facies of alkaline conditions, resulting in zeolites and carbonates.

Metasomatic alteration of the first group is a result of sea-water reaction with basalt on a regional scale. The least-stable phases under these conditions, volcanic glass and olivine, are subjected to hydration; the former is palagonitized and the latter is replaced by alkali-poor members of the nontronite-saponite series of smectites. This type of alteration does not result in large-scale removal of highly mobile components such as alkalies; it is essentially isochemical. In addition, plagioclase and clinopyroxene remain unaltered under these conditions. Fresh clinopyroxene and plagioclase are observed in thin sections of the rocks of Hole 462 and 462A. The plagioclase microphenocrysts of these rocks show primary compositional zonation (An_{80}–An_{45}) related to changes in primary magma chemistry during crystallization.

Metasomatic alteration of the second and third types is local, contrasting with alteration of the first type. This type of alteration occurs after consolidation and cracking of the emplaced rocks, and involves open-system circulation of high-temperature hydrothermal solutions. In the rocks recovered on Leg 61, such alteration has led to preferential formation of zeolite veins near glassy margins of thin sills and flows. This process was probably promoted by the alkalization of initially acidic volcanic hot-spring waters. Optical examination of the zeolites of Leg 61 rocks reveals the presence of at least three crystomorphologic types: (1) tabular forms, (2) drusy aggregates of euhedral prismatic crystals, and (3) radiating acicular bundles. The second type has the optical properties of phillipsite.

Monomineralic veins of calcite are commonly localized near basalt contacts with sedimentary rocks. Pyrite-chlorite veins are found in the entire section at Holes 462, 462A, and chlorite is being replaced by clay minerals in almost all cores. Pyrite appears to be the latest mineral; it occupies the interior portions of chlorite-clay veins. Thicker veins show the following mineral zonation from margin to core (Figs. 24–29) chlorite + pyrite (pH <7)→calcite→zeolite (pH >7) reflecting the increasing pH of the circulating solutions, caused by chemical reactions with solid rock. Sometimes opal, rather than zeolite, has replaced calcite grains, which indicates injection of fresh acidic solutions into the system. Colloform textures are characteristic of calcite, opal, and zeolite in veins. In addition, potassium- and aluminum-rich clay minerals are produced under these more-acidic conditions.

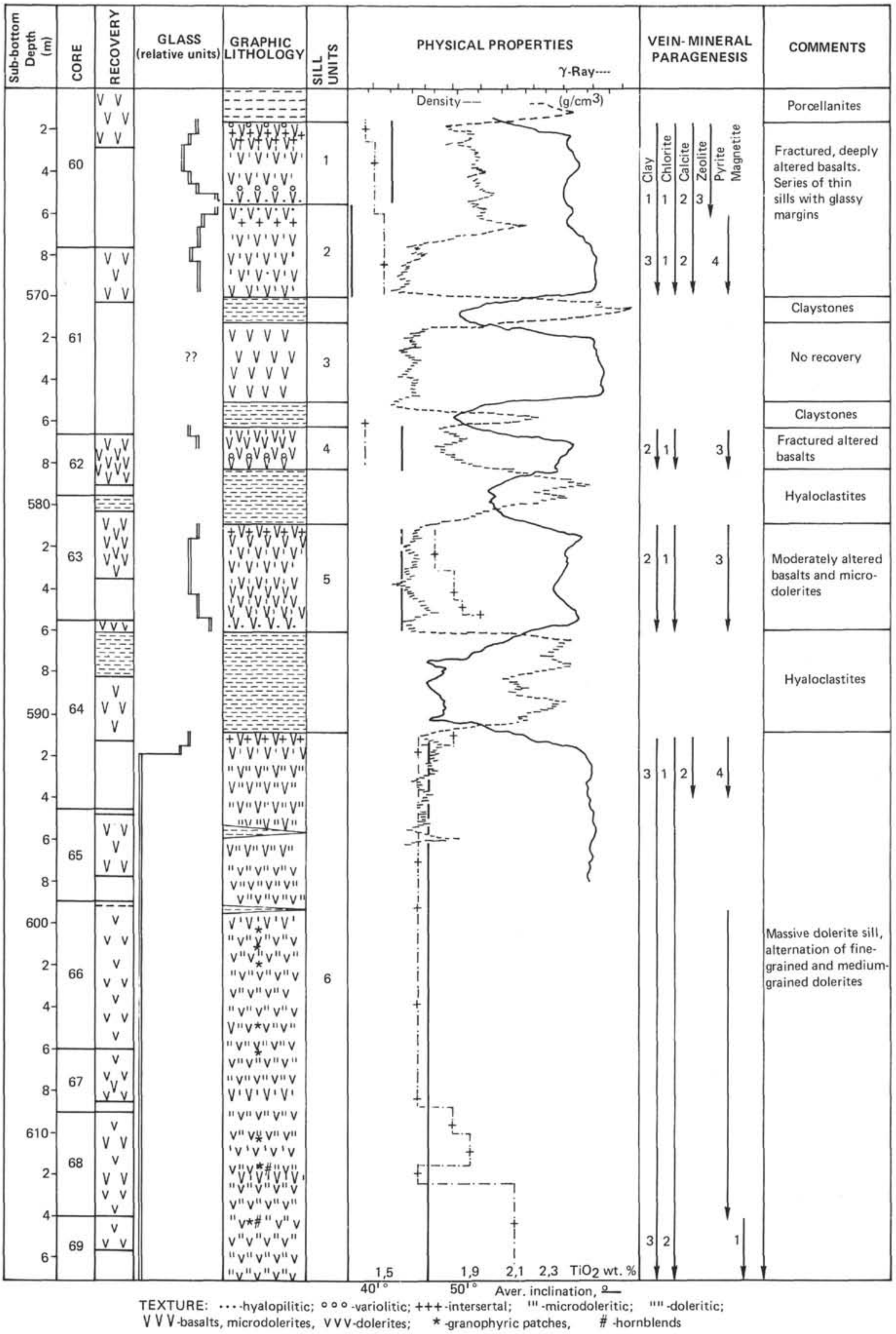


Figure 23. Leg 61, Hole 462, 560 to 617 meters.

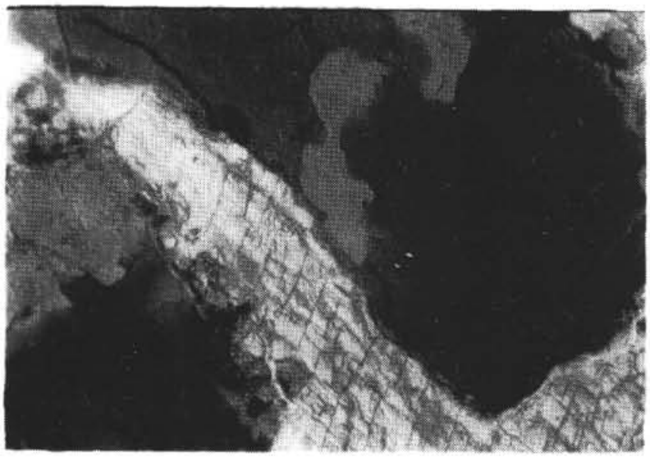


Figure 24. Part of a secondary-mineral vein at 462-60-2, 53-57 cm, showing two types of smectite and calcite (field of view is 1.0 mm).

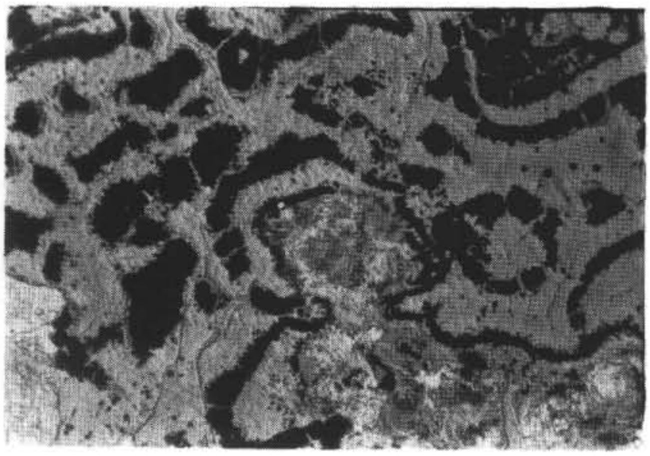


Figure 25. Green smectite and iron-manganese oxides at 462-60-2, 103-107 cm (field of view is 2.0 mm).

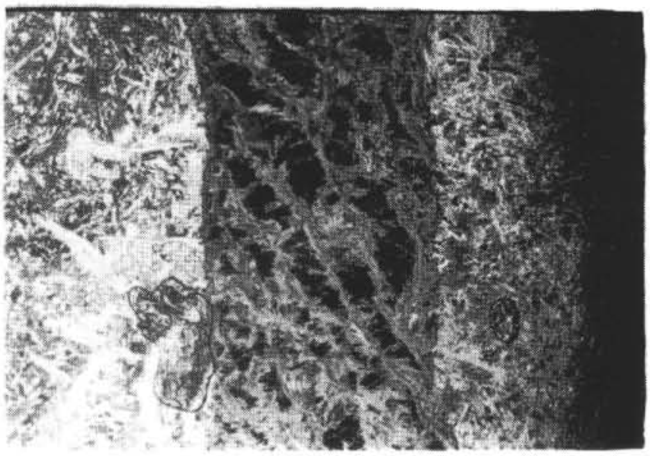


Figure 26. Vein of smectite and opaque material at 462-60-2, 103-107 cm (field of view is 4.0 mm).

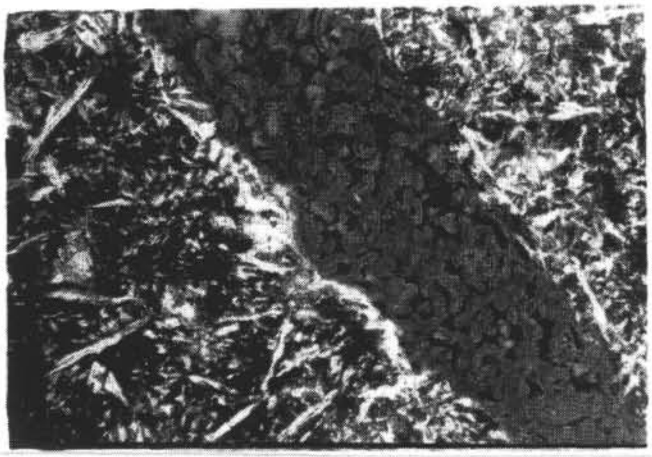


Figure 27. Vein of smectite and opaque material at 462-60-2, 103-107 cm (field of view is 4.0 mm).

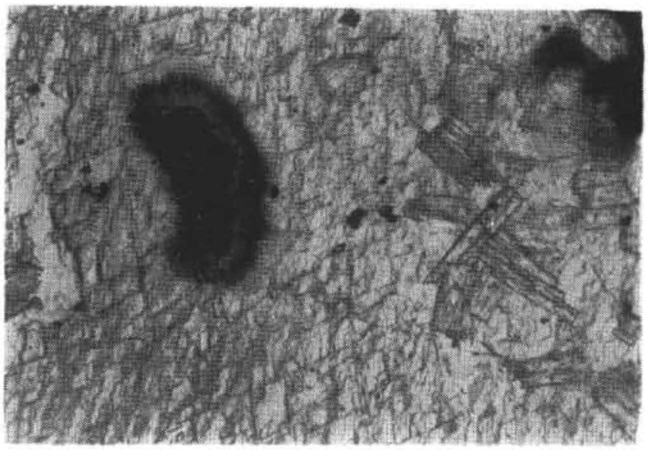


Figure 28. Dark patch consists of Fe-Mn oxide with celadonite rim. Zeolite replaces calcite on the right side of photomicrograph (field of view is 1.0 mm). (Same vein as in Fig. 29.)

Figure 29. Zoned secondary-mineral vein at 462-60-1, 55-59 cm. Outer part of vein is celadonite (dark), and inner part is calcite. Both minerals are replaced by zeolite (anhedral) (field of view is 3.0 mm).

According to Korzhinsky's (1957) theory, in agreement with our observations of vein mineral assemblages, acidic alteration is characterized by relative immobile "acidic" elements, such as Si, Ti, Al, and Fe^{+3}, and highly mobile Na, K, Ca, Mg, and Fe^{+2}. In processes of alkali alteration, the opposite is true, with the possible exception of Ti and Fe^{+3}, which are commonly rather refractory in either case. Thus, the chemical composition of the primary magma may be greatly modified by either acidic or alkaline open-system hydrothermal alteration.

Octahedral magnetite is found in contraction cracks of some of the thick sills drilled during Leg 61 (two systems of fractures with dips of about 30 and 60°). This mineral appears to be high-temperature infilling, and the cracks within which it is found are cut by all of the other types of veins described previously. These veins are analogous to late-magmatic pneumatolitic ore veins found in many thick sills on continents. Another notable feature of the Leg 61 sills is the presence of euhedral microphenocrysts of magnetite.

The last type of alteration observed in the Leg 61 sills is autometasomatic amphibolitization and biotitization. The phenomenon is well understood and requires no further comment. These are high-temperature phases in the Leg 61 sills; they appear to be Ti-rich, on the basis of their optical properties.

In summary, the following sequence of metasomatic alteration by acid and alkaline solutions can be expected:

1) Late-magmatic phase:
   a) Neutral to slightly alkaline stage: Ti-hornblende + Ti-biotite + magnetite veins.
2) Post-magmatic phase:
   a) Early alkaline stage: zeolite, calcite.
   b) early acidic stage: aluminous chlorite.
   c) Late alkaline to neutral stage: Fe- and Mg-rich clay minerals.
   d) Late acidic stage: pyrite, opal, and alkali-alumina-rich clay minerals.

It should be noted that only the acidic and alkalic alteration stages (near veins at Hole 462, 462A) may have resulted in large-scale remobilization of major elements such as Ca, Mg, Fe, Na, and K with associated modification of initial elemental abundances and ratios.

Basalt Chemistry

Because as discussed above, alteration has been important in the Leg 61 rocks, it is necessary to assess its importance quantitatively. At present, only LOI provides this capability. We have verified that most of our analyzed samples do not contain large amounts of zeolites, carbonates, and sulfides; thus, measured LOI is probably due almost entirely to water loss. Unfortunately, we do not yet know the oxidation state of iron in the rocks, so that our LOI determinations represent a minimum value. This is because all of the Fe^{+2} in rock is converted to Fe^{+3} during the analysis (Fe_2O_3/FeO = 1.11). Nevertheless, we can use the LOI determinations as an index of alteration, because all rocks have been similarly affected, and the original FeO/Fe_2O_3 of even the altered basalts does not vary over a very large range. Thus, the Leg 61 samples with total iron between 11 and 16 wt. % have corrected actual H_2O+ contents greater than 1.1 to 1.3 wt. %, as shown in Tables 11 and 12. Keeping this assumption in mind, we will attempt to determine the main petrochemical characteristics of the Nauru Basin volcanics (Tables 13 and 14).

Because of their high mobility, alkali elements are a very sensitive indicator of rock alteration. In the case of Holes 462 and 462A, we can use potassium values. Figure 30 shows that the primary K content of the fresh rocks is extremely low (note that most data plot at the extreme left of the diagram). The K contents decrease to 10^{-3} wt. % at the bottom of the section. In the thick sill (Unit 12, 462A; and Unit 6, 462; Fig. 30), potassium abundances are slightly higher in the portions which contain residual granitic material. As with other tholeiitic magmas, this enrichment in potassium is associated with an increase of SiO_2 (which does not lead to increased alkalinity) in the residual liquid. Our thin-section observations confirm that enrichment of K and H_2O is found most commonly in glassy rocks which have primary water. This observation supports the idea (developed earlier) that the alteration processes which have affected the rocks of Leg 61 are primarily low-temperature processes, and thus most primary mineral phases are fresh.

Potassium partitioning in the glassy rocks appears to follow three distinct patterns, as follows:

1) Hydration of glass, which does not mobilize potassium. Under such conditions the potassium contents of altered rocks are the same as for fresh rocks of the same type. This stage is characterized by the formation of alkali-deficient nontronite-group smectites, and is equivalent to the near-neutral stage of Korzhinskiy (1957). This type of alteration results only in the dilution of the rock components with water, and does not alter the rock's primary geochemical paragenesis.

2) The second type of alteration is usually multistage, and commonly results in the formation of veins near basalt contacts with sedimentary rocks. The observed assemblage of pyrite, chlorite, calcite, clay mineral, and quartz which is found in such veins is a testament to the acidic regime of this alteration type. In this case, the clay minerals which are stabilized are compositionally distinct from those formed under the conditions of alteration of the first type (as defined earlier).

3) Last, alteration of the third type is characterized by moderate water contents and enrichment of K in altered rocks. This is confirmed by the optical identification in rocks of this group of chlorite and a mineral which has the optical properties of hydromica. This type of alteration probably occurs at higher temperatures than the first and second types. The chemical composition of chlorite should allow us to estimate the temperature, which may have been as high as 400°C. Figure 30 shows clearly that H_2O enrichment is correlated with abundance of alteration products (by visual estimate) in the rocks.

Figure 31 shows that modification of CaO and Al_2O_3 contents (from initial values of >11 and $<14.2\%$,

Table 11. Chemical analyses of Igneous Rocks, Hole 462.

Unit	1	3	6	7	8	10	10	10	10	11
Sample	60-1, 90–92 cm	60-2, 139–142 cm	61-2, 53–56 cm	62-1 79–81 cm	62-1, 127–129 cm	63-1, 132–136 cm	63-2, 79–83 cm	63-3, 119–122 cm	64-1, 4–6 cm	64-3, 79–81 cm
SiO_2	48.38	49.65	48.65	48.93	50.19	48.81	48.85	49.07	49.45	49.33
TiO_2	1.40	1.42	1.46	1.39	2.18	1.76	1.84	1.85	1.91	1.84
Al_2O_3	15.01	15.37	14.33	13.56	16.24	14.38	14.82	15.08	15.53	14.78
FeO*	9.47	10.36	11.94	12.33	11.66	12.09	12.14	11.73	10.78	11.75
MnO	0.14	0.15	0.20	0.21	0.29	0.20	0.18	0.23	0.30	0.23
MgO	7.34	7.86	7.32	6.61	6.52	7.56	7.80	7.19	7.52	7.64
CaO	11.02	11.40	11.72	11.53	7.30	11.08	10.21	10.25	10.05	8.97
Na_2O										
K_2O	0.67	0.63	0.09	0.06	1.09	0.14	0.02	0.04	0.04	0.04
P_2O_5	0.22	0.25	0.22	0.22	0.24	0.25	0.26	0.25	0.22	0.22
Total	93.65	97.09	95.93	94.84	95.71	96.27	96.12	95.69	95.80	94.80
LOI[a]	7.38	4.96	0.85	0.70	2.59	1.28	1.96	1.50	1.27	2.03
FeO*/MgO	1.29	1.31	1.63	1.86	1.78	1.59	1.55	1.63	1.43	1.53
CaO/Al_2O_3	0.73	0.74	0.81	0.85	0.45	0.77	0.69	0.68	0.65	0.60
FeO^*/TiO_2	6.76	7.29	8.17	8.87	5.34	6.86	6.59	6.34	5.64	6.38

[a] Heated to 110° for 6 hours prior to determination of LOI; LOI = loss on ignition at 1050°C.

respectively) is noted in rocks with H_2O contents greater than 1 to 1.5%. Observed scatter in the data could be due to analytical error. The individual samples which constitute the various alteration groups are the same in this figure as in the others.

It is clear from the plot of LOI against Fe/Fe + Mg (Fig. 32) that iron content shows a slight decrease in abundance with alteration. This tendency is more marked in the rocks of Hole 462 than in those of Hole 462A. In addition, it can be seen that, for fresh rocks, there is a general tendency for increase of Fe/Mg from early to late magmatic phases. This increase is also obvious in the thick differentiated sills, such as Unit 12 of 462A (equivalent to Unit 6 of Hole 462).

It will be noted that two distinct patterns of chemical modification due to alteration are observed (Fig. 31). The first is characterized by depletion of Ca and enrichment of K and Al. The second is characterized by enrichment of K and unmodified abundances of Ca and Al. This has to do with the preservation or alteration of plagioclase. The first type is the result of deep hydrothermal alteration which affects glass, pyroxene, and plagioclase, whereas in the second type the latter mineral phases are not affected. In both types, aluminum is immobile and is concentrated by removal of more-mobile components from the rocks. This is clearly shown on the plot of Fe/(Fe + Mg) against Ca/Al (Fig. 33). Increases of Ca/Al are characteristic of picritic magmatic tendencies, because pyroxene (high Ca/Al) takes the place of plagioclase (assuming that changes in Ab/An of the plagioclase are negligible [20–30 mol %]). A decrease in this ratio is indicative of more-leucocratic magma compositions, where the albite molecule (low Ca/Al) is enriched relative to pyroxene and anorthite. It can be seen (Fig. 33) that Units 1 and 5 of Hole 462 and Units 8 and 11 of Hole 462A have been affected by hydrothermal alteration and are depleted in Ca.

The general tendency in magmatic evolutions, either because of deep-seated fractionation or local differentiation, is for late magmatic phases to be more leucocratic and more iron-rich.

Titanium is the most immobile element in the alteration processes under study; thus, it is of great value in understanding processes of magmatic differentiation of these rocks. The immobility of TiO_2 is clearly shown in the plot of TiO_2 against Fe/(Fe + Mg) (Fig. 34). This plot effectively separates altered from fresh rocks: the altered rocks are displaced to apparently more-Mg-rich composition parallel to the Fe/(Fe + Mg) axis, which is noted in comparing data for individual samples with average analyses for the same igneous unit.

According to their TiO_2 variations (Fig. 34), the rocks of Holes 462 and 462A can be divided into five groups arranged in an orderly progression from early to late magmatic phases. This pattern of TiO_2 variation is widely observed in thick sills, and is well illustrated in Figure 23. Deviations from this pattern are the result of submarine (instead of continental) emplacement of these basalts. With submarine basalts, it is possible for sea-water penetration to cause quenching at any stage in the solidification of the lavas. Rock textures indicative of this process are observed both in the marginal zones and interiors of sills (e.g., 462A-28-2, 73–75 cm). These textures are characterized by up to 10 to 15% of interstitial glassy patches within coarser-grained rocks from the interior portions of the thick, 50-meter sills. Fine-grained portions of the same sill do not show these anomalous TiO_2 contents. The slight scatter of Fe/Mg within the various TiO_2-content groups is due to secondary alteration, as well as high analytical error in the MgO determinations (by XRF method).

Assuming that TiO_2 content of altered basalts is an accurate reflection of primary magma chemistry, it is clear that at least two stages of deep-seated evolution have occurred in the Nauru Basin magmas (Fig. 35). The earlier and presumably shallower eruptions are chemically homogeneous and have compositions typical of oceanic tholeiite from other regions of the Pacific, as well as the deep rift valleys of the Atlantic and Indian Oceans (Shcheka et al., 1968). However, the Nauru Basin basalts have extremely low potassium contents. At the Barremian/Cenomanian boundary, we observe an abrupt change of magma composition, as well as mode of emplacement. Above this boundary, the rocks are richer in Fe and Ti and are more leucocratic (according to the Ca/Al criteria discussed before). In addition, the thick sills above this boundary display extreme local differentiation, leading to the production of residual granitic melt. The rocks above the boundary are also more coarse-grained, suggesting emplacement

Table 11. (Continued).

11	11	11	11	11	4	4	11	11	11
64-4, 74–76 cm	65-1, 27–30 cm	65-2, 23–26 cm	66-1, 19–21 cm	66-4, 12–14 cm	67-2, 90–94 cm	68-1, 73–75 cm	68-2, 37–39 cm	68-2, 49–51 cm	69-1, 36–38 cm
49.71	49.44	49.03	49.57	49.48	50.13	49.77	50.16	49.18	48.33
1.64	1.66	1.65	1.64	1.64	1.65	1.85	1.92	1.61	2.13
13.59	13.60	13.22	13.36	13.64	13.32	12.96	12.70	13.22	12.01
12.82	12.61	12.90	12.64	12.31	12.59	13.80	14.33	12.77	16.79
0.21	0.21	0.21	0.20	0.21	0.21	0.23	0.22	0.22	0.20
7.61	6.95	6.90	6.72	7.24	7.41	6.55	6.30	7.01	5.47
11.16	11.03	10.91	11.14	11.08	11.37	10.52	10.17	11.10	9.32
0.09	0.05	0.03	0.04	0.07	0.14	0.08	0.14	0.12	0.27
0.25	0.24	0.23	0.22	0.21	0.25	0.25	0.25	0.26	0.25
97.08	95.79	95.35	95.53	95.88	97.07	96.01	96.19	95.49	94.77
0.36	0.41	0.52	0.21	0.74	0.48	0.43	0.36	0.28	0.36
1.68	1.81	1.86	1.88	1.70	1.69	2.10	2.27	1.82	3.06
0.82	0.81	0.82	0.83	0.81	0.85	0.81	0.80	0.83	0.77
7.81	7.59	7.81	7.70	7.50	7.63	7.45	7.46	7.93	7.88

below a thicker section of sediments compared to the ones below the boundary.

These changes are characteristic of the waning stages of many volcanic episodes in continental regions, where they are indicative of decreased temperature within deep magma chambers. This leads to volatile enrichment, and enrichment of light elements and Ti (leucocratic tendencies). This pattern is commonly observed in recently stabilized geological provinces, and we can speculate that vertical movements of the Nauru Basin may have played a part in producing the observed magmatic evolution.

There appear to be two main possible explanations for the sequence of rocks which are found in the Nauru Basin. The first is that the lava found below 730 meters sub-bottom represents typical oceanic tholeiite basement of Barremian or older age. This suggestion is supported by the chemical composition and homogeneity of the magma, and especially by the anomalously low K contents (0.001–0.01 wt. % K_2O) in both fresh and altered samples. This casts doubt on the presence of a thick layer of K-bearing sediments and limestones below the lower basalts, because the presence of such sediments would lead to high-K alteration in the overlying basalts, as observed in the upper parts of Holes 462 and 462A. In addition, it is commonly observed on the continents that basic rocks overlying K-rich sedimentary rocks and limestones are enriched in potassium. The reasons for this potassium enrichment are not yet well understood. It could be due to the presence of sialic rocks in the zone of magma generation, to volatile transfer of alkalies, or a number of other processes. Whatever the cause, it is clear that such processes occur. Unfortunately, it is difficult to assess the potential importance of any of these mechanisms to oceanic rocks, because the thickness of the oceanic basement is not well known.

It is also possible that the chemistry of the Nauru Basin igneous complex has been the result of unique conditions of crystallization. For the most part, the Nauru Basin basalts differ from typical pillow basalts. For example, the Nauru Basin basalts have mostly holocrystalline textures. Even thin sills (25–35 cm) which have thick (5–10 cm) glassy margins, grade quickly (2–5 cm) into holcrystalline, microdoleritic-textured rock. In addition, in compound sills, the marginal zones lack glass and are composed of fine-grained rock with equigranular texture. Micro-injections of magma from the interiors of igneous bodies into the chilled marginal zones is commonly observed. All these observations are consistent with the idea that these basalts crystallized under a crust of water-saturated overlying rocks.

The Nauru Basin sill complex is similar in many respects to the flood basalt or trap complexes of continental platforms (e.g., the Sikerion; Godlevskiy, 1959), where giant eruptions (sometimes up to 1–3 km thick) culminate in the formation of layered igneous bodies in the more-stable regions. These layered complexes commonly include thin granitic layers. It is possible that despite the great thickness of many of the Nauru Basin sills, the development of rhythmic layering has been impeded by free access of water to the crystallizing sill.

However, the composition of continental trap basalt is different from that of the Nauru Basin basalts. This probably can be attributed to the fact that continental and oceanic crust differ greatly in composition. Therefore, it is possible that eruptions similar in all their fundamental characteristics to continental trap basalts may be present in oceanic regions of high spreading rate, but this fundamental similarity between the oceanic and continental occurrences may be obscured by chemical differences which result from the different crustal type.

An ancient continental anolog of the Nauru complex may be the Precambrian diabase basement complex of the Fenno-Scandian supracrustal massif. This complex is more than 5 km thick. Rocks from this complex as deep as the Conrad seismic discontinuity have been recovered, and it is composed of homogeneous diabase almost identical chemically to the Nauru Basin diabases.

Finally, despite strong doubt that the Nauru sill complex is underlain by sediments, it is clear that the com-

Table 12. Chemical Analyses of Igneous Rocks, Hole 462A.

Unit	1	1	1	2	2	2	3	3	3	3	4	4	5	5	5	5
Sample	14-2, 4–7 cm	14-2, 29–32 cm	15-1, 117–120 cm	16-1, 129–131 cm	17-1, 98–100 cm	17-2, 36–38 cm	18-1, 128–130 cm	18-2, 48–50 cm	19-1, 10–12 cm	19-1, 52–54 cm	19-2, 90–92 cm	20-1, 72–74 cm	20-1, 144–146 cm	20-2, 93–95 cm	21-1, 40–42 cm	21-1, 93–96 cm
SiO_2	52.23	52.97	50.96	49.97	50.03	49.26	50.38	50.59	49.50	50.00	49.88	49.63	49.24	50.32	50.30	50.33
TiO_2	1.90	1.51	1.45	1.40	1.39	1.40	1.37	1.34	2.01	1.40	1.38	1.63	1.64	1.64	1.66	1.74
Al_2O_3	18.56	15.40	13.83	14.06	13.92	13.97	14.03	13.87	16.27	13.96	13.67	13.52	13.32	13.53	13.66	14.00
FeO^*	9.07	9.99	12.20	12.11	11.97	11.77	12.23	12.49	11.83	12.65	12.72	13.46	13.04	13.82	13.33	13.02
MnO	0.07	0.12	0.20	0.20	0.19	0.19	0.19	0.38	0.38	0.23	0.20	0.28	0.11			
MgO	2.84	6.54	6.63	6.84	6.99	7.30	6.82	7.02	7.16	7.18	6.87	6.90	6.63	6.99	7.55	6.32
CaO	7.65	10.10	11.83	12.11	11.85	11.81	11.77	11.68	7.88	11.80	11.89	11.42	11.32	11.42	11.12	10.76
Na_2O																
K_2O	2.85	0.83	0.06	0.06	0.02	0.06	0.08	0.05	0.41	0.04	0.05	0.02	0.11	0.14	0.13	0.12
P_2O_5	0.21	0 22	0.21	0.23	0.22	0.22	0.20	0.20	0.23	0.20	0.19	0.23	0.26			
Total	95.10	97.34	96.96	96.55	96.17	95.57	96.68	97.04	95.06	97.03	96.51	96.58	95.30			
LOI[a]	2.46	1.99	0.63	0.43	0.71	0.79	0.79	0.73	0.36	0.66	0.66	0.07	0.00	0.07	0.45	1.69
FeO^*/MgO	3.19	1.52	1.84	1.77	1.71	1.61	1.79	1.77	1.65	1.76	1.85	1.95	1.96	1.97	1.76	2.06
CaO/Al_2O_3	0.41	0.65	0.85	0.86	0.85	0.84	0.83	0.84	0.48	0.84	0.87	0.84	0.85	0.84	0.81	0.76
FeO^*/TiO_2	4.77	6.61	8.41	8.65	8.61	8.40	8.92	9.32	5.88	9.03	9.21	8.25	7.95	8.42	8.03	7.48

[a] Heated to 110°C for 6 hours prior to determination of LOI; LOI = Loss on ignition at 1050°C.

Unit	6	7	8	9	9	10	10	10	10	10	11	11	11	12	12
Sample	21-1, 123–125 cm	21-1, 146–149 cm	21-2, 26–29 cm	22-1, 95–100 cm	22-1, 137–139 cm	22-2, 111–115 cm	22-3, 12–14 cm	22-4, 83–85 cm	22-5, 4–6 cm	22-5, 77–79 cm	23-1, 25–29 cm	23-2, 44–47 cm	23-2, 69–71 cm	23-2, 95–98 cm	23-3, 75–77 cm
SiO_2	48.98	47.77	48.71	48.80	48.80	49.85	49.00	50.28	49.15	50.15	50.26	49.03	49.41	49.65	49.75
TiO_2	1.89	1.88	1.74	1.66	2.14	2.08	2.15	1.67	1.69	1.66	1.85	1.70	1.59	1.83	2.17
Al_2O_3	14.74	15.06	15.02	13.60	16.92	16.78	17.34	13.58	13.76	13.91	14.90	13.75	16.86	15.37	17.12
FeO^*	12.85	12.88	12.78	13.46	12.14	11.25	11.65	12.69	13.49	12.43	12.80	12.38	11.59	12.64	11.11
MnO															
MgO	6.82	6.30	6.95	7.47	7.38	7.47	6.88	6.42	7.23	6.32	6.58	7.02	7.24	6.69	8.53
CaO	9.51	8.99	10.81	11.50	9.94	7.60	7.65	11.38	11.31	11.41	9.92	11.20	7.54	10.24	7.18
Na_2O															
K_2O	0.20	0.20	0.19	0.06	0.63	0.44	0.39	0.12	0.23	0.12	0.12	0.06	0.35	0.12	0.30
P_2O_5															
Total															
LOI[a]	3.77	2.64	2.65	0.44	2.67	1.11	0.51	0.67	1.03	1.29	1.17	0.58	2.30	1.49	0.51
FeO^*/MgO	1.88	2.04	1.83	1.80	1.64	1.50	1.69	1.97	1.86	1.96	1.94	1.76	1.60	1.88	1.30
CaO/Al_2O_3	0.64	0.59	0.72	0.84	0.58	0.45	0.44	0.83	0.82	0.82	0.66	0.81	0.44	0.66	0.41
FeO^*/TiO_2	6.79	6.85	7.34	8.10	5.67	5.40	5.41	7.59	7.98	7.48	6.91	7.28	7.28	6.90	5.11

Unit	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
Sample	23-4, 48–50 cm	24-1, 8–10 cm	24-1, 27–31 cm	24-4, 51–54 cm	25-1, 39–42 cm	25-1, 99–102 cm	B-1, 23–26 cm	B-1, 40–43 cm	27-1, 31–33 cm	27-1, 97–100 cm	27-2, 78–80 cm	27-2, 125–128 cm	27-3, 71–74 cm	28-1, 96–98 cm	28-2, 28–30 cm	28-2, 73–75 cm
SiO_2	48.41	48.18	49.36	50.38	50.61	48.40	49.81	49.85	48.21	49.43	49.56	48.61	49.31	50.17	50.56	48.50
TiO_2	1.73	1.73	1.73	1.64	2.00	1.63	1.66	1.64	1.72	1.52	1.62	1.62	1.60	1.73	1.66	2.18
Al_2O_3	14.40	14.12	14.02	14.84	16.16	13.55	13.37	13.34	14.35	13.39	13.26	13.25	13.03	13.25	13.50	12.27
FeO^*	12.22	12.81	12.39	13.25	10.48	13.38	12.48	12.91	12.60	12.77	13.03	13.23	13.00	12.83	12.78	15.57
MnO																
MgO	6.78	6.83	6.78	6.53	6.64	6.75	6.75	6.47	6.57	6.70	6.01	6.17	6.55	5.94	6.54	6.13
CaO	11.24	10.78	11.36	11.36	9.14	11.56	11.21	11.08	10.75	11.14	11.34	11.13	10.88	11.11	11.39	9.76
Na_2O																
K_2O	0.08	0.09	0.10	0.12	0.20	0.06	0.08	0.08	0.12	0.11	0.12	0.16	0.08	0.08	0.05	0.08
P_2O_5																
Total																
LOI[a]	1.12	1.33	0.81	0.81	2.16	0.59	0.79	1.02	2.60	1.16	0.51	0.36	0.67	0.28	0.44	0.83
FeO^*/MgO	1.80	1.87	1.82	2.02	1.57	1.98	1.84	1.99	1.91	1.90	2.16	2.14	1.98	2.15	1.95	2.53
CaO/Al_2O_3	0.78	0.76	0.81	0.76	0.56	0.85	0.83	0.83	0.75	0.83	0.85	0.84	0.83	0.84	0.84	0.79
FeO^*/TiO_2	7.06	7.40	7.16	8.07	5.24	8.20	7.51	7.87	7.32	8.40	8.04	8.16	8.12	7.41	7.69	7.14

Unit	12	12	12	12	12	12	12	12	12	12	13	13	14	14	15	16
Sample	28-3, 8–10 cm	28-3, 134–136 cm	28-4, 68–70 cm	28-5, 26–28 cm	29-1, 6–9 cm	29-6, 97–100 cm	30-1, 48–50 cm	30-3, 21–23 cm	31-1, 48–50 cm	32-1, 44–48 cm	13-2, 10–12 cm	36,CC, 21–23 cm	38-1, 53–55 cm	38-2, 18–20 cm	38-2, 64–67 cm	39-1, 59–61 cm
SiO_2	48.89	51.18	49.73	49.86	49.84	49.38	49.78	49.44	48.68	48.37	49.09	50.66	50.55	48.79	48.74	49.58
TiO_2	1.37	1.67	1.65	1.75	1.63	1.47	1.50	1.61	1.58	1.66	1.21	1.58	1.20	1.18	1.20	1.19
Al_2O_3	13.69	13.49	13.17	12.96	13.13	13.14	13.55	13.01	13.57	12.56	13.87	14.18	13.87	13.47	13.96	13.78
FeO^*	12.17	12.79	13.09	13.22	12.71	12.37	12.53	12.82	12.45	11.43	11.26	11.54	11.65	11.69	11.23	11.58
MnO																
MgO	6.66	6.49	6.29	6.65	6.78	7.04	7.42	6.86	6.43	6.33	7.06	7.33	7.21	7.11	7.43	7.14
CaO	11.86	11.30	10.88	10.35	11.15	11.18	10.97	10.85	10.66	10.70	11.77	12.06	12.35	12.00	12.02	12.04
Na_2O																
K_2O	0.08	0.04	0.14	0.08	0.07	0.29	0.42	0.30	0.39	0.78	0.31	0.31	0.13	0.10	0.11	0.02
P_2O_5																
Total																
LOI[a]	0.59	0.52	0.42	0.62	0.99	0.20	0.32	0.32	0.41	0.64	0.43	0.27	0.49	0.53	0.65	0.17
FeO^*/MgO	1.82	1.97	2.08	1.98	1.87	1.75	1.68	1.72	1.93	1.80	1.59	1.57	1.61	1.64	1.51	1.62
CaO/Al_2O_3	0.86	0.84	0.82	0.79	0.87	0.85	0.80	0.83	0.78	0.85	0.84	0.85	0.89	0.89	0.86	0.87
FeO^*/TiO_2	8.88	7.65	7.93	7.55	7.79	8.41	8.35	7.96	7.87	6.88	9.30	7.30	9.70	9.90	9.35	9.73

Unit	16	16	16	17	18	18	20	21	21	21	21	21	21	21	21	21
Sample	39-2, 97–99 cm	39-3, 76–78 cm	39-3, 142–144 cm	39-4, 4–6 cm	39-4, 67–70 cm	39-5, 98–100 cm	40-1, 86–90 cm	40-2, 23–25 cm	40-2, 41–43 cm	41-1, 10–12 cm	41-1, 130–133 cm	41-2, 110–112 cm	41-4, 80–82 cm	41-5, 78–80 cm	41-6, 100–102 cm	41-7, 106–109 cm
SiO_2	48.96	48.18	48.83	48.88	48.33	48.43	49.07	49.15	49.74	50.09	49.84	50.41	50.04	50.28	50.46	49.46
TiO_2	1.22	1.23	1.19	1.20	1.21	1.22	1.24	1.26	1.23	1.23	1.22	1.21	1.21	1.19	1.22	0.72
Al_2O_3	13.96	13.84	14.16	13.86	14.31	13.98	14.21	14.04	13.76	13.56	13.67	13.62	13.64	13.91	13.24	11.60
FeO^*	11.52	10.92	11.16	11.60	11.26	10.79	11.39	11.25	11.88	12.15	12.16	11.70	11.09	11.04	11.41	14.20
MnO																
MgO	7.22	7.33	7.09	7.39	7.78	7.10	7.48	6.59	6.73	7.17	7.24	6.79	7.36	7.35	7.03	11.32
CaO	12.09	12.41	12.21	12.23	12.36	12.10	12.30	12.15	12.41	12.04	12.36	11.97	12.04	12.08	11.83	5.05
Na_2O																
K_2O	0.12	0.03	0.04	0.09	0.06	0.08	0.10	0.25	0.04	0.04	0.04	0.02	0.05	0.09	0.32	0.56
P_2O_5																
Total																
LOI[a]	0.50	0.59	0.92	0.30	0.36	0.33	0.58	2.18	2.25	0.71	0.59	0.67	0.70	1.93	1.03	4.92
FeO^*/MgO	1.59	1.48	1.57	1.56	1.44	1.51	1.52	1.52	1.76	1.69	1.69	1.72	1.50	1.50	1.62	1.25
CaO/Al_2O_3	0.86	0.89	0.86	0.88	0.86	0.86	0.86	0.86	0.90	0.88	0.90	0.88	0.88	0.87	0.89	0.43
FeO^*/TiO_2	9.44	8.87	9.37	9.66	9.30	8.84	9.18	8.92	9.66	9.87	9.96	9.66	9.16	9.27	9.35	19.72

Unit	21	Sediment	22	22	22	22	22	22	22	22	22	22	23	23	23	23
Sample	41-7, 96–99 cm	41-7, 106–109 cm	44-1, 128–130 cm	44-2, 7–9 cm	45-1, 7–8 cm	45-2, 14–17 cm	45-3, 50–52 cm	45-5, 92–94 cm	46-2, 61–63 cm	46-2, 72–74 cm	46-2, 122–124 cm	46-4, 118–120 cm	47-1, 88–89 cm	47-2, 98–100 cm	48-1, 100–102 cm	48-4, 52–54 cm
SiO_2	49.80	49.46	49.05	50.85	50.73	49.26	50.02	49.35	48.93	50.39	49.50	49.09	49.26	49.02	48.53	48.70
TiO_2	1.23	0.72	0.91	0.96	0.93	0.95	0.93	0.94	0.93	0.90	0.85	0.90	0.92	0.90	0.90	0.90
Al_2O_3	13.83	11.60	13.83	13.47	14.30	14.46	14.20	14.53	14.50	14.31	14.37	14.10	14.15	14.04	14.04	13.83
FeO^*	11.67	14.19	10.69	12.86	10.73	11.02	10.70	10.80	10.15	10.88	9.92	10.75	10.92	10.79	10.68	10.90
MnO																
MgO	6.59	11.32	7.92	7.93	7.67	7.70	7.56	7.47	7.96	8.07	6.88	7.38	7.79	8.01	7.97	8.15
CaO	11.75	5.05	12.62	6.66	12.38	12.83	12.50	12.98	12.57	12.55	11.82	12.65	11.81	12.69	12.77	12.57
Na_2O																
K_2O	0.04	0.56	0.02	0.74	0.01	0.03	0.008	0.043	0.006	0.007	0.008	0.003	0.137	0.003	0.018	0.04
P_2O_5																
Total																
LOI[a]	0.51	4.92	0.32	7.46	0.81	0.26	0.66	0.23	0.62	0.96	0.65	0.85	1.97	0.81	0.93	0.81
FeO^*/MgO	1.77	1.25	1.34	1.62	1.39	1.43	1.41	1.44	1.27	1.34	1.44	1.45	1.40	1.34	1.34	1.33
CaO/Al_2O_3	0.85	0.43	0.91	0.49	0.86	0.88	0.88	0.89	0.86	0.87	0.82	0.89	0.83	0.90	0.90	0.90
FeO^*/TiO_2	9.48	19.70	11.74	13.39	11.53	1.60	11.50	11.48	10.91	12.08	11.67	11.94	11.86	11.98	11.86	12.11

Unit	23	24	24	24	24	24	24	24	24	25	26	26	27	28	29
Sample	48-4, 72–74 cm	49-1, 55–58 cm	49-1, 83–85 cm	49-3, 70–72 cm	49-4, 41–43 cm	50-2, 71–73 cm	50-3, 15–17 cm	50-6, 109–111 cm	51-4, 27–30 cm	52-4, 49–51 cm	56-1, 65–68 cm	56-1, 145–147 cm	58-4, 99–101 cm	59-3, 132–134 cm	59-6, 131–133 cm
SiO_2	48.38	48.80	49.08	49.28	48.70	48.48	49.54	49.27	48.89	48.84	49.53	49.98	48.57	49.54	50.18
TiO_2	0.92	0.93	0.92	0.95	0.95	0.93	0.99	0.91	0.99	0.98	0.95	0.99	1.02	0.98	1.01
Al_2O_3	14.22	14.07	13.93	13.82	13.91	13.77	12.77	13.85	13.91	13.83	13.65	14.08	14.06	13.51	13.70
FeO^*	10.87	10.85	10.84	11.01	10.76	10.91	11.26	10.95	11.23	11.11	10.92	10.71	10.96	11.13	11.43
MnO															
MgO	8.36	7.70	7.96	8.08	8.43	8.51	8.81	8.56	7.81	7.30	7.58	7.98	7.87	7.98	7.78
CaO	13.05	12.59	12.37	12.32	12.44	12.17	11.33	12.15	11.72	12.55	12.41	12.57	12.62	12.22	12.60
Na_2O															
K_2O	0.033	0.049	0.019	0.002	0.007	0.021	0.416	0.015	0.118	0.001	0.004	0.004	0.004	0.016	0.029
P_2O_5															
Total															
LOI[a]	0.69	0.14	0.85	0.98	1.20	0.93	1.08	2.32	1.16	0.26	1.25	0.31	0.51	0.82	0.29
FeO^*/MgO	1.30	1.40	1.36	1.36	1.27	1.28	1.27	1.27	1.43	1.52	1.44	1.34	1.39	1.39	1.46
CaO/Al_2O_3	0.91	0.89	0.88	0.89	0.89	0.88	0.88	0.87	0.84	0.90	0.90	0.89	0.89	0.90	0.91
FeO^*/TiO_2	11.81	11.66	11.78	11.58	11.32	11.73	11.37	12.03	11.34	11.33	11.49	10.81	10.74	11.35	11.31

Unit	29	29	30	30	30	31	31	32	31	32	32	33	34 Sed.	34	35	35
Sample	60-3, 99–101 cm	61-1, 30–32 cm	61-2, 115–118 cm	62-2, 10–12 cm	63-1, 36–38 cm	44-2, 53–59 cm	44-2, 106–109 cm	67-6, 124–126 cm	64-4, 30–32 cm	65-2, 60–62 cm	66-7, 33–35 cm	68-4, 116–118 cm	70-1, 2–4 cm	72-2, 53–55 cm	72-2, 124–126 cm	74-4, 72–74 cm
SiO_2	47.90	47.49	47.81	50.18	49.19	49.70	49.66	49.67	49.18	50.11	50.42	49.05	90.69	49.78	49.25	50.54
TiO_2	1.01	1.01	1.03	1.04	1.33	0.93	0.94	0.99	1.02	1.01	1.01	1.01	0.02	1.05	1.06	1.02
Al_2O_3	13.70	13.64	13.87	14.07	9.02	14.53	14.47	13.81	14.23	14.02	14.04	13.94	1.25	13.74	13.79	14.02
FeO^*	10.87	11.11	10.98	10.99	13.93	10.99	10.72	11.29	10.76	11.25	11.90	10.99	1.84	11.55	10.68	11.63
MnO																
MgO	7.35	7.35	7.55	7.55	10.46	7.69	7.32	8.10	7.47	7.67	8.04	7.46	1.01	7.93	7.58	7.82
CaO	12.51	12.36	12.36	12.88	10.90	12.59	12.97	12.34	12.56	12.25	12.38	12.36	2.17	12.15	12.40	12.63
Na_2O																
K_2O	0.021	0.096	0.042	0.018	0.074	0.05	0.03	0.045	0.11	0.074	0.093	0.034	1.73	0.09	0.09	0.04
P_2O_5																
Total																
LOI[a]	0.36	0.63	0.01	1.01	2.08	0.22	0.62	0.70	0.31	0.55	0.47	1.07	2.95	0.93	0.76	0.90
FeO^*/MgO	1.47	1.51	1.45	1.45	1.33	1.42	1.46	1.39	1.44	1.46	1.48	1.47	1.82	1.45	1.40	1.48
CaO/Al_2O_3	0.91	0.90	0.89	0.91	1.20	0.86	0.89	0.89	0.88	0.87	0.88	0.88	1.73	0.88	0.89	0.90
FeO^*/TiO_2	10.76	11.00	10.66	10.56	10.47	11.81	13.79	11.40	10.54	11.02	11.78	10.88	92	11.00	10.07	11.40

Table 13. Average chemical compositions of volcanic units, Site 462.

Unit	1	2	4	5	6	6	1	2	3	4	6	7	8	9	10	11	12
	Hole 462						Hole 462A										
Sample	2	1	1	7	7	3	1	3	4	3	1	1	2	1	3	4	25
SiO_2	49.01	48.65	48.93	49.04	49.51	49.42	50.96	49.75	50.21	49.73	50.30	50.33	48.84	48.80	49.86	49.34	49.38
TiO_2	1.41	1.46	1.39	1.84	1.64	1.97	1.45	1.40	1.37	1.64	1.66	1.74	1.82	1.66	1.67	1.78	1.63
Al_2O_3	15.19	14.33	13.56	14.95	13.42	12.56	13.83	13.98	13.88	13.45	13.66	14.00	14.88	13.60	13.75	14.60	13.52
Fe_2O_3	11.05	13.27	13.70	12.99	14.07	16.65	13.56	13.28	13.93	14.93	14.82	14.47	14.24	14.96	14.30	13.91	14.12
MnO	0.14	0.21	0.21	0.23	0.21	0.22	0.20	0.20	0.21	0.20							
MgO	7.60	7.32	6.61	7.52	7.12	6.11	6.63	7.04	6.97	6.84	7.55	6.32	6.89	7.47	6.65	6.77	6.59
CaO	11.21	11.72	11.53	10.40	11.11	10.00	11.83	11.92	11.79	11.39	11.11	10.76	10.16	11.50	11.37	10.89	11.06
Na_2O																	
K_2O	0.65	0.09	0.06	0.06	0.08	0.16	0.06	0.05	0.06	0.09	0.13	0.12	0.20	0.06	0.25	0.09	0.13
P_2O_5	0.23	0.22	0.24	0.24	0.24	0.25	0.21	0.22	0.20	0.25							
Total	96.10	96.84	95.79	98.77	97.83	97.72	98.73	97.84	98.62	98.37	99.11	97.74	97.02	98.05	97.85	97.38	97.05
LOI	6.17	0.85	0.70	1.50	0.43	0.38	0.63	0.64	0.71	0.04	0.45	1.69	3.21	0.44		1.09	0.71
Fe/(Fe + Mg) (atomic %)	42.3	47.7	51.2	46.7	49.8	57.8	50.1	48.7	50.3	52.5	49.8	53.6	50.1	50.2	51.9	50.9	51.8
CaO/Al_2O_3	0.74	0.82	0.85	0.70	0.83	0.80	0.86	0.85	0.85	0.85	0.81	0.77	0.68	0.85	0.83	0.75	0.82
FeO^*/TiO_2																	

All values from tables I-4, I-6.6(7) and 6(3)-primitive and differentiated microdolerites respectively.

plex is unique in the ocean (to our knowledge). Its discovery has important implications for the nature and evolution of oceanic crust.

Part C (by H. Tokuyama)

Two main rock types have been recovered from Hole 462A: (1) dolerite sills, and (2) basalts with pillow-like structure. Figure 21 shows the lithologic units distinguished in the sequence.

Basalt of type 2 was found only below Core 44, and further sedimentary layers thicker than 1 meter were not recovered below Core 44. Above Core 44, 21 dolerite sill units have been defined; these are separated by chilled margins from either sediment layers or other sill units. Below Core 44, four dolerite sill units and eight pillow-basalt units have been defined, mainly separated by chilled margins from one another.

The chemical compositions of fresh type 1 basalts from Hole 462A are plotted in terms of the ratio FeO^*/MgO versus TiO_2 (Fig. 36). On this figure, two groups may be identified on the basis of differences in TiO_2 content: a low TiO_2 type (0.9–1.04 wt. %), and a high TiO_2 type (1.18–1.85 wt. %); the former type was recovered below Core 44, and the latter type above Core 44.

That the glassy chilled margins of the high-TiO_2 type are characterized by microphenocrysts of clinopyroxene (but rare olivine) and that of the low-TiO_2 types by microphenocrysts of olivine (but rare clinopyroxene) is reflected by the difference in Fe^*/MgO ratios of the two types.

There are no large changes in chemical composition within individual low-TiO_2 sills, so that fractionation, which might be caused by minor removal of phenocryst phases during cooling, is very low. On the other hand, there are moderate changes in chemical composition of the high-TiO_2 sills, particularly in the granophyre schlieren. Thus, it is concluded that the difference between the high-TiO_2 type and the low-TiO_2 type is due to different magma types. From the bulk chemical composition and petrographic evidence, the type 2 basalt is seen to be the low-TiO_2 type. However, the pillow structure which these basalts exhibit is not normal; therefore they might not have been intrusive, but eruptive. Above this type 2 rock, thick sediment layers (mainly hyaloclastic) were recovered; the high-TiO_2, type 1 rock commonly is intruded into sediment. From this evidence, it is inferred that there was a significant time gap between low-TiO_2 type and high-TiO_2 volcanism. The earlier volcanism was characterized by alternating eruptions of the atypical pillow lava, and intrusions of sills with low TiO_2 content; the later volcanic episode was characterized by intrusion of high-TiO_2 sills within sediment. From the paleontological data, it might be inferred that the age of the earlier volcanism is late Barremian, and that of the later volcanism Cenomanian.

In comparison with the FAMOUS glass data (Bryan and Moore, 1977) and possible off-ridge intrusive or extrusive samples from this area (Bryan et al., 1976), both types 1 and 2 are depleted in TiO_2. From a petrologic viewpoint, both types 1 and 2 may have been produced by olivine fractionation of abyssal tholeiite in the upper mantle; however, the lithologic sequence of igneous rocks at Site 462 is very different from sequences formed at oceanic ridges. Therefore, the volcanic sequence at Site 462 might have formed by a process unlike that operating at oceanic ridges. Normal oceanic basement which would have formed, according to this model, at a typical ocean ridge could therefore directly underlie the sill-pillow complex.

An interesting aspect of Nauru Basin volcanism is that the above-described off-ridge volcanism produced intrusives rather than central volcanoes. One hypothesis that could account for this is that ridge-crest-related volcanism ceased from late Barremian to Cenomanian time in this region. If this cessation occurred, the lack of a normal tensional regime, like that prevailing at typical ridge crests, might have impeded access of magma to the surface. Instead of rising to the surface, the magma would have cooled and partly crystallized in the upper mantle. Small leaks from this chamber then might have ascended to the surface and produced the pillow-and-sill

Table 13. (Continued).

13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33
1	2	1	1	1	4	2	1	7	9	7	4	1	2	1	2	2	3	1	3	1
50.66	49.67	48.74	49.58	48.18	48.62	49.11	49.32	50.13	49.59	48.82	48.93	48.84	49.75	48.57	49.86	47.70	49.69	49.18	50.07	49.05
1.58	1.19	1.20	1.19	1.23	1.20	1.25	1.24	1.21	0.92	0.91	0.95	0.98	0.97	1.02	1.0	1.01	1.03	1.02	1.00	1.01
14.18	13.67	13.96	13.78	13.84	14.08	14.12	14.00	13.64	14.29	14.04	13.83	13.83	13.87	14.06	13.60	13.67	13.97	14.23	13.97	13.94
12.83	12.97	12.48	12.87	12.14	12.45	12.58	12.79	12.89	11.81	12.04	12.13	12.35	12.02	12.81	12.51	12.20	12.21	11.96	12.76	12.22
7.33	7.16	7.43	7.14	7.33	7.40	7.14	6.73	7.07	7.62	7.99	8.40	7.30	7.78	7.87	7.88	7.35	7.55	7.47	7.94	7.46
12.06	12.18	12.02	12.04	12.41	12.23	12.23	12.32	12.01	12.54	12.67	12.27	12.55	12.48	12.62	12.41	12.43	12.62	12.56	12.32	12.36
0.31	0.12	0.11	0.02	0.03	0.07	0.17	0.13	0.04	0.02	0.03	0.01	0.00	0.00	0.00	0.02	0.06	0.03	0.11	0.07	0.03
98.95	96.99	95.88	96.62	95.16	96.10	96.50	96.73	96.99	96.79	96.50	96.52	95.85	96.87	96.32	97.28	94.42	97.10	96.53	98.13	96.07
0.27	0.41	0.65	0.17		0.36	1.37	1.67	0.91	0.60	0.71	1.35	0.26	0.78	0.51	0.52	0.50	0.50	0.31	0.57	1.07
47.0	47.7	45.8	47.7	45.5	46.2	47.5	48.2	48.4	43.9	43.0	42.2	45.8	43.8	43.7	44.7	45.4	44.9	44.6	44.8	96.07
0.85	0.89	0.86	0.87	0.90	0.87	0.87	0.88	0.88	0.88	0.90	0.89	0.91	0.90	0.90	0.91	0.91	0.90	0.88	0.88	0.88

Table 14. Average chemical compositions of two types of altered basalts.

Unit	I(8)	II(10)
Sample	(462 + 462A)	(462 + 462A)
SiO_2	49.79	50.26
TiO_2	1.21	1.60
Al_2O_3	14.23	15.15
Fe_2O_3	11.94	13.22
Mn	0.14	0.30
MgO	7.47	7.23
CaO	11.42	7.25
Na_2O		
K_2O	0.42	0.95
P_2O_5	0.23	0.23
Total	96.85	96.19
LOI	2.72	3.30
Fe/(Fe + Mg) (atomic %)	44.5	49.4
CaO/Al_2O_3	0.80	0.48
FeO^*/TiO_2		

complex. Later, during Cenomanian time, the ridge might have become a typical active spreading center again, thus allowing magma to rise at the locus of renewed tension. By this time, however, the magma would have been fractionated, and the ridge crest would have been covered by some thickness of sediments. Therefore, this renewed volcanism would have been emplaced into the sediment as fractionated basalt sills.

Part D (by K. Seifert, T. Vallier, and K. Windom)

Introduction

Coring was resumed at Site 462A at a sub-bottom depth of 953 meters on July 19, 1978. Between July 19 and 25, 115.5 meters of rock was penetrated to give a total hole depth of 1068.5 meters at Site 462A. Total core recovered from the 115.5 meters drilled was 60.20 meters, giving a recovery of 52%, including both sediments and basalt. Less than 3 meters of sediment core was recovered, and approximately 112.5 meters of igneous rocks were drilled.

Physical Characteristics of Igneous Units

The recovered igneous rocks were divided into 11 units on the basis of grain-size variations. Available chemical and mineralogical data are insufficient to determine if these textural units represent genetically distinct units and to definitively distinguish between an intrusive or extrusive origin. The almost total absence of glass or indications of pillow structures suggests that the entire igneous section consists of intrusive sills, and the fine-grained texture of even the thicker units seems to indicate that intrusion occurred at very shallow depth. The 11 igneous units delineated in the post-July-19 drilling at Hole 462A start with the continuation of Unit 35 (Figs. 21 and 22) and go into Unit 44. Some decrease in plagioclase relative to augite occurs near the bases of Units 35 and 37. The fine-grained boundary layers between Units 41 and 42 and Units 42 and 43 contain several times more clay-mineral alteration than is found within the units.

Petrography

Preliminary studies of 27 thin-sections show variations in textures and compositions that are correlatable with cooling histories and alteration, rather than original magma compositions. The textures range from subophitic to intergranular, intersertal, and variolitic, and the mineralogical compositions show a wide range (Table 15).

Textures of coarser-grained rocks, generally from cooling-unit interiors, are subophitic and intergranular. As cooling unit boundaries are approached, the rocks become finer-grained and textures are intersertal and variolitic; these textures were observed together in thin sections of several rocks. Glass, now altered to smectite, occurs mostly in the interstices between grains. In those rocks having variolitic textures, the glass occurs both interstitially and as intergrowths with plagioclase and/or clinopyroxene in radiating varioles.

Microphenocrysts are common in the finer-grained rocks that have intersertal and variolitic textures. Most are clinopyroxene, olivine (pseudomorphed by smec-

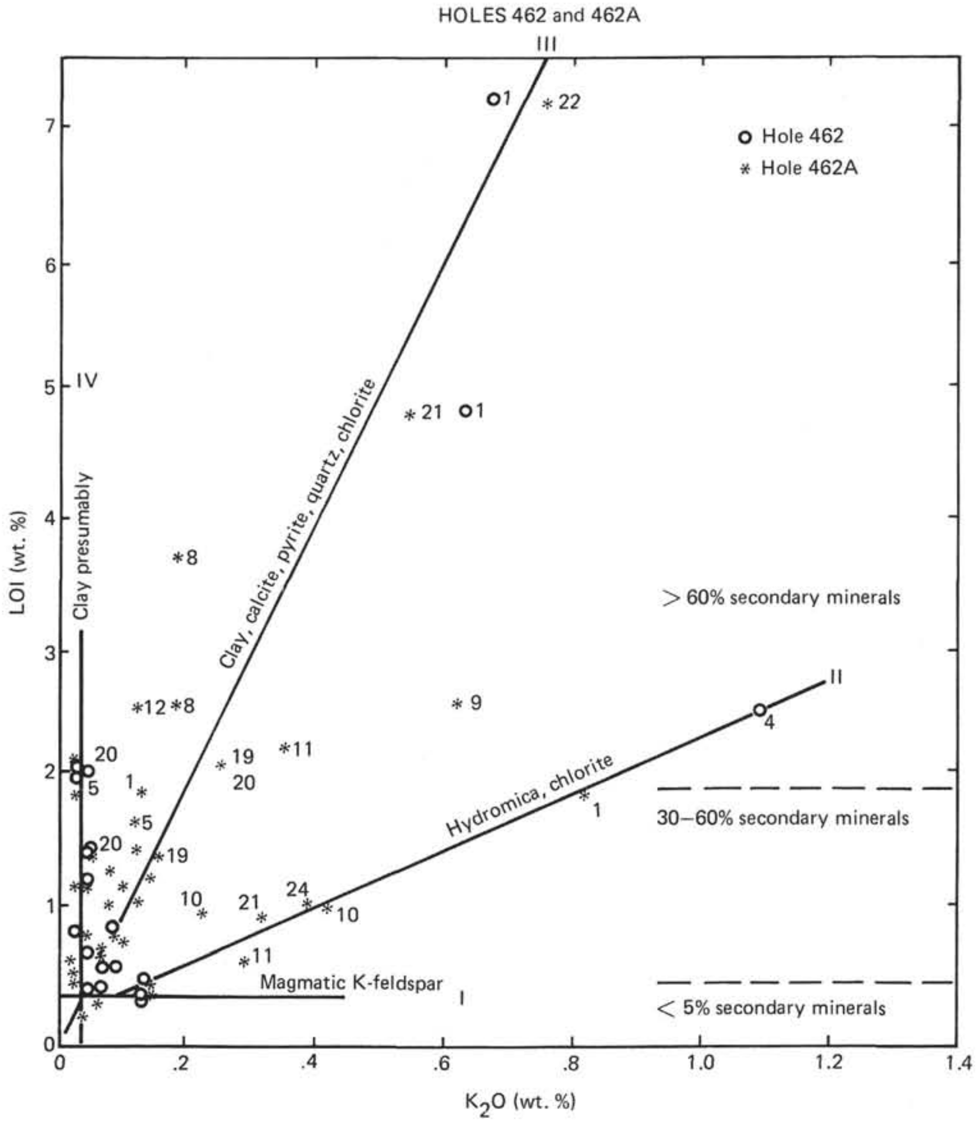


Figure 30. Correlation of K_2O and LOI for various types of altered volcanic rocks. Figures near points are numbers of units.

tites), and plagioclase that range in longest diameter from about 0.2 to 0.5 mm. Olivine microphenocrysts are particularly well developed, indicating their early crystallization. Some plagioclase microphenocrysts are zoned. Clinopyroxene (augite) microphenocrysts apparently crystallized at about the same time as the plagioclase microphenocrysts.

Primary phases of the basaltic rocks are plagioclase, clinopyroxene, olivine, titanomagnetite, and sideromelane. Both olivine and sideromelane are altered to smectite in nearly all studied thin-sections. Plagioclase contents range from 21 to 58% and average 44%. Clinopyroxene (augite) contents range from 18 to 47%. Titanomagnetite ranges from 2 to 14%. Glass content originally ranged from 1 to 49% and averaged about 12%, the amount varying with relative proximity to a cooling-unit margin and thickness of the cooling unit.

The variations in composition are caused by cooling histories and resultant differentiation, mostly by crystal settling. Overall, the rocks probably are olivine tholeiites, similar to those described from the upper part of Hole 462A and in the adjacent pilot hole (Hole 462).

Vein Minerals

Fracturing is common in the basalts. Many of these fractures are filled with veins containing one or more of the minerals pyrite (and marcasite), zeolite, calcite, and a green clay-like mineral. Fracturing seems to be most intense in the finer-grained parts of the basalt, although it is by no means restricted to such areas.

Pyrite occurs both as cubes and as more-massive vein coatings. It is found in association with zeolite, calcite, and dark-green clay. Its occurrence appears to be confined to the veins. Some of the sulfide has the appearance of chalcopyrite, although slightly oxidized pyrite may give the same appearance. Shore-based chemical studies will resolve this question.

Calcite occurs as individual crystals and groups of crystals, and as very fine-grained veins. It is usually clear to white, but also occurs as light-pink veins.

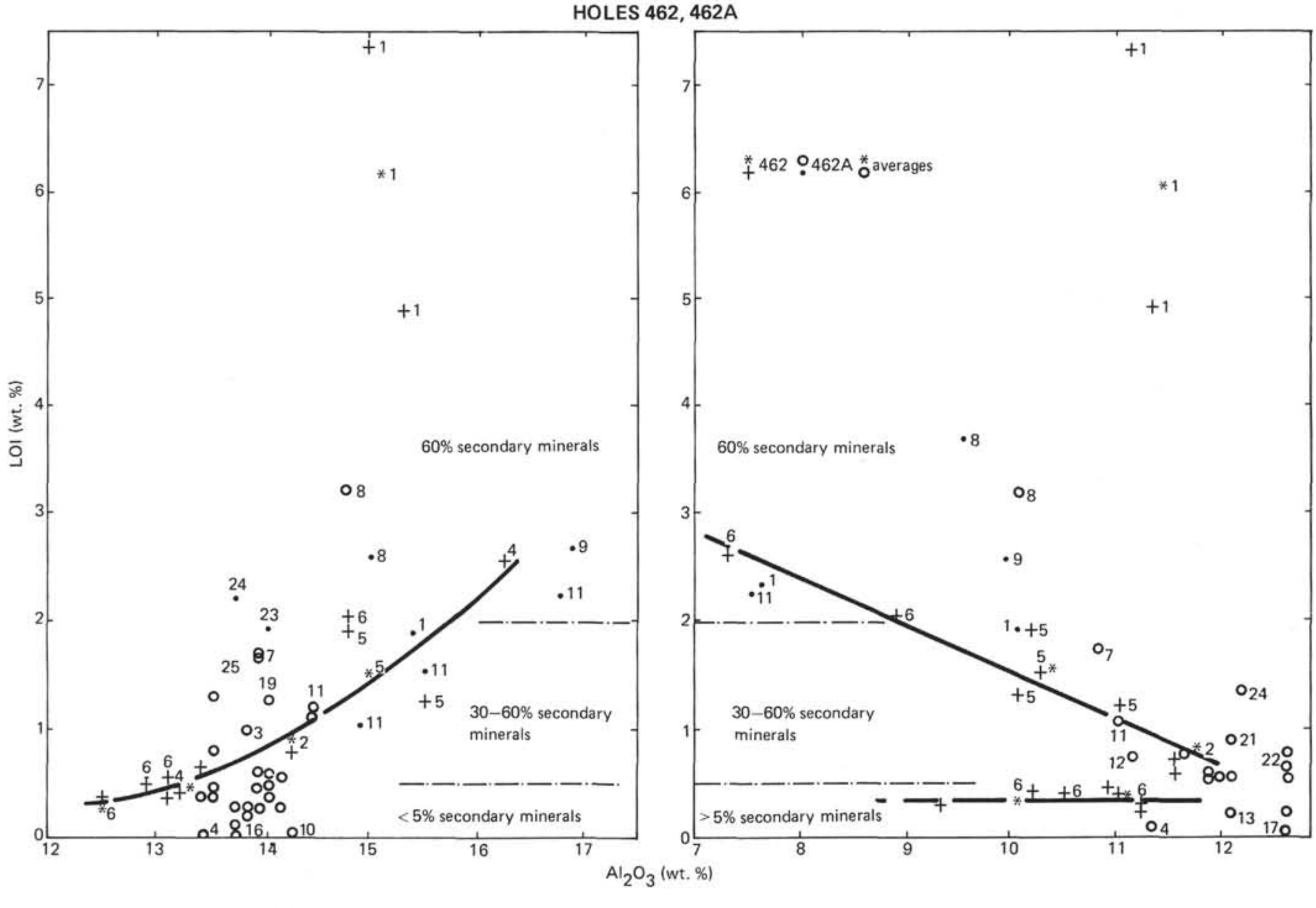


Figure 31. Correlation of Al, Ca, and LOI in volcanics. Figures near points are unit numbers.

Calcite is found in association with pyrite, zeolite, and the dark-green clay.

Zeolite has been identified in some of the veins. Optical examination indicates the presence of thomsonite in at least some of the zeolite-bearing veins; the presence of phillipsite has been inferred from a partial optical examination of other veins. The zeolite varies from large fibrous grains to smaller radiating clusters. It is found in association with pyrite and calcite; its association with the dark-green clay mineral has not been unambiguously determined.

The dark-green clay mineral is the most abundant of the vein minerals. It is very fine-grained and often exhibits slickensides. Virtually all of the original fractures (those not obviously induced by drilling) contain a coating of this material. No unequivocal determination of this material has been made, largely because of its very fine grained size; it is tentatively called smectite, but it may be chlorite. Shore-based X-ray-diffraction and/or DTA tests should resolve this question. The clay mineral associated with both pyrite and calcite.

Other vein minerals are also present. A light-green material forming a vein greater than 1 cm wide was recovered in Core 89. The material is extremely fine-grained, and it has not been identified.

PALEOMAGNETISM

Introduction

The paleomagnetic studies utilized the shipboard Digico spinner magnetometer and Schonstedt alternating field (AF) demagnetizer. During this leg, both of these instruments were limited in their capabilities. The Digico will not reliably give repeatable measurements below intensities of 1×10^{-5} emu/cm^3, normally a very high intensity for sedimentary rocks. The Schonstedt demagnetization unit had some anhysteretic remanent magnetization (ARM) potential, particularly above 500 Oe; a result of the dented and nonconcentric shielding cans. Susceptibility of basalt samples was measured using the Bison susceptibility meter.

Measurements were made on 2.5-cm-diameter, 2.4-cm-long mini-cores, oriented by a scribe line parallel to the edge of the large core. Recovery in the holes was generally high, providing very large pieces of the main core to sample. Paleomagnetic samples were generally taken from these large core pieces, which provided long edges from which the mini-core orientation was obtained. Thus, orientation errors could be minimized. Both sediments and basalts were studied, and each will be described separately.

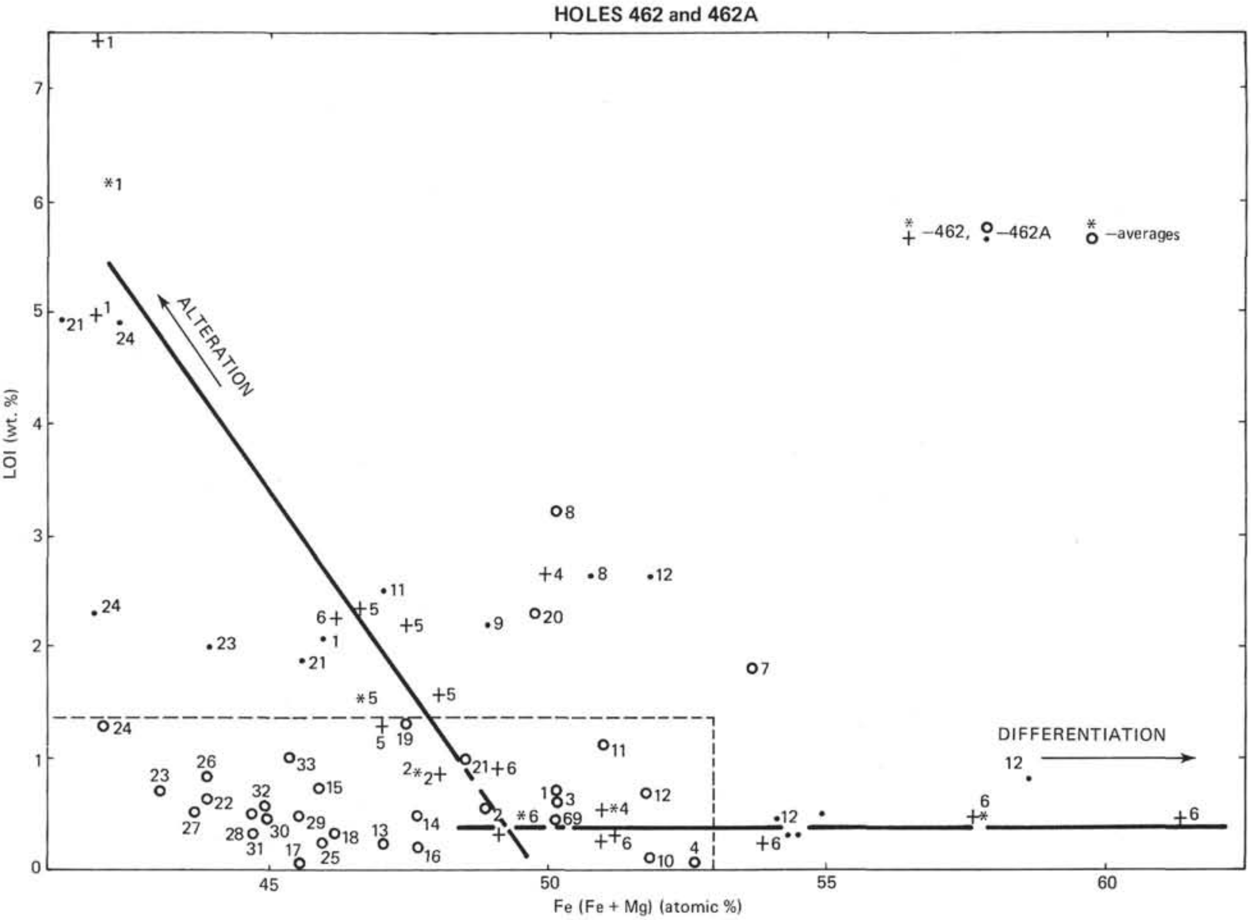


Figure 32. Correlation of Fe/(Fe + Mg) and LOI for volcanic rocks. Figures near points are unit numbers.

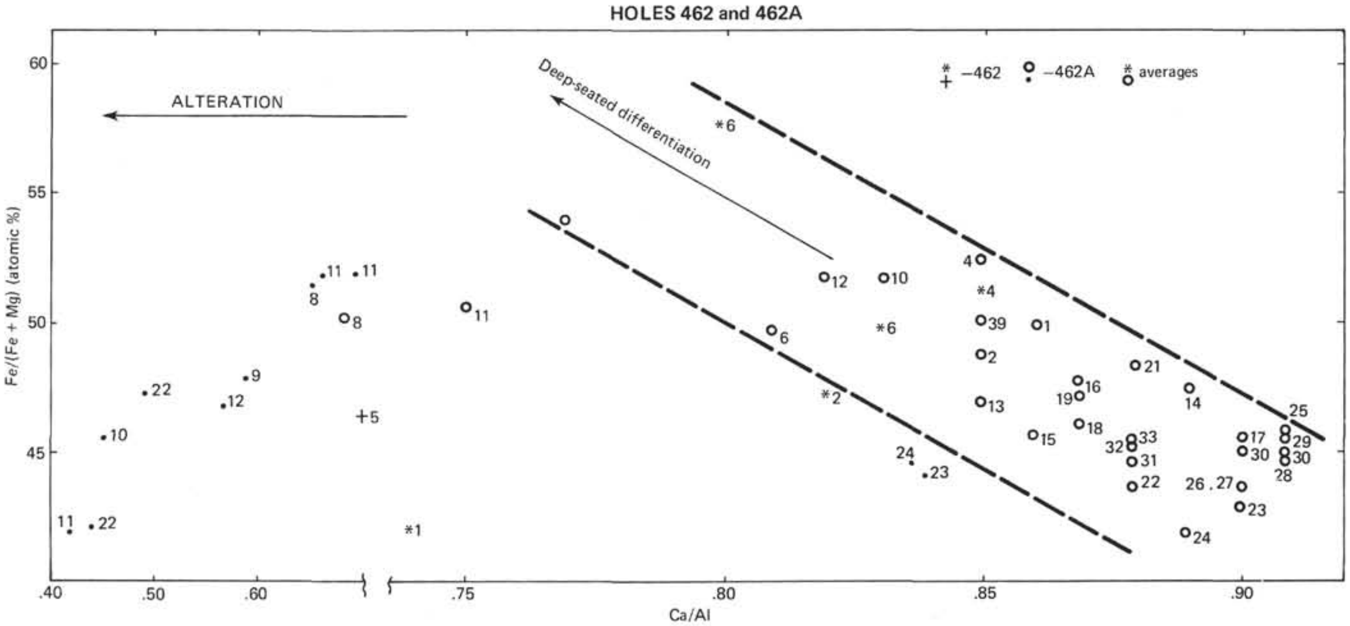


Figure 33. Correlation of Fe/(Fe + Mg) and Ca/Al ratios in volcanic rocks. Figures near points are unit numbers.

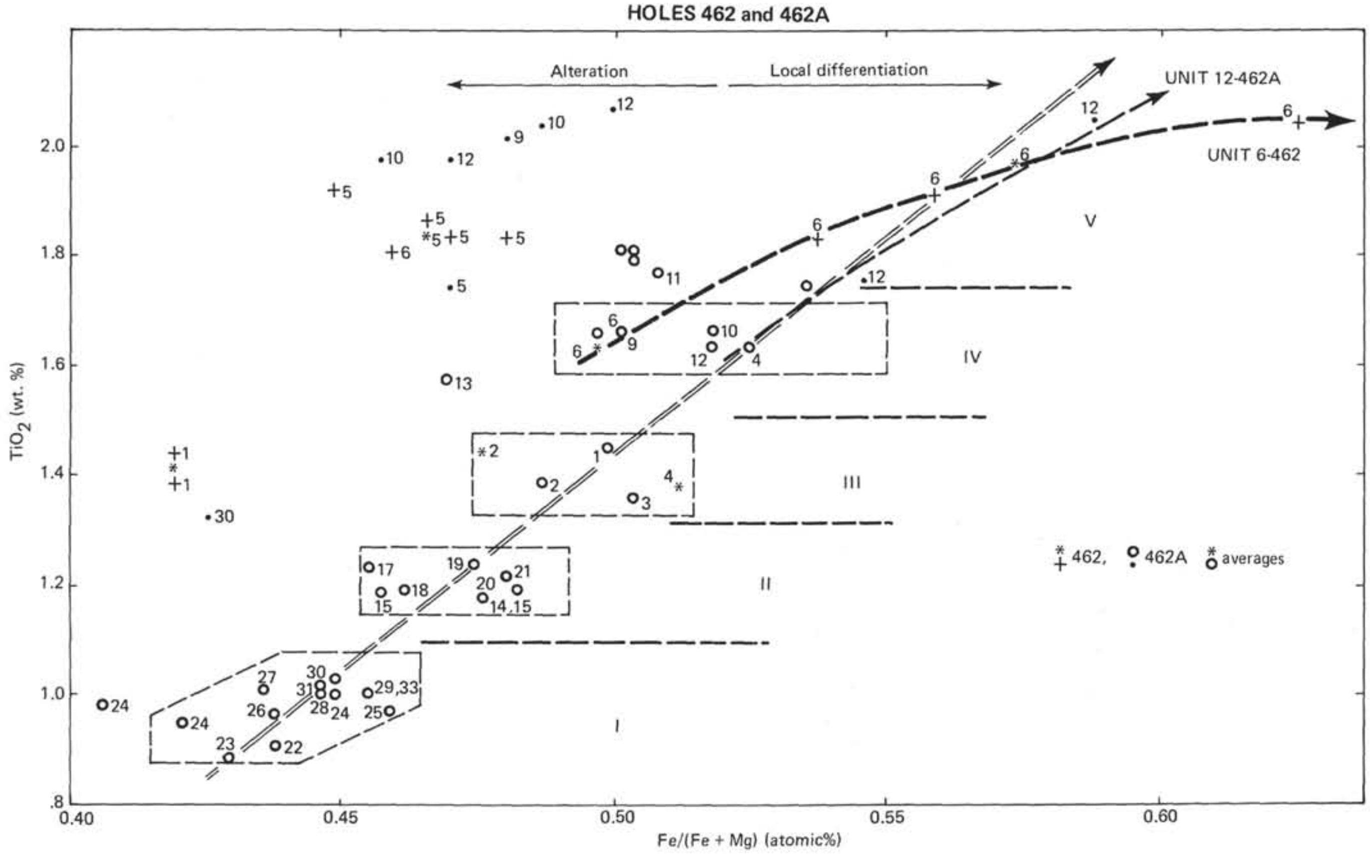


Figure 34. Correlation of Ti and Fe/(Fe + Mg) ratio in volcanics. Figures near points—unit numbers. Dashed line encloses points of fresh rocks.

Early Campanian to Cenomanian Sediments

Paleomagnetic samples of early Campanian to Cenomanian sediments from both Holes 462 and 462A have been measured. The samples were taken to bracket the reversed interval corresponding to Anomalies 33 and 34 of the sea-floor-spreading pattern, the reversed interval which serves as the younger boundary of the Cretaceous long normal-polarity interval. The study was undertaken in an attempt to better correlate the biostratigraphic age correlations (particularly using nannofossils) with the geomagnetic-reversal pattern in early Campanian-Santonian time.

Sampling was begun where the foraminifer age suggested the upper boundary of the reversed interval. The reversal of polarity was indeed detected at that very point.

Cores from both Holes 462 and 462A were sampled at roughly 75-cm intervals through about five core barrels, and periodically at closer spacings. Surprisingly, these sediments are very strongly magnetized (0.5–2.5 × 10^{-4} emu/cm^3) and easily could be measured on the Digico magnetometer. Furthermore, their intensity and stability permitted AF demagnetization, often in excess of 400 Oe, while remaining within the reliable portion of the Digico measurement range. Many samples were demagnetized stepwise at 12.5, 25, 50, 75, 100, 125, 150, 200, 250, 300, 350, and 400 Oe. Almost all samples were demagnetized to at least 100 Oe.

Cores from both holes show natural remanent magnetization (NRM) directions changing from southern-hemisphere normal (negative) inclinations to reversed (positive) inclinations, beginning at about 516.5 meters sub-bottom depth in Hole 462 (Core 55), and about 517.5 meters in Hole 462A (Core 9). Reversed polarity persists to 524 meters in Hole 462, and to 525 meters in 462A, changing back to normal in Cores 462-56 and 462A-10, respectively. Both polarity boundaries occur within core-barrel segments, not at breaks between segments. The remainder of each core remains normal into the Cenomanian, at which point basalt was encountered in both holes.

Although the inclinations are shallow and widely scattered, the reversal of polarity is clearly defined. AF demagnetization did little to reduce the scatter. Very little or no change in directions was effected by demagnetization. The NRM and demagnetized data are illustrated in Steiner (this volume). The magnetization is rather hard, exhibiting median destructive fields (MDF) greater than 150 Oe (generally greater than 200 Oe).

From the results obtained so far, it appears either that the recorded inclinations were very dispersed for some reason, or that it is not possible to clean these magnetizations effectively by AF demagnetization. These sediments may be similar to those encountered at DSDP Site 105. Those sediments, although Jurassic, were of similar red-brown colors and had high intensities and MDFs similar to those of the Site 462

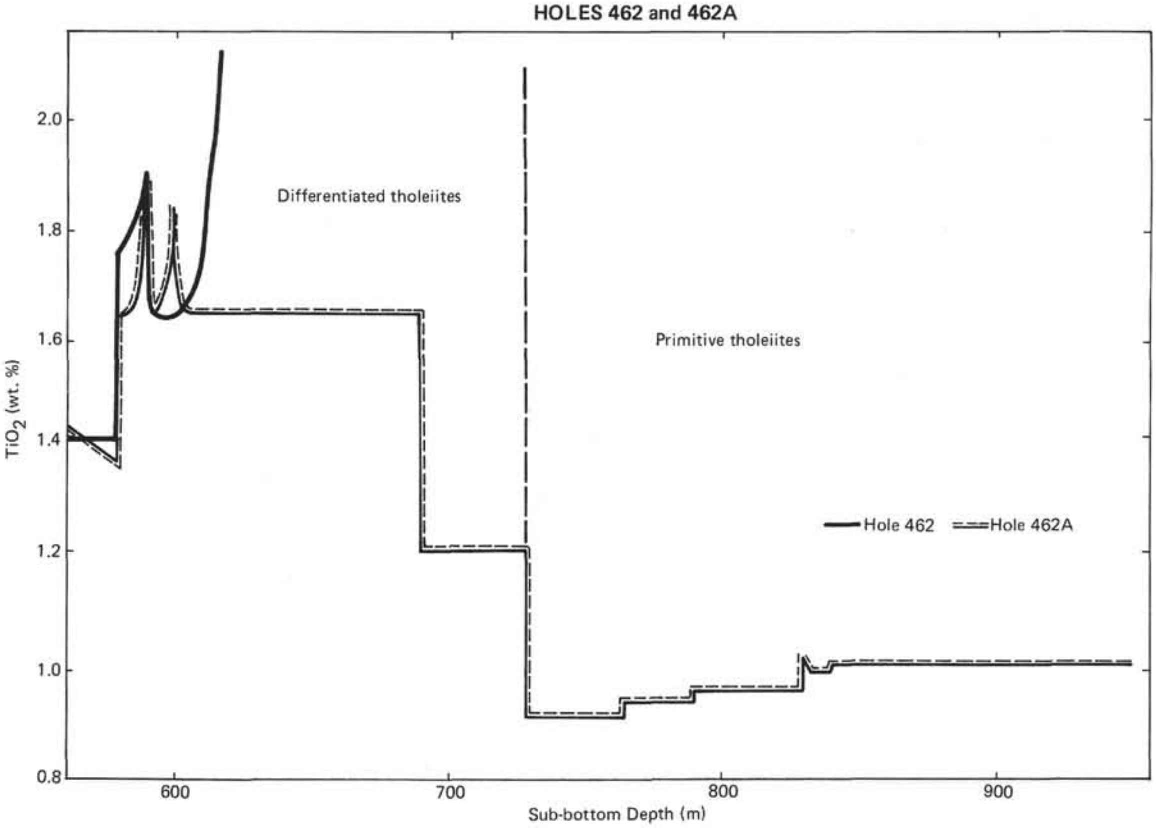


Figure 35. Variations of TiO_2 content in volcanic rocks.

sediments. They could effectively be cleaned only by thermal demagnetization. Thus, thermal demagnetization will be attempted on Site 462 samples on shore.

Within the reversed interval, in cores from both Holes 462 and 462A, an excursion of inclinations occurs at exactly the same point within the sediments relative to the reversal boundaries. The feature spans only 20 cm, but is so persistent as to occur in sediments of different color in each core. Occurring within the reversed-polarity interval, it consists of a shallowing of positive reversed inclinations, steepening into negative (apparently "normal") inclination values, and back again. Because this occurs at exactly the same level in both holes, cores from both holes were resampled to study this feature in more detail. The directions are illustrated and the details are described in Steiner (this volume).

Igneous Rock

In both Holes 462 and 462A, both the igneous rocks and the intercalated sediments were sampled to include as many of the petrographic units and sedimentary intervals as possible. This was based on the availability of material that was clearly oriented with respect to the up-direction of the hole. Nearly all of the petrographic units and the intercalated sedimentary units within these holes were sampled. Natural remanent magnetization and bulk susceptibility were measured. AF demagnetization has been carried out on most samples to obtain a stable inclination. AF demagnetization was performed at (12.5), 25, 50, (75), 100, 150, 200, 250, 300, 400, and 500 Oe. (The steps shown in parentheses were not done routinely on all samples.) The low coercivity of the magnetization precluded application of the 400- and 500-Oe steps to most igneous samples.

The shipboard Digico magnetometer has a detrimental effect on many samples after AF demagnetization was begun. The magnetometer incorporates as its shield from the earth's field a set of mu-metal cans. These cans have very narrow diameters, so that upon insertion a sample has to pass less than 1 cm from the can edges, an area of high magnetic field strength. It has been demonstrated repeatedly on Leg 61 basalts that the position and location of the sample as it enters the magnetometer can influence or *determine* the obtained direction. Samples generally are susceptible to the influence of this ring field around the magnetometer mouth only after demagnetization has begun. NRM measurements do not show much of the effect. Some samples are more susceptible than others—coarser-grained and high-susceptibility samples generally being the most susceptible. However, the influence begins to appear at different times during demagnetization of a sample, and often the influence on the directional change is too subtle to be detected immediately, if at all. Sometimes it can appear as a very smooth change away from the progressive demagnetization path of the natural remanence to a progressive path of increasing magnetization imparted by the can. Even in less-severe cases, it appeared that a combination of both processes produced the obtained directions. Even some visually fine-grained, low-suscep-

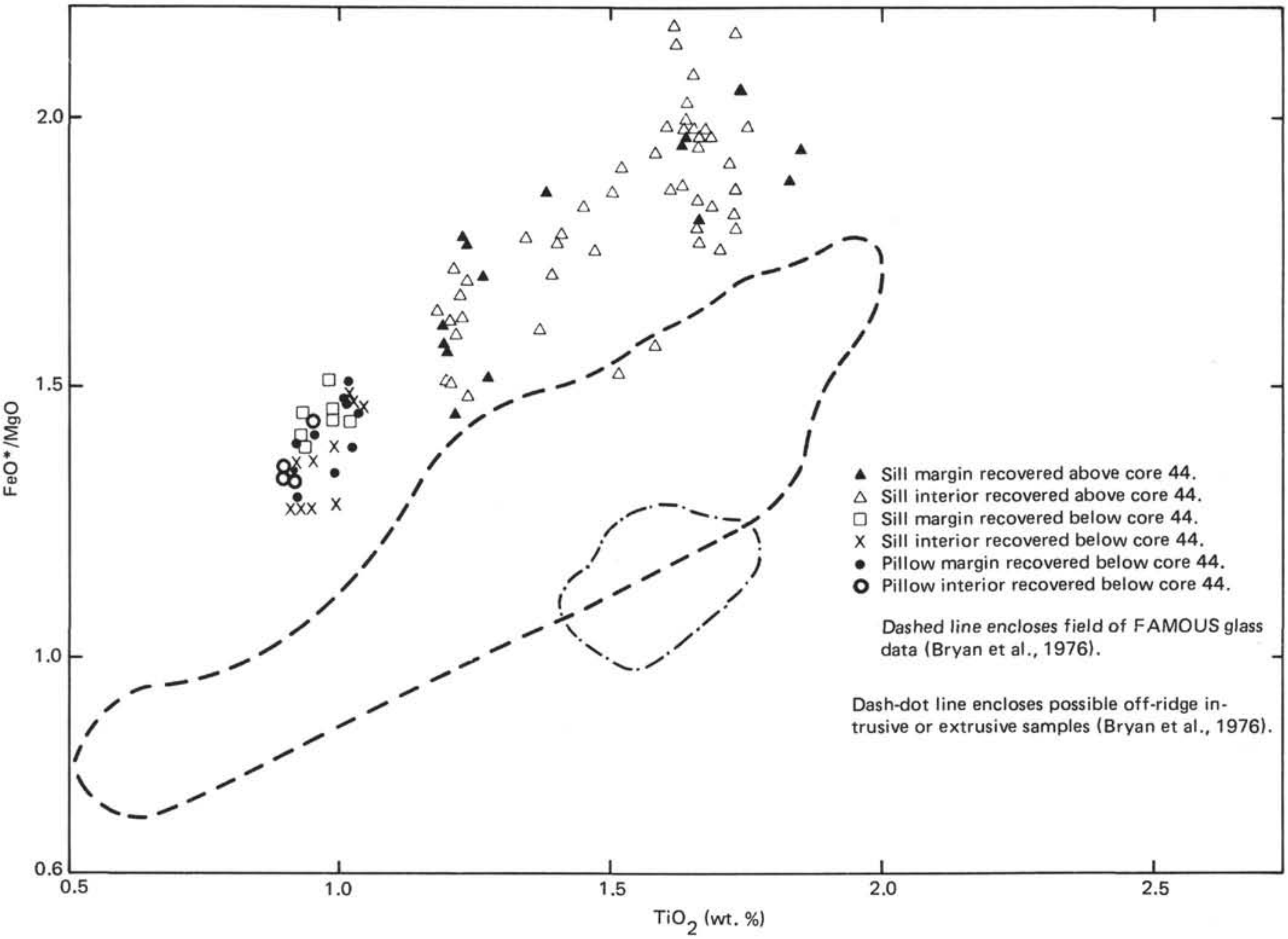


Figure 36. Covariation of FeO*/MgO and TiO_2 for Hole 462A.

Table 15. Petrographic characteristics of igneous rocks in Hole 462A below 953 meters.

Sample	Plagioclase	Clinopyroxene	Titanomagnetite	Altered Olivine	Clay	Other Minerals	Textures[s]	Phenocrysts[b]	No. of Points
462A-75-04, 78-80	54	37	7	—	3	—	S		1000
75-05, 31-32	54	36	5	Tr	5	—	S		700
75-05, 122-124	58	31	6	Tr	5	—	S		1000
76-01, 59-61	38	39	7	Tr	16	—	S		1000
77-01, 75-77	42	41	14	2	1	—	I-V	O, C, P	1000
77-01, 121-123	40	47	5	—	8	—	S		1000
77-02, 70-73	40	40	8	Tr	12	—	S-V	O	1000
78-01, 5-9	35	43	6	Tr	16	—	S-IS	O	1000
78-01, 96-98	38	44	8	Tr	10	—	V-S	O	1000
78-02, 87-89	41	38	9	—	12	—	Is		1000
79-01, 138-140	43	39	5	2	11	—	Is	O, C	1000
79-02, 135-137	42	39	7	2	10	Calcite (tr.)	Is-I	O, C, P	1000
79-05, 42-44	46	38	6	1	8	—	I	O	1000
79-05, 135-137	41	43	9	2	5	—	I-V	O, C, P	1000
81-01, 72-74	48	43	6	—	3	—	I		1000
81-03, 58-60	43	36	13	1	7	—	I	O, C, P	1000
84-03, 138-140	51	35	7	1	6	—	I	O, C, P	1000
84-04, 49-51	39	22	4		36	—	Is		1000
84-05, 75-77	43	43	6	Tr	8		S	O	1000
88-02, 83-85	50	37	4	2	7		I	O	500
88-02, 119-121	46	36	5	—	12	Alkalic Feldspar (tr.) Glass (2)	S		1000
88-02, 125-127	54	33	3	—	11		I		500
89-02, 38-40	30	31	2	Tr	35	Calcite (2)	Is	O	500
89-02, 72-74	21	18	12	—	49	—	V-I	C, P	500
90-01, 24-26	49	34	6	—	11	—	Is		500
90-03, 60-63	52	34	7	—	6	—	Is	P	500
90-05, 40-42	53	35	5	—	7	—	Is		500

[a] S = subophitic; I = intergranular; V = variolitic; Is = intersertal.
[b] O = olivine; C = clinopyroxene; P = plagioclase.

tibility rocks began to be biased once they were below 50% of their NRM intensities. The evidence for magnetometer bias is discussed in detail in Steiner (this volume). To a large extent, the bias has been removed by careful re-examination of the data, although some scatter remains which may testify to a remaining influence. The information and conclusions presented here are reasonably free of this influence.

Natural Remanent Magnetization

All samples, basalt and interbedded sediment, display negative NRM inclinations. Because the site was in the southern hemisphere during the Mesozoic (Larson, 1976; Lancelot and Larson, 1975), these samples possess a normal magnetization. Upon demagnetization, the initial −50 to −70° (and occasionally −80°) inclinations decrease to values between −30 and −55°. The site is now at 7°N (present inclination, 14°), and we believe that it moved north from only as far south as 20 to 30°S since the emplacement of these rocks (Larson, pers. comm.). Thus, it is puzzling to obtain a steep negative overprint on these inclinations. In general, all coarser-grained rocks (Hole 462A) displayed higher inclinations than the finer-grained rocks. Evidence from the lower part of Hole 462A (discussed in Steiner, this volume) suggests that the overprint is a drilling remanence.

Demagnetization

Most of the fine-grained basalts have NRM inclinations nearer the stable inclination, and they move to their stable inclination value with about 70 to 30% of their NRM intensity remaining. MDFs are usually between 80 and 120 Oe. The coarser-grained basalts and some of the fine-grained ones require the destruction of 80 to 90% of their NRM intensity before yielding a stable direction. Here, stable means that two or more consecutive demagnetization steps, usually 50 Oe apart, yield the same direction. The MDFs of coarse-grained samples range from 20 to 70 Oe.

Stable Inclinations, Hole 462 and the Upper Part of Hole 462A

Hole 462 generally exhibits very stable inclinations. Very little change occurs during demagnetization, except in the uppermost samples. The basalts of this hole have three distinct groups of stable inclinations. The upper six samples plotted in Figure 37 group around a mean of −38°, (standard deviation = 4.3°). The next four samples, below an 8-meter recovery gap, have a mean of −42.6° (standard deviation = 1.9°). Finally, the lower 13 samples are grouped around −48.2° (standard deviation = 2.6°). These three groups of inclinations correspond to separate petrologic units and suggest that petrologic Units 1 through 6 are contemporaneous, and that Units 7 through 10 are contemporaneous.

The only other magnetic feature which changes noticeably within Hole 462 is susceptibility, a distinct increase corresponding to the boundary between the second and third magnetic units. Susceptibility is appreciably higher in the lower unit, which may be related to the larger grain size. In the bottom of the hole, there is an enrichment in magnetite, both within the basalt and in a magnetite vein within the basalt. The host rock does not show any higher intensity or susceptibility, but a sample from a magnetite vein exhibiting octahedrons of magnetite does. Nevertheless, the direction remains the same as in the rest of the unit.

The upper basalts of Hole 462A resemble those of Hole 462 in some ways, although for the most part they are quite different. As in Hole 462, the upper basalts of Hole 462A have lower inclinations than underlying units. Values for Core 15 through part of Core 18 group around −25°. Cores 18 and 19 display a gradual increase to higher inclinations, −30 to −40°. Subsequent cores down through Core 24 have scattered inclinations grouped around −50°. The MDFs are much lower than those of Hole 462, averaging around 30 to 50 Oe. A considerable amount of soft component is removed during AF demagnetization, whereas there was little to none in Hole 462. Correlation between Holes 462 and 462A is not entirely obvious. In both holes, the upper inclinations are shallow relative to the underlying units, but the stable inclinations of higher units of Hole 462A do not correlate well with those of Hole 462. Recovery was very poor in the upper part of Hole 462, which contributes to the poor correlation. The stable inclinations of the upper two-thirds of petrographic Unit 12 are fairly similar to those of Unit 11 in Hole 462. Inclinations in Hole 462A are slightly higher and much more scattered, probably artifacts of the overprinting at Hole 462A. The marked susceptibility increase in Hole 462 between magnetic Units 2 and 3, is not clearly apparent in Hole 462A, although there is an increase at the same level (591 m), and it continues to be generally higher downhole from that point. Thus, in both susceptibility and stable inclination, there seems to be a correlation of petrographic Units 11 (Hole 462) and 12 (Hole 462A) in the two holes.

Stable Inclination in the Remainder of Hole 462A

Unit 12 is considered to be a very large sill (Fig. 22). In its lower third, remanence becomes harder, MDFs doubling in value from around 35 Oe to about 70 Oe. NRM intensities increase abruptly at this point. Thus, magnetic data suggest that the lower third of Unit 12 is really a different petrologic unit.

Immediately underlying Unit 12 is a volcaniclastic sedimentary section. Samples from this section show the same directions as the overlying basalt, and very stable remanence. The same was true of another volcaniclastic sedimentary unit between petrologic Units 9 and 10. The sediments were probably re-heated by the basalt intrusions.

The basalts of the upper petrographic units in both holes have experienced reduction alteration. Such alteration could have remagnetized these rocks, but measurements from samples centered on large chlorite-clay veins (as much as 6 mm across), or from samples riddled with veins, show the same directions and similar MDFs as large non-veined areas. Similarly, the magnetite vein in Hole 462 showed this same inclination, about −50°.

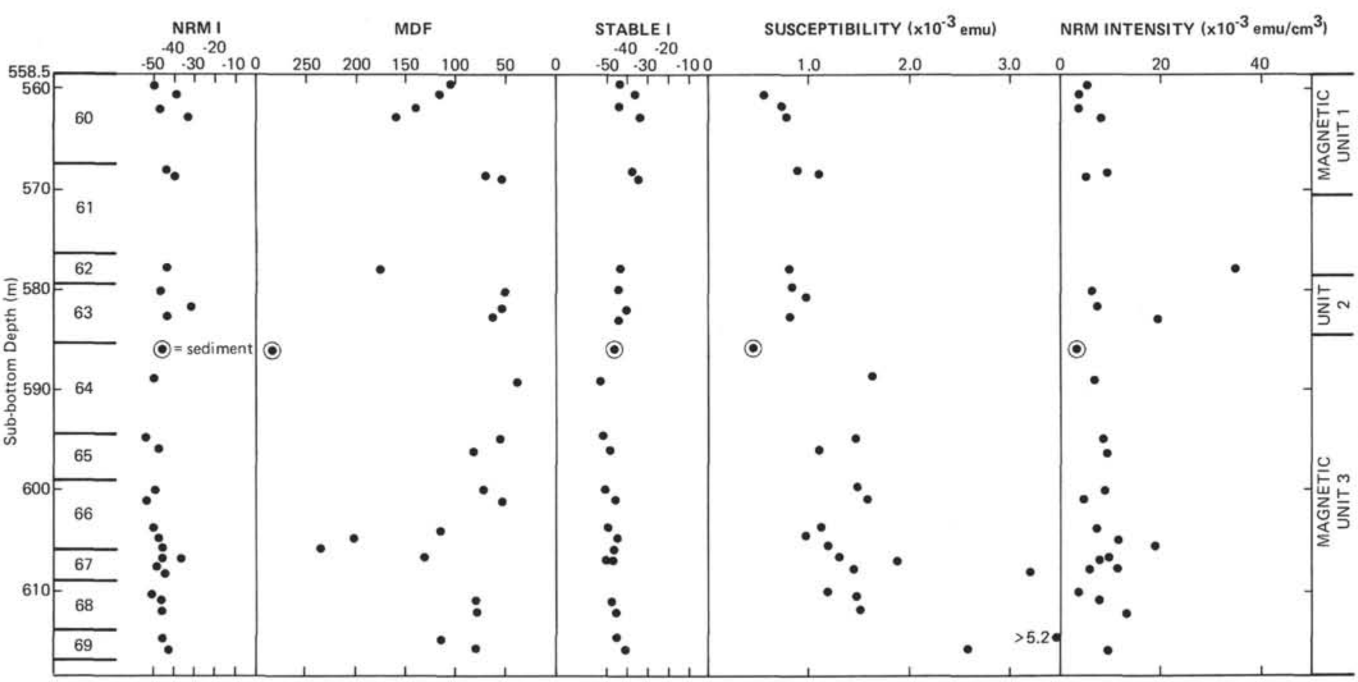


Figure 37. Some magnetics versus depth in hole.

The alteration is of interest because of the reducing nature and because magnetite is observed to be associated with it, suggesting that some remagnetization occurred. Both petrologic data (this summary) and the similarity of directions from heavily veined sediment and less-affected samples suggest that the alteration was deuteric, occurring shortly after emplacement.

Recovery was poor below petrologic Unit 12 and the underlying sediments. Petrologic Units 13 to 15 consist of only one or two samples each, and directions are scattered. Intensities are higher than in Units 1 to 11, and are comparable to the lower third of Unit 12. By Unit 16 (Core 39), the inclination seems to be shallower. At this point, titanium content decreases abruptly and remains low throughout the rest of the recovered basalt sequence, decreasing again at 730 meters (Fig. 21). From the point of the first Ti decrease (691 m sub-bottom), NRM intensity increases noticeably and remains higher than before throughout the remainder of the section. This suggests that the titanomagnetites below this point also have a lower titanium content than those above it.

Units 17 to 20 are again very narrow, and only a few samples with scattered directions were obtained. The next thick unit down-hole, Unit 21, has only two reliable values, both also shallow. Other values are questionable, for several reasons. Intervening between Units 18 and 21 are several poorly recovered sediment sequences (Fig. 22). One of these was dated as late Aptian (Core 40) and had sufficient material for a single paleomagnetic sample. It gave an inclination of −31°; however, the beds are inclined, and the inclination may be unreliable.

Below Unit 21, sediments again are encountered. Recovery at the base of these sediments (Core 43), dated as Barremian to Hauterivian, allowed the taking of nine samples. These have NRM inclinations of −45°; on demagnetization, they steepen to around −50°. Their stable inclinations are identical to those of the higher sediments and intrusives, even though the surrounding basalts are shallower.

Below the Barremian sediments, very fine-grained basalts occur, which are interpreted petrologically to be extrusive rocks. They display shallower NRM and demagnetized inclination than those higher in the core. The demagnetized inclination is 35.7° (standard deviation = 8°). These samples have relatively high MDFs, and the directions are less scattered than higher in the hole.

A thick, coarse-grained sill underlies the fine-grained rocks. The susceptibility values are relatively high. MDFs are low, and no stable inclination could be isolated. As discussed in Steiner (this volume), the magnetometer has a marked influence on these samples, causing their directions to appear to reverse in inclination during AF demagnetization. *None* of the inclinations for this unit are valid. Another small sill very similar to Unit 24 underlies it. Of two samples taken within it, the lower one shows the same susceptibility to the magnetometer, while the top one does not.

Below these high-susceptibility sills, inclinations in the finer-grained rocks (Cores 53–63) are similar to those of the fine-grained rocks above the sills, which have −36° inclinations, but there is more scatter in the data. The scatter is probably a reflection of the interspersed samples of fine-grained margins and coarser-grained flow interiors. The fine-grained samples throughout the rest of the section to Core 65 show the same stable inclinations, but because of the magnetometer's influence on coarse-grained, high-susceptibility rocks, the coarser-grained samples below about 825 meters sub-bottom generally were not demagnetized. A few trials showed that the magnetometer influence is too large to determine stable inclinations. These samples will be demagnetized on shore.

At about Core 64 to 65 (670–677 m sub-bottom, below petrologic Unit 30), susceptibility increased notably, from values around 1.0 to 1.2 × 10^{-3} Gauss/cm^3 to values of 1.3 to 1.5 × 10^{-3} Gauss cm^3. NRM intensity increases markedly about 7 × 10^{-3} Gauss to around 18 × 10^{-3} Gauss, larger than anything observed higher in the core. Almost all material is interpreted as sills. However, even a fine-grained unit intercalculated at 910 meters sub-bottom (Cores 69 to 70, petrologic Unit 34) shows these high intensities. The intensities remain high to the bottom of this hole, being generally higher in the coarser-grained samples. It is also at this point (677 m) that apparently total remagnetization occurs in the core, which continues to the bottom of the hole. All NRM inclinations are very steep upward values of -70 to $-85°$. Only two fine-grained intervals (petrographic Units 34 and 43) preserve the shallower NRM inclinations characteristic of the rest of the core.

Demagnetization of the coarse-grained samples proved useless. Attempted samples showed MDFs below 50 Oe, and no stable direction could be established. It appears that a drilling remanence has completely remagnetized the samples and caused the large increase in intensity. It is most interesting that NRM intensity seems to increase when the drilling rate is slower. With a lower rate, the time during which the rocks are under the influence of the magnetic field of the bottom assembly and the vibrations associated with drilling will be longer, increasing the intensity of a viscous magnetization. However, even the fine-grained units which still retain a stable magnetization show this large increase of intensity.

The two fine-grained units within the highly remagnetized sequence show NRM directions comparable to those of stable units higher in the hole. They also demagnetize to stable directions. Unit 34 displays a stable inclination of approximately $-38°$. Unit 43, however, displays a stable inclination of $-51°$, suggesting a genetic affinity with the sill sequence very near the top of the basaltic pile. On-shore demagnetization of the coarse units may provide information on this possibility.

At 993 meters sub-bottom, 4 meters of sediment shows one reversed and two normal directions. The fine-grained sediment carries a stable remanence, while the coarse-grained material like the surrounding basalt, is remagnetized. The three fine-grained samples exhibit stable inclinations of $+42$, -49, and $-37°$. One would assume that this is a record of a field reversal, which would be consistent with the sediment's Barremian age, the Barremian being a time of frequent reversals. However, the reversed sample has magnetic properties unlike those of the rest of the stable sediment in that interval, and somewhat distinct from those of sediment samples higher in the hole. First, the sample is from red sediment, which suggests baking. Second, the NRM intensity is abnormally high (1.25 × 10^{-2} Gauss) in comparison either to that of immediately underlying samples, or to that of other sedimentary samples in either hole. It also shows a very stable remanence and high MDF compared to those of the next two lower samples. All this makes one wonder about the origin of its remanence. Enclosing lavas are all heavily remagnetized, showing the monotonous, steep, upward magnetization, but do not hint at reversed igneous magnetization. All this leaves the meaning of the reversed sample ambiguous.

Summary

1. Campanian to Cenomanian sediments have recorded the reversal corresponding to Anomalies 33 and 34, bounding the Cretaceous long normal interval. The inclinations are low in contrast to the high inclinations of the basaltic sequence.
2. The igneous rock magnetization is relatively soft.
3. A steep up-hole remanence (probably drilling remanence) is overprinted on the igneous magnetizations.
4. All basalts and intercalated sediments (except one sample) are normally magnetized.
5. Two main groups of inclination are identified in the igneous rocks: approximately $-50°$ for the upper intrusives down to Core 32, and approximately $-37°$ for the intercalated extrusives and intrusives down to Core 65. The inclination changes slightly above the appearance of presumably extrusive units, suggesting that the upper intrusives (564–656 m) were emplaced at a different time than the units below 691 meters. The difference in age cannot be determined from these data. The vast difference between the overlying-sediment inclinations and the igneous-rock inclinations suggests that the igneous rocks probably record secular variations in the dipole field.
6. A completely overprinting remanence was acquired (apparently by drilling) in the lower half of the igneous section.

PHYSICAL PROPERTIES, WELL LOGS, AND UYEDA DOWN-HOLE TEMPERATURE PROBE

Physical Properties: Laboratory

METHODS

Sound velocity (compressional)[4], 2-minute GRAPE[5] wet-bulk density[4] (ratio of sediment weight to its volume), and continuous GRAPE wet-bulk density measurements were performed on laboratory samples, using methods described in Appendix I (this volume).

Cohesion or shear strength (g/cm^2) of clayey sediment was measured by the techniques described in Boyce (1976c), using a 1.6 cm (diameter) × 1.6 cm (height) vane. The vane was rotated with its axis parallel to bedding of a split core.

Gravimetric determination of wet-bulk density, wet-water content (ratio of the "weight of pore water" to "weight of the wet-saturated sediment or rock," expressed as a per cent), and porosity (ratio of "pore volume" to the "volume of the wet-saturated rock," expressed

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[4] Velocity, 2-minute GRAPE wet-bulk density, and thermal-conductivity measurements were done by R. Boyce, N. Fujii, and K. Thompson.

[5] Gamma-Ray Attenuation Porosity Evaluator.

as per cent) used traditional gravimetric water-immersion techniques[6] on 20-gram samples, as described in Appendix I.

Heat conductivity was measured with a quick thermal conductivity meter (QTM); this device uses a rectangular pad with a heater and thermocouple, which is placed on a flat rock sample, and the thermal conductivity is "automatically" measured and displayed on a panel. The technique and calibration are discussed in Appendix I.

Results

All data on sound velocity, wet-bulk density, water content, porosity, impedance, and heat conductivity are listed in Tables 16 and 17, and all except heat conductivity and vane shear strength are charted against depth. These data will not be further discussed, except interval-velocity discussions in the well-logging section, and best can be studied in Figures 38 through 48. When plotting the laboratory density and velocity on logging data, be advised that the vertical depths may be off as much as ±20 meters.

Logging Program in Sedimentary Rock and Basalt, Based on Gearhart–Owen Equipment

METHODS

The logging program can provide interpretive data for solutions of geophysical and geological problems: First, *in situ* geophysical parameters can be provided—sound velocity, density, porosity, electrical conductivity, and temperature. These data allow a more-integrated geophysical section to be determined. This integrated geophysical section will be at *in situ* conditions, which are difficult if not impossible to duplicate in laboratory measurements, and which will allow interpretation of remote-sensing data, such as seismic-reflection and -refraction data, gravity surveys, electrical resistivity surveys, and geothermal data. Second, the density (gamma-ray back-scatter) and porosity (neutron) logging data provide indexes to other physical parameters and allow the bulk mineral density (grain or matrix density) of the formation to be estimated statistically, which is the key (with the aid of sound velocity) to identification of certain sedimentary strata, some "potential ore deposits," and some igneous and metamorphic rocks. Third, natural gamma radiation (1) generally will distinguish argillaceous (high-count) formation from non-argillaceous sedimentary formation, and (2) in basalt is related to the K_2O content or some "alteration minerals." Fourth, if the porosity derived from the density log (assuming a 2.7-g/cm^3 grain density in sediments, and 3.0 g/cm^3 in basalt) does not match the porosity derived from the electric logs, then the following types of anomalies may be indicated: (1) minerals of extremely high or low grain density (different from 2.7 g/cm^3), (2) interstitial-water-salinity anomalies, (3) metallic minerals that are conductors of electricity, or (4) temperature anomalies. The continuous temperature log will assist in interpreting the electric logs and potentially locating zones of hydrothermal circulation and zones of fractured formations, and two or more temperature runs perhaps will allow a more accurate estimation of *in situ* temperature. Fifth, even when continuously coring, it is impossible to have complete core recovery, and the logging program provides data in the missing gaps, thus providing a more-representative, integrated geologic section, so that investigators are not misled by biased core recovery.

The logging tools and interpretation precautions are discussed in Appendix I. Where the hole is washed out, the data are not accurate.

The following suite of Gearhart-Owen logging tools were attempted at Hole 462:

1) Temperature log (thermocouple), 3.65 cm in diameter (absolute and differential temperature, ±0.05°C) (successful).

2) Sonic log (bore-hole compensated system, 9.21 cm diameter), caliper, and gamma-ray log (GR) (unsuccessful).

3) Density log (bore-hole compensated) (CDL), 6.99 cm in diameter, caliper, and GR (successful).

4) Induction log and 16-inch (40-cm) normal resistivity (successful).

The following suite of Gearhart-Owen logging tools were attempted at Hole 462A:

1) Neutron-log (thermal neutron), single detector and centered (free, therefore qualitative), 4.29 cm in diameter, and GR were run through the pipe, drill collars (>6737 m), and bumper ends (6074–6084 m) to bottom (semi-successful).

2) Sonic log (bore-hole compensated system), caliper, and GR (semi-successful).

The GR tool is run with each logging run for stratigraphic control. The GR also allows the density and velocity on two different logging runs to be correlated, because the depths are not accurate enough.

In general, when interpreting any of these logs, one should consult Lynch (1962) and a Gearhart-Owen manual to determine what precautions and data corrections are necessary, and to find the proper charts in various manuals and perform any needed corrections.

In regard to the sonic tool, Lynch (1962) discusses problems of (1) large hole diameters and low formation velocities (<2.1 km/s), (2) noise (high-velocity spikes), and (3) cycle skipping (low-velocity spikes).

Results

At Hole 462, of the attempted logging suite, only (1) the two temperature logs and GR; (2) the density, caliper, and GR; and (3) the induction log 16-inch normal and GR were successful. However, the data are only good below 349 meters below the sea floor, because the hole was washed out above this.

At Hole 462, the guard–neutron–GR and the sonic–GR logs were capable of logging only the washed-out portion of the hole (above 349 m), but only the neutron log was technically successful; because of the washed out hole, it appears to be of little use or value.

At Hole 462A, a gamma-ray–neutron combination was run through pipe, drill collars (>6737 m), and bumper subs (6074–6084 m) to a total depth of 947 meters below the sea floor.

Also at Hole 462A, the sonic, caliper, and GR logs were run in the open hole from 211 to 1050 meters; however, the upper (211–390 m) part of the hole was 95% washed out, and in general the formation velocities were too low (<2.1 km/s) to be measured accurately with corresponding large diameter of the hole, as the tool is centered in the hole. Below 390 meters, all of the low-velocity layers are subject to the same problems. This problem is discussed in Lynch (1962). In the basaltic parts of the hole, noise (as "high-velocity spikes") (Lynch, 1962) is a serious problem; many obvious examples with velocities about 7 km/s or greater are obvious artifacts.

The sonic-log data in soft formations may be affected by disturbance of the drill bit and *in situ* temperature disequilibrium. If these softer formations are drill-disturbed, the *in situ* overburden pressure could be partly released (e.g., horizontal expansion).

In Situ Interval-Velocity Estimates

The following *in situ* velocities were estimated using the Gearhart-Owen well logs and DSDP laboratory-measured velocities. Laboratory-velocity values are corrected to *in situ* conditions, using techniques in Boyce (1976a). The following intervals may or may not correspond to other lithologic or time units discussed elsewhere in this volume:

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[6] Gravimetric measurements were done by J. Rutherford and J. Pine aboard ship.

Table 16. Physical-property data, Hole 462.

				Compressional-Sound Velocity					Heat Conductivity at 21°C (cal. × 10^{-3}) (cm·s·°C)	GRAPE "Special" Wet-Bulk Density^{b} 2-Minute Count (g/cm^{3})		Gravimetric				
						Anisotropy										
Core	Section	Interval (cm)	Depth in Hole (m)	∥ Beds (km/s)	⊥ Beds (km/s)	∥ − ⊥ (km/s)	(∥ − ⊥)/⊥ (%)	Temperature^{a} (°C)		∥ Beds	⊥ Beds	Wet-Bulk Density (g/cm^{3})	Wet-Water Content (salt corrected) (%)	Porosity (salt corrected) (%)	Acoustic Impedance (g·10^{5}/cm^{2}·s)	Lithology
1	6	147-149	9.47	—	—	—	—	—	—	—	—	—	73.7	—	—	Interstitial-water sample (I.W.)
5	4	145-147	44.45	—	—	—	—	—	—	—	—	—	63.3	—	—	I.W.
10	4	145-147	91.95	—	—	—	—	—	—	—	—	—	35.1	—	—	I.W.
12	6	40-42^{d}	112.90	—	—	—	—	—	—	1.197^{d}	—	—	—	—	—	Disturbed radiolarian ooze (10YR 5/4)
14	6	16-26	131.76	—	—	—	—	—	3.00	—	1.625	—	—	—	—	Nannofossil ooze (10YR 8/2)
16	5	0-2	149.00	—	—	—	—	—	—	—	—	1.26	69.1	84.7	—	Clay (10YR 3/2)
16	5	0-10^{e}	149.00	1.565	1.539	0.026	1.69	22	1.81		1.416^{e}	1.43	53.9	75.1	2.20	Clay (10YR 3/2)
16	5	140-142	150.40	—	—	—	—	—	—	—	—	1.65	39.4	63.3	—	Clay (10YR 3/2)
19	5	0-2^{f}	177.50	1.548	1.552	0.004	0.26	22	—	1.284^{f}	—	—	—	—	1.99	Clay (10YR 2/2)
19	5	0-10	177.51	—	—	—	—	22	1.17	1.258	—	—	—	—	—	Clay (10YR 2/2)
19	5	122-124	178.73	—	—	—	—	—	2.68	1.700	—	—	—	—	—	Nannofossil ooze (N9)
19	5	142-146	178.92	1.550	—	—	—	22	2.82	1.615	—	—	—	—	2.528	Radiolarian nannofossil ooze (10YR 7/4)
20	4	145-147	180.45	—	—	—	—	—	—	—	—	—	35.4	—	—	I.W.
21	2	142-144	193.42	1.596	—	—	—	22	—	1.665	—	1.63	40.1	63.9	2.60	Radiolarian nannofossil chalk-ooze (10YR 8/2)
24	5	0-3^{g}	225.00	1.536	1.517	0.019	1.25	22	2.78	1.492^{g}	—	1.51	47.9	70.6	2.29	Nannofossil radiolarian ooze (10YR 4/2)
25	4	95-97	233.95	1.594	1.605	−0.011	−0.69	23	—	—	1.597	1.56	44.0	66.9	2.50	Nannofossil ooze (10YR 8/2)
26	4	145-147	234.45	—	—	—	—	—	—	—	—	—	27.2	—	—	I.W.
28	6	44-54	259.94	—	—	—	—	—	3.02^{h}	—	—	—	—	—	—	Nannofossil ooze (N9)
28	6	139-142	260.89	—	—	—	—	—	2.86^{i}	—	—	—	—	—	—	Radiolarian nannofossil ooze (10YR 7/4)
30	2	149-150	278.99	—	—	—	—	—	—	—	—	—	30.8	—	—	I.W.
32	2	65-67	297.15	3.371	—	—	—	23	—	2.106	—	2.08	8.7	17.7	7.01	Nannofossil chalk (N9)
32	4	54-56	300.04	1.648	1.609	0.039	2.42	23?	—	—	1.789	1.60	39.9	62.2	2.57?	Nannofossil chalk-ooze (N9)
34	CC	14-16	315.13	3.378	—	—	—	20?	—	—	—	2.12	7.2	14.8	7.16	Chert (laminated, black and tan)
35	1	30-33	323.80	1.644	1.656	−0.012	−0.72	18	—	1.734	—	1.70	35.9	59.7	2.82	Nannofossil ooze-chalk (N9)
36^{j}	1	105-107	334.05	1.656^{j}	1.646^{j}	0.010	0.61	19 (meas.)	—	—	1.710	1.56	43.99	66.8	2.57?	Nannofossil chalk (mottled, tan and orange)
36	3	0-2	336.00	—	—	—	—		—	—	—	—	35.3	—	—	I.W.
37	1	20-30	342.70	—	—	—	—	—	2.78	—	—	—	—	—	—	Nannofossil chalk (N9)
37	1	60-63	343.10	1.618	1.609	0.009	0.56	23	—	1.643	1.648	1.64	38.8	62.2	2.64	Nannofossil chalk (N9)
38	1	27-30	352.27	1.672	1.639	0.033	2.01	23	—	1.277	1.287	1.32	59.2	76.4	2.16	Nannofossil radiolarian chalk (10YR 6/2)
39	1	4-6	361.54	1.770	1.688	0.082	4.86	24	3.12	1.730	1.738	1.70	35.3	58.6	2.87	Nannofossil chalk (laminated) (N9)
39	1	50-53	362.03	1.666	1.660	0.006	0.36	24	2.31	1.506	1.404	1.44	49.5	69.3	2.39	Nannofossil radiolarian chalk (10YR 6/2)
42	1	11-12	390.11	4.112	4.049	0.63	1.56	23?	—	—	2.314	2.30	5.5	12.2	9.31	Siliceous limestone (N8)
42	1	44-46	390.44	4.819	—	—	—	23?	—	—	—	2.56	2.1	5.2	12.34	Chert (5Y 2/1)
43	1	5-7	399.55	5.186	—	—	—	22?	—	—	—	2.44	5.2	12.4	12.65	Chert (brown with white specks) (5YR 3/4)
43	1	15-17	399.65	2.118	—	—	—	22?	—	—	2.077	1.99	20.4	39.7	4.21	Limestone (10YR 8/2)
44	1	16-18	409.16	2.624	2.581	0.043	1.67	22?	—	—	2.408	2.29	12.4	27.8	5.91	Limestone (5Y 7/2)
44	1	27-29	409.27	4.666	—	—	—	22?	—	—	—	2.23	9.7	21.0	10.41	Chert (laminated and spotted) (5YR 3/2)
44	1	36-38	409.36	3.279	2.882	0.397	13.78	22?	—	2.131	—	—	—	—	6.14	Limestone (laminated) (5G 6/1)
47	CC	2-5	437.60	—	2.185	—	—	15	—	—	—	2.13	16.2	33.6	4.65	Limestone (10YR 6/2)
47	CC	21-23	437.80	—	4.290	—	—	15	—	—	—	—	—	—	—	Chert (porcellanite) (10YR 5/4)
48	1	0-2	447.06	—	—	—	—	—	—	—	—	—	25.9	—	—	I.W.
48	1	29-31	447.29	2.004	—	—	—	23	3.97	—	1.992	2.11	19.2	39.5	4.23	Sandstone (laminated) (5G 4/1)
48	1	116-118	448.16	2.524	2.406	0.118	4.90	23	—	1.991	—	1.97	19.8	37.9	4.74?	Limestone (5GY 6/1)
48	2	48-50	448.98	1.780	1.753	0.027	1.54	23	—	1.938?	—	1.74?	33.3	56.6?	3.05?	Claystone (5GY 4/1)
49	2	25-27	458.25	2.011	1.955	0.056	2.86	23	—	2.037	1.962	2.00	20.4	39.8	3.91	Volcanic siltstone (5GY 6/1)
49	2	125-127	459.25	1.919	1.877	0.042	2.23	23	3.12?	1.798	1.791	1.79	32.7	56.9	3.36	Limestone (5GY 6/1)
49	3	53-55	460.03	1.969	1.840	0.129	7.01	23	3.94?	2.042	2.046	2.02	21.8	42.9	3.72	Nannofossil chalk (5Y 7/1)
50	2	131-132	468.81	2.190	2.168	0.022	1.01	23	2.80	1.982	1.950	1.96	26.4	50.3	4.25	Volcanic sandstone (5G 6/1)
50	4	3-6	470.53	2.351	2.298	0.053	2.31	23	2.79	1.978	1.947	1.96	26.0	49.6	4.50	Volcanic sandstone (5G 6/1)
50	5	144-146	473.44	1.825	1.736	0.089	5.13	23	3.05	1.831	1.797	1.77	34.1	58.7	3.07	Volcanic mudstone (5G 6/1)
51	1	98-100	476.48	2.128	2.036	0.092	4.52	23	4.24, 4.40	—	2.252	2.18	15.6	33.1	4.44	Limestone (5GY 6/1)
51	2	63-67	477.63	1.834	1.755	0.079	4.50	23	2.96	—	—	1.80	32.7	57.4	3.16	Volcanic siltstone (5G 6/1)
52	1	6-8	485.06	2.011	1.894	0.117	6.18	23	3.30	1.880	—	1.80	30.0	52.6	3.41	Volcanic breccia coarse sandstone (5G 6/1)
52	1	52-54	485.52	1.852	1.780	0.072?	4.04	23	—	1.994	1.994	1.96	24.7	47.4	3.49	Laminated sandstone-claystone (5G 6/1)
52	2	78-81	487.28	2.078	1.981	0.097	4.89	23	—	2.168	—	2.11	17.9	37.0	4.18	Calcareous volcanic claystone (5G 6/1)
53	1	2-3	494.52	2.127	1.922	0.205	10.67	22?	—	—	2.236	2.02?	21.8?	42.9?	3.88?	Claystone (5Y 4/1)
53	1	52-54	495.02	1.852	1.780	0.072	4.04	22?	—	—	—	1.89	27.4	50.4	3.36	Laminated siltstone-claystone (5Y 4/1)
53	CC	1-3	497.10	2.262	1.980	0.282	14.24	22?	—	—	1.992	1.97	20.5	39.6	3.52	Calcareous claystone (5Y 6/1)
54	1	7-9	504.07	1.974	1.900	0.074	3.89	23	5.12	—	2.242	2.22	13.6	29.5	4.22	Limestone (5Y 6/1)
54	1	145-147	505.44	2.409?	2.302	0.107	4.65	23	—	—	2.071	2.06	18.3	36.7	5.11	Limestone (5BG 7/2)

54	1	148-149	505.48	—	—	—	—	—	—	—	—	—	30.1	—	—	I.W.
54	3	82-84	507.82	1.990?	2.190?	−0.200	−9.13	23	4.11	—	2.302	2.20	14.5	31.0	4.82?	Limestone (5Y 6/1)
55	1	84-86	514.34	2.261	2.122	0.139	6.55	21	4.42	—	2.080	2.16	16.2	34.2	4.58	Limestone (5Y 6/1)
55	2	67-69	515.67	2.395	2.257	0.138	6.11	21	—	—	2.056	2.00	21.0	40.9	4.51	Limestone (5B 7/4)
55	3	54-56	517.04	2.526	2.641	−0.115	−4.35	21	4.25	—	1.950	1.95	22.2	42.2	5.15	Limestone (5Y 6/8)
55	5	14-16	519.64	2.083	1.825	0.258	14.14	21	—	—	1.696	1.78	33.2	57.5	3.25	Claystone (5Y 4/1)
56	1	100-102	523.50	1.861	1.676	0.185	11.04	21?	2.47?	—	1.800	1.80	32.0	56.3	3.02	Claystone (10R 2/2)
57	1	135-137	532.85	1.971	1.625	0.346	21.29	21?	—	—	—	1.88	28.6	52.6	3.06	Claystone (10R 3/7)
57	2	102-104	534.02	1.867	1.818	0.049	2.70	21?	—	—	1.874	1.82	30.0	53.4	3.31	Siltstone (laminated) (10R 4/2)
57	3	45-47	534.95	1.750	1.728	0.022	1.24	21?	2.99	—	1.765	1.73	36.2	61.1	2.99	Sandstone (5G 6/1)
58	1	69-71	541.19	1.860	1.793	0.067	3.74	23	2.70	—	1.624	1.62	37.5	59.5	2.90	Zeolitic claystone (5YR 4/1)
58	3	145-147	—	—	—	—	—	—	—	—	—	—	37.6	—	—	I.W.
58	4	75-77	545.75	2.001	1.913	0.088	4.60	23	3.24	—	2.022	1.99	21.9	42.7	3.81	Zeolitic mudstone (5YR 5/2)
58	4	129-131	546.29	2.388	2.282	0.106	4.65	23	3.88	—	1.926	1.92	22.8	42.7	4.38	Nannofossil-rich marlstone (2.5YR 8/2)
59	1	45-47	549.95	1.970	1.753	0.217	12.38	23	3.01	—	1.839	1.84	28.1	50.6	3.23	Zeolitic mudstone (5YR 5/4)
59	1	63-65	550.13	1.950	1.839	0.111	6.04	23	2.92	—	1.890	1.89	26.5	48.8	3.48	Zeolitic marlstone (5YR 5/2)
60	1	0-5	558.50	5.292	—	—	—	23	—	2.687	—	—	—	—	14.22	Chert (5YR 4/1)
60	1	12-14	558.62	1.713	—	—	—	23	—	2.015	—	—	—	—	3.45	Claystone (10R 3/2)
60	1	43-45	558.93	1.765	1.917	−0.152	−7.93	23	—	2.046	—	—	—	—	3.92	Claystone (10R 2/2)
60	2	63-65	560.63	5.154	—	—	—	23	3.79	2.882[k]	—	2.80	3.0	8.1	14.43	Basalt (cracks) (half core)
60	2	63-65	560.63	5.046[l,m]	5.042[m]	0.004	0.08	23	—	2.810	—	—	—	—	—	Basalt (cracks) (mini-core)
60	2	78-80	560.78	—	4.290[m]	—	—	23	—	2.843	—	—	—	—	11.37?	Basalt (vein parallel to velocity path)
60	2	78-80	560.78	4.049[m]	—	—	—	23	—	—	—	—	—	—	—	Basalt (vein across velocity path)
61	1	48-51	567.98	5.526[m]	5.465[m]	0.061	1.12	19	4.77	2.893	—	2.86	1.8	4.9	15.63	Basalt (cracks)
61	1	126-128	568.76	5.346[m]	5.332[m]	0.014	0.26	19	—	2.883	—	2.89	1.7	4.9	15.41	Basalt
62	1	85-87	577.35	5.863[m]	5.864[m]	0.001	0.02	19	7.00	3.073	—	2.88	1.9	5.2	16.9	Basalt (coarse-grained)
62	2	32-34	578.32	4.832[m]	4.796[m]	0.036	0.75	24	—	—	—	—	—	—	—	Basalt
62	2	109-111	579.09	5.310[m]	5.275[m]	0.035	0.66	19	4.32	2.872	—	2.98	0.7	2.0	15.7	Basalt (fine-grained)
63	1	58-60	580.08	—	3.113[m]	—	—	19	—	—	—	2.32	15.9	36.1	7.22	Volcanic glass
63	2	32-34	581.32	4.794[m]	4.521[m]	0.273	6.04	19	4.15	2.816	—	2.56?	5.0?	12.4?	11.57	Basalt (near cracks)
63	3	117-120	583.67	4.716[m]	4.826[m]	−0.110	−2.28	19	3.49	2.798	—	2.74?	5.5?	14.6?	13.22	Basalt (cracked)
64	1	105-107	586.55	2.897[m]	2.941[m]	−0.044	−1.50	23	—	2.176	—	2.15	19.0	39.8	6.32	Claystone (5G 2/1)
64	2	113-115	588.13	2.415[m]	2.682[m]	−0.267	−9.96	23	—	1.926	—	1.94	26.6	50.2	5.20	Claystone (5G 4/1)
64	3	48-50	588.98	4.878[m]	4.821[m]	0.057	1.18	23	4.18	2.809	—	2.79	4.4	11.8	13.45	Basalt
65	1	38-40	594.88	5.435[m]	5.325[m]	0.110	2.07	23	7.27	2.989	—	2.97	2.2	6.5	15.82	Basalt
65	2	7-9	596.07	5.429[m]	5.408[m]	0.021	0.39	23	4.67	2.940	—	2.96	2.2	6.2	16.01	Basalt
66	1	25-27	599.25	5.415[m]	5.269[m]	−0.146	−2.77	19	4.79	2.996	—	2.97	2.2	6.3	15.65	Basalt
66	1	25-27	599.25	5.854[n]	—	—	—	15	—	—	—	—	—	—	—	Basalt
66	1	25-27	599.25	5.816[n]	—	—	—	15	—	—	—	—	—	—	—	Basalt
66	2	61.5-63.5	601.12	5.177[m]	5.171[m]	0.006	0.12	20	5.10	2.934	—	2.96	2.8	8.0	15.31	Basalt
66	2	61.5-63.5	601.12	5.622[n]	—	—	—	15	—	—	—	—	—	—	—	Basalt
66	2	61.5-63.5	601.12	5.766[n]	—	—	—	15	—	—	—	—	—	—	—	Basalt
66	4	81-83	604.31	5.365[m]	5.337[m]	0.028	0.52	20	4.70	2.885	—	2.95	2.7	7.9	15.74	Basalt
66	4	81-83	604.31	5.699[n]	—	—	—	15	—	—	—	—	—	—	—	Basalt
66	4	81-83	604.31	5.582[n]	—	—	—	15	—	—	—	—	—	—	—	Basalt
66	5	54-56	605.54	5.318[m]	5.218[m]	0.086	1.65	21	4.63	2.953	—	2.95	2.6	7.6	15.39	Basalt
66	5	54-56	605.54	5.590	—	—	—	15	—	—	—	—	—	—	—	Basalt
66	6	8-10	606.58	5.304[m]	5.504[m]	0.200	3.63	21	5.22	2.990	—	2.98	2.2	6.3	16.40	Basalt
66	6	8-10	606.58	5.947[n]	—	—	—	15	—	—	—	—	—	—	—	Basalt
66	6	8-10	606.58	5.870[n]	—	—	—	15	—	—	—	—	—	—	—	Basalt
67[o]	1	13-15	606.13	5.811[n]	—	—	—	15	4.52, 4.12	2.951	—	2.96	2.2	6.2	17.20	Basalt
67	2	123-126	608.73	5.795[n]	—	—	—	15	5.10, 5.39	2.924	—	2.96	2.3	6.7	17.15	Basalt
68	1	24-26	609.24	5.813[n]	—	—	—	15	—	2.893	—	2.95	1.0	2.9	17.15	Basalt
68	2	66-68	611.16	5.948[n]	—	—	—	15	4.29	2.991	—	2.99	0.8	2.2	17.78	Basalt
68	3	15-17	612.15	5.935[n]	—	—	—	15	3.97	3.047	—	3.00	0.6	1.8	17.81	Basalt
68	3	102-104	613.02	5.870[n]	—	—	—	15	5.06	3.009	—	2.98	0.7	1.9	17.49	Basalt
69	1	24-26	614.24	5.221[n]	—	—	—	15	6.86	—	—	2.90	2.4	6.8	15.14	Basalt (cracked)
69	2	36-38	615.86	5.640[n]	—	—	—	15	5.31	2.973	—	2.93	1.5	4.2	16.53	Basalt

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[a] Temperature estimated from time after core was on deck until measurement. The time after core was on deck was estimated in heat-conductivity measurements. Temperature was estimated from the "time-temperature curve" and assumes that cores were at 14.2°C when they arrived on deck.

[b] ϱ_g and ϱ_{gc} = 2.7 g/cm^2 for sedimentary rock, and 3.00 g/cm^3 for basaltic rock.

[c] Impedance is generally the product of the gravimetric wet-bulk density and vertical velocity.

[d] Vane shear strength = 370.0 g/cm^2, remolded = 57.9 g/cm^2, sensitivity = 7.1.

[e] Vane shear strength = 984.6 g/cm^2, remolded = 162.2 g/cm^2, sensitivity = 6.1.

[f] Vane shear strength = 393.9 g/cm^3, remolded = 35.1 g/cm^2, sensitivity = 11.7.

[g] Vane shear strength = 289.5 g/cm^3, remolded = 59.9 g/cm^2, sensitivity = 4.8.

[h] Analog GRAPE = 1.65 g/cm^3, 62.7%.

[i] Analog GRAPE = 1.55 g/cm^2, 68.7%.

[j] Below Core 36, cores were firm; therefore, we waited ~2 hours before velocity measurements. Above Core 36, temperature measurements show that cores were within 1 to 2°C of room temperature.

[k] All 2-Minute GRAPE on basalt mini-cores are through the axis of the mini-core.

[l] Velocities are on mini-cores and are through diameter of mini-core.

[m] Mini-core.

[n] Full diameter (6.6 cm) core, run immediately when core arrived on deck (cores).

[o] All cores below (and including 67 have velocities measured on the "full diameter cores."

Table 17. Physical-property data, Hole 462A.

				Compressional-Sound Velocity					Heat Conductivity at 21°C	GRAPE "Special" Wet-Bulk Density^{b} 2-Minute Count (g/cm^{3})		Gravimetric				
						Anisotropy										
Core	Section	Interval (cm)	Depth in Hole (m)	∥ Beds (km/s)	⊥ Beds (km/s)	∥ − ⊥ (km/s)	(∥ − ⊥)/⊥ (%)	Temp.^{a} (°C)	(cal. × 10^{-3})/(cm•s•°C)	∥ Beds	⊥ Beds	Wet-Bulk Density (g/cm^{3})	Wet-Water Content (salt corrected) (%)	Porosity (salt corrected) (%)	Acoustic Impedance (g•10^{5}/cm^{2}•s)	Lithology
1	1	2–3	78.52	1.509^{g}	—	—	—	18^{d}	—	—	—	—	—	—	—	Nannofossil ooze (10YR 8/2)
1	1	9–12	78.59	1.529^{g}	—	—	—	18^{d}	—	—	—	—	—	—	—	Radiolarian ooze (5YR 5/2)
1	1	14–16	78.64	1.568^{g}	—	—	—	18^{d}	—	—	—	—	—	—	—	Foraminifer nannofossil ooze (5YR 9/2)
1	1	44–46	78.94	1.533^{g}	—	—	—	18^{d}	—	—	—	—	—	—	—	Nannofossil radiolarian ooze (10YR 5/4)
2	2	72–74	250.22	1.592^{g}	—	—	—	19^{d}	—	—	—	1.63	39.4	62.8	2.59	Nannofossil ooze (lump) (10YR 8/2)
2	5	41–42	255.91	—	—	—	—	—	—	—	—	1.57	42.0	64.1	—	Interstitial-water sample (I.W.)
3	1	1–3	401.51	4.854^{g}	—	—	—	20?	—	2.477	—	2.55	1.7	4.1	12.37	Chert (laminated) (N7)
4	1	0–2	411.02	3.869^{g}	—	—	—	24	—	—	—	2.07	6.6	13.3	8.01	Porcellanite (irregular edge) (5G 4/1)
4	1	14–16	411.14	3.580^{g}	—	—	—	24	—	—	—	2.34	7.1	16.2	8.38	Siliceous limestone (N9)
4	1	54–55	411.54	5.016^{g}	—	—	—	24	—	—	—	2.52	0.8	1.9	12.64	Chert (5Y 6/1)
4	1	66–68	411.66	2.667^{g}	—	—	—	24	—	—	—	1.97	11.0	21.1	5.25	Limestone (laminated) (10YR 8/2 to 6/2)
5	1	3–5	420.53	(orientation?)	4.464^{g}	—	—	20?	—	—	—	2.58	0.4	0.9	11.52	Chert (quartzose) (10YR 2/2)
5	1	18–20	420.68	(orientation?)	4.852^{g}	—	—	20?	—	—	—	2.55	0.7	1.7	12.37	Chert (quartzose) (10R 4/2)
6	CC	—	430.00	2.916^{g}	—	—	—	15	—	—	—	—	—	—	—	Limestone (10YR 7/2)
6	CC	—	430.05	4.487^{g}	—	—	—	15	—	—	—	—	—	—	—	Chert (10YR 2/2)
7	1	39–41	439.89	2.818^{g}	2.955^{g}	−0.137	−4.64	22	3.01	—	—	—	—	—	5.26	Sandstone (calcarenite) (10YR 6/2)
7	2	123–125	442.23	2.859^{g}	2.653^{g}	0.206	7.76	22	—	—	—	1.91	14.8	27.7	5.07	Siliceous limestone (10YR 7/2)
H-3	1	20–22	449.20	2.096^{g}	1.978^{g}	0.118	5.97	21	—	—	—	2.08	18.8	38.1	4.11	Claystone (5YR 4/1)
H-3	2	8–10	450.58	2.711^{g}	2.051^{g}	0.660	32.18	21	5.21	—	—	2.21	14.2	30.7	4.53	Sandstone (5G 6/1)
H-3	2	121–122	451.71	2.037^{g}	2.089^{g}	−0.052	−2.49	21	—	—	—	2.06	18.1	36.5	4.30	Limestone (5B 7/1)
8	1	121–123	488.21	2.252^{g}	2.126^{g}	0.126	6.03	20?	—	—	—	2.14	15.9	33.1	4.55	Calcareous claystone (5Y 6/1)
8	2	38–40	488.88	1.767^{g}	1.753^{g}	0.014	0.80	20?	—	—	—	1.77	33.5	59.9	3.10	Volcanic-ash sandstone (5Y 4/1)
8	3	19–21	490.19	2.189^{g}	1.980^{g}	0.209	10.56	20?	—	—	2.040	1.99	22.1	42.8	3.94	Claystone (5YR 4/1)
8	3	134–136	491.34	2.610^{g}	2.279^{g}	0.331	14.52	20?	3.92	—	2.193	2.14	16.0	33.4	4.88	Limestone (5Y 6/1)
H-4	2	28–30	498.29	2.838^{g}	2.543^{g}	0.295	11.60	21?	5.08	—	2.216	2.20	13.5	28.9	5.59	Limestone (10YR 7/1)
H-4	2	110–112	499.10	2.650^{g}	2.356^{g}	0.294	12.48	21	5.42	—	2.134	2.04	17.4	34.5	4.81	Limestone (10YR 7/1)
H-4	3	40–42	499.90	2.181^{g}	2.144^{g}	0.037	1.73	21	4.54	—	2.239	2.22	13.9	30.1	4.76	Limestone (10YR 7/1)
H-4	3	67–69	500.17	2.219^{g}	2.124^{g}	0.095	4.47	21	4.63	—	2.244	2.21	14.0	30.3	4.69	Limestone (10YR 7/1)
9	1	90–94	516.40	2.363^{g}	2.088^{g}	0.275	13.17	21	—	—	—	1.87	24.3	44.3	3.90	Claystone (10YR 2/2)
9	1	129–131	516.79	2.546^{g}	2.420^{g}	0.126	5.21	21	4.09	—	—	1.97	19.5	38.9	4.77	Limestone (10YR 6/2)
9	4	17–19	520.17	2.262^{g}	2.114^{g}	0.148	7.00	21	3.81	—	—	2.08	18.7	37.8	4.40	Limestone (5B 7/1)
9	6	42–44	523.42	1.832^{g}	1.736^{g}	0.096	5.53	21	—	—	—	1.81	31.0	54.8	3.14	Claystone (5YR 4/4)
10	1	25–27	525.25	1.833^{g}	1.671^{g}	0.162	9.69	20?	—	—	—	1.76	33.7	57.8	2.94	Claystone (5YR 4/4)
10	2	47–49	526.97	1.844^{g}	1.644^{g}	0.200	12.17	20?	—	—	—	1.68	38.5	63.2	2.76	Claystone (5YR 4/4)
10	3	133–135	529.33	1.946^{g}	1.822^{g}	0.124	6.81	20?	—	—	—	1.85	30.2	54.4	3.37	Claystone (10YR 2/2)
11	1	93–95	535.43	1.925^{g}	1.833^{g}	0.092	5.02	20?	—	—	—	1.83	30.7	54.9	3.35	Claystone (5Y 4/1)
11	1	140–142	535.90	2.092^{g}	2.055^{g}	0.037	1.80	20?	—	—	—	1.88	29.1	53.4	3.86	Siltstone (laminated) (5GY 6/1)
11	CC	1–3	536.33	1.925^{g}	1.865^{g}	0.060	3.22	20?	—	—	—	1.89	28.1	51.7	3.52	Sandstone (5G 4/1)
12	1	81–83	544.81	1.826^{g}	1.756^{g}	0.070	3.99	20?	—	—	—	1.66	36.9	60.0	2.91	Claystone (5YR 4/4)
13	1	19–21	533.19	1.908^{g}	1.831^{g}	0.077	4.21	20?	—	—	—	1.88	27.7	50.9	3.44	Claystone (5YR 4/4)
13	2	65–67	555.15	2.295^{g}	2.089^{g}	0.206	9.86	20?	—	—	—	2.07	17.6	35.6	4.32	Claystone (laminated) (10YR 2/2)
13	2	93–94	555.93	—	—	—	—	20?	—	—	—	1.80	31.2	54.8	—	Claystone (mottled) (10YR 6/2)
14	1	27–29	563.27	2.289^{g}	—	—	—	15	—	—	—	1.91	25.9	48.2	4.37	Claystone (10YR 2/2)
14	2	31–33	564.81	5.289^{f}	—	—	—	15	—	2.798	—	—	—	—	—	Basalt clasts in breccia
15	1	0–5	566.50	2.085^{g}	—	—	—	15	—	1.796	—	—	—	—	3.74	Siltstone, laminated
15	1	78–81	567.28	6.300^{f}	—	—	—	15	—	2.984	—	2.99	0.4	1.2	18.84	Basalt (dense)
15	1	78–81	567.28	6.186^{f}	—	—	—	15	—	—	—	—	—	—	—	Basalt (dense)
15	1	78–81	567.28	5.894^{e}	—	—	—	19	—	—	—	—	—	—	—	Basalt (dense)
16	1	34–36	572.34	5.915^{f}	—	—	—	15	—	3.000	—	2.98	0.6	1.7	17.63	Basalt
16	1	62–64	572.62	6.091^{f}	—	—	—	15	—	2.979	—	2.99	0.5	1.4	18.21	Basalt
17	1	88–91	574.88	5.812^{f}	—	—	—	15	4.69	—	—	2.98	0.6	1.7	17.32	Basalt
17	2	52–54	576.92	6.090^{f}	—	—	—	15	5.16	2.903	—	2.97	0.8	2.3	18.09	Basalt (vein)
18	2	15–17	577.65	5.349^{f}	—	—	—	15	4.49?	2.931	—	2.82	2.7	7.5	15.08	Basalt (vein)
18	2	60–62	578.10	5.971^{f}	—	—	—	15	—	3.048	—	2.97	0.7	2.1	17.73	Basalt (2-mm vein)
19	1	34–36	578.34	5.842^{f}	—	—	—	15	—	—	—	2.97	0.6	1.7	17.35	Basalt (cracked)
19	2	119–121	580.69	4.657^{f}	—	—	—	15	—	—	—	2.69	4.2	11.0	12.52	Basalt (vein)
20	1	27–29	581.27	5.421^{f}	—	—	—	24	4.29	—	—	2.87	1.5	4.3	15.56	Basalt (cracked)

20	2	6–8	582.56	6.028^{f}	—	—	—	24	4.53	3.162	—	2.99	0.2	0.6	18.02	Basalt
21	1	86–88	586.86	5.273^{f}	—	—	—	15	—	—	—	2.89	0.9	2.5	15.24	Basalt (cracked)
22	2	1–3	589.51	2.706^{g}	2.303^{g}	0.403	17.50	22?	—	2.208	—	2.12	17.0	35.1	4.88	Claystone (N3)
22	3	53–55	591.53	5.605^{f}	—	—	—	15	—	2.933	—	2.94	0.5	1.5	16.48	Basalt
22	5	59–61	594.59	5.883^{f}	—	—	—	15	—	2.996	—	2.97	0.4	1.2	17.47	Basalt
23	1	143–146	598.43	5.211^{f}	—	—	—	15	—	2.956	—	2.94	0.6	1.8	15.32	Basalt (cracks across velocity path)
23	3	8–10	600.08	5.167^{f}	—	—	—	15	—	2.965	—	2.91	0.9	2.5	15.04	Basalt (cracks parallel to velocity path)
23	4	70–72	602.20	5.080^{f}	—	—	—	15	—	2.868	—	2.83	1.6	4.3	14.38	Basalt
24	1	16–18	606.16	5.186^{f}	—	—	—	15	4.17	2.876	—	2.85	1.4	4.0	14.78	Basalt
24	2	8–11	607.58	5.501^{f}	—	—	—	15	3.86	3.023	—	2.89	0.6	1.8	15.90	Basalt
24	3	19–21	609.19	5.372^{f}	—	—	—	15	—	—	—	2.89	1.0	2.8	15.53	Basalt
25	1	83–86	615.83	5.517^{f}	—	—	—	15	—	2.971	—	2.91	1.1	3.2	16.05	Basalt
27	2	10–12	627.60	5.918^{f}	—	—	—	15	—	3.055	—	3.00	0.4	1.1	17.75	Basalt
27	2	72–74	628.22	5.797^{f}	—	—	—	15	—	3.033	—	2.99	0.5	1.4	17.33	Basalt
28	1	119–121	631.19	5.974^{f}	—	—	—	15	4.35	3.079	—	2.98	0.5	1.3	17.80	Basalt
28	2	89–92	632.39	6.031^{f}	—	—	—	15	4.75	3.054	—	2.99	0.4	1.3	18.03	Basalt
28	3	75–77	633.75	5.953^{f}	—	—	—	15	4.51	3.114	—	2.99	0.7	2.0	17.80	Basalt
28	4	139–142	635.89	5.817^{f}	—	—	—	15	4.60	2.971	—	2.99	0.5	1.5	17.39	Basalt
29	1	9–11	636.09	5.873^{f}	—	—	—	15	—	2.969	—	2.96	1.0	2.9	17.38	Basalt (velocity path across vein)
29	2	117–119	638.67	5.679^{f}	—	—	—	15	4.84	—	—	—	—	—	—	Basalt (cracked)
29	3	44–46	639.44	6.062^{f}	—	—	—	15	—	2.991	—	2.95	1.3	3.6	17.88	Basalt
29	4	70–73	641.20	6.145^{f}	—	—	—	15	5.10	3.070	—	2.98	1.0	2.9	18.31	Basalt
29	5	6–8	642.06	5.257^{f}	—	—	—	15	—	—	—	2.99	0.9	2.7	15.71	Basalt (velocity path, across 4-mm vein)
30	1	42–44	645.42	6.198^{f}	—	—	—	15	4.84	3.025	—	2.75	4.9	13.1	17.04	Basalt
30	2	34–36	646.84	6.107^{f}	—	—	—	15	5.38	3.082	—	2.95	1.1	3.0	18.02	Basalt
30	3	19–21	648.19	6.154^{f}	—	—	—	15	3.97	3.050	—	2.99	0.8	2.2	18.40	Basalt
30	4	14–16	649.64	6.169^{f}	—	—	—	15	5.18	3.050	—	3.00	0.8	2.4	18.51	Basalt
31	1	56–58	654.51	5.880^{f}	—	—	—	15	—	2.991	—	3.01	0.8	2.2	17.70	Basalt
32	1	31–33	655.81	5.672^{f}	—	—	—	15	—	2.952	—	2.92	1.1	3.2	16.56	Basalt veins
32	2	42–45	657.42	3.117^{f}	—	—	—	~15	3.33	—	2.068	2.03	21.3	42.2	6.33	Sandstone (5GY 4/1)
32	2	42–45	657.42	3.125^{g}	2.881^{g}	0.244	8.47	~21	—	—	—	—	—	—	—	Sandstone (5GY 4/1)
33	CC	1–3	663.10	2.981^{g}	—	—	—	15	—	—	—	—	—	—	—	Sandstone (5GY 4/1)
35	CC	0–2	681.10	—	2.898^{g}	—	—	15								Sandstone (5GY 4/1)
B-2	1	69–71	690.69	5.677^{f}	—	—	—	24	—	—	—	2.95	1.2	3.5	16.75	Basalt
38	1	89–91	691.89	5.988^{f}	—	—	—	15	4.36	3.019	—	2.96	1.0	3.0	17.72	Basalt
38	2	6–8	692.56	6.054^{f}	—	—	—	15	4.76	3.055	—	2.97	1.1	3.2	17.98	Basalt
39	1	139–141	693.39	5.937^{f}	—	—	—	15	3.61	3.040	—	2.96	1.1	3.1	17.57	Basalt
39	2	107–109	694.57	5.977^{f}	—	—	—	15	5.77?	2.959	—	2.95	1.1	3.1	17.63	Basalt
39	3	105–107	696.05	5.889^{f}	—	—	—	15	4.54	2.967	—	2.98	0.9	2.6	17.55	Basalt
40	1	25–27	702.25	5.700^{f}	—	—	—	15	—	—	—	2.95	1.3	3.6	16.82	Basalt
40	1	99–101	702.99	2.965^{f}	—	—	—	15	3.43	—	—	—	—	—	—	Volcanic laminated claystone (N3)
40	1	99–101	702.99	2.952^{g}	3.163^{g}	−0.211	−6.67	21	—	—	2.124	2.12	20.1	41.6	6.71	Volcanic laminated claystone (N3)
40	2	42–44	703.92	5.617^{f}	—	—	—	15	4.36	2.951	—	2.94	1.3	3.6	16.52	Basalt
41	1	51–53	711.51	5.889^{f}	—	—	—	15	—	3.046	—	3.00	1.1	3.3	17.67	Basalt
41	3	124–126	715.24	5.980^{f}	—	—	—	15	—	3.045	—	2.99	1.1	3.1	17.88	Basalt
41	5	80–82	717.80	5.992^{f}	—	—	—	15	—	2.938	—	2.98	1.0	2.9	17.86	Basalt
41	7	108–110	721.08	2.964^{f}	—	—	—	15	—	—	—	—	—	—	—	Claystone (spotted) (N4)
41	7	108–110	721.08	2.829^{g}	2.958^{g}	−0.129	−4.36	21?	—	—	—	2.19	18.2	38.7	6.48	Claystone (spotted) N4)
41	8	14–16	721.64	3.438^{f}	—	—	—	15	—	—	—	—	—	—	—	Sandstone (5G 4/1)
41	8	14–16	721.64	3.398^{g}	3.393^{g}	0.005	0.15	21?	—	2.168	—	2.12	18.2	37.7	7.19	Sandstone (5G 4/1)
42	1	24–26	720.24	2.453^{f}	—	—	—	15	—	—	—	—	—	—	—	Claystone (5G 4/1)
42	1	24–26	720.24	2.346^{g}	1.955^{g}	0.391	20.00	21?	—	—	—	1.88	24.6	45.1	3.68	Claystone (5G 4/1)
42	2	46–48	721.96	3.002^{f}	—	—	—	15	—	—	—	—	—	—	—	Sandstone (5GY 4/1)
42	2	46–48	721.96	2.944^{g}	2.813^{g}	0.131	4.66	21?	—	—	—	2.15	18.3	38.5	6.05	Sandstone (5GY 4/1)
43	1	145–147	724.45	2.632^{g}	2.497^{g}	0.135	5.41	20	—	—	—	2.04	21.7	43.3	5.09	Sandstone (5Y 4/1)
43	2	145–147	725.95	2.630^{g}	2.456^{g}	0.174	7.08	20	—	—	—	2.04	21.2	42.2	5.01	Laminated claystone and siltstone (5Y 3/1)
44	1	0–2	729.00	2.072^{f}	—	—	—	15	—	—	—	—	—	—	—	Claystone (5YR 3/2)
44	1	15–17	729.15	4.976^{f}	—	—	—	15	—	—	—	2.98	0.7	2.0	14.83	Basalt (chilled margin)
44	3	139–141	733.39	5.502^{f}	—	—	—	15	—	—	—	2.95	1.3	3.5	16.23	Basalt
45	1	105–107	734.05	5.771^{f}	—	—	—	15	4.45	2.994	—	2.93	1.0	3.0	16.91	Basalt
45	3	4–6	736.04	5.903^{f}	—	—	—	15	4.52	3.001	—	2.96	0.7	2.1	17.47	Basalt
46	1	119–121	739.19	5.976^{f}	—	—	—	15	3.71	2.961	—	2.93	0.8	2.3	17.51	Basalt
46	2	112–114	740.62	6.089^{f}	—	—	—	15	4.84	—	—	2.94	0.7	2.0	17.90	Basalt (cracks and veins)
46	4	13–15	742.63	6.068^{f}	—	—	—	15	4.35	2.958	—	2.95	0.6	1.8	17.90	Basalt
46	5	80–83	744.80	5.332^{f}	—	—	—	15	4.07	—	—	2.89	1.7	4.8	15.41	Basalt (cracks)
47	1	59–61	747.59	5.513^{f}	—	—	—	15	—	—	—	2.89	2.2	6.3	15.93	Basalt (cracks)
47	2	11–13	748.61	5.968^{f}	—	—	—	15	—	2.982	—	2.96	1.0	2.8	17.67	Basalt
47	3	36–38	750.36	5.660^{f}	—	—	—	15	—	2.926	—	2.91	1.2	3.4	16.47	Basalt (cracks)
48	1	110–112	757.10	5.737^{f}	—	—	—	15	5.45	2.900	—	2.96	1.0	2.9	16.98	Basalt
48	4	61–63	761.11	6.026^{f}	—	—	—	15	4.32	2.945	—	2.97	0.7	2.1	17.90	Basalt
49	1	81–83	765.81	5.811^{f}	—	—	—	15	4.20	2.979	—	2.95	0.9	2.5	17.14	Basalt
49	3	6–8	768.06	5.683^{f}	—	—	—	15	3.76	2.922	—	2.93	1.0	2.9	16.65	Basalt

Table 17. (Continued).

				Compressional-Sound Velocity					Heat Conductivity	GRAPE "Special" Wet-Bulk Density^b 2-Minute Count (g/cm^3)		Gravimetric				
						Anisotropy										
Core	Section	Interval (cm)	Depth in Hole (m)	| Beds (km/s)	⊥ Beds (km/s)	| − ⊥ (km/s)	(| − ⊥)/⊥ (%)	Temp.^{a} (°C)	at 21°C $\frac{(\text{cal.} \times 10^{-3})}{(\text{cm}\cdot\text{s}\cdot{}^{\circ}\text{C})}$	| Beds	⊥ Beds	Wet-Bulk Density (g/cm^3)	Wet-Water Content (salt corrected) (%)	Porosity (salt corrected) (%)	Acoustic Impedance (g·10^5/cm^2·s)	Lithology
50	1	18–20	774.18	6.012^f	—	—	—	15	4.61	2.989	—	2.98	0.8	2.2	17.92	Basalt
50	4	21–23	778.71	5.549^f	—	—	—	15	—	2.818	—	2.86	1.7	4.8	15.87	Basalt (cracks)
50	6	7–8	781.57	6.124^f	—	—	—	15	5.05?	2.990	—	2.99	0.6	1.7	18.31	Basalt
50	6	124–126	782.74	6.027^f	—	—	—	15	5.29	—	—	2.99	0.6	1.6	18.02	Basalt
51	1	16–18	778.66	6.085^f	—	—	—	15	—	—	—	2.98	0.6	1.8	18.13	Basalt
51	2	135–137	781.35	5.975^f	—	—	—	15	—	—	—	2.97	0.9	2.5	17.75	Basalt
51	3	67–69	782.17	5.841^f	—	—	—	15	4.54	—	—	2.96	1.0	2.8	17.29	Basalt
51	4	20–22	—	—	—	—	—	—	—	2.449	—	—	—	—	—	Volcanic glass
52	1	131–133	788.81	5.853^f	—	—	—	15	4.37	2.932	—	2.95	0.7	2.1	17.27	Basalt
52	2	118–120	790.18	5.920^f	—	—	—	15	4.44	2.934	—	2.94	0.6	1.6	17.40	Basalt
53	1	25–27	792.25	5.866^f	—	—	—	15	—	2.952	—	2.93	0.7	2.0	17.19	Basalt (near cracks)
53	2	95–97	794.45	6.052^f	—	—	—	15	—	3.002	—	2.94	0.7	1.9	17.79	Basalt
54	1	13–15	797.63	5.930^f	—	—	—	15	—	2.994	—	2.93	0.8	2.3	17.37	Basalt
54	2	30–32	799.30	5.838^f	—	—	—	15	—	2.991	—	2.93	0.8	2.3	17.11	Basalt
55	1	48–51	801.48	5.776^f	—	—	—	15	—	2.993	—	2.95	0.8	2.2	16.92	Basalt (near cracks)
56	1	129–131	807.79	5.904^f	—	—	—	15	—	3.011	—	2.97	0.9	2.5	17.30	Basalt
57	1	10–12	815.60	6.085^f	—	—	—	15	—	3.063	—	3.01	0.8	2.4	18.32	Basalt
58	1	53–55	825.03	5.873^f	—	—	—	15	5.44	2.946	—	2.96	1.1	3.2	17.38	Basalt
58	3	36–38	827.86	5.640^f	—	—	—	15	—	2.998	—	2.93	1.7	4.9	16.53	Basalt
58	4	47–49	829.47	5.552^f	—	—	—	15	—	—	—	2.92	1.7	4.9	16.21	Basalt
59	1	62–64	834.12	5.948^f	—	—	—	15	4.88	2.997	—	2.98	1.0	3.0	17.73	Basalt
59	2	57–59	835.57	6.030^f	—	—	—	15	4.50	2.984	—	2.97	0.8	2.3	17.91	Basalt
59	3	6–8	836.56	5.956^f	—	—	—	15	—	2.841	—	2.97	0.8	2.3	17.69	Basalt (cracked)
59	4	49–51	838.49	6.038^f	—	—	—	15	4.55	2.978	—	2.93	0.9	2.6	17.69	Basalt
59	5	4–6	839.54	6.096^f	—	—	—	15	—	2.946	—	2.95	0.9	2.7	17.98	Basalt
59	6	33–35	841.33	5.654^f	—	—	—	15	—	—	—	—	—	—	—	Basalt
61	1	32–34	851.82	5.818^f	—	—	—	15	4.29	2.943	—	2.93	1.5	4.2	17.05	Basalt
61	2	64–66	853.64	5.734^f	—	—	—	15	—	2.948	—	2.92	1.4	4.0	16.74	Basalt
61	3	45–47	854.95	5.849^f	—	—	—	15	—	3.009	—	2.93	1.1	3.1	17.14	Basalt
61	4	60–62	856.60	5.851^f	—	—	—	15	4.01	—	—	2.94	1.4	4.1	17.20	Basalt (cracked)
62	1	94–96	861.44	5.887^f	—	—	—	15	—	3.001	—	2.95	1.2	3.4	17.37	Basalt
62	2	52–54	862.52	5.778^f	—	—	—	15	4.38	—	—	2.93	1.7	4.9	16.93	Basalt (cracked)
62	3	32–34	863.82	5.639^f	—	—	—	15	—	—	—	2.97	1.1	3.2	16.75	Basalt (cracked)
63	1	124–126	865.90	5.819^f	—	—	—	15	—	2.994	—	2.95	1.4	4.0	17.17	Basalt
63	2	88–90	866.88	5.646^f	—	—	—	15	—	—	—	2.93	1.7	5.0	16.54	Basalt (cracked)
64	2	7–9	871.07	6.086^f	—	—	—	24	5.70	3.012	—	2.99	0.7	2.0	18.20	Basalt
64	2	121–123	872.21	5.372^f	—	—	—	24	—	2.939	—	2.92	1.5	4.3	15.69	Basalt (vein-cracks)
64	5	27–29	875.77	5.394^f	—	—	—	24	—	—	—	2.91	1.9	5.5	15.70	Basalt (cracked)
65	1	10–12	876.60	5.952^f	—	—	—	15	4.72	3.033	—	2.95	0.9	2.7	17.56	Basalt
65	2	93–95	878.93	6.038^f	—	—	—	15	4.59	2.983	—	2.97	0.8	2.2	17.93	Basalt
65	3	10–12	879.66	5.876^f	—	—	—	15	—	2.985	—	2.97	0.8	2.4	17.45	Basalt
66	1	142–144	884.42	5.962^f	—	—	—	15	4.95	—	—	2.97	0.9	2.5	17.71	Basalt
66	2	124–126	885.74	5.809^f	—	—	—	15	4.40	2.914	—	2.98	0.7	2.0	17.31	Basalt
66	4	91–93	888.41	5.995^f	—	—	—	15	5.19	2.885	—	2.97	0.9	2.5	17.81	Basalt
66	5	62–64	889.62	5.891^f	—	—	—	15	5.12	2.993	—	3.00	0.5	1.5	17.67	Basalt
66	6	70–72	891.20	6.098^f	—	—	—	15	5.08	2.977	—	3.00	0.5	1.5	18.29	Basalt
66	7	4–6	892.04	5.992^f	—	—	—	15	4.81	3.000	—	2.98	0.7	2.1	17.86	Basalt
67	1	119–121	893.19	6.110^f	—	—	—	15	4.73	2.984	—	3.00	0.7	2.1	18.33	Basalt
67	3	2–4	895.02	6.127^f	—	—	—	15	5.19	3.025	—	2.98	0.7	2.1	18.26	Basalt
67	7	17–19	901.17	5.954^f	—	—	—	15	4.68	2.943	—	3.00	0.7	1.9	17.86	Basalt
68	1	48–50	901.48	6.136^f	—	—	—	15	5.14	3.003	—	2.97	0.5	1.3	18.22	Basalt
68	2	74–76	903.24	6.200^f	—	—	—	15	4.82	3.062	—	3.00	0.4	1.1	18.60	Basalt
68	4	107–109	906.57	5.934^f	—	—	—	15	5.06	3.072	—	2.93	0.8	2.2	17.39	Basalt (cracked)
68	5	108–110	908.08	6.163^f	—	—	—	15	—	2.961	—	2.98	0.5	1.4	18.37	Basalt
69	1	60–62	910.60	5.605^f	—	—	—	15	—	2.929	—	2.93	1.0	3.0	16.42	Basalt (cracked)
69	2	43–45	911.93	5.766^f	—	—	—	15	—	—	—	2.97	0.6	1.7	17.13	Basalt (cracked)
69	3	77–79	913.77	5.780^f	—	—	—	15	—	3.019	—	2.97	0.6	1.8	17.17	Basalt (cracked)

70	1	121–123	920.22	4.159	—	—	—	15	4.44	2.984	—	—	—	—	12.41	Slickenside (green)
70	2	77–79	921.27	5.759^f	—	—	—	15	—	—	—	2.95	0.9	2.6	16.99	Basalt
71	1	44–46	928.44	5.374^f	—	—	—	15	4.2	2.925	—	2.92	1.6	4.6	15.69	Basalt (vein)
72	1	43–45	931.43	5.757^f	—	—	—	15	—	3.036	—	2.96	1.1	3.0	17.04	Basalt
72	2	44–46	932.94	6.017^f	—	—	—	15	—	3.153	—	2.97	0.6	1.7	17.87	Basalt
73	1	37–39	937.37	5.452^f	—	—	—	15	—	2.957	—	2.93	1.4	3.9	15.97	Basalt
73	2	19–21	938.69	5.511^f	—	—	—	15	—	2.896	—	2.94	1.1	3.1	16.20	Basalt
73	3	52–54	940.52	5.896^f	—	—	—	15	—	2.985	—	2.96	1.0	2.9	17.45	Basalt
74	1	5–7	946.05	5.850^f	—	—	—	24	4.30	3.178	—	2.94	1.3	3.7	17.20	Basalt
74	2	79–81	948.29	5.999^f	—	—	—	24	4.84	3.028	—	2.95	1.1	3.3	17.70	Basalt
74	3	118–120	950.18	6.071^f	—	—	—	24	5.13	2.957	—	2.97	1.1	3.1	18.03	Basalt
74	4	123–125	951.73	5.902^f	—	—	—	24	—	2.969	—	2.94	1.3	3.7	17.35	Basalt
74	5	94–96	952.94	5.978^f	—	—	—	24	4.16	3.046	—	2.96	1.6	4.6	17.69	Basalt
75	2	31–33	954.81	6.231^e	6.256^e	−0.025	−0.40	21.5	4.87	2.948	—	2.96	1.7	3.4	18.52	Basalt
75	4	10–13	957.60	—	6.293^e	—	—	21.5	5.35	2.932	—	2.98	0.9	2.7	18.75	Basalt
76	1	43–45	958.43	5.960^e	6.097^e	−0.137	−2.25	20	4.84	3.002	—	2.99	1.1	3.3	18.23	Basalt
77	1	20–23	967.21	5.874^e	5.885^e	−0.011	−0.19	17?	4.58	3.048	—	2.97	1.1	3.1	17.48	Basalt
77	2	70–73	969.20	5.774^e	5.761^e	0.013	0.23	17?	—	—	—	2.97	1.6	4.7	17.11	Basalt
77	2	75–78	969.25	—	—	—	—	—	4.75	2.961	—	—	—	—	—	Basalt
78	1	91–93	976.93	5.948^e	6.048^e	−0.100	−1.65	21	4.64	2.995	—	2.95	1.5	4.4	17.84	Basalt
78	2	82–84	978.32	5.756^e	5.814^e	−0.058	1.00	21	4.54	2.943	—	2.95	1.2	3.4	17.15	Basalt (fractured)
79	1	138–140	986.38	5.667^e	5.670^e	−0.003	−0.05	21	4.44	2.963	—	2.92	2.2	6.3	16.56	Basalt
79	1	138–140	986.38	5.800^h	5.695^h	0.105	1.84	21								Basalt
79	2	135–137	987.85	5.582^e	5.612^e	−0.030	−5.35	21	4.47	2.970	—	2.92	1.9	5.4	16.39	Basalt
79	2	135–137	987.85	5.590^h	5.499^h	0.091	1.65	21								Basalt
79	5	42–44	991.42	6.029^e	5.937^e	0.092	1.55	21	4.88	3.025	—	2.98	1.0	2.8	17.69	Basalt
79	5	42–44	991.42	6.109^h	6.073^h	0.036	0.59	21	—	—	—	—	—	—	—	Basalt
80	1	30–32	994.30	2.909^e	2.934^e	0.025	−0.85	21	3.43	2.269	—	2.22	15.4	33.4	6.51	Siltstone (N4)
80	1	103–106	995.03	2.947^e	2.858^e	0.089	3.11	21	2.88	2.220	—	2.16	16.9	35.6	6.17	Sandy mudstone (N3)
80	2	68–70	996.08	2.945^e	2.940^e	0.005	0.17	21	3.17	2.205	—	2.17	16.8	35.7	6.38	Sandy siltstone (5YR 2/1)
80	3	42–44	997.42	5.375^e	5.435^e	−0.059	−1.09	21	4.22	2.961	—	2.91	2.0	5.7	15.82	Basalt
81	1	94–96	998.94	—	—	—	—	—	4.87	—	—	—	—	—	—	Basalt
81	1	90–92	998.90	6.111^e	5.950^e	0.161	2.71	19	—	—	—	2.98	0.9	2.6	17.73	Basalt
81	3	41–42	1001.41	—	—	—	—	—	4.44	—	—	—	—	—	—	Basalt
81	3	58–60	1001.58	5.817^e	5.913^e	−0.096	−1.62	19	—	3.066	—	2.98	1.1	3.2	17.62	Basalt
84	1	107–109	1006.57	6.095^e	6.144^e	−0.049	−0.80	19	4.87	3.007	—	3.00	0.4	1.2	18.43	Basalt
84	3	108–110	1009.58	6.145^e	5.920^e	0.225	3.80	19	4.62	—	—	2.97	1.0	3.0	17.58	Basalt
84	5	75–75	1012.25	6.165	6.174^e	−0.009	−0.15	19	4.87	2.982	—	3.00	1.0	2.5	18.52	Basalt
85	1	118–120	1015.68	6.066^e	6.059^e	0.007	0.12	19	4.74	3.010	—	2.99	1.3	3.8	18.12	Basalt
85	3	34–36	1017.84	6.227^e	6.246^e	−0.019	−0.30	19	5.00	2.998	—	3.00	1.6	4.6	18.74	Basalt
87	1	31–33	1026.31	6.039^e	5.994^e	0.045	0.75	22	4.75	2.973	—	2.97	1.7	4.8	17.80	Basalt
87	2	37–39	1027.87	5.999^e	6.074^e	−0.075	−1.23	22	4.90	3.024	—	2.99	1.6	4.5	18.16	Basalt
88	2	45–48	1034.45	6.104^e	6.047^e	0.057	0.94	21	5.66, 5.55	2.989	—	3.01	1.2	3.6	18.20	Basalt
88	3	17–20	1035.67	5.961^e	5.891^e	0.007	0.12	21	4.51	2.982	—	2.96	1.6	4.7	17.44	Basalt
89	1	62–65	1037.12	6.080^e	6.069^e	0.011	0.18	20	4.49	2.962	—	2.95	1.7	4.8	17.90	Basalt
89	3	121–123	1040.71	5.569^e	5.781^e	−0.212	−3.67	20	4.13	2.960	—	2.96	2.4	6.8	17.11	Basalt
90	1	86–88	1042.36	5.544^e	5.644^e	−0.100	−1.77	21	431, 432	2.956	—	2.96	2.3	6.7	16.71	Basalt
90	3	78–80	1045.28	5.748^e	5.664^e	0.084	1.48	21	4.38	2.966	—	2.96	2.3	6.7	16.77	Basalt
90	4	99–101	1046.99	5.548^e	5.554^e	−0.006	0.11	21	4.38	2.916	—	2.92	2.6	7.5	16.22	Basalt

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[a] Temperature estimated from time after core on deck until measurement. The time after the core was on deck was estimated in the heat-conductivity measurements. Temperature was estimated using "time-temperature curve," assuming that cores were at ~14°C when they arrived on deck.

[b] ϱ_g and ϱ_{gc} = 2.7 for sedimentary rocks, and 3.0 for basaltic rocks.

[c] In general, impedance = gravimetric density × vertical velocity.

[d] Measured.

[e] Velocity measured on a mini-core (across diameter).

[f] Velocity measured on a whole core. Basalt velocity on whole core; for Core 16-74, immediately after it arrived on deck.

[g] This velocity was measured on D-shaped sample after 2 hours (~21°C) at room temperature (24°C).

[h] Half of whole core, wrapped (2.8 cm).

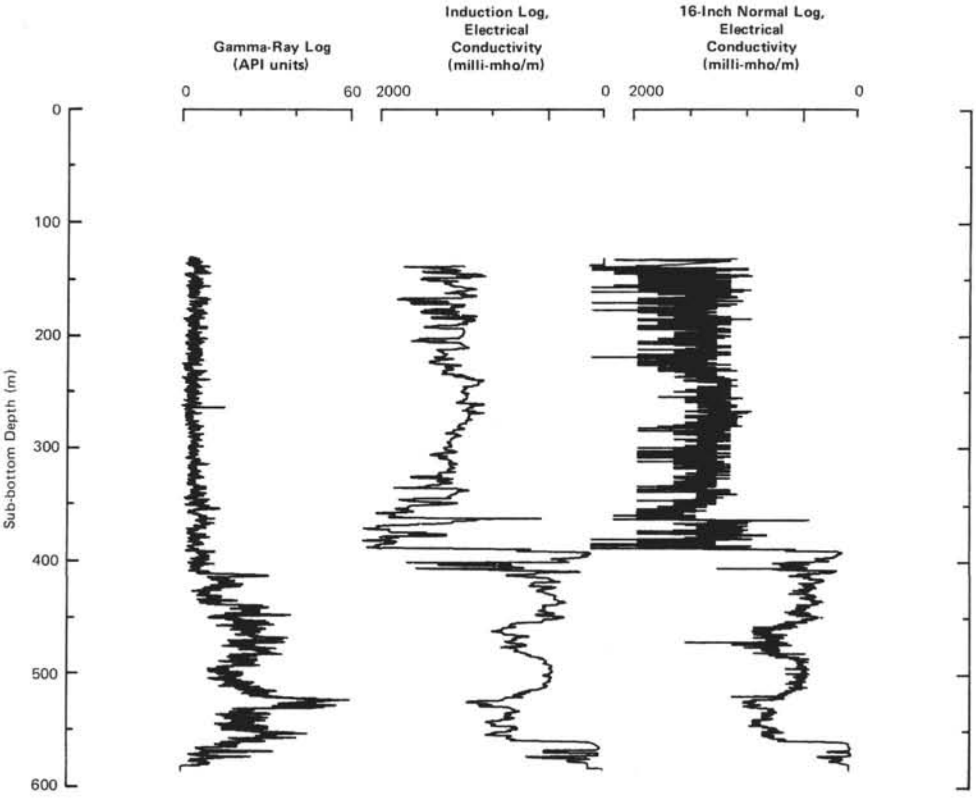


Figure 38. Gamma-ray log, induction log, and 16-inch normal electrical-resistivity log from a single wireline lowering in Hole 462.

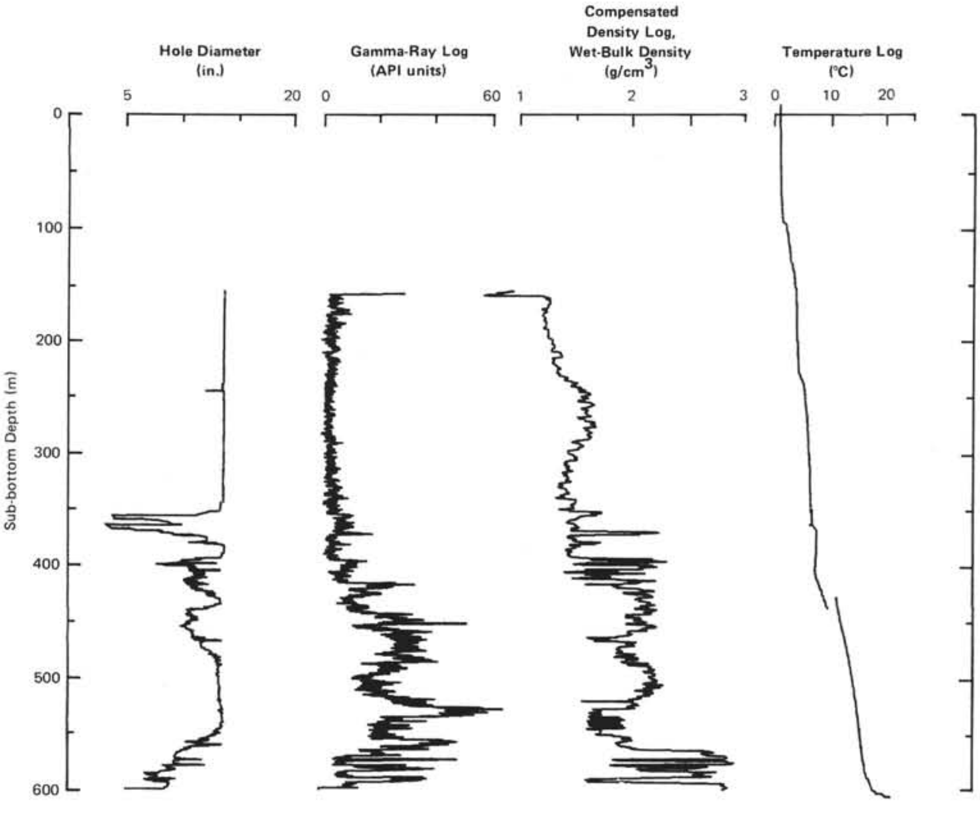


Figure 39. Caliper (hole-diameter) log, gamma-ray log, compensated density log, and the second temperature log, Hole 462.

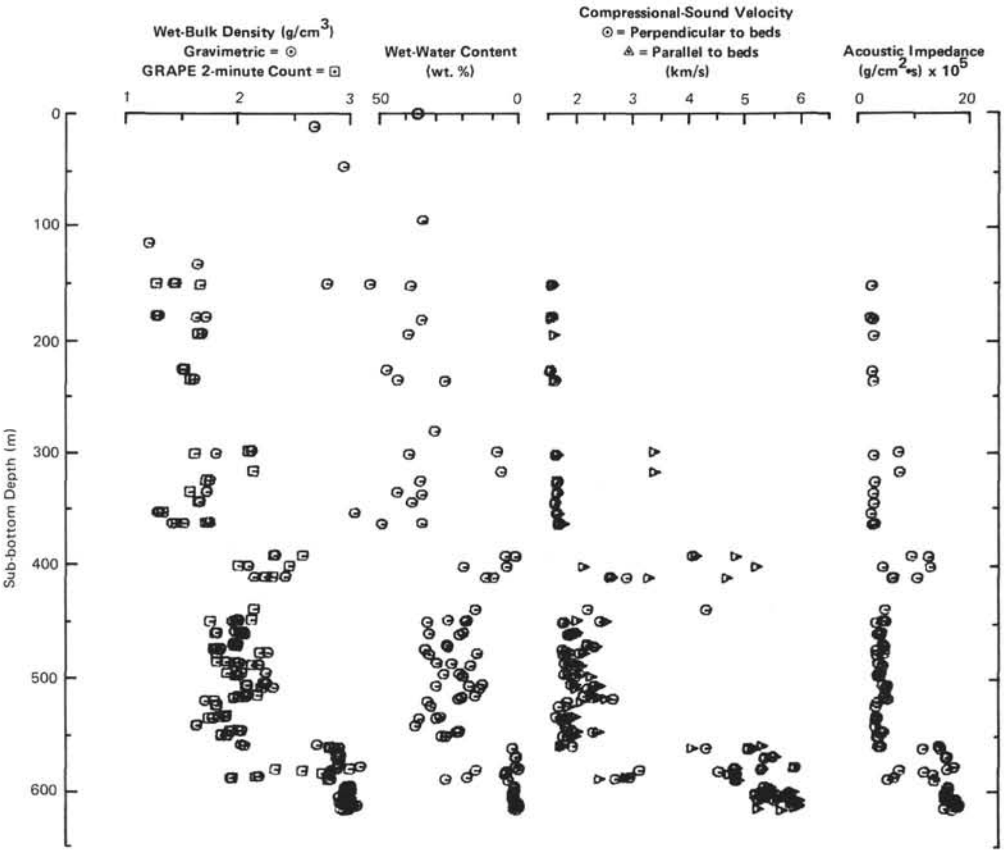


Figure 40. Laboratory-measured density, wet-water content, compressional-sound velocity, and acoustic impedance, Hole 462.

1) From 0 to 150 meters: Pleistocene to early Miocene radiolarian ooze, foraminifer nannofossil ooze, siliceous mud, and nannofossil ooze have an estimated *in situ* velocity of 1.57 km/s. This is based on laboratory velocities, as there are no sonic-log data with this interval.

2) From 150 to 390 meters: middle Eocene to early Miocene nannofossil ooze and chalk, radiolarian nannofossil ooze and chalk, and radiolarian ooze and chalk have an estimated *in situ* interval velocity of 1.75 km/s (1.70 km/s is the average if the high velocities of chert are not included). These velocities are primarily on laboratory velocities, as the sonic-log data in this interval for the most part appear to be artifacts. However, the sonic log does suggest the presence of 3% high-velocity limestone or chert in this interval.

3) From 390 to 447 meters: middle Maestrichtian to early middle Eocene chert and limestone have an estimated *in situ* interval velocity of 2.2(?) km/s. This velocity is based on the sonic log. Laboratory samples in this interval are only from the high-velocity limestone and chert (as great as 5.2 km/s) probably representing biased recovery of hard and more-resistant layers.

4) From 447 to 522 meters: late Albian–Cenomanian to early Campanian volcaniclastics and limestone have an estimated interval velocity of 2.3 km/s. This estimate is from laboratory-measured velocities, as the sonic-log data (1.8 km/s) may be in part an artifact of the hole's diameter being too large to measure accurately the formation's low velocities (Lynch,1962).

5) From 522 to ~560 meters: ?late Santonian to late Albian–Cenomanian claystone, siltstone, zeolitic marl, and minor chert have an estimated *in situ* interval velocity of 1.94 km/s. This estimate is based on laboratory-measured velocities, as the sonic-log data may be an artifact of the formation's log velocities and corresponding large hole diameters.

6) From ~560 to ~729 meters: basalt and intercalated claystone and sandstone have an estimated *in situ* interval velocity of 4.76 km/s. This is a subjective interpretation of the Gearhart–Owen sonic log: it assumes that the 54.5 meters of sediment has an average velocity of 2.7(?) km/s, and that the remaining basalt has an average velocity of 5.78 km/s. Extremely low velocities (<2.1 km/s) may be artifacts of the large hole diameters in the washed-out parts of the hole.

7) From ~729 to 1068 meters (total depth): basalt and minor intercalated claystone and sandstone has an estimated *in situ* velocity of 5.63 km/s. This is a subjective estimate from the Gearhart–Owen sonic log.

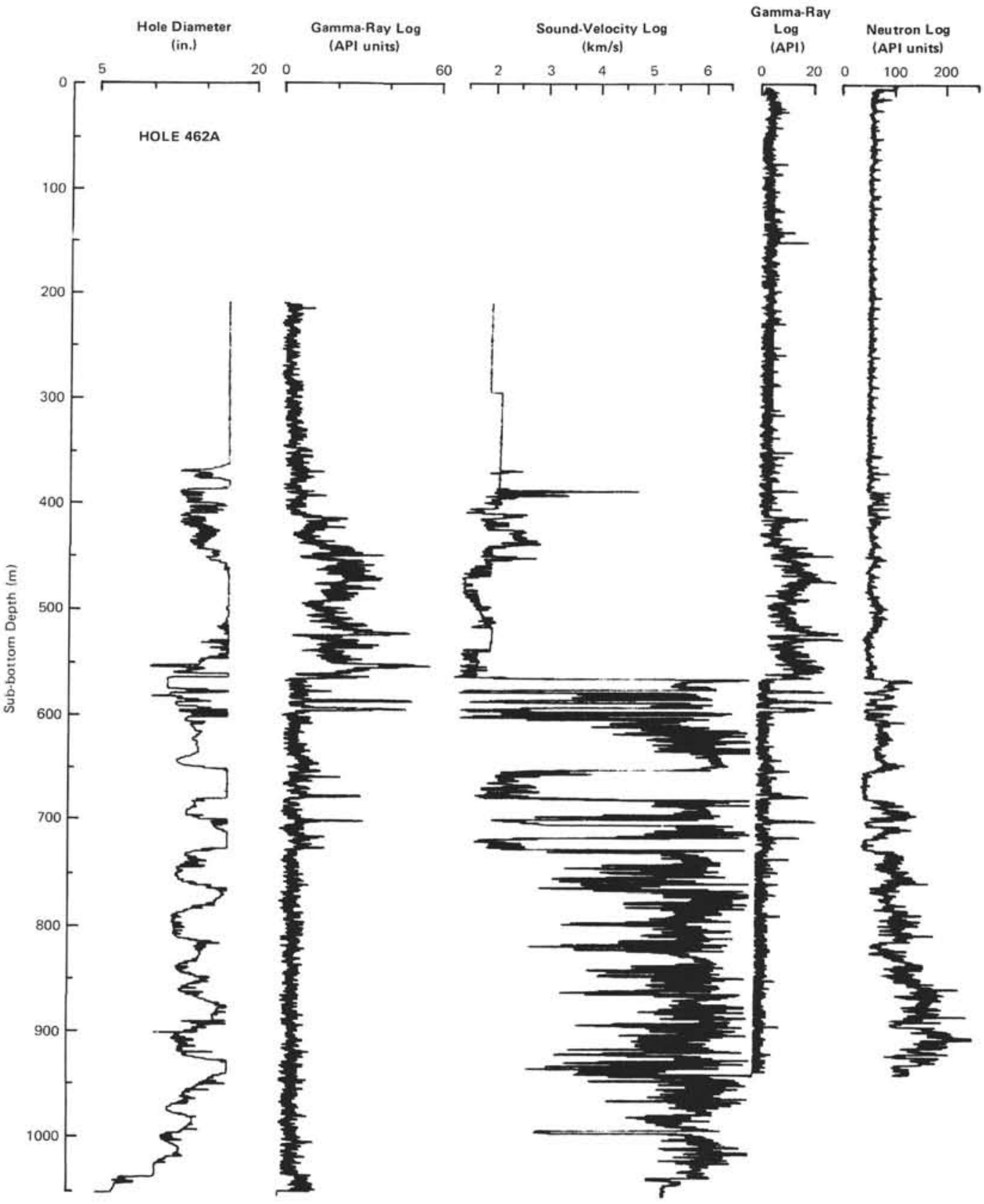


Figure 41. Caliper (hole-diameter) log, gamma-ray log, and compensated compressional-sound-velocity Log (run on a single lowering), and gamma-ray and neutron log (both run through drill string, and both on a single wire-line lowering), Hole 462A.

Comparison of Electric Log to Density Log

As a check on the quality of the density log and electrical-conductivity log, the porosity derived from the density log was compared to the induction log at 5640 meters from the rig floor on the log.

1) The formation electrical resistivity (R_0) after borehole correction is 3.096 ohm-m.

2) The interstitial water (36‰ salinity) has an electrical resistivity (R_w) (after Thomas et al., 1934; pressure corrections of Horne and Frysinger, 1963) of 0.2248 ohm-m at 13.5°C (from second Gearhart–Owen temperature log).

3) Archie's (1942) equation

$$F = R_0/R_w = \phi^{-2}$$

gives a porosity (ϕ) of 25%.

4) The compensated density log gives a density of 2.24 g/cm^3, which, assuming a grain density of 2.7 g/cm^3, represents a porosity of 27%.

5) Therefore, the electrical log appears to be giving quantitative data relative to the density log.

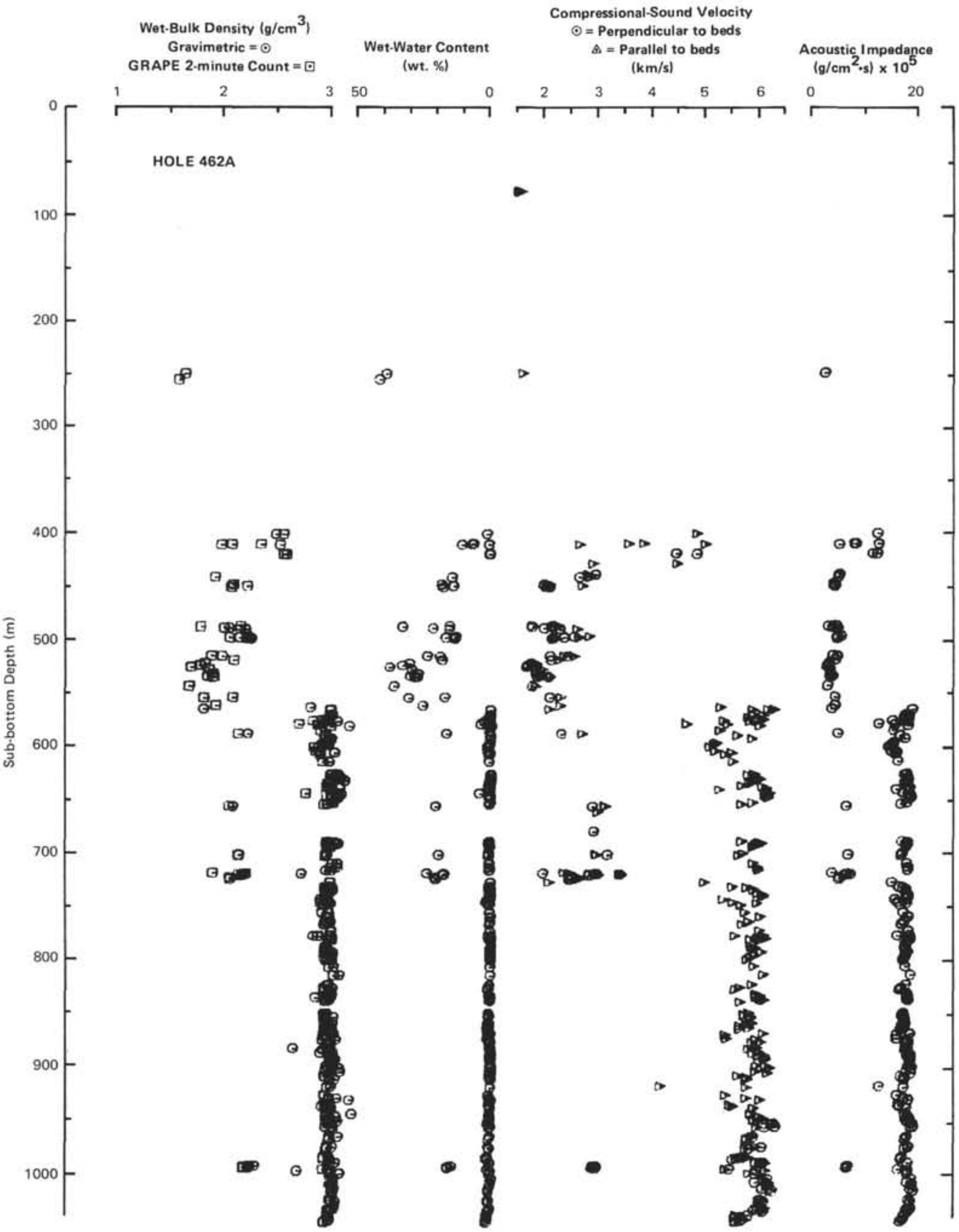


Figure 42. Laboratory-measured density, wet-water content, compressional-sound velocity, and acoustic impedance, Hole 462A.

The density log compares very well with density data measured in the laboratory (GRAPE 2-minute data) when the latter are plotted over the log, considering the sampling differences.

The good comparison of the electric log and density log also suggests that the second-temperature-log data can be used to quantitatively interpret the electric log. A cursory inspection of conductivity and density curves does not indicate any unusual anomalies in the logged section.

Lithologic Characterization by the Density, Sonic, and Gamma-Ray Logs

The stratigraphic section is divided into nine units (which do not coincide necessarily with units discussed elsewhere in this volume).

1) From 0 to 160 meters, the GR is of low intensity and is attenuated by the pipe and bottom-hole assembly. In general, the low GR intensity suggests biogenic oozes of low "clay" content (early Miocene–Pleistocene bio-

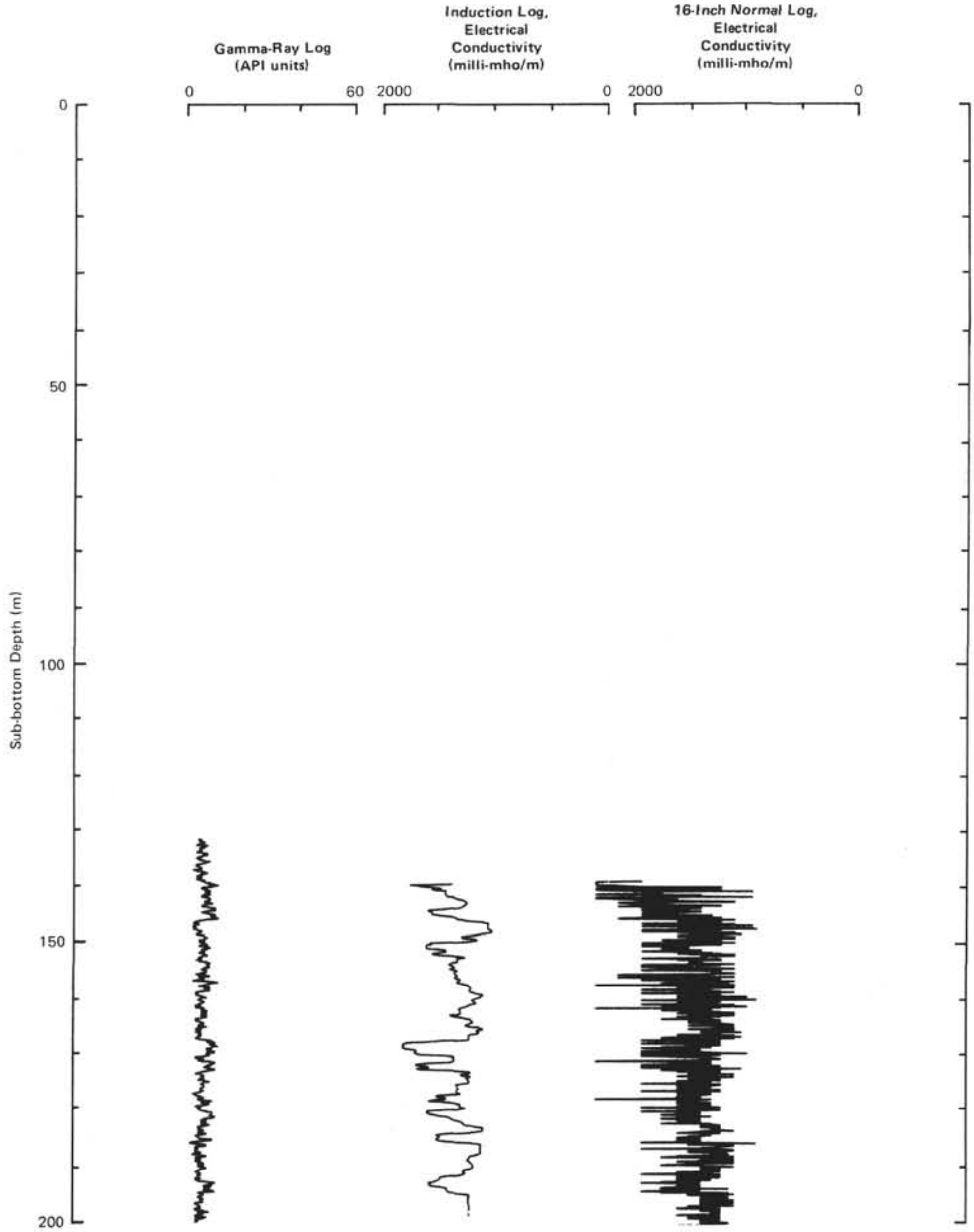


Figure 43. Gamma-ray log, induction log, and 16-inch normal electrical-resistivity log from a single wireline lowering in Hole 462.

genic oozes). A high GR response at 48 to 53 meters may represent an ashy or more-clayey layer.

2) From 160 to 350 meters, the GR is in general low intensity, indicating a formation with a relatively uniform, low clay content (primarily late Eocene to early Miocene biogenic oozes). Minor variations of the GR intensity could represent "clayey" or ashy layers.

3) From 350 to 411 meters, the GR intensity is greater and more variable than in the overlying formation, indicating a greater and variable "clay" content (or greater number of thin "clay" layers). The low density values (1.5–1.9 g/cm^3) represent chalk layers, and the higher density values represent layers of limestone and chert, the latter being up to <5 meters thick. (This interval is early? to middle Eocene.)

4) From 411 to 522 meters, the GR varies greatly and is greater than in the overlying formation, indicating that this formation has a greater clay content than the overlying formation and a very irregular clay content, or that numbers of thin clay layers vary in proportion to the GR intensity. In general, the density is 2.0 to 2.2 g/cm^3; however, high GR counts from 461 to 463 meters indicate "claystone" whose density is 1.7 g/cm^3. (This interval is early Campanian to early(?) Eocene limestone, chert, and volcaniclastics, with wide variation in density and "clay" content, or number of thin "clayey" layers.)

5) From 522 to 532 meters, low-density (1.7 g/cm^3) claystone is indicated by high gamma-ray count. High gamma-ray count may also be related to organic-car-

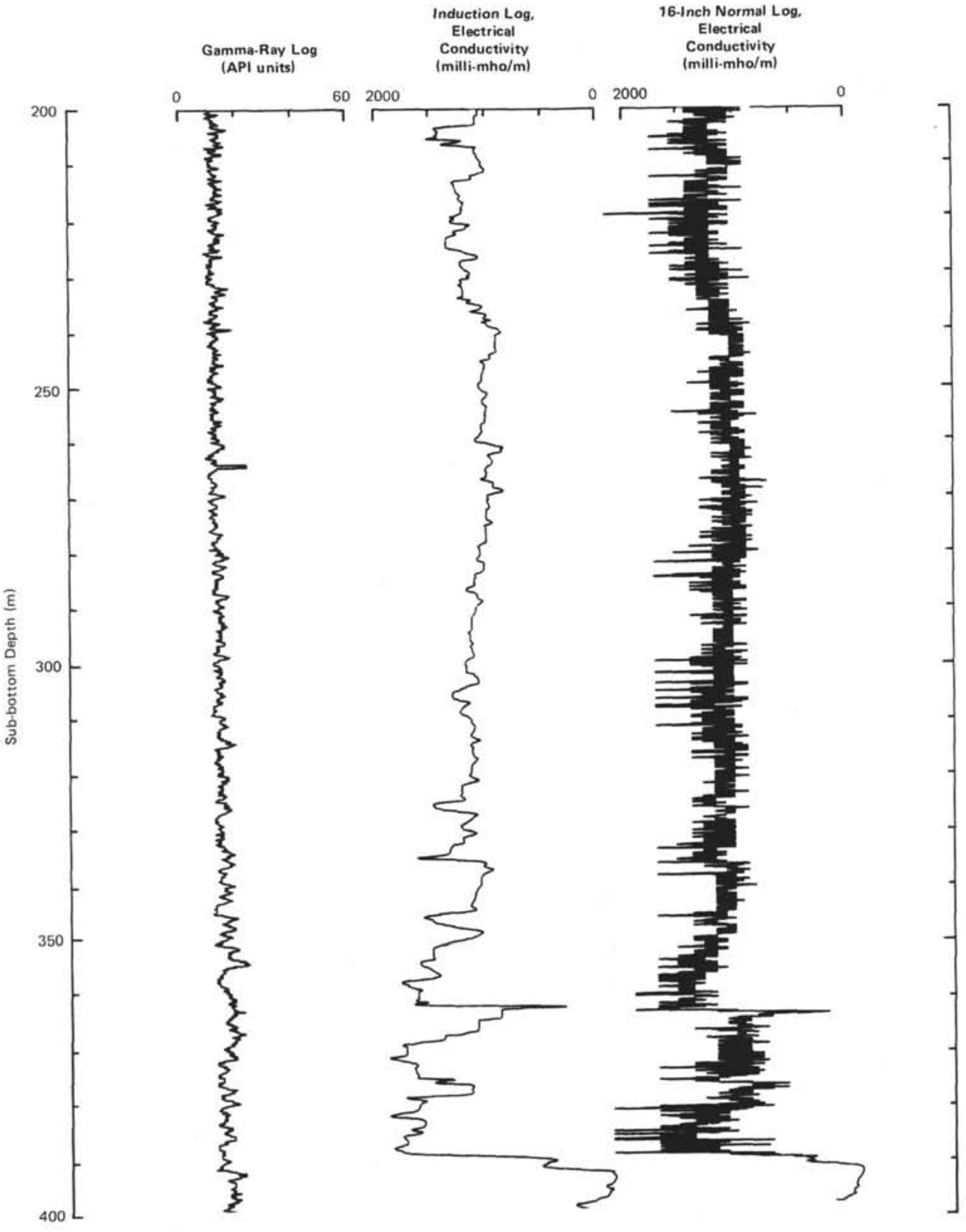


Figure 43. (Continued).

bon-rich or zeolitic lithologies. The 522-meter horizon is near the Santonian/Campanian boundary, and the interval is Santonian(?).

6) From 537 to 549 meters, a low-density (1.7–1.9 g/cm^3) layer has a moderate GR intensity, indicating a formation with medium clay content (or a medium number of thin clay layers). This interval is Santonian claystone, zeolitic claystone, siltstone, and mudstone. The Santonian/Coniacian boundary is near 549 meters and appears to be marked by a GR change.

7) From 549 to 561 meters, the high GR intensity indicates a "clayey" formation (or greater number of thin clayey layers). This interval is Cenomanian to late Albian(?) zeolitic claystone, nannofossil radiolarian marl, chert, and claystone.

8) From 561 to 565 meters, the 2.7 g/cm^3 density suggests a sedimentary formation such as limestone or marlstone. However, the cores recovered basalts; therefore, the layer is probably fractured 2.9-g/cm^3 basalt. The GR is higher than lower basalt (below 565 m), suggesting either greater K_2O content, greater clay content, fractures, or some other form of alteration.

9) From ~565 to ~1068 meters, the low-GR, high-density (2.9 g/cm^3) layer and the high-velocity layer (>4 km/s) are basalt, sedimentary interbeds being indicated by high GR counts, low density (1.7–1.9 g/cm^3),

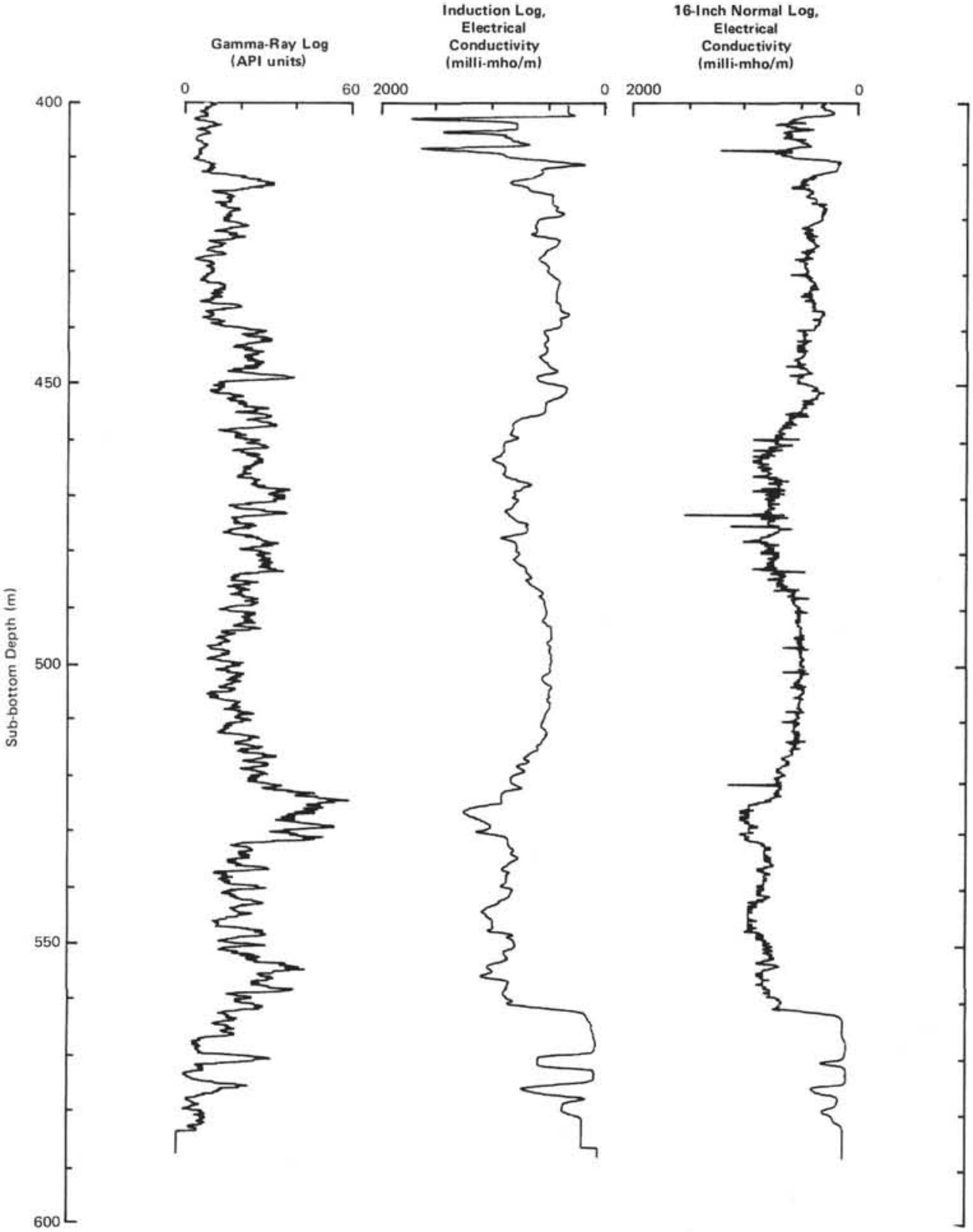


Figure 43. (Continued).

and low(?) velocities (< 4.0 km/s). Thirty-two per cent of the section appears to be sedimentary in the upper 565 to 729 meters of the basalt sills, whereas below 729 meters the basalt-sill section appears to have about 5%(?) sedimentary material.

The high porosity, neutron log, low density log, and low sonic log in some parts of the basalt section may indicate fractured zones. Sill units are indicated at some depths by increasing and then decreasing velocities (with increasing depth), by the lab data, and by the sonic log; and in some cores, by increasing and decreasing density on the analog GRAPE (462A, Core 22 is a good example), which appears to directly correspond to grain size.

In a given lithologic unit where the mineralogy is simple (such as clay and carbonate) and where porosity is similar throughout, the GR can be calibrated to estimate percentages of clay (or other GR contributions):

GR_L = GR intensity in the non-clayey material (e.g., pure chalk, ooze, or limestone).

GR_H = GR intensity is the "clayey" material (e.g., claystone, shale, etc.).

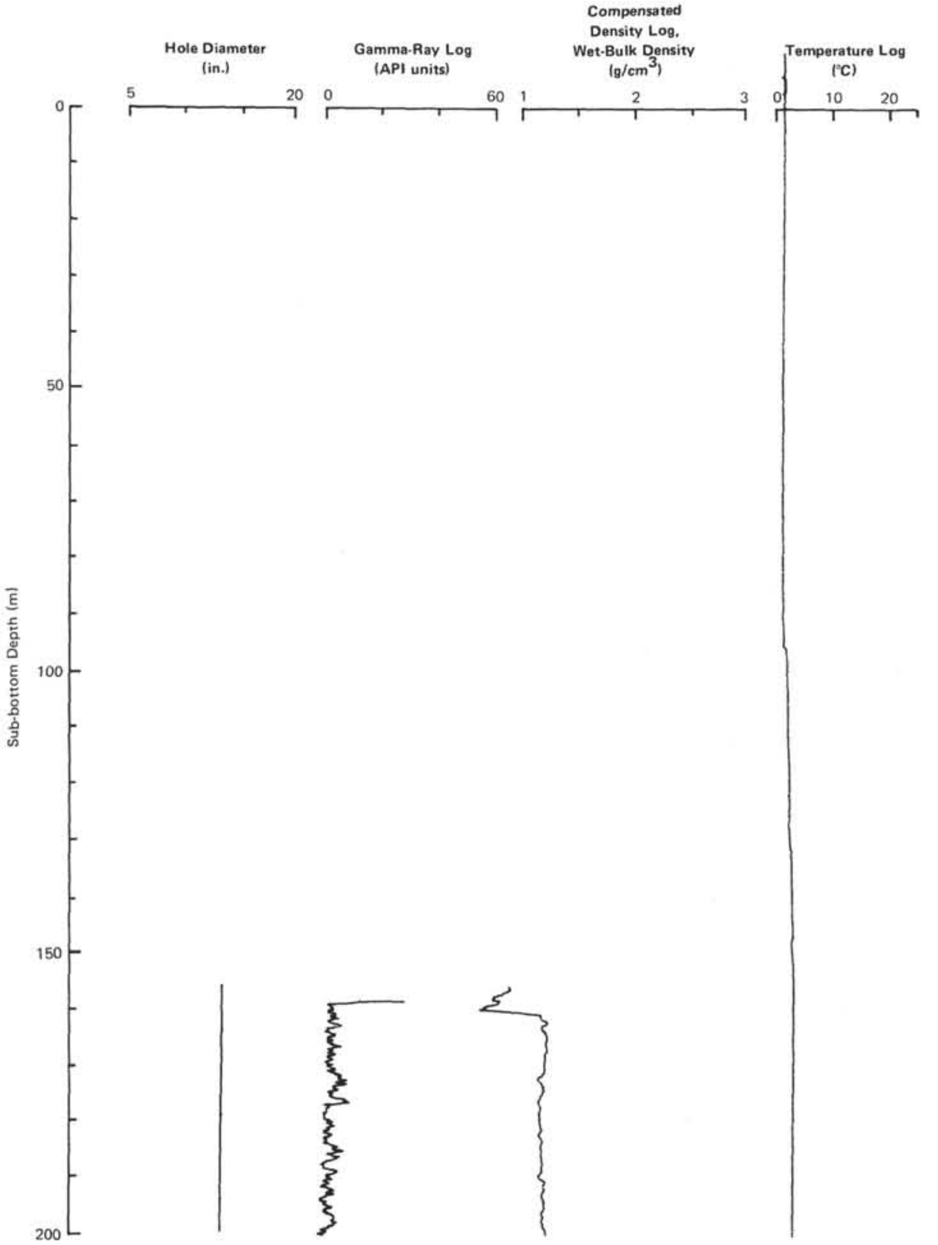


Figure 44. Caliper (hole-diameter) log, gamma-ray log, compensated density log, and the second temperature log, Hole 462.

GR_c = any GR on the log.
E = empirical calibration curve for each lithologic unit.

The estimated per cent of clayey minerals is given by

$$E\left[\frac{GR_H - GR_c\ \text{(formation)}}{GR_H - GR_L}\right] \times 100.$$

The unit from 161 to 351 meters is too low in GR to do this, but the unit from 351 to 561 meters might be calibrated as follows (assuming that the high GR is not related to other radioactive sources, such as authigenic minerals at unconformities, or hydrothermal deposits):

GR_L = 1 API unit
GR_H = 70 API units

Therefore, percentage of "clay" in that section may be estimated by the expression:

$$E\left(\frac{70\ API - GR_c\ \text{(formation)}}{70\ API - 1\ API}\right) \times 100.$$

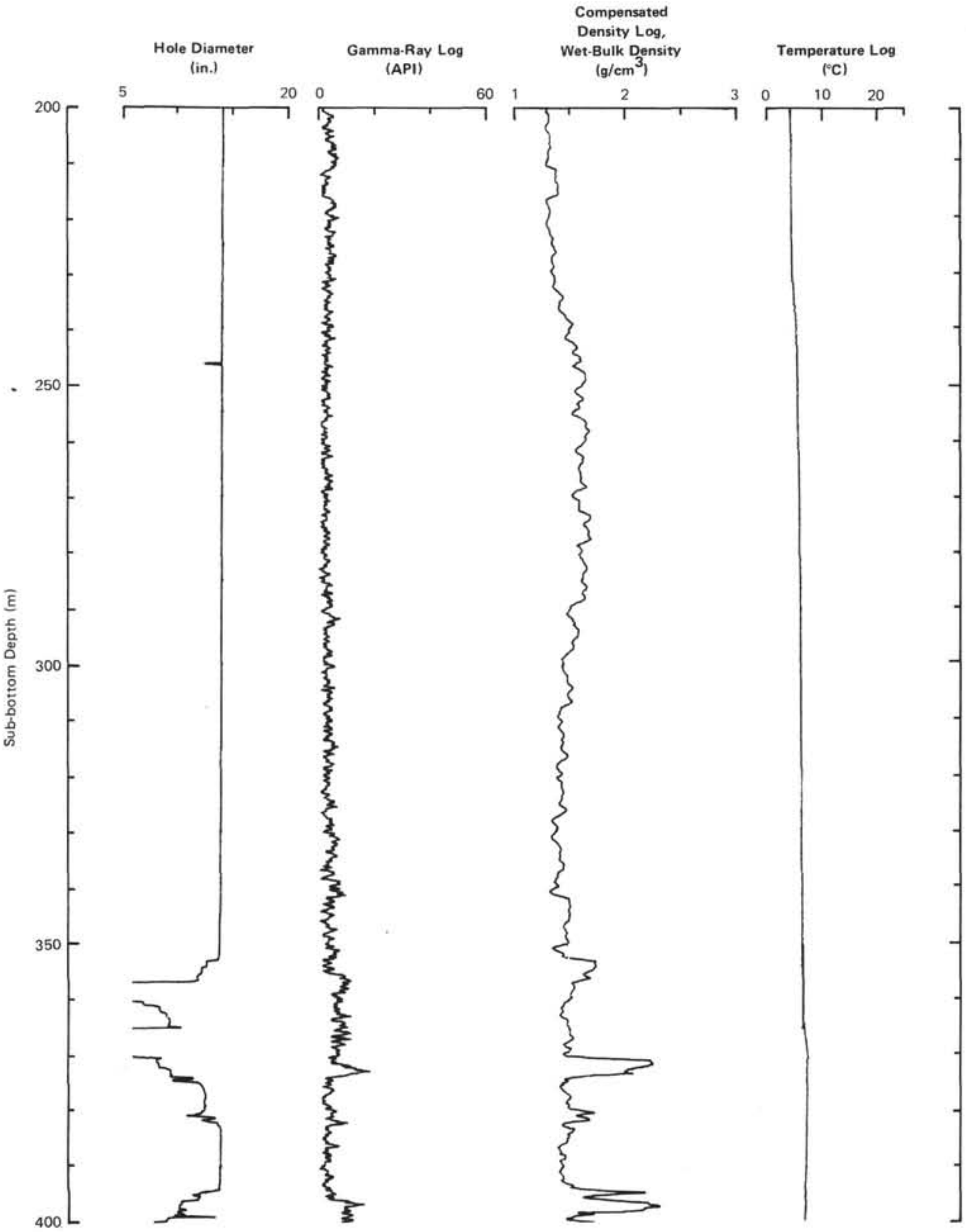


Figure 44. (Continued).

This relationship could be calibrated for basalt, for example, if the K_2O content or alteration material is significant:

GR_H = GR intensity in high K_2O content (K_2O measured).
GR_L = GR intensity in low K_2O content (K_2O measured).
GR_c = any GR count in the basalt section.
E = calibration curve for each basalt unit.

$$\% K_2O = E \left[\frac{GR_H - GR_c}{GR_H - GR_L} \right] \times 100.$$

In summary, the GR could be calibrated empirically to measure variations of a variety of mineral constituents.

Unconformities sometimes are marked by higher gamma-ray counts. This could be related to (1) a lower sedimentation rate, so that more authigenic radioactive

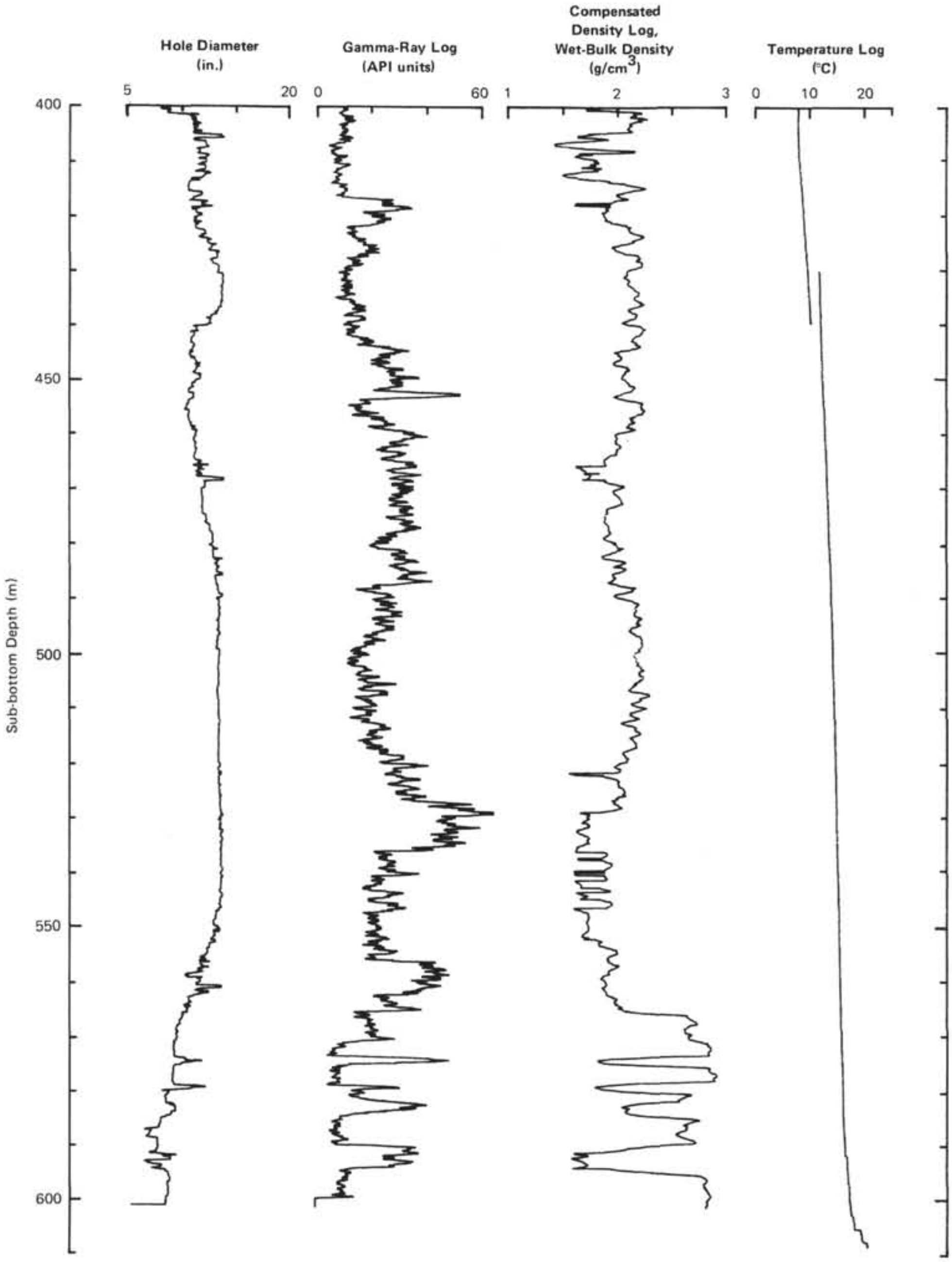


Figure 44. (Continued).

ions can be concentrated, or (2) dissolving of carbonate, giving more "clayey" material along an unconformity than in the overlying formation (where the sedimentation rate may be higher). These are generalities and there are many exceptions.

Gearhart-Owen Temperature Log

Two Gearhart-Owen temperature logs were run. The first soon (11-13 hours) ceased after circulation, and the second after 42 to 44 hours. These runs were (1) to detect any permeable fractures and hydrothermal circulation in the basalt section (to know if heat is transported by convection of hydrothermal water or by simple "heat conductivity" of the rock), (2) to help calculate a "true" *in situ* temperature with the results of both temperature logs. Another primary reason for the second logging run is to approximately measure the hole temperature, so that the electric logs can be interpreted properly.

The following data permit calculation of "true" *in situ* temperatures:

1) At 2305 hours on 5 June 1978, we stopped drilling.

2) At 0100 hours on 6 June, we stopped circulation (485 barrels of mud were pumped at 0415 hours).

3) The first temperature log started at 1203 hours on 6 June and ended at 1403 hours in the bottom of the hole. (The probe was left about 8 minutes to be certain it had reached equilibrium.)

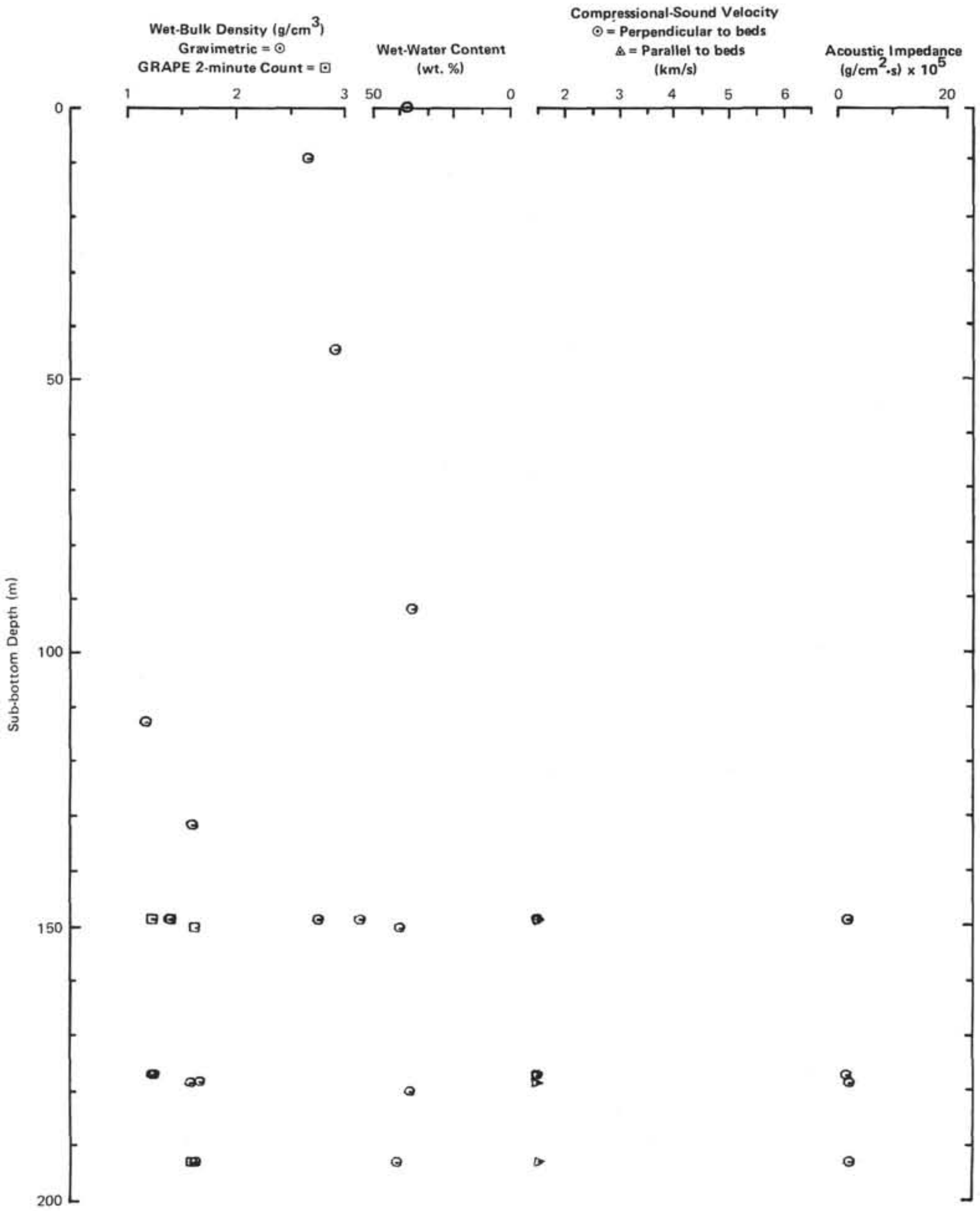


Figure 45. Laboratory-measured density, wet-water content, compressional-sound velocity, and acoustic impedance, Hole 462.

4) Above 349 meters, the hole is washed out; therefore, data above this point are questionable.

5) The second temperature log started at 1900 hours and ended at 2100 hours on 7 June 1978 (it remained on bottom about 10 minutes).

The first temperature log found a high-over-low temperature anomaly (while going down the hole) in the basalt section suggesting some combination of the following: (1) convection of the mud in the hole, (2) flow of warmer formation water from the basalt into the hole, causing a high temperature anomaly, (3) flow of hole fluids into permeable fractured basalt, causing a negative temperature anomaly, or (4) fracturing of the basalt, the drilling fluids cooling the fractured portions of the basalt more than the massive portions.

The bottom water is ~1.4°C, and the temperature at 608 meters (second temperature log) in the hole was 22.4°C.

Uyeda Temperature Probe

METHODS

Temperatures "ahead" of the drill bit (temperature could be affected by the cooling effects of circulation during drilling) were measured with the Uyeda temperature probe (theoretical precision and accuracy ±0.05(?)°C). This probe measures and electronically stores temperatures at 2-minute intervals while being lowered and inserted into the formation at the bottom of the hole.

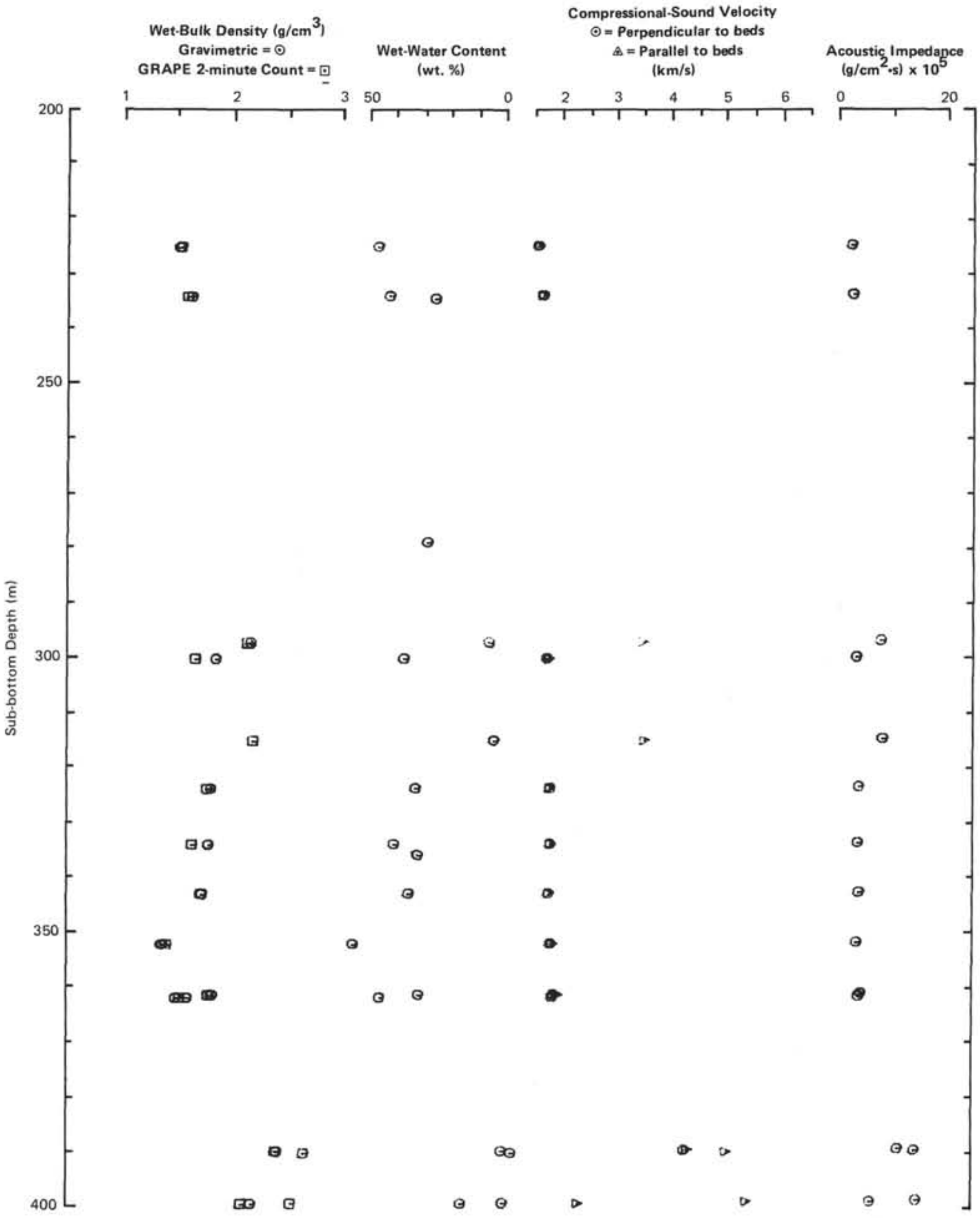


Figure 45. (Continued).

Results

Only three measurements are valid: (1) 8.4°C at 133.5 meters; (2) 10.7°C at 181 meters; and (3) 12.3°C at 219 meters. In this interval, an average temperature gradient of 45°C/km was obtained.

Another set of three measurements (using a different thermistor) gave anomalous results and 2.0 to 4.3°C for 1.9°C bottom-water temperatures (as measured in the first set of data). This will be subject to further study.

The temperature gradient is related to heat flow as follows:

$$\frac{g}{K} = \frac{T_1 - T_2}{D_1 - D_2}$$

where

g = heat flow (μcal/cm^2).
T_1 = temperature at 200 m (°C).

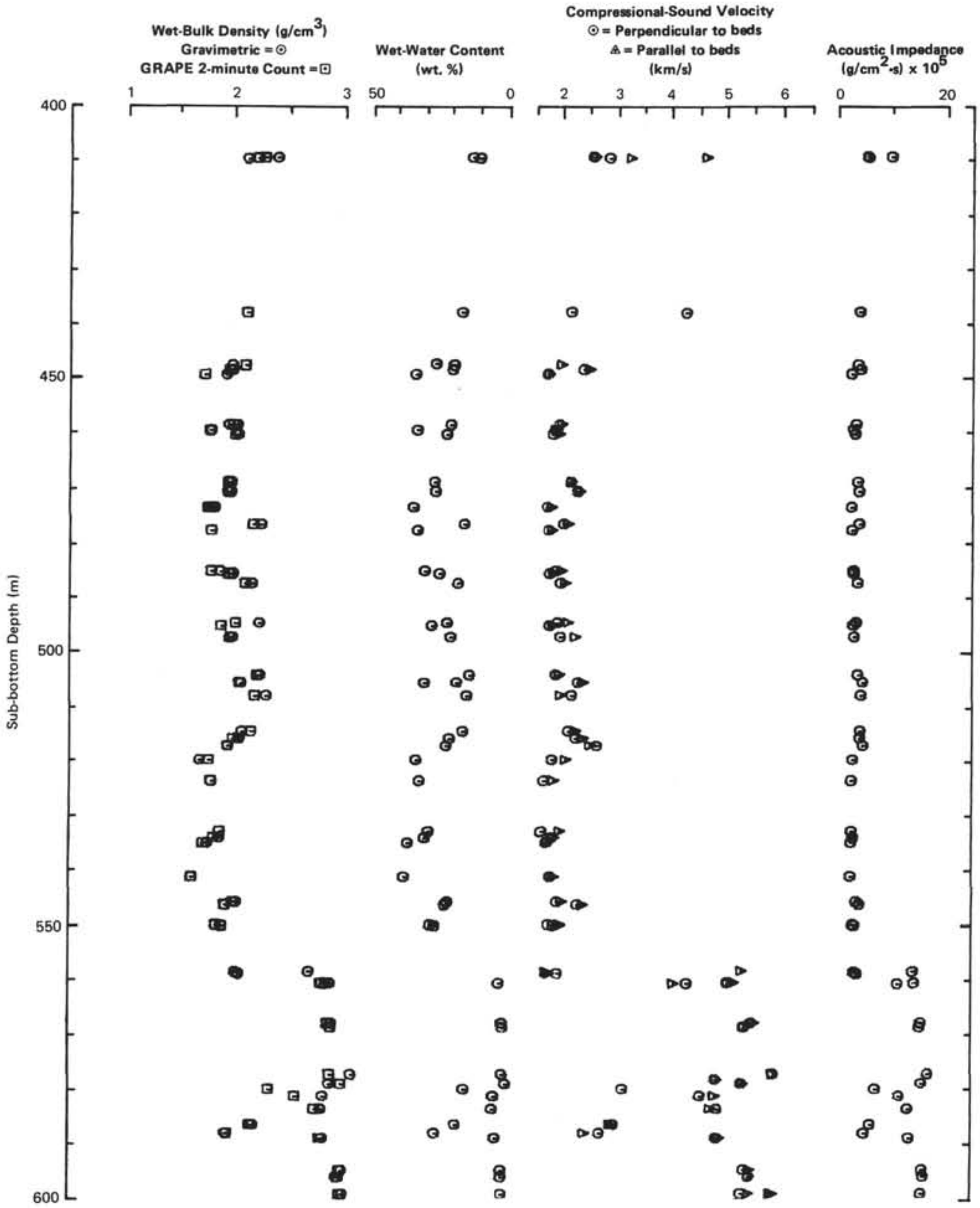


Figure 45. (Continued).

T_2 = temperature at 100 m (°C).
D_1 = depth of 200M (cm).
D_2 = depth of 100M (cm).
K = heat conductivity of the formation [10^{-3} cal/ (sec•cm•C°)]

The gradient of 45°C/km corresponds to a heat flow of 1.15 μcal/cm^2, which compares well to a predicted typical heat flow value of 1.1 μcal/cm^2 (Lee and Uyeda, 1965).

Because

$$g = \left(\frac{T_1 - T_2}{D_1 \; ' \; D_2}\right)(K)$$

then

$$\text{Site 462 heat flow} = 1.15\ \mu\text{cal/cm}^2 = [2.56 \times 10^{-3}\ \text{cal/(cm•sec•°C)}]\ [45°\text{C/km}]$$

However, the formation conductivity is determined using porosity values of disturbed sediment, which may or may not represent accurately the *in situ* formation. Calculation and assumptions of the conductivity are discussed below.

The formation conductivity value between 100 to 200 meters was determined as follows: the average analog GRAPE density was 1.6 g/cm^3, and by assuming a 2.7-g/cm^3 grain density a porosity of 65% can be de-

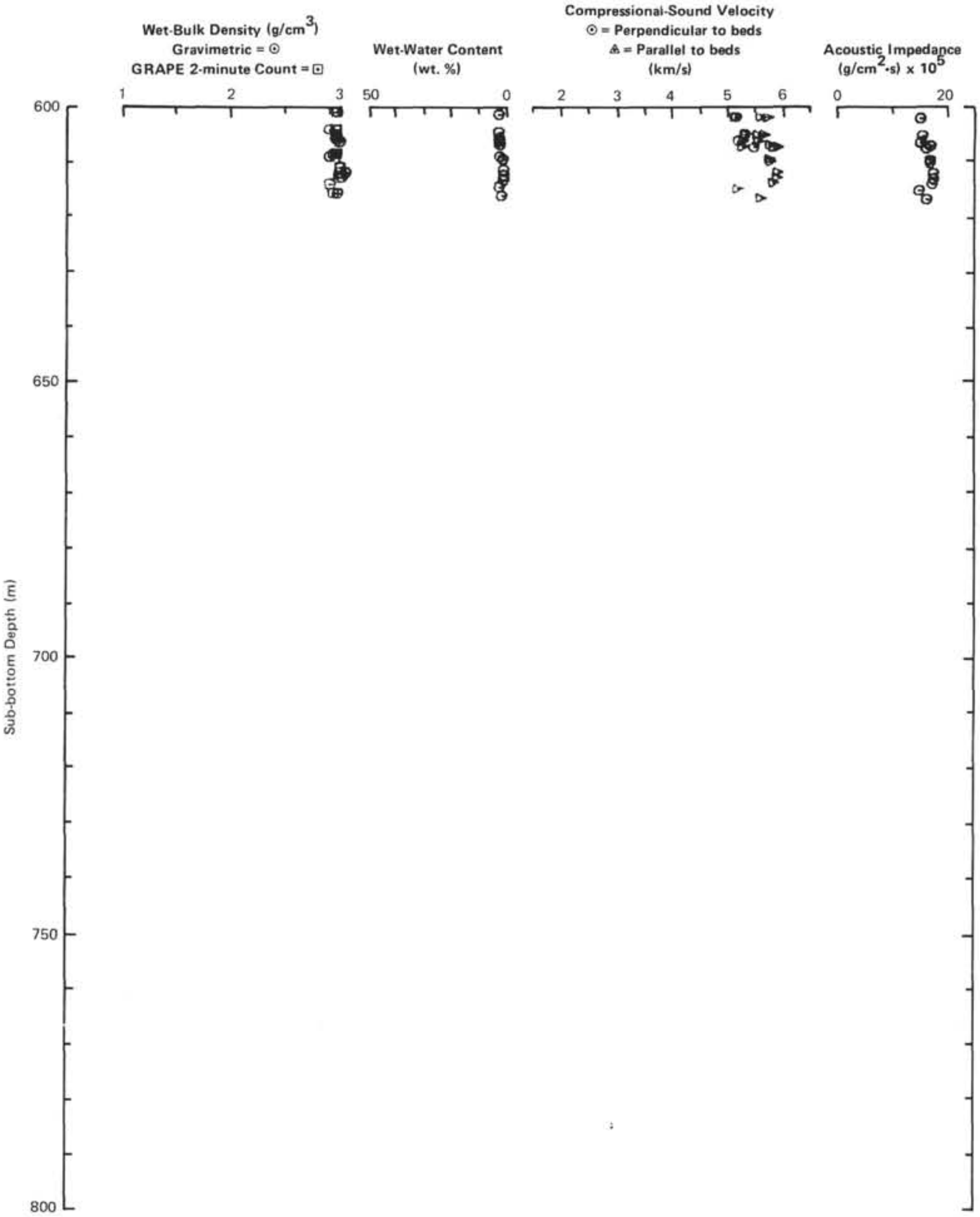


Figure 45. (Continued).

rived. However, when overburden pressure is released, the porosity here will increase by about three porosity units (Hamilton, 1976); therefore, we subtract 3% from 65%, obtaining a 62% porosity under *in situ* conditions. Our conductivity-porosity measurements at Hole 462 are compatible with the "porosity-conductivity" diagram in Nafe and Drake (1963); thus, for a carbonate section, using the Nafe and Drake (1963) diagram and 62% porosity, we obtain an average conductivity value of 2.60 cal/(cm•sec•°C) under laboratory conditions. This was corrected (−1.5%) to 2.56 cal/(cm•sec•°C) under *in situ* conditions (Bullard, 1963; 25°C to 10°C = −4%; and from one atmosphere to 500 kg/cm^2 = +2.5%; therefore, a total −1.5% correction must be applied to the laboratory-determined conductivity).

Comparison of the Uyeda temperature data cannot precisely be made to the Gearhart-Owen continuous temperature log, because the hole was washed out seriously in the interval of interest; however, the change in slope seen on the Uyeda probe (depth/temperature plot) can also be seen in the Gearhart-Owen temperature log, but this could also be an artifact of the hole conditions. The Uyeda probe read 1.9°C for bottom water, whereas the Gearhart-Owen log read about 1.4°C.

CORRELATION OF DRILLING RESULTS AND SEISMIC DATA

Seismic profiling on *Glomar Challenger* during Leg 61 was carried out with Bolt 20- and 120-in.^{3} air guns, firing at 10-second intervals. The EDO #2 recorder was

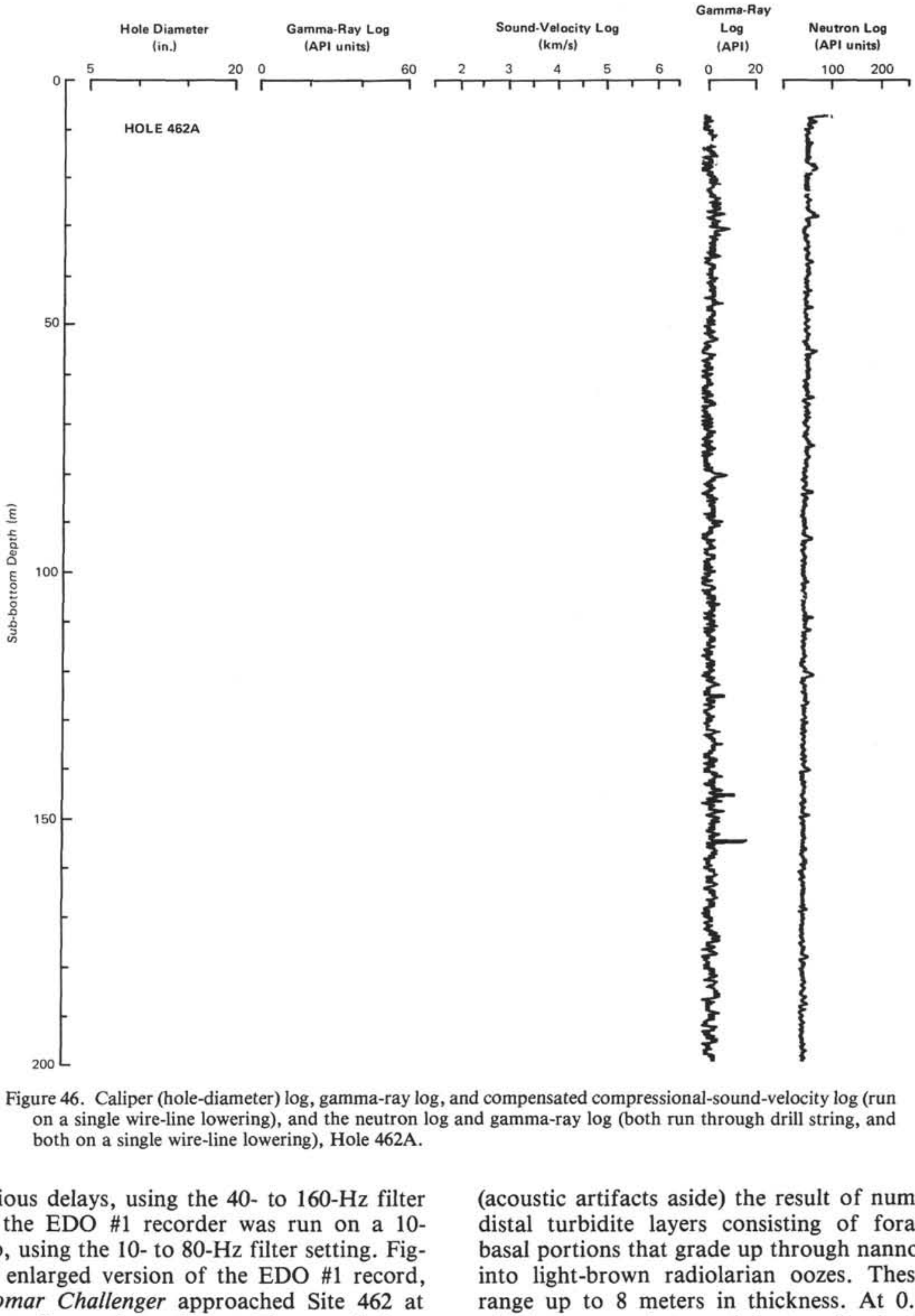


Figure 46. Caliper (hole-diameter) log, gamma-ray log, and compensated compressional-sound-velocity log (run on a single wire-line lowering), and the neutron log and gamma-ray log (both run through drill string, and both on a single wire-line lowering), Hole 462A.

run with various delays, using the 40- to 160-Hz filter setting, and the EDO #1 recorder was run on a 10-second sweep, using the 10- to 80-Hz filter setting. Figure 49 is an enlarged version of the EDO #1 record, made as *Glomar Challenger* approached Site 462 at 6.7 knots from the north-northwest. The correlations shown to the right of the seismic profile are based on shipboard Hamilton-frame velocity measurements, from which interval compressional velocity (V_c) values were derived; on lithologies encountered in the continuous coring program, and on natural gamma/compensated density/caliper logs; drilling rates were also taken into account.

From 0 to 0.19 seconds sub-bottom, the record shows numerous parallel, closely spaced reflectors, probably (acoustic artifacts aside) the result of numerous, thin, distal turbidite layers consisting of foraminifer-rich basal portions that grade up through nannofossil oozes into light-brown radiolarian oozes. These turbidites range up to 8 meters in thickness. At 0.19 seconds, which corresponds to a sub-bottom depth of 150 meters, there is a change in interval V_c from 1.57 to 1.75 km/s, and an unconformity of middle Miocene age. However, neither the interval V_c increase nor the unconformity appears to be identifiable in the seismic record. In the interval 0.31 to 0.35 seconds, a relatively transparent layer exists, roughly corresponding to the transition from calcareous ooze to chalk in the cores of Oligocene age between 216 and 243 meters, and to a slight density increase on the compensated density log (which may be

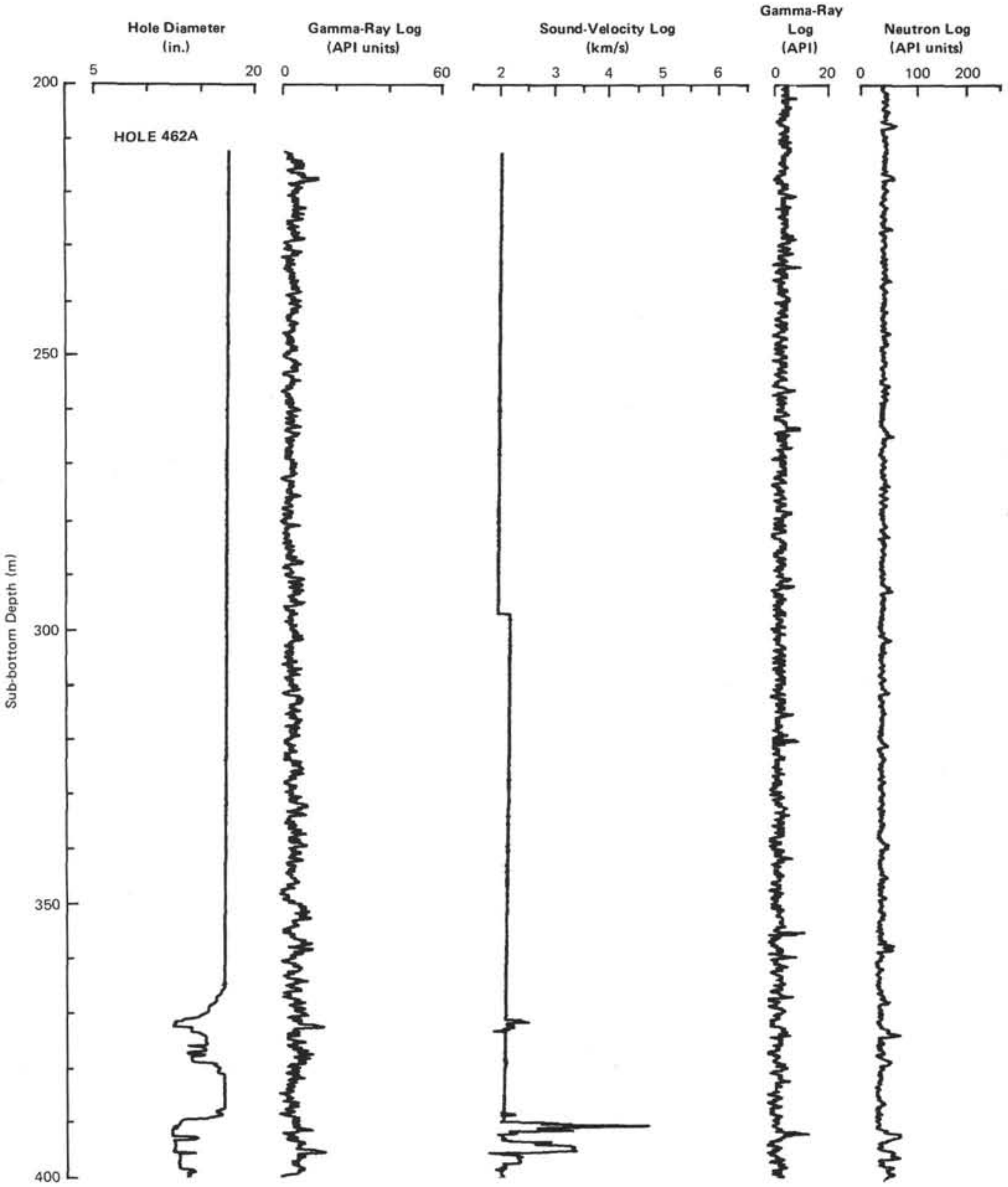


Figure 46. (Continued).

an artifact, because the hole was washed out). Whereas minor porcellanite and chert occurrences were noted between 300 and 380 meters sub-bottom, the major chert build-ups in limestone were first drilled at 390 meters in strata of early Eocene age. This major chert section is obvious in the compensated density log. The 390-meter level was picked on the seismic profile where a subtle change in reflector character is seen at 0.46 seconds. This is at the top of a high interval V_c of 2.20 km/s. The bottom of this 2.20-km/s interval corresponds to the 0.52-second pick on the seismic profile, but surprisingly there is no obvious change in reflector spacing or character. Between 0.52 and 0.58 seconds sub-bottom is a slightly higher-velocity interval of 2.30 km/s, the top of which is near the Mesozoic/Cenozoic boundary and the first appearance of a sequence of volcaniclastic sandstone, siltstone, and zeolitic claystone of Campanian to early to middle Maestrichtian age at 447 meters sub-bottom. The bottom of the 2.23-km/s interval at 522 meters sub-bottom in strata of early Campanian age corresponds to the 0.58-second pick on the seismic profile, where a slight change in the thickness and spacing of the reflectors is seen. Between 0.58 and 0.62 seconds sub-bottom, there is a low-velocity interval of 1.94 km/s that extends from 522 to 560 meters sub-bottom; it is occupied by zeolitic mudstones and well-laminated orange and black shales and mudstones of Cenomanian to early Campanian(?) age. At a sub-bottom depth of 560 meters, basalt sills intercalated with shales and mudstones were drilled to total depth at 617 meters. The sill top was picked at 0.62 seconds sub-bottom, where a major change in reflector intensity and

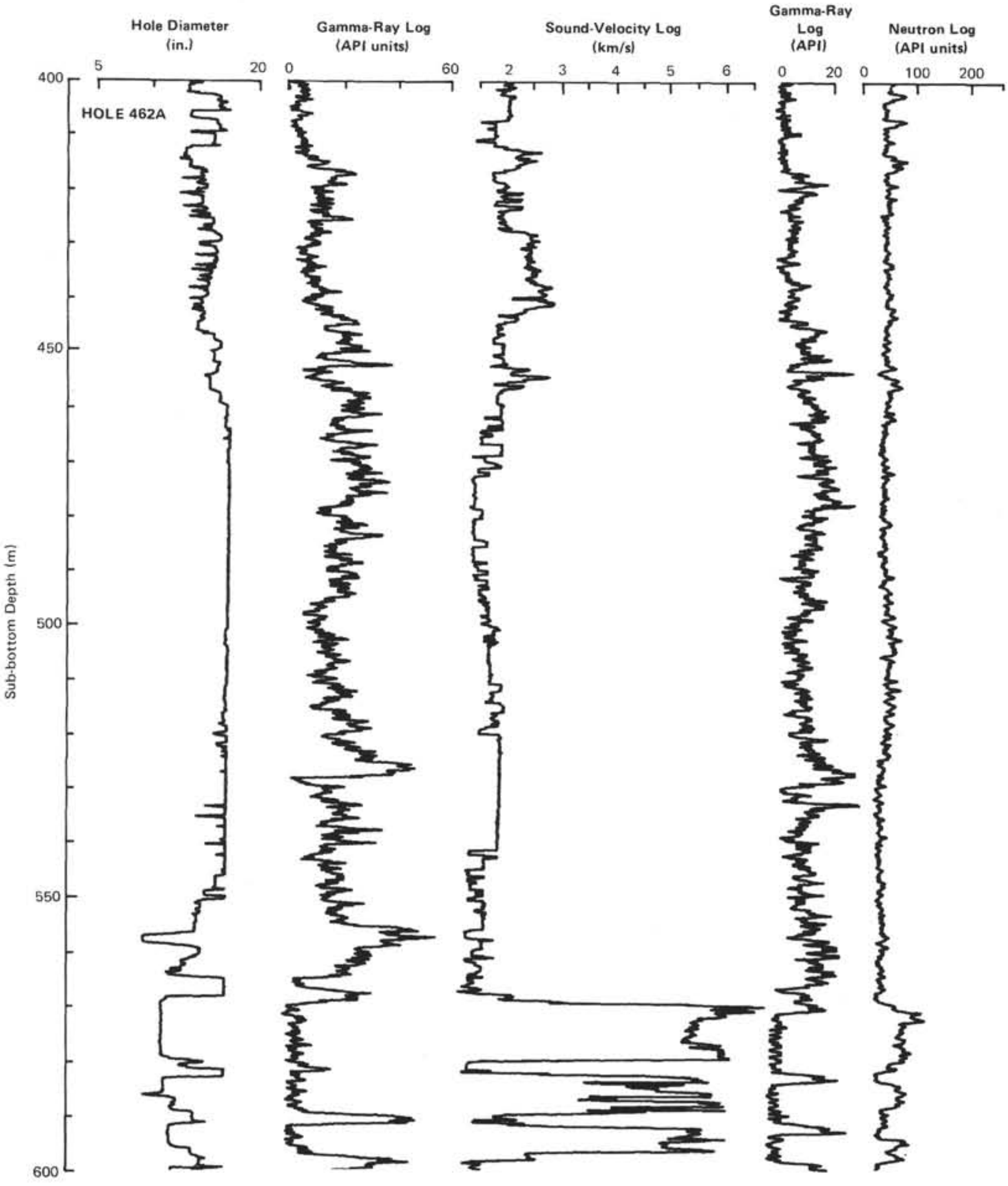


Figure 46. (Continued).

spacing can be seen. At this level, the reflectors lose their high degree of parallelism, and when traced across the seismic profile they show considerable relief.

The sub-bottom time picks for the *Glomar Challenger* seismic profile were transferred to the *Kana Keoki* seismic profile run during the site survey for Site 462 (Fig. 50). This air-gun profile was run at a filter setting of 30 to 100 Hz, but a larger gun was used. The 0.46- and 0.52-second picks correspond to the same picks on the *Glomar Challenger* record, and could possibly correspond to the 2.20-km/s interval on the *Glomar Challenger* record, which is interpreted to be the 390 to 447-meter interval which extends from the top of the major chert horizon to the top of the volcaniclastic sandstone and siltstone section. The 0.58-second pick fits the lowest relatively flat horizontal reflector, at the top of the 1.94-km/s zeolitic shale section that lies above the sills at 560 meters. At 0.62-seconds, the reflectors are broken and irregular, indicating the top of the sill and intercalated shale-mudstone section at Site 462, which extends to the total depth 617 meters.

We believe that the true basement, the surface of the presumed 148-m.y.-old plate, is not to be seen on either the *Glomar Challenger* line or the *Kana Keoki* line.

The *Kana Keoki* line passed 0.5 nautical miles north of Site 462 and was run on a course of 067°; the *Challenger* line was run on a course of 145° over the site. The two lines therefore are nearly perpendicular to each other.

Refer to Wipperman et al. (this volume) for a discussion of depth-velocity relations derived from ASPER work and refraction shooting, using ocean-

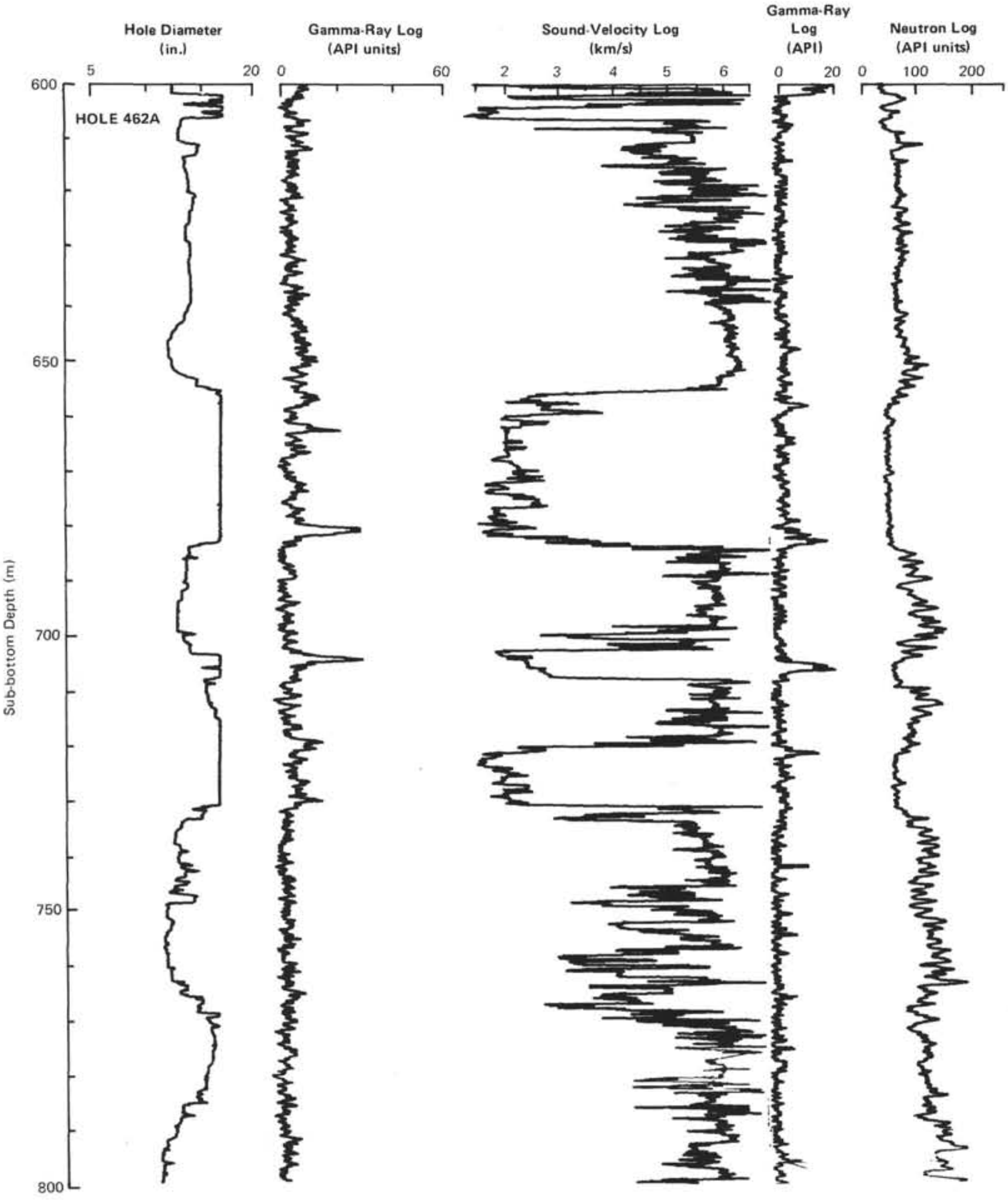


Figure 46. (Continued).

bottom seismometers and sonobuoys during the site-survey operations on *Kana Keoki*.

SUMMARY AND CONCLUSIONS

Introduction

The following text synthesizes the major scientific results of drilling at Site 462 in the Nauru Basin. Certain other topics are discussed in the previous sections of this site report. For conclusions and summaries of results concerning detailed biostratigraphy, organic geochemistry, physical properties, and seismic correlation, the reader is referred to these sections. The last part of the following text contains speculations concerning the areal extent and thickness of the mid-Cretaceous volcanic complex in the western central Pacific Ocean basin, and its relation to the Late Jurassic magnetic-anomaly pattern of the Nauru Basin. *Caveat emptor.*

Sedimentation and Stratigraphy

Sedimentation in the Nauru Basin since at least Cenomanian time has been dominated by deposition of turbidites from surrounding highs (Fig. 1). As shown in Figure 14, faunas from shallow-bank and reef environments, as well as faunas from deep-water environments, have been redeposited in the Nauru Basin. Turbidite

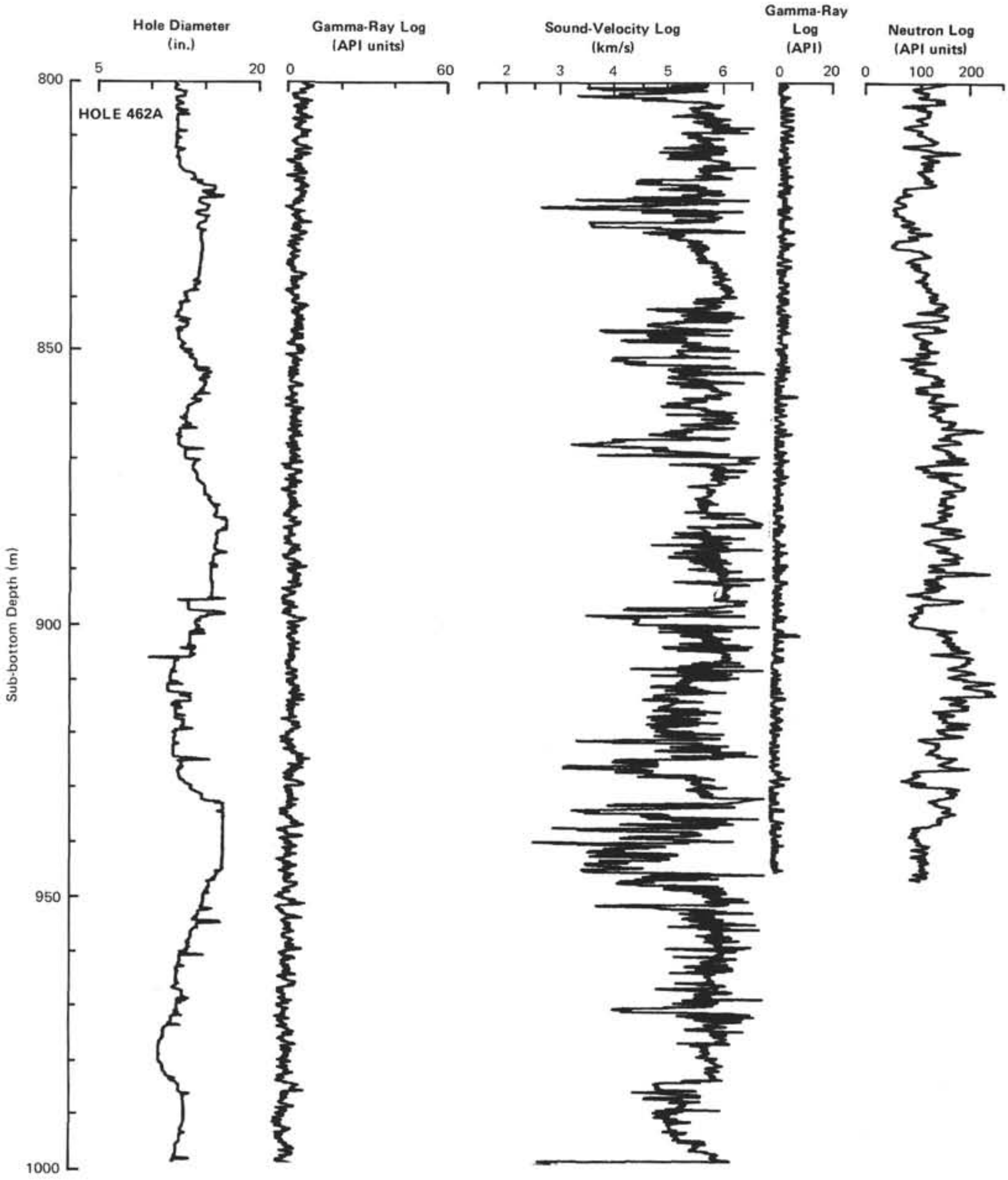


Figure 46. (Continued).

sources must have included the Marshall Islands, the Ontong–Java Plateau, and the eastern Caroline Islands.

Three major sedimentary units were delineated at Site 462 (Fig. 51):

1) 0 to 297 meters; calcareous and radiolarian oozes and chalks, mainly of turbidite origin and of Oligocene or younger age.

2) 297 to 447 meters; cherts, chalks, and limestones of Eocene to Maestrichtian age.

3) 447 to 599 meters; volcanogenic and zeolitic sandstones, mudstones, and limestones, extending down into the sill complex.

Sediments found deep within the sill complex are discussed in the section on igneous petrology.

The present water depth of the Site is 5180 meters, and it therefore lies well below the CCD. The normal "background" sediments are brown-red clays. However, Unit 1 is made up of turbidites 0.1 to 8 meters thick. A typical turbidite is made up of a basal layer of white foraminifer-nannofossil ooze that grades up into light-brown radiolarian ooze, which in turn is capped by brown pelagic clay. Within Unit 1, the ooze/chalk transition lies between 230 and 250 meters. Much of the fine-fraction $CaCO_3$ in the form of small planktonic and benthic foraminifers and nannofossils probably has its origin in the highly eroded northeast face of the Ontong–Java Plateau. The bathymetry of Site 462 (Fig. 4) shows turbidite and levee features, indicating flow into the area from the southwest.

Against this general background of turbidite oozes and chalks, two less common but significant lithologic contributions are found in Unit 1, ash and shallow-

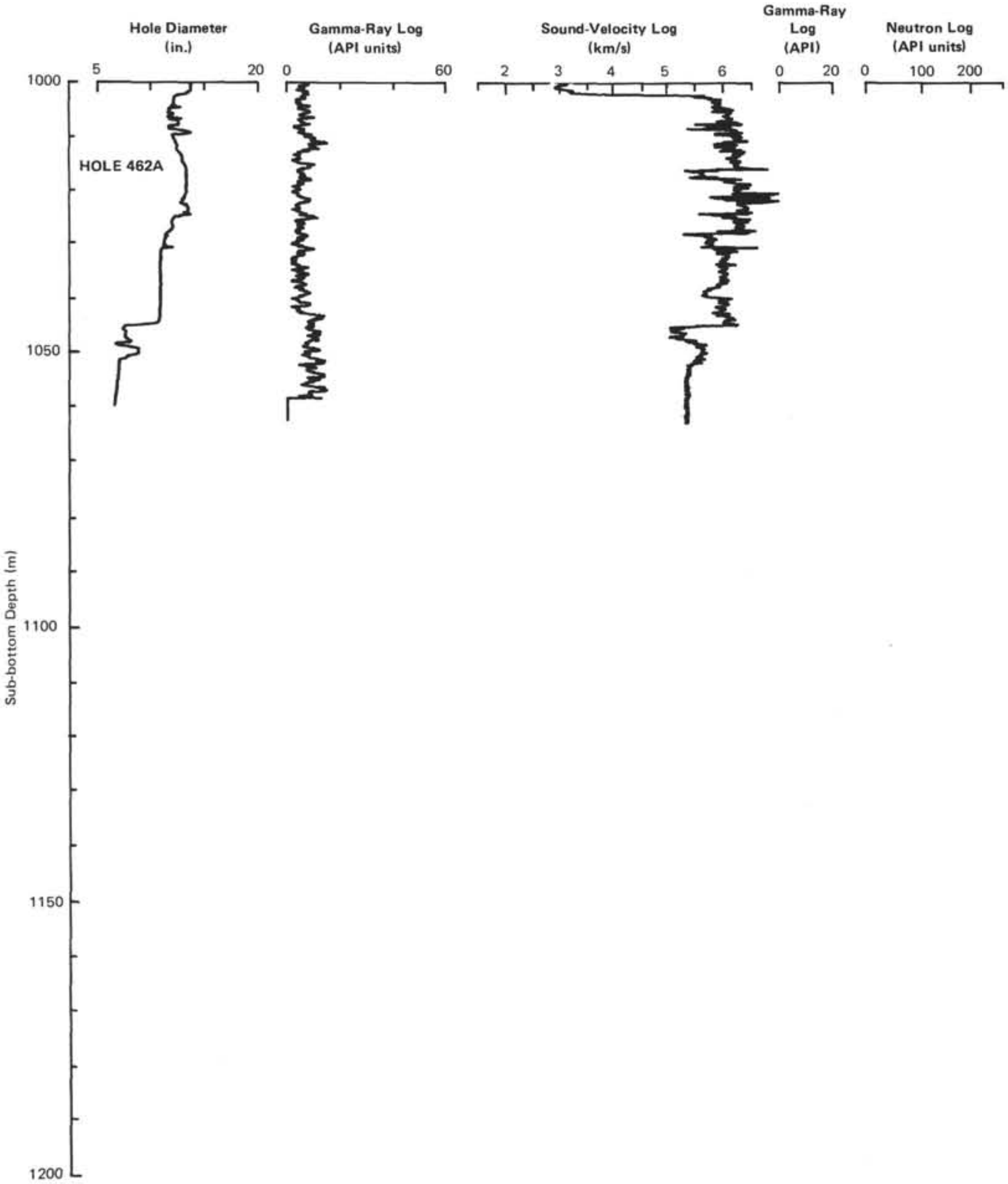


Figure 46. (Continued).

water sand. The ash is found in Cores 4, 5, and 6, and also was indicated by a modest increase in the drilling rate at the bottom of Core 5. Judging from inspection of the first-run gamma-ray log, we believe that the principal ashy interval is between 44 and 50 meters.

The ashy component is brown within radiolarian ooze, and greenish-gray within carbonate ooze. Yellow-brown glass, glass partly altered and crowded with opaque dust, feldspar, pyroxene, and some amphibole are the components from volcanic activity nearby. Perhaps they record the growth of Kusaie Island, the easternmost and apparently youngest of the Caroline Islands chain. Kusaie is the island closest to Site 462, lying about 260 km to the southwest.

Sands of shallow-water origin characterize parts of Cores 21, 22, 29, 32, and 34 and are thickest at about 210 meters sub-bottom. According to the gamma-ray and density logs, the principal interval is at 207 to 212 meters. The carbonate component of the coarse fraction is a mixture of chalky-lustered, recrystallized, highly abraded fragments of large foraminifers, mollusks, echinoid spines, calcareous red algae, corals, and, rarely, bryozoans. Rare fragments of white to pale-yellow calcite spar are also present. Identified large foraminifers include *Heterostegina* spp., *Spherogypsina* sp., *Chapmanina*(?), discocyclinids, and nummulitids. Core 22 was especially rich, containing, among other large foraminifers, alveolinids, *Cyclocypeus*, lepidocyclinids, etc.

This assemblage is Eocene in age, but also contains Paleocene and Cretaceous redeposited elements. The assemblage indicates an origin in a reef to shallow-bank environment. In thin-section, intensely recrystallized and strongly calcite-cemented rock fragments contain-

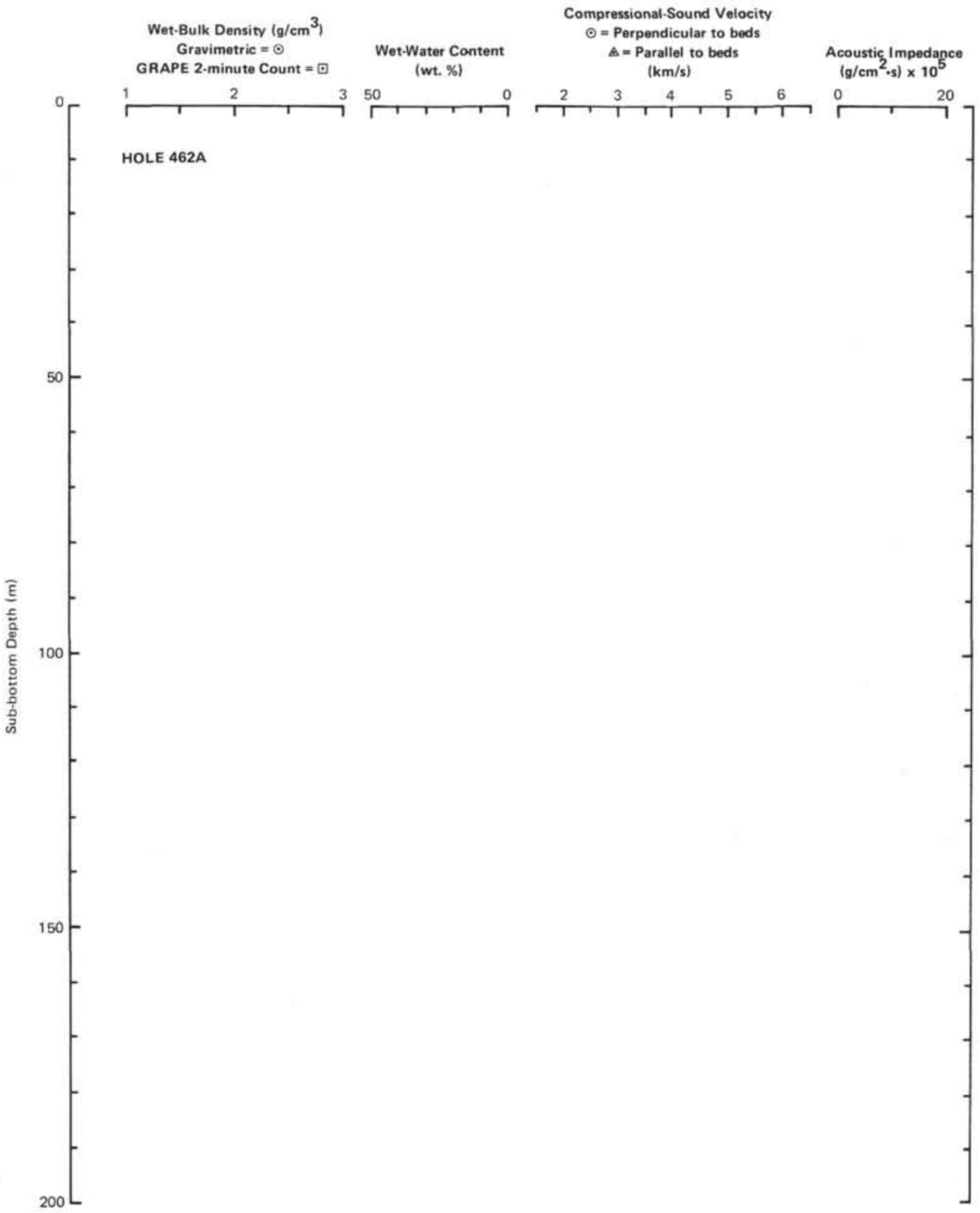


Figure 47. Laboratory-measured density, wet-water content, compressional-sound velocity, and acoustic impedance, Hole 462A.

ing the above-listed fossil elements are seen. This indicates that lithified reef rock, as well as individual skeletal fragments of Eocene age, was transported into the deeper-water Oligocene facies. A similar event took place during Oligocene time in the Line Islands (Winterer, Ewing, et al., 1973).

Volcanic grains are another component of the sand. They are mainly lithic grains (commonly vesicular and opaque to transmitted light at their greatest thickness), but vitric and crystal (pyroxene) grains are also present. Like the lime sand, they are detrital. Probably they represent times in the Oligocene when the Marshall Islands atolls were above sea level, and foraminifers of probable Eocene age and volcanic rock were eroded from the tops and submarine slopes of the islands. The Ralak Chain of the Marshalls lies about 230 to 400 km northeast and east of the site (Fig. 1), and the unnamed group of the Marshalls (containing Enewetak Atoll and numerous closer atolls, seamounts, and guyots) is the same distance to the northwest. Enewetak Atoll was emergent during the Oligocene.

Unit 2 is essentially a diagenetically advanced and older version of Unit 1. Turbidites dominate this limestone-and-chert unit. The cherts are the normal types encountered at many DSDP sites. At 447 meters, there is a fairly sharp break in the type of sedimentation, from the dominantly calcareous Unit 2 to a volcaniclastic-rich Unit 3.

Unit 3 embraces the time interval between late Campanian/early Maestrichtian and Cenomanian. The top

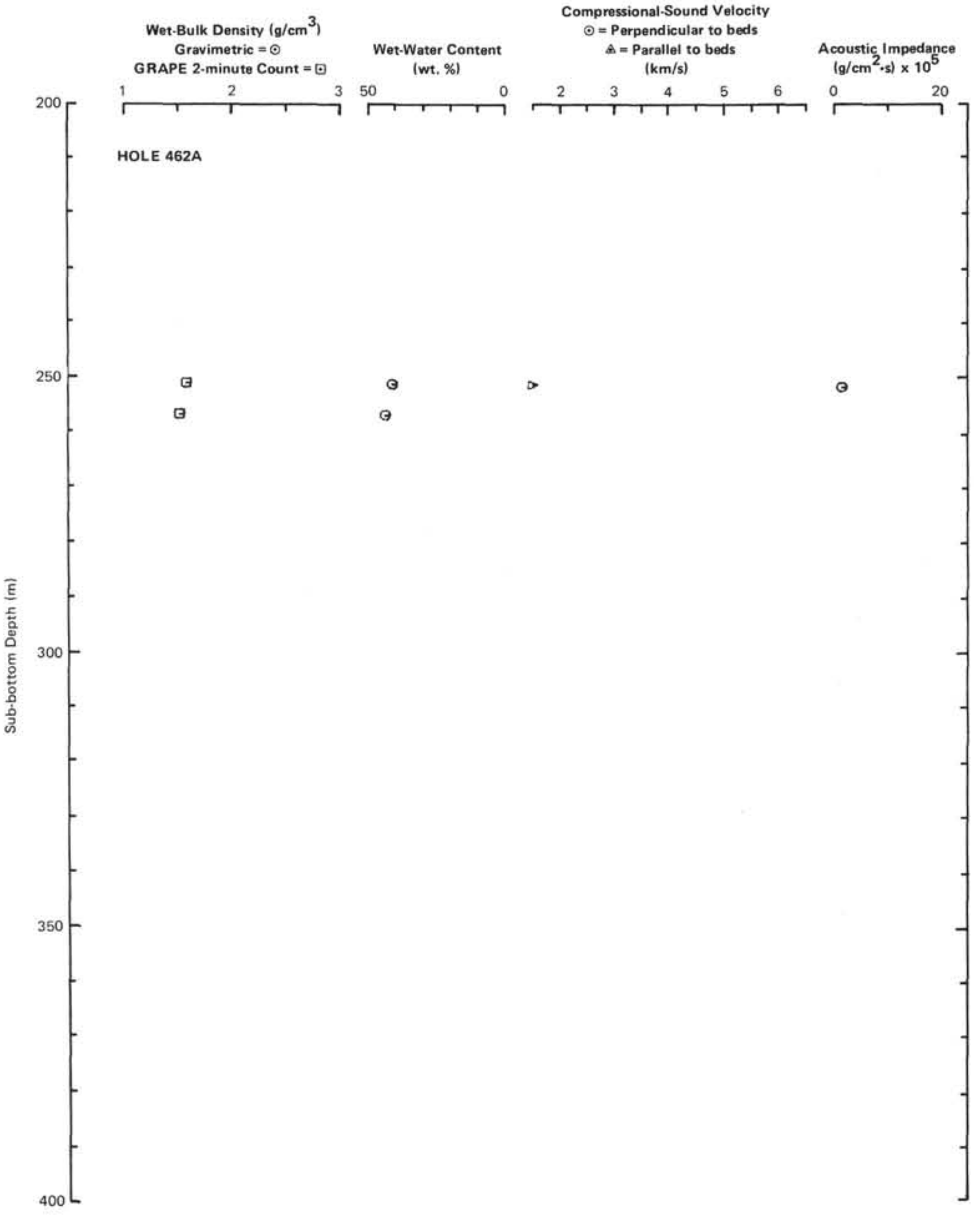


Figure 47. (Continued).

of the unit comprises light-olive-gray to pale-yellow nannofossil chalks and limestones. These sediments, which contain considerable percentages of unspecified carbonate, traces of volcanogenic grains, and very sparse radiolarians and sponge spicules, are interpreted as a pelagic product in which the amount of redeposition has been modest.

Interbedded and intermixed with these "host" lithologies are a series of greenish-gray to greenish-black volcaniclastic sediments. These deposits are perhaps the most striking feature of this unit; they display a range of sedimentary structures: tabular and trough cross-lamination, horizontal and parallel lamination, angular and scoop-shaped scours, and pebbly mudstone conglomerates whose clasts range up to 2 cm in length. Grading is obvious in many of the volcaniclastic sediments, and one bed, attaining a thickness of 2.55 meters, fines upward from a dark-greenish-gray, granular base to a greenish-gray, burrow-mottled, clay-rich nannofossil limestone. Slump structures, both within the scale of the core itself and apparently extending over several tens of centimeters, characterize particularly the basal levels of the volcaniclastic sediments; inclined bedding, up to 30° from the horizontal, is present locally. The basal part of the volcaniclastic section comprises a matrix-rich volcanic breccia ("wackestone"), where sparse altered mafic clasts are enveloped in bluish-gray clay. Volcanic glass, heavy minerals, radiolarians, sponge spicules, fish remains, and clay constitute the fine fraction.

Associated with these volcaniclastic sediments are a variety of shallow-water skeletal grains. In Core 48-2, of Maestrichtian age, abraded tests of large benthic fora-

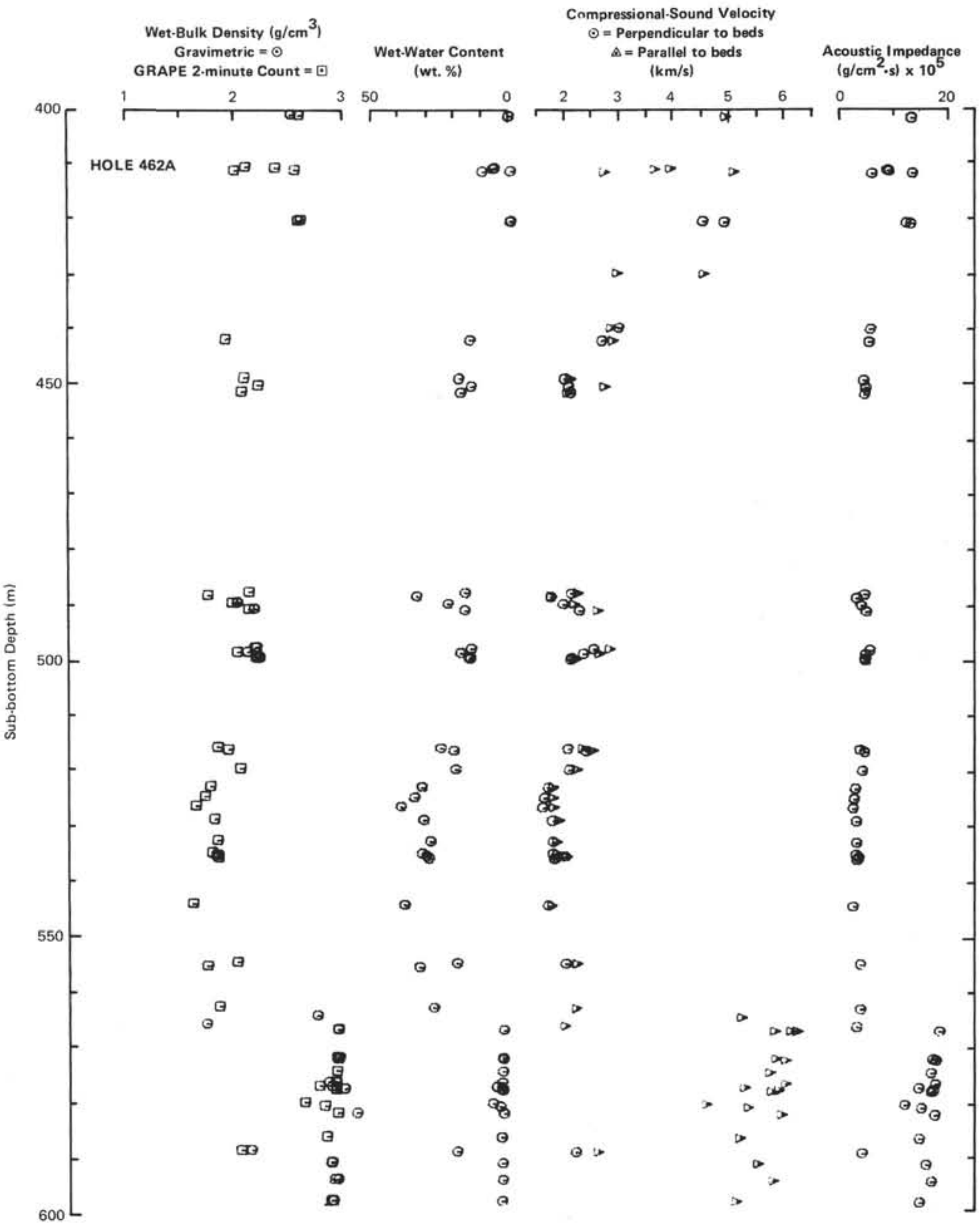


Figure 47. (Continued).

minifers (including *Pseudorbitoides, Vaughanina*, and *Asterorbus*), are found.

In Core 51-3, of late Campanian age, the coarse-grained carbonate components are a poorly sorted mixture of small (<1 mm), unidentifiable calcite fragments, large foraminifers, echinoid spines (rare), fragments of white to yellow calcite spar and mollusk shells. Many of the large foraminifers are relatively well preserved, but most, like the echinoid spines, are thickly coated with clear to white and yellow, subhedral calcite crystals. There is a striking contrast between well-preserved (slightly chalky), large foraminifers and calcite-coated forms that appear to have been broken out of calcite rock. Identified large benthic foraminifers include *Vaughanina* sp., *Pseudorbitoides* sp., and amphisteginids. In Core 52, rudist fragments were found.

These shallow-water fossils of Maestrichtian to late Campanian age indicate that shallow banks within the photic zone existed, probably in the Marshall Islands area, as noted above. The presence of calcite-cemented material mixed with the free individual foraminifer tests suggests that these banks may have emerged, and that subsequently fragments of these emergent limestones mixed with co-existing reef and fore-reef material in the turbidites.

The coincidence of redeposited fossils of Campanian–Maestrichtian age in deeper-water facies of the same age at Site 462 and at Sites 165 (Leg 17), 315, and

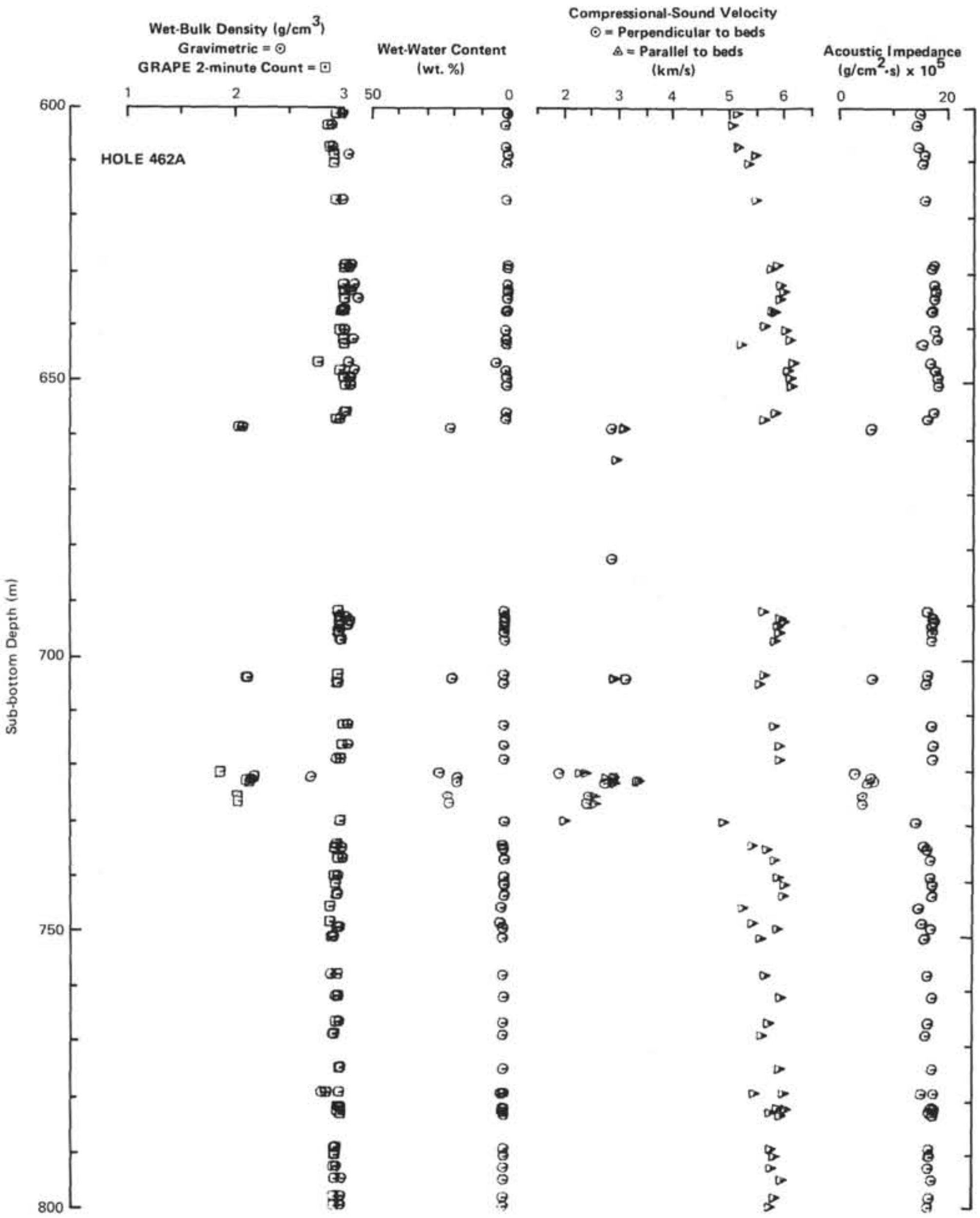


Figure 47. (Continued).

316 (Leg 33) in the Line Islands indicates that during Campanian–Maestrichtian time shallow-water carbonate banks and reefs existed over a wide area of the central Pacific Basin.

The volcaniclastic sediments, with their associated fauna, are clearly redeposited, and because many of them display features typical of Bouma sequences they readily may be interpreted as turbidites. The matrix-rich volcanic breccias probably were formed by deposition from a plastic, mobile mass—possibly a debris flow. It is possible that the original texture was more granular, and that considerable *in situ* devitrification of glass to clay minerals has taken place. All these volcaniclastic sediments presumably reflect synchronous nearby volcanism.

Below the volcaniclastic sediments are light-olive-gray claystones to limestones, typically in sequences that are calcareous and laminated at the base and pass upwards into more-clay-rich, burrowed tops. Above this burrowed level, zeolitic claystones, usually consisting of pale-bluish-green and pale-brown layers (2–3 cm thick) are typically developed. The olive-gray limestones to claystones here are interpreted as redeposited material, and the zeolitic claystones as the product of background pelagic sedimentation. Farther down the section, the thickness of the zeolitic claystones gradually increases, and colors of grayish-red and reddish-brown dominate over the pale-bluish-green hues. Olive-green claystones die away downward until the pale-reddish-brown, zeolitic claystones to siltstones, locally evincing faint hori-

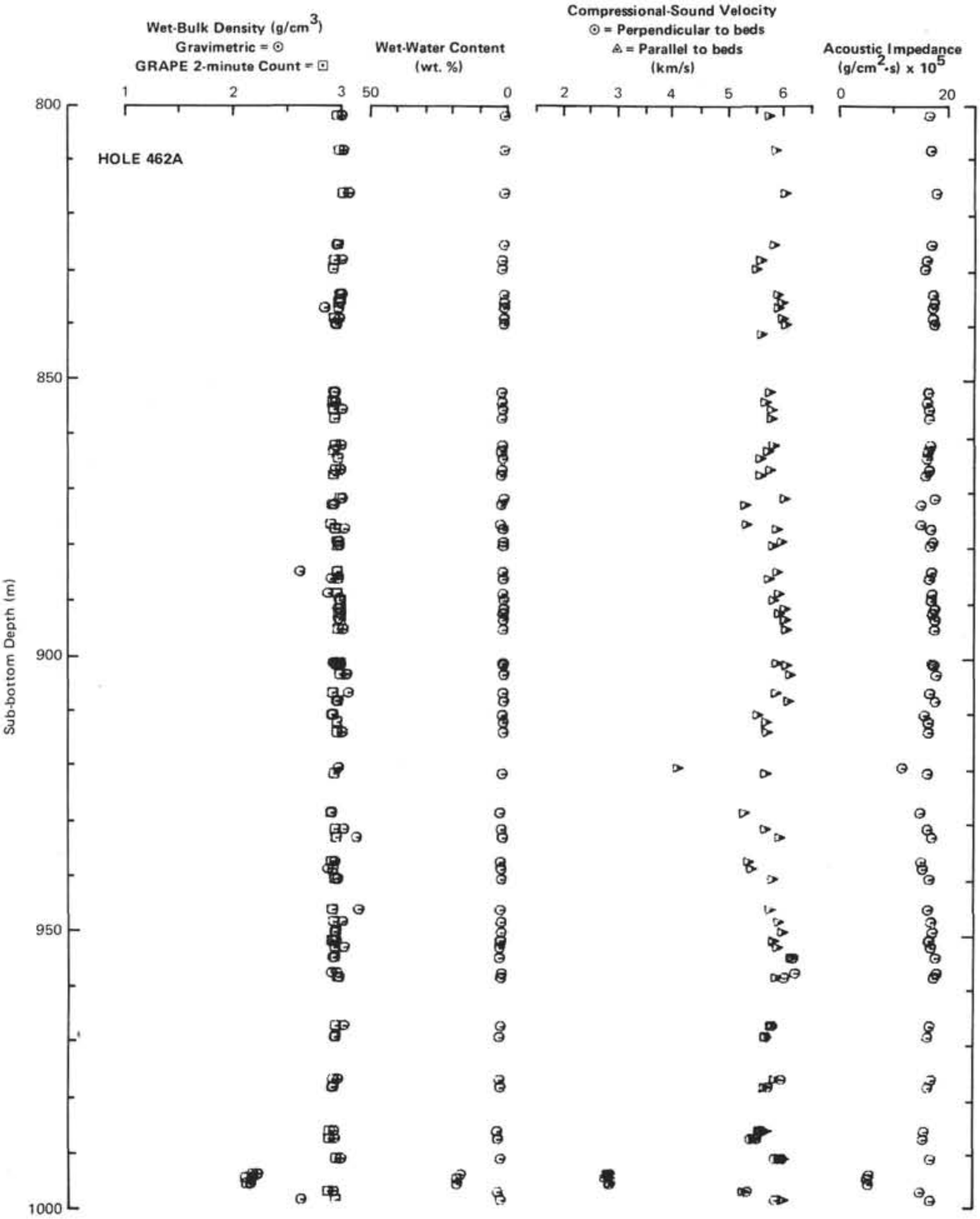


Figure 47. (Continued).

zontal lamination, become the dominant lithology. Traces of radiolarians, sponge spicules, fish teeth, and nannofossils constitute the fauna and flora. Occasionally, beds of greenish-gray, horizontally laminated volcaniclastics are interbedded (Core 57, Section 3, and core catcher). Near the base of the section, green mottles and calcite veins occur, and horizontal lamination is common; a nannofossil marlstone is recorded from Core 58, Section 4. Core 59, also zeolitic mudstone (with nannofossils in Section 1) is dominantly reddish-to light-brown, but contains horizontal, millimeter-scale laminae colored dark yellowish-orange, moderate brown, and grayish-green. Most significant perhaps are interbedded reddish-brown and greenish-brown horizontal laminae and a distinct black horizon. Zeolitic mudstone, containing a piece of moderate-brown porcellanite is in contact with basalt.

The zeolitic mudstones presumably represent alteration products of fine-grained volcanic material which has undergone modest redeposition; the former presence of siliceous organisms, tentatively identified in smear slides, is supported by the presence of chert.

The grayish-brown to black sediments, dated at about the Cenomanian/Turonian boundary, are intriguing in that similarly colored, coeval, organic-rich sediments are recorded from a variety of locations within the major ocean basins and in pelagic sections on land.

The discovery at Site 462 of redeposited bank and reef skeletal debris of Campanian–Maestrichtian age is

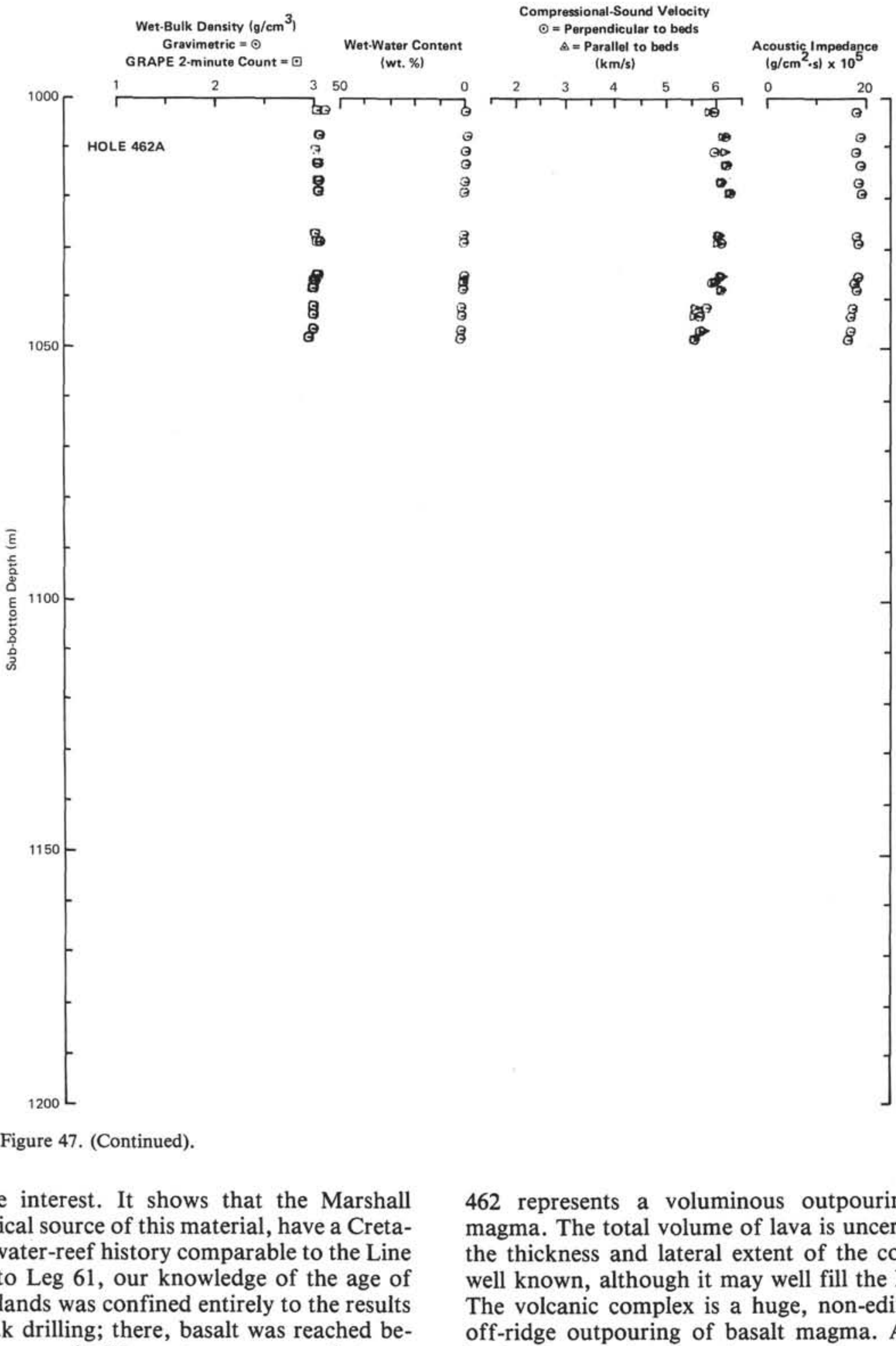


Figure 47. (Continued).

of considerable interest. It shows that the Marshall Islands, the logical source of this material, have a Cretaceous shallow-water-reef history comparable to the Line Islands. Prior to Leg 61, our knowledge of the age of the Marshall Islands was confined entirely to the results of the Enewetak drilling; there, basalt was reached below middle Eocene reefs. We must now assume that perhaps drilling at Enewetak stopped in post-Cretaceous basalt flows and that the Cretaceous reef was not reached.

Igneous Petrology

Site 462 is the location of a mid-Cretaceous volcanic complex at least 500 meters thick that presumably overlies sediments and volcanic basement of Late Jurassic age. The mid-Cretaceous volcanic section drilled at Site 462 represents a voluminous outpouring of basalt magma. The total volume of lava is uncertain, because the thickness and lateral extent of the complex is not well known, although it may well fill the Nauru Basin. The volcanic complex is a huge, non-edifice-building, off-ridge outpouring of basalt magma. As such, it is both unique and enigmatic.

The volcanic complex is made up of single sills, multiple sills, extrusive or semi-extrusive flows, and hyaloclastic sediments. The upper 170 meters of the complex, from 560 to 730 meters sub-bottom, is made up of interbedded single sills, multiple sills, and hyaloclastic sediments. The single sills are characterized by (1) glassy margins or fine-grained marginal zones with sub-horizontal attitude, and (2) orderly, coarsening-inward grain-size variations, coarse-grained interiors, and dia-

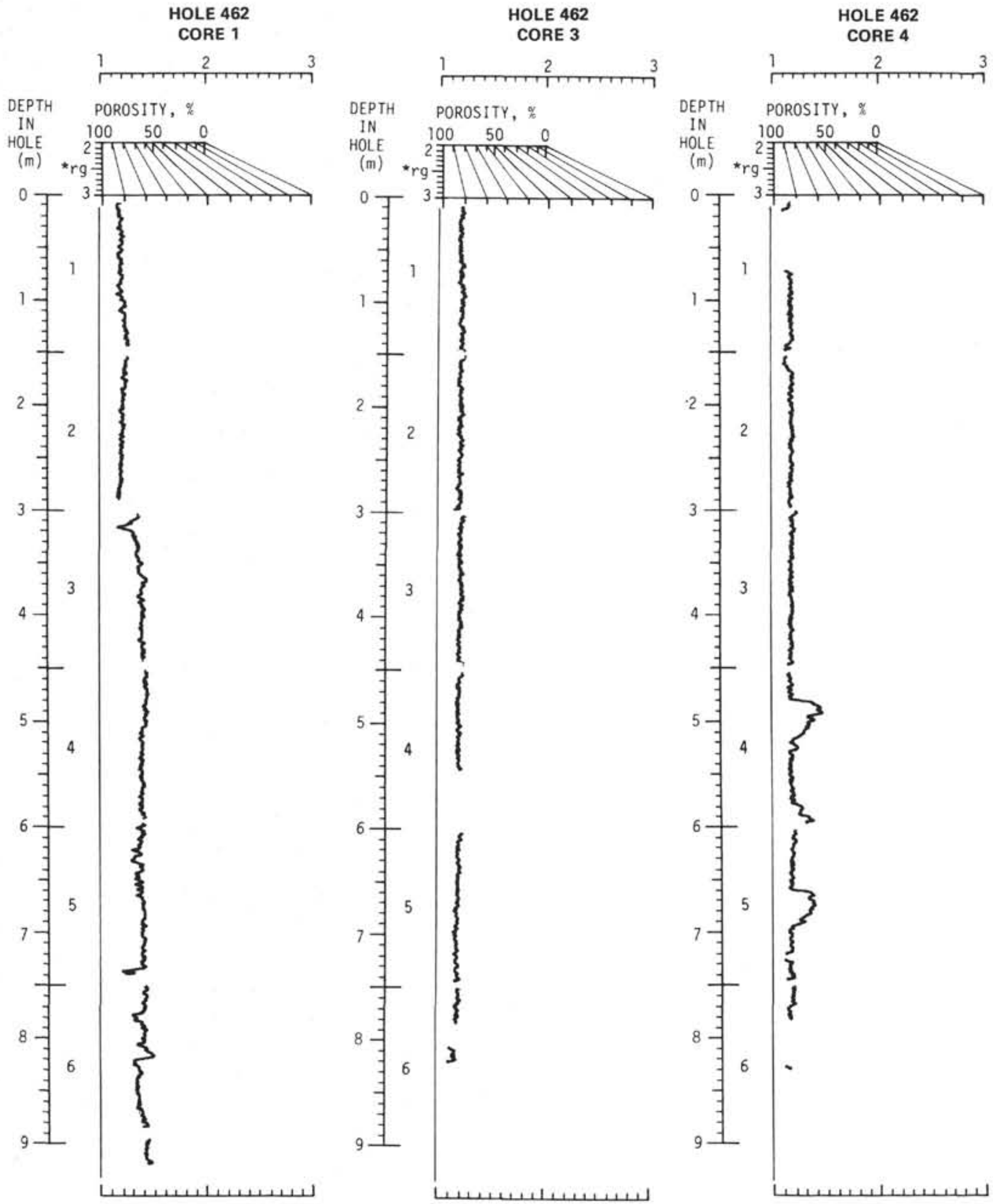
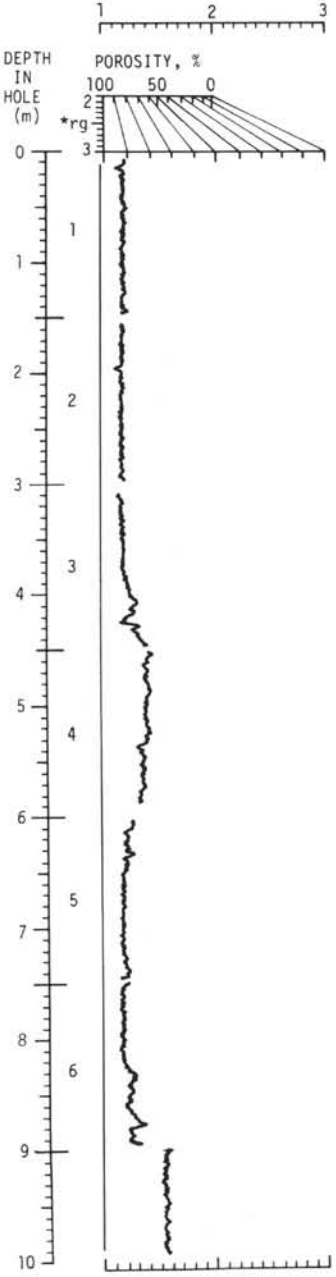


Figure 48. Continuous GRAPE wet-bulk density versus depth in each core.

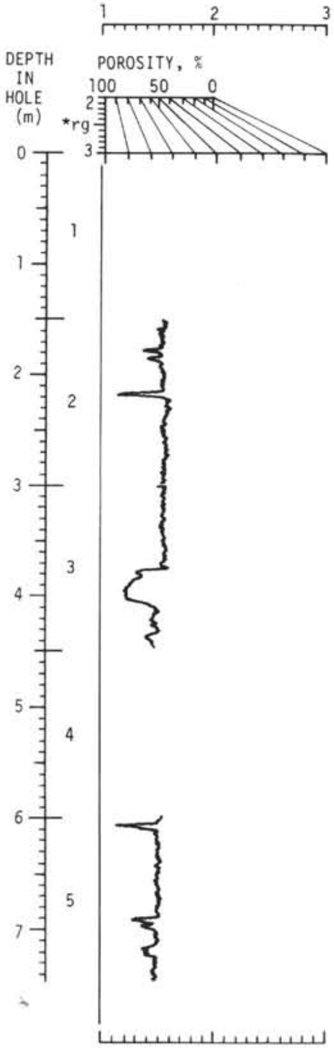
All Leg 61 GRAPE analog computer data have been edited for publication. For Leg 61 Analog GRAPE data, all rock diameters were measured by hand, usually one measurement per 5-cm core segment. Some of these core segments are very rough and irregular; therefore, when these diameters (and assumption of offset from the gamma-ray beam, as described by Equation 36 in Boyce, 1976b) are applied to the raw GRAPE data, then the resulting adjusted data (dotted lines) are subject to huge errors, particularly when small irregular-diameter core segments are scanned and the calculated (Equation 38) offset is incorrect. The unadjusted GRAPE data are plotted as a solid line, with "diameter-adjusted" data presented as a dotted line. This allowed the obvious errors to be corrected by hand. More importantly, this presentation allows investigators to manipulate the data. Investigators interested in the density of a specific layer or rock piece should check the sample diameter from the core photographs and make the appropriate diameter corrections as discussed in Boyce (1976b).

Note: The upper scale is GRAPE Wet-Bulk Density (1.0 to 3.0 g/cm^3): solid lines (————) are GRAPE analog data, assuming a 6.61-cm core diameter; dotted lines (••••••) are GRAPE analog data adjusted for actual core diameter; circled (⊙) dots are the wet-bulk density calculated from 2-minute counts on a stationary sample; scale to be determined by selecting the proper grain density (r_g) and extrapolating horizontally.

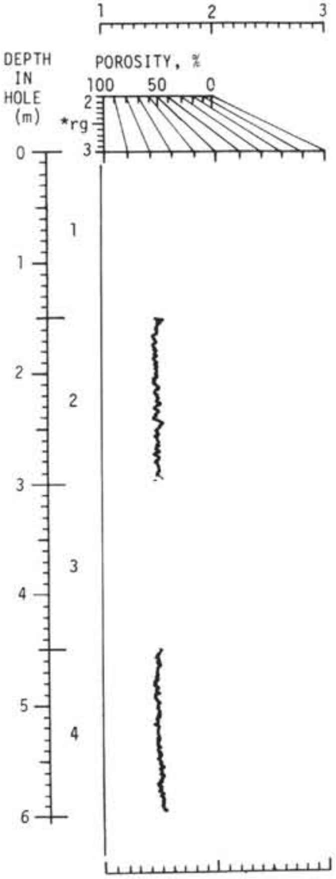
HOLE 462
CORE 5



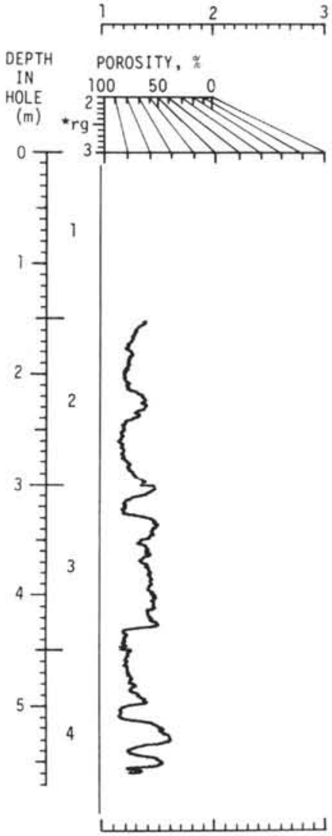
HOLE 462
CORE 6



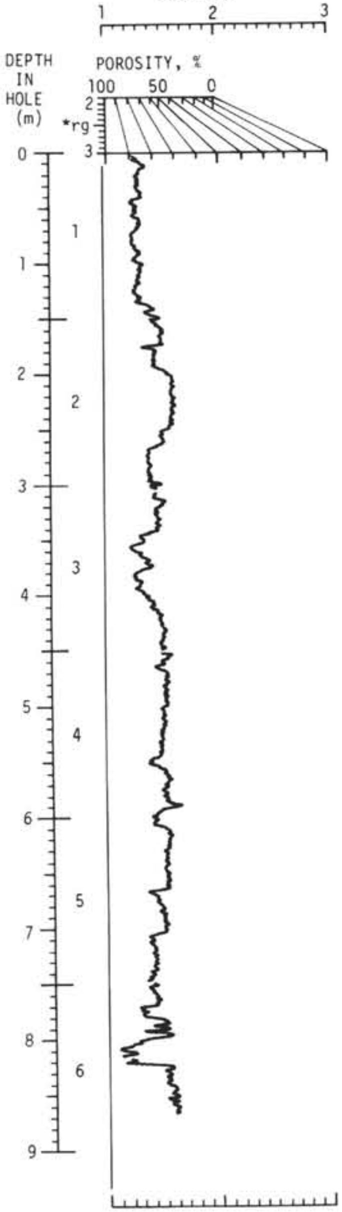
HOLE 462
CORE 7



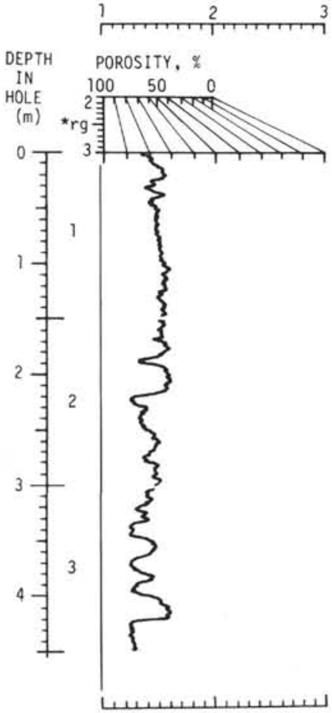
HOLE 462
CORE 8



HOLE 462
CORE 10



HOLE 462
CORE 11



HOLE 462
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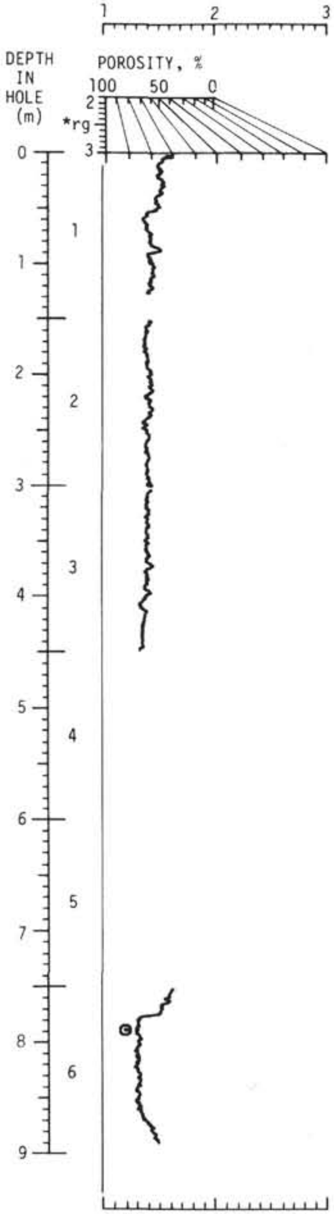
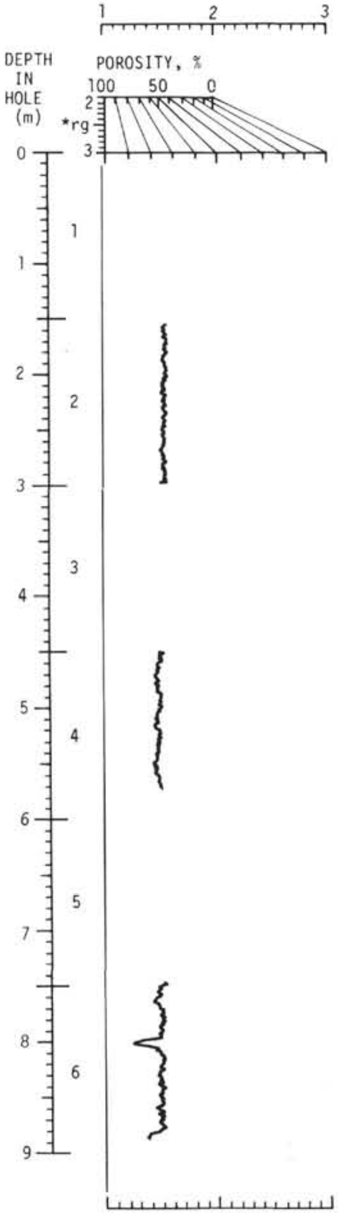
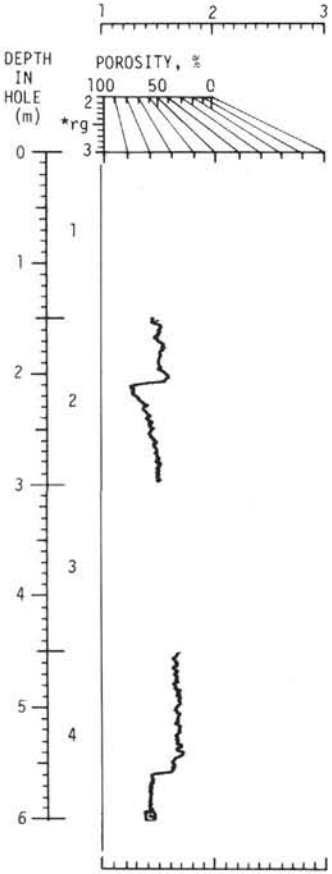


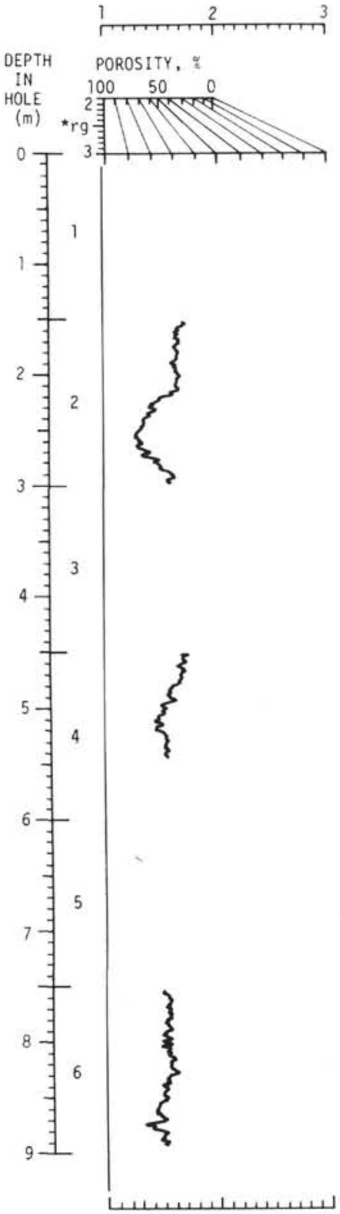
HOLE 462
CORE 13



HOLE 462
CORE 16



HOLE 462
CORE 17



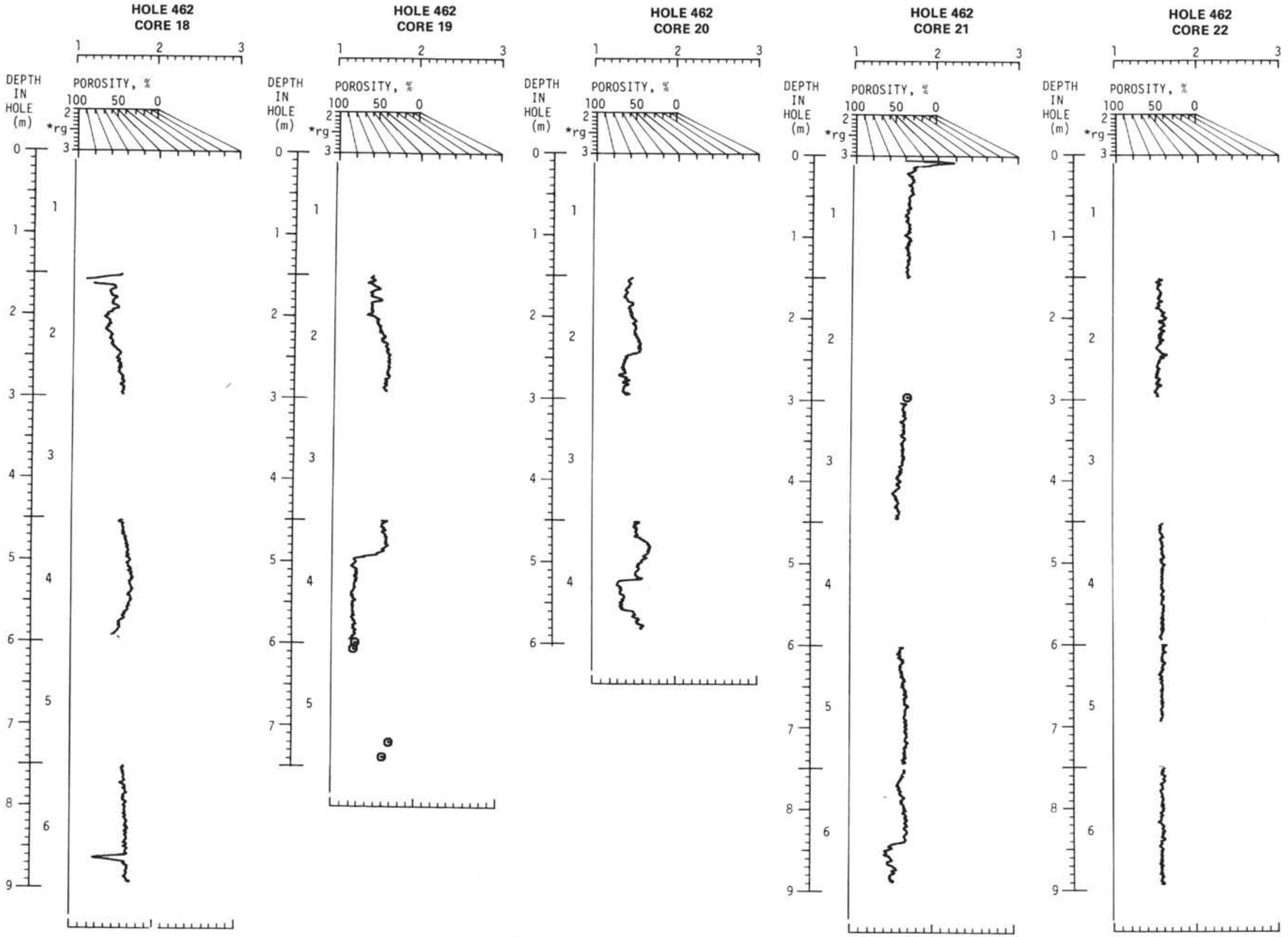
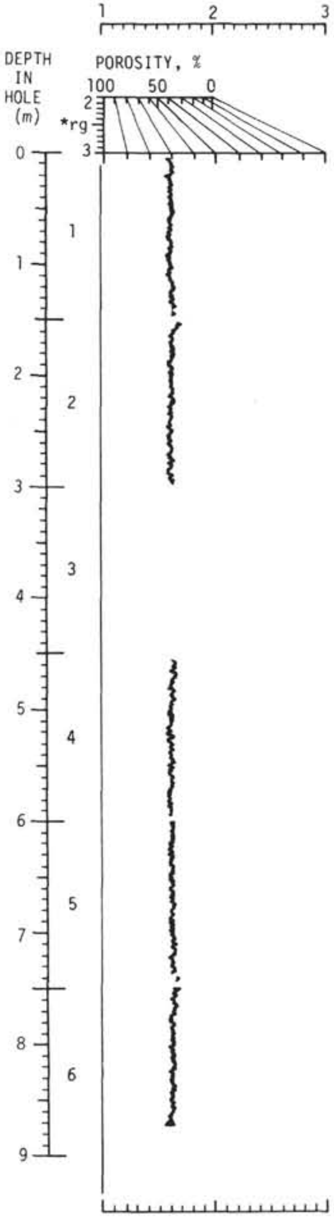


Figure 48. (Continued).

HOLE 462
CORE 23



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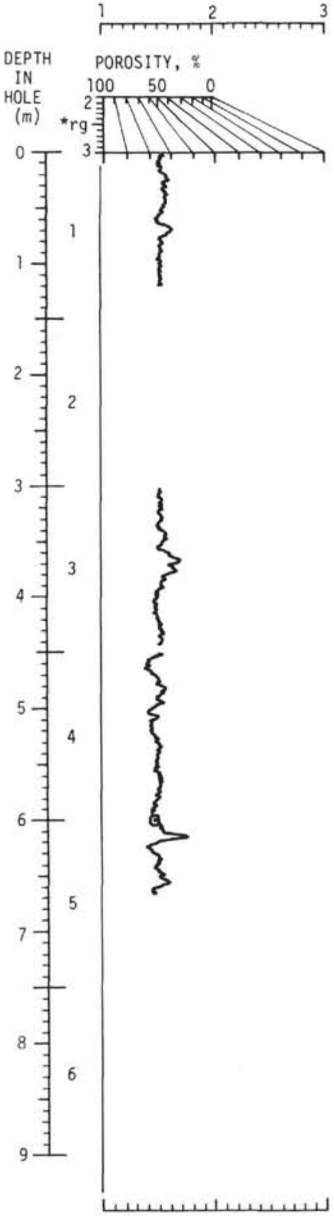

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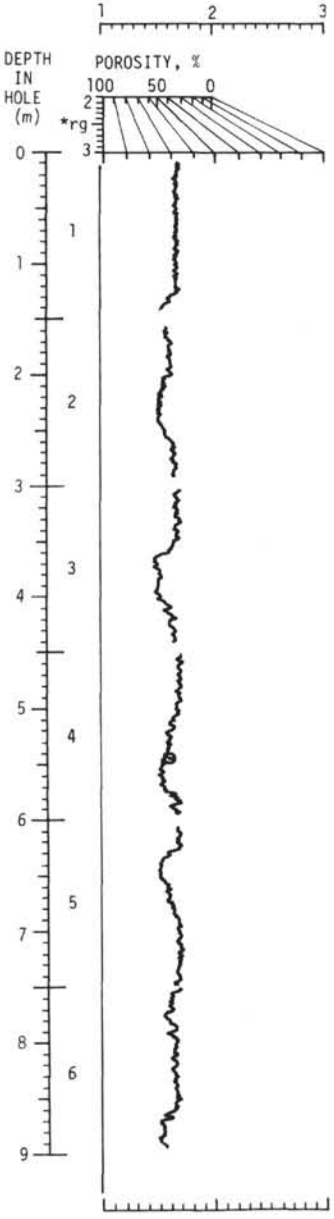
CORE 25



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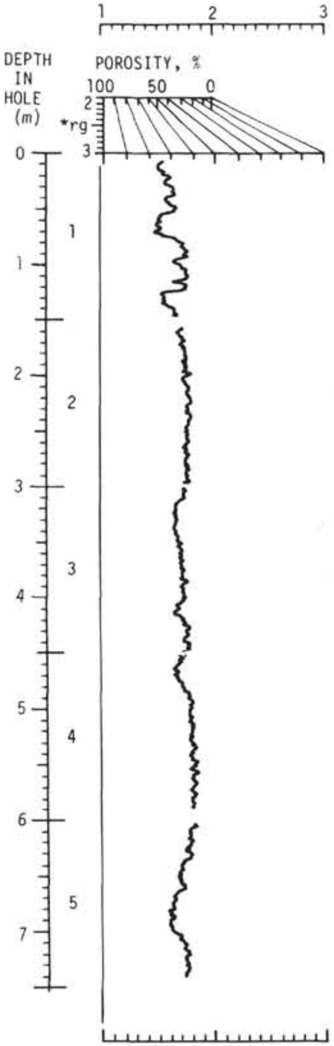
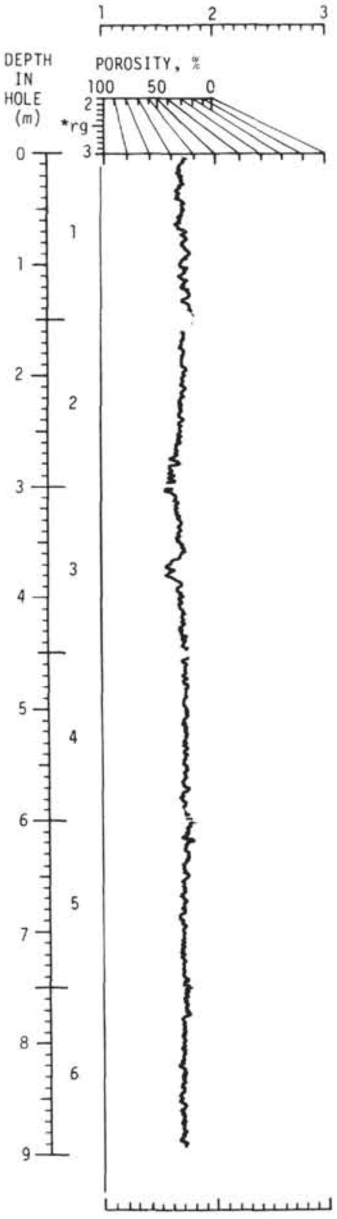
CORE 26



HOLE 462
CORE 27



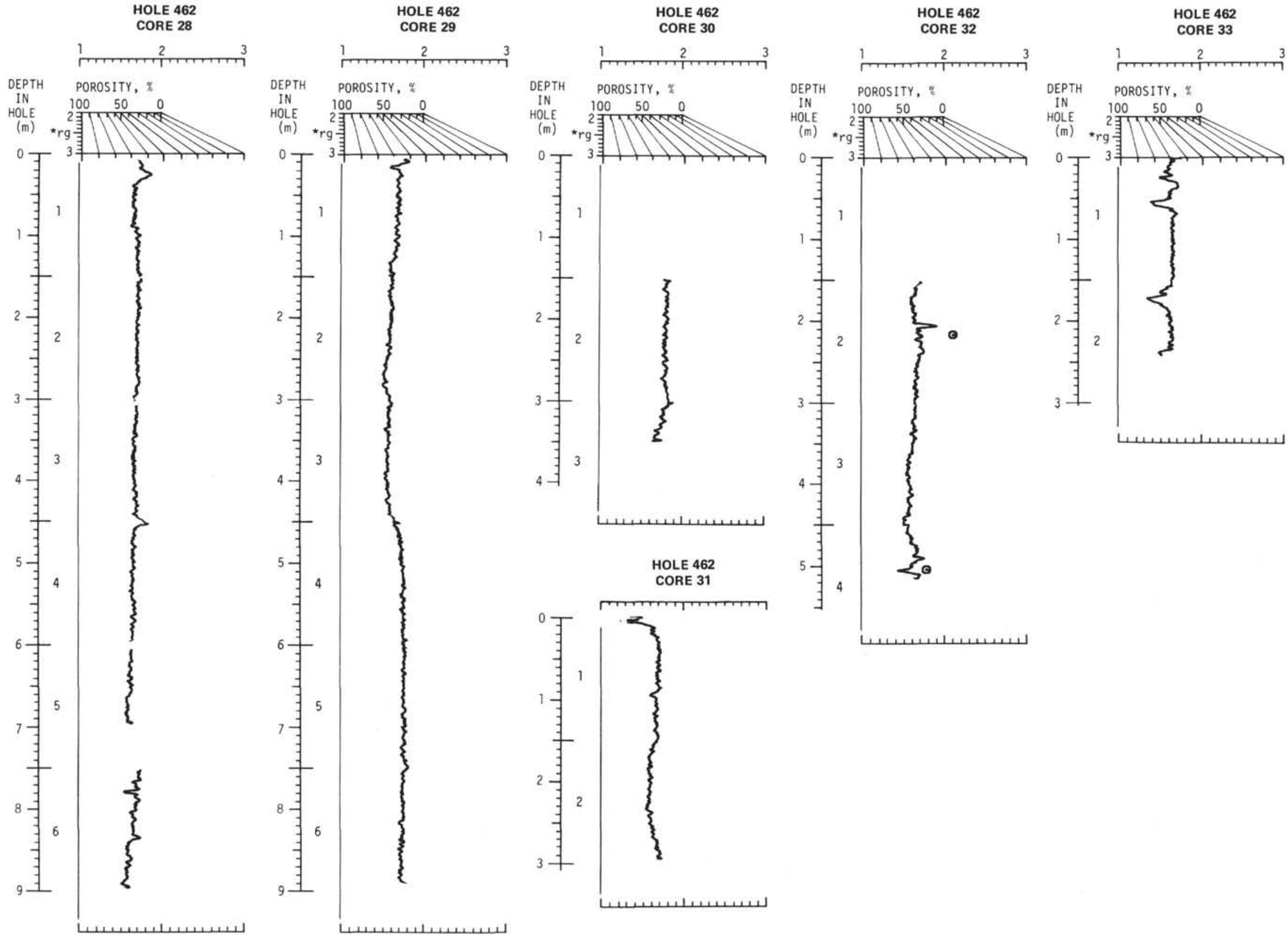
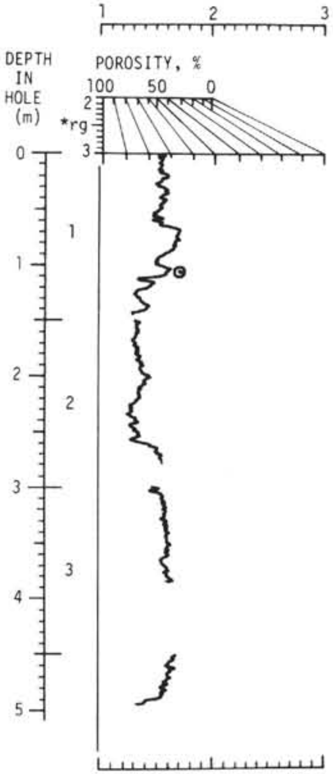
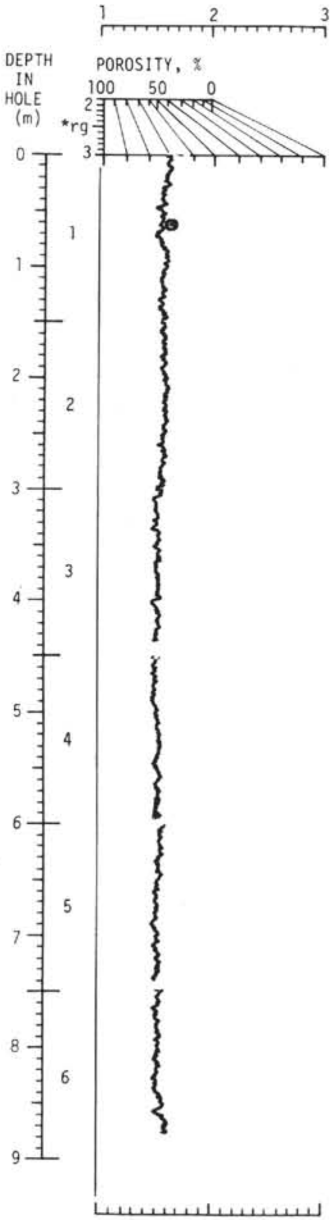


Figure 48. (Continued).

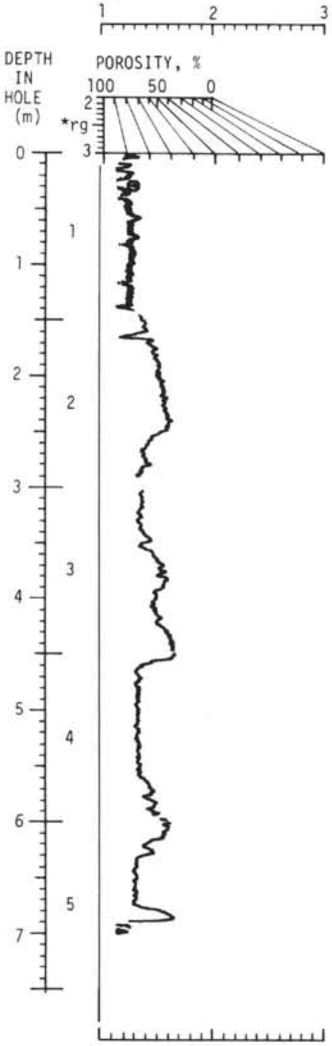
HOLE 462
CORE 36



HOLE 462
CORE 37



HOLE 462
CORE 38



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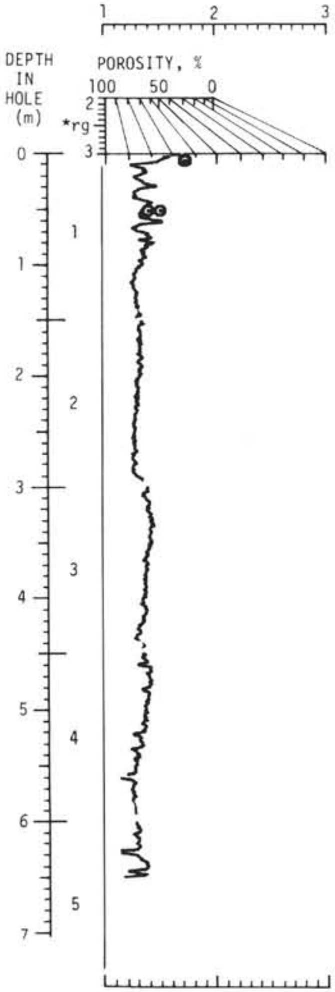
CORE 39



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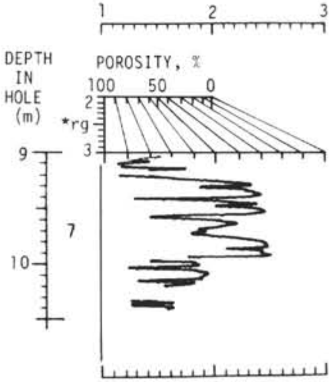

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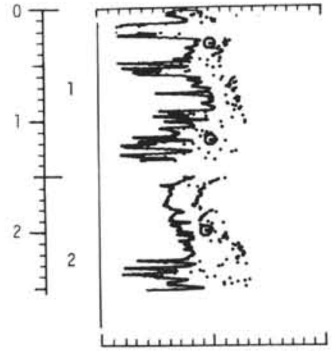


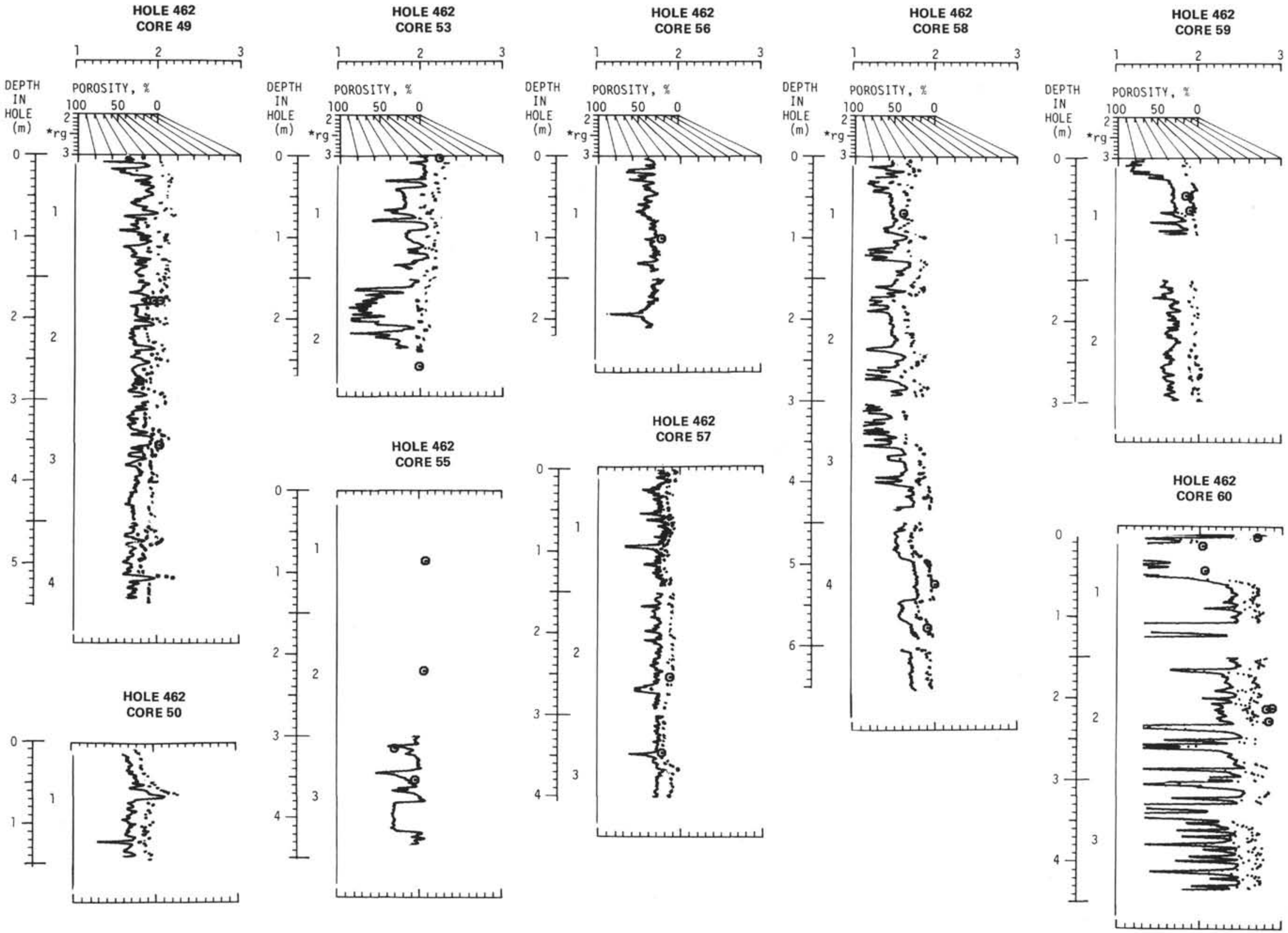
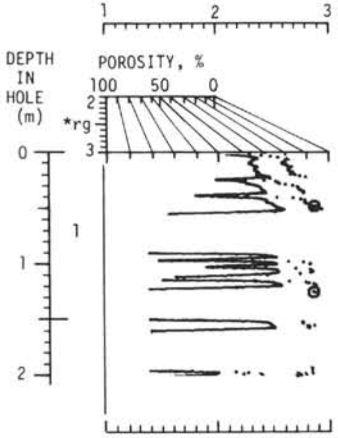


Figure 48. (Continued).

HOLE 462
CORE 61



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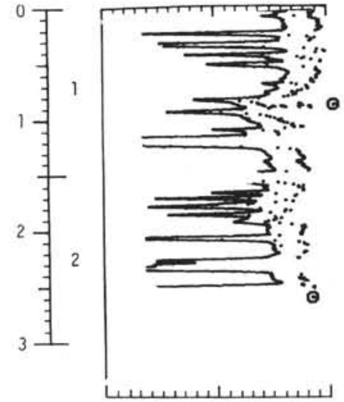
CORE 62



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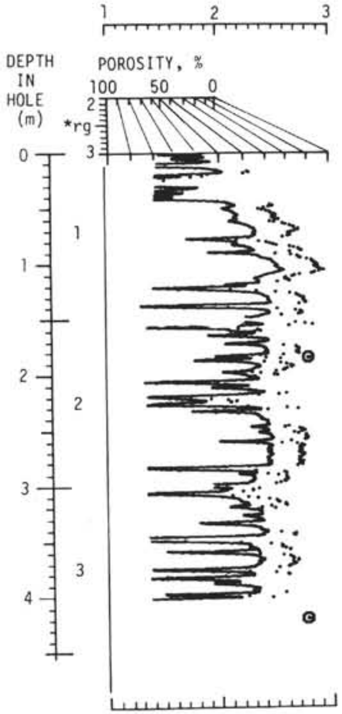
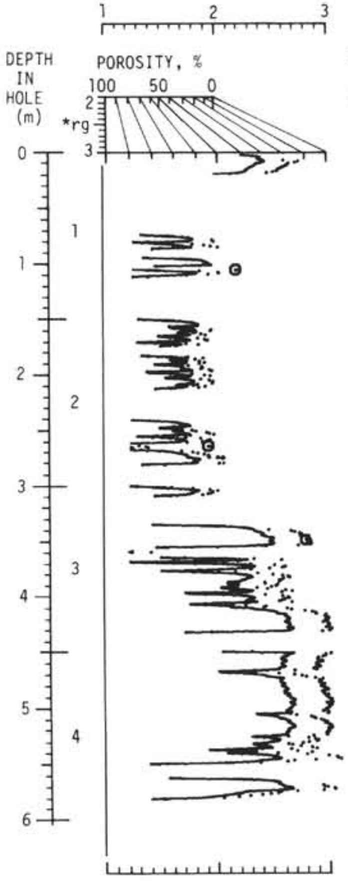
CORE 63



HOLE 462
CORE 64



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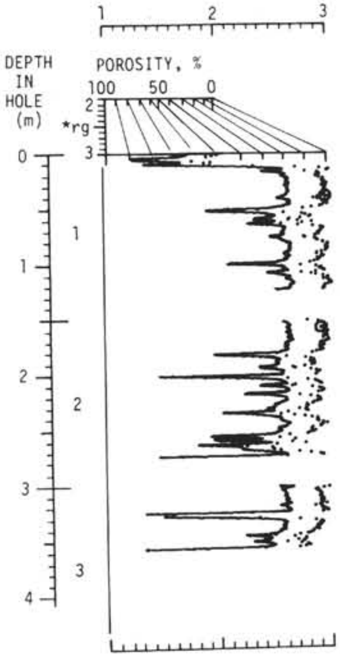
CORE 65



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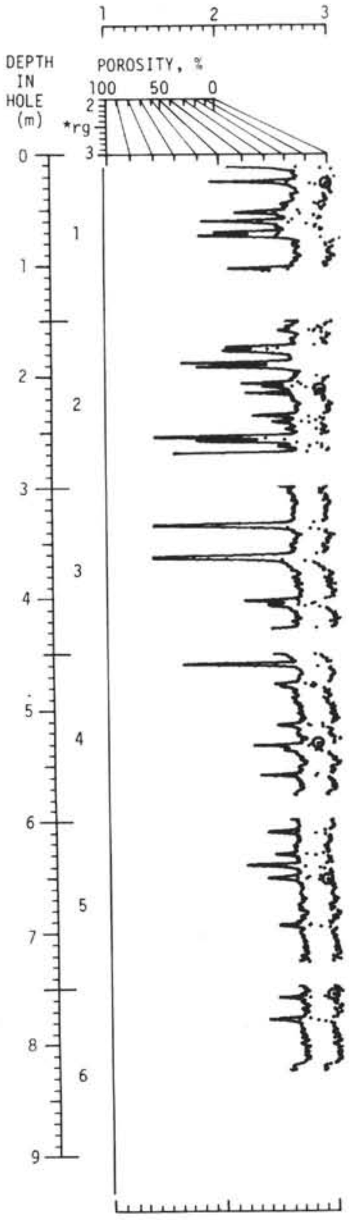
CORE 66



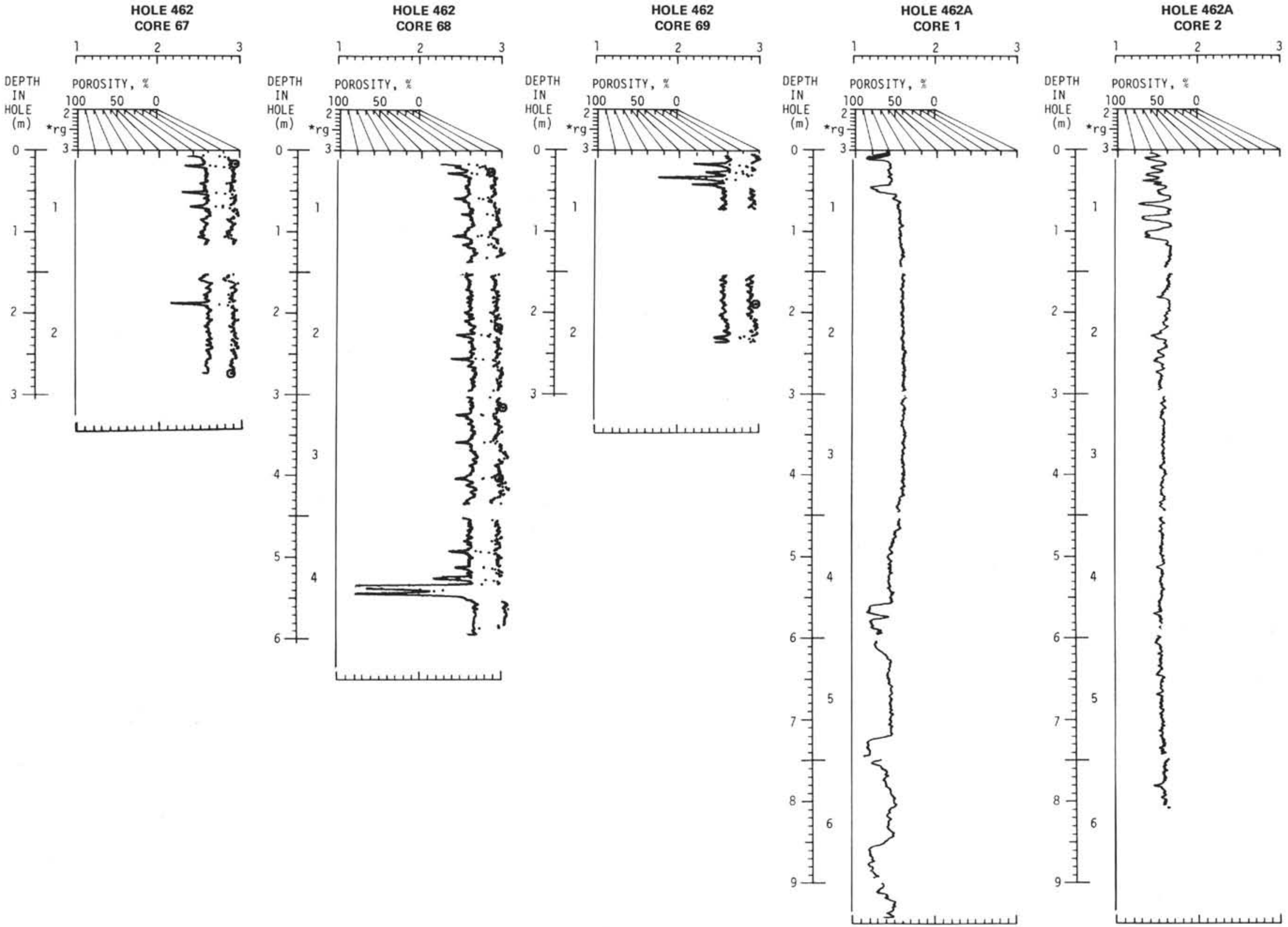
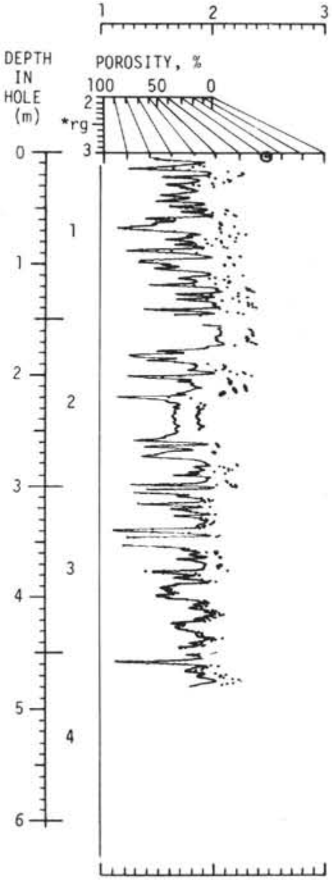
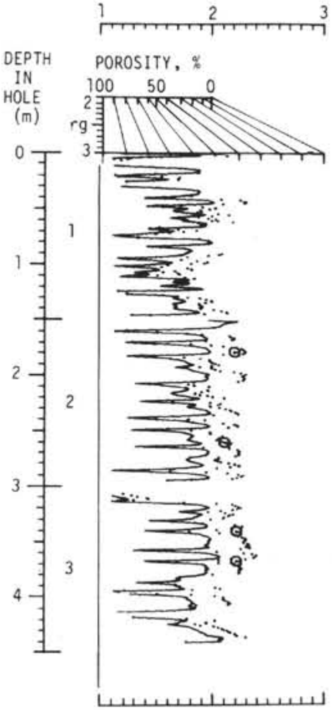


Figure 48. (Continued).

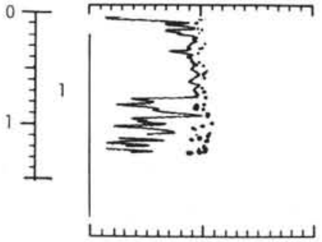
HOLE 462A
CORE H-3



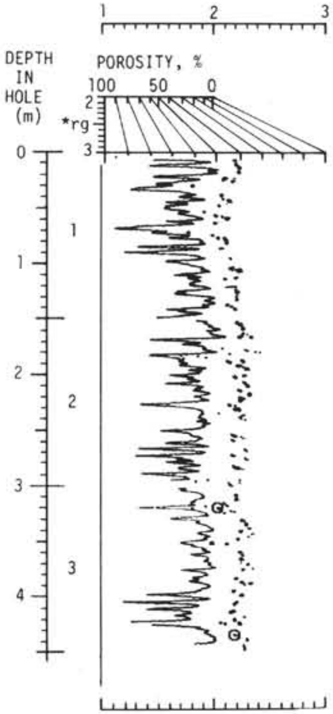
HOLE 462A
CORE H-4



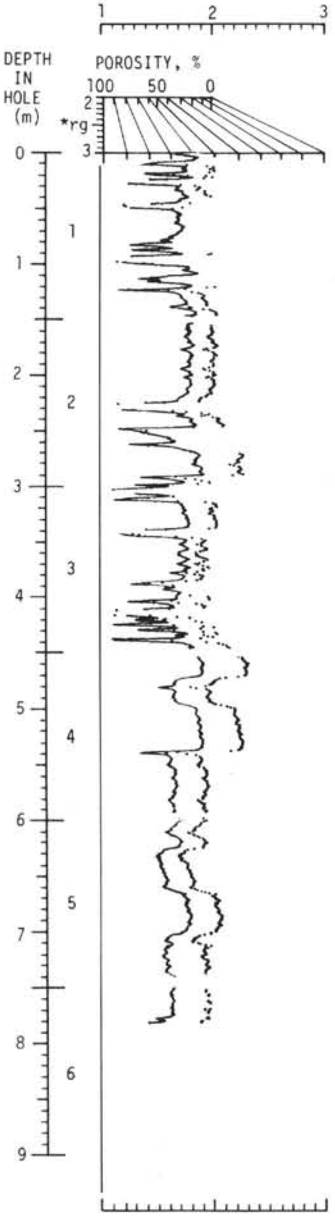
HOLE 462A
CORE 7



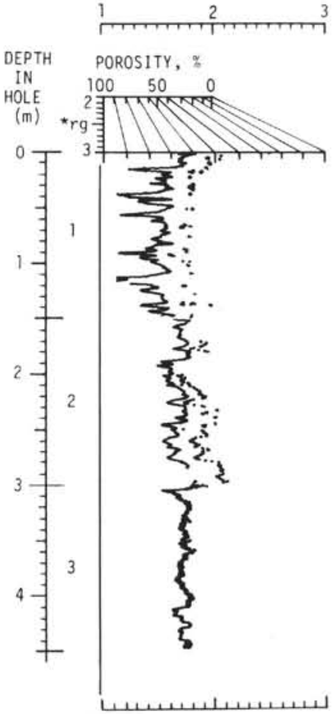
HOLE 462A
CORE 8



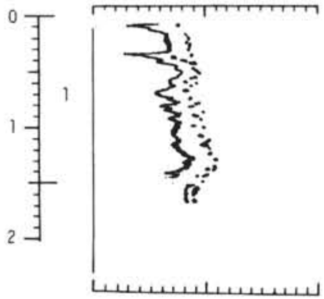
HOLE 462A
CORE 9

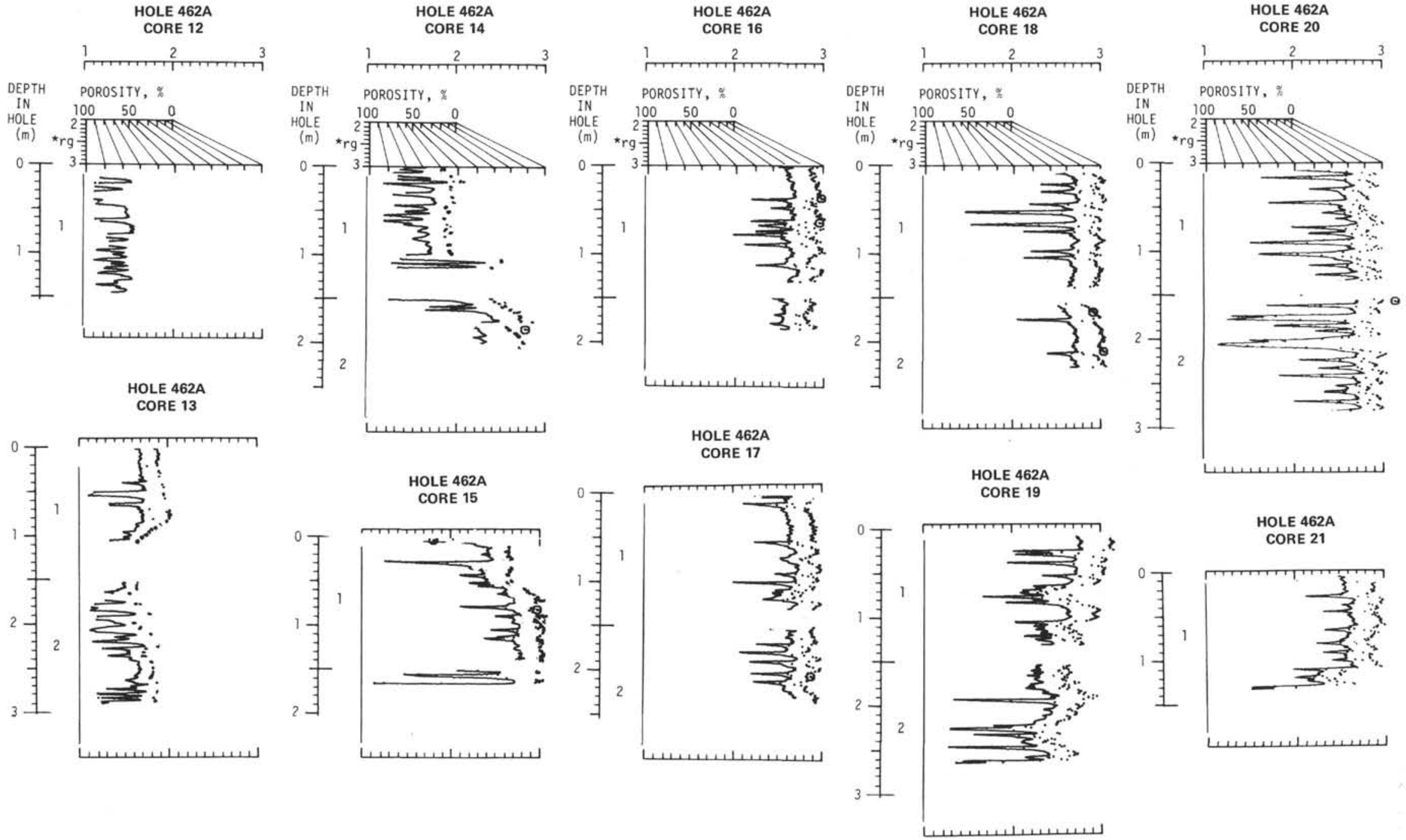


HOLE 462A
CORE 10



HOLE 462A
CORE 11




HOLE 462A CORE 12

HOLE 462A CORE 13

HOLE 462A CORE 14

HOLE 462A CORE 15

HOLE 462A CORE 16

HOLE 462A CORE 17

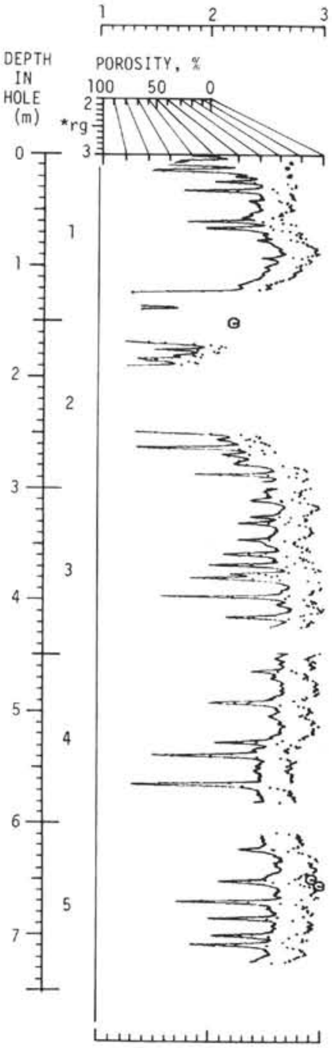
HOLE 462A CORE 18

HOLE 462A CORE 19

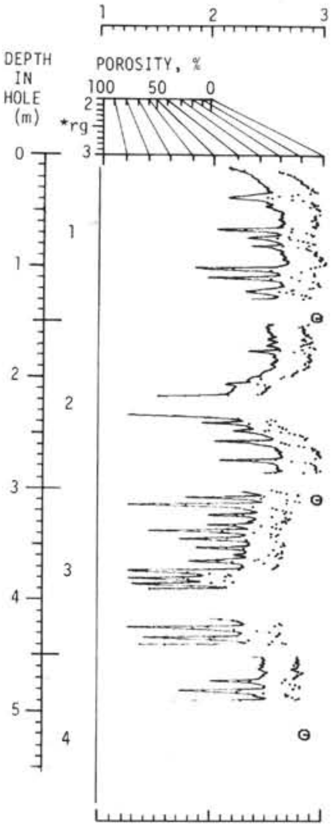
HOLE 462A CORE 20

HOLE 462A CORE 21

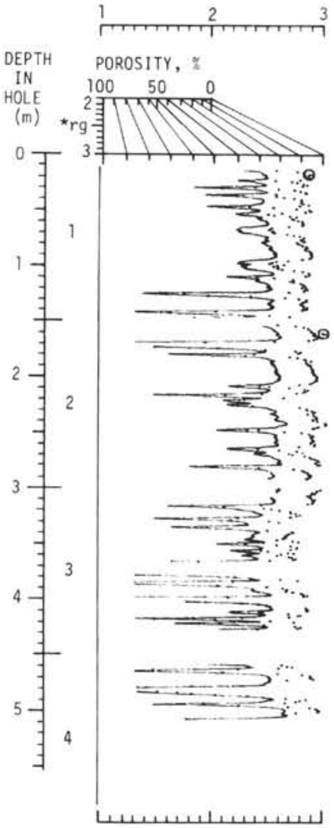
Figure 48. (Continued).



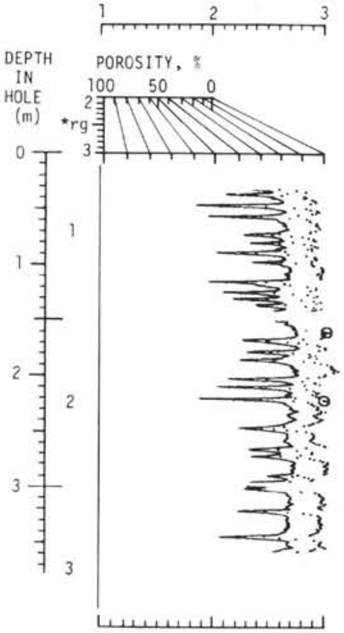
HOLE 462A
CORE 22



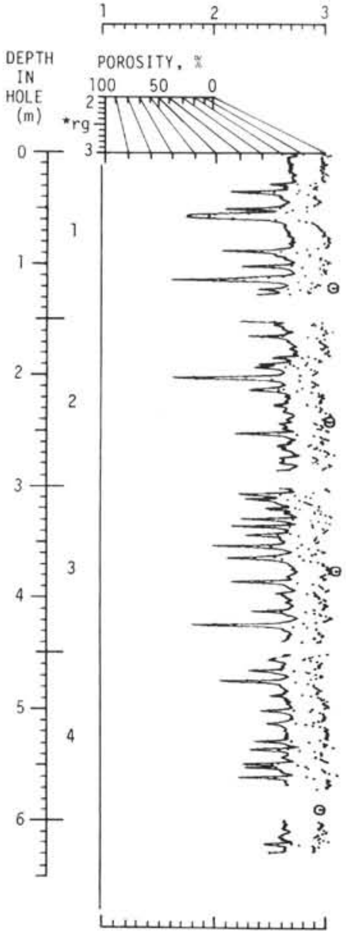
HOLE 462A
CORE 23



HOLE 462A
CORE 24



HOLE 462A
CORE 27



HOLE 462A
CORE 28

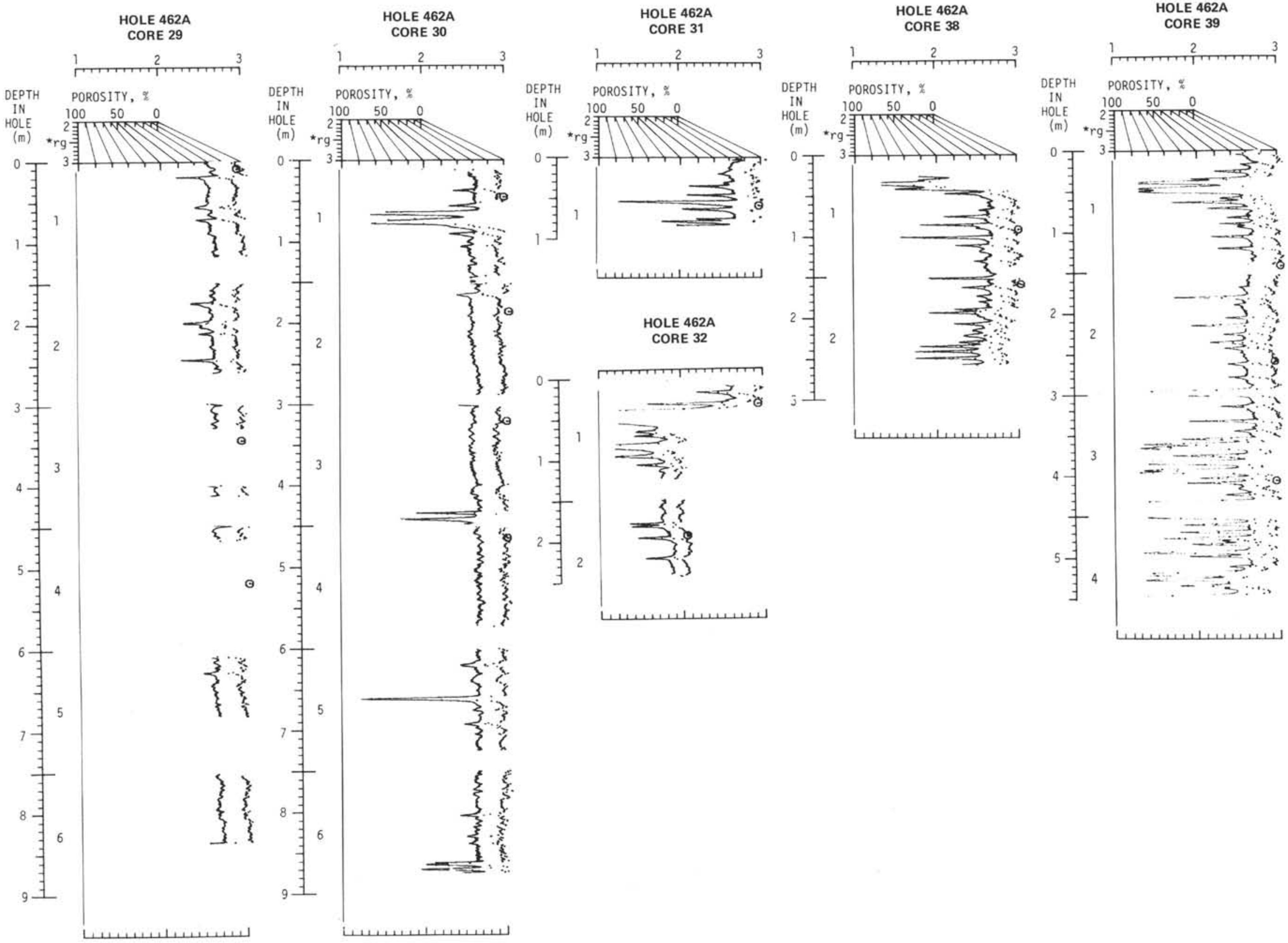
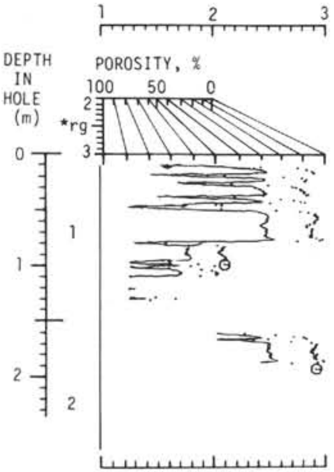
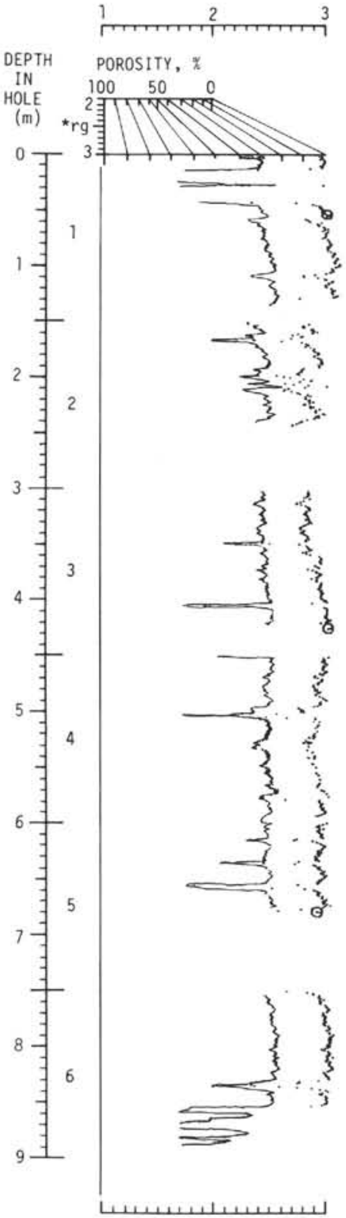


Figure 48. (Continued).

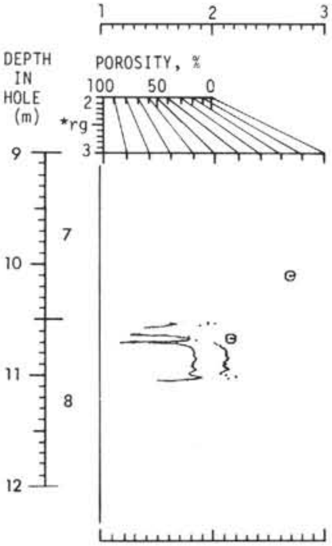
HOLE 462A
CORE 40



HOLE 462A
CORE 41



HOLE 462A
CORE 41 (continued)



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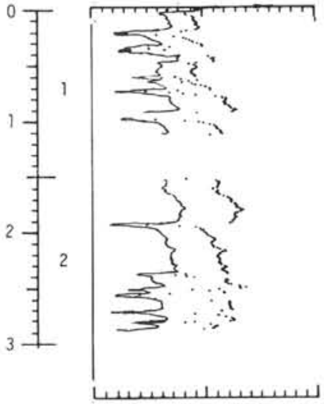
CORE 42



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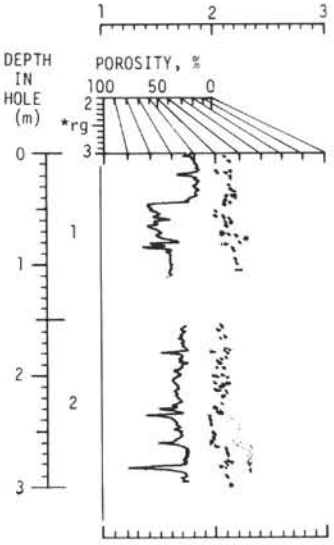
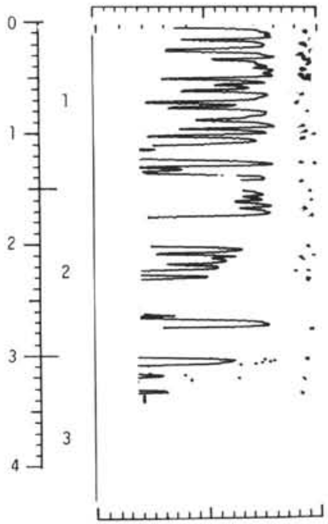
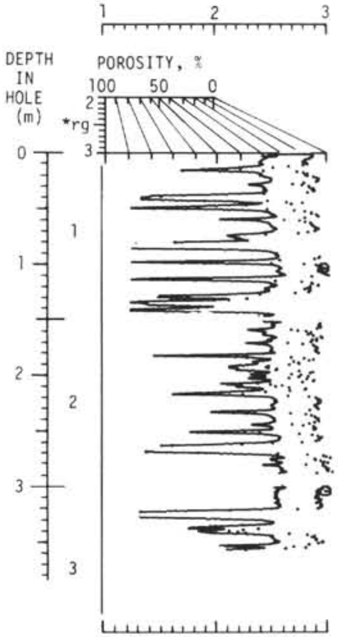
CORE 43



HOLE 462A
CORE 44



HOLE 462A
CORE 45



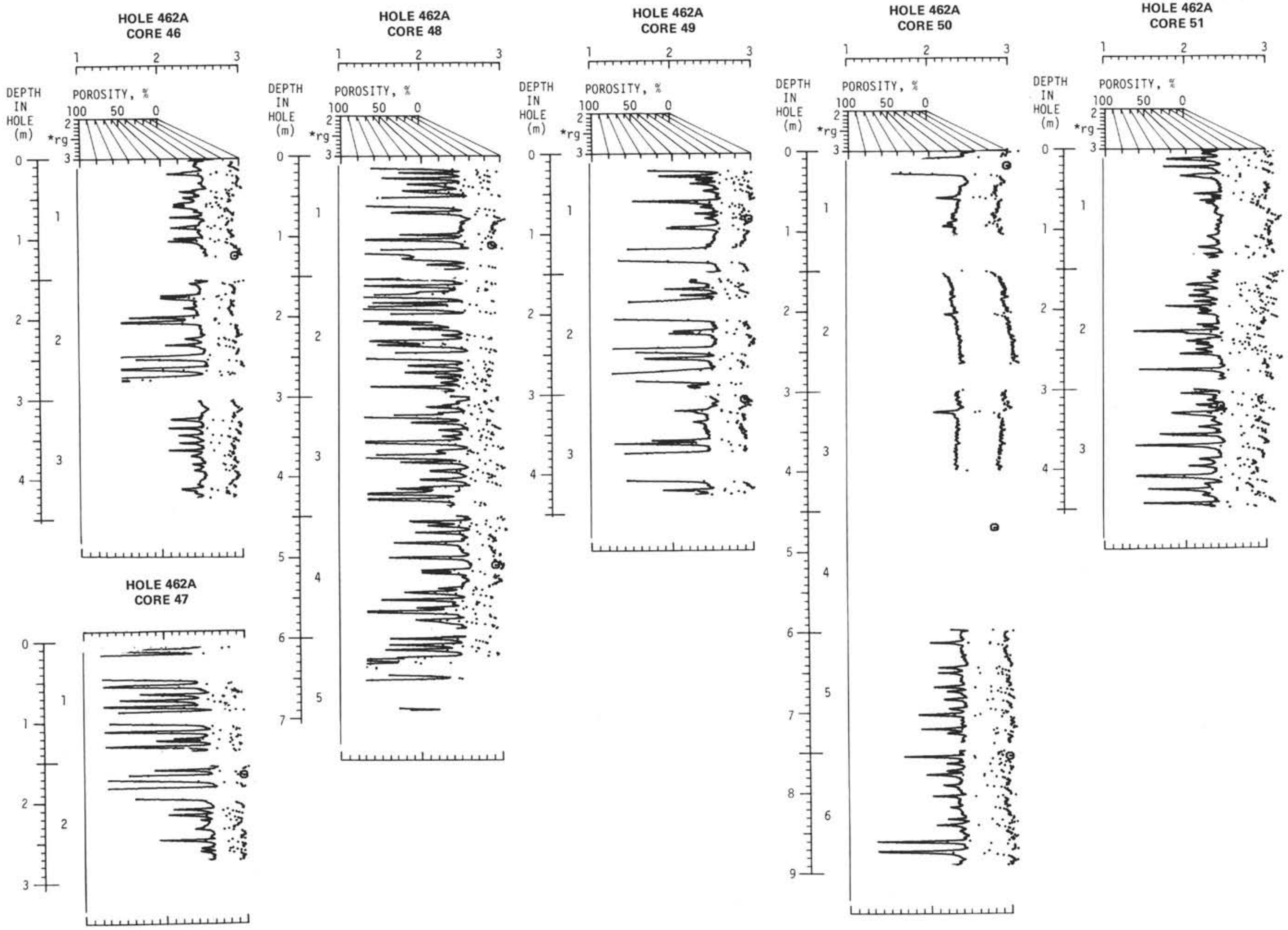
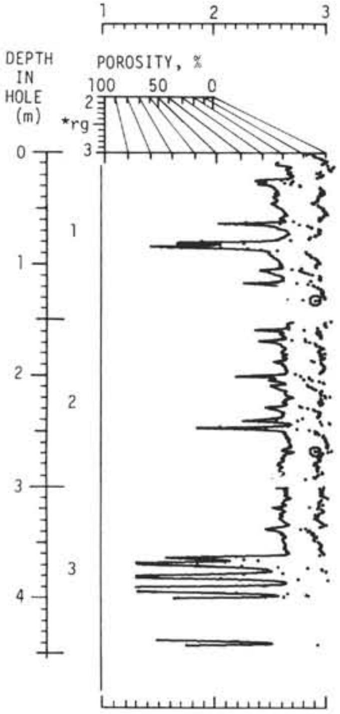
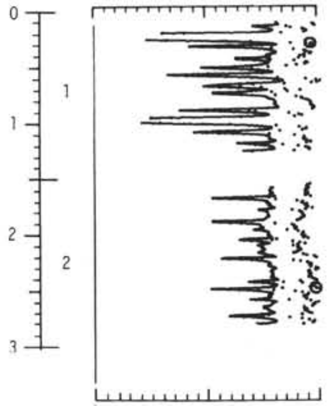


Figure 48. (Continued).

HOLE 462A
CORE 52



HOLE 462A
CORE 53



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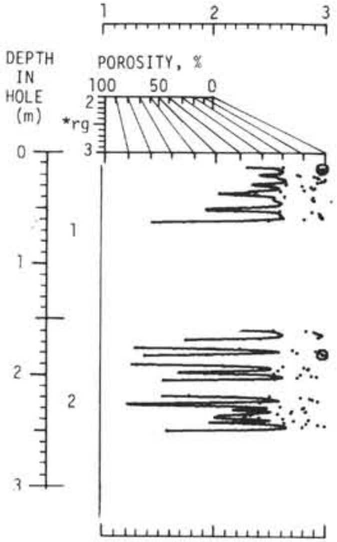
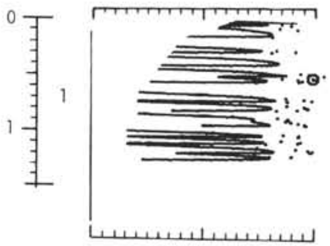
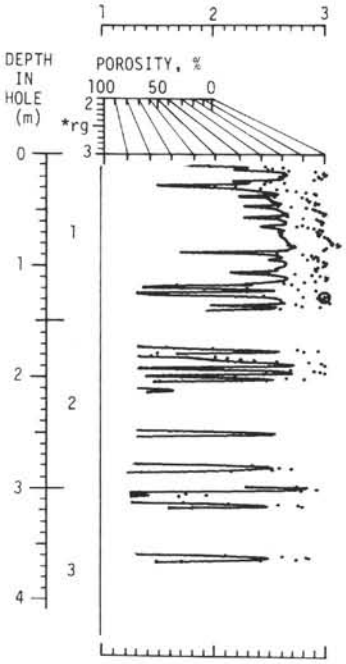
CORE 54



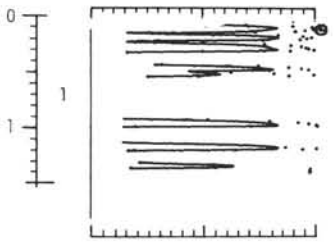
HOLE 462A
CORE 55



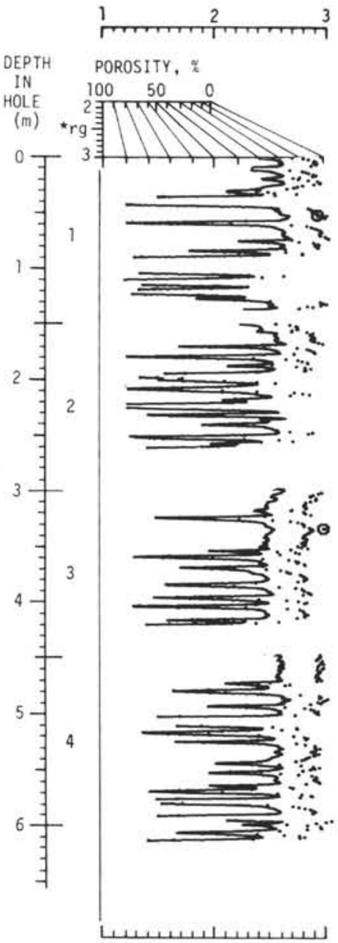
HOLE 462A
CORE 56



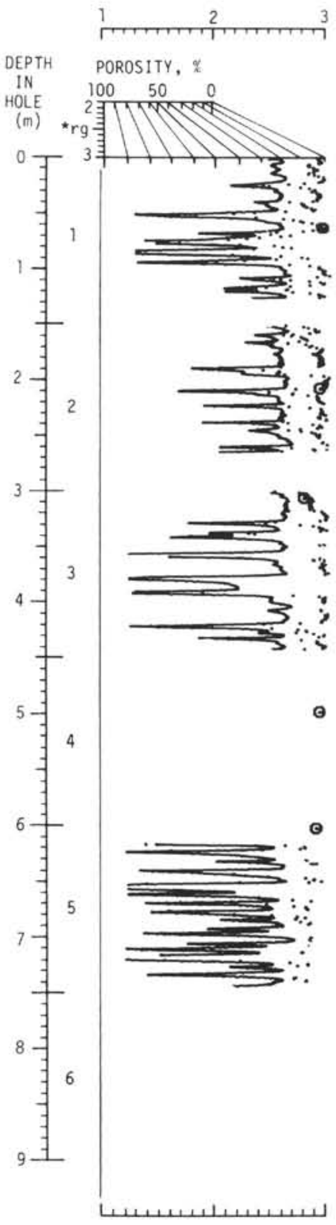
HOLE 462A
CORE 57



HOLE 462A
CORE 58



HOLE 462A
CORE 59



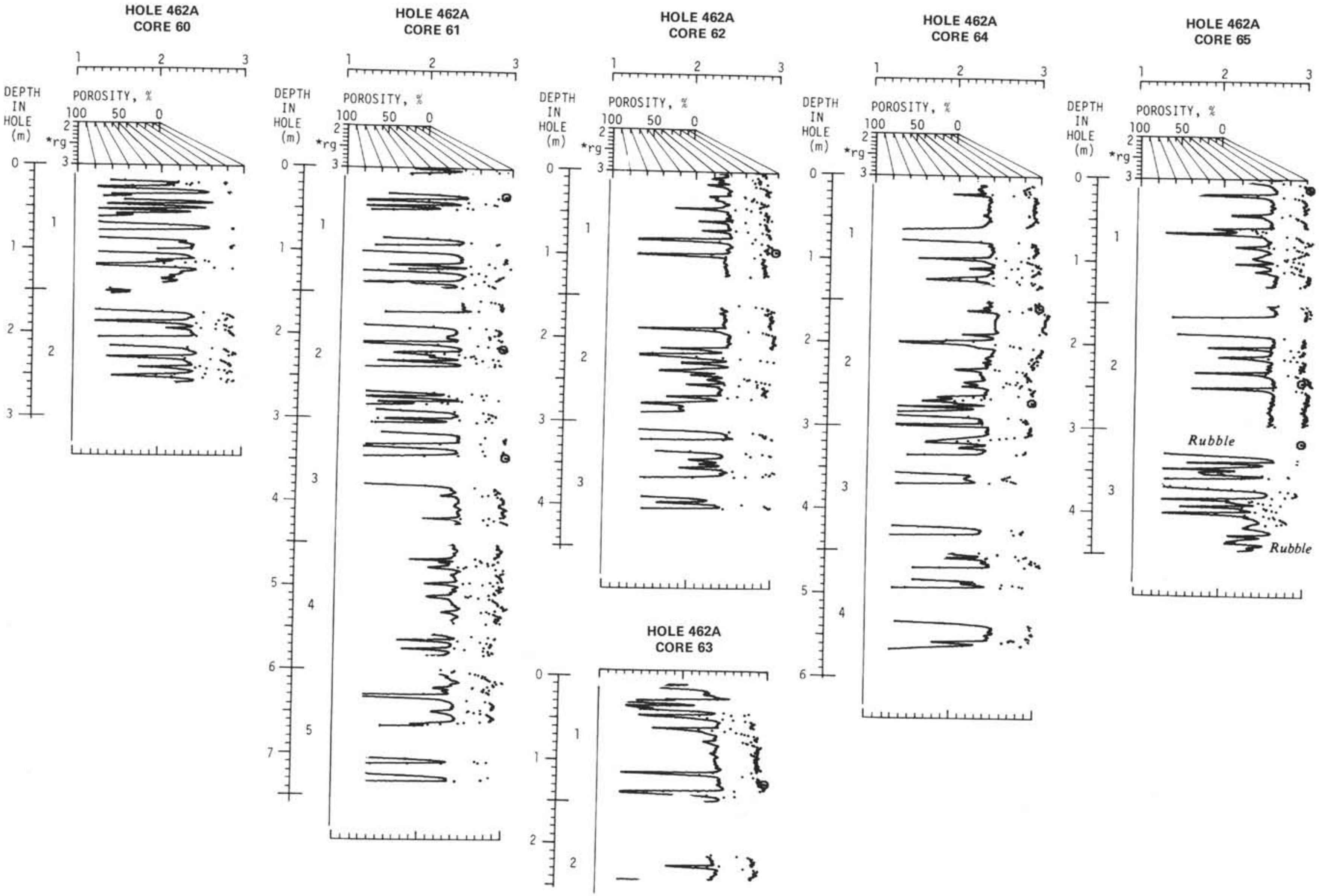
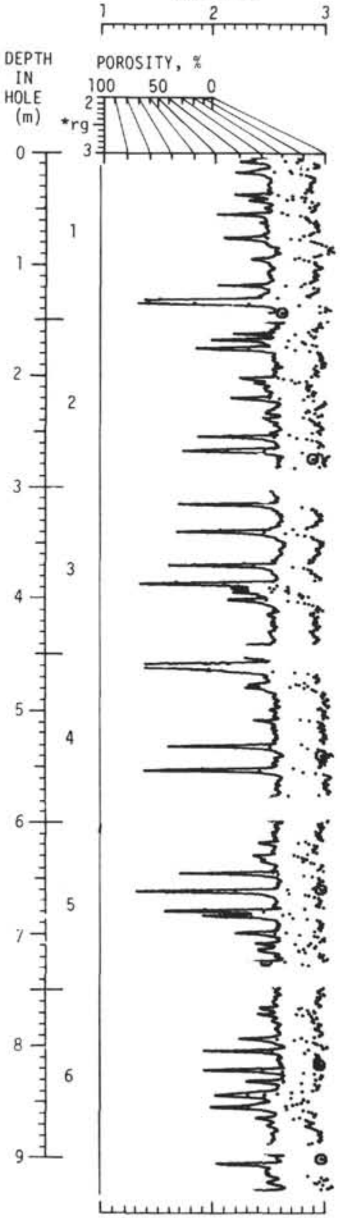
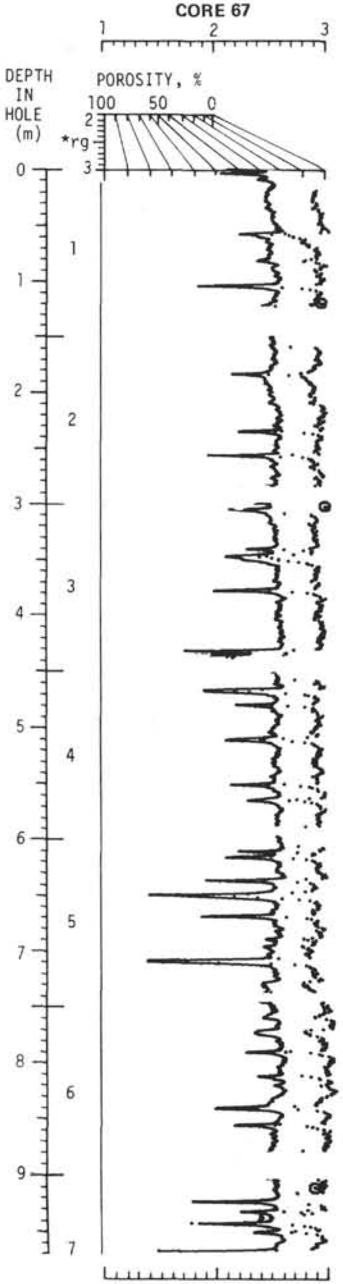


Figure 48. (Continued).

HOLE 462A CORE 66



HOLE 462A CORE 67



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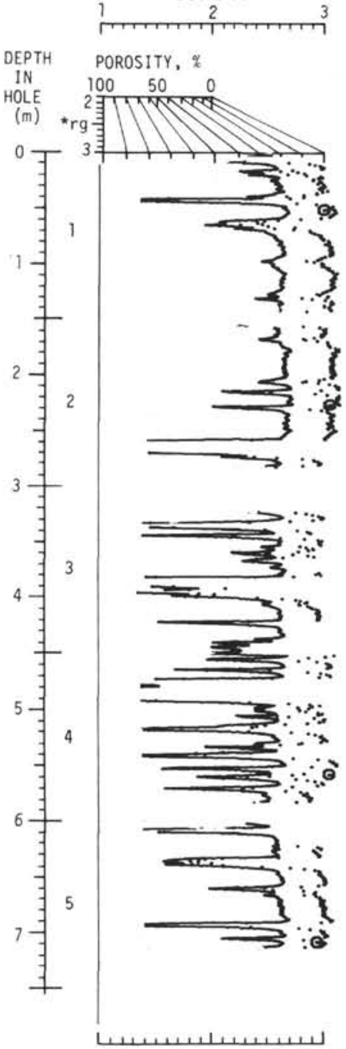
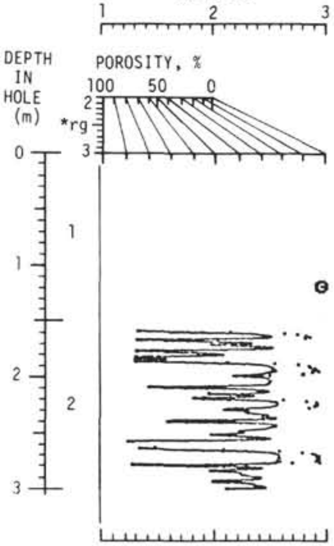
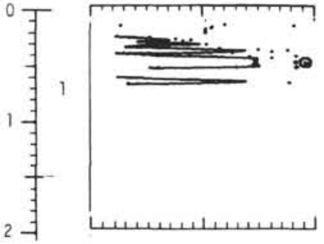


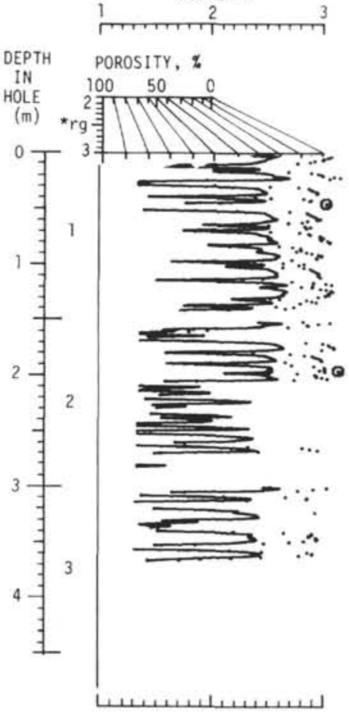
HOLE 462A CORE 70



HOLE 462A CORE 71



HOLE 462A CORE 72



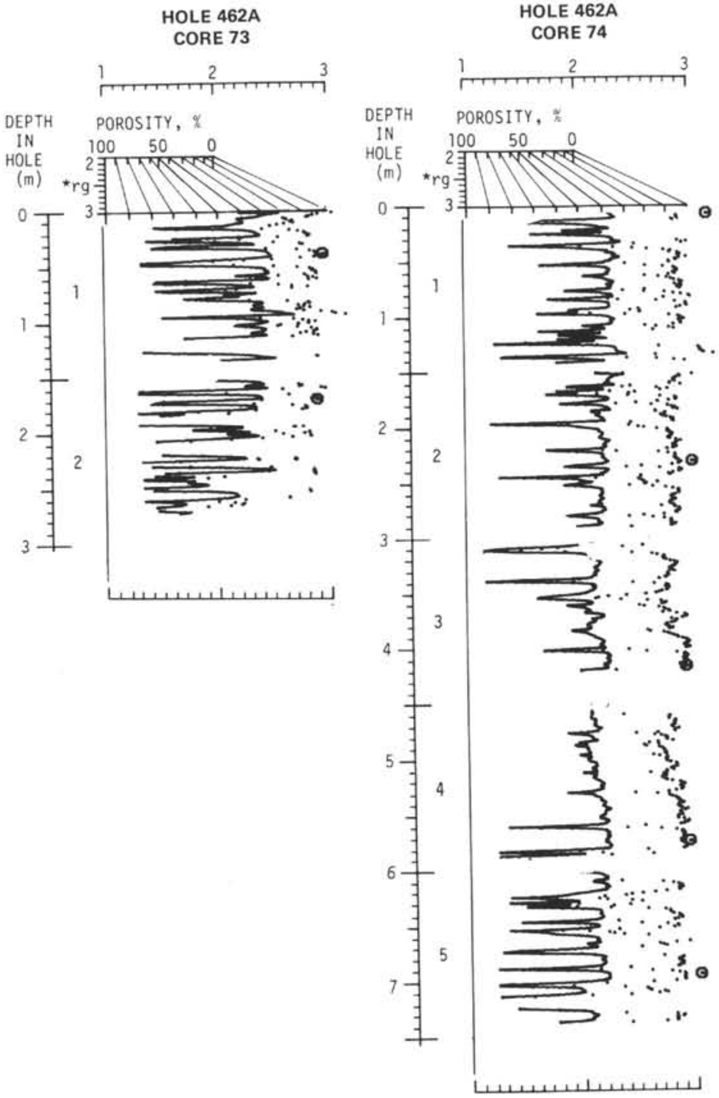


Figure 48. (Continued).

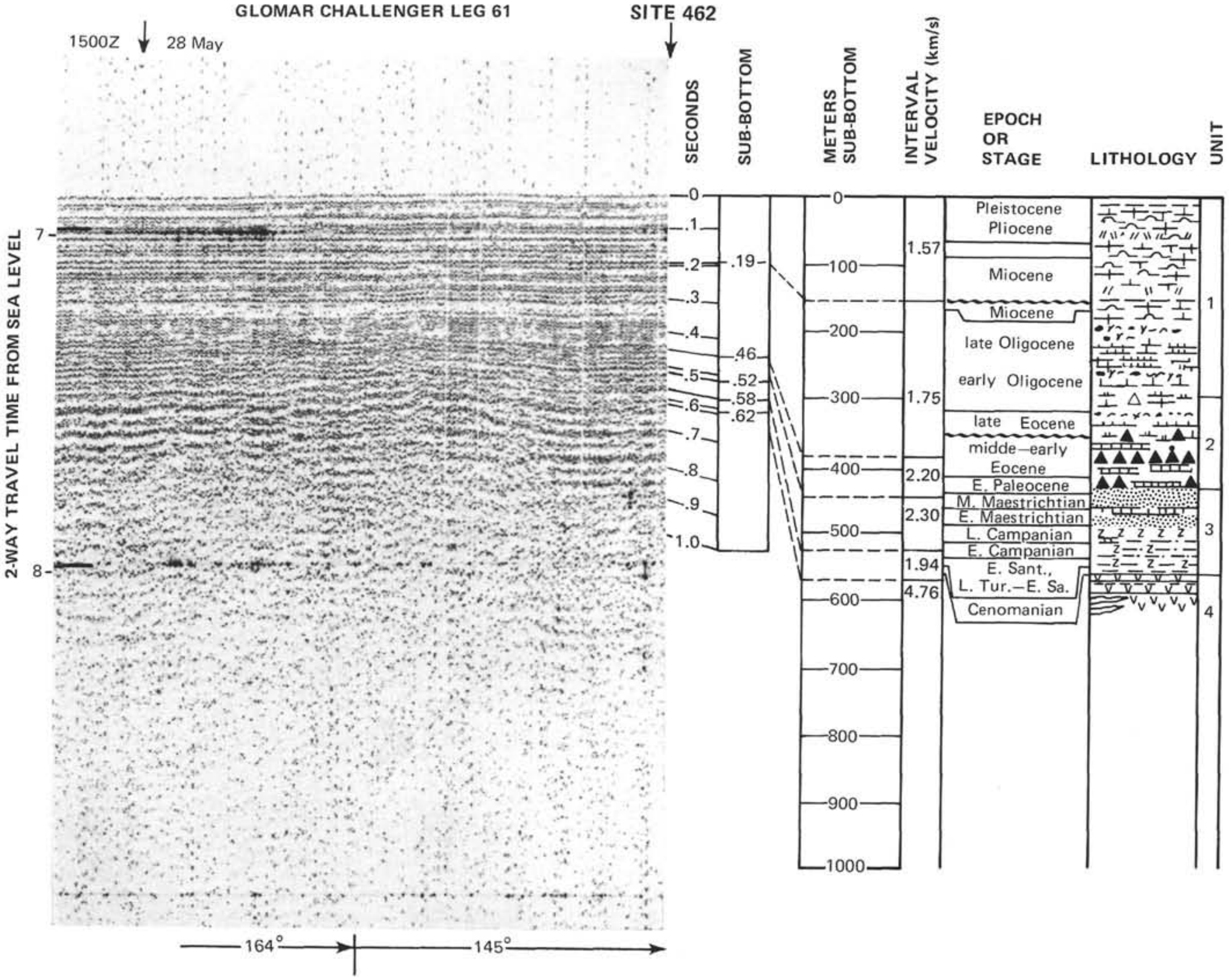


Figure 49. Correlation of drilling results and seismic data.

basic textures. Their thicknesses range from a few tens of centimeters to over 50 meters. Multiple sills are more difficult to distinguish, but where fine-grained to glassy apophyses are present, multiple intrusion can be demonstrated on a small scale; on larger scales, it has been inferred from the presence of alternating fine-grained and coarser-grained units which lack glassy margins.

The upper part of the sill complex in Hole 462 consists of intercalated igneous and sedimentary units, the latter largely hyaloclastitic. Four of these were found in Cores 63, 64, 65, and 66, between 580 and 606 meters sub-bottom (Fig. 9). The first, stratigraphically highest of these horizons is a grayish-black to black, waxy claystone with relict hyaloclastite texture, containing abundant zeolites and fragments of dark material which may be either organic or Fe-rich material. Chemical analysis of the material (XRF) reveals a composition very similar to that of the enclosing sill, except for an elevated Mg content. The second and thickest of these sedimentary intervals comprises greenish-black siltstones to claystones which are horizontally and cross-laminated. The component particles are chiefly altered volcanic glass set in a matrix of clay that probably resulted from terminal devitrification of an igneous precursor. The material at 65-1, 0–20 cm is essentially identical to this; that at 66-1, 0–16 cm, however, is grayish-red and grayish-blue-green volcaniclastic claystones containing some fish debris.

The above-described sediments presumably are rafts or relict layers of considerable lateral extent, enveloped during emplacement of the basic sill; therefore, they are likely to have undergone considerable thermal metamorphism. The stratigraphically highest intercalation, with its black, waxy character, is similar to dark Cenomanian sediments that lie directly above the sill; these are inferred to have been deposited under reducing conditions. The grayish-red and grayish-blue-green volcaniclastic claystones, perhaps the product of an oxidizing environment, may be pre-Cenomanian. These remarks are, however, entirely unsubstantiated: much would depend on whether the intrusion had merely pried apart the sediments, or whether any material had been assimilated. Redeposition has clearly operated during forma-

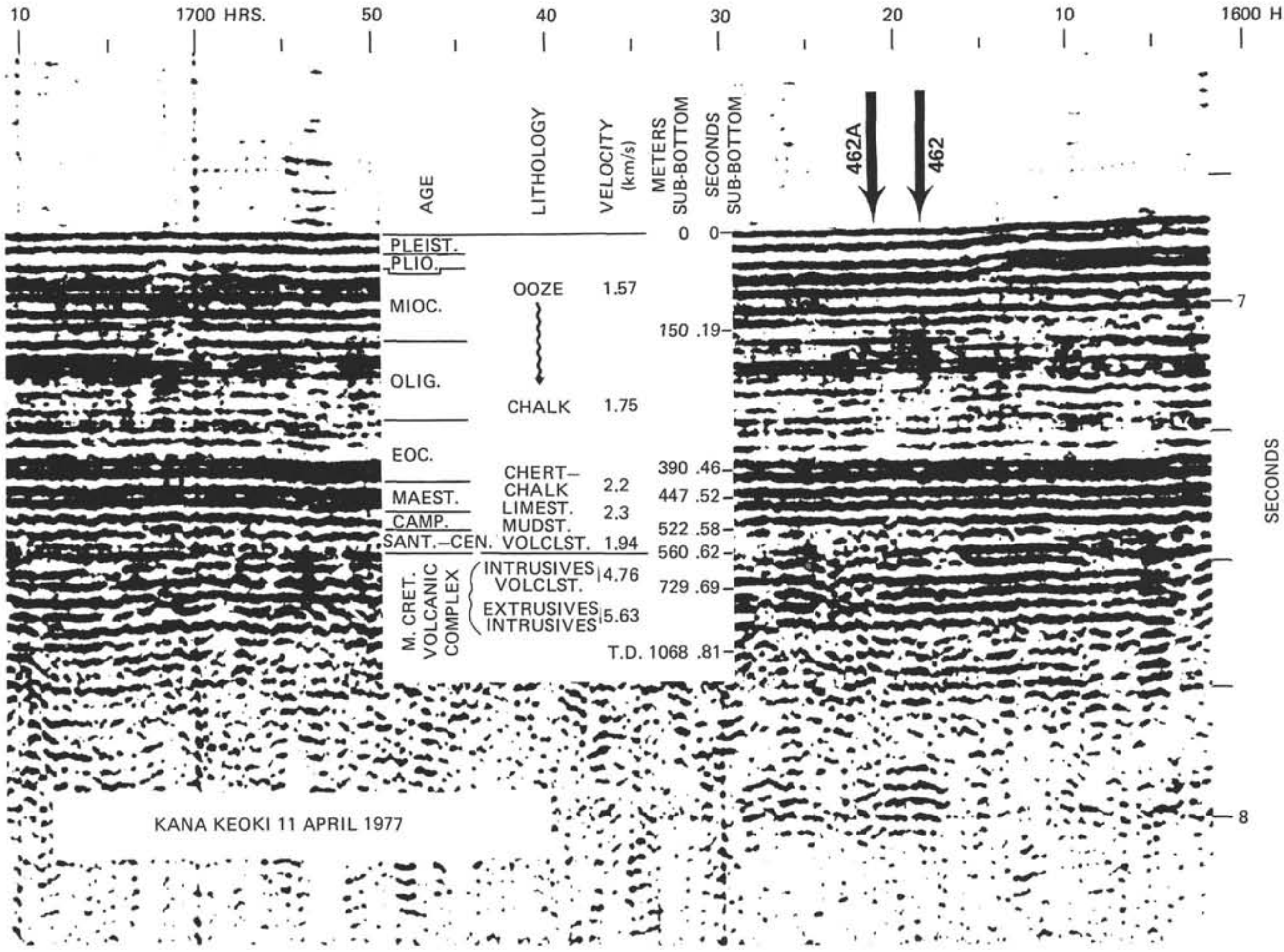


Figure 50. *Kana Keoki* seismic run, 0.5 miles north of Site 462.

tion of the cross- and horizontally laminated, greenish-black siltstones that constitute the two central intercalations. For example, in Hole 462A, Core 20, which is roughly equivalent to Cores 62 and 63 in Hole 462, volcaniclastic sandstones and siltstones show abundant grading, cross- and parallel laminations and soft-sediment deformation.

The middle 200 meters of the volcanic complex, from 730 to 930 meters, consists of sills similar to those described above, interbedded with extrusive or semi-extrusive flows. No sediments were recovered in this interval. The flows have the following characteristics: (1) variable but small thickness (0.3–2.0 m) of units; (2) thick (up to 4 cm) glassy margins on upper and lower contacts; (3) fine grain size throughout, but a patchy appearance which results from mixed textures; (4) variable attitudes of glassy margins; dips of glassy margins range from horizontal to vertical; contorted shapes, often with re-entrant surfaces are common; (5) cooling cracks normal to glassy surfaces are ubiquitous, and numerous cracks are present in the interior, crystalline portions of units; these interior cracks do not display preferred orientation; (6) inclusions and thin apophyses of fine-grained material in more-coarse-grained basalt, which suggest turbulent flow and mixing within cooling units.

These characteristics and the total lack of sediment inclusions leave little doubt that these units were extruded directly onto the sea floor; however, they have none of the characteristics of pillow lava. They lack (1) radial cooling fractures, (2) concentric structures, (3) regular curved surfaces, (4) interior hollows or vugs, and (5) inter-pillow matrix material. The mode of extrusion of these flows could be either: (1) slabby pahoehoe type, or (2) a series of shingled, lobate, narrow advancing flow fronts similar to pillow lava, but extruded more rapidly.

From 930 to 1068 meters (total depth), generally sill-type basalts were recovered, except for about 3 meters of volcaniclastic sediments at 994 to 998 meters, described below. The sills in this interval are generally thicker than those above and consist of fine- to medium-grained diabase. Below 1000 meters, the basalts are finer grained, having textures ranging from variolitic to subophitic to intergranular or intersertal. They may represent an intercalation of sills and flows, although no contacts were recovered.

At 994 meters below the sea floor, below 428 meters of almost continuous diabase, 239 cm of volcaniclastic sediment was recovered at 79-6, 80-1, and 80-2. The uppermost portion of this unit, at 79-6, is grayish red,

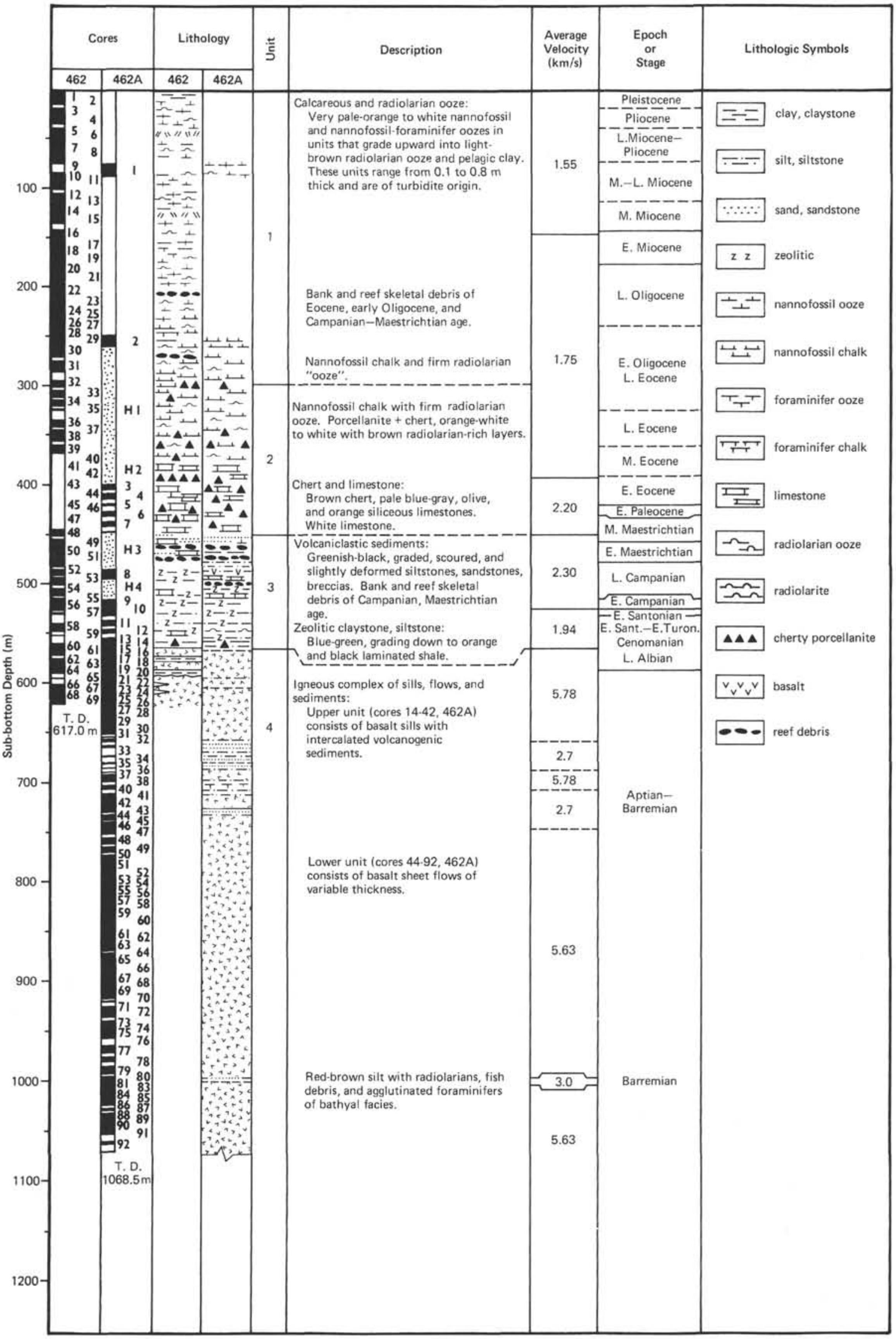


Figure 51. Columnar sections at Site 462, showing cored intervals, lithologic units, interval seismic velocities, and ages.

and the lower portion, in Core 80, is various shades of dark gray and brownish-black. Sandy and rarely pebbly siltstone occurs. This unit exhibits evidence of scour, parallel and cross-laminations, and three obvious instances of graded bedding, becoming finer upward from fairly sharp contacts. Between 42.5 and 62.5 cm in Section 80-1 is a conglomerate layer. The matrix of this unit is the same kind of sandy siltstone described above. The clasts are angular, oriented parallel to bedding, made up of "intraformational" material, and average 5 to 8 mm in size. The largest clast, at 55 cm, measures about 20 × 5 mm. Rarely, basalt pebbles occur as clasts, but no carbonate material was observed. The coarsest material in this layer occurs near the middle, from 51 to 56 cm, the grain size grading both up and down to coarse-sand size. Underlying the conglomerate is 117 cm of generally homogeneous sandy siltstone containing rare coarser and finer laminae. A second conglomerate, also containing angular clasts, occurs between 59 and 65 cm in Section 80-2. The clasts are "intraformational" material, average about 5 mm in size, and ranging up to 15 mm. Boundaries of this unit are rather abrupt. The lowest unit in this sequence is 46 cm of sandy siltstone containing faint parallel layering at 1- to 2-cm intervals. At the base of this unit is a 1- to 2-cm interval of lighter-gray material, and on one corner of the lowest piece (80-2, 101 cm) is a small amount of black, vitreous material.

Several smear slides taken along this unit reveal the sediment composition: almost entirely (95%+) very angular, shard-like, clear to olive-colored grains of smectite (nontronite?). Trace amounts (1–2% each) of glass, feldspar, and opaque minerals also occur. No carbonate grains were observed. One thin layer (80-1, 18 cm) contained Barremian radiolarians, fish debris, and an agglutinated-foraminifer assemblage. This assemblage indicates bathyal to abyssal depths of deposition. Thus, these oldest fossils, of Barremian age, recovered at Site 462 show that the Nauru Basin was perhaps 5 km deep at that time, approximately 30 m.y. after formation of the underlying basement at the site. Such a depth is not inconsistent with the depth predicted by an exponential subsidence curve.

Petrographically, the basalts are aphyric to sparsely phyric and have a few phenocrysts of clear to light-brown augite, zoned bytownite to labradorite, and occasionally olivine pseudomorphs, usually altered to green smectite. Sideromelane and augite are also often replaced by smectite. Opaque minerals are generally represented by titanomagnetite. Textures range from glassy to variolitic to diabasic, all intermediate textures being represented. In the thicker sills, patches of distinctive granophyre-facies mineralogy appear. These patches usually consist of intergrown quartz and potassium feldspar micro-pegmatite, many patches also including a colorless, acicular, prismatic phase which could be apatite.

Fracturing is common in the basalts. Most of these fractures are filled with veins containing one or more of the minerals pyrite (and marcasite), zeolite, calcite, magnetite, chlorite, various smectites, and a green clay-like mineral.

At least two major types of post-solidification alteration have probably affected the rocks: (1) sea-water alteration, which has resulted in the precipitation of smectites, calcite, zeolite, sulfides, SiO_2, Mn–Fe hydroxides; and (2) late-magmatic or deuteric processes which have resulted in the production of micro-pegmatite, amphibole, and possibly chlorite, quartz, and Fe-oxide mineralization.

About 150 samples from Holes 462 and 462A down to 953 meters were analyzed for Si, Al, Ti, Mg, Fe, Ca, and K, and about 15 for Mn and P, using shipboard XRF techniques. All analyzed samples have chemical compositions very similar to those of altered mid-ocean-ridge tholeiite, like those reported widely in the *Initial Reports* of previous DSDP legs, and elsewhere. The rocks display a narrow range of TiO_2, K_2O, MgO, CaO, and SiO_2, but unusually large variation in the abundance of Al_2O_3 and FeO in the light of the narrow variation of the other major oxides. Few of the inter-element correlations which are the hallmark of abyssal tholeiite (K–Ti, Mg–Fe, Mg–Ca, K–Ca, etc.) are observed in the rocks of Hole 462A. Those which are observed, such as TiO_2 versus FeO/MgO, display a scatter much greater than normal for oceanic tholeiite, and the abundances of TiO_2 for a given Fe/Mg are different than those usually observed. Another significant difference between the rocks of Hole 462A and mid-ocean-ridge tholeiite is the extremely low K_2O abundance of the former. Many of the analyzed samples have K_2O abundances which are comparable to those of dunite.

Holes 462 and 462A are separated by about 500 meters, and some igneous correlations can be made between the two holes. There is little doubt that the thick sill at the bottom of Hole 462 is the same sill at Hole 462A between 605 and 656 meters. In addition, some of the sediment horizons encountered at similar sub-bottom depths in both holes may be continuous between the holes. It is clear, however, that most of the thin sills of Hole 462 do not extend laterally to Hole 462A. Many of the thinner sediment horizons also appear to "lens out."

This pattern suggest significant three-dimensional lithologic heterogeneity on a scale of less than 500 meters. However, since the chemical compositions of the uppermost basalts in each hole are very similar, it is probable that they are closely related temporally. They even may have been fed by the same major conduit.

Paleomagnetism

Late Cretaceous sediments were measured on the shipboard Digico spinner magnetometer and demagnetized with the Schonstedt AF demagnetizer in an attempt to isolate the top of the Cretaceous long normal-polarity interval in Nauru Basin sediments.

Sampling of time-equivalent sections of early Campanian through Cenomanian age in Holes 462 and 462A shows the presence of the reversed interval corresponding to Anomalies 33 and 34, the end of the Cretaceous long normal-polarity interval. In addition to the reversal, there is a peculiar deviation of inclinations just preceding the termination of this reversed period. Its occurrence in both cores in precisely the same stratigraphic position suggests that it may be a real feature of the magnetic field. Scattered inclinations from Site 462 cores suggest a paleolatitude of 7°S in early Campanian to Santonian time. Sparse sampling through the Cenomanian suggests a steepening to 10° or more.

The mid-Cretaceous volcanic complex was sampled continuously to determine its magnetic properties. A plot of NRM intensity, susceptibility, stable inclination, and petrology versus depth is shown in Figure 52 that summarizes these results. The basalts show a generally strong NRM intensity that increases with depth and becomes scattered toward the bottom of the hole. The NRM inclination also steepens in this fashion, pointing to an increase in drilling remanence associated with the

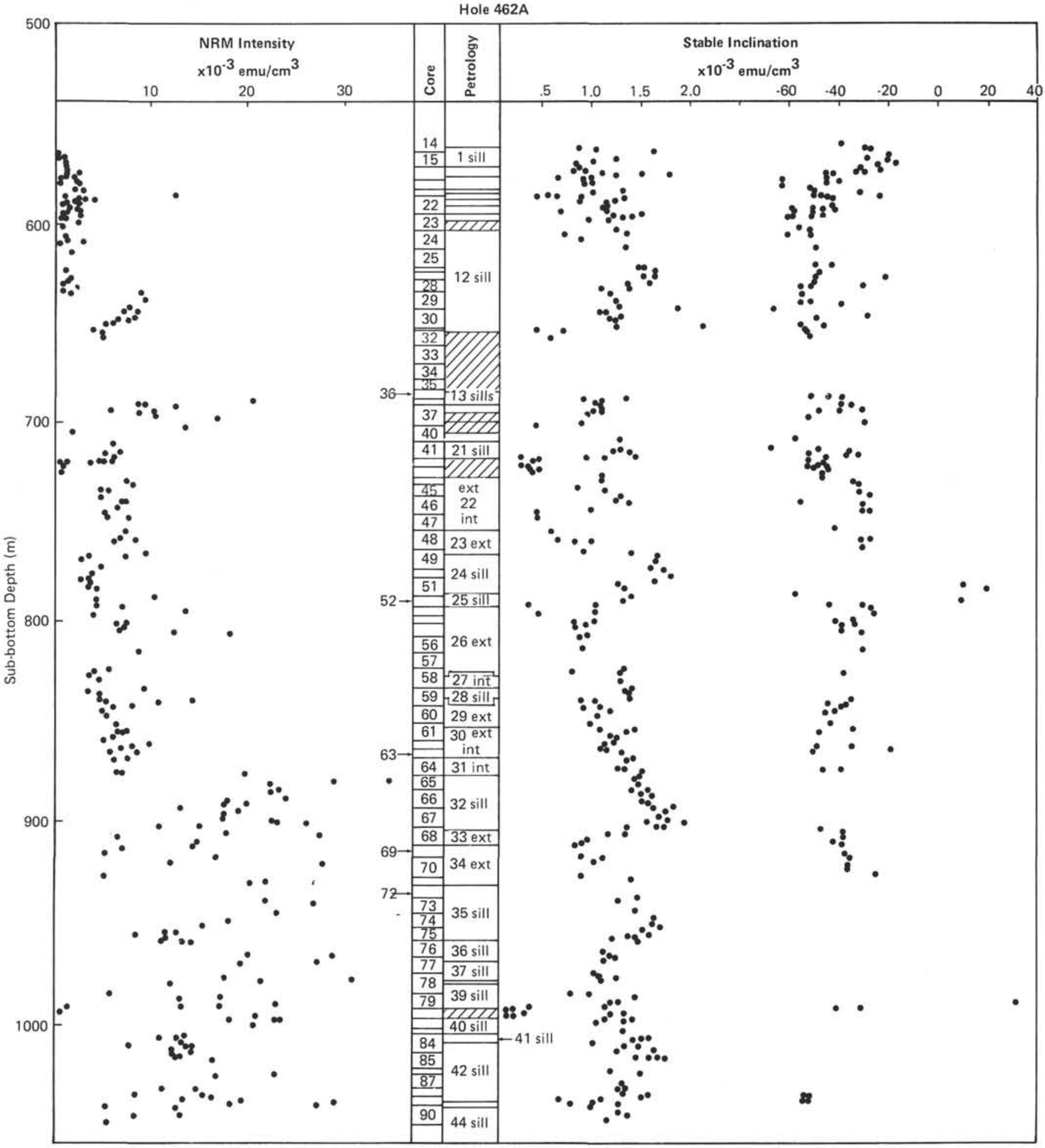


Figure 52. Paleomagnetism at Hole 462A.

lower part of the sill complex. The sills in the upper part of the section do not show this pronounced drilling remanence, for no apparent reason. The most accurate estimate of NRM intensity probably comes from the interval between 564 and 875 meters: 0.005 to 0.010 emu/cm^3.

Although the basalts are relatively strongly magnetized, this magnetization is rather soft, median destructive fields of the finer-grained rocks ranging from 80 to 120 Oe, and those of the coarser-grained samples from 20 to 70 Oe. This demagnetization lowers the NRM inclination from very steep up-hole values to "stable" inclinations that average 30 to 50° up. Many of the samples have directions that will not stabilize, but continue to decrease in inclination as stronger demagnetizing fields are applied. An inclination range of 30 to 50° corresponds to a paleolatitude of formation of 16 to 31°S, in general agreement with reconstructions by Lancelot and Larson (1975) for this region during the mid-Cretaceous. Also in agreement with the mid-Cretaceous age of the complex is its ubiquitous normal magnetization, except for one sediment sample in Core 80, at 994 meters. This volcaniclastic material is unambiguously oriented and reversely magnetized. Although it is volcaniclastic, adjacent pelagic material is Barremian, so the possibility exists that it is included material that is considerably older than most of the volcanic complex. Except for this sample, the sediments have stable inclinations well within the range of the igneous rocks. They are also characterized by relatively strong NRM intensities and MDFs considerably larger than those of the basalts.

Susceptibility is relatively larger and generally ranges from 1.0 to 1.5 $\times 10^{-3}$. There is often a distinct tendency for susceptibility to correlate with petrology, extrusive sequences showing considerably lower susceptibility than sill-type basalts.

In summary, the magnetic properties of the volcanic complex suggest that it was emplaced in a relatively short time on the Pacific Plate, at about 25°S, sometime during the mid-Cretaceous normal magnetic interval.

Regional Geology and Geophysics

Site 462 in the northern Nauru Basin is the location of a mid-Cretaceous volcanic complex at least 500 meters thick composed of sills, flows, and volcaniclastic sediments. It presumably overlies Jurassic-aged sediments and oceanic crust, as evidenced by the well-substantiated magnetic-anomaly correlations in this area. It is likely that this volcanic complex is present throughout the Nauru Basin, and it may extend to adjacent regions. Within the Nauru Basin, we correlate the presence of the volcanic complex with seismic-profiler records that show many flat-lying, low-amplitude reflections beneath the middle Eocene chert horizon. These flat-lying reflectors obscure the original basement surface, which presumably has the form of smoothed, buried, abyssal hills typical of other areas of sea floor generated at fast spreading rates. The Nauru Basin is also characterized by a lack of refracted arrivals observed on sonobuoys, and a thick unit of 3.5- to 4.5-km/s material measured with wide-angle reflections. Explosives shot to ocean-bottom seismometers recorded an abnormally thick layer (~2.5-3.0 km) characterized by upper crustal "Layer 2" velocities (~5.0-6.0 km/s). These characteristics are probably due to propagation of acoustic energy through the volcanic complex, the underlying Jurassic sediments, and Jurassic basement at Site 462.

The Cretaceous volcanic complex at Site 462 probably is between 500 and 1000 meters thick. It is likely that it thickens to the south, as evidenced by a smooth, uphill, southerly gradient that cannot be explained by age progression along a cooling curve, nor by lithospheric flexure near a subduction zone. The sea floor shoals by about 700 meters from anomaly M26 at Site 462 to anomaly M16 near Nauru Atoll, 500 km to the south. We interpret this shoaling as a thickening of the mid-Cretaceous volcanic complex that is substantially greater than the change in depth if the complex is in isostatic equilibrium.

Late Jurassic magnetic anomalies M29 to M20 are well-lineated, high-amplitude anomalies that exhibit the fine-scale features and characteristic amplitude envelope that make them recognizable lineations on a worldwide scale (see Larson and Schlanger, this volume). Although the sea floor trends uphill across these lineations, both the sea floor and the middle Eocene chert horizon remain as relatively smooth surfaces. South of M20 are anomalies M19 to M16, which are lineated but anomalously low-amplitude features; they also lack characteristic small-scale features and uniform cross-sectional shapes. The sea-floor and middle Eocene chert surfaces in this region are rough, apparently covering faults or small seamounts formed during the culmination of the mid-Cretaceous volcanic event. This thickening of the sill complex presumably has disrupted the underlying oceanic crust enough to deform the Late Jurassic magnetic signature.

Besides the Nauru Basin, the mid-Cretaceous volcanic event likely is present in other areas. The Ontong-Java Plateau to the west has Aptian basalts sampled at Site 289 that are similar in chemistry to the Site 462 igneous units. No obvious fracture zone, ridge, island chain, or other tectonic feature offsets the Nauru Basin from the Ontong-Java Plateau, so it is at least consistent with the available evidence that they represent the same volcanic event. To the east, across the Marshall Islands, drilling at Site 169 bottomed in a mid-Cretaceous sill likely related to the same event. The island chains themselves, such as the Marshalls, Gilberts, and Line Islands, may represent slightly later culminations of the mid-Cretaceous outpouring. The Mid-Pacific Mountains and the "basement" of the present-day Caribbean also appear to be related to this mid-Cretaceous volcanic event. Thus, this event appears to have regional, if not worldwide, significance (see Schlanger and Premoli Silva, this volume; Larson and Schlanger, this volume).

Returning to the mid-Cretaceous volcanic complex at Site 462 and the well-defined Jurassic magnetic anomaly pattern of that region, it may well be asked how these two features can co-exist in the same area. Although the volcanic complex is strongly magnetized with mid-Cretaceous remanent magnetization, we do not believe this is difficult to explain if viewed simply as a magnetic problem. Since the volcanic complex was emplaced during the mid-Cretaceous, it is uniformly and normally magnetized. It presumably extends over a broad area, and thus can be approximated as a uniformly magnetized slab that is horizontally infinite. Such a body will produce no magnetic anomaly, regardless of its remanent magnetic intensity, because no magnetization variation exists in any horizontal direction.

The crucial, unanswered question raised by Site 462 is the manner in which this large volume of volcanic material was subsequently injected into this area without disturbing the existing, well-defined magnetic-anomaly pattern. The igneous units at Site 462 are generally thin and fine grained to glassy, indicating emplacement at shallow depths, in close proximity to source conduits. Thus, the volcanic complex could not have its sources tens or hundreds of kilometers away and cannot be explained as having flowed in from a large horizontal distance to simply cover the underlying oceanic crust. It must have source conduits within the site survey area (100 × 100 km), which is the location of magnetic anomalies M26, M27, and M28. These anomalies are well lineated, and no fracture zones, offsets, or seamounts disturb the anomaly pattern.

The simplest and least-disruptive manner to fracture the Jurassic basement to provide local magma conduits is probably doming and tension cracking associated with thermal uplift that accompanied the Cretaceous event. If this occurred as simple pull-apart rifts, with little or no dip-slip displacement, it would at least appear possible that the fracturing could have occurred without significant disruption of the magnetic structure of the country rock.

The manner in which these Cretaceous dikes cooled is crucial, because oceanic basalt can be demagnetized at low temperatures (100–150°C) if heat is applied for long enough periods of time (10–100 yr) (see Larson and Schlanger, this volume). Thus, conductive cooling of these Cretaceous dikes alone will thermally demagnetize much of the adjacent Jurassic basement. It is possible but unlikely that the Cretaceous volcanic complex had only a few source vents, because that would require the unlikely coincidence that Site 462 is fortuitously located next to one of them. We suspect instead that the Nauru Basin was pervaded by stress cracks and dikes, and that convective cooling by sea water admitted through these tension fractures was also required to maintain the Jurassic basement below its magnetic blocking temperature for extended periods of time. The questions raised by the coexistence of the Cretaceous volcanic complex with the Jurassic magnetic-lineation patterns are considered in more detail by Larson and Schlanger (this volume).

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Plate 1. Typical subophitic texture, Section 462A-74-4 (width of photomicrograph = 3 mm).

Plate 2. Typical intergranular texture, Section 462A-90-5 (width of photomicrograph = 3 mm).

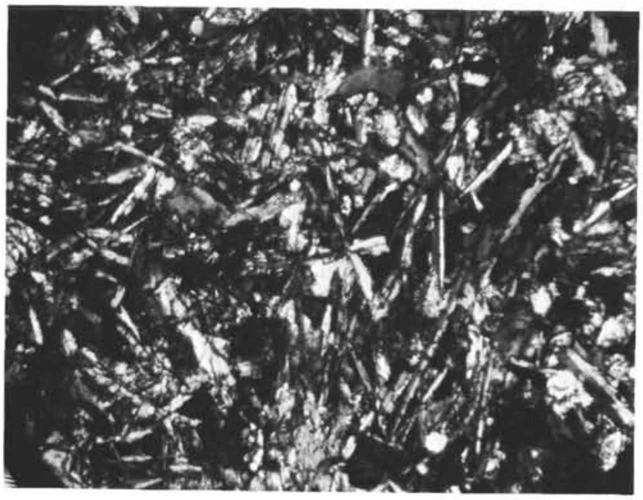


Plate 3. Typical intersertal texture, Section 462A-79-2, (width of photomicrograph = 3 mm).

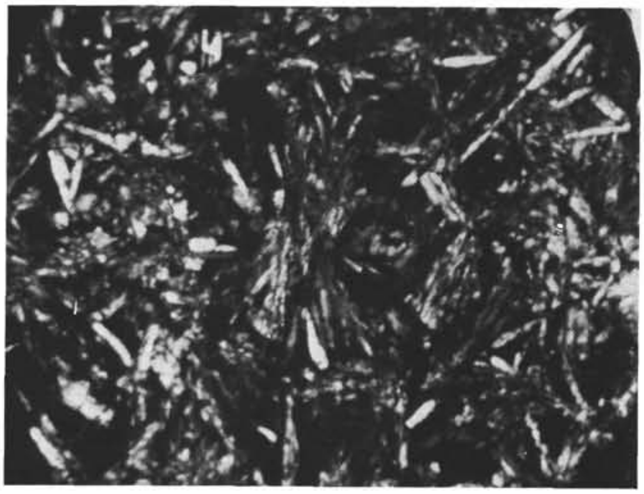


Plate 4. Typical variolitic texture, Section 462A-77-2 (width of photomicrograph = 3 mm).

Plate 5. Close up of variolite, Section 462A-89-2 (width of photomicrograph = 0.5 mm).

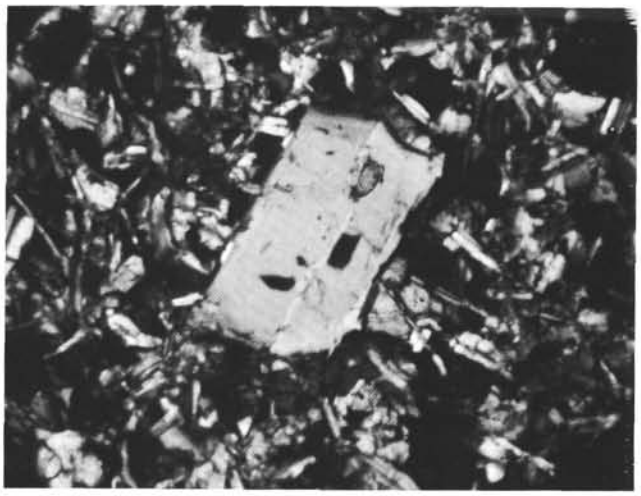


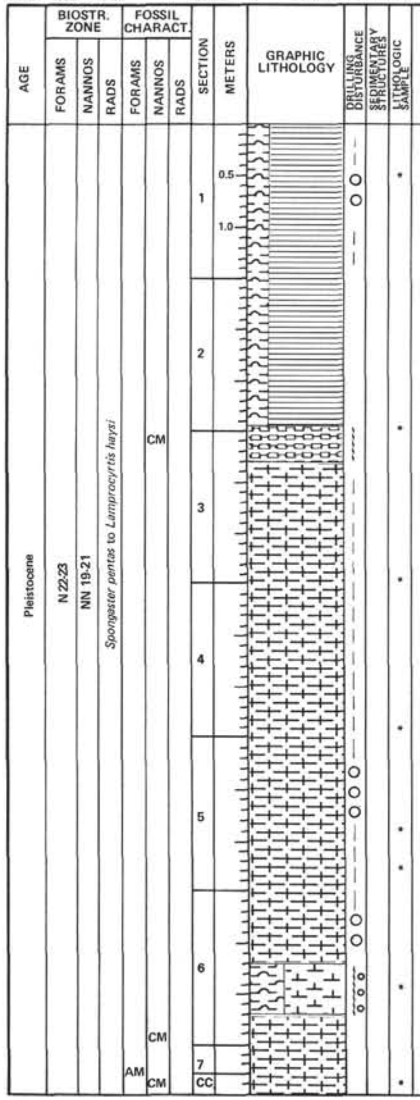
Plate 6. Plagioclase phenocryst in intergranular matrix, Section 462A-81-1 (width of photomicrograph = 3 mm).

Plate 7. Olivine pseudomorph in intersertal matrix, Section 462A-77-1 (width of photomicrograph = 3 mm).

Plate 8. Interstitial glass, Section 462A-88-2 (width of photomicrograph = 3 mm).

Plate 9. Contact of zeolite-bearing vein with basalt, Section 462A-90-1 (width of photomicrograph = 3 mm).

SITE 462 HOLE CORE 1 CORED INTERVAL: 0.5 to 10.0 m



LITHOLOGIC DESCRIPTION

0-2.98 m. SLIGHTLY SILICEOUS PELAGIC CLAY: dark yellowish brown (10YR 4/4), radiolarian rich, and homogeneous to slightly mottled.

2.98-9.5 m. CALCAREOUS OOZE: very pale orange (10YR 8/2), to white (N 9/1) homogeneous to (rare) slightly mottled or laminated nannofossil ooze to foraminifer to foraminiferal nannofossil ooze to nannofossil-foraminiferal ooze. Coarsest sediment is in soupy disturbed interval of Section 6 (nannofossil-foraminiferal ooze).

SMEAR SLIDE (%)

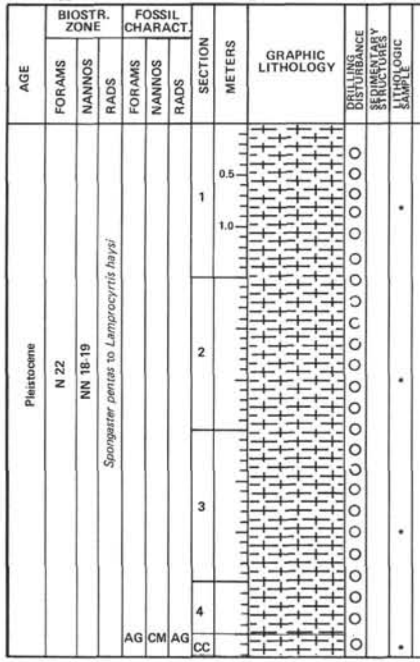
	Slightly siliceous pelagic clay	Slightly siliceous pelagic clay	Nannofossil ooze	Foraminiferal nannofossil ooze	Nannofossil ooze
TEXTURE AND MINERALS:	1-25 (D)	1-51 (M)	2-148 (D)	3-145 (D)	4-143 (D)
Sand size	14	5	0	23	0
Silt size	14	15	20	7	10
Clay size	72	80	80	70	90
Quartz	–	–	–	–	–
Feldspar	–	–	Tr	–	–
Volcanic glass	1	–	–	–	Tr
Palagonite	3	1	Tr	–	Tr
Micronodules	–	–	Tr(?)	–	–
Zeolite	–	–	–	–	Tr
Carbonate unsp.	–	–	–	–	–
Foraminifera	–	–	10	20	8
Calc. nannofossils	–	–	88	75	92
Diatoms	1	4	Tr	1	–
Radiolaria	25	12	2	3	Tr
Sponge spicules	Tr	1	–	1	Tr
Silicoflagellates	–	2	Tr	–	–
Fish remains	Tr	–	Tr	–	Tr

SMEAR SLIDE (%)

	Foraminiferal nannofossil ooze	Nannofossil ooze	Foraminiferal nannofossil ooze	Foraminiferal nannofossil ooze	Foraminiferal nannofossil ooze
TEXTURE AND MINERALS:	5-86 (M)	5-127 (M)	5-141 (M)	6-95 (M)	CC (D)
Sand size	5	2	5	25	12
Silt size	15	8	10	15	86
Clay size	80	90	85	60	2
Clay	–	Tr	–	2	2
Quartz	–	–	Tr	–	–
Feldspar	–	–	–	–	–
Volcanic glass	–	–	–	–	–
Palagonite	–	Tr	–	1	–
Micronodules	2	1	Tr	Tr	–
Zeolite	–	–	–	–	–
Carbonate unsp.	–	–	–	1	–
Foraminifera	15	8	15	35	10
Calc. nannofossils	79	90	84	59	86
Diatoms	–	–	–	–	Tr
Radiolaria	4	1	1	2	2
Sponge spicules	–	–	Tr	Tr	Tr
Silicoflagellates	–	Tr	–	–	Tr
Fish remains	Tr	–	Tr	Tr	–

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

SITE 462 HOLE CORE 2 CORED INTERVAL: 10.0 to 19.5 m



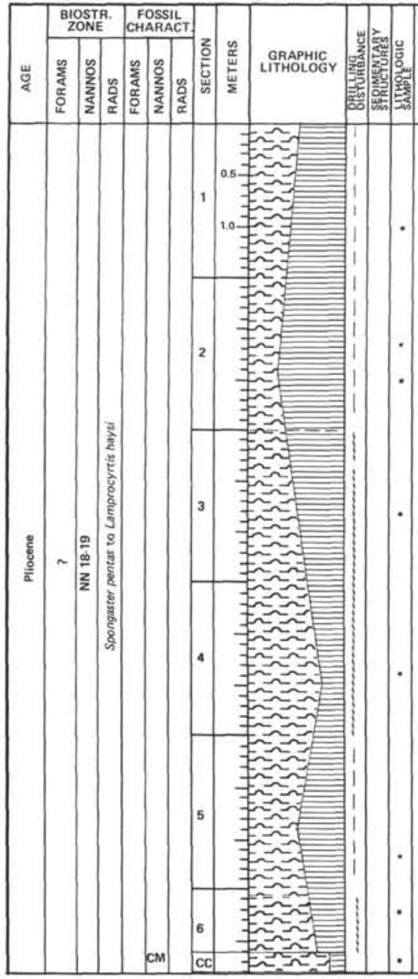
LITHOLOGIC DESCRIPTION

0-5 m. FORAMINIFERAL NANNOFOSSIL OOZE: thoroughly distributed and poured into 3.3 sections of liner.

SMEAR SLIDE (%)

	Nannofossil ooze	Foraminiferal nannofossil ooze	Foraminiferal nannofossil ooze	Foraminiferal nannofossil ooze
TEXTURE AND MINERALS:	1-80 (D)	2-100 (D)	3-100 (D)	CC (D)
Sand size	5	5	15	15
Silt size	5	5	5	5
Clay size	90	90	80	80
Heavy minerals	–	–	Tr	Tr
Foraminifera	5	5	15	15
Calc. nannofossils	93	93	83	83
Diatoms	0.5	0.5	0.5	0.5
Radiolaria	1	1	1	1
Sponge spicules	0.5	0.5	0.5	0.5
Silicoflagellates	–	Tr	–	–
Fish remains	–	–	Tr	Tr

SITE 462 HOLE CORE 3 CORED INTERVAL: 19.5 to 29.0 m



LITHOLOGIC DESCRIPTION

0-3 m. SILICEOUS MUD: dark yellowish brown (10YR 4/4), homogeneous, and radiolarian-rich.

Gradational Boundary

3.0-8.1 m. RADIOLARIAN OOZE: dark yellowish brown (10YR 4/4) and clay-rich.

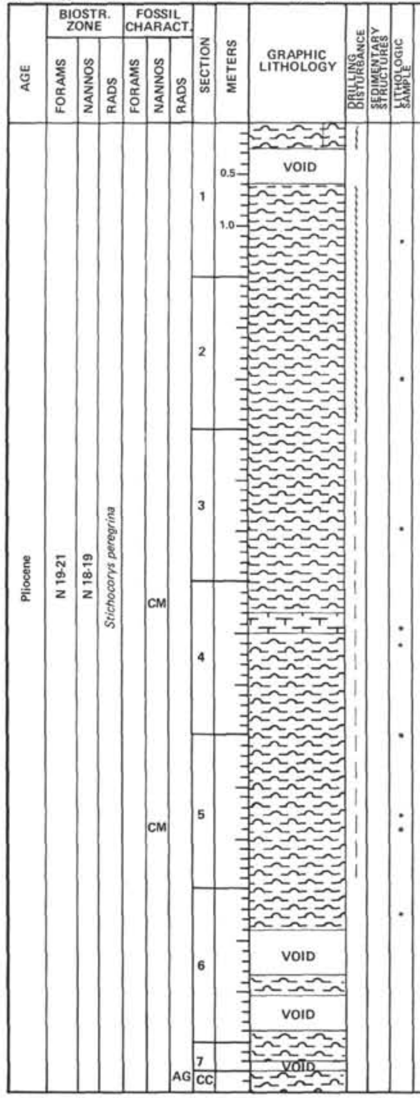
SMEAR SLIDE (%)

	Siliceous mud	Siliceous mud	Siliceous mud	Siliceous mud
TEXTURE AND MINERALS:	1-100 (D)	2-64 (M)	2-100 (D)	3-80 (D)
Sand size	10	3	3	3
Silt size	30	27	27	39
Clay size	60	70	70	58
Clay	60	60	68	58
Pyrite	1	–	1	1
Micronodules	1	–	1	1
Zeolite	Tr	–	Tr	–
Foraminifera	–	–	–	–
Calc. nannofossils	–	–	–	–
Diatoms	15	40	8	10
Radiolaria	15		15	20
Sponge spicules	8		7	10
Silicoflagellates	Tr		Tr	Tr
Carbonate unsp.	–	–	–	–

SMEAR SLIDE (%)

	Siliceous ooze	Siliceous ooze	Siliceous ooze	Siliceous ooze
TEXTURE AND MINERALS:	4-90 (D)	5-120 (D)	6-20 (D)	CC (D)
Sand size	10	3	10	5
Silt size	60	57	60	85
Clay size	30	40	30	10
Clay	30	40	30	5
Pyrite	Tr	Tr	Tr	Tr
Micronodules	–	–	–	–
Zeolite	–	–	–	–
Foraminifera	–	–	–	Tr
Calc. nannofossils	–	–	–	5
Diatoms	15	10	10	40
Radiolaria	50	40	50	40
Sponge spicules	5	10	10	7
Silicoflagellates	Tr	Tr	Tr	Tr
Carbonate unsp.	–	–	–	3

SITE 462 HOLE CORE 4 CORED INTERVAL: 29.0 to 38.5 m



LITHOLOGIC DESCRIPTION

0.0-4.8 m. RADIOLARIAN OOZE: dark yellowish brown (10YR 4/4) with rare intervals of slight mottling.
4.8-5.0 m. NANNOFOSSIL OOZE: very pale orange (10YR 8/2).
5.0-5.15 m. ASHY FORAMINIFERAL SAND: laminated light yellowish brown (10YR 6/4) and dark gray (10YR 4/1).
5.15-7.6 m. RADIOLARIAN OOZE: as above.

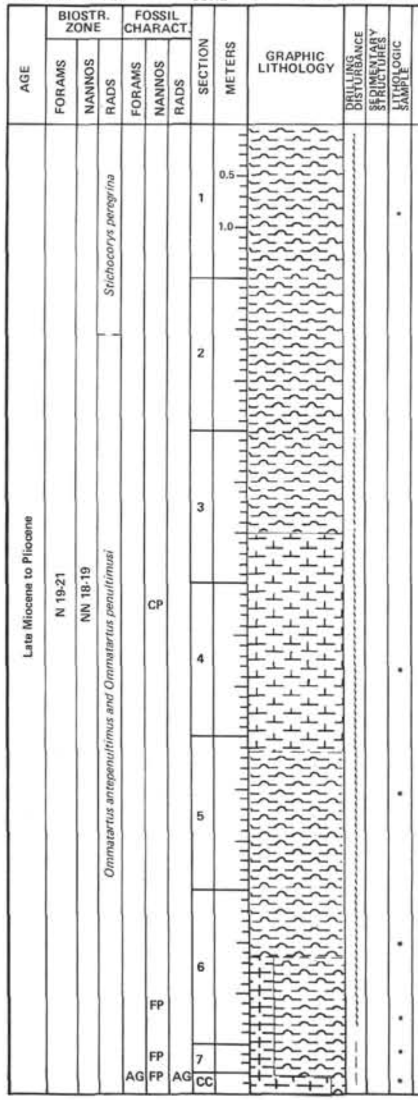
SMEAR SLIDE (%)

	Siliceous ooze	Siliceous ooze	Siliceous ooze	Nannofossil ooze	Ashy foraminiferal sand
TEXTURE AND MINERALS:	1-110 (M)	2-100 (D)	3-100 (D)	4-40 (M)	4-53 (M)
Sand size	10	5	5	5	45
Silt size	85	90	90	15	45
Clay size	5	5	5	80	10
Clay	5	5	5	–	–
Feldspar	–	–	–	–	6
Mica	–	–	–	–	
Heavy minerals	–	–	–	–	
Hornblende	–	–	–	–	–
Apatite	–	–	–	–	–
Magnetite	–	–	–	–	–
Volcanic glass	–	–	–	–	3
Palagonite	–	–	–	–	1
Micronodules	–	–	–	–	30
Zeolite	–	–	–	–	–
Carbonate unsp.	–	–	–	–	10
Foraminifera	–	–	–	–	40
Calc. nannofossils	–	–	–	93	2
Diatoms	15	25	25	2	–
Radiolaria	70	60	60	4	2
Sponge spicules	10	10	10	1	1
Silicoflagellates	Tr	Tr	Tr	Tr	–
Fish remains	–	–	–	–	Tr
Pyrite	–	–	–	–	–

SMEAR SLIDE (%)

	Volcanic ash	Foraminiferal ooze	Slightly siliceous nannofossil ooze	Siliceous ooze
TEXTURE AND MINERALS:	5-4 (M)	5-70 (M)	5-95 (M)	6-20 (D)
Sand size	10	53	1	5
Silt size	90	15	9	87
Clay size	–	32	90	8
Clay	10	–	–	8
Feldspar	2	–	–	–
Mica	–	–	–	–
Heavy minerals	–	–	–	–
Hornblende	Tr	–	–	–
Apatite	Tr	–	–	–
Magnetite	15	–	–	–
Volcanic glass	61	Tr	–	–
Palagonite	5	–	–	–
Micronodules	–	–	–	–
Zeolite	1	–	–	–
Carbonate unsp.	3	–	–	–
Foraminifera	2	50	Tr	–
Calc. nannofossils	Tr	47	92	–
Diatoms	–	–	2	30
Radiolaria	0.5	3	5	50
Sponge spicules	0.5	–	1	12
Silicoflagellates	–	–	–	Tr
Fish remains	–	–	–	–
Pyrite	Tr	–	–	–

SITE 462 HOLE CORE 5 CORED INTERVAL: 38.5 to 48.0 m



LITHOLOGIC DESCRIPTION

0.0-4.0 m. RADIOLARIAN OOZE: dark yellowish brown (10YR 4/2), moderately to slightly mottled brownish yellow (10YR 7/6), clay-rich, and diatom-rich.
4.0-6.15 m. NANNOFOSSIL OOZE: very pale brown (10YR 7/3), mottles and drilling diapirs of lighter tints (to 10YR 8/2); and parts rich in radiolaria.

Gradational Boundary

6.15-9.5 m. RADIOLARIAN OOZE: dark yellowish brown (10YR 7/6). Considerable calcareous component below 8.2 m, in irregular deformed masses. Considerable carbonate and glass in the core-catcher sample.

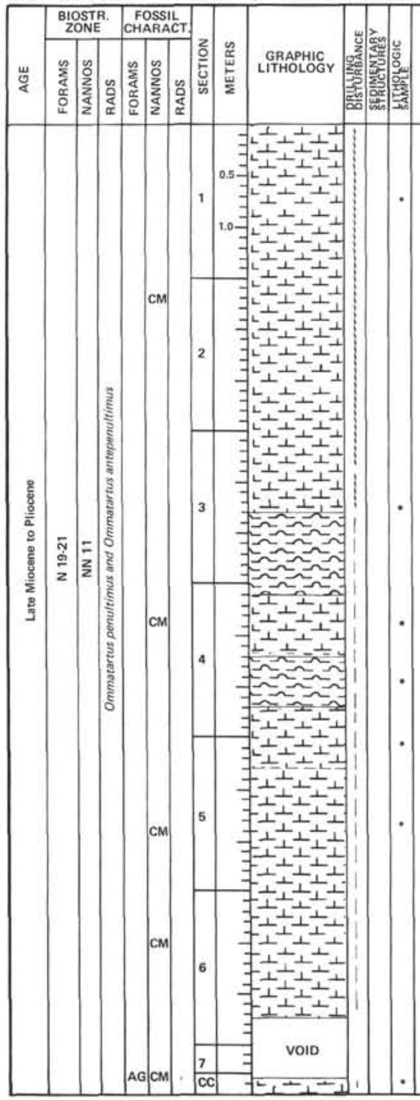
SMEAR SLIDE (%)

	Siliceous ooze	Nannofossil ooze	Slightly siliceous nannofossil ooze	Radiolarian ooze
TEXTURE AND MINERALS:	1-80 (D)	3-142 (M)	4-80 (D)	5-50 (D)
Sand size	5	–	20	20
Silt size	80	5	50	60
Clay size	15	95	30	20
Clay	15	–	–	5
Feldspar	–	–	–	–
Heavy minerals	–	–	–	–
Volcanic glass	–	–	–	Tr
Palagonite	–	–	–	Tr
Carbonate unsp.	–	–	20	–
Foraminifera	–	–	10	–
Calc. nannofossils	–	95	60	–
Diatoms	20	0.5	Tr	15
Radiolaria	50	3	5	75
Sponge spicules	15	1.5	5	4
Silicoflagellates	Tr	–	–	Tr
Fish remains	–	–	–	1

SMEAR SLIDE (%)

	Radiolarian ooze	Calcareous radiolarian ooze	Radiolarian nannofossil ooze	Ashy slightly siliceous foraminiferal nannofossil ooze
TEXTURE AND MINERALS:	6-50 (D)	6-120 (D)	7-10 (M)	CC (D)
Sand size	25	40	25	30
Silt size	60	40	25	40
Clay size	15	20	50	30
Clay	5	5	–	–
Feldspar	–	–	–	1
Heavy minerals	–	–	–	3
Volcanic glass	–	–	–	5
Palagonite	–	–	–	–
Carbonate unsp.	–	1	–	40
Foraminifera	–	10	10	15
Calc. nannofossils	–	15	50	28
Diatoms	15	5	2	Tr
Radiolaria	75	60	35	5
Sponge spicules	5	3	2	3
Silicoflagellates	Tr	Tr	–	–
Fish remains	Tr	1	1	–

SITE 462 HOLE CORE 6 CORED INTERVAL: 48.0 to 57.5 m



LITHOLOGIC DESCRIPTION

0.0-38.0 m. ASHY NANNOFOSSIL OOZE: greenish gray (5G 6/1) with local smears of white, 10 cm at base is coarser ground.
3.8-4.6 m. RADIOLARIAN OOZE: greenish gray (10GY 5/2), locally moderate mottles.
4.6-5.2 m. NANNOFOSSIL OOZE: nearly white (N9), with light gray (N8) to light greenish gray (5GY 6/1) mottles.
5.2-5-7 m. RADIOLARIAN OOZE: as in 3.8-4.6 m above.
5.7-6.3 m. NANNOFOSSIL OOZE: as in 4.6-5.2 m above.

Gradational Contact

6.3-8.8 m. NANNOFOSSIL OOZE: very pale orange (10YR 8/2).

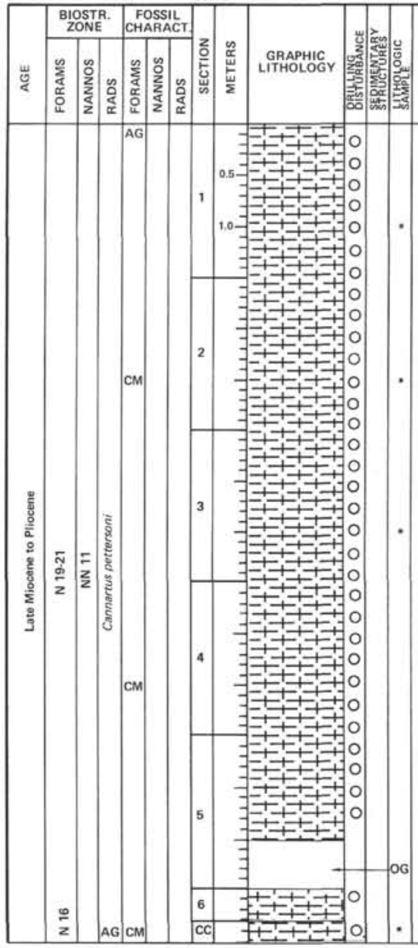
SMEAR SLIDE (%)

	Ashy nannofossil ooze	Ashy nannofossil ooze	Radiolarian nannofossil ooze	Radiolarian ooze
TEXTURE AND MINERALS:	1-70 (D)	3-77 (D)	4-40 (D)	4-93 (D)
Sand size	5	20	–	3
Silt size	35	50	5	75
Clay size	60	30	95	22
Clay	5	–	Tr	5
Heavy minerals	–	1	–	–
Volcanic glass	15	10	Tr	–
Zeolite	–	–	Tr	–
Carbonate unsp.	Tr	13	–	–
Foraminifera	10	10	–	–
Calc. nannofossils	62	60	95	Tr
Diatoms	Tr	Tr	–	–
Radiolaria	5	3	5	95
Sponge spicules	3	3	Tr	–
Silicoflagellates	Tr	–	–	Tr
Fish remains	Tr	–	Tr	–

SMEAR SLIDE (%)

	Nannofossil ooze	Nannofossil ooze	Nannofossil ooze
TEXTURE AND MINERALS	5-11 (D)	5-83 (D)	CC (D)
Sand size	2	–	5
Silt size	50	80	75
Clay size	48	20	20
Clay	–	–	–
Heavy minerals	–	–	–
Volcanic glass	–	–	–
Zeolite	–	–	–
Carbonate unsp.	–	–	–
Foraminifera	5	2	5
Calc. nannofossils	94	98	94
Diatoms	Tr	–	–
Radiolaria	Tr	Tr	0.5
Sponge spicules	1	–	0.5
Silicoflagellates	–	–	–
Fish remains	–	–	–

SITE 462 HOLE CORE 7 CORED INTERVAL: 57.5 to 67.0 m



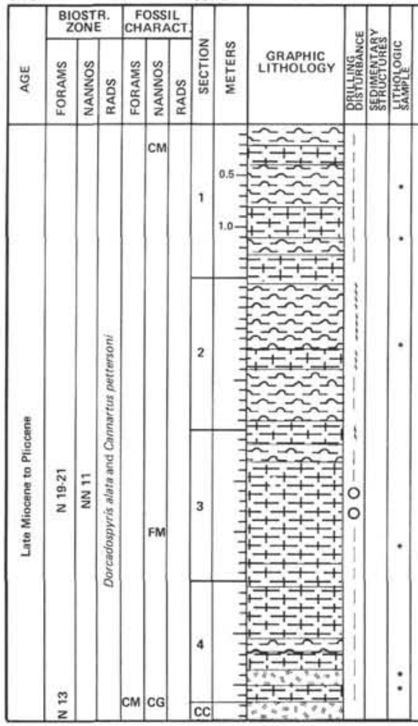
LITHOLOGIC DESCRIPTION

0.0-8.6 m. FORAMINIFERAL NANNOFOSSIL OOZE to NANNOFOSSIL FORAMINIFERAL OOZE: pinkish gray (5YR 8/1) to pinkish white (5YR 9/1), all soupy from intense drilling disturbance. Below 2.0 m the core is richer in foraminifers and is more "sandy" in texture.

SMEAR SLIDE (%)

	Foraminiferal nannofossil ooze	Nannofossil foraminiferal ooze	Nannofossil foraminiferal ooze	Foraminiferal ooze
TEXTURE AND MINERALS	**1-100 (D)**	**2-100 (D)**	**3-100 (D)**	**CC (D)**
Sand size	20	30	30	30
Silt size	40	50	50	50
Clay size	40	20	20	20
Foraminifera	25	50	50	55
Calc. nannofossils	74	48	48	45
Radiolaria	0.5	1	1	–
Sponge spicules	0.5	1	1	–

SITE 462 HOLE CORE 8 CORED INTERVAL: 67.0 to 76.5 m



LITHOLOGIC DESCRIPTION

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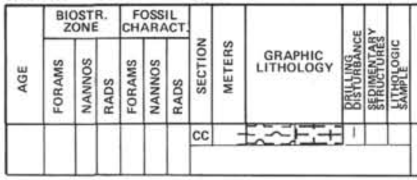
0.0-5.4 m. Alternations of RADIOLARIAN OOZE AND NANNOFOSSIL-FORAMINIFERAL OOZE: radiolarian ooze is moderate brown (5YR 4/4), calcareous ooze is very pale orange (10YR 8/2), all are moderately to intensely deformed by drilling giving "diapir-like" arched contacts and streaked mottles.
5.4-5.5 m. Lumpy, clay-rich SILICEOUS CALCAREOUS OOZE to lithic volcaniclastic, probably ASH: mixed pale orange (10YR 8/2), dusky brown (5YR 2/2).
5.5-5.6 m. CALCAREOUS OOZE: as above.
5.6-5.7 m. Core-Catcher and this interval same as 5.4-5.5 m above.

SMEAR SLIDE (%)

	Radiolarian ooze	Nannofossil foraminiferal ooze	Slightly siliceous nannofossil ooze	Nannofossil foraminiferal ooze	Foraminiferal nannofossil radiolarian ooze	Calcareous volcanic ash
TEXTURE AND MINERALS	**1-60 (D)**	**1-110 (D)**	**2-60 (D)**	**3-115 (D)**	**4-95 (M)**	**4-99**
Sand size	50	30	10	20	40	20
Silt size	35	40	50	50	10	70
Clay size	15	30	40	30	50	10
Clay	15	–	3	2	22	–
Heavy minerals	Tr	–	–	–	Tr	Tr
Volcanic glass	Tr	–	–	–	–	30
Carbonate unsp.	–	–	–	–	–	5
Foraminifera	Tr	50	Tr	50	10	5
Calc. nannofossils	–	48	80	45	30	30
Diatoms	10	–	2	–	4	Tr
Radiolaria	65	1	10	3	30	Tr
Sponge spicules	10	1	5	Tr	2	Tr
Silicoflagellates	–	–	–	–	2	–
Opaque lithic grains of volcanic origin	–	–	–	–	–	30

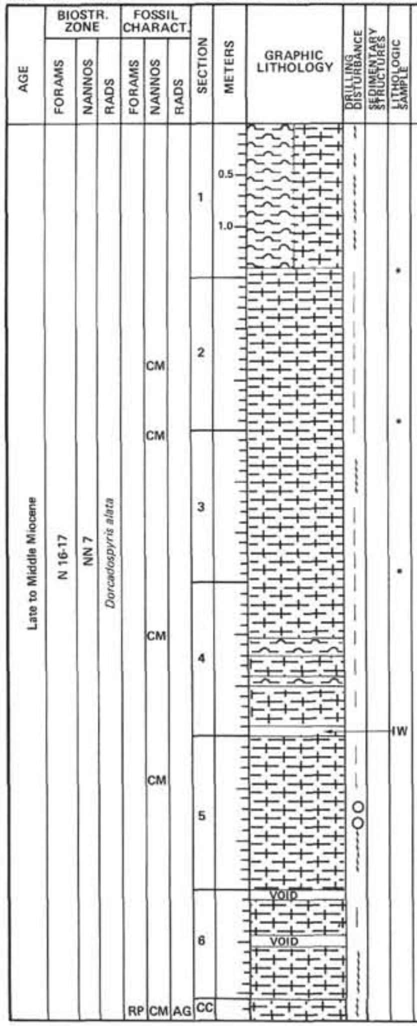
SITE 462 HOLE CORE 9 CORED INTERVAL: 76.5-86.0 m



LITHOLOGIC DESCRIPTION

Core-Catcher only: Mixed masses of pale orange (10YR 9/2) **CALCAREOUS** and moderate brown (5YR 4/4) **RADIOLARIAN OOZES.**

SITE 462 HOLE CORE 10 CORED INTERVAL: 86.0 to 95.5 m



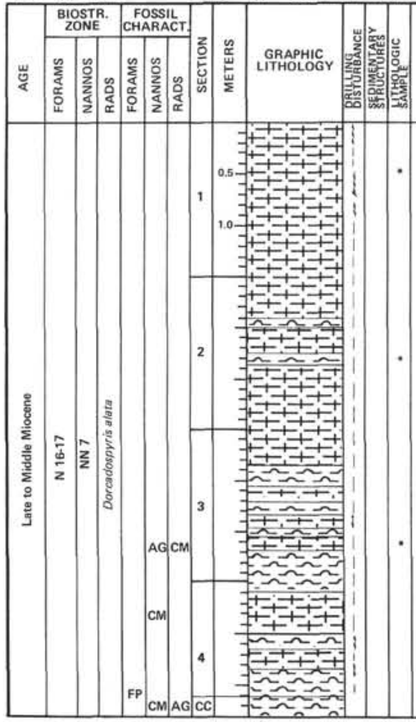
LITHOLOGIC DESCRIPTION

0.0-8.6 m. Interlayered **CALCAREOUS AND RADIOLARIAN OOZES:** Mainly **NANNOFOSSIL OOZE**, very pale orange (10YR 8/2), some whiter and more foraminifer rich; some is **RADIOLARIAN OOZE**, moderate brown (10YR 4/4) to brownish yellow (10YR 5/6). Top 1.4 m is intensely disturbed. Below 1.4 m, mottles and layers, all moderately to intensely disturbed, of radiolarian ooze are in calcareous ooze.

SMEAR SLIDE (%)

	Nannofossil foraminiferal ooze	Nannofossil ooze	Nannofossil ooze	Radiolarian ooze
TEXTURE AND MINERALS	**1-141 (M)**	**2-142 (D)**	**3-61 (M)**	**3-143 (D)**
Sand size	10	1	40	–
Silt size	70	60	50	–
Clay size	20	39	10	–
Clay	–	–	10	–
Volcanic glass	–	–	–	Tr
Carbonate unsp.	–	–	Tr	1
Foraminifera	30	1	–	10
Calc. nannofossils	70	97	–	85
Diatoms	–	–	5	–
Radiolaria	Tr	2	75	3
Sponge spicules	–	Tr	10	1
Fish remains	–	Tr	–	–

SITE 462 HOLE CORE 11 CORED INTERVAL: 95.5 to 105.0 m



LITHOLOGIC DESCRIPTION

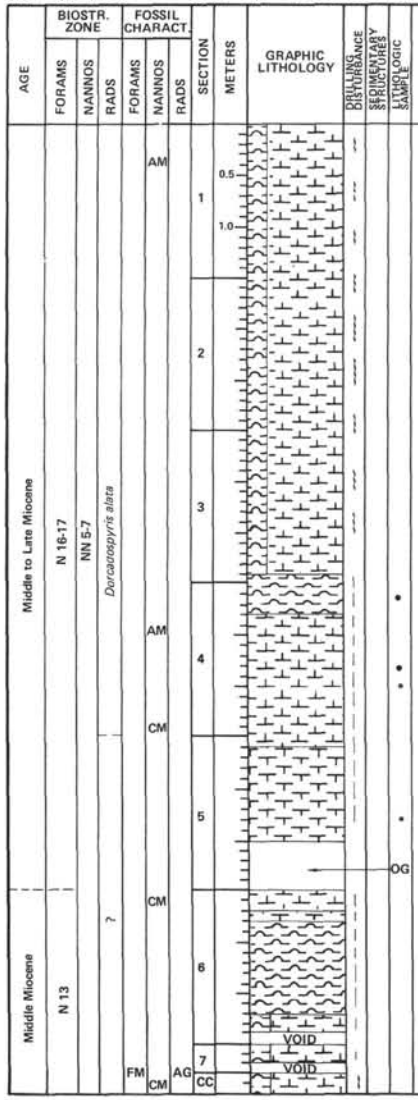
0.0-5.6 m. Interlayered **CALCAREOUS AND RADIOLARIAN OOZES:** Mainly **NANNOFOSSIL OOZE**, very pale orange (10YR 8/2) to moderate orange pink (5YR 8/4), to nearly white (N9) and foraminifer-rich. There are interlayers and mottles of moderate brown (5YR 3/4) **RADIOLARIAN OOZE**.

SMEAR SLIDE (%)

	Nannofossil ooze	Radiolarian ooze	Nannofossil foraminiferal ooze
TEXTURE AND MINERALS	**1-50 (D)**	**2-179 (D)**	**3-115 (M)**
Sand size	10	77	–
Silt size	10	3	–
Clay size	80	20	–
Clay	–	18	–
Foraminifera	2	–	35
Calc. nannofossils	90	3	63
Diatoms	1	2	–
Radiolaria	4	70	1*
Sponge spicules	3	6	–
Silicoflagellates	–	1	–
Fish remains	–	–	1

*Fragments

SITE 462 HOLE CORE 12 CORED INTERVAL: 105.0 to 114.5 m



LITHOLOGIC DESCRIPTION

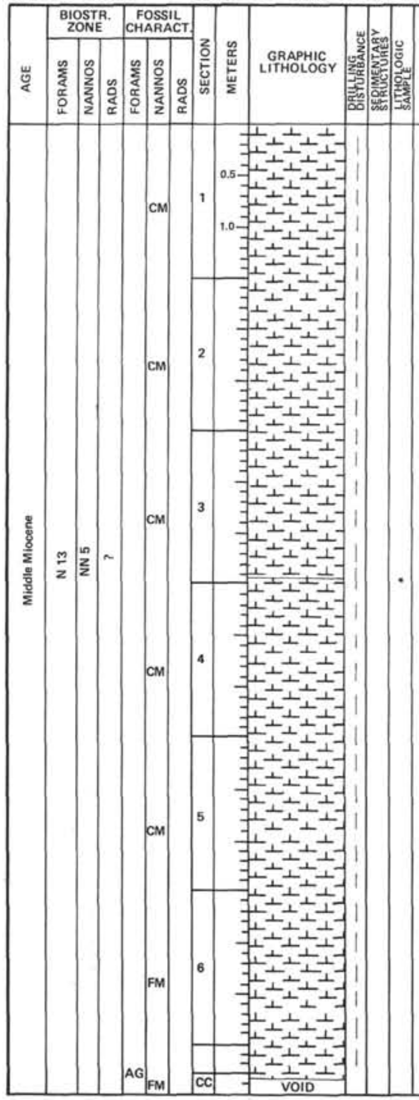
0.0-9.2 m. Interlayered **CALCAREOUS AND RADIOLARIAN OOZE.**
0.0-4.4 m. Mixed moderate yellowish brown (10YR 5/4) **RADIOLARIAN OOZE** with pale orange (10YR 8/2) **NANNOFOSSIL OOZE,** intensely disturbed.
4.4-4.8 m. Moderate yellowish brown (10YR 5/4) **RADIOLARIAN OOZE.**
4.8-6.1 m. Pale orange (10YR 8/2) **NANNOFOSSIL OOZE.**
6.1-7.0 m. White (N9) **FORAMINIFERAL OOZE.**
7.5-7.8 m. Same as 4.8-6.1 m.
7.7-7.8 m. Same as 6.1-7.0 m.
7.8-8.7 m. Same as 4.4-4.8 m.
8.7-9.24 m. Same as 0.0-4.4 m.

SMEAR SLIDE (%)

	Radiolarian ooze	Nannofossil ooze	Foraminiferal ooze
TEXTURE AND MINERALS	4-18 (D)	4-100 (D)	5-86 (D)
Sand size	80	10	20
Silt size	4	10	40
Clay size	16	80	40
Light volcanic glass	–	–	1
Carbonate unsp.	–	20	–
Foraminifera	–	5	55
Calc. nannofossils	2	70	42
Diatoms	1	–	–
Radiolaria	75	5	2
Sponge spicules	5	–	Tr
Silicoflagellates	1	–	–
Clay	16	–	–

CARBONATE BOMB: (% $CaCO_3$)
4, 16-19 cm: 24
4, 75-77 cm: 88

SITE 462 HOLE CORE 13 CORED INTERVAL: 114.5 to 124.0 m



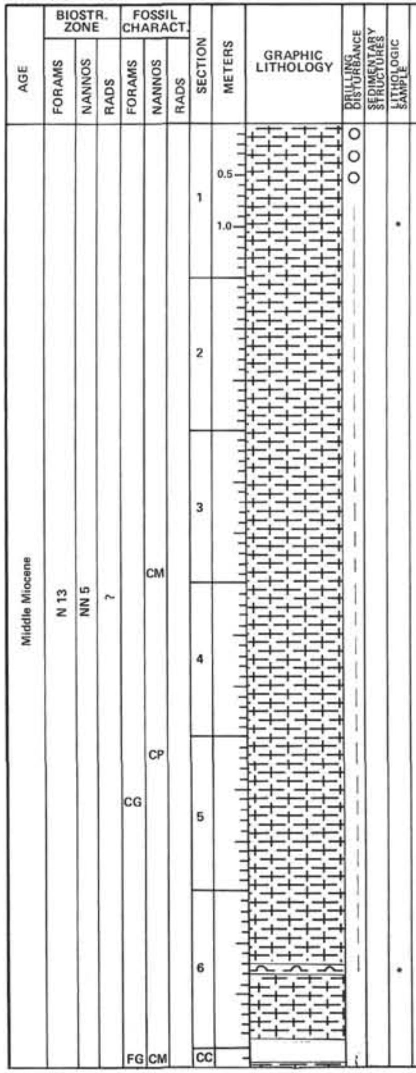
LITHOLOGIC DESCRIPTION

0.0-4.45 m. Grayish orange (10YR 7/4) **NANNOFOSSIL OOZE** with ~5-10% mottles of brown (10YR 5/4) **RADIOLARIAN OOZE** and white (N9) **FORAMINIFERAL OOZE.**
4.45-9.33 m. Mottles are less frequent and are confined to 10 to 20 cm thick layers within mottle-free grayish orange (10YR 7/4) **FORAMINIFERAL NANNOFOSSIL OOZE.**

SMEAR SLIDE (%)

	Foraminiferal nannofossil ooze
TEXTURE AND MINERALS	3-146
Sand size	15
Silt size	15
Clay size	70
Foraminifera	15
Calc. nannofossils	75
Radiolaria	10
Silicoflagellates	Tr

SITE 462 HOLE CORE 14 CORED INTERVAL: 124.0 to 133.5 m



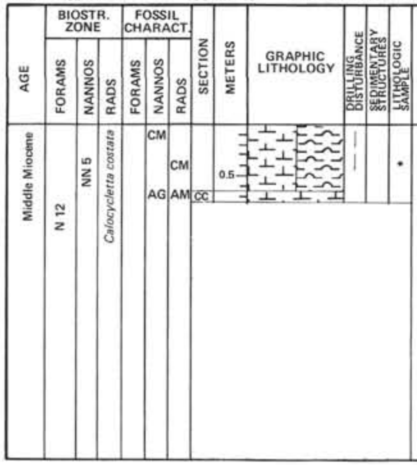
LITHOLOGIC DESCRIPTION

0.0-9.0 m. CALCAREOUS OOZE: Very pale orange (10YR 8/2), slightly mottled (with small mottles) white (N9) to moderate brown (10YR 5/4) **FORAMINIFERAL-NANNOFOSSIL to NANNOFOSSIL-FORAMINIFERAL OOZE.** Browner mottles (and disturbed bed at 8.2 m) are **RADIOLARIAN OOZE.**

SMEAR SLIDE (%)

	Foraminiferal nannofossil ooze	Slightly siliceous nannofossil ooze	Radiolarian ooze
TEXTURE AND MINERALS	1-100 (D)	5-90 (D)	6-75 (M)
Sand size	15	30	10
Silt size	35	30	75
Clay size	50	40	15
Clay	–	5	7
Heavy minerals	–	–	Tr
Volcanic glass	–	–	Tr
Zeolite	–	–	2
Foraminifera	20	30	–
Calc. nannofossils	75	45	Tr
Radiolaria	5	20	90
Sponge spicules	Tr	Tr	Tr
Fish remains	–	Tr	1

SITE 462 HOLE CORE 15 CORED INTERVAL: 133.5 to 143.0 m



LITHOLOGIC DESCRIPTION

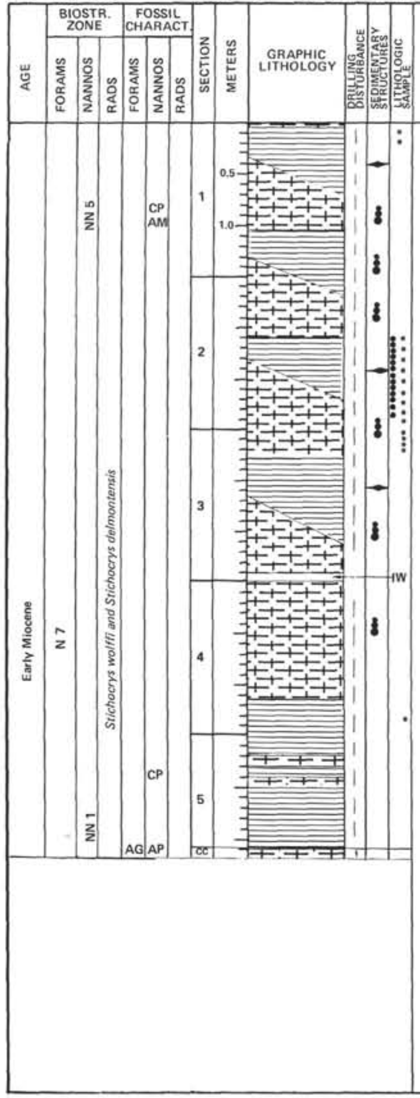
0.0-0.70 m. Mixed moderate brown (10YR 5/4) **RADIOLARIAN OOZE,** grayish orange (10YR 7/4) **NANNOFOSSIL OOZE,** and pale orange (10YR 8/2) **FORAMINIFERAL OOZE.**

0.07-0.8 m. Lapilli-bearing and ash-bearing mixed, moderate brown (10YR 5/4) **RADIOLARIAN OOZE** and grayish orange (10YR 7/4) **NANNOFOSSIL OOZE.**

SMEAR SLIDE (%)

	Nannofossil Ooze	Nannofossil Ooze
TEXTURE AND MINERALS	1-30 (D)	CC-3 (D)
Sand size	15	–
Silt size	45	–
Clay size	50	–
Clay	–	–
Volcanic glass (clear)	1	1
Foraminifera	5	–
Calc. nannofossils	85	94
Radiolaria	10	5
Sponge spicules	Tr	Tr
Fish remains	Tr	

SITE 462 HOLE CORE 16 CORED INTERVAL: 143.0 to 152.5 m



LITHOLOGIC DESCRIPTION

0.0-5.65 m. GRAIN-SIZE GRADED (COARSER AT BASE) BEDS (TURBIDITES) of nannofossil ooze grading upward into pelagic clay. Bases at 0.5 m, 1.05 m, 2.15 m, 3.30 m, and 5.65 m. Pale orange (10YR 8/2) **NANNOFOSSIL to FORAMINIFERAL-NANNOFOSSIL OOZE** and very dark grayish brown (10YR 3/2) stiff **PELAGIC CLAY,** moderately siliceous, some zeolites, mottled and slight to moderate drilling disturbance.

5.65-7.1 m. Same lithologies as in 0.0-5.65 m interval, but more distinct interbeds of slightly **SILICEOUS PELAGIC CLAY and FORAMINIFERAL-NANNOFOSSIL OOZE.**

SMEAR SLIDE (%)

	Foraminiferal nannofossil ooze	Siliceous pelagic clay	Siliceous pelagic clay	Siliceous nannofossil ooze	Siliceous nannofossil ooze	Siliceous nannofossil ooze	Siliceous nannofossil ooze	Siliceous nannofossil ooze
TEXTURE AND MINERALS	1-2 (D)	1-15 (D)	2-62 (D)	2-72 (D)	2-82 (D)	2-92 (D)	2-102 (D)	2-112 (D)
Sand size	50	10	15	10	10	10	10	15
Silt size	20	10	25	40	60	60	60	70
Clay size	30	80	60	50	30	30	30	15
Clay	–	86	60	5	5	5	2	2
Heavy minerals	Tr	Tr	–	–	–	–	Tr	–
Volcanic glass	Tr*	Tr*	–	–	–	–	–	–
Zeolite	–	2	Tr	–	Tr	Tr	–	–
Carbonate unsp.	–	–	1	–	–	–	–	–
Foraminifera	30	–	1	–	–	–	1	3
Calc. nannofossils	70	1	1	74	80	80	87	75
Diatoms	–	–	Tr	–	–	–	–	–
Radiolaria	Tr	10	18	10	7	7	5	15
Sponge spicules	Tr	–	18	10	8	8	5	5
Fish remains	Tr	1	1	1	Tr	Tr	Tr	Tr

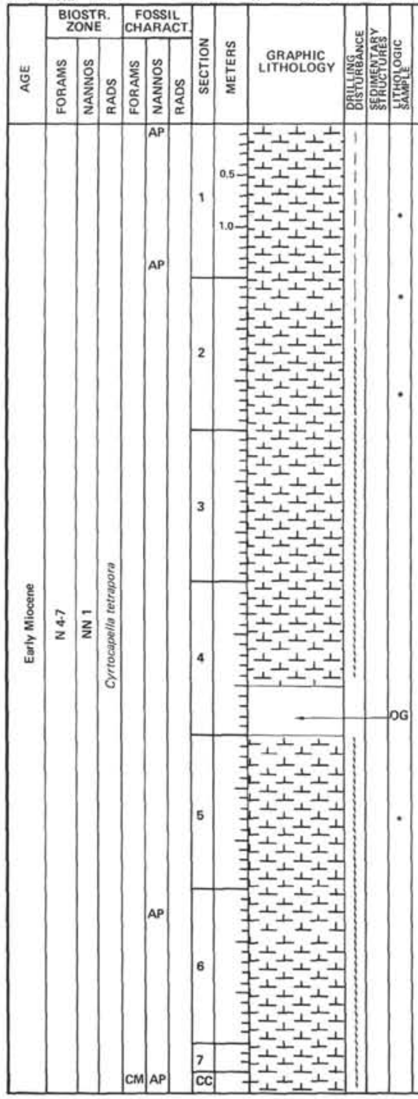
SMEAR SLIDE (%)

	Siliceous nannofossil ooze	Foraminiferal nannofossil ooze	Foraminiferal nannofossil ooze	Foraminiferal nannofossil ooze	Foraminiferal nannofossil ooze	Siliceous foraminiferal ooze	Siliceous foraminiferal ooze	Pelagic zeolitic clay
TEXTURE AND MINERALS	2-122 (D)	2-132 (D)	2-142 (D)	3-2 (D)	3-11 (D)	3-18 (D)	3-25 (D)	4-130 (D)
Sand size	15	20	20	20	20	20	25	–
Silt size	70	70	70	70	70	70	60	5
Clay size	15	10	10	10	10	10	15	95
Clay	2	–	–	–	–	–	–	85
Heavy minerals	–	–	–	–	–	–	–	–
Volcanic glass	–	Tr	Tr	Tr	–	–	–	–
Zeolite	–	–	–	–	–	–	–	10
Carbonate unsp.	–	–	–	–	–	–	–	–
Foraminifera	5	20	20	20	15	20	20	–
Calc. nannofossils	73	74	74	74	77	57	57	–
Diatoms	–	–	–	–	–	–	–	–
Radiolaria	15	3	3	3	5	20	20	5
Sponge spicules	5	3	3	3	3	3	3	–
Fish remains	Tr	Tr	Tr	Tr	Tr	Tr	Tr	Tr

CARBONATE BOMB (% $CaCO_3$)

2, 63-65 cm: 5%
2, 74-76 cm: 40%
2, 85-87 cm: 56%
2, 99-101 cm: 62%
2, 109-111 cm: 71%
2, 119-121 cm: 73 %
2, 129-131 cm: 74%
2, 139-141 cm: 80%
2, 148-150 cm: 79%
3, 1-3 cm: 83%
3, 8-10 cm: 81%
3, 19-21 cm: 81%
3, 29-57 cm: 81%

SITE 462 HOLE CORE 17 CORED INTERVAL: 152.5 to 162.0 m



LITHOLOGIC DESCRIPTION

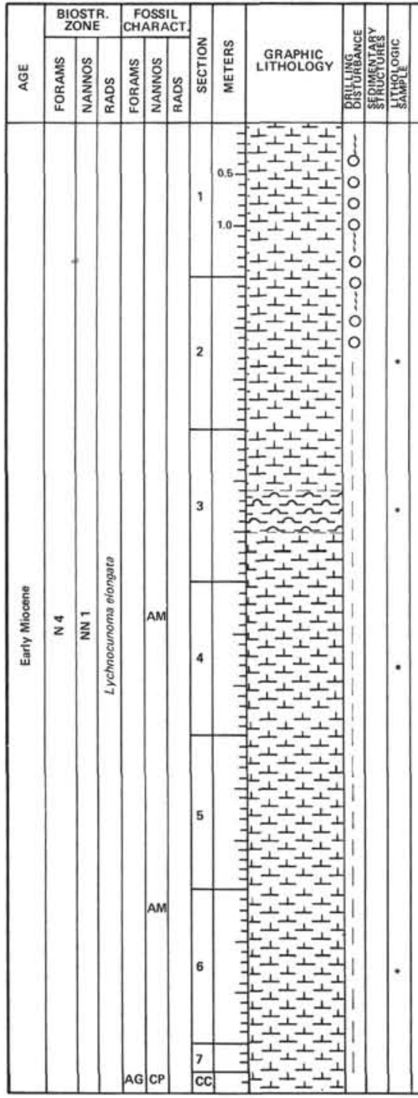
0.0-9.7 m. Strongly disturbed (intense drilling deformation) **NANNOFOSSIL OOZE,** with local portions of **CLAY-RICH RADIOLARIAN OOZE,** e.g. at 2.2, 5.0 and 6.4 m, suggesting tops of turbidites at these depths. The **NANNOFOSSIL OOZE** is mainly very pale orange (10YR 8/2) to grayish orange (10YR 7/4) to darker (with non-carbonate admixture), siliceous with radiolarian fragments, and nannofossils have over-growths.

SMEAR SLIDE (%)

	Siliceous foraminifer nannofossil ooze	Calcareous foraminiferal radiolarian ooze	Radiolarian ooze	Radiolarian ooze
TEXTURE AND MINERALS	1-85 (D)	2-15 (D)	2-108 (D)	5-77 (D)
Sand size	40	–	30	20
Silt size	40	–	40	40
Clay size	20	–	30	30
Clay	–	–	30	30
Carbonate unsp.	–	20*	Tr	–
Acicular carb. crystals	10	–	–	–
Foraminifera	25	20	–	–
Calc. nannofossils	38	5	–	–
Radiolaria	25	50	65	65
Sponge spicules	2	5	5	5

*Recrystallized nannofossils

SITE 462 HOLE CORE 18 CORED INTERVAL: 162.0 to 171.5 m



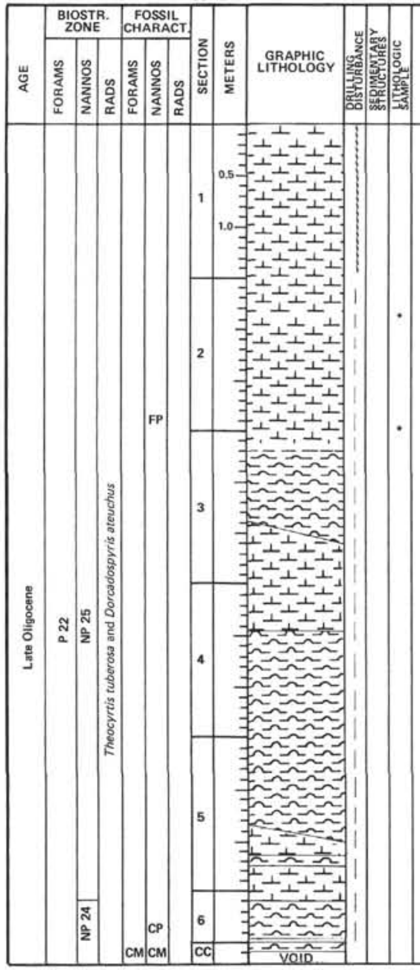
LITHOLOGIC DESCRIPTION

0.0-3.6 m. NANNOFOSSIL OOZE: locally **RADIOLARIAN-RICH,** and grading to **CALCAREOUS RADIOLARIAN OOZE,** very pale brown (10YR 7/3) to darker (10YR 4/4) to lighter (N9) depending on more or less radiolarian remains.
3.6-4.0 m. RADIOLARIAN OOZE: dusky yellowish brown (10YR 2/2) with abundant nannofossils.
4.0-9.4 m. RADIOLARIAN-NANNOFOSSIL OOZE, as in the 0.0-3.6 m interval.

SMEAR SLIDE (%)

	Nannofossil radiolarian ooze	Nannofossil radiolarian ooze	Nannofossil ooze	Radiolarian nannofossil ooze
TEXTURE AND MINERALS	2-80 (D)	3-80 (D)	4-80 (D)	6-80 (D)
Sand size	–	20	30	30
Silt size	–	65	50	50
Clay size	–	15	20	20
Clay	–	5	–	–
Foraminifer	–	–	–	10
Calc. nannofossils	37	15	40	40
Radiolaria	50	75	50	40
Sponge spicules	3	5	Tr	3
Fish remains	–	Tr	–	–
Acicular calcite crystals	10	–	10	7

SITE 462 HOLE CORE 19 CORED INTERVAL: 171.5 to 181.0 m



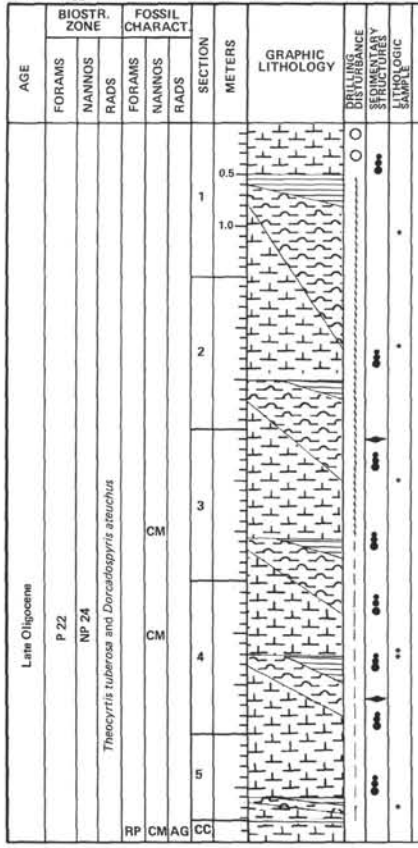
LITHOLOGIC DESCRIPTION

0.0-8.0 m. ALTERNATING CALCAREOUS RADIOLARIAN OOZE and SILICEOUS NANNOFOSSIL OOZE: perhaps turbidites with bases at about 3.2, 4.95, 7.25, and 7.65 m; the **CALCAREOUS OOZE** is very pale brown (10YR 7/4) to very pale orange (10YR 8/2) to white (N9) and has abundant radiolarians; the **SILICEOUS OOZE** is dusky yellowish brown (10YR 2/2) and has abundant nannofossils. These lithologies are mixed by the drilling operation.

SMEAR SLIDE (%)

	Radiolarian nannofossil ooze	Radiolarian nannofossil ooze
TEXTURE AND MINERALS	2-40 (D)	2-147 (D)
Sand size	30	30
Silt size	50	50
Clay size	20	20
Foraminifera	10	10
Calc. nannofossils	47	47
Radiolaria	40	40
Sponge spicules	3	3

SITE 462 HOLE CORE 20 CORED INTERVAL: 181.0 to 190.5 m



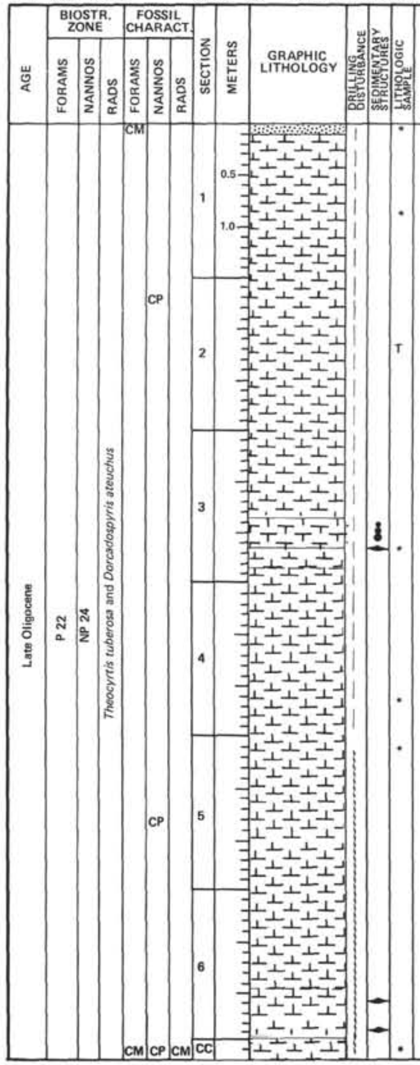
LITHOLOGIC DESCRIPTION

0.0-6.9 m. GRAIN-SIZE GRADED BEDS (COARSER AT BASE) of light **CALCAREOUS OOZE** grading up through a mottled zone into dark **CLAY**: bases at 0.5, 2.5, 4.05, 5.3, and 6.6 m. (Interpreted to be turbidites.) **CALCAREOUS OOZES** are **NANNOFOSSIL OOZE** to **RADIOLARIAN NANNOFOSSIL OOZE**, grayish orange (10YR 7/4) to white (N9). **PELAGIC CLAY** is dark yellowish brown (10YR 4/2), siliceous with radiolarians (grading to **RADIOLARIAN OOZE**) and sponge spicules; and calcareous, with nannofossils.

SMEAR SLIDE (%)

	Radiolarian nannofossil ooze	Radiolarian nannofossil ooze	Radiolarian nannofossil ooze	Nannofossil foraminiferal ooze	Calcareous spicular radiolarian ooze	Radiolarian ooze
TEXTURE AND MINERALS	1-110 (D)	2-70 (D)	3-50 (D)	4-70 (D)	4-80 (D)	5-70 (D)
Sand size	30	20	30	25	55	15
Silt size	50	50	50	60	5	70
Clay size	20	20	20	15	40	15
Clay	3	–	10	5	20	15
Foraminifera	–	2	–	50	Tr	–
Calc. nannofossils	47	56	39	37	25	1
Diatoms	Tr	–	–	–	7	2
Radiolaria	45	40	50	5	30	77
Sponge spicules	5	2	1	3	18	5
Fish remains	Tr	–	–	–	Tr	–

SITE 462 HOLE CORE 21 CORED INTERVAL: 190.5 to 200.0 m



LITHOLOGIC DESCRIPTION

0.0-0.05 m. COARSE SAND: volcanic grains and shallow water foraminifers.

0.05-3.8 m. RADIOLARIAN-NANNOFOSSIL OOZE: grayish orange (10YR 7/4) to very pale orange (10YR 8/2). Drilling disturbance is 4-10 cm long "biscuits" of firm ooze, which is separated by drilling paste of ooze.

3.8-4.1 m. FORAMINIFERAL OOZE: white (N9).

4.1-9.1 m. RADIOLARIAN and NANNOFOSSIL OOZE as in the 0.05-3.8 m interval. Darker and mottled, clay-bearing **RADIOLARIAN NANNOFOSSIL OOZE** at the top and bottom of this unit.

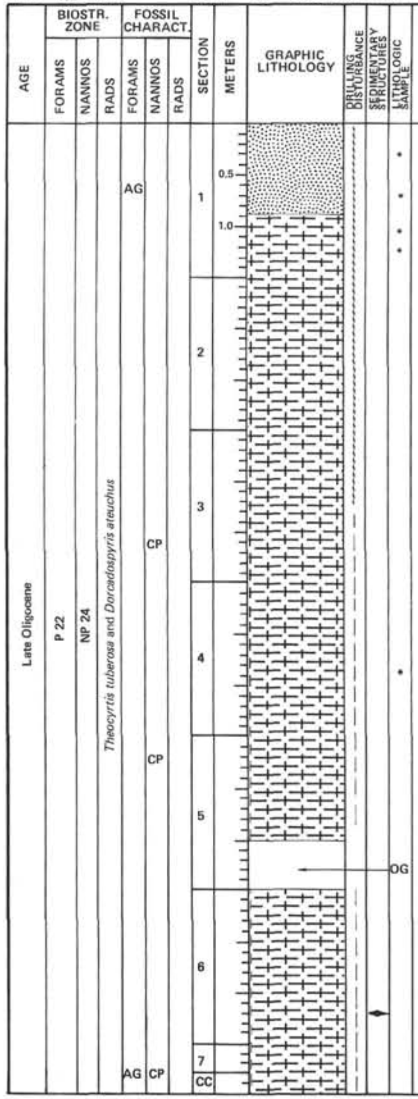
SMEAR SLIDE (%)

	Calcareous ash layer	Radiolarian nannofossil ooze	Foraminiferal ooze	Radiolarian nannofossil ooze	Radiolarian nannofossil ooze	Radiolarian nannofossil ooze
TEXTURE AND MINERALS	1-4 (M)	1-80 (D)	3-110 (D)	4-116 (D)	5-16 (D)	CC (D)
Sand size	50	10	50	15	5	15
Silt size	50	70	40	65	60	55
Clay size	–	20	10	20	35	30
Volcanic glass	5	–	–	–	–	–
Carbonate unsp.	30	–	–	–	–	–
Foraminifera	–	1	60	5	–	–
Calc. nannofossils	1	67	38	62	77	57
Radiolaria	–	30	1	30	20	30
Sponge spicules	Tr	2	1	3	3	3
Opaque volc. grains	62	–	–	–	–	–
Heavy minerals	2	–	–	–	–	–
Clay	–	–	–	–	–	10

THIN SECTION DESCRIPTION

2, 65 cm: Porcellanite, dominant lithology; composed of opal-CT (low-temperature cristobalite/tridymite), dense, brown pigmented, layers of fish remains. A few ghosts of radiolarians, filled with opal-CT. Opal-CT 88%, clay 10%, trace radiolarians, and fish remains 2%.

SITE 462 HOLE CORE 22 CORED INTERVAL: 200.0 to 209.5 m



LITHOLOGIC DESCRIPTION

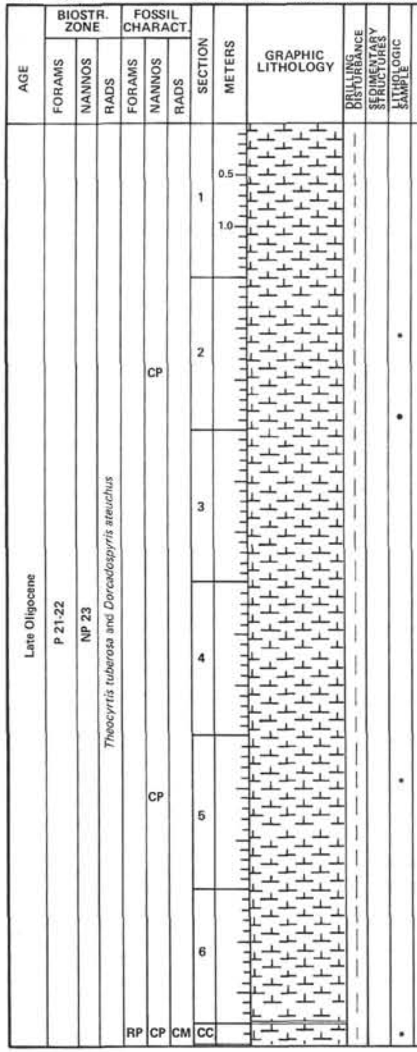
0.0-0.9 m. SAND: coarse grained, intensely disturbed by drilling, of volcanic and shallow-water fossil grains (and some rust-scale grains). The foraminifers are large.

0.9-9.5 m. NANNOFOSSIL-FORAMINIFERAL OOZE: ooze is very pale orange (10YR 8/2); near the 25-75% boundary DSDP uses for nannofossil-foraminiferal versus foraminiferal-nannofossil ooze nomenclature; and is slightly siliceous.

SMEAR SLIDE (%)

	Firm radiolarian ooze	Ashy nannofossil ooze	Slightly siliceous nannofossil ooze	Nannofossil radiolarian ooze	Nannofossil foraminiferal ooze
TEXTURE AND MINERALS	1-30 (M)	1-70 (D)	1-102 (D)	1-121 (M)	4-80 (D)
Sand size	–	–	15	10	50
Silt size	–	–	50	80	30
Clay size	–	–	35	10	20
Clay	–	5	5	–	–
Heavy minerals	–	2	–	–	–
Volcanic glass	–	5	–	–	–
Palagonite	3	1	–	–	–
Zeolite	5	–	–	–	–
Foraminifera	–	–	10	–	25
Calc. nannofossils	2	45	72	35	65
Diatoms	–	–	–	Tr	–
Radiolaria	86	–	10	60	10
Sponge spicules	3	Tr	3	5	Tr
Fish remains	1	–	–	–	Tr
Opaque: Volcanic	–	42	–	–	–

SITE 462 HOLE CORE 23 CORED INTERVAL: 209.5 to 219.0 m



LITHOLOGIC DESCRIPTION

0.0-8.8 m. Homogeneous pale orange (10YR 8/2) **FORAMINIFERAL NANNOFOSSIL OOZE** with small patches of white (N9) **FORAMINIFERAL NANNOFOSSIL OOZE.**

8.8-8.9 m. Grayish orange (10YR 7/4) **RADIOLARIAN NANNOFOSSIL OOZE.**

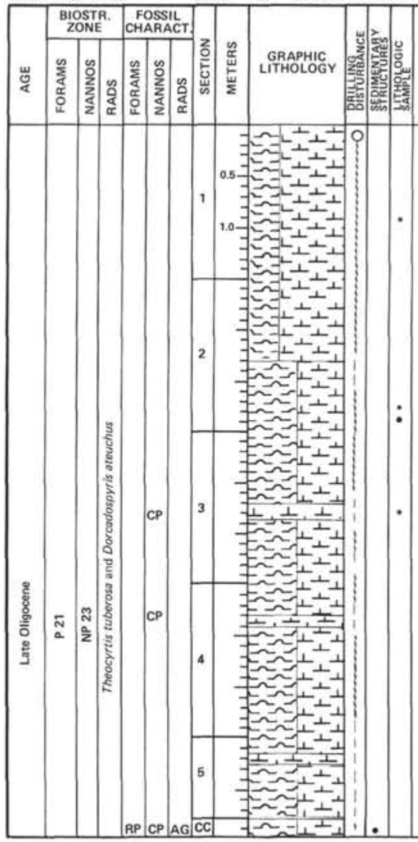
SMEAR SLIDE (%)

TEXTURE AND MINERALS	Foraminiferal nannofossil ooze 2-60 (D)	Foraminiferal nannofossil ooze 5-46 (D)	Radiolarian nannofossil ooze CC (M)
Sand size	27	15	–
Silt size	32	25	–
Clay size	41	60	–
Clay	–	–	7
Volcanic glass	–	–	Tr
Palagonite	1	–	–
Carbonate unsp.	22	15	5
Foraminifera	10	10	5
Calc. nannofossils	60	70	60
Diatoms	–	–	2
Radiolaria	3	2	15
Sponge spicules	4	5	6
Fish remains	–	–	Tr

CARBONATE BOMB (% $CaCO_3$)

2, 58-60 cm: 90%

SITE 462 HOLE CORE 24 CORED INTERVAL: 219.0 to 228.5 m



LITHOLOGIC DESCRIPTION

0.0-2.3 m. RADIOLARIAN OOZE: intensely disturbed by drilling.
2.3-6.9 m. Dominantly RADIOLARIAN NANNOFOSSIL OOZE with interbeds of pale orange (10YR 8/2) **NANNOFOSSIL OOZE.** Color of radiolarian nannofossil ooze is moderate yellowish brown (10YR 7/4) to grayish orange (10YR 7/4).

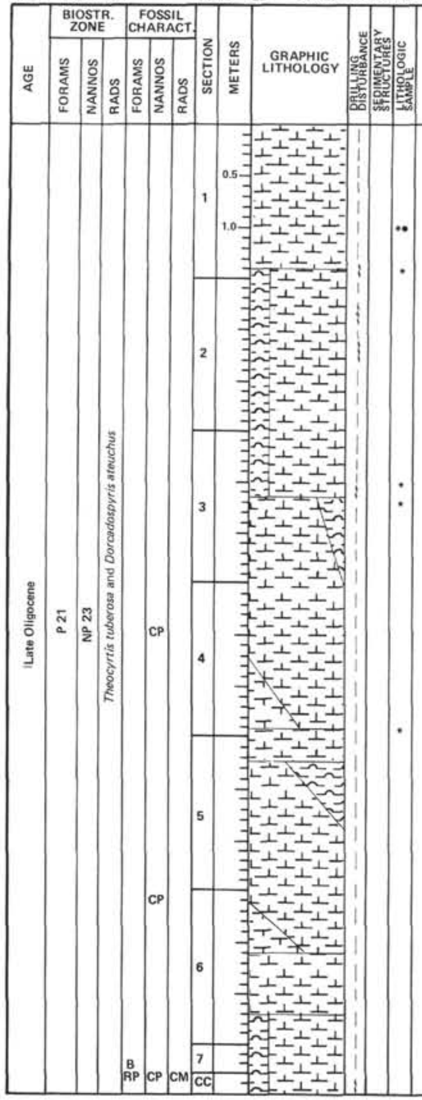
SMEAR SLIDE (%)

	Radiolarian ooze	Radiolarian ooze	Nannofossil ooze	Radiolarian ooze
TEXTURE AND MINERALS	1-97 (D)	2-124 (D)	3-79 (M)	CC (D)
Sand size	40	50	5	50
Silt size	40	30	15	30
Clay size	20	20	80	20
Volcanic glass	Tr	1*	–	Tr**
Palagonite	–	–	Tr	–
Pyrite	?	–	–	–
Carbonate unsp.	–	–	7	–
Foraminifer	Tr	–	1	1
Calc. nannofossils	59	48	90	48
Radiolaria	40	50	–	50
Sponge spicules	1	1	2	1
Fish remains	–	Tr	–	–

*Clear
**Brown and clear

CARBONATE BOMB (% $CaCO_3$)
2, 134-136 cm: 78%
cc: 63%

SITE 462 HOLE CORE 25 CORED INTERVAL: 228.5 to 238.0 m



LITHOLOGIC DESCRIPTION

0.0-9.54 m. Pale orange (10YR 8/2) to white (N9) **NANNOFOSSIL OOZE** and slightly grayish orange (10YR 7/4) **RADIOLARIAN NANNOFOSSIL OOZE** alternating with layers which grade from white (N9) **NANNOFOSSIL OOZE** to grayish orange (10Y 7/4) **RADIOLARIAN NANNOFOSSIL OOZE** at top. (These graded layers are interpreted to be turbidites.)

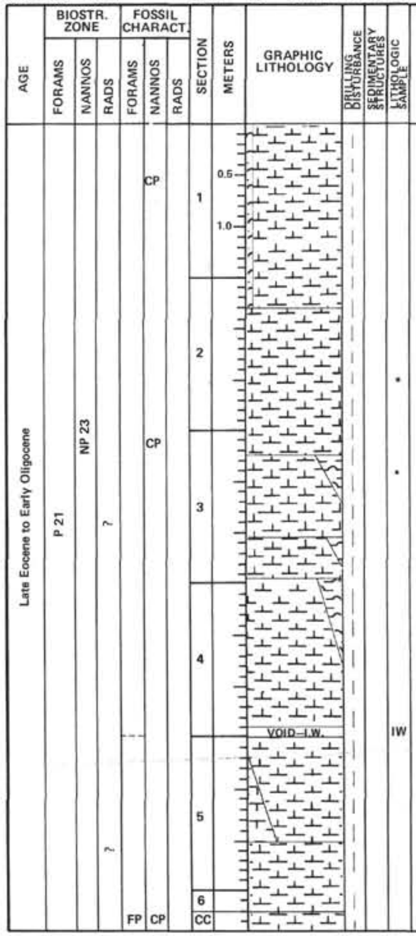
SMEAR SLIDE (%)

	Nannofossil ooze	Radiolarian nannofossil ooze	Slightly siliceous nannofossil ooze	Radiolarian nannofossil ooze	Nannofossil foraminifer ooze
TEXTURE AND MINERALS	1-90 (D)	1-144 (D)	3-52 (D)	3-68 (D)	4-141 (D)
Sand size	12	15	5	–	30
Silt size	18	65	30	–	60
Clay size	70	20	65	–	10
Feldspar	–	Tr	–	–	–
Volcanic glass	Tr*	Tr	Tr**	1	Tr
Palagonite	–	–	–	2	–
Foraminifera	8	–	5	Tr	30
Calc. nannofossils	86	84	80	70	60
Diatoms	–	–	–	–	–
Radiolaria	5	15	14	25	10
Sponge spicules	1	1	1	2	Tr
Fish remains	Tr	Tr	Tr	Tr	Tr

*Clear
**Light

CARBOMATE BOMB (% $CaCO_3$)
1, 90-92 cm: 89%

SITE 462 HOLE CORE 26 CORED INTERVAL: 238.0 to 247.5 m



LITHOLOGIC DESCRIPTION

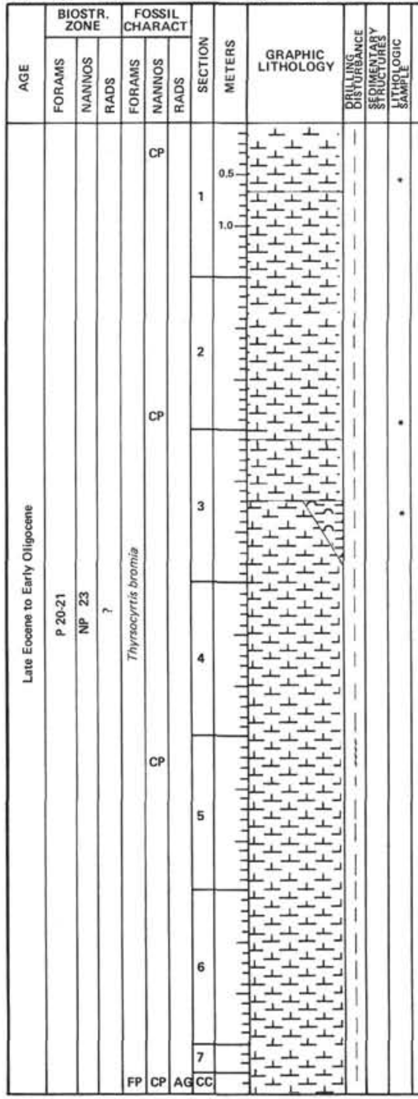
0.0-7.92 m. NANNOFOSSIL OOZE layers with some graded layers which grade downward from grayish orange (10YR 7/4) **RADIOLARIAN NANNOFOSSIL OOZE** to pale orange (10YR 8/2) **NANNOFOSSIL OOZE**, and some even to white (N9) **FORAMINIFERAL NANNOFOSSIL OOZE.**

SMEAR SLIDE (%)

	Nannofossil ooze	Nannofossil ooze
TEXTURE AND MINERALS	2-100 (D)	3-43 (D)
Sand size	8	6
Silt size	22	9
Clay size	70	85
Volcanic glass	Tr	Tr (clear)
Foraminifera	Tr	–
Calc. nannofossils	90	95
Diatoms	–	–
Radiolaria	10	5
Sponge spicules	Tr	Tr
Fish remains	Tr	Tr

CARBONATE BOMB (% $CaCO_3$)
2,97-99 cm: 92

SITE 462 HOLE CORE 27 CORED INTERVAL: 247.5 to 257.0 m



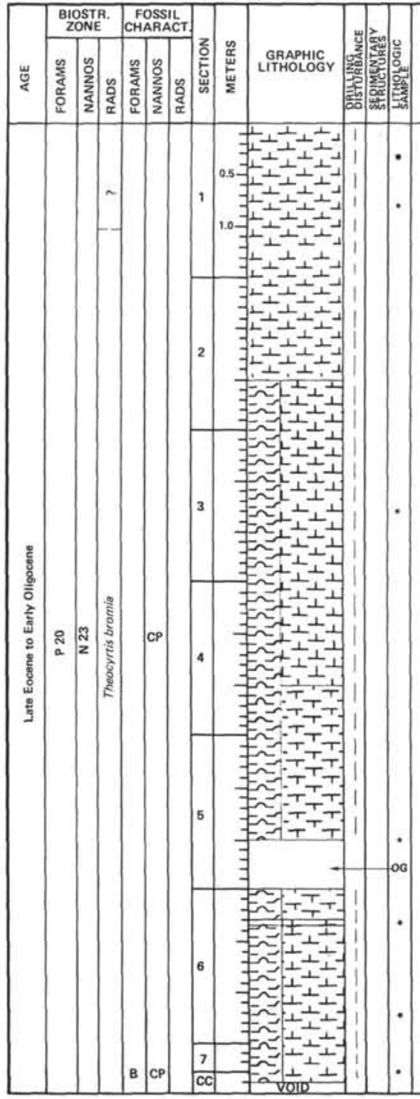
LITHOLOGIC DESCRIPTION

0.0-9.85 m. Pale orange (10YR 8/2) **NANNOFOSSIL OOZE** with a few horizons firm enough to merit the name **"CHALK"**. A few thin layers occur of white (N9) **NANNOFOSSIL OOZE** or grayish orange (10YR 7/4) **RADIOLARIAN NANNOFOSSIL OOZE.**

SMEAR SLIDE (%)

	Nannofossil ooze	Nannofossil ooze	Radiolarian nannofossil ooze
TEXTURE AND MINERALS	1-50 (D)	2-147 (M)	3-84 (D)
Sand size	20	35	30
Silt size	60	45	60
Clay size	20	20	10
Volcanic glass	–	Tr	–
Foraminifera	Tr	25	–
Calc. nannofossils	80	64	74
Radiolaria	20	10	25
Sponge spicules	Tr	1	1
Silicoflagellates	Tr	–	–
Fish remains	Tr	Tr	Tr

SITE 462 HOLE CORE 28 CORED INTERVAL: 257.0 to 266.5 m



LITHOLOGIC DESCRIPTION

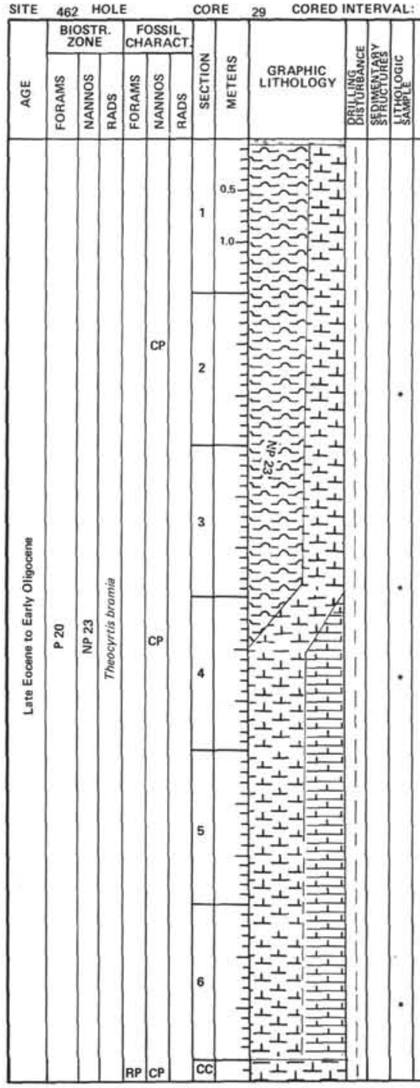
0.0-5.5 m. White (N9) **NANNOFOSSIL OOZE** with pods of **CHALK** produced by drilling disturbance. Becoming more siliceous below as the content of radiolarians increases.
5.5 to 7.8 m. White (N9) **RADIOLARIAN FORAMINIFERAL OOZE.**
7.8-9.7 m. Alterations of white (N9) and grayish orange (10YR 7/4) **RADIOLARIAN NANNOFOSSIL OOZE.**

SMEAR SLIDE (%)

	Nannofossil ooze	Slightly siliceous nannofossil ooze	Radiolarian-foraminifer ooze	Radiolarian-nannofossil ooze	Radiolarian-nannofossil ooze	Radiolarian nannofossil ooze
TEXTURE AND MINERALS	1-80 (D)	3-80 (D)	5-96 (M)	6-32 (D)	6-122 (D)	CC (D)
Sand size	5	10	40	15	10	10
Silt size	45	40	40	45	40	40
Clay size	50	50	20	40	50	50
Clay	5	5	–	5	5	5
Foraminifera	5	10	30	–	Tr	Tr
Calc. nannofossils	84	75	49	62	79	79
Radiolaria	5	9	20	3	13	13
Sponge spicules	1	1	1	3	3	3
Fish remains	Tr	Tr	Tr	–	–	–
Diatoms	–	–	–	–	Tr	Tr

CARBONATE BOMB (% $CaCO_3$)
1, 34-36 cm: 91

SITE 462 HOLE CORE 29 CORED INTERVAL: 266.5 to 276.0 m



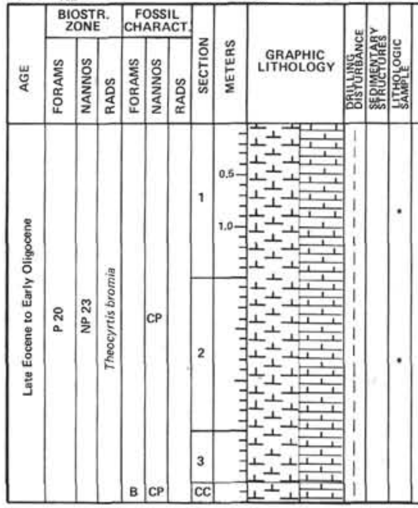
LITHOLOGIC DESCRIPTION

0.0-0.05 m. VOLCANIC GLASS plus derived shallow water **GRAINS** in white (N9) **RADIOLARIAN NANNOFOSSIL OOZE** matrix.
0.05-5.00 m. White (N9) **RADIOLARIAN NANNOFOSSIL OOZE to CHALK.**
5.0-9.20 m. White (N9) **NANNOFOSSIL OOZE to CHALK.**

SMEAR SLIDE (%)

	Radiolarian nannofossil ooze	Nannofossil ooze	Nannofossil ooze	
TEXTURE AND MINERALS	2-100 (D)	3-143 (D)	4-70 (D)	6-100
Sand size	10	25	2	5
Silt size	40	50	48	45
Clay size	50	25	50	50
Clay	5	5	5	5
Foraminifera	5	8	Tr	3
Calc. nannofossils	64	55	89	81
Radiolaria	25	32	3	10
Sponge spicules	1	Tr	3	1
Fish remains	Tr	Tr	–	–

SITE 462 HOLE CORE 30 CORED INTERVAL: 276.0 to 285.5 m



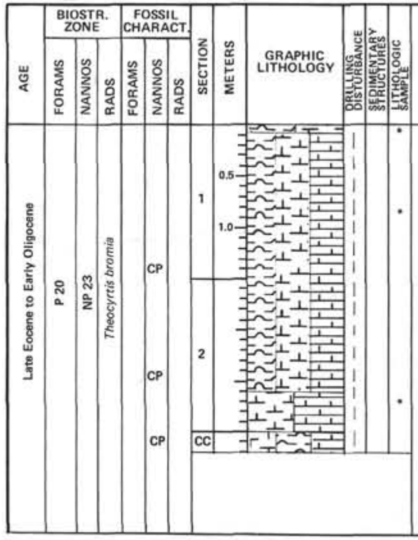
LITHOLOGIC DESCRIPTION

0.0-3.8 m. White (N9) **NANNOFOSSIL OOZE TO CHALK.** Distinct chalky layers or "biscuit" shaped lumps.

SMEAR SLIDE (%)

	Nannofossil ooze	Nannofossil ooze
TEXTURE AND MINERALS	1-80 (D)	2-80 (D)
Sand size	5	–
Silt size	45	30
Clay size	50	70
Clay	5	2
Foraminifera	Tr	Tr
Calc. nannofossils	84	97
Radiolaria	10	1
Sponge spicules	1	Tr
Fish remains	Tr	–

SITE 462 HOLE CORE 31 CORED INTERVAL: 285.5 to 295.0 m



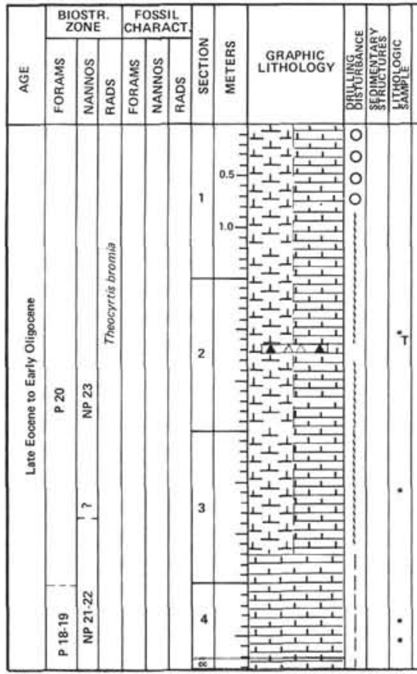
LITHOLOGIC DESCRIPTION

0.0-0.08 m. White (N9) to grayish orange-pink (5YR 7/2) **NANNOFOSSIL-RADIOLARIAN OOZE.**
0.08-2.61 m. White (N9) **RADIOLARIAN NANNOFOSSIL OOZE** alternating with **CHALK.**
2.61-3.0 m. Very pale orange (10YR 8/2) **NANNOFOSSIL OOZE** alternating with **CHALK.**
3.0-3.2 m. Very pale orange (10YR 8/2) **RADIOLARIAN NANNOFOSSIL OOZE** alternating with **CHALK.**

SMEAR SLIDE (%)

	Nannofossil radiolarian ooze	Radiolarian nannofossil ooze	Nannofossil ooze
TEXTURE AND MINERALS	1-2 (D)	1-80 (D)	2-130 (D)
Sand size	10	30	3
Silt size	50	30	40
Clay size	31	40	57
Clay	10	10	5
Foraminifera	–	5	–
Calc. nannofossils	45	49	84
Diatoms	Tr	–	–
Radiolaria	30	35	10
Sponge spicules	15	1	1
Fish remains	–	Tr	Tr

SITE 462 HOLE CORE 32 CORED INTERVAL: 295.0 to 304.5 m



LITHOLOGIC DESCRIPTION

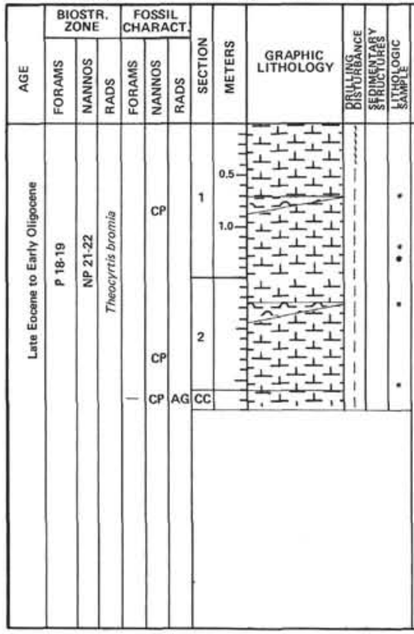
0.0-5.3 m. Very pale orange (10YR 8/2) **RADIOLARIAN NANNOFOSSIL OOZE AND CHALK.** "Ooze" apparently was chalk, homogenized by the drilling and mixed with rusty scale from pipe. Firmer (chalk) below 4.2 m. At 2.1 m a 6 cm piece of **PORCELLANITE CHERT,** black (N1) with brownish streaks. Inside a 4 mm rind, lighter shade and more porcellanitic (thin section).

SMEAR SLIDE (%)

	Radiolarian ooze	Radiolarian ooze	Radiolarian ooze	Radiolarian ooze
TEXTURE AND MINERALS	2-60 (D)	3-60 (D)	4-35 (M)	4-59
Sand size	15	15	20	3
Silt size	45	45	50	82
Clay size	40	40	30	15
Clay	5	5	5	5
Carbonate unsp.	10	–	–	–
Foraminifera	1	1	10	–
Calc. nannofossils	50	60	64	27
Diatoms	–	–	–	Tr
Radiolaria	3	30	20	60
Sponge spicules	4	4	1	8
Fish remains	–	–	Tr	–
Volcanic glass	–	–	1	–
Volcanic grains	–	–	Tr	–

THIN SECTION DESCRIPTION:
2, 65-66 cm: Porcellanite--Clays 10%, opal CT (low-temperature cristobalite/tridymite) 88%; trace Radiolaria; fish remains 2%; dense brown pigmented layers. A few "ghosts" of radiolarians, filled with Opal-CT.

SITE 462 HOLE CORE 33 CORED INTERVAL: 304.5 to 314.0 m



LITHOLOGIC DESCRIPTION

0.0-2.8 m. RADIOLARIAN RICH NANNOFOSSIL CHALK: whitish (N9) to orangish white (10YR 9/1). Radiolarians are 20-40%, nannofossils are about 50-80%, and minor occurrences of clay and sponge spicules.

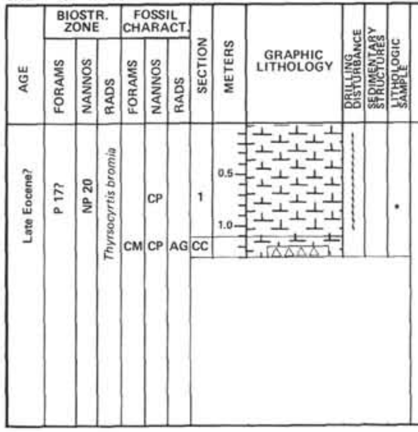
Two gradational (grades downward into **NANNOFOSSIL CHALK**) beds of very firm, pale yellowish brown (10YR 6/2) **RADIOLARIAN OOZE** at 0.70-0.87 m, and 1.7 to 1.92 m. (These have been interpreted as possible turbidite layers with bases 0.7 and 1.7 m, and/or instead, tops of solution zones.)

SMEAR SLIDE (%)

	Nannofossil radiolarian ooze	Nannofossil radiolarian ooze	Radiolarian ooze	Nannofossil radiolarian ooze
TEXTURE AND MINERALS	1-76 (M)	1-120 (D)	2-27 (D)	2-101 (D)
Sand size	5	10	10	10
Silt size	85	50	80	60
Clay size	10	40	10	30
Clay	–	5	3	3
Volcanic glass	–	–	Tr	–
Foraminifera	–	–	–	Tr
Calc. nannofossils	20	72	8	47
Diatoms	–	–	Tr	–
Radiolaria	70	20	–	35
Sponge spicules	10	3	15	15
Fish remains	Tr	–	Tr	Tr

CARBONATE BOMB (% $CaCO_3$)
1, 130-132 cm: 86

SITE 462 HOLE CORE 34 CORED INTERVAL: 314.0 to 323.5 m



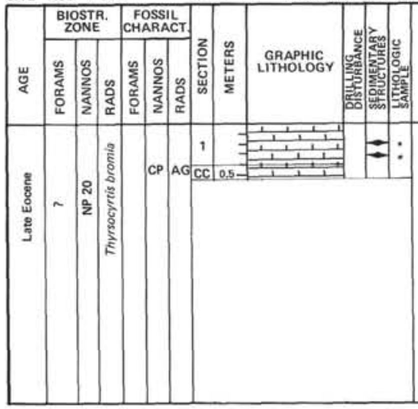
LITHOLOGIC DESCRIPTION

0.0-1.2 m. Breccia and drilling paste of **RADIOLARIAN-RICH NANNOFOSSIL CHALK;** overall it is very pale orange (10YR 8/2).
Wedged in Core-Catcher: A piece of **PORCELLANITE**– brownish black (5YR 2/1) with 1 mm thick, 2-4 cm long of moderate brown (5YR 4/4) lenses.

SMEAR SLIDE (%)

TEXTURE AND MINERALS	Radiolarian nannofossil ooze (dominant lithology) 1-80
Sand size	5
Silt size	45
Clay size	50
Clay	5
Foraminifera	1
Calc. nannofossils	76
Radiolaria	15
Sponge spicules	3

SITE 462 HOLE CORE 35 CORED INTERVAL: 323.5 to 333.0 m



LITHOLOGIC DESCRIPTION

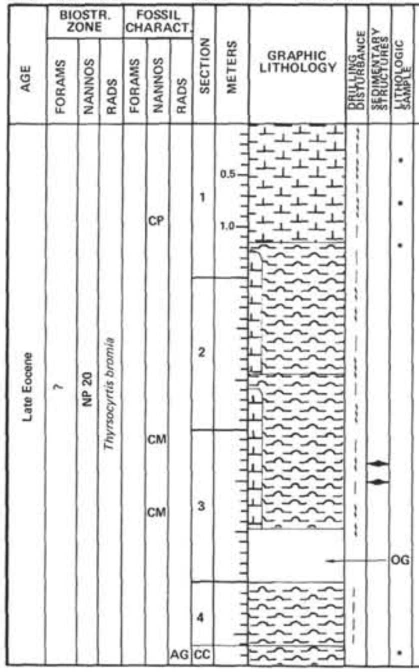
0.0-0.5 m. Pieces of white (N9) **NANNOFOSSIL CHALK** which is slightly siliceous and mottled. There is one piece of light olive gray (5Y 6/1), very firm **RADIOLARIAN OOZE** with mottles.

SMEAR SLIDE (%)

TEXTURE AND MINERALS	Radiolarian ooze 1-18	Nannofossil chalk 1-34
Quartz	Tr	–
Clay	10	–
Volcanic glass	1*	1
Carbonate unsp.	–	2
Calc. nannofossils	10	90
Radiolaria	70	5
Sponge spicules	9	1

*Dark and light

SITE 462 HOLE CORE 36 CORED INTERVAL: 342.5 to 352.0 m



Very firm radiolarian ooze (5YR 6/4)

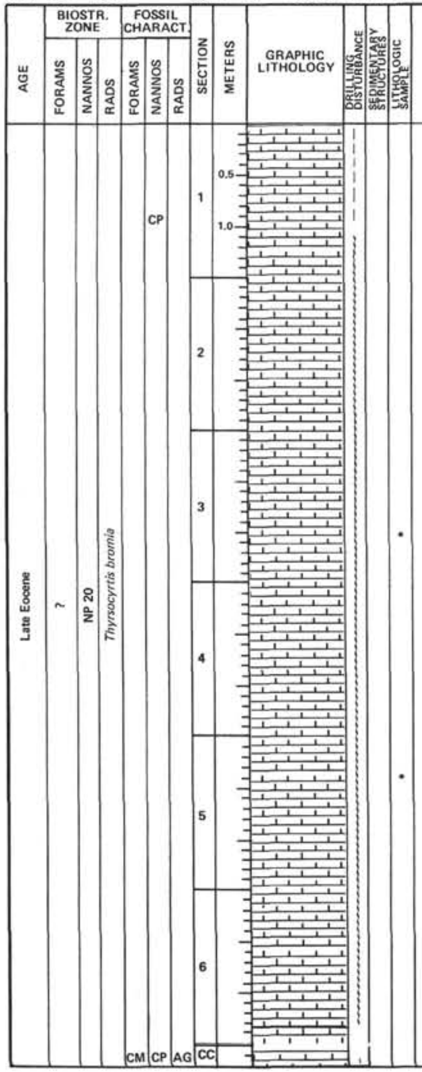
LITHOLOGIC DESCRIPTION

0.0-5.29 m. Alternating very pale orange (10YR 8/2) **NANNOFOSSIL CHALK** with occasional interbeds of light brown (5YR 6/4) very firm **RADIOLARIAN OOZE.** Disturbed areas, which appear to be graded mixtures, probably are mechanical drilling artifacts.

SMEAR SLIDE (%)

TEXTURE AND MINERALS	Nannofossil ooze 1-36 (D)	Nannofossil chalk 1-77 (D)	Firm radiolarian ooze 1-119 (D)	Very firm radiolarian ooze CC (D)
Sand size	5	10	20	1
Silt size	55	80	75	94
Clay size	40	10	5	5
Clay	1	–	–	2
Feldspar	–	–	–	–
Volcanic glass	–	Tr	2	4
Calc. nannofossils	89	80	Tr	Tr
Radiolaria	10	10	95	93
Sponge spicules	Tr	–	1	1
Fish remains	Tr	Tr	2	–

SITE 462 HOLE CORE 37 CORED INTERVAL: 342.5 to 352.0 m



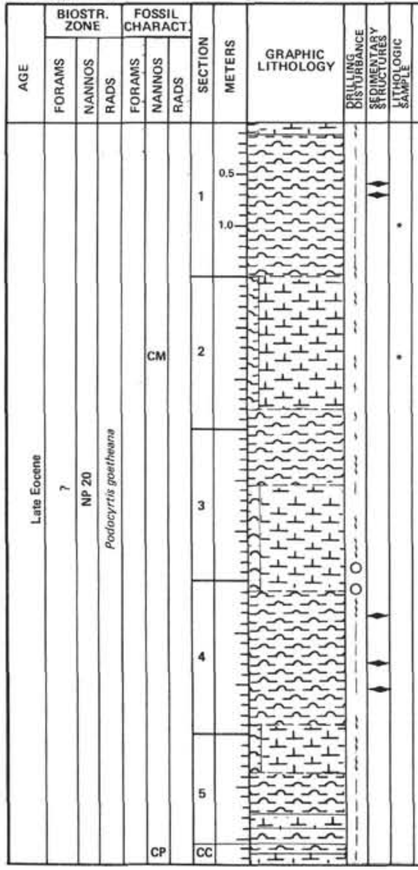
LITHOLOGIC DESCRIPTION

0.0-9.0 m. Very pale orange (10YR 8/2) **RADIOLARIAN-NANNOFOSSIL CHALK,** predominantly ground-up by drilling below 0.9 m.

SMEAR SLIDES (%)

TEXTURE AND MINERALS	**Radiolarian-nannofossil chalk 3-107**	**Radiolarian nannofossil ooze 5-40**
Sand size	15	15
Silt size	75	75
Clay size	10	10
Volcanic glass	Tr	Tr
Foraminifera	10	3
Calc. nannofossils	64	75
Radiolaria	25	20
Sponge spicules	1	2
Fish remains	Tr	Tr

SITE 462 HOLE CORE 38 CORED INTERVAL: 352.0 to 361.5 m



LITHOLOGIC DESCRIPTION

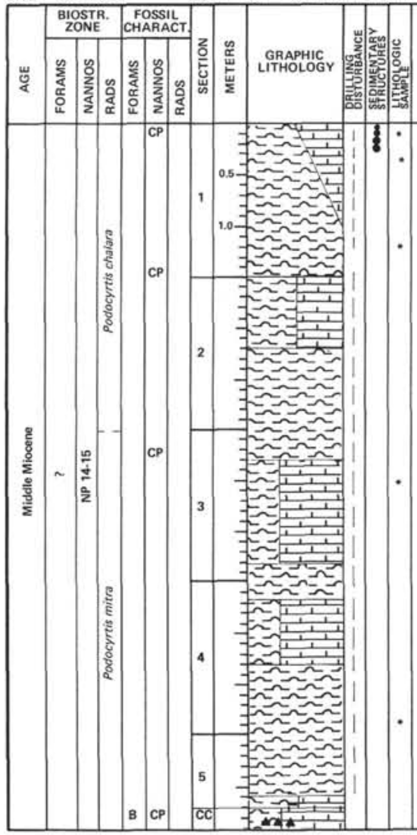
0.0-7.36 m. Interlayered moderate yellowish brown (10YR 5/4) and very pale orange (10YR 8/2) **RADIOLARIAN-BEARING NANNOFOSSIL OOZE.** Contacts of nannofossil ooze over radiolarian ooze are sharp at 0.15 m, 0.53 m, and 0.70 m. Above these contacts the nannofossil ooze appears to grade upward into Radiolarian ooze. Drilling disturbance appears to have "smeared out" the radiolarian ooze over nannofossil ooze contacts.

SMEAR SLIDE (%)

TEXTURE AND MINERALS	**Very firm radiolarian ooze 1-100**	**Radiolarian-bearing nannofossil chalk 2-80**
Sand size	15	5
Silt size	75	55
Clay size	10	40
Clay	5	–
Feldspar	Tr	–
Heavy minerals	Tr*	–
Volcanic glass	Tr†	1 (light)
Foraminifera	–	5
Calc. nannofossils	Tr	80
Radiolaria	90	11
Sponge spicules	5	3

*Hornblende
†Light + dark

SITE 462 HOLE CORE 39 CORED INTERVAL: 361.5 to 371.0 m



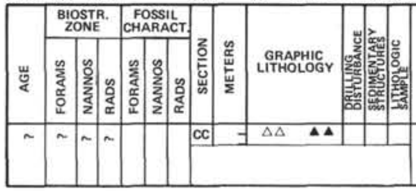
LITHOLOGIC DESCRIPTION

0.0-5.6 m. Alternations of very pale orange (10YR 8/2) to grayish orange pink (5YR 7/2) to white (N9) **RADIOLARIAN NANNOFOSSIL CHALK** with moderate brown (5YR 4/4) **NANNOFOSSIL-RADIOLARIAN CHALK.** Some layers are graded with darker clay-rich tops that are burrow mottled. more homogeneous toward base.
5.6-6.7 m. Moderate orange pink (10YR 7/4) **RADIOLARIAN OOZE.**
6.7-6.9 m (Core-Catcher): Pale yellowish brown (10YR 6/6) **RADIOLARIAN-NANNOFOSSIL CHALK** and moderate brown (5YR 3/4) and moderate orange pink (5YR 8/2) **CHERT.**

SMEAR SLIDE (%)

	Radiolarian nanno-fossil chalk	Nannofossil radiolarian ooze	Radiolarian ooze	Radiolarian nannofossil ooze	Radiolarian ooze
TEXTURE AND	1-16	1-34	1-117	3-51	4-137
MINERALS	(D)	(M)	(D)	(D)	(D)
Sand size	5	20	5	10	10
Silt size	65	65	75	60	60
Clay size	30	15	20	30	30
Clay	10	5	20	5	30
Calc. nannofossils	50	40	–	55	Tr
Radiolaria	30	50	80	35	65
Sponge spicules	10	5	–	5	5

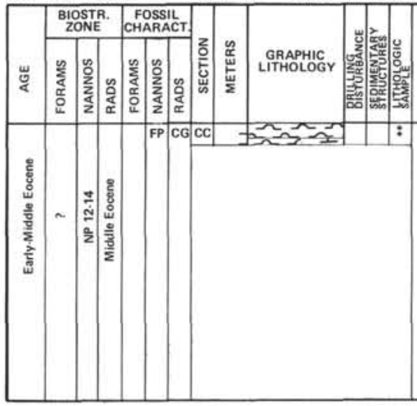
SITE 462 HOLE CORE 40 CORED INTERVAL: 371.0 to 380.5 m



LITHOLOGIC DESCRIPTION

0.0-0.2 m. Two pieces in Core-Catcher: one piece is moderate orange pink (5YR 8/4) **PORCELLANITE**, the other piece is light gray (N8 and N7) **CHERT.**

SITE 462 HOLE CORE 41 CORED INTERVAL: 380.5 to 390.0 m



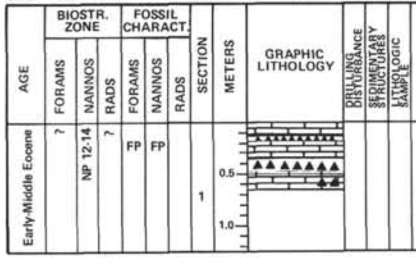
LITHOLOGIC DESCRIPTION

0.0-0.2 m. Core-Catcher sample: Consolidated pale yellowish-brown (10YR 6/2) **RADIOLARIAN OOZE** and very pale orange (10YR 8/2) **RADIOLARIAN NANNOFOSSIL OOZE.**

SMEAR SLIDE (%)

	Firm radiolarian ooze	Radiolarian nannofossil ooze
TEXTURE AND MINERALS	CC-3	CC-23
Sand size	10	20
Silt size	70	50
Clay size	20	20
Clay	20	10
Carbonate unsp.	–	27
Calc. nannofossils	–	3
Radiolaria	72	45
Sponge spicules	8	15

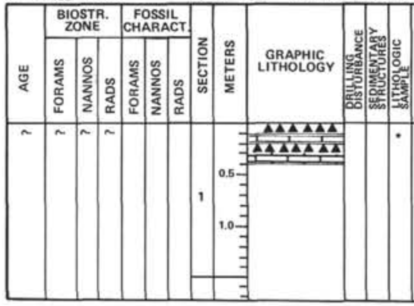
SITE 462 HOLE CORE 42 CORED INTERVAL: 390.0 to 399.5 m



LITHOLOGIC DESCRIPTION

0.0-0.7 m. Bluish-white (5B 9/1) **SILICIFIED LIMESTONE** with intervals of pale yellowish brown (10YR 6/2) and moderate reddish brown (10YR 4/6) to dusky yellowish-brown (10YR 2/2) **CHERT.**

SITE 462 HOLE CORE 43 CORED INTERVAL: 399.5 to 409.0 m



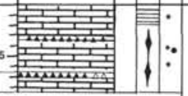
LITHOLOGIC DESCRIPTION

0.0-0.4 m. Alterations of white (N9) **NANNOFOSSIL LIMESTONE** and moderate reddish brown (10R 4/6) **CHERT.** Some light gray (N7) **CHERT** in the white limestone.

SMEAR SLIDE (%)

	Nannofossil limestone (silicified)
TEXTURE AND MINERALS	1-12
Quartz, Authigenic	~ 5
Foraminifera	5
Calc. nannofossils	90

SITE 462 HOLE CORE 44 CORED INTERVAL: 409.0 to 418.5 m

AGE	BIOSTR. ZONE			FOSSIL CHARACT.			SECTION	METERS	GRAPHIC LITHOLOGY	DRILLING DISTURBANCE	SEDIMENTARY STRUCTURES	LITHOLOGIC SAMPLE
	FORAMS	NANNOS	RADS	FORAMS	NANNOS	RADS						
Early Eocene	P 6 (middle part)	NP 10-11		RP CP RP FP	FM		1 CC	0.5				

LITHOLOGIC DESCRIPTION

0.0-0.68 m. Yellowish gray (5YR 8/1) to light gray (N7) **SILICIFIED LIMESTONE;** some laminated levels. Light brown (5YR 5/6) greenish gray (5G 6/1) **CHERT.** White (N9) to greenish gray (5G 6/1) wispy bedded **NANNOFOSSIL LIMESTONE;** some **PORCELLANITE.**

0.68-0.73 m. Moderate brown (5YR 4/4) **CHERT** in Core-Catcher.

SMEAR SLIDE (%)

TEXTURE AND MINERALS	Limestone(?) 1-13	Siliceous limestone 1-44	Nannofossil limestone 1-58
Sand size	0	0	0
Silt size	60	60	80
Clay size	40	40	20
Feldspar	Tr	–	–
Heavy minerals	Tr*	–	–
Volcanic glass	–	1**	1†
Micronodules	–	–	Tr
Carbonate unsp.	70	47	34
Calc. nannofossils	20	20	45
Radiolaria	10*	30††	20
Fish remains	Tr	Tr	–
Clay	–	2	–

*Calcitized

**Light>dark

†Light

††Poor preservation

CARBONATE BOMB (% $CaCO_3$)

1, 42-44 cm: 24%

SITE 462 HOLE CORE 45 CORED INTERVAL: 418.5 to 428.0 m

AGE	BIOSTR. ZONE			FOSSIL CHARACT.			SECTION	METERS	GRAPHIC LITHOLOGY	DRILLING DISTURBANCE	SEDIMENTARY STRUCTURES	LITHOLOGIC SAMPLE
	FORAMS	NANNOS	RADS	FORAMS	NANNOS	RADS						
Early Paleocene	?	NP 3-4			FM		1 CC					

LITHOLOGIC DESCRIPTION

0.0-0.2 m. Pieces of pale yellowish brown (10YR 6/2) to dark yellowish brown (10YR 4/2) **CHERT.** Some cherts are laminated.

0.2-0.4 m. Core-Catcher sample: Pale yellowish-brown (10YR 6/2) laminated **LIMESTONE** and one piece of moderate brown (5YR 4/4) **CHERT.**

SMEAR SLIDE (%)

TEXTURE AND MINERALS	Limestone CC-10
Clay	10
Carbonate unsp.	72
Foraminifera	Tr
Calc. nannofossils	15
Radiolaria*	3

*Radiolaria replaced by calcite

SITE 462 HOLE CORE 46 CORED INTERVAL: 428.0 to 437.5 m

AGE	BIOSTR. ZONE			FOSSIL CHARACT.			SECTION	METERS	GRAPHIC LITHOLOGY	DRILLING DISTURBANCE	SEDIMENTARY STRUCTURES	LITHOLOGIC SAMPLE
	FORAMS	NANNOS	RADS	FORAMS	NANNOS	RADS						
Middle Maestrichtian and Early-Middle Paleocene	Paleocene (17-19 cm) *Globotruncana gansseri zone* (3-4 cm)	*Arkhangelskiella cymbiformis*		FP	FP		CC					

LITHOLOGIC DESCRIPTION

0.0-0.2 m. Core-Catcher only: Very pale orange (10YR 8/2) grainy, speckled coarse **LIMESTONE,** and light olive gray (5Y 6/1) **LIMESTONE** with veins of **NATIVE COPPER.** Moderate brown (5YR 4/4) **CHERT.**

SMEAR SLIDE (%)

TEXTURE AND MINERALS	Limestone CC	
Sand size	Dominant	
Silt size	–	
Clay size	–	
Volcanic grains	1	
Volcanic glass	2	dark and light
Palagonite	1	gold and brown
Carbonate unsp.	90	
Foraminifera	5	(probably greater percentage of foraminifer as a result of crushing in the smear slide)
Calc. nannofossils	1	
Radiolaria	Tr	
Sponge spicules	Tr	

SITE 462 HOLE CORE 47 CORED INTERVAL: 437.5 to 447.0 m

AGE	BIOSTR. ZONE			FOSSIL CHARACT.			SECTION	METERS	GRAPHIC LITHOLOGY	DRILLING DISTURBANCE	SEDIMENTARY STRUCTURES	LITHOLOGIC SAMPLE
	FORAMS	NANNOS	RADS	FORAMS	NANNOS	RADS						
Middle Maestrichtian	*Globotruncana gansseri*	*Arkhangelskiella cymbiformis*		FP	RP		CC					

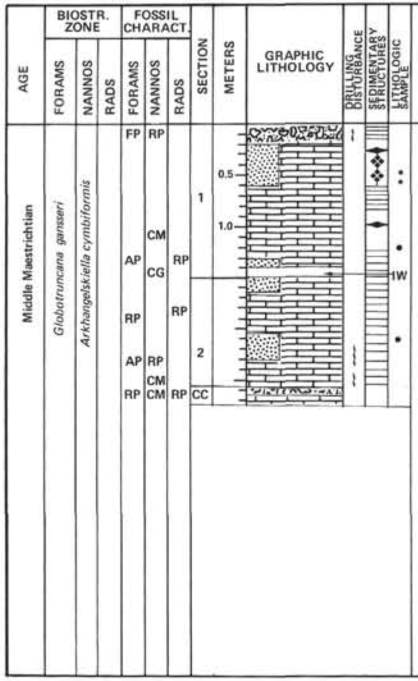
LITHOLOGIC DESCRIPTION

0.0-0.2 m. Only Core-Catcher sample: Lumps of moderate brown (5YR 4/4 to 5YR 3/4) **CHERT.** Pale yellowish brown (10YR 6/2) **LIMESTONE.**

SMEAR SLIDE (%)

TEXTURE AND MINERALS	Limestone CC	
Volcanic glass	3	dark>light
Palagonite	1	
Pyrite (?)	Tr	angular opaque, not brassy
Carbonate unsp.	71	
Calc. nannofossils	25	
Radiolaria	Tr	
Fish remains	Tr	

SITE 462 HOLE CORE 48 CORED INTERVAL: 447.0 to 456.5 m



LITHOLOGIC DESCRIPTION

0.0-0.2 m. Drilling breccia of various lithologies.
0.2-2.8 m. Green **SANDY LIMESTONE** alternating with greenish gray **NANNOFOSSIL LIMESTONE.** The **SANDY LIMESTONE** is overall greenish gray (5G 6/1), which is a blend from greenish black (5GY 2/1) grains (altered volcanic) speckled on light gray (N7) background, and showing bedding. The gray **NANNOFOSSIL LIMESTONE** varies from light olive gray (5Y 6/1) to pale yellowish brown (10YR 6/2), showing bedding. Both lithologies have mm to cm scale of bedding and prominent local burrows. **SANDS** are probably redeposited (siliceous foraminifers, volcanic grains, size sorted), not ash.

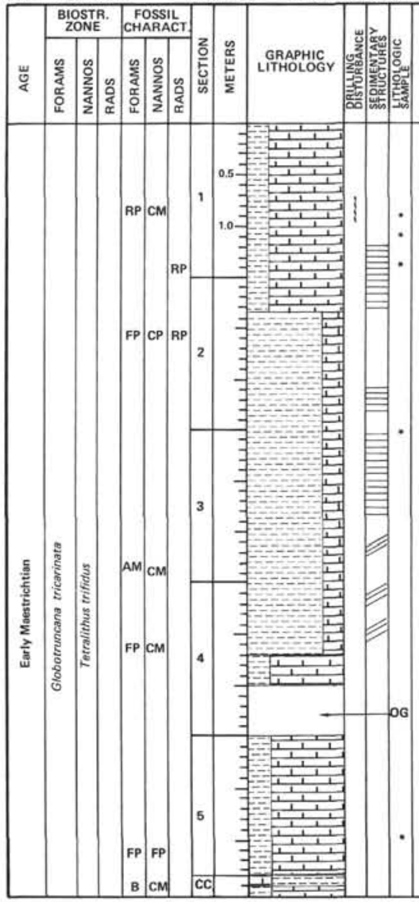
SMEAR SLIDE (%)

TEXTURE AND MINERALS	Calcareous volcaniclastic sandstone 1-50	Nannofossil limestone 1-61
Sand size	60	–
Silt size	20	–
Clay size	20	–
Clay	7	Tr
Quartz	Tr	–
Feldspar	2	–
Heavy minerals	8	Tr
Volcanic glass	2*	Tr
Palagonite	Tr	1
Carbonate unsp.	33	84
Foraminifera	20**	–
Calc. nannofossils	20	15
Radiolaria	8**	Tr

*Some glass devitrified
**Most radiolaria and foraminifera are microcrystalline

CARBONATE BOMB (% $CaCO_3$)
1, 113-115 cm: 50%
2, 57-59 cm: 62%

SITE 462 HOLE CORE 49 CORED INTERVAL: 456.5 to 466.0 m



LITHOLOGIC DESCRIPTION

0.0-7.05 m. Lithologies are (1) medium dark gray (N4) to olive gray (5Y 4/1) to dark greenish gray (5G 4/1) **NANNOFOSSIL MARL;** (2) light gray (N7 ± 1) **NANNOFOSSIL CHALK to NANNOFOSSIL MARL;** (3) dark to very dark gray (N3 to N2) **VOLCANIC SILTSTONE;** and (4) (minor) greenish gray (5G 7/1) waxy **VOLCANIC ASH.**

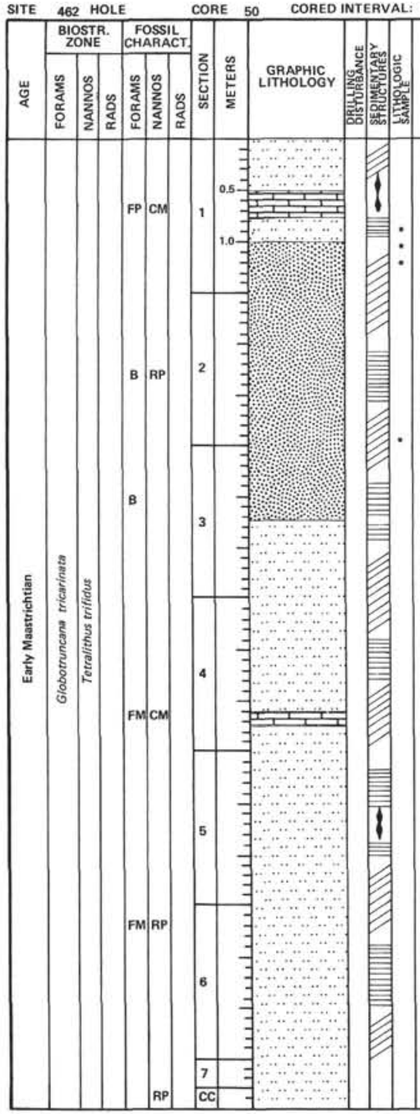
These lithologies are present in fine beds to lamellae. In general the lithologies are thin bedded, thus lithologic symbols indicate only the dominant lithology.

SMEAR SLIDE (%)

TEXTURE AND MINERALS	Nannofossil marl 1-90 (D)	Nannofossil chalk 1-110 (D)	Zeolitic radiolarian ooze 1-130 (M)	Volcanic siltstone 2-141 (D)
Sand size	1	1	1	10
Silt size	20	15	74	80
Clay size	79	84	25	10
Clay	25	10	–	10
Quartz	Tr	–	–	–
Feldspar	1	–	Tr	10
Heavy minerals	–	–	–	30
Volcanic glass	2*	–	–	20
Zeolite	–	–	97	–
Carbonate unsp.	41†	39†	–	–
Calc. nannofossils	30	50	1-2	2
Sponge spicules	–	Tr	–	–
Fish remains	Tr	Tr	1	1
Opaque	–	1	1	22
Detrital carbonate	–	Tr	–	–
Amphibole	Tr	–	Tr	–
Clinopyroxene	Tr	–	–	–
Pumice fragments	–	–	–	Tr
Altered glass	–	–	–	5

*Fresh clear
†Nannofossil fragments(?)

SITE 462 HOLE CORE 50 CORED INTERVAL: 466.0 to 474.4 m



LITHOLOGIC DESCRIPTION

0.0-9.5 m. VOLCANICLASTIC SILTSTONE and SANDSTONE, shades of medium and dark gray (N5-N2); coarser volcanic-rich **SANDS** (probably redeposited, not tuff) are greenish gray (5G 4/1). Scour and cross-bedding common; some mottles and thin parallel laminae in fine, dark beds.

At 0.50-0.75 m and **5.60-5.75 m, NANNOFOSSIL LIMESTONE;** burrowed and scoured, not cross-bedded.

At 4.65 m, a 1 cm light brown (5YR 5/6 and lighter and darker) **NANNOFOSSIL-bearing Claystone.**

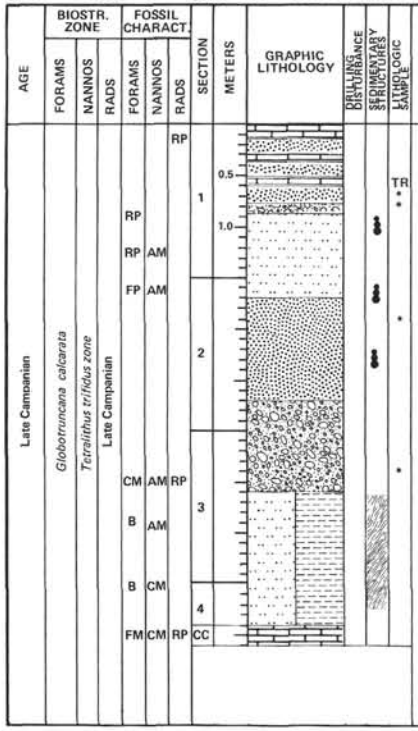
SMEAR SLIDE (%)

	Nannofossil chalk	Nannofossil chalk	Volcanic siltstone or ashy siltstone	Volcanic siltstone
TEXTURE AND MINERALS	1-65 (D)	1-71 (D)	1-90 (D)	1-140 (D)
Sand size	–	–	5	5
Silt size	60	80	80	90
Clay size	40	20	15	5
Clay	–	–	8	19
Quartz	–	–	2	–
Feldspar	Tr	–	5	–
Volcanic glass	Tr	Tr[a]	70	60
Zeolite	–	–	–	–
Carbonate unsp.	45	66	–	–
Calc. nannofossils	50	30	Tr	Tr
Calcite crystals	–	–	–	–
Detrital calcite	–	–	–	–
Radiolaria	Tr[f]	–	–	–
Sponge spicules	Tr	–	–	–
Fish remains	Tr	1	–	1
Opaques	5	–	10[b]	–
Clinopyroxene	–	–	5	–
Chlorite	–	–	–	–
Amorphous[c]	–	–	–	–
Heavy minerals	–	–	–	30
Pyrite	–	–	–	–

	Marly siltstone	Chlorite replacement vein	Nannofossil-bearing claystone	Claystone
TEXTURE AND MINERALS	2-123 (D)	3-140 (M)	4-15 (M)	6-68 (D)
Sand size	5	–	–	–
Silt size	92	–	–	15
Clay size	3	–	–	85
Clay	10	–	–	87
Quartz	Tr	–	–	–
Feldspar	–	–	Tr	Tr
Volcanic glass	Tr	Tr[e]	3	Tr
Zeolite	Tr	–	Tr	–
Carbonate unsp.	–	–	12	–
Calc. nannofossils	–	–	5	2
Calcite crystals	84[d]	–	–	–
Detrital calcite	–	–	Tr	Tr
Opaques	–	–	–	10
Clinopyroxene	Tr	–	Tr	–
Chlorite	–	98	–	–
Amorphous[c]	–	–	80	–
Pyrite	–	–	–	Tr
Fish remains	1	2	Tr	1

a = altered and fresh
b = includes orange particles
c = orange-brown clay
d = detrital or sparry cements
e = clear
f = fragments

SITE 462 HOLE CORE 51 CORED INTERVAL: 475.5 to 485.0 m



LITHOLOGIC DESCRIPTION

0.0-5.1 m. Dark greenish gray (5G 4/1) sequences of grain-size graded **VOLCANICLASTIC SEDIMENT.** These grain-size graded beds typically have **CONGLOMERATE** (pebble diameter, 2-5 cm) and fining upwards through cross- and parallel-laminated levels to very light gray (N8) **MARLY NANNOFOSSIL LIMESTONES.** Fucoid burrows are common in these limestones. Some strata in parts of the core occur at angles of 15-30° from the horizontal and may represent slump folds. Contorted bedding occurs from 3.6-4.7 m.

SMEAR SLIDE (%)

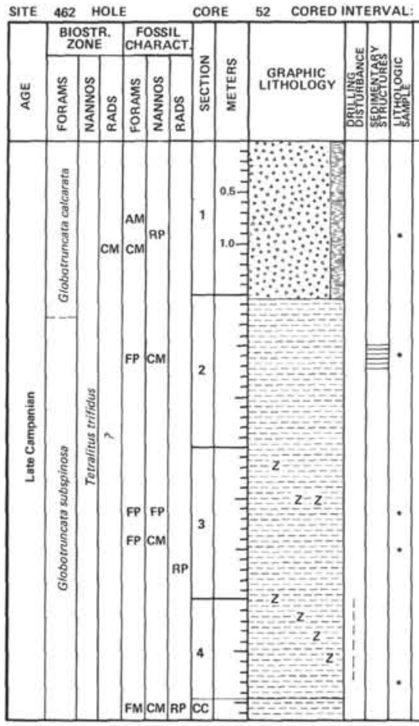
	Volcanic siltstone	Marly nannofossil limestone	Marly nannofossil limestone	Claystone
TEXTURE AND MINERALS	1-60 (D)	1-76 (D)	2-36 (D)	3-36 (D)
Sand size	–	–	–	3
Silt size	–	40	30	12
Clay size	–	60	70	85
Clay	20	40	40	81
Feldspar	Tr	–	–	–
Heavy minerals	1	–	–	Tr
Zeolite	23	–	–	1
Carbonate unsp.	Tr	35	30	7
Foraminifera	–	2.5(?)	–	–
Calc. nannofossils	–	20	29	3
Radiolaria	–	2.5(?)	–	Tr
Sponge spicules	–	–	–	3
Opaque	20	–	–	–
Volcanic glass	36*	–	1	5**

*Fresh and altered
**Altered

THIN SECTION DESCRIPTION
1, 59-63 cm: Altered vitric tuff

X-RAY DIFFRACTION:
1, 59-63 cm: Abundant smectite; common x-ray amorphous material (x-ray amorphous material is not fresh glass, as all glass is altered); common clinoptilolite; common to trace amounts of feldspar, kaolinite and calcite.

SITE 462 HOLE CORE 52 CORED INTERVAL: 485.0 to 494.5 m



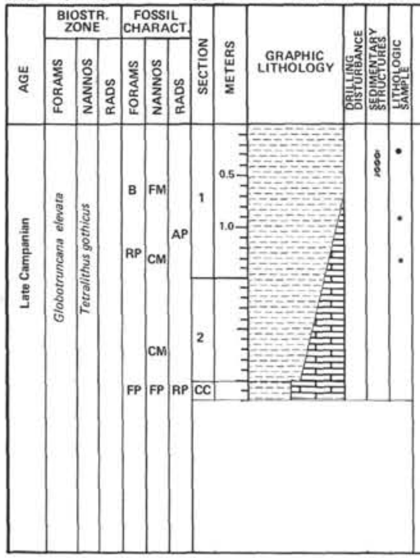
LITHOLOGIC DESCRIPTION

0.0-2.8 m. Greenish gray (5G 6/1) matrix-rich **VOLCANIC BRECCIA,** interbedded with **MARLY LIMESTONES.**
2.8-5.7 m. Greenish gray (5G 6/1) to light olive gray (5Y 6/1), finely parallel laminated and massive burrowed units of **CLAYSTONE.** Some thin (0-2 cm) pale blue-green (5BG 7/4) and dark yellowish brown (10YR 4/2) layers of **ZEOLITIC CLAYSTONE.** Light gray (N7) levels are **LIMESTONE.** The Core-Catcher sample is **CALCAREOUS CLAYSTONE.**

SMEAR SLIDE (%)

	Claystone	Claystone	Calcarenite	Limestone	Zeolitic claystone
TEXTURE AND MINERALS	**1-90 (D)**	**2-55 (D)**	**3-68 (M)**	**3-100 (D)**	**4-29 (M)**
Silt size	15	25	–	20	–
Clay size	85	75	–	80	–
Clay	85	74	38	10	8
Heavy minerals	Tr	Tr	Tr	–	–
Zeolite	1	1	2	–	90
Carbonate unsp.	8	10	50	85	–
Foraminifera	1	Tr	–	–	–
Calc. nannofossils	3	5	5	5	–
Radiolaria	Tr	–	–	–	–
Fish remains	Tr	Tr	–	–	–
Volcanic glass	2	10	5	–	2

SITE 462 HOLE CORE 53 CORED INTERVAL: 494.5 to 504.0 m



LITHOLOGIC DESCRIPTION

0.0-2.5 m. Light olive gray (5Y 6/1) to olive gray (5Y 4/1) **CLAYSTONE.** Thin (1-3 cm) pale blue-green (5BG 7/4) and dusky yellowish brown (10YR 2/2) **ZEOLITIC CLAYSTONE** layers. Some mottling becoming more carbonate-rich downward. Thin layers of dusky yellowish brown (10YR 2/2) **VOLCANOGENIC CLAYSTONE.**
2.5-2.7 m. Core-catcher sample is light olive-gray (5Y 6/1) **MARLY LIMESTONE.**

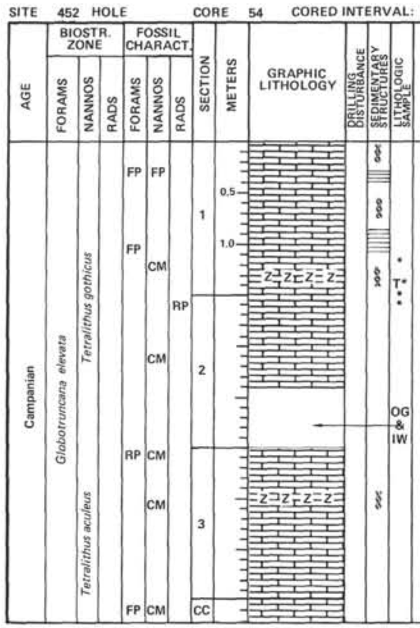
SMEAR SLIDE (%)

	Zeolitic claystone	Marly limestone	Volcanogenic claystone
TEXTURE AND MINERALS	**1-19 (M)**	**1-95 (D)**	**1-126 (M)**
Sand size	–	–	–
Silt size	–	20	–
Clay size	–	80	–
Feldspar	–	–	Tr
Heavy minerals	–	–	1
Zeolite	60	–	3
Carbonate unsp.	–	50	5
Calc. nannofossils	1	10	3
Clay	39	40	73
Volcanic glass	–	–	15*

*Altered

CARBONATE BOMB (%, $CaCO_3$)
1, 25-28 cm: 67%

SITE 452 HOLE CORE 54 CORED INTERVAL: 509.0 to 513.5 m



LITHOLOGIC DESCRIPTION

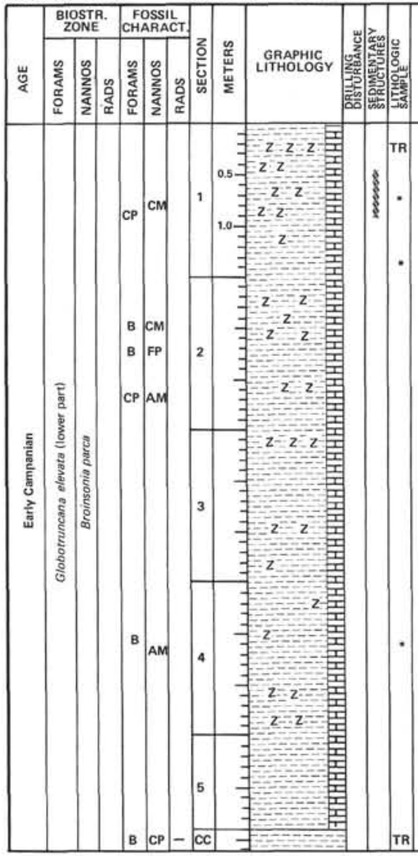
0.0-4.5 m. Light olive gray (5Y 6/7) **LIMESTONE,** consisting of parallel-laminated units passing up through massive units to finally dark burrow-mottled, more **CLAY-rich** tops. Overlying these are pale bluish-green (5BG 7/2) and pale brown (5YR 5/2) **ZEOLITIC** layers.
4.5-4.7 m. The Core-catcher sample is light olive gray (5Y 6/1) and light bluish-gray (5B 7/7) **LIMESTONE.**

SMEAR SLIDE (%)

	Limestone	Zeolitic claystone	Limestone
TEXTURE AND MINERALS	**1-110 (D)**	**1-144 (M)**	**1-148 (D)**
Silt size	20	50	30
Clay size	80	50	70
Clay	10	–	5
Feldspar	–	1	–
Heavy minerals	–	–	Tr
Volcanic glass	Tr	–	Tr
Micronodules	–	Tr	–
Zeolite	Tr	98	–
Carbonate unsp.	80	–	75
Calc. nannofossils	10	Tr	20
Radiolaria	–	–	Tr
Sponge spicules	–	–	Tr
Fish remains	Tr	1	–

THIN SECTION DESCRIPTION
1, 144 cm: Zeolitic claystome–zeolites 90%, zeolitic radiolarian casts (probably former radiolarian ooze).

SITE 462 HOLE CORE 55 CORED INTERVAL: 513.5 to 522.5 m



LITHOLOGIC DESCRIPTION

0.0-6.9 m. Pinkish-gray (5YR 8/1) to brownish gray (5YR 6/1) **CLAYSTONE** with burrow-rich layers, typically capped by pale bluish-green (5BG 7/2) and pale brown (5YR 5/2) **ZEOLITIC MARLSTONE.** Some olive gray **CLAYSTONE.** Pale brown to grayish red (10R 4/2) **ZEOLITIC MARLSTONES** in units <40 cm thick.
6.7-6.9 m. Core-catcher sample is grayish red (10R 4/2) **ZEOLITIC CLAYSTONE.**

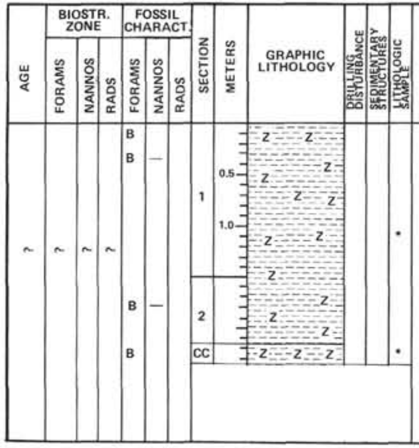
SMEAR SLIDE (%)

	Zeolitic claystone	Claystone	Claystone	Zeolitic marlstone	Zeolitic marlstone
TEXTURE AND MINERALS	1-66 (D)	1-72 (D)	1-140 (D)	2-110 (D)	4-130 (D)
Sand size	–	–	–	–	–
Silt size	65	25	10	10	5
Clay size	35	75	90	90	95
Clay	35	72	81	25	45
Feldspar	–	–	–	–	1
Heavy minerals	–	Tr	–	–	–
Palagonite	–	–	–	8	4
Zeolite	60	5	3	10	15
Carbonate unsp.	–	10	5	10	5
Calc. nannofossils	–	10	10	45	25
Volcanic glass (alt)	5	3	1	2	5

THIN SECTION DESCRIPTION
5, 24-27 cm: Claystone with uniform extinction and ~2% fish remains.
5, CC: Zeolitic marlstone.

X-RAY DIFFRACTION
5, 24-27 cm: Abundant x-ray amorphous matter, palygorskite, and smectite; common quartz; traces of clinoptilolite and opal-CT.
5, CC: Abundant smectite; common clinoptilolite, x-ray amorphous material, and calcite; common to traces of palygorskite and quartz.

SITE 462 HOLE CORE 56 CORED INTERVAL: 522.5 to 531.5 m



LITHOLOGIC DESCRIPTION

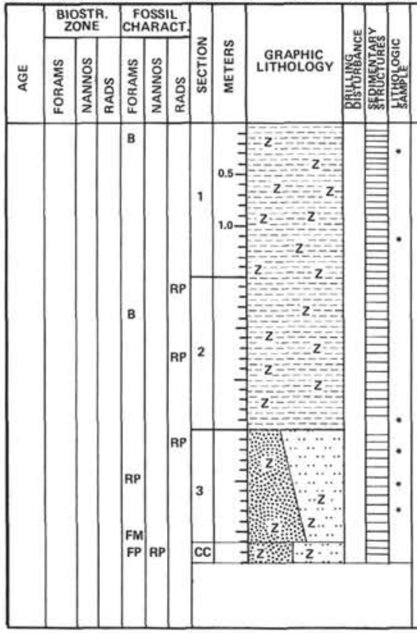
0.0-2.35 m. Pale reddish-brown (10R 5/4) **ZEOLITIC CLAYSTONE** with sparse pale blue-green (5BG 7/2) blotches.

SMEAR SLIDE (%)

TEXTURE AND MINERALS	Zeolitic claystone (D)	Zeolitic claystone (D)
Silt size	20	5
Clay size	80	95
Clay	5	30
Feldspar	Tr	1
Heavy minerals	Tr	Tr
Volcanic glass	3*	4
Palagonite	7	5
Zeolite	80	60
Sponge spicules	–	Tr
Fish remains	–	Tr

*Light

SITE 462 HOLE CORE 57 CORED INTERVAL: 531.5 to 540.5 m



LITHOLOGIC DESCRIPTION

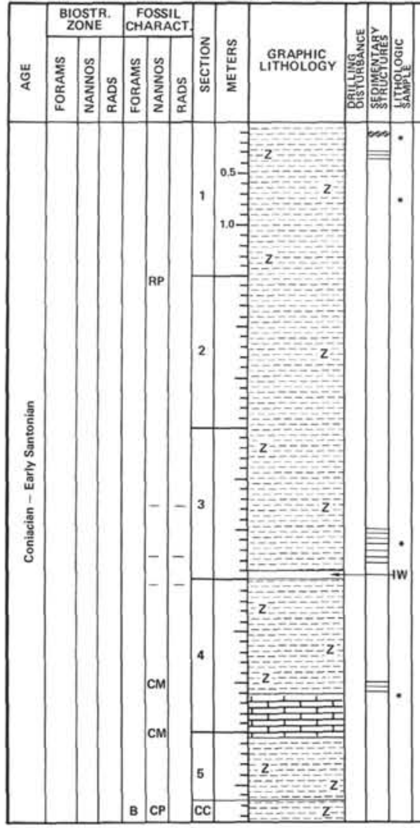
0.0-3.0 m: Laminated grayish-red (10R 4/2) **ZEOLITIC CLAYSTONE,** with sparse blue-green (5BG 7/2) blotches. Some thin (1 cm) layers of medium gray **ZEOLITIC SILTSTONE.** From 2.8-3.0 m is light olive gray (5Y 6/1).
3.0-4.13 m: Greenish (5G 6/1) t0 dark greenish-gray (5GY 4/1) parallel-laminated **VOLCANICLASTIC SANDSTONE and SILTSTONE** containing some carbonate.
4.13-4.33 m: Core-catcher sample is light olive gray (5Y 6/1) **ZEOLITIC MUDSTONE** and greenish-gray parallel-laminated **VOLCANICLASTIC SANDSTONE.**

SMEAR SLIDE (%)

	Zeolitic siltstone	Zeolitic claystone	Zeolitic mudstone	Calcareous zeolitic siltstone	Calcareous volcaniclastic siltstone
TEXTURE AND MINERALS	1-30 (M)	1-117 (D)	2-143 (D)	3-20 (D)	3-78 (D)
Sand size	–	–	–	–	10
Silt size	60	25	50	60	60
Clay size	40	75	50	40	30
Clay	10	20	10	5	5
Feldspar	20	2	5	5	5
Heavy minerals	5	6	Tr	2	3
Volcanic glass	30*	2	25	20	35
Palagonite	–	14	5	10	2
Zeolite	35	56	55	38	20
Carbonate unsp.	–	–	–	20	30
Calc. nannofossils	–	–	–	Tr	–
Radiolaria	–	–	–	Tr**	–

*Mainly altered
**Silicified

SITE 462 HOLE CORE 58 CORED INTERVAL: 540.5 to 549.5 m



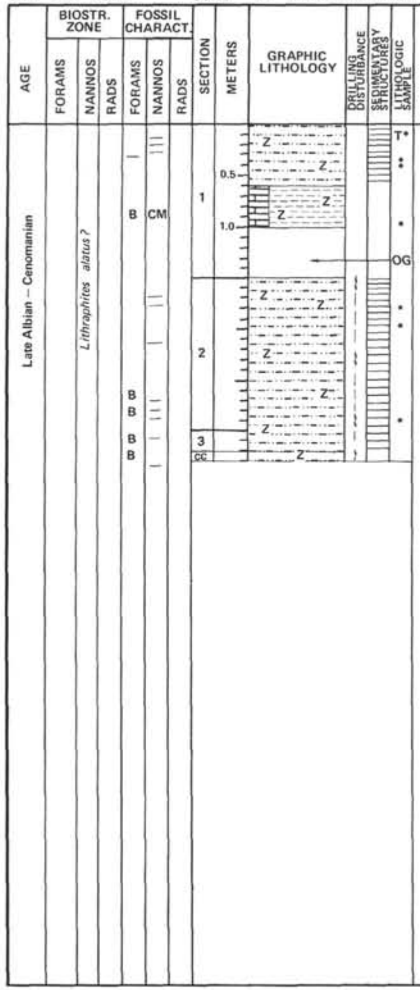
LITHOLOGIC DESCRIPTION

0.0-5.6 m: ZEOLITIC CLAYSTONE to ZEOLITIC MUDSTONE in shades of brown (5YR 4/1, 6/4, 5/2, to 10R 3/2). Blue-green to green mottles occur along cracks (joints and irregular fractures). Drusy calcite and quartz occur locally along the cracks at 2.0 and 2.8 m.
5.6-6.1 m: Grayish orange (2.5YR 7/2) **NANNOFOSSIL MARLSTONE.**
6.1-6.8 m: Brown **ZEOLITIC MUDSTONE** as in the 0.0 to 5.6 m interval.

SMEAR SLIDE (%)

	Black mottle	Zeolitic marlstone	Zeolitic marlstone	Marlstone
TEXTURE AND MINERALS	1-3 (M)	1-75 (D)	3-120 (D)	4-120 (D)
Sand size	–	–	–	–
Silt size	–	10	20	–
Clay size	–	90	80	–
Clay	–	40	45	25
Feldspar	–	3	Tr	–
Heavy minerals	–	2	Tr	–
Volcanic glass	5	10	10	Tr
Palagonite	Tr	5	–	Tr
Zeolite	–	40	45	5
Carbonate unsp.	–	–	–	50
Calc. nannofossils	–	–	–	20
Opaque	85	–	–	–

SITE 462 HOLE CORE 59 CORED INTERVAL: 549.5 to 558.5 m



LITHOLOGIC DESCRIPTION

0.0-0.6 m. Laminated, **ASHY ZEOLITIC MUDSTONE** in various shades of brown with minor yellow and green.
0.6-O.G. Sample (1.02 m) is pale brown (5YR 5/2) **ZEOLITIC MARLSTONE** with nannofossils.
O.G. Sample (1.53 m) to 3.3 m. ZEOLITIC MUDSTONE has alternating laminae and mottles of reddish brown (2.5YR 5/4) and grayish brown (5YR 3/2).
A Fe-Mn-rich 3-cm thick bed occurs at 1.8 m.

SMEAR SLIDE (%)

	Altered volcanic ash	Zeolitic mudstone	Zeolitic mudstone	Zeolitic marlstone
TEXTURE AND MINERALS	1-15 (M)	1-39 (D)	1-45 (D)	1-94 (D)
Sand size	–	5	–	–
Silt size	70	35	–	20
Clay size	30	60	–	80
Clay	–	20	–	30
Feldspar	2	Tr	3	1
Heavy minerals	3	Tr	5	Tr
Volcanic glass	–	25	–	5
Volcanic glass (alt.)	10	–	10	–
Palagonite	35	5	5	4
Zeolite	50	50	–	35
Carbonate unsp.	–	–	–	10
Calc. nannofossils	–	–	–	15
Opaque	–	–	–	–

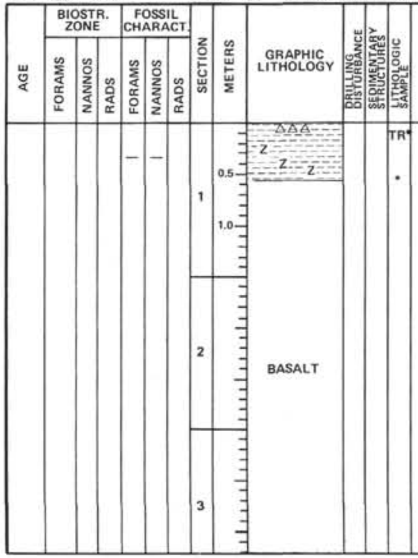
SMEAR SLIDE (%)

	Mn-Fe oxides	Zeolitic mudstone	Zeolitic mudstone
TEXTURE AND MINERALS	2-24 (D)	2-40 (D)	2-139 (M)
Sand size	–	–	–
Silt size	–	40	40
Clay size	–	60	60
Clay	–	–	–
Feldspar	–	–	–
Heavy minerals	–	5	5
Volcanic glass	5	40	40
Volcanic glass (alt.)	–	–	–
Palagonite	–	–	10
Zeolite	5	45	45
Carbonate unsp.	–	–	–
Calc. nannofossils	–	–	–
Opaque	90*	–	–

*Coatings on zeolite

THIN SECTION DESCRIPTION
1, 13-15 cm: Radiolarian porcellanite; opal-CT is abundant, quartz is common.

SITE 462 HOLE CORE 60 CORED INTERVAL: 558.5 to 567.5 m



LITHOLOGIC DESCRIPTION

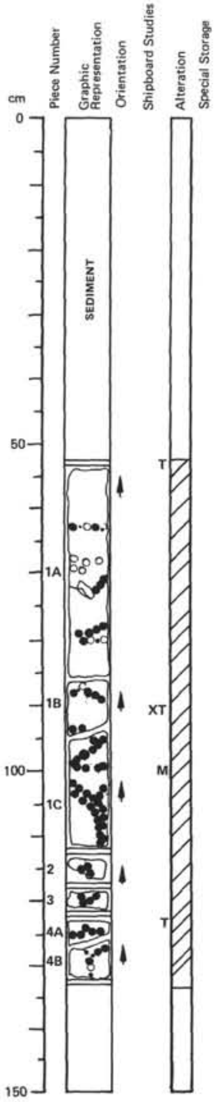
0.0-0.56 m. Grayish red (10YR 4/2) to dark reddish-brown (10R 3/4) **ZEOLITIC CLAYSTONE** with one piece of moderate brown (5YR 3/4) **PORCELLANITE.**
0.56-4.2 m: See detailed description "Visual Core Descriptions of Igneous Rock". Basalt with abundant selvages of altered glass and veins.

SMEAR SLIDE (%)

	Zeolitic claystone	Palagonitic claystone
TEXTURE AND MINERALS	1-15	1-53
Sand size	–	–
Silt size	50	–
Clay size	50	–
Clay	50	47
Volcanic glass	–	3
Palagonite	40	50
Zeolite	10	–
Sponge spicules	–	Tr

THIN SECTION DESCRIPTION
1, 0.0-2.0 cm: Goethite-rich quartzose chert.

X-RAY DIFFRACTION
1, 0.0-2.0 cm: Abundant quartz; common x-ray amorphous matter; common to trace goethite.



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
6 1	4 6 2		6 0	1

Depth: 558.5 to 560.0 m

MAJOR ROCK TYPE—MASSIVE APHYRIC, SLIGHTLY PHYRIC, BASALT SILL

Macroscopic Description:
Pieces 1 through 4 are massive, aphyric (slightly phyric basalt sill, with veins of celadonite, calcite, and celadonite plus calcite and clay.
Texture: 55 to 60 cm = chilled margin (?); 60 to 99 cm = transitional zone (fine grained); and 99 cm to 133 cm = slightly coarse grained.
Color: 55 to 60 cm = pinkish gray (5YR 8/1); 60 to 133 cm = greenish gray (5G 6/1); and chlorite vein = dusky blue green (5BG 3/2).
Alteration: has occurred around the veins.

Thin Section Descriptions
Section 1, 55 cm, piece 1A: Highly altered basalt sampled at chill margin of sill.
Phenocrysts: Olivine < 1%, 0.3-0.5 mm, euhedral, replaced by Fe smectite and iddingsite; plagioclase (An70) 1.5%, 0.3-1.0 mm, skeletal and euhedral, often replaced by calcite; clinopyroxene 1%, 0.3-0.5 mm, euhedral, clear in color (fresh).
Groundmass: Plagioclase 5%, microlites and microphenocrysts; quench spherulites about clinopyroxene, magnetite 10%, fine grained dust; glass is altered; zeolite (alteration), 2V = 20° 0.03 mm, aciculor, r>v, high relief.
Texture: Variolitic to hyalopilitic and groundmass mesostasis.
Alteration: Carbonate in veins and groundmass replacing plagioclase groundmass; clay in veins and groundmass replacing olivine, plagioclase, and glass groundmass; zeolites in veins replacing previous alteration products; chlorite in veins and glass groundmass replacing plagioclase, and glass groundmass. Sequence of alteration is (1) clay plus chorite, (2) calcite, and (3) zeolites.
Section 1, 90-92 cm, piece 1B: Highly altered basalt in sill interior.
Phenocrysts: Plagioclase (An65) 10%, 0.3-1.0 mm (An65). phenocrysts + microphenocrysts; clinopyroxene 10%, 0.2-1.0 mm, microphenocrysts, clear to light brown (fresh).
Groundmass: Plagioclase 10%, 0.03 mm; clinopyroxene 10%, 0.03 mm; magnetite 15%, 0.03 mm; glass 60%, mesotasis.
Alteration: Green clays in veins and groundmass replacing olivine and glass.
Texture: Intersertal, mesotasis.
Section 1, 125-127 cm, Piece 4: Highly altered basalt in sill interval, at a vein.
Phenocrysts: Olivine ~ 1%, ~0.5 mm pseudomorphic (clay); (aphyric).
Groundmass: Plagioclase 15%, 0.01-0.05 mm; clinopyroxene 10%, 0.01-0.05 mm; magnetite 10%, 0.01-0.05 mm; glass 65%, altered mesostasis.
Alteration: Clays in vein and patches replacing plagioclase, groundmass, and olivine; zeolites and chlorite veins and patches replacing plagioclase, clinopyroxene, and groundmass.
Texture: Intersertal, mesostasis.

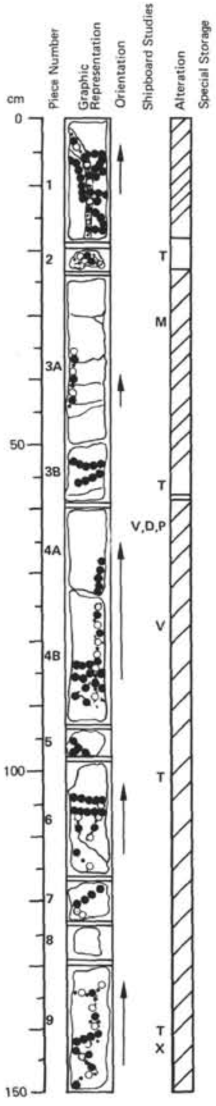
Shipboard Geometry (XRF, %):

	Altered basalt
SiO_2	48.38
TiO_2	1.40
Al_2O_3	15.01
FeO	9.47
MnO	0.14
MgO	7.34
CaO	11.02
Na_2O	–
K_2O	0.67
P_2O_5	0.22
Total	93.65
LOI†	7.38
FeO* ÷ MgO	1.29
CaO ÷ Al_2O_3	0.72
FeO* ÷ TiO_2	6.76

Paleomagnetism/Physical Properties:

Interval	**101 cm**
Intensity (10^{-3} emu/cc)	5.0
NRM Incl. (°)	–49.7
MDF (Oe.)	105.0
Stable Incl. (°)	–43.9
Vp ∥ (km/s)	–
Vp ⊥ (km/s)	–
D (g/cm)	–
P (%)	–

*Heated to 110°C for six hours prior to determination of LOI
†LOI = Loss on ignition at 1050°C



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
6 1	4 6 2		6 0	2

Depth: 560.0 to 561.5 m

MAJOR ROCK TYPE—MASSIVE APHYRIC BASALT SILL, same unit as above in 60–Section 1.

Macroscopic Description:
Massive aphyric basalt sill with veins, of celadonite, calcite, and celadonite plus calcite and clay.
Pieces 1, 2, 3A, 3B, 10-60cm: Slightly coarse grained.
Pieces 4 and 5, 60-98 cm: are transitional zone.
Piece 6, 98-150 cm: fine grained (aphyric).

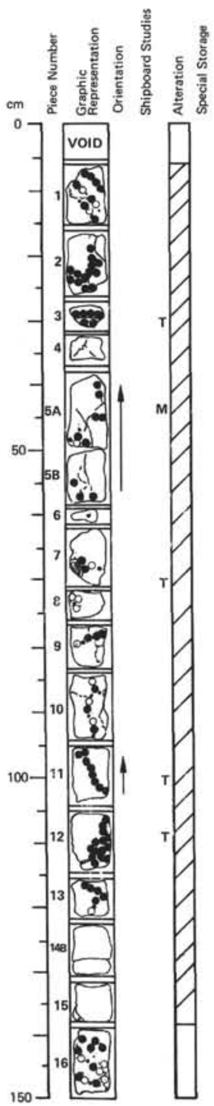
Thin Section Description:
Section 2, 21-23 cm: Basalt and calcite vein in sill (Piece 2).
Phenocrysts: Olivine 1%, 0.5 mm, pseudomorphic after greenish brown clay; plagioclase (An68) 2%, 0.3-0.6 mm, clinopyroxene (augite) 0.2-0.5 mm; euhedral.
Groundmass: Plagioclase 15%; clinopyroxene 40%; magnetite 20%; glass mesostasis.
Alteration: Sequence is (1) calcite, (2) green clay, (3) zeolite plus chlorite in veins.
Texture: Spherulitic to intersertal, mesostasis.
Section 2, 53-57 cm, Piece 3B: Altered diabase from sill interior.
Phenocrysts: Aphyric clinopyroxene.
Groundmass: Plagioclase (An68) 35%, 0.2-1.0 m; clinopyroxene 35%, 0.1-0.4 mm; magnetite 10%, 0.01 to 0.1 mm.
Alteration: Clays 20% replacing clinopyroxene and plagioclase and in diktytaxitic vugs.
Texture: Equigranular to microdiabasic.
Section 2, 103-107 cm, Piece 6: Altered basalt in sill interior.
Phenocrysts: Plagioclase (An73) 2%, 0.5-0.7 mm; clinopyroxene (augite) 1%, ~0.2-0.5 mm, skeletal and euhedral.
Groundmass: Plagioclase 15%; clinopyroxene 15%; magnetite 10%; glass 60%, altered mesostasis.
Alteration: Zeolite, green smectite, chlorite, nontronite Fe hydroxides and oxides in veins. Glass in groundmass altered to brown and green clays.
Texture: Hyalopilitic, spherulitic, variolitic, mesostasis.
Section 2, 135-139 mm, Piece 9: Altered basalt.
Phenocrysts: Olivine 1%, 0.3-0.5 mm, altered. Plagioclase (An80) 1%, 0.3-0.7 mm; clinopyroxene (augite) 2%, 0.2-0.4 mm; and spinel.
Groundmass: Plagioclase 10%, <0.02-0.1 mm; clinopyroxene 40%, quench phase, <0.02-0.1 mm; magnetite 20%, <0.02-0.1 mm; and glass 30% (altered).
Alteration: Zeolite and chlorite replacing plagioclase; clay replacing glass in the groundmass; and olivine pseudomorphic of smectite.
Texture: Hyalopilitic, glomerophyric.

Shipboard Geochemistry (XRF, %):

	Altered basalt 139-142 cm
SiO_2	49.65
TiO_2	1.42
Al_2O_3	15.37
FeO	10.36
MnO	0.15
MgO	7.86
CaO	11.40
Na_2O	–
K_2O	0.63
P_2O_5	0.25
Total	97.09
LOI	4.96
FeO ÷ MgO	1.31
CaO ÷ Al_2O_3	0.74
FeO ÷ TiO_2	7.29

Paleomagnetism/Physical Properties:

Interval	**33 cm**	**63-65 cm**	**78-80 cm Across Vein**
Intensity (10^{-3} emu/cc)	3.8	–	–
NRM Incl. (°)	–38.2	–	–
MDF (Oe.)	115.0	–	–
Stable Incl. (°)	–36.1	–	–
Vp ∥ (km/s)	–	5.15	4.05
Vp ⊥ (km/s)	–	–	4.23
D (g/cc)	–	2.80	–
P (%)	–	8.1	–



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
6 1	4 6 2		6 0	3

Depth: 561.5 to 563.0 m

MAJOR ROCK TYPE—MASSIVE APHYRIC BASALT SILL

Macroscopic Description:
Massive aphyric basalt sill with veins, of celadonite, calcite, and celadonite plus calcite and clay. Same unit as above in Core 60, Section 1. Pieces 1-15 (140 cm) are fine grained.

Thin Section Descriptions:

Section 3, 34-36 cm, Piece 3: Highly altered aphyric basalt from interior of sill.

Phenocrysts: Olivine <1-2%, 0.1-0.2 mm, equidimensional, pseudomorphs; plagioclase (An70-80) 1-15%, 0.2-0.6 mm elongated-tabular; clinopyroxene (augite) 1-22%, 0.2-0.4 mm, euhedral to rounded spinel < 1%; picotite, 0.01 mm, inclusion in olivine pseudomorphs.

Groundmass: Plagioclass 1-5%, microtites; clinopyroxene tr,disseminated, <0.02 mm; glass 78-99% (totally altered), variolitic aggregates.

Alteration: Clay (reddish brown) in groundmass replacing glass; chlorite in veins and replacing all minerals; veins of zeolites in groundmass. Smectite and iddingsite replacing olivine in phenocrysts. Chlorite in veins replacing all minerals.

Texture: Variolitic.

Section 3, 66-69 cm, Piece 7: Altered aphyric basalt sill.

Phenocrysts: Olivine 2%, 0.2-0.6 mm, altered, euhedral; plagioclase (An80-72) 8%, 0.2-2.0 mm, elongated laths, marginal rims more acid; clinopyroxene trace.

Groundmass: Plagioclase (An75) 10%, <0.2 mm, microlites; clinopyroxene 30%(?), <0.05 mm, disseminated grains and stellated aggregates; magnetite >1%, <0.02 mm, dust-like; ilmenite(?); glass 59%, intersertal, partly altered.

Alteration: Clays (70%) in groundmass replacing glass (to brown smectite); chlorite (light green) in veins replacing all minerals; olivine in phenocrysts altered to smectite.

Texture: Variolitic.

Section 3, 97-102 cm, Piece 11: Altered aphyric basalt sill.

Phenocrysts: Olivine ?%, 0.1-0.2 mm, equidimensional, pseudomorphs; plagioclase (An65-55) 15%, 0.04-1.0 mm; elongated laths, glomeroporphyric aggregates; clinopyroxene 5%, 0.2-0.4 mm, equidimensional, rounded, disseminated crystals.

Groundmass: Plagioclase 10%, <0.2-0.06 mm, small microtites, zonation distinct; clinopyroxene 2%, <0.04 mm, rounded grains; disseminated grains and stelleo aggregate; magnetite 20%, <0.004 mm, dust-like; ilmenite(?); glass 68% altered.

Alteration: Reddish-brown Fe-rich saponite(?) and smectite (interstitial) replacing olivine, plagioclase and all glass in groundmass.

Texture: Hyalopilitic to variolitic.

Section 3, 108-113 cm, Piece 12: Altered aphyric basalt sill.

Phenocrysts: Olivine ?%, 0.1-0.4 mm; equidimensional pseudomorphs; plagioclase (An42-65) 2%, 0.5-0.2 mm, elongated laths, often glomeroporphyric aggregates; clinopyroxene 1%, 0.2-0.5 mm, equidimensional, rounded disseminated crystals.

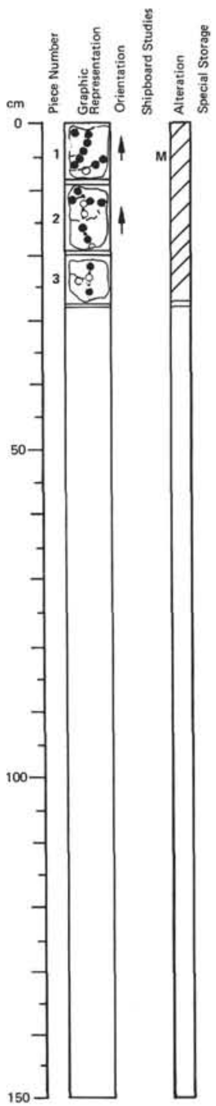
Groundmass: Plagioclase (An60-45) 30%, <0.5 mm, microlites, more acid margins; clinopyroxene 15%, <0.2 mm, intersertal, round; magnetite 20%, <0.4 mm, dust-like disseminated grains; ilmenite(?); glass 35%, interstitial, altered.

Alteration: Fe-rich smectite (40%) in groundmass and phenocrysts replacing olivine and glass; chlorite (5%) replacing plagioclase of glomeroporphyric.

Texture: Intersertal.

Paloomagnetism/Physical Properties :

Interval	**41 cm**
Intensity (10^{-3} emu/cc)	3.2
NRM Incl. (°)	–46.7
MDF (Oe.)	140.0
Stable Incl. (°)	–42.9
Vp ∥ (km/s)	–
Vp ⊥ (km/s)	–
D (g/cc)	–
P (%)	–



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
6 1	4 6 2		6 0	4

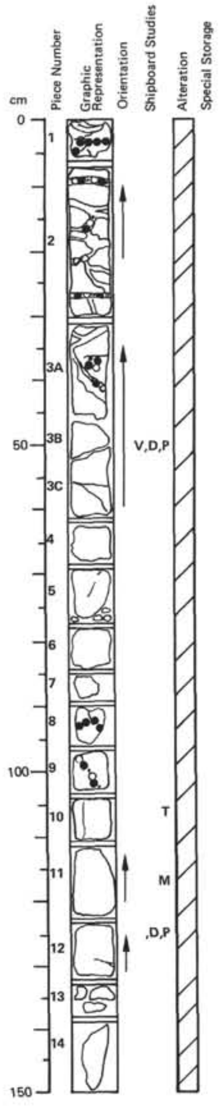
Depth: 563.0 to 564.5 m

MAJOR ROCK TYPE—MASSIVE APHYRIC BASALT SILL

Macroscopic Description:
Massive aphyric basalt sill with veins, of celadonite, calcite, and celadonite plus calcite and clay. Same unit as above in Core 60, Section 1. Pieces 1-3 are aphyric basalt.

Paleomagnetism

Interval	**5 cm**
Intensity (10^{-3} emu/cc)	7.9
NRM Incl. (°)	–34.4
MDF (Oe.)	160.0
Stable Incl. (°)	–34.2



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462		61	1

Depth: 567.5 to 569.0 m

MAJOR ROCK TYPE—MASSIVE APHYRIC BASALT SILL

Macroscopic Description:

Massive aphyric basalt sill with veins, of celadonite, calcite, and celadonite plus calcite and clay. Same unit as above in Core 60, Section 1. In Piece 14 (133-150 cm) sulfides occur on basalt surface.

Thin Section Descriptions:

Section 1, 105-108 cm, Piece 10: Altered diabase sill.

Phenocrysts: Olivine <1%, 0.4-0.5 mm, pseudomorphs; plagioclase (An60 zoned to An30 at rim) <1%, 0.5-1.0 mm; clinopyroxene (2V ~65°, augite) <1%, 0.1-0.2 mm; spinel <1%, 0.04 mm, inclusions in olivine only.

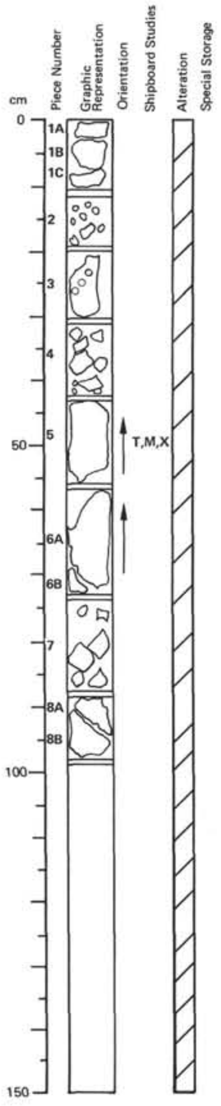
Groundmass: Plagioclase 50%, 0.2-0.4 mm; clinopyroxene 45%, 0.07-0.1 mm, rock contains clots (2-4 mm); magnetite 5%, 0.4 mm, euhedral.

Alteration: Olivine phenocrysts altered to green clay; clays 10% replacing clinopyroxene, plagioclase and groundmass.

Texture: Hyalopilitic, diabasic.

Paleomagnetism/Physical Properties:

Interval	117 cm	48-51 cm	126-128 cm
Intensity (10^{-3} emu/cc)	9.8	–	–
NRM Incl. (°)	–44.2	–	–
MDF (Oe.)	70.0(?)	–	–
Stable Incl. (°)	–36.0(?)	–	–
Vp ∥ (km/s)	–	5.53(?)	5.35(?)
Vp ⊥ (km/s)	–	5.47(?)	5.33(?)
D (g/cc)	–	2.96	2.89
P (%)	–	4.9	4.9



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462		61	2

Depth: 569.0 to 570.5 m

MAJOR ROCK TYPE—MASSIVE APHYRIC BASALT SILL

Macroscopic Description:

Massive aphyric basalt sill with fractures. Same unit as above in Core 60, Section 1, of celadonite, calcite, and celadonite plus calcite and clay. Pieces 2, 4 and 7 are small particles [artifact(?) of drilling(?)].

Thin Section Description:

Section 2, 53-56 cm, Piece 5: Altered diabase sill.

Phenocrysts: Olivine (?) pseudomorphs; plagioclase (An70) <1%, 0.5-1.0 mm.

Groundmass: Plagioclase (An60 zoned to An40) 0.3-0.5 mm; clinopyroxene (augite, 2V ~60°) 40%, 0.1-0.4 mm; magnetite 5%.

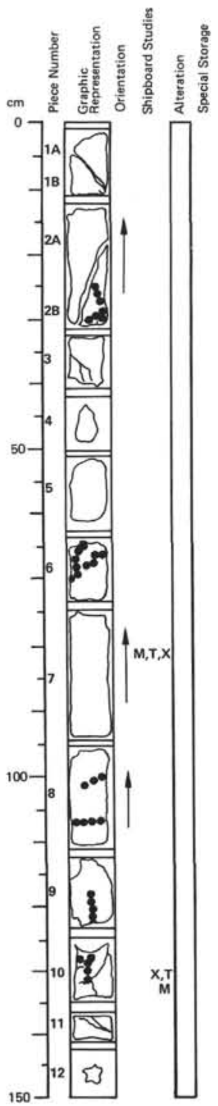
Alteration: Clays (brownish) (20%) replacing olivine phenocrysts and clinopyroxene groundmass.

Shipboard Geochemistry (XRF, %):

Interval	53-55 cm
SiO_2	48.65
TiO_2	1.46
Al_2O_3	14.33
FeO	11.94
MnO	0.20
MgO	7.32
CaO	11.72
Na_2O	–
K_2O	0.09
P_2O_5	0.22
Total	95.95
LOI	0.85
FeO ÷ MgO	1.63
CaO ÷ Al_2O_3	0.81
FeO ÷ TiO_2	8.17

Paleomagnetism/Physical Properties:

Interval	49 cm
Intensity (10^{-3} emu/cc)	5.2
NRM Incl. (°)	–40.2
MDF (Oe.)	55.0
Stable Incl. (°)	–34.8(?)
Vp ∥ (km/s)	–
Vp ⊥ (km/s)	–
D (g/cc)	–
P (%)	–



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462		62	1

Depth: 576.5 to 578.0 m

MAJOR ROCK TYPE––MASSIVE APHYRIC BASALT SILL

Macroscopic Description:

Massive aphyric basalt sill, with veins of celadonite.
Same unit as Core 60, Section 1.
Fine grained = 1-116 cm;
Transitional zone = 116-122 cm;
Slightly coarse grained = 116-122 cm.
The basalt in the section appears to be slightly fresh.

Thin Section Descriptions:

74-81 cm, Piece 7: Altered diabase.

Phenocrysts: Olivine < 1%, 0.3-0.5 mm, pseudomorphs; plagioclase (An80 zoned to An50) < 1%, 0.5-1.0 mm.

Groundmass: Plagioclase (An75 zoned to An40) 40%, 0.5-0.8 mm; clinopyroxene 55%, 0.3-0.5 mm; magnetite 5%, 0.05-0.2 mm, ti-magnetite, euhedral.

Alteration: Brown orange clay pseudomorphs after olivine; clays (10%) replacing plagioclase and clinopyroxene.

Texture: Diabasic.

127-129 cm, Piece 10: Altered basalt.

Phenocrysts: Olivine < 1%, 0.6-0.8 mm, pseudomorphs, plagioclase (An74) < 1%, 0.2-0.4 mm; clinopyroxene (augite) < 1%, 0.08-0.2 mm, altered glass inclusions.

Groundmass: Clinopyroxene, greenish altered; quench; ilmenite 20%, 0.003-0.03 mm, "railroad-track" textured; ti-magnetite; glass quench.

Alteration: Green clay (20%) replacing olivine phenocrysts; chlorite (60%) replacing plagioclase, glass inclusions, and variolitic groundmass.

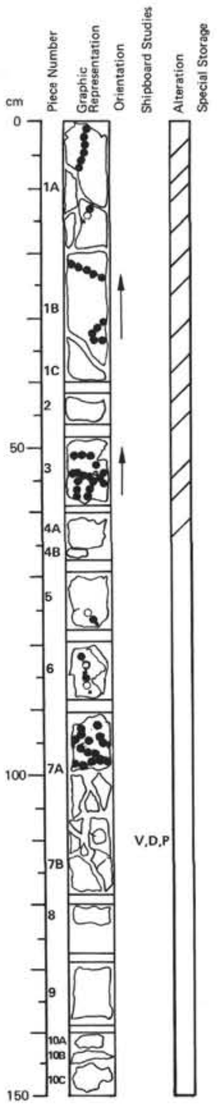
Texture: Variolitic.

Shipboard Geochemistry (XRF, %):

Interval	**79-81 cm**	**127-129 cm**
SiO_2	48.93	50.19
TiO_2	1.39	2.18
Al_2O_3	13.56	16.24
FeO	12.33	11.66
MnO	0.21	0.29
MgO	6.61	6.52
CaO	11.53	7.30
Na_2O	–	–
K_2O	0.06	1.09
P_2O_5	0.22	0.24
Total	94.84	95.71
LOI	0.70	2.59
FeO ÷ MgO	1.86	1.78
CaO ÷ Al_2O_3	0.85	0.45
FeO ÷ TiO_2	8.87	5.37

Paleomagnetism/Physical Properties :

Interval	**132 cm**	**85-87 cm**
Intensity (10^{-3} emu/cc)	34.4	–
NRM Incl. (°)	–44.2	–
MDF (Oe.)	175.0	–
Stable Incl. (°)	–42.9	–
Vp ∥ (km/s)	–	5.86(?)
Vp ⊥ (km/s)	–	5.85(?)
D (g/cc)	–	2.88
P (%)	–	5.2



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462		62	2

Depth: 578.0 to 579.5 m

MAJOR ROCK TYPE––MASSIVE APHYRIC BASALT SILL

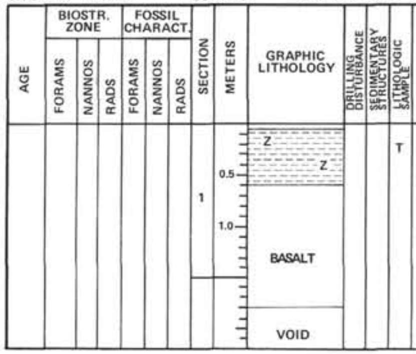
Macroscopic Description:

Massive aphyric basalt sill, with veins of celadonite, and celadonite plus calcite and clay. Same unit as in Core 60, Section 1. Several slight grain size changes occur in this section.

Physical Properties:

Interval	**109 cm**
Vp ∥ (km/s)	5.31(?)
Vp ⊥ (km/s)	5.28(?)
D (g/cc)	2.98
P (%)	2.0

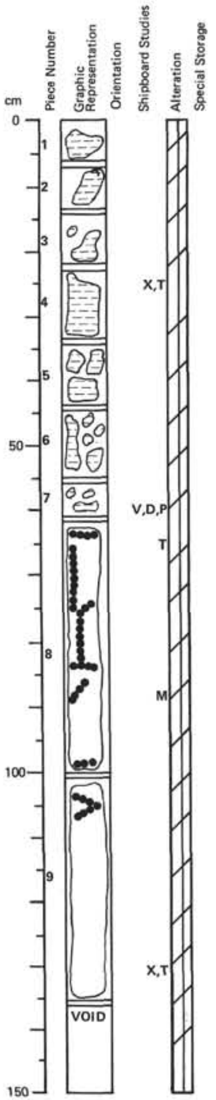
SITE 462 HOLE CORE 63 CORED INTERVAL: 579.5 to 585.5 m



LITHOLOGIC DESCRIPTION

0.0-0.6 m. Black (N1) **CLAYSTONE.**
0.6-1.8 m. BASALT. See detailed description in "Visual Core Descriptions of Igneous Rock".

THIN SECTION DESCRIPTION
1, 26-29 cm: Highly altered volcanogenic siltstone; dominantly volcanogenic debris with a fabric of intergrown green secondary clay minerals. Some detrital grains have recognizable pseudomorphic outlines, which are replaced by clay minerals.



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462		63	1

Depth: 579.5 to 580.9 m

MAJOR ROCK TYPE: 0-61 CM BLACK (N1) CLAYSTONE and ALTERED BASALT SILL

Macroscopic Description:
See sedimentary core form for detailed description of sedimentary material. Altered basalt sill with hyalopilitic and variolitic textures and veins of Celadonite. Grain size increases from 64 to 68 cm. Alteration is almost complete at 136 to 150 cm.

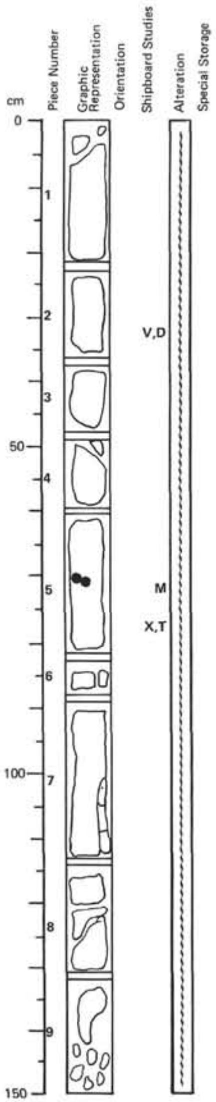
Thin Section Description:
64-68 cm, Piece 8: Altered basalt from sill:
Phenocrysts: Plagioclase (An78-An30) 2%, 0.2-0.5 mm; clinopyroxene (augite) 2%, 0.2-0.3 mm.
Groundmass: Plagioclase (An60 zoned) 20%, 0.1-0.2 mm; clinopyroxene, common quench textured but replaced; magnetite [ti-magnetite(?)] 20%, ~0.01 mm.
Alteration: Clays and chlorite (total 60%) replacing plagioclase, clinopyroxene and groundmass, intergrown chlorite plus clay.
Texture: Hyalopilitic, variolitic.
132-136 cm, Piece 9: Altered diabase sill.
Phenocrysts: Plagioclase < 1%, 0.8-1.0 mm.
Groundmass: Plagioclase (An78 zoned to An60) 40%, 0.1-0.5 mm; clinopyroxene (augite) 20% (50% counting altered clinopyroxene), 0.1-0.2 mm; magnetite (ti-magnetite) 10%, 0.1-0.3 mm.
Alteration: Clays (brownish) and chlorite replacing clinopyroxene and plagioclase. Intergrowth of clay and chlorite.
Texture: Diabasic.

Shipboard Geochemistry (XRF, %):

Interval	**132-136 cm**
SiO_2	48.81
TiO_2	1.76
Al_2O_3	14.38
FeO	12.09
MnO	0.20
CaO	11.08
Na_2O	–
K_2O	0.14
P_2O_5	0.25
Total	96.27
LOI	1.28
FeO ÷ MgO	1.59
CaO ÷ Al_2O_3	0.77
FeO ÷ TiO_2	6.86

Paleomagnetism/Physical Properties:

Interval	**89 cm**	**58-60 cm**
Intensity (10^{-3} emu/cc)	6.0	–
NRM Incl. (°)	–46.4	–
MDF (Oe.)	50.0	–
Stable Incl. (°)	–44.0	–
Vp ∥ (km/s)		•
Vp ⊥ (km/s)	–	3.11(?)
D (g/cc)	–	2.32
P (%)	–	36.1



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462		63	2

Depth: 580.9 to 582.4 m

MAJOR ROCK TYPE––MASSIVE MICRODIABASIC BASALT SILL

Macroscopic Description:
Homogeneous microdiabasic altered basalt, with very sparse plagioclase phenocrysts as in bottom of Section 1. A vein of celadonite occurs at 79-83 cm.

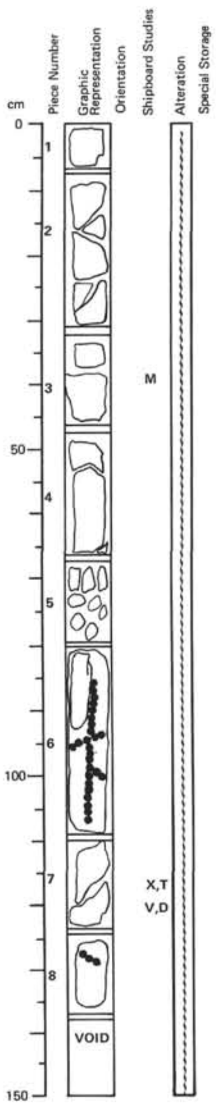
Thin Section Description:
77-83 cm, Piece 5: Altered diabase.
Phenocrysts: Plagioclase < 1%, 0.8-1.1 mm, (AN<?, no section).
Groundmass: Plagioclase (An70 zoned to An42 on rim) 40%, 0.1-0.3 mm; clinopyroxene (augite) 20% (50% if counting the altered clinopyroxene), 0.2-0.5 mm; glomerophyric clots with plagioclase.
Alteration: Brownish clays and chlorite (40% total) replace clinopyroxene and plagioclase, and also form veins.
Texture: Diabasic.

Shipboard Geochemistry (XRF,%):

Interval	**79-83 cm**
SiO_2	1.84
TiO_2	1.84
Al_2O_3	14.82
FeO	12.14
MnO	0.18
MgO	7.80
CaO	10.21
Na_2O	–
K_2O	0.02
P_2O_5	0.26
Total	96.12
LOI	1.96
FeO ÷ MgO	1.55
CaO ÷ Al_2O_3	0.69
FeO ÷ TiO_2	6.59

Paleomagnetism/Physical Properties:

Interval	**71 cm**	**32-34 cm**
Intensity (10^{-3} emu/cc)	7.1	–
NRM Incl. (°)	–32.2	–
MDF (Oe.)	55.0	–
Stable Incl. (°)	–39.9	–
Vp ∥ (km/s)	–	4.83(?)
Vp ⊥ (km/s)	–	4.80(?)
D (g/cc)	–	2.84
P (%)	–	



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462		63	3

Depth: 582.4 to 583.8 m

MAJOR ROCK TYPE—MASSIVE MICRODIABASIC BASALT SILL

Macroscopic Description:
Homogeneous microdiabasic basalt with very sparse plagioclase phenocrysts. Same as Core 63, Section 2 with the exception that it goes through grain size maximum at the end of Section 2 and decreases thereafter. Veins are celadonite.

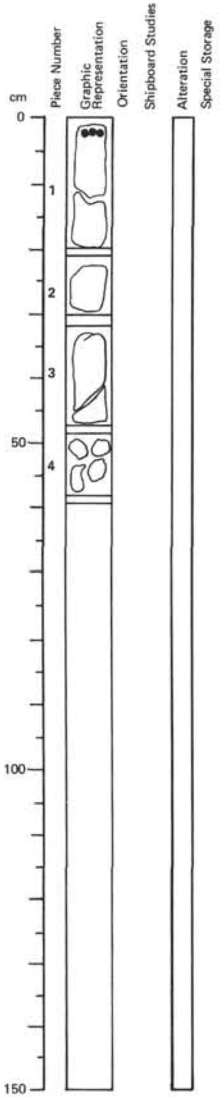
Thin Section Descriptions:
119-122 cm, Piece 7: Altered diabase.
Phenocrysts: Plagioclase <1%, 0.8-1.1 mm.
Groundmass: Plagioclase (An70 zoned to An42) 40%, 0.1-0.3 mm; clinopyroxene (augite) 20% (50% if altered clinopyroxene included), 0.2-0.5 mm; glomerophyric clots with plagioclase.
Alteration: Brownish clays and chlorite (>40% total) replace clinopyroxene and plagioclase, and also form veins.
Texture: Diabasic.

Shipboard Geochemistry (XRF, %):

Interval	**119-127 cm**
SiO_2	49.07
TiO_2	1.85
Al_2O_3	15.08
FeO	11.73
MnO	0.23
MgO	7.19
CaO	10.25
Na_2O	–
K_2O	0.04
P_2O_5	0.25
Total	95.69
LOI	1.50
FeO ÷ MgO	1.63
CaO ÷ Al_2O_3	0.68
FeO ÷ TiO_2	6.34

Paleomagnetism/Physical Properties:

Interval	**40 cm**	**117-120 cm**
Intensity (10^{-3} emu/cc)	19.5	–
NRM Incl. (°)	–43.0	–
MDF (Oe.)	65.0	–
Stable Incl. (°)	–43.7	–
Vp ∥ (km/s)	–	4.72(?)
Vp ⊥ (km/s)	–	4.83(?)
D (g/cc)	–	2.83
P (%)	–	–



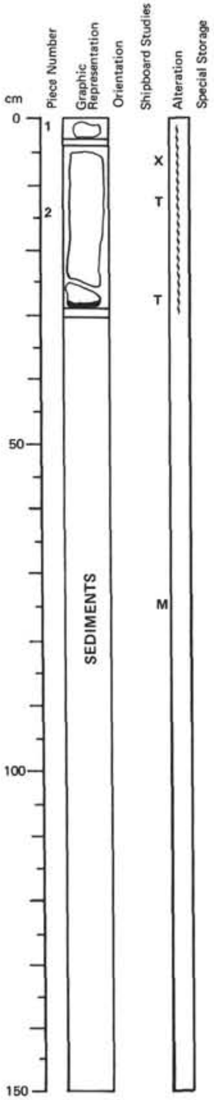
VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462		63	4

Depth: 583.8 to 584.4 m

MAJOR ROCK TYPE—MASSIVE MICRODIABASIC BASALT SILL

Macroscopic Description:
Homogeneous microdiabasic basalt sill, with very sparse plagioclase phenocrysts. Same as Section 3. Celadonite veins near 3 cm, 10 cm and 43 cm in Section 4.



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462		64	1

Depth: 585.5 to 587.0 m

MAJOR ROCK TYPE—SPARSELY PHYRIC HOLOCRYSTALLINE BASALT and VOLCANICLASTIC SILTSTONE and CLAYSTONE

Macroscopic Description:
Sparsely plagioclase phyric holocrystalline basalt. Chilled margin at contact with sedimentary material at 30 cm. See sedimentary core description for details on sedimentary material.

Thin Section Descriptions:
13-15 cm: Dolerite near margin of sill.
Phenocrysts: Plagioclase (An55) 5%, 0.3-0.4 mm subhedral-prisms; clinopyroxene 5%, 0.3-0.4 mm, subhedral.
Groundmass: Plagioclase 40%, 0.05-0.1 mm; clinopyroxene 40%, 0.03 to 0.09 mm; magnetite 10%, 0.03-0.1 mm.
Alteration: Clays (20%) replacing plagioclase and pyroxene.
Texture: Subophitic; microlite groundmass.
28-30 cm: Hyalopilitic basalt at glassy margin.
Phenocrysts: Plagioclase 3%, 0.2 mm, prismatic; clinopyroxene 1%, 0.2 mm, subhedral.
Groundmass: Plagioclase 40%, <0.05 mm, spherulitic texture; clinopyroxene 5%, <0.05 mm; magnetite 5%, <0.05 mm; glass 46%, altered.
Alteration: Interstitial clays (40%) replacing glass and pyroxene.
Texture: Hyalopilitic.

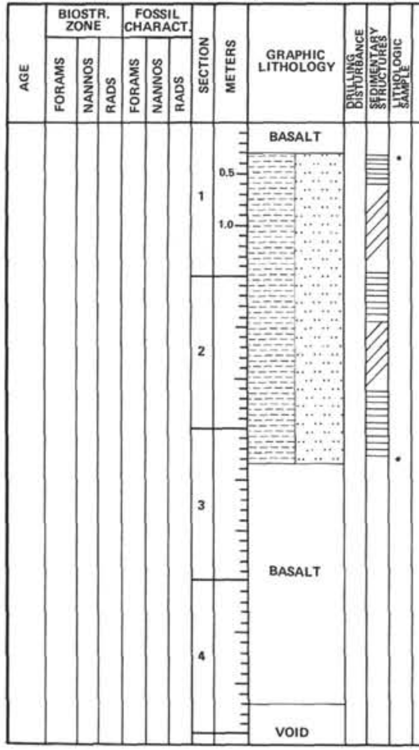
Shipboard Geochemistry (XRF, %):

Interval	**4-6 cm**
SiO_2	49.45
TiO_2	1.91
Al_2O_3	15.53
FeO	10.78
MnO	0.3
MgO	7.52
CaO	10.05
Na_2O	–
K_2O	0.04
P_2O_5	0.22
Total	95.80
LOI	1.27
FeO + MgO	1.43
CaO ÷ Al_2O_3	0.65
FeO ÷ TiO_2	5.64

Paleomagnetism/Physical Properties:

Interval	**76 cm**
Intensity (10^{-3} emu/cc)	3.3
NRM Incl. (°)	–45.6
MDF (Oe.)	320.0
Stable Incl. (°)	–46.7
Vp ∥ (km/s)	–
Vp ⊥ (km/s)	–
D (g/cc)	–
P (%)	–

SITE 462 HOLE CORE 64 CORED INTERVAL: 585.5 to 594.5 m



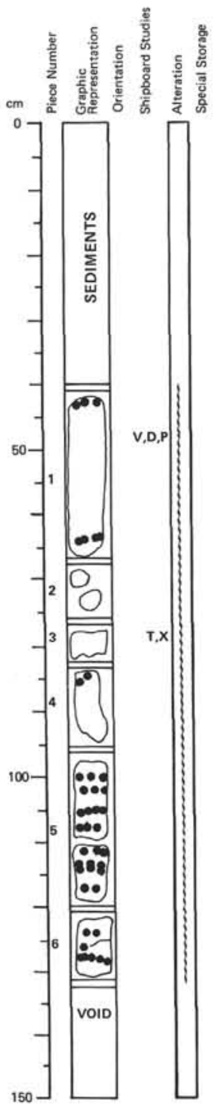
LITHOLOGIC DESCRIPTION

0.0-0.34 m. BASALT. See detailed description in "Visual Core Descriptions of Igneous Rock".
0.34-3.35 m. Dominantly greenish-black (5G 2/1) **VOLCANICLASTIC SILTSTONE to CLAYSTONE** with faint horizontal and cross-laminations. Some unidentifiable fish debris and radiolarians noted by the paleontologists.
3.34 m. Grayish-brown (5YR 3/2) **VOLCANICLASTIC CLAYSTONE.**
3.35-5.7 m. BASALT. See detailed description in "Visual Core Descriptions of Igneous Rock".

SMEAR SLIDE (%)

TEXTURE AND MINERALS	**Claystone 1-40 (D)**	**Volcanic Claystone 3-34 (M)**
Sand size	–	–
Silt size	20	–
Clay size	80	–
Clay	80*	19
Zeolite	Tr	–
Volcanic glass (altered)	20	80**

*Mainly chlorite
**Altered to clay



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462		64	3

Depth: 588.5 to 589.9 m

MAJOR ROCK TYPE—SPARSELY PHYRIC and APHYRIC HOLOCRYSTALLINE BASALT

Macroscopic Description:

~41 to ~85 cm: Sparsely plagioclase phyric holocrystalline basalt, with celadonite veins.
~85 to ~110 cm: Holocrystalline basalt, with celadonite and pyritic veins.
~110 to ~133 cm: Holocrystalline aphyric basalt.

Thin Section Description:

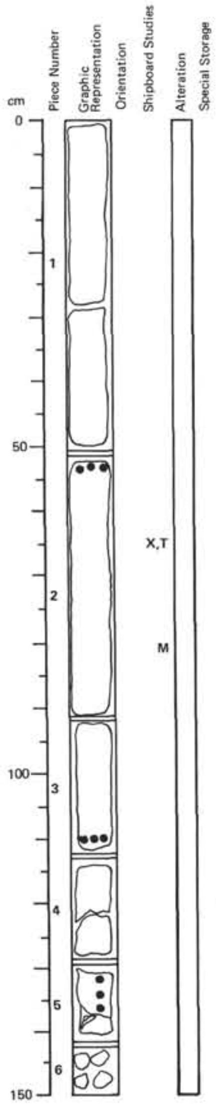
80-82 cm: Dolerite near interior of sill.
Phenocrysts: Plagioclase (An65) 1%, 0.8-1.6 mm maximum 4 mm, few phenocrysts, but most microphenocrysts; clinopyroxene 3%, >0.5 mm, subhedral.
Groundmass: Plagioclase 43%, 0.05-0.65 mm, subhedral, prismatic to microlitic; clinopyroxene 40%, 0.03-0.4 mm, subhedral, prismatic to microlitic; magnetite 13%, 0.01-0.2 mm.
Alteration: Clays (5%) disseminated spots replacing plagioclase and pyroxene.
Texture: Subophitic.

Shipboard Geochemistry (XRF, %):

Interval	**79-81 cm**
SiO_2	49.33
TiO_2	1.84
Al_2O_3	14.78
FeO	11.75
MnO	0.23
MgO	7.64
CaO	8.97
Na_2O	–
K_2O	0.04
P_2O_5	0.22
Total	94.80
LOI	2.03
FeO ÷ MgO	1.53
CaO ÷ Al_2O_3	0.60
FeO + TiO_2	6.38

Physical Properties:

Interval	**48-50 cm**
Vp ∥ (km/s)	4.88
Vp ⊥ (km/s)	4.82
D (g/cc)	2.79
P (%)	11.8



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462		64	4

Depth: 589.9 to 591.4 m

MAJOR ROCK TYPE—APHYRIC HOLOCRYSTALLINE BASALT

Macroscopic Description:

Homogeneous aphyric holocrystalline basalt with celadonite and pyrite in veins.

Thin Section Description:

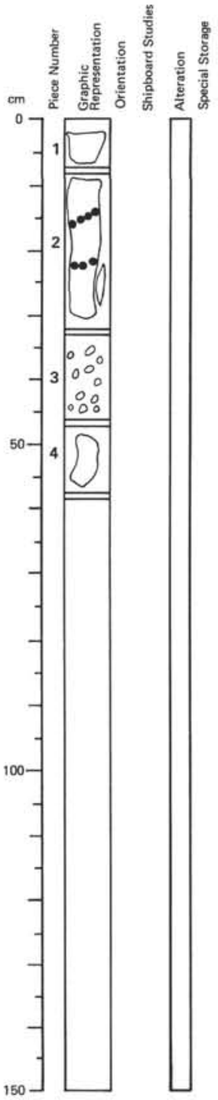
65-67 cm: Dolerite in transition zone of sill margin to its interior.
Phenocrysts: Plagioclase (An_{52}) 5%, 0.5-0.7 mm, euhedral to subhedral; clinopyroxene 5%, 0.4-0.6 mm, subhedral; ti-magnetite 2%, 0.4-0.6 mm.
Groundmass: Plagioclase 38%, <0.15 mm, subhedral to euhedral; clinopyroxene 38%, <0.1 mm, subhedral; magnetite 12%, <0.8 mm, euhedral; groundmass minerals to microlite.
Alteration: Clays (~5%) in spots replacing pyroxene and plagioclase.

Shipboard Geochemistry (XRF, %):

Interval	**74-76 cm**
SiO_2	49.71
TiO_2	1.64
Al_2O_3	13.59
FeO	12.82
MnO	0.21
MgO	7.61
CaO	11.16
Na_2O	–
K_2O	0.09
P_2O_5	0.25
Total	97.08
LOI	0.36
FeO ÷ MgO	1.68
CaO ÷ Al_2O_3	0.82
FeO ÷ TiO_2	7.81

Paleomagnetism/Physical Properties:

Interval	**80 cm**
Intensity (10^{-3} emu/cc)	6.7
NRM Incl. (°)	–50.2
MDF (Oe.)	40.0
Stable Incl. (°)	–53.4
Vp ∥ (km/s)	–
Vp ⊥ (km/s)	–



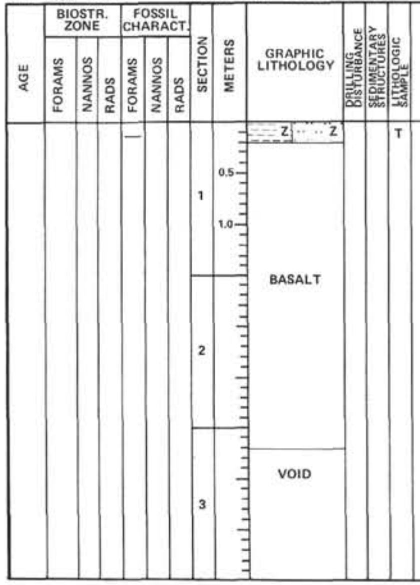
VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462		64	5

MAJOR ROCK TYPE—APHYRIC HOLOCRYSTALLINE BASALT

Macroscopic Description:
Homogeneous aphyric holocrystalline basalt with celadonite and pyrite in veins.

SITE 462 HOLE CORE 65 CORED INTERVAL: 594.5 to 599.0 m



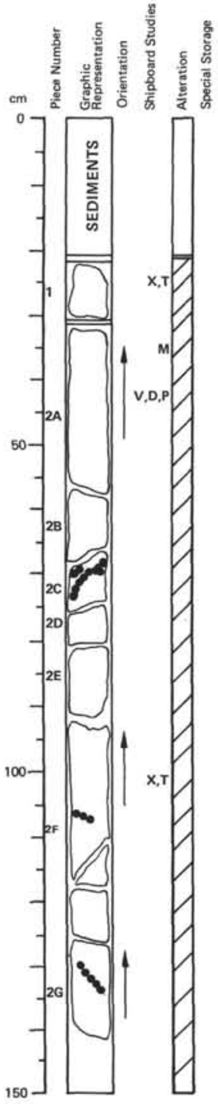
LITHOLOGIC DESCRIPTION

0.0-0.2 m. Greenish-black (5GY 2/1) and 5G 2/1) **VOLCANICLASTIC SILTSTONE and CLAYSTONE**, locally zeolitic.
0.2-3.2 m. BASALT. See detailed description in "Visual Core Descriptions of Igneous Rock".

SMEAR SLIDE (%)

	Zeolitic Claystone
TEXTURE AND	**1-9**
MINERALS	**(D)**
Sand size	—
Silt size	70
Clay size	30
Clay	30
Volcanic glass (altered)	50
Zeolite	20
Fish remains	Tr

THIN SECTION DESCRIPTION
1, 5-8 cm: Highly altered vitric tuff; mainly glass particles altered to well-crystallized clay minerals; zeolites in pores.



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

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

Depth: 594.5 to 596.0 m

MAJOR ROCK TYPE—VOLCANICLASTIC SILTSTONE and CLAYSTONE, and MASSIVE BASALT SILL

Macroscopic Description:

See sedimentary visual core descriptions for the sediment descriptions. Massive, altered, subophitic dolerite, with celadonite veins. It is dark greenish gray (5G 4/1). With the unaided eye the basalt, at the contact between sediment and basalt, does not appear to have a "chilled margin", although the grain size is fine.

Thin Section Descriptions:

22-24 cm: Dolerite near margin of sill.

Phenocrysts: Plagioclase (An60-33) 8%, 0.3-0.6 mm, prismatic to subhedral, microphenocrysts; clinopyroxene 13%, 0.4-0.7 mm, subhedral, microphenocrysts; ti-magnetite 4%, 0.3-0.4 mm, microphenocrysts.

Groundmass: Plagioclase 30%, 0.05-0.15 mm, subhedral; clinopyroxene 36%, 0.03-0.1 mm, prismatic; magnetite 9%, 0.03-0.8 mm; plagioclase and clinopyroxene groundmass to intergranular, quartz and alkali feldspar as granophyric intergrowth.

Alteration: Clays (6%), in spots, replacing clinopyroxene and plagioclase.

Texture: Subophitic.

100-102 cm: Dolerite near interior of sill.

Phenocrysts: Plagioclase (An60) 10%, 0.4-0.7 mm, prismatic to subhedral, microphenocrysts, clinopyroxene 10%, 0.3-0.7 mm, subhedral, microphenocrysts; ti-magnetite 3%, 0.3-0.4 mm.

Groundmass: Plagioclase 33%, 0.05-0.15 mm, subhedral; clinopyroxene 33%, 0.03-0.1 mm, prismatic; plagioclase and clinopyroxene to intersertal; magnetite 11%, 0.03-0.08 mm.

Alteration: Clays (6%), in spots, replacing clinopyroxene and plagioclase.

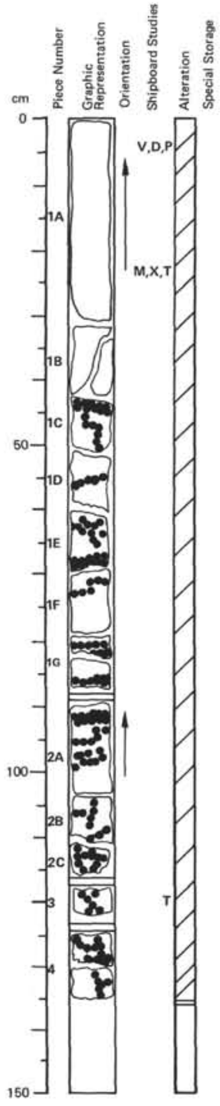
Texture: Subophitic to intergranular.

Shipboard Geochemistry (XRF, %):

Interval	**27-30 cm**
SiO_2	49.44
TiO_2	1.66
Al_2O_3	13.60
FeO	12.61
MnO	0.21
MgO	6.95
CaO	11.03
Na_2O	–
K_2O	0.05
P_2O_5	0.24
Total	95.79
LOI	0.41
FeO ÷ MgO	1.81
CaO ÷ Al_2O_3	0.81
FeO ÷ TiO_2	7.59

Paleomagnetism/Physical Properties:

Interval	**34 cm**	**38-40 cm**
Intensity (10^{-3} emu/cc)	8.8	–
NRM Incl. (°)	–54.3	–
MDF (Oe.)	55.0	–
Stable Incl. (°)	–50.8	–
Vp ∥ (km/s)	–	5.44(?)
Vp ⊥ (km/s)	–	5.33(?)
D (g/cc)	–	2.97
P (%)	–	6.5



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

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

Depth: 596.0 to 597.5 m

MAJOR ROCK TYPE—MASSIVE BASALT SILL

Macroscopic Description:

Massive subophitic dolerite, moderately altered and with celadonite veins. Same unit as in Core 65, Section 1.

Thin Section Descriptions:

20-22 cm: Dolerite near interior part of sill.

Phenocrysts: Plagioclase (An57) 16%, 0.3-2.0 mm, prismatic to subhedral, zonation in coarse grains; clinopyroxene 6%, 0.4-0.7 mm, subhedral; ti-magnetite 4%, 0.3-0.4 mm.

Groundmass: Plagioclase 35%, 0.05-0.15 mm, subhedral; clinopyroxene 30%, 0.03-~0.1 mm, prismatic; plagioclase and clinopyroxene groundmass to intergranular; magnetite 9%, 0.03-0.09 mm; quartz is present.

Alteration: Clays (6%) in spots replacing clinopyroxene and plagioclase.

Texture: Subophitic.

120-122 cm: Dolerite transitional zone between the margin and interior of the sill.

Phenocrysts: Olivine 1-2%, 0.3-0.7 mm, subhedral altered margins; plagioclase (An72-50) 13%, 0.4-0.7 mm, subhedral to prismatic; clinopyroxene 5%, 0.3-0.45 mm, subhedral; ti-magnetite 4%.

Groundmass: Plagioclase 35%, 0.05-0.15 mm, subhedral; clinopyroxene 30%, 0.03-0.1 mm, prismatic; plagioclase and clinopyroxene to microlites; magnetite 12%, 0.02-0.1 mm.

Alteration: Clays (5%) in spots, replacing pyroxene, olivine, and plagioclase. Iddingsite replacing rims of olivine.

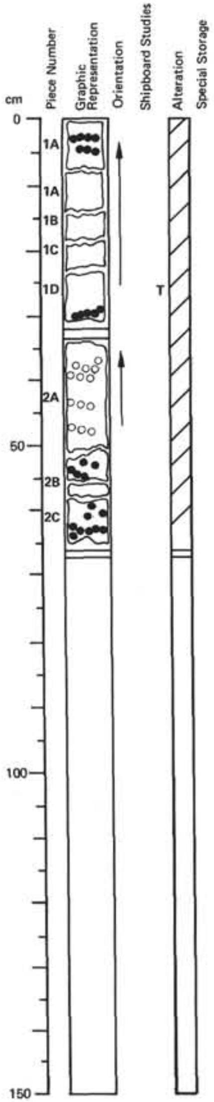
Texture: Subophitic.

Shipboard Geochemistry (XRF, %):

Interval	**23-26 cm**
SiO_2	49.03
TiO_2	1.65
Al_2O_3	13.22
FeO	12.90
MnO	0.21
MgO	6.90
CaO	10.91
Na_2O	–
K_2O	0.03
P_2O_5	0.23
Total	95.35
LOI	0.52
FeO ÷ MgO	1.86
CaO ÷ Al_2O_3	0.82
FeO ÷ TiO_2	7.81

Paleomagnetism/Physical Properties:

Interval	**22 cm**	**7-9 cm**
Intensity (10^{-3} emu/cc)	9.2	–
NRM Incl. (°)	–48.2	–
MDF (Oe.)	80.0	–
Stable Incl. (°)	–48.3	–
Vp ∥ (km/s)	–	5.43(?)
Vp ⊥ (km/s)	–	5.41(?)
D (g/cc)	–	2.96
P (%)	–	6.2



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

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

Depth: 597.5 to 599.0 m

MAJOR ROCK TYPE—MASSIVE BASALT SILL

Macroscopic Description:

Massive, moderately altered, subophitic dolerite with veins of celadonite and calcite.
Same unit as in Core 65, Section 1.

Thin Section Description

27-29 cm: Dolerite near margin of sill.

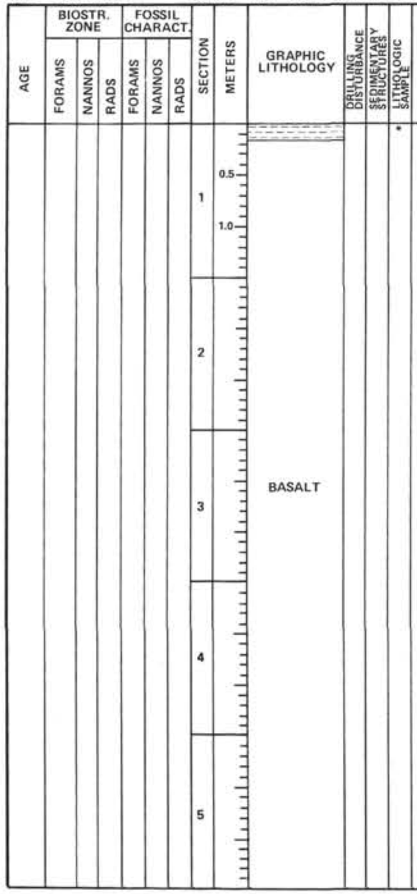
Phenocrysts: Plagioclase (An50) 15%, 0.3-0.7 mm, subhedral to prismatic; clinopyroxene 3%, 0.3-~0.4 mm, subhedral; ti-magnetite 3%, 0.3-0.5 mm.

Groundmass: Plagioclase 35%, 0.05-0.15 mm, subhedral; clinopyroxene 30%, 0.3-0.1 mm, prismatic; plagioclase and clinopyroxene groundmass to microlitic; quartz 2%, myrmekite patches, granophryic phase.

Alteration: Clays (8%) in spots, replacing clinopyroxene and plagioclase.

Texture: Subophitic.

SITE 462 HOLE CORE 66 CORED INTERVAL: 599.0 to 606.0 m



LITHOLOGIC DESCRIPTION

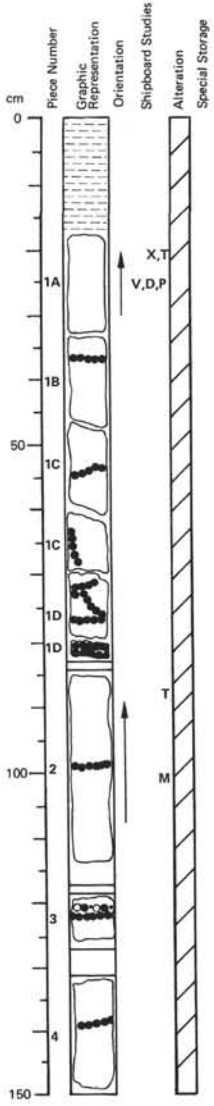
0.0-0.16 m. Grayish red (10R 4/2) and grayish blue-green (5BG 5/2) **VOLCANICLASTIC CLAYSTONE.**

0.16-7.5 m. BASALT. See detailed description in "Visual Core Descriptions of Igneous Rocks".

SMEAR SLIDE (%)

TEXTURE AND MINERALS	**Silty Claystone 1-7 (D)**
Clay-Palagonite	47
Heavy minerals	Tr
Volcanic glass (altered)	50
Zeolite	3
Calc. nannofossils	Tr*
Fish remains	Tr

*Contamination(?)



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462		66	1

Depth: 599.0 to 600.5 m

MAJOR ROCK TYPE—–VOLCANICLASTIC CLAYSTONE and MASSIVE BASALT SILL

Macroscopic Description:
See sedimentary visual core forms for detailed description of claystone. Massive, dark greenish gray (5G 4/1), moderately altered, subophitic dolerite with veins, of celadonite and celadonite plus calcite and clay.
17 cm, Piece 1A: Recovered contact between basalt and sediment. The basalt does not have a glassy chill margin, but it has a slightly fine grain-size.

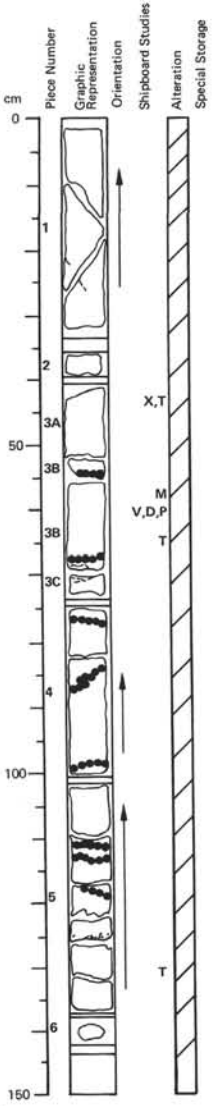
Thin Section Description
22-24 cm: Dolerite near margin of sill.
Phenocrysts: Plagioclase (An62-35) 13%, 0.3-0.6 mm, subhedral to prismatic, microphenocrysts; clinopyroxene 3%, 0.3-0.5 mm, subhedral, microphenocrysts; ti-magnetite 2%, 0.3-0.5 mm; microphenocrysts.
Groundmass: Plagioclase 35%, 0.05-0.15 mm, subhedral; clinopyroxene 33%, 0.3-0.1 mm, prismatic; plagioclase and clinopyroxene to microlitic; magnetite 14%, 0.02-0.1 mm; quartz is present.
Alteration: Clays (5%), in spots, replacing clinopyroxene.
Texture: Subophitic.
86-88 cm: Dolerite in transitional zone between margin and interior of sill.
Phenocrysts: Plagioclase (An45) 15%, 0.5-0.7 mm, subhedral to prismatic; clinopyroxene 5%, 0.4-0.6 mm, subhedral; ti-magnetite 3%, 0.4-0.6 mm; microphenocrysts.
Groundmass: Plagioclase 35%, 0.05-0.2 mm, subhedral; clinopyroxene 30%, 0.03-0.1 mm, prismatic; magnetite 12%, 0.2-0.1 mm; quartz is present; groundmass microlitic.
Alteration: Clays (5%), in spots, replacing clinopyroxene.
Texture: Subophitic.

Shipboard Geochemistry (XRF, %):

Interval	**19-21 cm**
SiO_2	49.57
TiO_2	1.64
Al_2O_3	13.36
FeO	12.64
MnO	0.20
MgO	6.72
CaO	11.14
Na_2O	–
K_2O	0.04
P_2O_5	0.22
Total	95.53
LOI	0.21
FeO ÷ MgO	1.88
CaO ÷ Al_2O_3	0.83
FeO ÷ TiO_2	7.70

Paleomagnetism/Physical Properties:

Interval	**103 cm**	**25-27 cm**
Intensity (10^{-3} emu/cc)	8.7	–
NRM Incl. (°)	–50.0	–
MDF (Oe.)	75.0	–
Stable Incl. (°)	–50.9	–
Vp ∥ (km/s)	–	5.82
Vp ⊥ (km/s)	–	5.81
D (g/cc)	–	2.97
P (%)	–	6.3



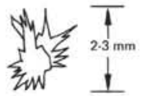
VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

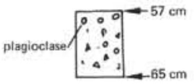
LEG	SITE	HOLE	CORE	SECT.
61	462		66	2

Depth: 600.5 to 602.0 m

MAJOR ROCK TYPE—–MASSIVE BASALT SILL

Macroscopic Description:
Massive, moderately altered, subophitic dolerite, with veins of clay and celadonite. Same unit as Core 66, Section 1 above.
57-65 cm: Glomerporphyric texture, 2-3 mm in diameter:

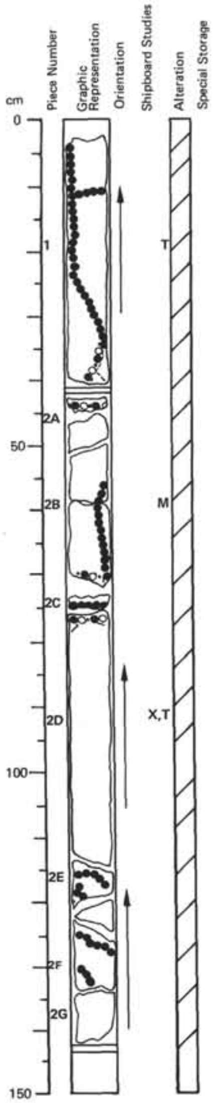




Thin Section Description:
65-67 cm: Dolerite from sill interior.
Phenocrysts: None
Groundmass: Plagioclase (An45-76) elongated prisms and zoned tabular crystals, 0.1-3.0 mm; clinopyroxene 32%, 0.1-3.0 mm, interstitial elongated prisms; magnetite 7%, 0.1-0.5 mm, anhedral, irregular; alkali feldspar 1%, 0.5 mm, intergranular, granophyric aggregates.
Alteration: Clays (5%), spotted aggregates around magnetite and pyroxene.
Texture: Ophytic.

Paleomagnetism/Physical Properties:

Interval	**56 cm**	**61.5-63.5 cm**
Intensity (10^{-3} emu/cc)	4.4	–
NRM Incl. (°)	–53.2	–
MDM (Oe.)	55.0	–
Stable Incl. (°)	–44.9	–
Vp ∥ (km/s)	–	5.62
Vp ⊥ (km/s)	–	5.77
D (g/cc)	–	2.96
P (%)	–	8.0



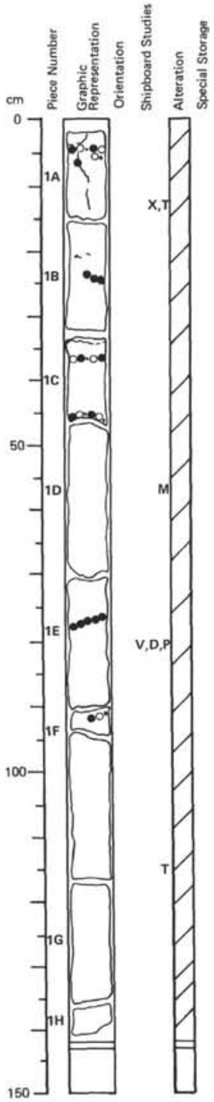
VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462		66	3

Depth: 602.0 to 603.5 m

MAJOR ROCK TYPE—MASSIVE BASALT SILL

Macroscopic Description:
Massive, moderately altered, subophitic dolerite with veins, celadonite and celadonite plus calcite and clay. Same unit as in Core 66, Section 1.



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462		66	4

Depth: 603.5 to 604.5 m

MAJOR ROCK TYPE—MASSIVE BASALT SILL

Macroscopic Description:
Massive, moderately to badly altered subophitic dolerite with veins, celadonite and celadonite plus calcite and clay. Same unit as in Core 66, Section 1. Sparse occurrences of pyrite aggregates and green clay (?) patches.

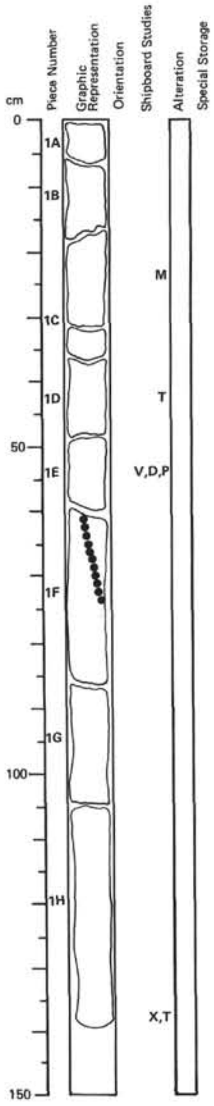
Thin Section Description:
12-14 cm: Dolerite in sill interior.
Phenocrysts: None
Groundmass: Plagioclase (An56-76) 60%, <0.02-1.2 mm, microlitic, prismatic, coarse-tabular; clinopyroxene 32%, 0.04-0.8 mm, interstitial, more coarse tabular crystals; magnetite 8%, 0.08-0.4 mm, anhedral, irregular.
Alteration: Clays (5%) in spotted aggregates around magnetite and pyroxene.
Texture: Microdolerite to glomerophorphyric.

Shipboard Geochemistry (XRF, %):

Interval	**12-14 cm**
SiO_2	49.48
TiO_2	1.64
Al_2O_3	13.64
FeO	12.31
MnO	0.21
MgO	7.24
CaO	11.08
Na_2O	–
K_2O	0.07
P_2O_5	0.21
Total	95.88
LOI	0.74
FeO ÷ MgO	1.70
CaO ÷ Al_2O_3	0.81
FeO ÷ TiO_2	7.50

Paleomagnetism/Physical Properties:

Interval	**59 cm**	**81-83 cm**
Intensity (10^{-3} emu/cc)	7.6	–
NRM Incl. (°)	−51.3	–
MDF (Oe.)	115.0	–
Stable Incl. (°)	−48.5	–
Vp ∥ (km/s)	–	5.59
Vp ⊥ (km/s)	–	5.70
D (g/cc)	–	2.95
P (%)	–	7.9



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462		66	5

Depth: 604.5 to 605.5 m

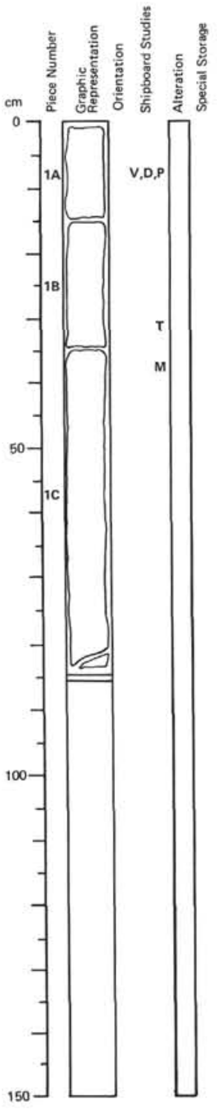
MAJOR ROCK TYPE—MASSIVE BASALT SILL

Macroscopic Description:
Massive, moderately altered, subophitic dolerite, with veins of celadonite. Sparse pyrite aggregates and green clay patches. Same unit as in Core 66, Section 1.
unit as in Core 66, Section 1.

Thin Section Description:
42-45 cm: Dolerite from sill interior.
Phenocrysts: None
Groundmass: Plagioclase (An48-78) 38%, 0.02-0.4 mm, microlites and elongated prisms, coarser tabular grains; clinopyroxene 45%, 0.08-0.6 mm, interstitial and resorbed tabular crystals; magnetite 15%, 0.04-0.4 mm, irregular and skeletal crystals; quartz and alkali feldspar (total 2%), 0.2-0.4 mm, granophyric aggregates; holocrystalline rock.
Alteration: Clays (10%) in spotted aggregates around magnetite and pyroxene.
Texture: Subophitic.

Paleomagnetism/Physical Properties:

Interval	**23 cm**	**54-58 cm**
Intensity (10^{-3} emu/cc)	11.2	–
NRM Incl. (°)	–48.4	–
MDF (Oe.)	200.0	–
Stable Incl. (°)	–45.3	–
Vp ∥ (km/s)	–	5.60
Vp ⊥ (km/s)	–	–
D (g/cc)	–	2.95
P (%)	–	7.6



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462		66	6

Depth: 605.5 to 606.0 m

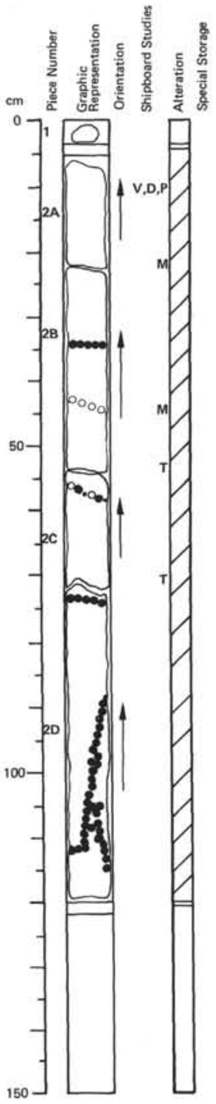
MAJOR ROCK TYPE—MASSIVE BASALT SILL

Macroscopic Description:
Massive, moderately to highly altered, subophitic dolerite, same unit as in Core 66, Section 1, except for the 30-38 cm interval. At 30-38 cm glomerophorphyritic texture with plagioclase as in Core 66, Section 2.

Thin Section Description:
30-33 cm: Dolerite from interior of a sill.
Phenocrysts: None
Groundmass: Holocrystalline rock; plagioclase (An48-76) 55%, <0.02-2.2 mm, elongated prisms and coarser tabular crystals with zonation; clinopyroxene 35%, 0.08-1.6 mm, interstitial elongated prisms are resorbed; magnetite 8%, 0.08-0.8 mm, irregular, skeletal crystals are common; quartz and alkali feldspar (total 2%) 0.04 mm, granophyric aggregates.
Alteration: Clays (10%) form spotted aggregates around magnetite and pyroxene.
Texture: Subophitic to glomeroporpyritic.

Paleomagnetism/Physical Properties:

Interval	**39 cm**	**8-10 cm**
Intensity (10^{-3} emu/cc)	18.3	–
NRM Incl. (°)	–47.1	–
MDF (Oe.)	235.0	–
Stable Incl. (°)	–46.9	–
Vp ∥ (km/s)	–	5.88
D (g/cc)	–	2.98
P (%)	–	6.3



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462		67	1

Depth: 606.0 to 607.5 m

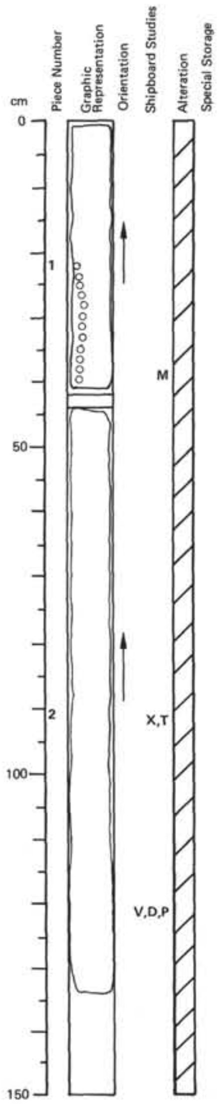
MAJOR ROCK TYPE—MASSIVE ALTERED BASALT SILL

Macroscopic Description:
Massive, altered, aphyric, holocrystalline dolerite, with veins, of celadonite, calcite, and celadonite plus calcite and clay. "Spotted" glomerophyric texture from 44 to 74 cm.

Thin Section Description:
50-54 cm: Microdolomite on "spotted" texture from sill interior.
Phenocrysts: Holocrystalline rock.
Groundmass: Plagioclase (An45-82) elongated prisms, coarser tabular crystals have zonation; clinopyroxene 20%, 0.1-1.4 mm, irregular elongated prisms are resorbed; magnetite 15%, 0.08-0.4 mm, common irregular skeletal crystals; chalcopyrite and pyrrhotite (total trace), 0.08-0.1 mm, disseminated grains.
Alteration: Clays (5%) in spotted aggregates around magnetite and pyroxenes.
Texture: Doleritic, ophitic.
68-72 cm: Microdolerite at contact, "spotted" glomerophyric texture with "non-spotted" sill interior.
Phenocrysts: None.
Groundmass: Holocrystalline rock; plagioclase (An42-72) <0.02-2.2 mm, elongated prisms, zonation in coarser tabular crystals; clinopyroxene 22%, 0.04-2.2 mm, interstitial and elongated resorbed prisms; magnetite 12%, 0.1-0.4 mm, interstitial.
Alteration: Clays (10%) spots around magnetite and pyroxene (replacing).
Texture: Spotted microdoleritic to doleritic.

Paleomagnetism/Physical Properties:

Interval	22 cm	46 cm	13-15 cm
Intensity (10^{-3} emu/cc)	9.4	8.3	–
NRM Incl. (°)	–46.8	–37.5	–
MDF (Oe.)	130.0	130.0	–
Stable Incl. (°)	–48.9	–47.5	–
Vp ∥ (km/s)	–	–	5.81
D (g/cc)	–	–	2.96
P (%)	–	–	6.2



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462		67	2

Depth: 607.5 to 609.0 m

MAJOR ROCK TYPE—MASSIVE BASALT SILL

Macroscopic Description:
Massive, altered, aphyric, holocrystalline dolerite, same as in Core 67, Section 1.

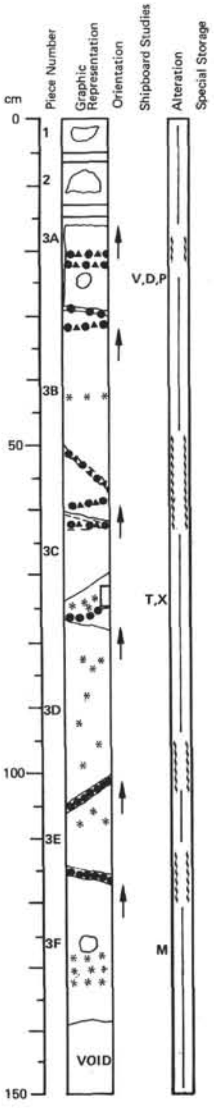
Thin Section Description:
90-94 cm: Dominant lithology, microdolerite of sill interior.
Phenocrysts: None.
Groundmass: Holocrystalline; plagioclase (An48-75) 60%, <0.02-0.8 mm, elongated prisms, zonation in coarser tabular crystals, cumulophyric; clinopyroxene 25%, 0.07-0.5 mm, interstitial, magnetite 15%, interstitial.
Alteration: Clays (20%) in spots and veins replacing all minerals.
Texture: Microdoleritic to doleritic.

Shipboard Geochemistry (XRF, %):

Interval	90-94 cm
SiO_2	50.13
TiO_2	1.65
Al_2O_3	13.32
FeO	12.59
MnO	0.21
MgO	7.41
CaO	11.37
Na_2O	–
K_2O	0.14
P_2O_5	0.25
Total	97.07
LOI	0.48
FeO ÷ MgO	1.69
CaO ÷ Al_2O_3	0.85
FeO + TiO_2	7.63

Paleomagnetism/Physical Properties:

Interval	38cm	103 cm	123-126 cm
Intensity (10^{-3} emu/cc)	11.7	6.4	–
NRM Incl. (°)	–47.6	–47.0	–
MDF (Oe.)	–	115.0	–
Stable Incl. (°)	–	–49.1	–
Vp ∥ (km/s)	–	–	5.80
D (g/cc)	–	–	2.96
P (%)	–	–	6.7



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462		68	1

Depth: 609.0 to 610.4 m

MAJOR ROCK TYPE—MASSIVE BASALT SILL

Macroscopic Description:

Massive, altered aphyric dolerite, with veins. It is identical to the previous section (Core 67, Section 2). Alteration is greater near celadonite veins. Within the celadonite veins the stellated peels of pyrite frequently occurs.

Code to graphic representation:

*** = intervals enriched in clinopyroxene and plagioclase glomerporphyritic aggregates.

Thin Section Description:

73-75 cm: Microdolerite from sill interior.

Phenocrysts: None

Groundmass: Holocrystalline rock; olivine 1%, 0.2-0.4 mm, altered (to brown smectite), equidimensional; plagioclase (An40-100) 40%, 0.04 x 0.1 mm to 0.1 x 1.2 mm, elongated prisms, zonation of the coarser tabular laths and near quartz; clinopyroxene 45%, 0.2-2.0 mm, interstitial and elongated resorbed prisms; magnetite 12%, 0.06-0.6 mm, interstitial; pyrrhotite 1%, 0.04-0.1 mm, intergrowths with magnetite; quartz 1%, 0.08-1.2 mm, interstitial and in granophyric intergrowth; alkali feldspar tr, <0.02 mm, granophyric intergrowths with quartz; hornblende trace, 0.04 to 0.3 mm, ti-bearing, biotite trace, ~0.08 mm, ti-bearing; hornblende and biotite reaction rims with magnetite.

Alteration: Clays (2%) pseudomorphs of olivine and pyroxene.

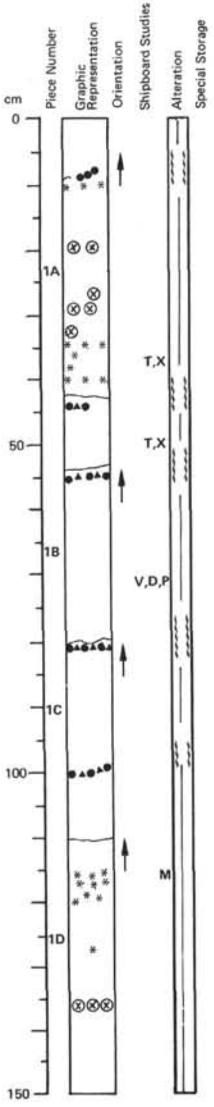
Texture: Doleritic (ophitic).

Shipboard Geochemistry (XRF, %):

Interval	**73-75 cm**
SiO_2	49.77
TiO_2	1.85
Al_2O_3	12.96
FeO	13.80
MnO	0.23
MgO	6.55
CaO	10.52
Na_2O	–
K_2O	0.08
P_2O_5	0.25
Total	96.01
LOI	0.43
FeO ÷ MgO	2.10
CaO ÷ Al_2O_3	0.81
FeO ÷ TiO_2	7.45

Paleomagnetism/Physical Properties:

Interval	**126 cm**	**24-26 cm**
Intensity (10^{-3} emu/cc)	4.1	–
NRM Incl. (°)	−51.2	–
MDF (Oe.)	–	–
Stable Incl. (°)	–	–
Vp ∥ (km/s)	–	5.813
D (g/cc)	–	2.92
P (%)	–	–



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462		68	2

Depth: 610.4 to 611.9 m

MAJOR ROCK TYPE—MASSIVE BASALT SILL

Macroscopic Description:

Massive, altered, aphyric to microporphyritic clinopyroxene-plagioclase dolerites with celadonite-pyrite veins. Same unit as the basalt in Core 68, Section 1. See Core 68, Section 1 for codes to some of the symbols in the graphic representation.

Thin Section Description:

49-51 cm: Microdolerite from sill interior.

Phenocrysts: None

Groundmass: Holocrystalline rock; olivine 2%, 0.2-0.5 mm, altered, equidimensional; plagioclase (An45-70) 58%, 0.05 x 0.2 mm to 0.2 x 1.5 mm; elongated prisms, zonation in coarser grains; clinopyroxene 25%, 0.2-1.2 mm, interstitial; magnetite 12%, 0.04-0.2 mm, interstitial; pyrrohotite 2%, 0.04-0.1, intergrowths with magnetite; brown hornblende 1%, 0.05-0.4 mm, ti-bearing, rims around magnetite; partly changed to green hornblende; biotite trace, 0.02-0.05 mm, ti-bearing thin plates near olivine pseudomorphs; apatite trace 0.02-0.04 mm, euhedral.

Alteration: Clays (3%) replacing olivine and partly pyroxene.

Texture: Doleritic (ophitic).

37-39 cm: Microdolerite from sill interior.

Phenocrysts: None.

Groundmass: Holocrystalline rocks; olivine 1%, 0.4-0.8 mm, altered, equidimensional; plagioclase (An45-78) 21%, 0.04 x 1.0 mm to 0.6 x 2.0 mm, elongated prisms, zonation more distinct in coarse grains; clinopyroxene 60%, 0.4-2.2 mm, interstitial, poikilophitic laths; magnetite 15%, 0.1-0.8 mm, interstitial dust-like in olivine pseudomorphs; pyrrhotite 1%, 0.04-0.2 mm, intergrowths with magnetite; quartz 1%, 0.08-0.8 mm, interstitial, includes needles of apatite; brown hornblende 1%, 0.06-0.4 mm, ti-bearing, rims around magnetite, partly oxidized, biotite trace, 0.02-0.08 mm, ti-bearing, rare plates near magnetite.

Alteration: Clays (2%) forming pseudomorphs after olivine and partly replacing pyroxene.

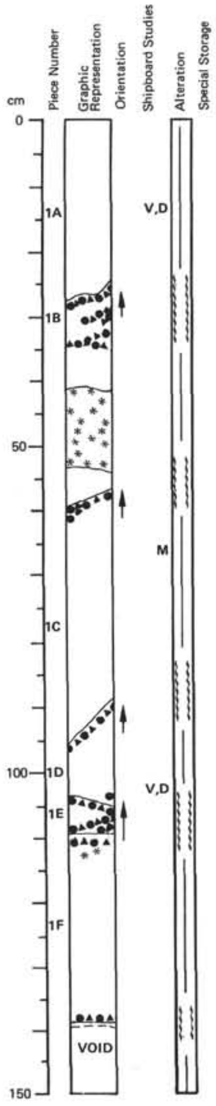
Texture: Doleritic (ophitic).

Shipboard Geochemistry (XRF, %):

Interval	**37-39 cm**	**49-51 cm**
SiO_2	50.15	49.18
TiO_2	1.92	1.61
Al_2O_3	12.70	13.22
FeO	14.33	12.77
MnO	0.22	0.22
MgO	6.30	7.01
CaO	10.17	11.10
Na_2O	–	–
K_2O	0.14	0.12
P_2O_5	0.25	0.26
Total	96.19	95.49
LOI	0.36	0.28
FeO ÷ MgO	2.27	1.82
CaO ÷ Al_2O_3	0.80	0.85
FeO ÷ TiO_2	7.46	7.93

Paleomagnetism/Physical Properties:

Interval	**114 cm**	**66-68 cm**
Intensity (10^{-3} emu/cc)	7.9	–
NRM Incl. (°)	−47.8	–
MDF (Oe.)	80.0	–
Stable Incl. (°)	−48.1	–
Vp ∥ (km/s)	–	5.00
D (g/cc)	–	3.01
P (%)	–	–



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
6 1	4 6 2		6 8	3

Depth: 611.9 to 613.3 m

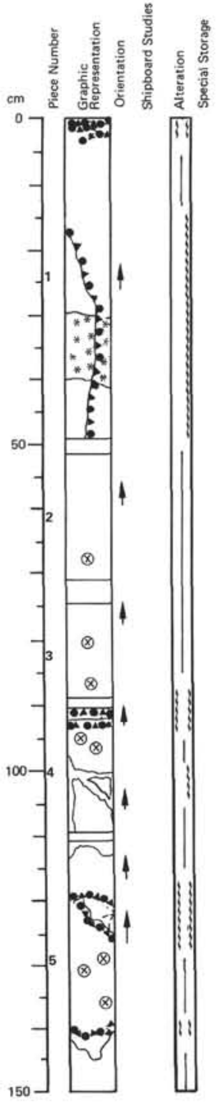
MAJOR ROCK TYPE—MASSIVE BASALT SILL

Macroscopic Description:

Massive, altered, aphyric to microporphyritic clinopyroxene-plagioclase dolerites, with celadonite pyrite veins. Same unit as the basalt in Core 68, Sections 1 and 2. See Core 68, Section 1 for codes to some of the symbols used in the graphic representation.

Paleomagnetism/Physical Properties:

Interval	**64 cm**	**15-17 cm**	**102-104 cm**
Intensity (10^{-3} emu/cc)	13.4	–	–
NRM Incl. (°)	–47.2	–	–
MDF (Oe.)	80.0	–	–
Stable Incl. (°)	–46.3	–	–
Vp∥ (km/s)	5.94	5.94	5.87
D (g/cc)	3.07	3.07	3.02



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

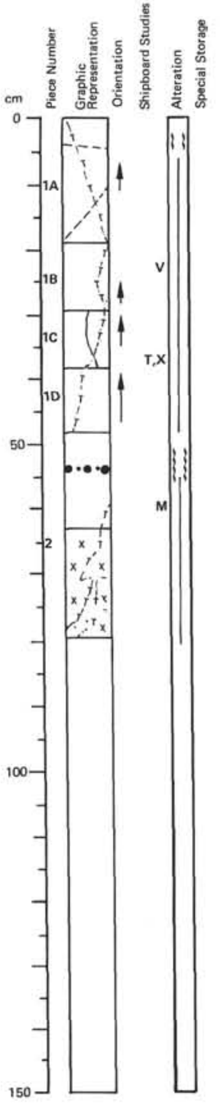
LEG	SITE	HOLE	CORE	SECT.
6 1	4 6 2		6 8	4

Depth: 613.3 to 614.0 m

MAJOR ROCK TYPE—MASSIVE BASALT SILL

Macroscopic Description:

Massive, altered, aphyric to microporphyritic clinopyroxene-plagioclase dolerite, with celadonite pyrite veins. Same unit as in Core 68, Section 1, 2, and 3. See Core 68, Section 1 for codes to some of the symbols used in the graphic representation.



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462		69	1

Depth: 614.0 to 615.5 m

MAJOR ROCK TYPE—MASSIVE BASALT SILL

Macroscopic Description:
Altered, medium- to fine-grained dolerite and microdolerite, with veins, and enrichment in magnetite (up to 20%). The texture is doleritic (ophitic) microdolerite; plagioclase 60-70%, 3.0-5.0 mm long and 0.5-2.0 mm wide; clinopyroxene 20-30%, about 1.0-3.0 mm, and equidimensional; magnetite 10-20%, and 0.5-2.0 mm; pyrrhotite occurs as rare, disseminated, small (0.5-1.0 mm) grains; plagioclase and magnetite (commonly as octahedrons) are fresh, and clinopyroxene is slightly altered to chlorite. Veins are celadonite-clay, and talc and Ti-magmite. X X X X X X = intervals of fine-grained dolerite. Talc and ti-magnetite veins consist of talc and small amounts of chalcopyrite and octahedrons of magnetie (0.5-3.0 mm). This vein material fills two systems of contraction fissures, sub-vertical and sub-horizontal. Chlorite-clay veins appear to cut the ti-magnetite. Talc veins thus appear to have formed at a later stage. The coarser (1.0-3.0 mm) talc pseudomorphs are probably olivine.

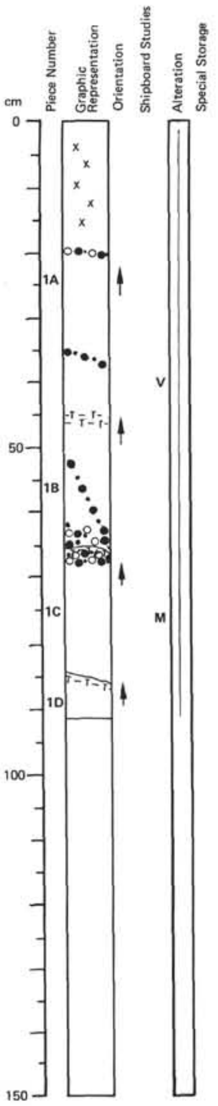
Thin Section Description:
36-39 cm: Dolerite in lower part of sill.
Phenocrysts: None.
Groundmass: Holocrystalline rock; plagioclase (An38-68) 53%, 0.1-0.4 mm elongated prisms, tabular-zoned; clinopyroxene (30%), 0.08-3.0 mm, irregular, interstitial elongated prisms; magnetite 10%, 0.1-2.0 mm, anhedral, skeletal crystal; pyrrhotite trace, 0.04-0.08 mm, rounded, rare disseminated grains; quartz 5%; anhedral grains, intergrowth in granophyric aggregates; alkali feldspar 2%, granophyric aggregates; apatite trace, <0.04 mm, needles in quartz.
Alteration: Clay (17%) pseudomorphs after pyroxene and magnetite.
Texture: Ophitic.

Shipboard Geochemistry (XRF, %):

Interval	**36-38 cm**
SiO_2	48.33
TiO_2	2.13
Al_2O_3	12.01
FeO	16.79
MnO	0.20
MgO	5.47
CaO	9.32
Na_2O	–
K_2O	0.27
P_2O_5	0.25
Total	94.77
LOI	0.36
FeO ÷ MgO	3.06
$CaO \div Al_2O_3$	0.77
$FeO \div TiO_2$	7.88

Paleomagnetism/Physical Properties:

Interval	**59 cm**	**24-16 cm**
Intensity (10^{-3} emu/cc)	48.5	–
NRM Incl. (°)	–46.4	–
MDF (Oe.)	115.0	–
Stable Incl. (°)	–44.6	–
Vp ∥ (km/s)	–	5.221
D (g/cc)	–	–
P (%)	–	–



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462		69	2

Depth: 615.5 to 617.0 m

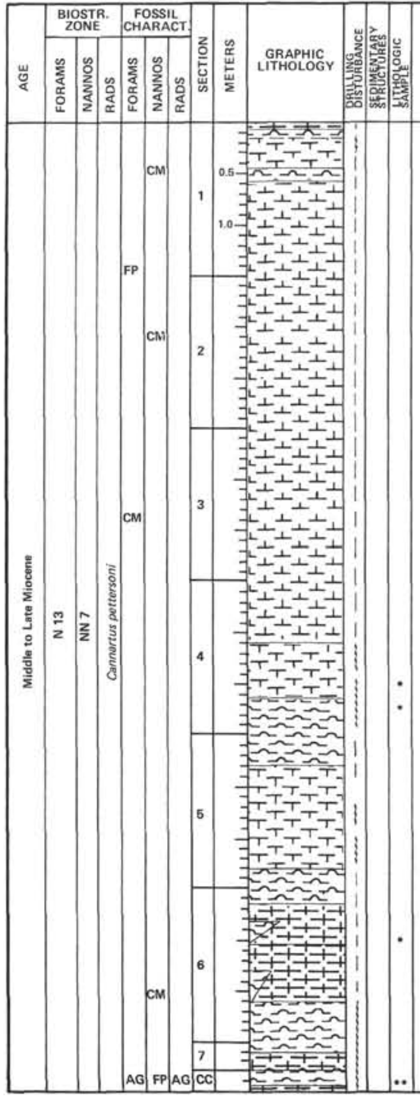
MAJOR ROCK TYPE—MASSIVE BASALT SILL

Macroscopic Description:
Altered, medium- to fine-grained dolerite and microdolerite with veins and enrichment in magnetite. This section is part of the previous section and all features of the rock are the same as the previous section.

Paleomagnetism/Physical Properties:

Interval	**75 cm**	**36-38 cm**
Intensity (10^{-3} emu/cc)	9.6	–
NRM Incl. (°)	–44.2	–
MDF (Oe.)	80.0	–
Stable Incl. (°)	–41.8(?)	–
Vp ∥ (km/s)	–	5.64
D (g/cc)	–	–
P (%)	–	–

SITE 462 HOLE A CORE 1 CORED INTERVAL: 78.5 to 88.0 m



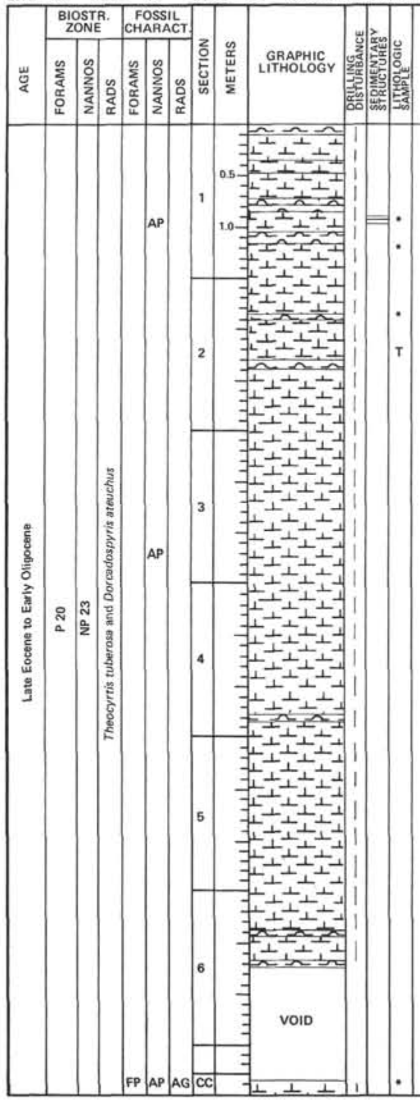
LITHOLOGIC DESCRIPTION

0.0-9.7 m. Alternating intervals of **NANNOFOSSIL OOZE, NANNOFOSSIL-FORAMINIFERAL OOZE, FORAMINIFERAL OOZE, NANNOFOSSIL RADIOLARIAN OOZE, and RADIOLARIAN OOZE.** Colors range from moderate brown (5YR 4/4) and moderate yellowish brown (10YR 5/4) for **RADIOLARIAN OOZES** through very pale orange (10YR 8/2) for **NANNOFOSSIL OOZES,** and to nearly white (N9) in grainy-appearing **FORAMINIFERAL OOZE. FORAMINIFERAL OOZE** was the most drill-disturbed lithology (most permeable to drilling fluid?). Some slight to moderate mottling in the **RADIOLARIAN OOZES;** no other structures were visible.

SMEAR SLIDE (%)

	Nannofossil foraminiferal ooze	Radiolarian ooze	Nannofossil ooze	Nannofossil foraminiferal ooze	Radiolarian ooze
TEXTURE AND MINERALS	**4-100 (D)**	**4-120 (D)**	**6-49 (D)**	**CC-A (D)**	**CC-B (D)**
Sand size	49	2	8	30	15
Silt size	26	93	12	55	45
Clay size	25	5	80	15	40
Clay	–	5	3	–	10
Feldspar	–	–	–	–	Tr
Volcanic glass	Tr	–	–	Tr	Tr
Foraminifera	49	–	3	45	–
Calc. nannofossils	50	1	87	53	1
Diatoms	–	3	2	–	4
Radiolaria	1	86	3	2	78
Sponge spicules	–	5	1	Tr	5
Silicoflagellates	–	–	1	–	Tr
Fish remains	–	–	–	–	1
Palagonite	–	–	–	–	2

SITE 462 HOLE A CORE 2 CORED INTERVAL: 249.5 to 259.0 m



LITHOLOGIC DESCRIPTION

0.0 to 8.3 m: Very pale orange (10YR 8/2) **NANNOFOSSIL CHALK** in firm "biscuits" separated by intervals of pastey ooze (may be artifact created by drilling operation). Some pieces are faintly burrowed.
In the 0.0-2.4 m interval are several layers of **NANNOFOSSIL-RADIOLARIAN CHALK** (or very firm **NANNOFOSSIL-BEARING RADIOLARIAN OOZE**). These layers are dark yellowish brown (10YR 4/2) and the undisturbed portions are faintly laminated and burrowed.

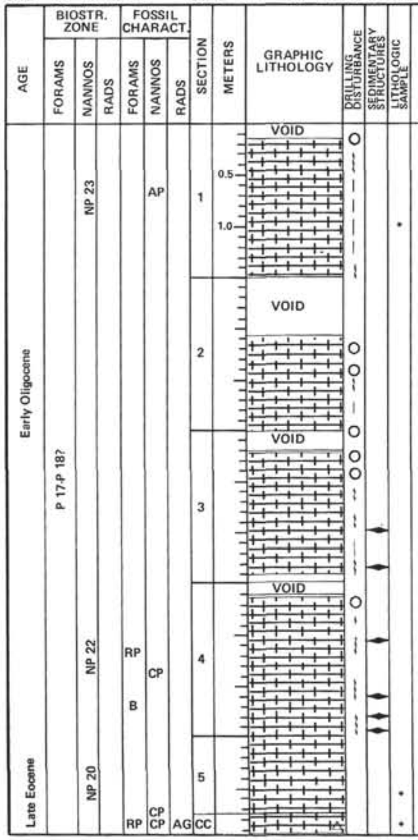
SMEAR SLIDE (%)

	Nannofossil radiolarian ooze	Nannofossil chalk	Nannofossil-bearing radiolarian ooze	Nannofossil ooze
TEXTURE AND MINERALS:	**1-89 (D)**	**1-125 (D)**	**2-36 (M)**	**2-CC (D)**
Sand size	15	2	5	2
Silt size	55	65	70	75
Clay size	30	33	25	23
Clay	5	–	10	–
Feldspar	–	Tr	–	–
Volcanic glass	Tr	Tr	–	Tr
Palagonite	1	Tr	4	Tr
Foraminifera	–	–	3	10
Calc. nannofossils	45	80	15	88
Radiolarians	49	19	60	1
Sponge spicules	Tr	1	8	1
Fish remains	1	–	Tr	–

THIN SECTION DESCRIPTION:

2, 72 cm: Radiolarian-rich chert (dominant lithology); sand size 30%; silt size 30%; clay size 40%; trace palagonite; micrite 60%; foraminifers 15%; trace calcareous nannofossils; radiolarians 25%; trace sponge spicules; and trace fish remains. Radiolarians occur as whole and fragmented tests and are filled mainly with micrite. Foraminifers are not badly broken, most chambers are empty, and others are filled with micrite. Under high power some micrites are nannofossils, and some are discoasters.

SITE 462 HOLE A CORE H1 CORED INTERVAL: 259.0 to 373.0* m



LITHOLOGIC DESCRIPTION

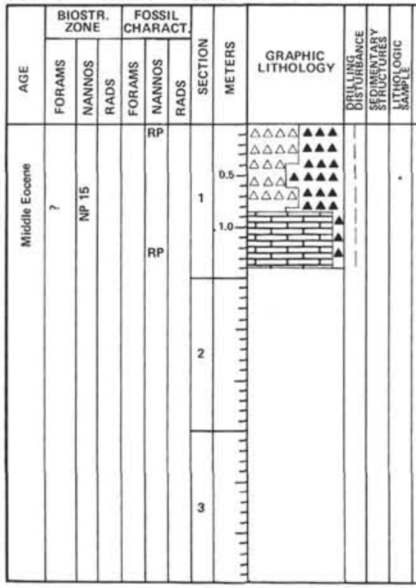
*This is a wash core between the interval 259.0 to 373.0 m. The material in this core could be from any portion of that interval.

0.0 to 5.9 m: Very pale orange (10YR 8/2) and white (N9) **FORAMINIFERAL NANNOFOSSIL CHALK** with fine lamillae to 5 cm thick layers of grayish orange (10YR 2/4) very firm, burrowed **CALCAREOUS RADIOLARIAN OOZE**. The largest **RADIOLARIAN OOZE** units are at 3-114 to 118 cm, 4-146 to 121 cm, and 5-47 to 52 cm.
A piece of **PORCELLANITE** is in the Core-Catcher sample.

SMEAR SLIDE (%)

	Foraminiferal nannofossil chalk	Foraminiferal nannofossil chalk	Calcareous nannofossil ooze	Nannofossil chalk
TEXTURE AND	1-100	4-26	5-48	H-CC
MINERALS:	(D)	(D)	(M)	(D)
Sand size	2	–	60	5
Silt size	80	85	30	85
Clay size	18	15	10	10
Volcanic glass	Tr	1	–	–
Palagonite	Tr	Tr	Tr	Tr
Foraminifera	20	20	–	10
Calc. nannofossils	63	72	20	67
Radiolarians	15	7	75	20
Sponge spicules	2	–	5	3

SITE 462 HOLE A CORE H2 CORED INTERVAL: 373.0 to 401.5* m



LITHOLOGIC DESCRIPTION

† This is a wash core between the interval 373.0 to 401.5 m. The material in this core could be from any portion of that interval.

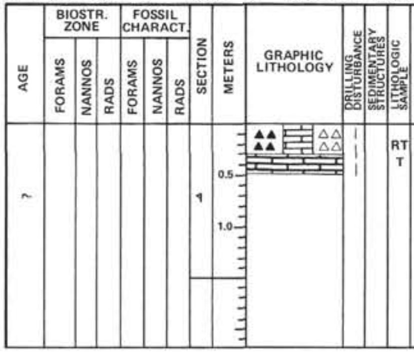
0.0 to 1.4 m: Pieces of very light gray (mainly N8) **PORCELLANITE** with lenses, blebs, and inclusions of **CHERT**. These **CHERTS** are grayish orange (10YR 7/7), grayish orange pink (10R 8/2), grayish red (10R 4/2), pale olive gray (5Y 7/1), light gray (N7), and related colors. Near 0.8 m are two grayish blue green (5BG 5/2) pieces.
A 4 cm thick **CLAYSTONE** occurs at 0.6 m and near the top of the core.
A few pieces of **CHALK** occur in the Core-Catcher sample.

SMEAR SLIDE (%)

	Claystone
TEXTURE AND	1-57
MINERALS:	(M)
Sand size	–
Silt size	5
Clay size	95
Clay	95
Radiolarians	5

THIN SECTION DESCRIPTION
1, 55-60 cm: Porcellaneous radiolarian claystone with abundant opal-CT and fish remains; and adjacent porcellaneous limestone, with common opal-CT and quartz. The claystone has radiolarians which are filled with clinopitilolite. Fish remains are enriched in the boundary layer between claystone and limestone.
1, 131-135 cm: Coarse foraminifer arenite; quartzose patches but opal-CT is also common; shallow water debris, echinoids, molluscoid fragments, bryozoans (?) or algae (?); volcanic grains.

SITE 462 HOLE A CORE 3 CORED INTERVAL: 401.5 to 411.0 m



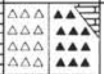
LITHOLOGIC DESCRIPTION

0.0 to 0.45 m: Pieces of very light gray (N8), partly **SILICIFIED LIMESTONES,** light gray and moderate brown (5YR 4/4) **QUARTZOSE CHERT** and a single piece of dark greenish gray (5G 4/1) **PORCELLANITE (OPAL-CT)** at 25 cm.

THIN SECTION DESCRIPTION
1, 24 cm: Quartzose chert with calcareous and opal-CT relics, also shallow water debris, radiolarians. Quartz replaces sponge spicules, but opal-CT is also abundant.
1, 37-39 cm: Opal-CT and quartz-rich foraminiferal arenite with shallow water debris.

X-RAY DIFFRACTION
1, 24 cm: Quartzose chert abundant quartz, common x-ray amorphous material; common calcite;

SITE 462 HOLE A CORE 4 CORED INTERVAL: 411.0 to 420.5 m

AGE	BIOSTR. ZONE FORAMS	BIOSTR. ZONE NANNOS	BIOSTR. ZONE RADS	FOSSIL CHARACT. FORAMS	FOSSIL CHARACT. NANNOS	FOSSIL CHARACT. RADS	SECTION	METERS	GRAPHIC LITHOLOGY	DRILLING DISTURBANCE	SEDIMENTARY STRUCTURES	LITHOLOGIC SAMPLE
Late (?) Early Eocene	P 7-P 9 (?)			RP			1 2 3	0.5 1.0				*T T T T

LITHOLOGIC DESCRIPTION

0.0 to 0.7 m: Dark greenish gray (5G 4/1) **PORCELLANITE,** white (N9) **PORCELLANITE** and **LIMESTONE.** Moderate brown (5YR 4/4) granular **CHERT** with horizontal lamination of grayish orange-pink (5YR 7/4) **CHERT.**

SMEAR SLIDE DESCRIPTION:

1, 15 cm: Limestone (dominate lithology); clay 5%; zeolite(?) 1%; carbonate unspecified 93%; discoaster 1%; and trace fish remains.

THIN SECTION DESCRIPTION:

1, 14 cm: Siliceous limestone (dominate lithology); sand size 1%; silt size 99%; foraminifers 1%, and radiolarians 2%, both commonly filled with opal-CT plus quartz; discoasters 2%, replaced by quartz (?); silica 45%, replacing foraminifers and nannofossils (?); calcite 40%, rhombohedral; calcite 10%.

1, 39 cm: Foraminiferal biomicrite (dominant lithology); sand size 32%; silt size 8%; clay size 60%; palagonite trace; micronodules 1%; carbonate unspecified 67%; foraminifers 30%, spar-filled, some corroded fragmentary foraminifer tests, some foraminifer tests contain lepispheres; radiolarians 1%; sponge spicules 1%; and rare chlorite grains.

1, 54 cm: Chert (silicified volcanic foraminifer sandstone) (dominant lithology); quartz 70%; authigenic; calcite 10%; apatite 2%, and 18%; Clays, ores from volcanic grains. In this quartzose chert a former porcellanite (opal-CT) precursor stage can be seen; many opal-CT lepispheres are now transformed to quartz. Common siliceous outlines of foraminifers with some sparry calcite remaining.

1, 66 cm: Porcellanite (impure siliceous limestone) (dominant lithology); before silification of rock–sand size 60%; silt size 40%; clay mineral 23%, in sand size clots; volcanic lithic grains 3%; volcanic glass 2%; palagonite 2%; carbonate unspecified 40%; foraminifera 30%, mainly replaced; nannofossils; sponge spicules; radiolarians (?); trace fish remains. After silification of rock: quartz 7%; opal-CT 31%; calcite 35%; clay mineral, etc. 30%. Quartz replaces some clay clots and some calcareous groundmass.

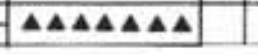
SITE 462 HOLE A CORE 5 CORED INTERVAL: 420.5 to 430.0 m

AGE	BIOSTR. ZONE FORAMS	BIOSTR. ZONE NANNOS	BIOSTR. ZONE RADS	FOSSIL CHARACT. FORAMS	FOSSIL CHARACT. NANNOS	FOSSIL CHARACT. RADS	SECTION	METERS	GRAPHIC LITHOLOGY	DRILLING DISTURBANCE	SEDIMENTARY STRUCTURES	LITHOLOGIC SAMPLE
Early Eocene	?	NP 10-12		B	CM		CC					

LITHOLOGIC DESCRIPTION

Core-Catcher: Moderate yellowish-brown to dusky yellowish brown (10YR 5/4 to 10YR 4/2) **CHERT.**

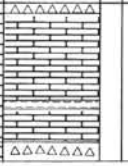
SITE 462 HOLE A CORE 6 CORED INTERVAL: 430.0 to 439.5 m

AGE	BIOSTR. ZONE FORAMS	BIOSTR. ZONE NANNOS	BIOSTR. ZONE RADS	FOSSIL CHARACT. FORAMS	FOSSIL CHARACT. NANNOS	FOSSIL CHARACT. RADS	SECTION	METERS	GRAPHIC LITHOLOGY	DRILLING DISTURBANCE	SEDIMENTARY STRUCTURES	LITHOLOGIC SAMPLE
?							CC					

LITHOLOGIC DESCRIPTION

Core-Catcher: Dark yellowish brown (10YR 4/2) **CHERT** and gray (N7) **LIMESTONE.**

SITE 462 HOLE A CORE 7 CORED INTERVAL: 439.5 to 449.0 m

AGE	BIOSTR. ZONE FORAMS	BIOSTR. ZONE NANNOS	BIOSTR. ZONE RADS	FOSSIL CHARACT. FORAMS	FOSSIL CHARACT. NANNOS	FOSSIL CHARACT. RADS	SECTION	METERS	GRAPHIC LITHOLOGY	DRILLING DISTURBANCE	SEDIMENTARY STRUCTURES	LITHOLOGIC SAMPLE
Middle Maestrichtian	*Globotruncana gansseri*	*Arkhangelskiella cymbiformis*		RP RP CP RP AP FP AP RP	FP FP RP CP TP RP	FP CP	1 CC	0.5 1.0				* T * T RT * *

LITHOLOGIC DESCRIPTION

0.0 to 1.35 m: Mostly light olive gray (5Y 6/1) horizontally- and cross-laminated **ZEOLITIC CALCARENITE.** Some pale yellowish-brown (10YR 6/2) **PORCELLANITE** at the top of the calcarenite and some pale yellowish-brown (10YR 6/2) **CLAYSTONE to LIMESTONE** at its base.

1.35 to 1.55 m: The Core-Catcher sample is moderate yellowish-brown (10YR 5/4) **PORCELLANITE.**

SMEAR SLIDE (%)

	Porcellanite	Zeolitic calcarenite	Zeolitic limestone	Zeolitic calcarenite	Limestone with silicified layers
MINERALS	1-3 (M)	1-55 (D)	1-100 (D)	1-105 (D)	1-127 (M)
Clay	–	–	15	–	5
Quartz, authigenic	–	–	–	–	10
Volcanic glass (alt.)	–	3	2	3	–
Zeolite	–	10	10	10	–
Carbonate unsp.	3	87*	73	87*	85
Foraminifera	–	Tr	–	Tr	–
Radiolaria	10**	–	–	–	5***
Opal-CT	87	–	–	–	–

*Some neomorphic spar

**Some opal-CT or quartz

***Quartz

THIN SECTION DESCRIPTION

1, 83-86 cm: Foraminiferal calcarenite (dominant lithology); planktonic foraminifera dominant; mollusc shells with common foliated structure; rare echinoid spines; common volcanic glass, vesicular, some devitrified with feldspar laths; common palagonite; dominant, sparry calcite in filling foraminifer tests and inter-particle voids; rare feldspar; trace of fish debris, clinopyroxene, and glauconite.

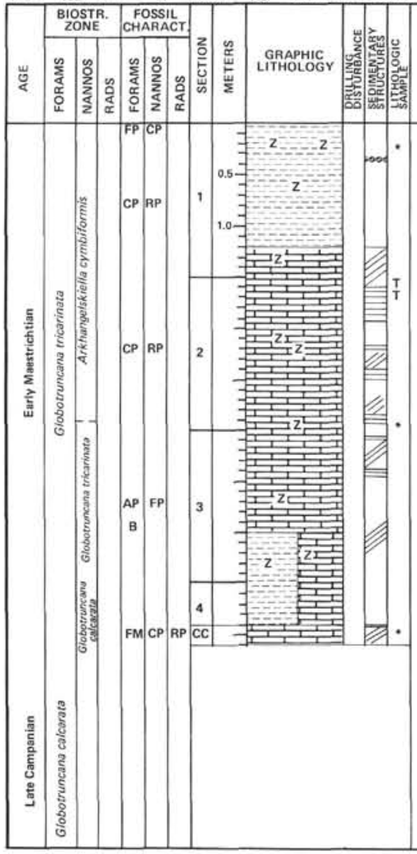
1, 86-87 cm: Clinoptilolite-rich tuffaceous biocalcarenite; highly altered volcanic grains 10%; few radiolarians.

X-RAY DIFFRACTION (XRD)

1, 86-87 cm: Clinoptilolite-rich tuffaceous biocalarenite; XRD of HCl-residue = abundant smectite; and common clinoptilolite and x-ray amorphous material.

1, 21 cm: Volcanic-rich foraminiferal sandstone (or biosparite) (dominant lithology): sand size 85%; silt size 14%; clay size 1%; altered clay 3%; opaques 1%; palagonite 3%; zeolite < 1%; calcite 15%, sparry cement; calcite 10%, micrite; calcite 5%, detrital; foraminifers 55%, spar-filled; radiolarians trace, probable opal-CT, well preserved; trace fish remains; volcanic glass 3%, altered; chlorite or other green clay mineral mold-filling of mollusc fragments. Sparite or microsporite matrix, some neomorphic (?). Finely laminated fine-grained sandstone of redeposited foraminifers, detrital calcite (some sparrly, red algae, bryozoans), and volcanic grains.

SITE 462 HOLE A CORE H3 CORED INTERVAL: 449.0 to 487.0 m



LITHOLOGIC DESCRIPTION

0.0 to 4.8 m: Interbeds of pale yellowish brown (10YR 6/2) **NANNOFOSSIL CLAYSTONE** and greenish gray (5G 6/1) cross- and horizontally-laminated mixed **VOLCANICLASTIC and CARBONATE SANDSTONES and SILTSTONES.** The **CLAYSTONE** is commonly burrowed with pale blue-green (5BG 7/2) to very light gray (N8) **NANNOFOSSIL MARLSTONE.**

SMEAR SLIDE (%)

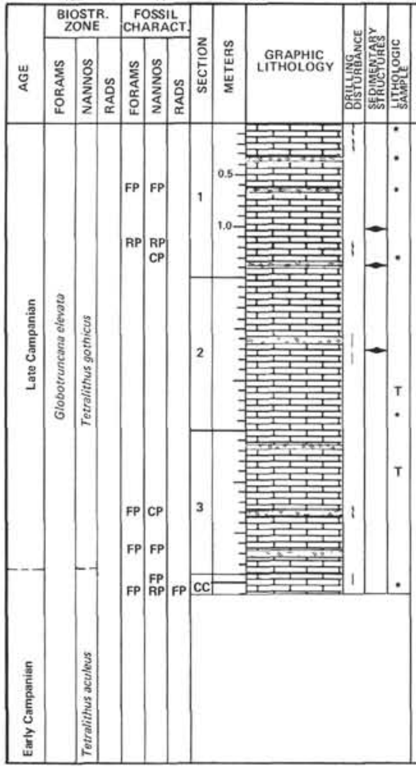
	Nannofossil marlstone	Limestone	Calcareous volcaniclastic sandstone
TEXTURES AND MINERALS	**1-22 (D)**	**2-145 (D)**	**CC (D)**
Sand size	–	–	25
Silt size	20	–	75
Clay size	80	–	–
Clay	40	–	–
Feldspar	–	–	5
Heavy minerals	1	Tr	Tr
Volcanic glass	2	2	25
Palagonite	2	–	–
Zeolite	10	–	25
Carbonate unsp.	20	98	20
Calc. nannofossils	25	–	–
Radiolaria	–	Tr	–
Sponge spicules	–	Tr	–
Volcanic grains (alt.)	–	–	25

THIN SECTION DESCRIPTION

2, 8.0 cm: Volcanic foraminiferal sandstone (biosporite) (dominant lithology): sand size 80%; silt size 15%; clay size 5%; feldspar tr; heavy minerals tr; clay matrix 6%, also, filling foraminifers; volcanic grains 5%, mainly altered to clay; volcanic glass 10%, altered to clay; palagonite 2%; calcite 30%, sparry cement; carbonate unspecified detrital 5%; foraminifers 40%, sparry filled; fish remains 2%. Laminae of fine sand-sized redeposited foraminifers, detrital calcite, and altered volcanic grains.

2, 21 cm: Limestone (foraminiferal biomicrite) (dominant lithology)– sand size 10%; silt size 90%; trace palagonite; carbonate unspecified 80%; foraminifer 10% redeposited (?); calcareous nannofossils 10%, most recrystallized.

SITE 462 HOLE A CORE H4 CORED INTERVAL: 496.0 to 515.5 m



LITHOLOGIC DESCRIPTION

0.0 to 4.7 m: Varicolored brownish gray (5YR 9/1, 10YR 7/1, 10YR 6/2), bedded and mottled, nannofossil-bearing **LIMESTONE.** Several 1-4 cm thick beds of blue green (5BG 7/1 to 5/1) and grayish brown (5YR 3/2) **ASH,** as indicated in the graphic presentation. (It is possible that other such beds existed in situ, but were "washed out" by the drilling process, because tops and bottoms and ends of some pieces of limestone have zeolitic-clay-ash adhering to them.)

SMEAR SLIDE (%)

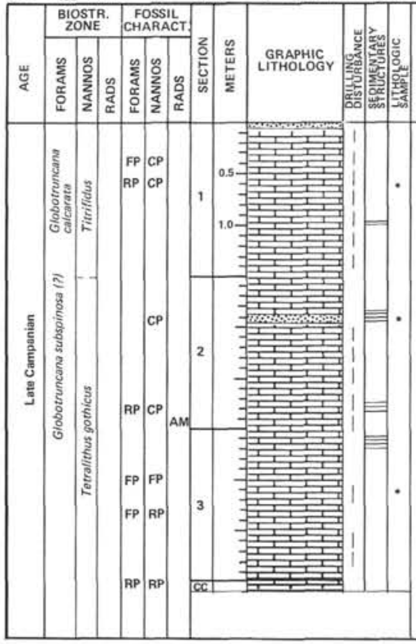
	Limestone	Zeolitic volcanic ash	Ashy limestone	Zeolitic ash	Limestone	
TEXTURE AND MINERALS	**1-5 (D)**	**1-36 (M)**	**1-66 (M)**	**1-131 (M)**	**2-135 (M)**	**CC (D)**
Sand size	–	1	10	5	1	–
Silt size	35	19	50	15	19	–
Clay size	65	80	40	80	80	–
Clay	–	25	10	10	5	–
Feldspar	–	–	–	–	Tr	–
Heavy minerals	Tr	–	2	2	Tr	–
Opaques	–	–	–	–	Tr	–
Volcanic glass	2	60	20	54	Tr	Tr
Palagonite	–	–	–	–	–	Tr
Pyrite	Tr	–	Tr	–	–	–
Zeolite	Tr	12	Tr	30	–	–
Carbonate unsp.	88	3	54	–	90	90
Calc. nannofossils	10	–	10	2	5	10
Fish remains	Tr	Tr	–	Tr	Tr	Tr

THIN SECTION DESCRIPTION

2, 110 cm: Micritic limestone: Silt size 3%; clay size 97%; palagonite 1%; carbonate unspecified 97%, micrite; carbonate-spar 1%; foraminifers 1%; opal trace. No structures or fabric. Radiolarian ghosts.

3, 40 cm: Micrite limestone; Silt size 10%; clay size 90%; opaques trace; clay 5%; volcanic glass trace; palagonite 2%; carbonate unspecified 91%; foraminifers 2%, fragments. Fabric of aligned elongated grains.

SITE 462 HOLE A CORE 8 CORED INTERVAL: 487.0 to 496.5 m



LITHOLOGIC DESCRIPTION

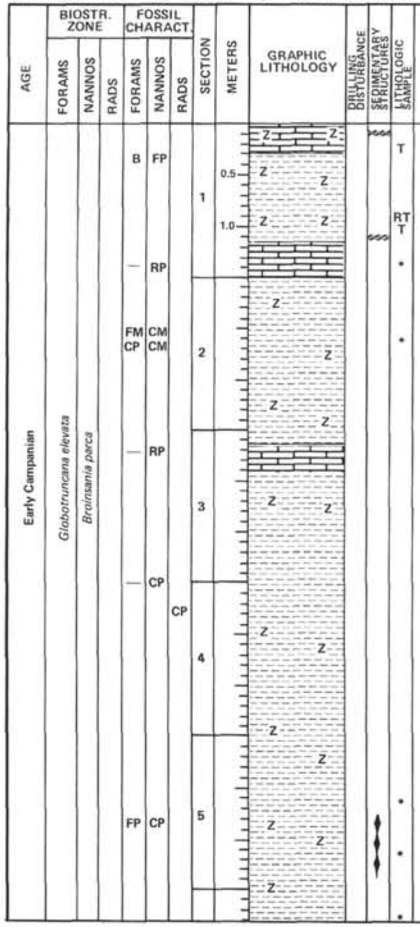
0.0 to 4.6 m: LIMESTONE and MARLY NANNOFOSSIL LIMESTONE. Color ranges from medium brownish gray (5YR 5/1), light olive gray (5Y 6/1), very light gray (N8), to medium light gray (10YR 7/1). Some of the darker areas are richer in clay (to waxy) and are better laminated. Most pieces are slightly moddled.
VOLCANIC SANDSTONE layers occur at 0.0 to 0.08 m and 1.07 to 1.95 m.

SMEAR SLIDE (%)

	Marly nannofossil limestone	Volcanic sandstone	Limestone
TEXTURE AND MINERALS	1-60 (D)	2-42 (M)	3-55 (M)
Sand size	–	70	–
Silt size	25	20	20
Clay size	75	10	80
Clay	15	–	10
Heavy minerals	4	15	Tr
Volcanic glass	Tr	10	–
Palagonite	1	–	Tr
Zeolite	10	10	–
Carbonate unsp.	50	4	85
Calc. nannofossils	20	1	5
Volcanic grains (alt.)	–	60	–

THIN SECTION DESCRIPTION
2, 38 cm: Calcite cemented, epi-clastic, volcanic and carbonate sandstone (minor lithology); sand size 90%; silt size 10%; feldspar 3%; heavy minerals 2%; volcanic grains 30%, mainly altered to clay; palagonite trace; carbonate unspecified detrital 20%; carbonate cement 35%; foraminifers 10%. Grains are subangular to subrounded.

SITE 462 HOLE A CORE 9 CORED INTERVAL: 515.5 to 525.0 m



LITHOLOGIC DESCRIPTION

0.0 to 4.5 m: Light gray (N7) **ZEOLITIC LIMESTONE** interbedded with olive gray (5Y 4/1) **CLAYSTONE.** Some layers of yellowish brown (10YR 6/2) and pale blue green (5BG 7/2) layers. Some burrows.
4.5 to 7.8 m: Grayish red (10R 4/2) to light brown (5YR 6/4) **ZEOLITIC CLAYSTONE** with layers and blotches of pale blue green (5BG 7/2). Minor burrow mottling. **NATIVE COPPER** in Section 5 at several levels surrounded by haloes of pale blue green (5BG 7/2) **CLAYSTONE.** Pale reddish brown (10R 5/4) **CLAYSTONE** at base.

SMEAR SLIDE (%)

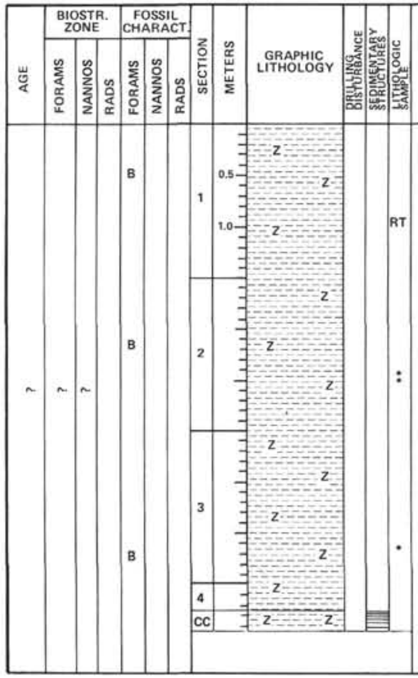
	Zeolitic claystone	Zeolitic limestone	Claystone	Zeolitic claystone	Zeolitic claystone	Zeolitic claystone
TEXTURE AND MINERALS	1-94 (D)	1-140 (D)	2-60 (D)	5-60 (M)	5-111 (D)	6-32 (D)
Sand size	3?	–	–	–	–	–
Silt size	27?	–	15	–	–	–
Clay size	70?	–	85	–	–	–
Clay	70	5	81	50?	77	77
Heavy minerals	Tr	–	Tr	–	–	–
Volcanic glass	–	Tr	3	<1	–	–
Pyrite	–	–	1	–	–	–
Zeolite	30	10	5	49?	20	20
Carbonate unsp.	Tr	80	5	–	–	–
Calc. nannofossils	Tr	2	5	–	–	–
Radiolarian	10*	3*	–	–	3*	3*
Fish remains	–	–	Tr	–	Tr	Tr

*Clayey and zeolitic casts

THIN SECTION DESCRIPTION
1, 29 cm: Micritic limestone–Clay 10%; zeolitic 1%; recrystallized nannofossils 79%; microfossil-ghosts 10%. Faint bedding indicated by the orientation of silt-sized micro-fossil ghosts (some voids are filled with zeolites).
1, 90 cm: Zeolitic radiolarian claystone–Clay 80%; zeolite 20%, replaced and filled with radiolarians; trace opal-CT (?). Alteration of clay-rich and radiolarian-rich layers.
1, 93-95 cm: Zeolitic and opal-CT rich radiolarian claystone.

X-RAY DIFFRACTION:
1, 93-95 cm: Zeolitic and opal-CT rich radiolarian claystone. Abundant opal-CT; common smectite and clinoptilolite.

SITE 462 HOLE A CORE 10 CORED INTERVAL: 525.0 to 534.5 m



LITHOLOGIC DESCRIPTION

0.0 to 4.75 m: Dominantly pale reddish brown (10R 5/4) partly **ZEOLITIC CLAYSTONE** becoming moderate brown (5YR 4/4) at the base. Rare layers of grayish-blue green (5BG 5/2). Some chondites burrows. Some grayish blue green (5BG 5/2) horizontally- and cross-laminated **VOLCANICLASTIC SILTSTONE** in Section 3.
4.75 to 4.95 m: Core-catcher sample is moderate brown (5Y 4/4) and pale blue green (5BG 5/2) horizontally-laminated **ZEOLITIC CLAYSTONE to SILTSTONE.**

SMEAR SLIDE (%)

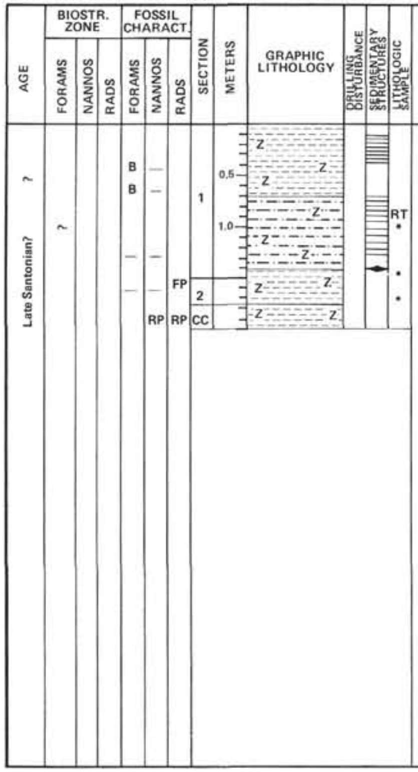
	Claystone	Claystone	Volcaniclastic siltstone	Zeolitic claystone	Volcaniclastic siltstone
TEXTURE AND MINERALS	2-90 (M)	2-100 (D)	3-119 (D)	4-10 (M)	CC (D)
Sand size	–	–	–	–	–
Silt size	2	8	90	–	90
Clay size	98	92	10	–	10
Clay	96	92	10	37	5
Feldspar	–	–	3	–	3
Volcanic glass (alt.)	1	3	84	3	82
Zeolite	3	2	3	60	10
Radiolaria	?*	3*			
Sponge spicules	–	–	Tr	–	–

*Casts

THIN SECTION DESCRIPTION
2, 47 cm: PALYGORSKITE CLAYSTONE: Silt size 70%; clay size 30%; clay 36%; palagonite 10%; hematite 2%; zeolite 50%; fish remains 2%. Felted mass of zeolite laths in clay, which are moderately well-aligned in bedding plane.

X-RAY DIFFRACTION
2, 47 cm: PALYGORSKITE CLAYSTONE: Abundant palygorskite; common feldspar, quartz and smectite.

SITE 462 HOLE A CORE 11 CORED INTERVAL: 534.5 to 544.0 m



LITHOLOGIC DESCRIPTION

0.0 to 0.7 m: Grayish red (10R 4/2) horizontally- and cross-laminated **ZEOLITIC CLAYSTONE.**
0.7 to 1.45 m: Greenish gray (5G 6/1) **ZEOLITIC VOLCANICLASTIC SILTSTONE to SANDSTONE** with horizontal and ripple bedding.
1.45 to 2.0 m: ZEOLITIC CLAYSTONE has faint mottling in the upper part and is grayish red (10R 4/2) in the upper part grading downward to light olive gray (5Y 6/1).

SMEAR SLIDE (%)

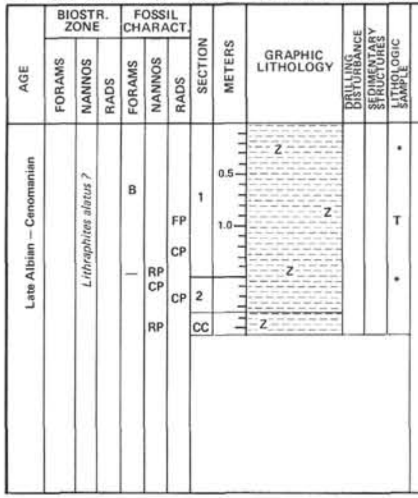
	Zeolitic volcaniclastic siltstone	Volcaniclastic vitric siltstone	Calcareous claystone
TEXTURE AND MINERALS	1-95 (D)	1-142 (D)	2-22 (D)
Sand size	–	–	–
Silt size	100	100	20
Clay size	–	–	80
Clay	–	–	73
Feldspar	1	5	3
Volcanic glass	39*	83	1
Zeolite	40	2	3
Carbonate unsp.	20	10	20
Fish remains	Tr	Tr	Tr
Sponge spicules	Tr	–	–

*Altered

THIN SECTION DESCRIPTION
1, 90-94 cm: Clinoptilolite-rich tuffaceous siltstone with radiolarians. Volcanic grains and clinoptilolite casts of radiolarians.
1, 140 cm: Clay replaced hyaloclastite sandstone–Sand size 90%; silt size 10%; feldspar grains 3%; opaques 5%; volcanic glass replaced by clay 75%; unidentified vermiculite 2%; unspecified carbonate 15%. Former volcanic grains (60-120 microns) mainly angular polygons, some subangular to subrounded. Cement appears to be clay, but could be zeolite.

X-RAY DIFFRACTION
1, 90-94 cm: Clinoptilolite-rich tuffaceous siltstone with radiolarians. Abundant smectite; common calcite and x-ray amorphous material; traces of opal-CT and clinoptilolite.

SITE 462 HOLE A CORE 12 CORED INTERVAL: 544.0 to 553.5 m



LITHOLOGIC DESCRIPTION

0.0 to 2.0 m: Dominantly light brown (5YR 6/4) **RADIOLARIAN CLAYSTONE** with local intervals of grayish blue-green (5BG 5/2).

SMEAR SLIDE (%)

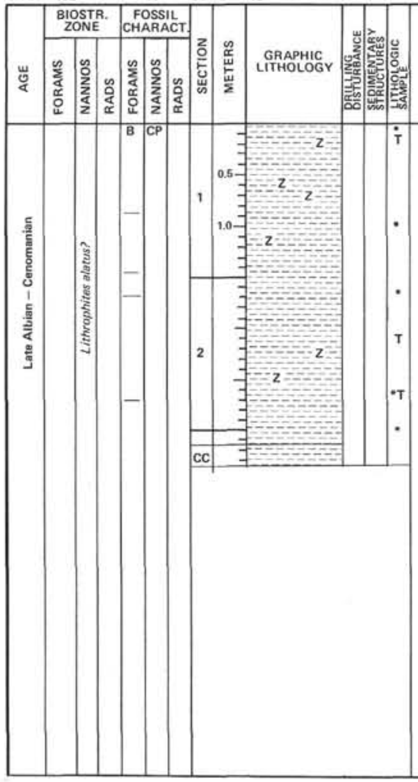
TEXTURE AND MINERALS	Radiolarian claystone 1-30 (D)	Radiolarian claystone 2-2 (D)
Sand size	–	5
Silt size	–	13
Clay size	–	82
Clay	75	81
Volcanic glass	–	3
Zeolite	5	3
Carbonate unsp.	–	2
Calc. nannofossils	–	1
Radiolaria	20*	10*

*Highly altered and coated and filled with silicates.

THIN SECTION DESCRIPTION

1, 81 cm: Zeolitic mudstone–Sand size 2%; silt size 58%; clay size 40%; heavy minerals 1%; clay 40%; palagonite 4%; zeolite 50%; carbonate unspecified 2%; calcareous nannofossils trace; radiolarians 2%; fish remains 1%.

SITE 462 HOLE A CORE 13 CORED INTERVAL: 553.5 to 563.0 m



LITHOLOGIC DESCRIPTION

0.0 to 3.35 m: Mostly dusky yellowish-brown (10YR 2/2) **ZEOLITIC CLAYSTONE** with streaks of black (N1) and light brown (5YR 6/4). Gray **ZEOLITIC CLAYSTONE** within 2.33-2.77 m. Some pale blue green (5BG 5/2) **RADIOLARIAN-RICH** levels.
The base of core (and Core-Catcher sample) is distinctly darker where **CLAYSTONE** is black (N1) with light brown streaks and zeolites are less common.

SMEAR SLIDE (%)

TEXTURE AND MINERALS	Calcareous claystone 1-10 (D)	Zeolitic claystone 1-100 (D)	Radiolarian sand 2-2 (M)	Zeolitic claystone 2-10 (D)	Zeolitic claystone 2-120 (D)	Claystone 3-2 (D)
Sand size	–	–	80	–	–	–
Silt size	–	–	5	10	20	–
Clay size	–	–	15	90	80	100
Clay	80	88	14	80	74	100
Feldspar	–	–	1	–	–	–
Heavy minerals	<1	–	–	Tr	–	–
Pyrite	–	1	–	–	–	–
Zeolite	5	10*	–	10	20*	–
Carbonate unsp.	5	–	–	–	1	–
Calc. nannofossils	5	–	–	–	–	–
Radiolaria	–	–	80**		–	–
Fish remains	–	–	Tr	–	–	Tr
Volcanic glass (alt.)	5	1	5	10	5	–

*Corroded
**Complete spheres quartz filled molds

THIN SECTION DESCRIPTION

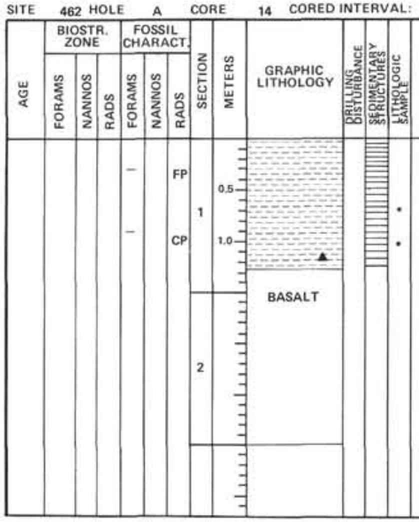
1, 19 cm: Zeolitic mudstone–Silt size 20%; clay size 80%; feldspar 1%; clay 74%; opaques 2%; zeolite 20%; carbonate unspecified 1%; calcareous nannofossils 2%; faint bedding.

2, 3.0-7.0 cm: Palygorskite claystone–Uniform extinction; fish remains 2-3%; radiolarians common in some layers.

2, 65 cm: Zeolitic claystone–Sand size 1%; silt size 9%; clay size 90%; feldspar 3%; opaques 1%; clay 60%; palagonite 10%; zeolite 25%; fish remains 1%.

2, 120 cm: Zeolitic radiolarian claystone–Altered volcanic glass 5%; many clinoptilolite-filled radiolarian casts.

SITE 462 HOLE A CORE 14 CORED INTERVAL: 563.0 to 566.5 m



LITHOLOGIC DESCRIPTION

0.0 to 1.25 m: Moderate brown (5YR 4/4) to dusky yellowish-brown (10YR 2/2) to black (N1) faintly laminated **CLAYSTONE.** Laminae dip 20°. Black (N1) **CHERT** at base of section.
Below 1.25 m is basalt which is described in **"Visual Core Descriptions of Igneous Rock".**

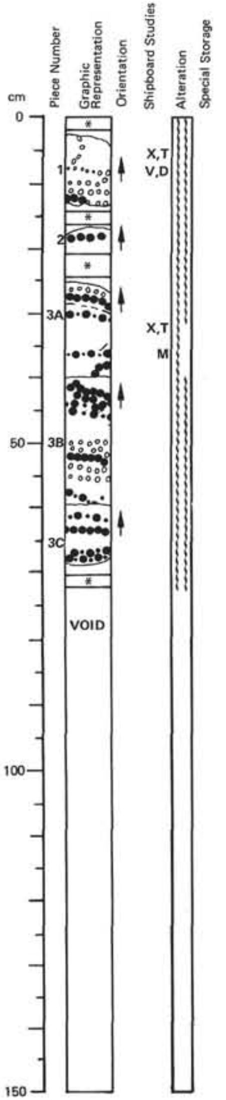
SMEAR SLIDE (%)

TEXTURE AND MINERALS	Radiolarian claystone 1-70 (D)	Claystone 1-101 (D)
Sand size	–	4
Silt size	–	1
Clay size	–	95
Feldspar	1	1
Clay	87	98
Micronodules	2	2
Zeolite	5	5
Calc. nannofossils	–	Tr
Radiolaria	5*	–

*Silica-filled spheres

THIN SECTION DESCRIPTION

1, 120 cm: Goethite-rich radiolarian quartz chert.



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	14	2

Depth: 565.0 to 566.5 m

MAJOR ROCK TYPE—BASALT SILL

Macroscopic Description:

From 0.0-69.0 cm is fine grained, slightly to moderately altered microdolerites cut by numerous veins of calcite (thickest), celadonite, and clay-celadonite-calcite veins. Key to symbols in graphic presentation is: in Explanatory Notes chapter (this volume).
Gray color of microdolerites grade slowly near vein to yellowish brown. Microdolerites consist of about 60% plagioclase (microphenocrysts and microlites), about 20% clinopyroxene (microphenocrysts and interstitial), and about 8-10% magnetite (small irregular grains). Pyroxene partly altered to light green smectite.
From 2.0-7.0 cm the texture of the microdolerite is more fine grained.

Thin Section Description:

4-7 cm: Sharp contact of phyric to aphyric basalt from chilled margin (top).
Microphenocrysts: Plagioclase (An45-65) 0.05 x 0.6 mm, (aphyric = 52%, phyric = trace), elongated prisms with the marginal envelopes more acid; clinopyroxene (phyric = 40%, aphyric = trace) 0.5 mm, equidimensional; magnetite (phyric = 8%, aphyric = trace), 0.6 mm, deeply altered to dark brown oxides.
Groundmass: Plagioclase (An35-65), microlites, altered; clinopyroxene, altered, equidimensional; magnetite 10%, <0.04 mm; glass >70%, altered.
Alteration (80%): Carbonate, in interior of veins, replacing vein in filling is in the form of colloform aggregates; clays in margins of veins and groundmass, replacing glass. The clays in the veins are bright green, and in the glass are pale green. Pyrite in margin of vein replacing vein in filling. The pyrite is altered to hydroxides.
Texture: Intersertal.
29-32 cm: Altered basalt from interior of sill.
Phenocrysts: Plagioclase < 1%, 0.8-1.0 mm, laths, highly altered.
Groundmass: Plagioclase (An80 zoned to An38) 27%, 0.1-0.5 mm, highly altered; clinopyroxene (augite) 25%, 0.1-0.4 mm, subhedral to euhedral, 2V angle ~40°; Ti-magnetite 10%, 0.004-0.08 mm, colorless; quartz < 1%, 0.1 mm, anhedral, with apatite inclusions.
Alteration: Brown clay (3%) and chlorite (35%) replacing plagioclase and clinopyroxene.
Texture: Intergranular to diabasic.

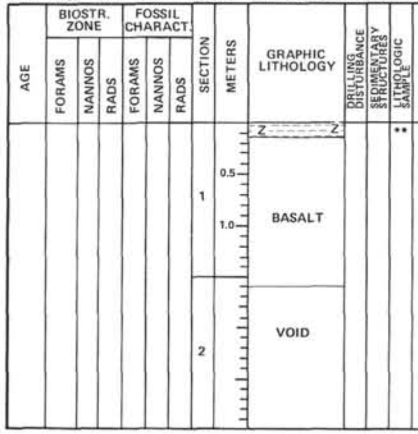
Shipboard Geochemistry (XRF, %):

Interval	4-7 cm	29-32 cm
SiO_2	52.23	52.97
TiO_2	1.90	1.51
Al_2O_3	18.56	15.40
FeO	9.07	9.99
MnO	0.07	0.12
MgO	2.84	6.54
CaO	7.65	10.10
Na_2O_5	–	–
K_2O	2.85	0.83
P_2O_5	0.21	0.22
Total	95.10	97.34
LOI	2.46	1.99
FeO ÷ MgO	3.19	1.52
CaO ÷ Al_2O_3	0.41	0.65
FeO ÷ TiO_2	4.77	6.61

Paleomagnetism/Physical Properties:

Interval	6-8 cm	36 cm
NRM Intensity (10^{-3} emu/cc)	–	0.3
NRM Incl. (°)	–	–61.1
MDF (Oe.)	–	55.0
Stable Incl. (°)	–	–38.4
Vp ∥ (km/s)	5.01	–
D (g/cc)	2.87	–
P (%)	–	–

SITE 462 HOLE A CORE 15 CORED INTERVAL: 566.5 to 572.0 m



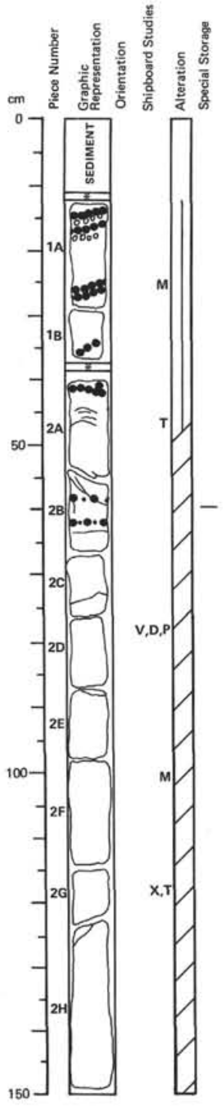
LITHOLOGIC DESCRIPTION

0.0 to 0.1 m: Two pieces of **VOLCANIC ZEOLITIC MUDSTONE** which may have caved into hole.

0.1 m and below: Basalt which is described in detail in **"Visual Core Description of Igneous Rock".**

SMEAR SLIDE (%)

	Volcanic zeolitic mudstone	Volcanic zeolitic mudstone
TEXTURE AND MINERALS	1-3 (M)	1-8 (M)
Sand size	–	15
Silt size	80	70
Clay size	20	15
Heavy minerals	2	2
Volcanic glass (altered)	85	93
Carbonate spartrag.	10	5



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG		SITE			HOLE	CORE		SECT.	
6	1	4	6	2	A	1	5		1

Depth: 566.5 to 568.0 m

MAJOR ROCK TYPE—BASALT SILL

Macroscopic Description:
There is ~10 cm of sediment at the top of the section which is described in detail in the Sedimentary Visual Core Description. Altered (? grain-size) basalt extends from 0.1-0.6 m and has many veins, of calcite and celadonite veins and complex veins of calcite, celadonite, etc. Below 0.6 m the altered basalt is aphanitic and veins are less abundant. At ~36 cm are chlorite and clay halos.

Thin Section Description:

44-48 cm: Highly altered basalt from sill margin with alteration vein.
Phenocrysts: None.
Groundmass: Plagioclase (An50 zoned to ?) 30%, 0.1-0.3 mm; clinopyroxene (augite) 20%, 0.1-0.4 mm, subhedral, clear and highly replaced; magnetite 15%; alteration products 35%.
Alteration: Pyroxene almost totally replaced by green clay and chlorite (in that order); iron and manganese oxides and hydroxides, carbonate, green and brown clays, zeolites, and chlorites are replacing groundmass and also occur in groundmass and veins.
Texture: Intergranular to diabasic.

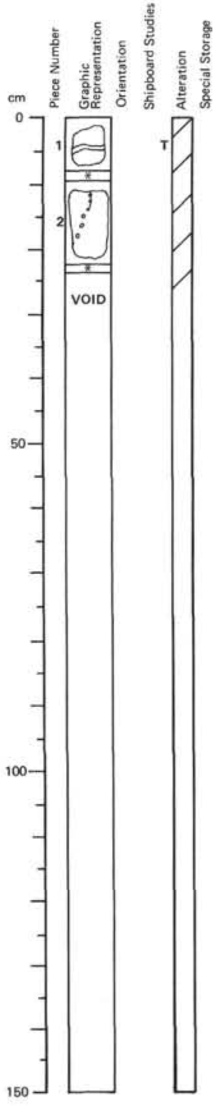
117-120 cm: Altered basalt from interior of sill.
Phenocrysts: None.
Groundmass: Plagioclase (An70-50) 20%, 0.1-0.5 mm; clinopyroxene (augite) 45%, 0.1-0.4 mm, subhedral, light greenish brown; Ti-magnetite 10%, 0.05-0.2 mm, (does not include dust-like magnetite found with clay and zeolite in altered zone).
Alteration: Green and brown clays, fibrous and low relief zeolite, and magnetite dust (total 25%), replacing clinopyroxene.
Texture: Diabasic.

Shipboard Geochemistry (XRF, %):

Interval	**117-120 cm**
SiO_2	50.96
TiO_2	1.45
Al_2O_3	13.83
FeO	12.20
MnO	0.20
MgO	6.63
CaO	11.83
Na_2O	–
K_2O	0.06
P_2O_5	0.21
Total	96.96
LOI	0.63
FeO ÷ MgO	1.84
CaO ÷ Al_2O_3	0.85
FeO ÷ TiO_2	8.41

Paleomagnetism/Physical Properties:

Interval	**25 cm**	**78-81 cm**	**110 cm**
NRM Intensity (10^{-3} emu/cc)	0.7	–	1.1
NRM Incl. (°)	–72.4	–	–47.3
MDF (Oe.)	35.0	–	55.0
Stable Incl. (°)	–28.8	–	–27.1?
Vp ∥ (km/s)	–	6.30	–
D (g/cc)	–	2.99	–
P (%)	–	1.1	–



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG		SITE			HOLE	CORE		SECT.	
6	1	4	6	2	A	1	5		2

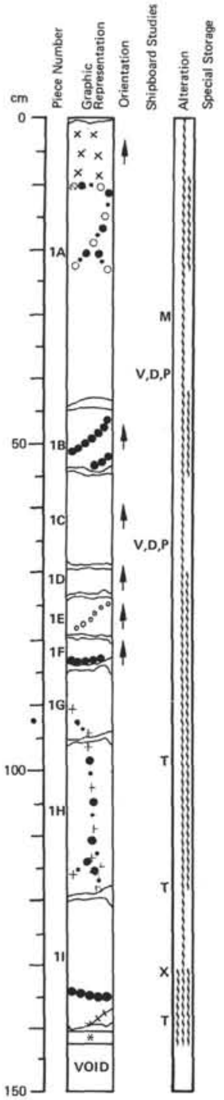
Depth: 568.0 to 568.2 m

MAJOR ROCK TYPE—BASALT SILL

Macroscopic Description:
Basalt with veins of calcite and pyrite. Slight coarsening of grain-size in a zone from 3.0-5.0 cm.

Thin Section Description:

6-9 cm: Altered basalt from sill interior.
Phenocrysts: Plagioclase (An80 zoned) < 1%, 0.3-0.5 mm, anhedral.
Groundmass: Plagioclase (An77 zoned to An36) 20%, 0.1-0.4 mm; clinopyroxene (augite) 35%, 0.1-0.5 mm, 2V angle ~55°; Ti-magnetite 10%, 0.005-0.2 mm (also fine grained, associated with green clay); clays 35%, green alteration.
Alteration: Clays (35%) alteration of clinopyroxene in groundmass. Vein has (1)calcite plus pyrite (colloform), (2) calcite (colloform), (3) clay (brown), (4) chalcedony (colloform), (5) quartz (granular), and (6) second generation calcite.
Texture: Diabasic.



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	16	1

Depth: 572.0 to 573.5 m

MAJOR ROCK TYPE—BASALT SILL

Macroscopic Description:
From 0.0-139.0 cm more fine grained microdolerites, the same as in Core 15, Section 2. Quartz-celadonite-clay-calcite and quartz-diorite-like veins appear at the end of the interval. —////— quartz-diorite-like veins; X X X finer grained microdolerites. Visible alteration is observed near veins, pyroxene is slightly replaced by green smectite. Quartz-diorite-like veins consist of quartz and plagioclase, partly altered to calcite and bright green smectite. alteration is observed near veins, pyroxene is slightly replaced by green smectite. Quartz-diorite-like veins consist of quartz and plagioclase, partly altered to calcite and bright green smectite.

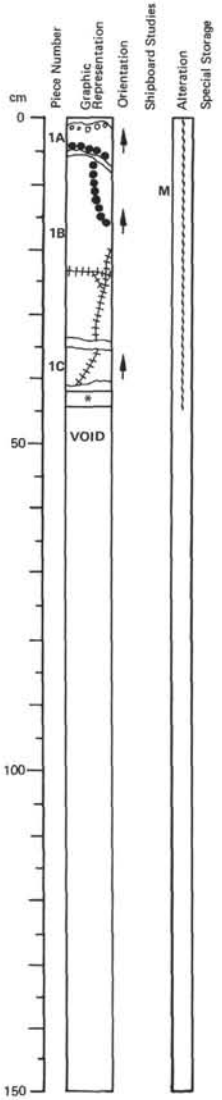
Thin Section Description:
97-101 cm: Altered basalt from sill interior.
Phenocrysts: Plagioclase < 1%, 0.3-0.6 mm, subhedral, strongly zoned.
Groundmass: Plagioclase (An75), 0.2-0.7 mm, not strongly zoned; clinopyroxene (augite) 56%, 0.1-0.6 mm, subhedral, light brown; Ti-magnetite 7%, 0.002-0.3 mm.
Alteration: Carbonate (2%) and green clay (10%) in patchy replacement of rock. Also vein with pyrite, calcite, chalcedony, clay, and quartz.
Texture: Diabasic.
116-119 cm: Vein in highly altered basalt from sill interior. Basalt is similar to Core 16, Section 1 and altered to green clay, brown clay, and minor chlorite. Vein contains calcite, chlorite, chalcedony, pyrite, bright yellow-green clay, and brown clay.
137-140 cm: Vein in altered basalt. Vein contains quartz, calcite, pyrite, green clay, brown clay, Fe-Mn oxides and hydroxides, chalcedony, second generation of calcite and possibly zeolite (?).

Shipboard Geochemistry (XRF, %):

Interval	**129-131 cm**
SiO_2	49.97
TiO_2	1.40
Al_2O_3	14.06
FeO	12.11
MnO	0.20
MgO	6.84
CaO	12.11
Na_2O	–
K_2O	0.06
P_2O_5	0.23
Total	96.55
LOI	0.43
FeO + MgO	1.77
CaO ÷ Al_2O_3	0.86
FeO + TiO_2	8.65

Paleomagnetism/Physical Properties:

Interval	**29 cm**	**34-36 cm**	**62-64 cm**
NRM Intensity (10^{-3} emu/cc)	1.1	–	–
NRM Incl. (°)	–67.5	–	–
MDF (Oe.)	35.0	–	–
Stable Incl. (°)	–20.3	–	–
Vp ‖ (km/s)	–	5.92	6.09
D (g/cc)	–	2.98	2.98
P (%)	–	1.7	1.4



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	16	2

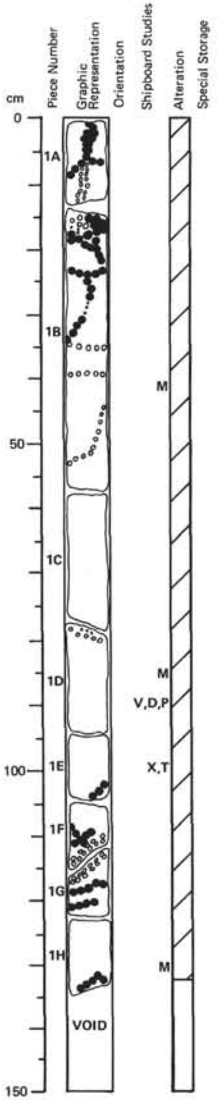
Depth: 573.5 to 574.0 m

MAJOR ROCK TYPE—BASALT SILL

Macroscopic Description:
Microdolerites the same as in Core 16, Section 1.

Paleomagnetism:

Interval	**12 cm**
NRM Intensity (10^{-3} emu/cc)	1.3
NRM Incl. (°)	–62.6
MDF (Oe.)	40.0
Stable Incl. (°)	–27.2



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	17	1

Depth: 574.0 to 575.5 m

MAJOR ROCK TYPE—BASALT SILL

Macroscopic Description:
Massive subophitic dolerite with veins of celadonite, calcite, clay, and calcite plus celadonite and clay. The dolerite is aphanitic to sparsely spotted with clinopyroxene aggregates and plagioclase phenocrysts. Microphenocrysts are plagioclase and clinopyroxene, and microlites of plagioclase, clinopyroxene and Ti-magnetite (plagioclase > clinopyroxene > Ti-magnetite). The dolerite, chlorite veins and clay veins are, respectively, medium bluish gray (5B 5/1), dark green, and light olive brown (5Y 5/6). Sulfide (pyrite) occurs in some veins. Alteration is moderate to slightly moderate.

(5Y 5/6). Sulfide (pyrite) occurs in some veins.

Alteration is moderate to slightly moderate.

Thin Section Description:
98-100 cm: Subophitic dolerite from sill interior.

Phenocrysts: Plagioclase (An50-55) 2%, 0.4-0.5 mm, acicular to prismatic. These are considered to be microphenocrysts.

Groundmass: Plagioclase (An70-58) 47%, <0.2 mm, subhedral; microlitic to groundmass; clinopyroxene 46%, <0.2 mm, subhedral, microlitic to groundmass; magnetite 5%, <0.05 mm, prismatic, most common in altered part.

Alteration: Clays (25%) in spotted locations and in the mesostasis, replacing clinopyroxene.

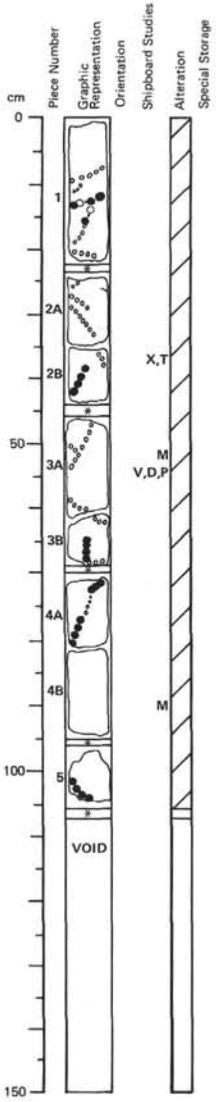
Texture: Subophitic.

Shipboard Geochemistry (XRF, %):

Interval	**98-100 cm**
SiO_2	50.03
TiO_2	1.39
Al_2O_3	13.92
FeO	11.97
MnO	0.19
MgO	6.99
CaO	11.85
Na_2O	–
K_2O	0.02
P_2O_5	0.22
Total	96.17
LOI	0.71
FeO ÷ MgO	1.71
CaO + Al_2O_3	0.85
FeO ÷ TiO_2	8.61

Paleomagnetism/Physical Properties:

Interval	**41 cm**	**88-91 cm**	**129 cm**
NRM Intensity (10^{-3} emu/cc)	1.2	–	2.4
NRM Incl. (°)	–35.1	–	–24.0
MDF (Oe.)	50.0	–	55.0
Stable Incl. (°)	–20.3	–	–18.4
Vp ∥ (km/s)	–	5.81	–
D (g/cc)	–	2.98	–
P (%)	–	1.7	–



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	17	2

Depth: 575.5 to 577.0 m

MAJOR ROCK TYPE—BASALT SILL

Macroscopic Description:
Massive veined subophitic dolerite as mentioned in Core 17, Section 1.

Thin Section Description:
36-38 cm: Subophitic dolerite from sill interior.

Phenocrysts: Plagioclase (An55-60) 3%, 0.5-<1.0 mm, prismatic; clinopyroxene 1%, 0.5 mm, associated with plagioclase laths; phenocrysts to microphenocrysts.

Groundmass: Plagioclase 45%, <0.2 mm, subhedral to euhedral, microlite to groundmass; clinopyroxene 46%, <0.2 mm, euhedral, microlite to groundmass; magnetite 5%, <0.05 mm, prismatic, microlite to groundmass, absorbed more frequently in altered part; clinopyroxene and plagioclase often form spherulitic aggregates.

Alteration: Clays (30%) in spotted locations and mesostasis, replacing pyroxene.

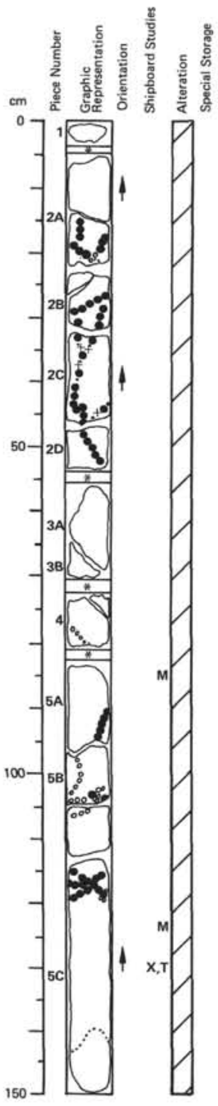
Texture: Subophitic.

Shipboard Geochemistry (XRF, %):

Interval	**36-38 cm**
SiO_2	49.26
TiO_2	1.40
Al_2O_3	13.97
FeO	11.77
MnO	0.19
MgO	7.30
CaO	11.81
Na_2O	–
K_2O	0.06
P_2O_5	0.22
Total	95.57
LOI	0.79
FeO ÷ MgO	1.61
CaO ÷ Al_2O_3	0.84
FeO ÷ TiO_2	8.40

Paleomagnetism/Physical Properties:

Interval	**52-54 cm**	**89 cm**
NRM Intensity (10^{-3} emu/cc)	–	1.1
NRM Incl. (°)	–	–34.0
MDF (Oe.)	–	45.0
Stable Incl. (°)	–	–24.4
Vp ∥ km/s)	6.09	–
D (g/cc)	2.97	–
P (%)	2.3	–



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG		SITE			HOLE	CORE		SECT.	
6	1	4	6	2	A	1	8		1

Depth: 576.0 to 577.5 m

MAJOR ROCK TYPE—MASSIVE BASALT SILL

Macroscopic Description:
Massive, veined, subophitic dolerite. Veins are celadonite, calcite, clay and complex veins.

Piece 1: Aphyric with microphenocrysts of clinopyroxene and plagioclase; slightly altered.
Piece 2A-5C: Aphanitic to sparse spots (more frequent than Core 17) of clinopyroxene aggregates and phenocrysts (<2.0 mm) with some veins of calcite, chlorite and clay. This dolerite is made of phenocrysts of clinopyroxene, and microphenocrysts of clinopyroxene, plagioclase, and microlites of clinopyroxene, plagioclase and Ti-magnetite (clinopyroxene ≈ plagioclase > Ti-magnetite). In some veins, sulfide (pyrite?) occurs. Color and alteration are the same as mentioned in Core 17, Section 1.

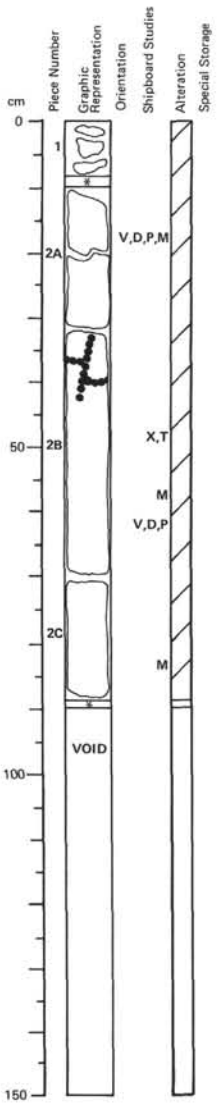
Thin Section Description:
128-130 cm: Subophitic dolerite from sill interior.
Phenocrysts: Plagioclase (An60) 7%, 0.4-0.7 mm, subhedral-euhedral, microphenocrysts to phenocrysts; clinopyroxene 7%, 0.4-0.8 mm, subhedral-euhedral; microphenocrysts to phenocrysts.
Groundmass: Plagioclase (40%) <0.4 mm, partly spherulitic, microlite to groundmass; clinopyroxene 40%, <0.4 mm, prismatic, microlite to groundmass; magnetite 6%, <0.05 mm, partly dust, microlite to groundmass, more common occurrences altered areas.
Alteration: Clays (25%) in spotted locations, replacing microphenocrysts of clinopyroxene and mesostasis of plagioclase.
Texture: Subophitic.

Shipboard Geochemistry (XRF, %):

Interval	128-130 cm
SiO_2	50.38
TiO_2	1.37
Al_2O_3	14.03
FeO	12.23
MnO	0.19
MgO	6.82
CaO	11.77
Na_2O	–
K_2O	0.08
P_2O_5	0.20
Total	96.68
LOI	0.79
FeO ÷ MgO	1.79
CaO ÷ Al_2O_3	0.83
FeO ÷ TiO_2	8.92

Paleomagnetism/Physical Properties:

Interval	85 cm	122 cm
NRM Intensity (10^{-3} emu/cc)	1.9	2.1
NRM Incl. (°)	–35.3	–37.9
MDF (Oe.)	<50.0	60.0
Stable Incl. (°)	–24.7	–31.6
Vp ∥ (km/s)	–	–
D (g/cc)	–	–
P (%)	–	–



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG		SITE			HOLE	CORE		SECT.	
6	1	4	6	2	A	1	8		2

Depth: 577.5 to 579.0 m

MAJOR ROCK TYPE—MASSIVE BASALT SILL

Macroscopic Description:
The massive subophitic dolerite is aphanitic to slightly porphyritic, veined, and is the same as mentioned in Core 18, Section 1. Veins are celadonite, calcite, clay and complex veins.

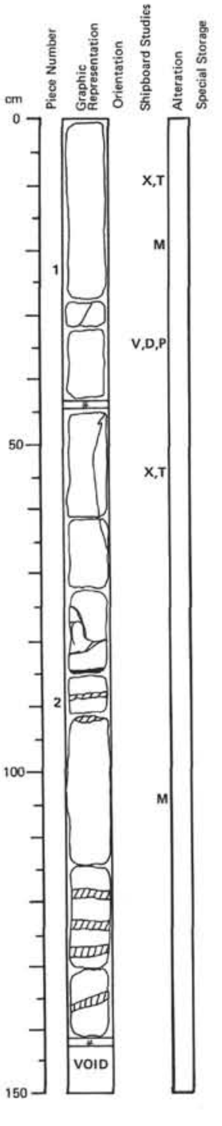
Thin Section Description:
48-50 cm: Subophitic dolerite from sill interior.
Phenocrysts: Plagioclase (An55) 7%, 0.4-0.9 mm; clinopyroxene 8%, 0.4-1.0 mm, partly large laths of clinopyroxene enclosing laths of plagioclase (ophitic texture); microphenocrysts to phenocrysts.
Groundmass: Plagioclase 40%, 0.1-0.4 mm, euhedral to subhedral, microlite; clinopyroxene 39%, 0.1-0.4 mm, subhedral to euhedral, microlite; magnetite 6%, <0.1 mm, microlite, partly dust-like; trace of quartz and alkali feldspar.
Alteration: Clays (30%), in spotted locations, replacing microphenocrysts of clinopyroxene and microlite of plagioclase and clinopyroxene.
Texture: Subophitic.

Shipboard Geochemistry (XRF, %):

Interval	48-50 cm
SiO_2	50.59
TiO_2	1.34
Al_2O_3	13.87
FeO	12.49
MnO	0.38
MgO	7.02
CaO	11.68
Na_2O	–
K_2O	0.05
P_2O_5	0.20
Total	97.04
LOI	0.73
FeO ÷ MgO	1.77
CaO ÷ Al_2O_3	0.84
FeO ÷ TiO_2	9.32

Paleomagnetism/Physical Properties:

Interval	15-17 cm	57 cm	60-62 cm
NRM Intensity (10^{-3} emu/cc)	–	0.7	–
NRM Incl. (°)	–	–51.9	–
MDF (Oe.)	–	35.0	–
Stable Incl. (°)	–	–33.0	–
Vp ∥ (km/s)	5.52	–	6.14
D (g/cc)	2.82	–	2.92
P (%)	1.9	–	2.1



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	19	1

Depth: 578.0 to 579.5 m

MAJOR ROCK TYPE—BASALT (SILL)

Macroscopic Description:
Massive, veined basalt. From 45.0-65.0 cm is a vein with dark green edges and a light green (10G 8/2) interior (caladonite?, zeolite?); from 75.0-85.0 cm the veins are celadonite, pale green material and pyrite; from 85.0-92.0 cm veins are celadonite and pale green minerals and from 118.0-150.0 cm the veins also have pyrite blotches.

Thin Section Description:

10-12 cm: Microdolerite from sill interior.

Phenocrysts: Olivine, 0.2-0.4 mm, euhedral, smectite pseudomorphs; plagioclase (An42-90), elongated prisms and tables, margins more acid; trace of clinopyroxene.

Groundmass: Plagioclase (An60-80) 55%, 0.02-0.12 mm x 0.2-0.6 mm, microlites; clinopyroxene 36%, 0.08-0.6 mm, equidimensional; magnetite 8%, 0.06-0.2 mm, intergranular; glass 15%, altered to dark brown clay.

Alteration: Clays (15%) in isolated pseudomorphs, replacing olivine (?), pyroxene (?), and glass.

Texture: Microdolerite.

49-51 cm: Microdolerite from sill interior. (Includes grain-size boundary and vein.)

Phenocrysts: Plagioclase (An45-62) ~1%, 0.8 x 1.5 mm, zoned tables; clinopyroxene, trace, 0.6 x 0.8 mm.

Groundmass: Plagioclase 31%, prisms and microlites; clinopyroxene 45%, anhedral; magnetite 8%, intergranular; glass 15%, interstitial, altered.

Alteration: Sphene (trace in leucoxene aggregates near and within veins. Glass (15%, in groundmass, altered to dark brown clay; carbonate (2%) in small relics in clay, is of hydrothermal origin; clays (63%) in vein interior, are of hydrothermal origin; zeolites (2%), in interior of the veins and later veins, are of hydrothermal origin. Muscovite and paragonite (15%) in vein margins, replacing clays and pyroxene fibrous radial aggregates.

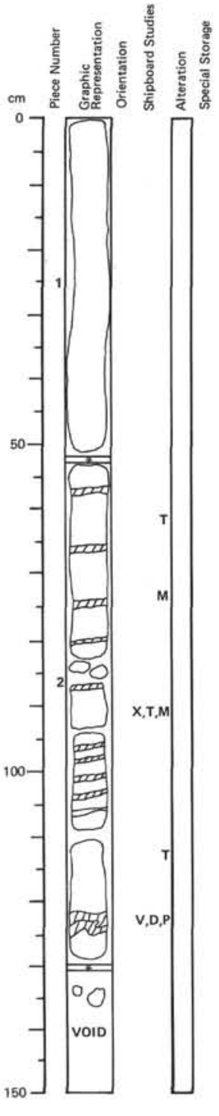
Texture: Microdoleritic to intersertal.

Shipboard Geochemistry (XRF, %):

Interval	10-12 cm	52-54 cm
SiO_2	49.50	50.00
TiO_2	2.01	1.40
Al_2O_3	16.27	13.96
FeO	11.83	12.65
MnO	0.38	0.23
MgO	7.16	7.18
CaO	7.88	11.80
Na_2O	–	–
K_2O	0.41	0.40
P_2O_5	0.23	0.20
Total	95.06	97.03
LOI	0.36	0.66
FeO ÷ MgO	1.65	1.76
CaO ÷ Al_2O_3	0.48	0.84
FeO ÷ TiO_2	5.88	9.03

Paleomagnetism/Physical Properties:

Interval	18 cm	34-36 cm	104 cm
NRM Intensity (10^{-3} emu/cc)	0.8	–	0.5
NRM Incl. (°)	–46.3	–	–63.2
MDF (Oe.)	60.0	–	27.0
Stable Incl. (°)	–29.6	–	–43.2
Vp ∥ (km/s)	–	5.84	–
D (g/cc)	–	2.97	–
P (%)	–	1.7	–



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	19	2

Depth: 579.5 to 580.8 m

MAJOR ROCK TYPE—BASALT (SILL)

Macroscopic Description:
Altered, veined basalt sills. Veins are of celadonite, pale green material, and pyrite. From 0.0-50.0 cm veins occur (throughout) approximately every 2.0 cm. Below 50.0 cm, veins occur as shown in graphic presentation. From 77.0-105.0 cm is a zone of fine grain-size.

Thin Section Description:

58-60 cm: Altered aphyric basalt from sill bottom.

Phenocrysts (micro): Trace of plagioclase.

Groundmass: Highly altered clinopyroxene 14%?) and plagioclase (14%?); magnetite 12%; glass (?) altered.

Alteration: Pale grayish green clays (60%) are replacing all minerals and glass.

Texture: Microdolerite intersertal.

89-93 cm: Altered phyric basalt of sill top.

Microphenocrysts: Trace plagioclase; clinopyroxene ~2%, 0.2-1.0 mm, euhedral.

Groundmass: Plagioclase 15%, <0.02 mm, laths, needles; clinopyroxene 2%, <0.02 mm, equidimensional; magnetite 8%, <0.02 mm, dust-like; glass 75%, mesostasis, deeply altered.

Alteration: Clays (80%) are replacing all minerals and glass.

Texture: Hyalopilitic to variolitic.

113-116 cm: Slightly phyric basalt from next to glassy margin of a sill.

Phenocrysts: Plagioclase (trace), 0.1 x 1.2 mm, elongated prisms; clinopyroxene ~2%, 0.2-1.0 mm, equidimensional.

Groundmass: Plagioclase 20%, <0.04 mm, laths; clinopyroxene 2%, ~0.04 mm, irregular; magnetite 8%, <0.02 mm, dust-like; glass 70%, opaque mesostasis.

Alteration: Clays (70%) replacing glass in the mesostasis.

Texture: Intersertal.

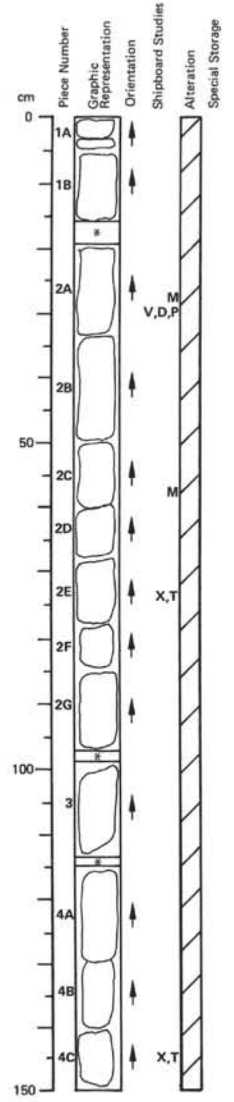
Shipboard Geochemistry (XRF, %):

Interval	90-92 cm
SiO_2	49.88
TiO_2	1.38
Al_2O_3	13.67
FeO	12.72
MnO	0.20
MgO	6.87
CaO	11.89
Na_2O	–
K_2O	0.05
P_2O_5	0.19
Total	96.51
LOI	0.66
FeO ÷ MgO	1.85
CaO ÷ Al_2O_3	0.87
FeO ÷ TiO_2	9.21

Paleomagnetism/Physical Properties:

Interval	73 cm	93 cm	119-121 cm
NRM Intensity (10^{-3} emu/cc)	0.5	0.7	–
NRM Incl. (°)	–48.9	–41.4	–
MDF (Oe.)	50.0	50.0	–
Stable Incl. (°)	–34.2	–43.8	*
Vp ∥ (km/s)	–	–	4.61
D (g/cc)	–	–	2.6
P (%)	–	–	11.0

*Vein



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	20	1

Depth: 581.0 to 582.5 m

MAJOR ROCK TYPE—BASALT (SILL)

Macroscopic Description:

Massive fine grain-sized basalt with veins. From 35.0-60.0 cm, veins of celadonite pyrite occur which are 0.5-2.0 mm thick. From ~55.0 cm and downward, the rock appears to subtly become finer in grain size and more leucocratic.

Thin Section Description:

72-74 cm: Slightly phyric basalt from area next to glassy margin of a sill.

Microphenocrysts: Clinopyroxene ~2%, 0.5-1.2 mm, equidimensional.

Groundmass: Plagioclase (trace) <0.02 mm, common spots of variolitic aggregates; magnetite 7%, dust-like, intergranular and spots in mesostasis; glass 30%, altered, spots and interstitial.

Vugs: Vugs 2%, 0.08 mm, in groundmass, zeolite fillings, elongated to irregular shapes, surrounded by variolitic aggregates.

Alteration: Clays (30%) in glass spots and mesostasis, replacing glass and all minerals.

Texture: Intersertal to variolitic.

144-146 cm: (Piece 4C) Basalt from sill interior.

Phenocrysts: Olivine (?%) pseudomorphs of green clay; plagioclase (An60) 1%, 0.2-0.4 mm; clinopyroxene (augite) 2%, 0.3-0.6 mm, euhedral, twinned and with inclusions.

Groundmass: Plagioclase (An55) 25%, <0.2 mm, skeletal microlites and crystallites; clinopyroxene (augite), 2V angle = 50°, 47%, <0.08 mm, quench texture; Ti-magnetite 10%, <0.02 mm, anhedral to euhedral.

Alteration: Green and brown clays (15%) replacing clinopyroxene and groundmass.

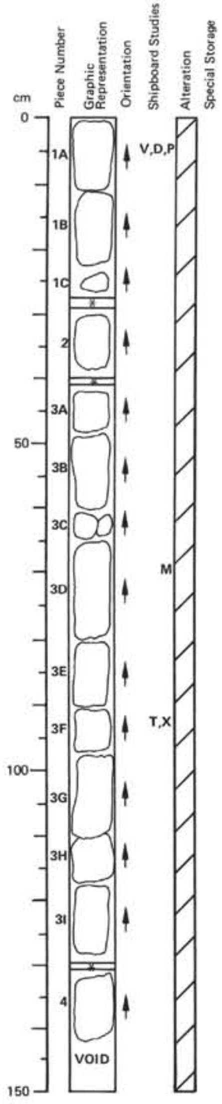
Texture: Intersertal.

Shipboard Geochemistry (XRF, %):

Interval	72-74 cm	144-146 cm
SiO_2	49.63	49.24
TiO_2	1.63	1.64
Al_2O_3	13.52	13.32
FeO	13.46	13.04
MnO	0.28	0.11
MgO	6.90	6.63
CaO	11.42	11.32
Na_2O	–	–
K_2O	0.02	0.11
P_2O_5	0.23	0.26
Total	96.58	95.30
LOI	0.07	0.00
FeO ÷ MgO	1.95	1.96
CaO ÷ Al_2O_3	0.84	0.85
FeO ÷ TiO_2	8.25	7.95

Paleomagnetism/Physical Properties:

Interval	28 cm	59 cm	27-29 cm
NRM Intensity (10^{-3} emu/cc)	2.2	2.3	–
NRM Incl. (°)	–53.0–	–43.6	–
MDF (Oe.)	55.0	60.0	–
Stable Incl. (°)	–45.8	–40.3	–
Vp ∥ (km/s)	–	–	5.42
D (g/cc)	–	–	2.87
P (%)	–	–	4.3



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	20	2

Depth: 582.5 to 584.0 m

MAJOR ROCK TYPE—BASALT (SILL)

Macroscopic Description:

Massive fine grain-sized basalt. From 100.0-120.0 cm are 1-2 mm thick veins of celadonite plus pyrite.

Thin Section Description:

93-95 cm: Altered basalt from sill interior.

Phenocrysts: Plagioclase <1%, 0.5 mm; clinopyroxene (augite) 3% (microphenocrysts), 0.3-0.5 mm.

Groundmass: Plagioclase (An60-An50) 25%, 0.2-0.5 mm, euhedral-anhedral; Ti-magnetite 10%, 0.005-0.2 mm; glass 3%, altered to clay, interstitial triangular patches.

Alteration: Green clays replacing glass (3%) and clinopyroxene (10%); zeolites (5%) replacing clinopyroxene.

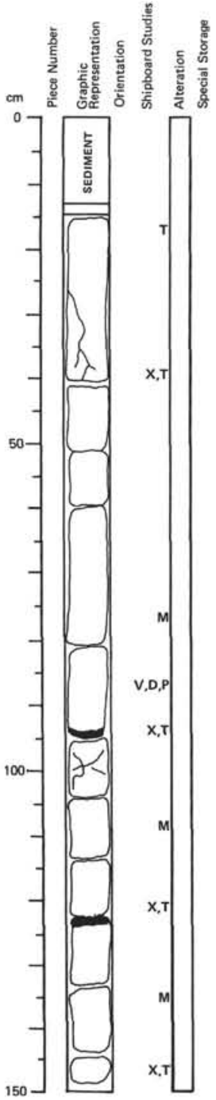
Texture: Intergranular to diabasic (subophitic).

Shipboard Geochemistry (XRF, %):

Interval	93-95 cm
SiO_2	50.32
TiO_2	1.64
Al_2O_3	13.53
FeO	13.82
MnO	–
MgO	6.99
CaO	11.42
Na_2O	–
K_2O	0.14
P_2O_5	–
Total	–
LOI	0.07
FeO ÷ MgO	1.97
CaO ÷ Al_2O_3	0.84
FeO ÷ TiO_2	8.42

Paleomagnetism/Physical Properties:

Interval	6-8 cm	71 cm	137 cm
NRM Intensity (10^{-3} emu/cc)	–	1.9	2.8
NRM Incl. (°)	–	–76.3	–54.1
MDF (Oe.)	–	40.0	45.0
Stable Incl. (°)	–	–64.9	–49.7
Vp ∥ (km/s)	6.03	–	–
D (g/cc)	2.99	–	–
P (%)	0.5	–	–



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	21	1

Depth: 586.0 to 587.5 m

MAJOR ROCK TYPE—BASALT (SILL)

Macroscopic Description:

Sediment from 0.0-14.0 cm. (See Sedimentary Visual Description.) Three basalt sills (units):

Unit 1 occurs from 15.0-~96.0 cm; grain-size increases from 15.0 cm to a maximum at 40.0-42.0 cm and decreases from 42-93 cm where a glassy chill margin exists from 93.0-96.0 cm; dark veins.

Unit 2 occurs from ~96.0-~123.0 cm. Veined basalt without any apparent top or lower chill margins in tact. (Actual top and bottom of this unit are missing.)

Unit 3 occurs from ~123.0-150.0 cm(?). The upper boundary is marked by a glassy margin with red "baked" sediment (123-125 cm).

Thin Section Description:

16-20 cm (Piece 1A): Highly altered diabase from sill interior.

Phenocrysts: Plagioclase <1%, 0.9-1.0 mm; clinopyroxene (augite) 2%, 0.4-0.8 mm, with ophitic plagioclase.

Groundmass: Plagioclase (An68) 21%, 0.2-0.4 mm, subhedral; clinopyroxene (augite) 45%, 0.1-0.6 mm, subhedral, light brown; magnetite (Ti) 5%, <0.1 mm, subhedral to euhedral; glass 2%, small interstitial patches of altered glass; quartz variolitic, patches with fresh glass.

Alteration: Brown clays (25%) in large patches (2mm), replacing all minerals.

Texture: Diabasic.

40-42 cm (Piece 1A): Highly altered diabase from sill interior.

Phenocrysts: Clinopyroxene (augite) 1%, 0.4-1.0 mm, subhedral.

Groundmass: Plagioclase (An75-45) 20%, 0.2-0.5 mm, subhedral to euhedral; clinopyroxene (augite) 36%, 0.1-0.3 mm, subhedral, light brown; Ti-magnetite 5%, <0.05 mm; glass 8%, interstitial altered glass patches.

Alteration: Clays and chlorite (30%) occur as (1) large patches of clay with minor (late) chlorite, and (2) in veins in the rock.

Texture: Diabasic.

95-96 cm (Piece 1C): Altered glassy basalt from bottom chill margin of sill.

Phenocrysts: Plagioclase (An78-65) 2%, <0.15 mm, zoned, euhedral, and microphenocrysts; clinopyroxene (augite) 3%, 0.05-0.2 mm; euhedral, and microphenocrysts.

Groundmass: Plagioclase 5%, <0.03 mm, small microlites and crystallites; clinopyroxene (augite) 5%, <0.005 mm, quench textured form; magnetite (Ti) 10%, <0.02 mm; glass 75%, glassy groundmass, mostly altered.

Alteration: Clays and chlorite replacing groundmass, glass, and clinopyroxene.

Texture: Variolitic.

123-125 cm (Piece 1B): Altered basalt from interior of sill.

Phenocrysts: Plagioclase (An55-65) 1%, 0.3-0.5 mm; oscillatory zoning; clinopyroxene (augite) 2%, 0.5-1.0 mm, subophitic texture.

Groundmass: Plagioclase (An60) 40%, 0.1-0.3 mm; clinopyroxene (augite) 37%, <0.02 mm, subhedral to anhedral, light brown, magnetite (Ti) 5%, <0.05 mm, subhedral; glass 15%, altered interstitial glass patches.

Alteration: Green clays (10%) replacing clinopyroxene. Greenish brown clays replaced interstitial glass patches.

Texture: Interstitial, subophitic clinopyroxene.

146-149 cm (Piece 1K): Altered fine-grained basalt next to glassy margin of sill.

Phenocrysts: Plagioclase trace, 0.1 mm, subhedral; clinopyroxene (augite) 3%, 0.1-0.2 mm, euhedral-subhedral microphenocrysts.

Groundmass: Plagioclase 39%, <0.03 mm, skeletal and microlites; clinopyroxene 38%, <0.01 mm, quench crystals and small variolites; magnetite (Ti) 10%, <0.01 mm; glass 15%(?) (all glass plucked from section ?).

Alteration: Clays plus chlorite (10%) are replacing groundmass, but also occur in veins.

Texture: Hyalopilitic to interstitial.

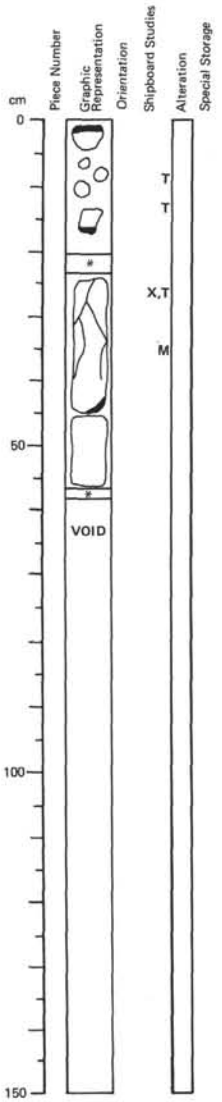
Leg 61, Site 462, Hole A, Core 21, Section 1—Continued

Shipboard Geochemistry (XRF, %):

Interval	40-42 cm	93-96 cm	123-125 cm	146-149 cm
SiO_2	50.53	50.33	48.98	47.77
TiO_2	1.66	1.74	1.89	1.88
Al_2O_3	13.66	14.00	14.74	15.06
FeO	13.33	13.02	12.85	12.88
MnO	—	—	—	—
MgO	7.55	6.32	6.82	6.30
CaO	11.12	10.76	9.51	8.99
Na_2O	—	—	—	—
K_2O	0.13	0.12	0.20	0.20
P_2O_5	—	—	—	—
Total	—	—	—	—
LOI	0.45	1.69	3.77	2.64
FeO ÷ MgO	1.76	2.06	1.88	2.04
CaO ÷ Al_2O_3	0.81	0.76	0.64	0.59
FeO ÷ TiO_2	8.03	7.48	6.79	6.85

Paleomagnetism/Physical Properties:

Interval	76 cm	86-88 cm	108 cm	135 cm
NRM Intensity (10^{-3} emu/cc)	1.0	—	12.5	2.5
NRM Incl. (°)	−73.1	—	−56.2	−52.6
MDF (Oe.)	20.0	—	50.0	25.0
Stable Incl. (°)	−64.2	—	−52.6	−49.3
Vp ∥ (km/s)	—	5.27	—	—
D (g/cc)	—	2.89	—	—
P (%)	—	2.5	—	—



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	21	2

Depth: 587.5 to 588.0 m

MAJOR ROCK TYPE—BASALT SILLS

Macroscopic Description:

Two basalt sills (units). From 0.0-26.0 cm occurs glassy margin and baked sediment fragment; either the bottom contact of Unit 3 or top contact of Unit 4.

Unit 4, occurs from 26.0-57.0(?) cm. From 26.0-29.0 cm grain size increases downward.

Note: The fragments in the top of this section include (1) two basalt fragments which contain glassy margins; (2) two basalt fragments which lack glassy margins, and (3) one small fragment of red (10R 4/6) baked sediment with a portion of glassy margin of a sill. None of these fragments are in stratigraphic order and therefore it is impossible to distinguish if these miscellaneous fragments represent the bottom of a chilled margin of Unit 3 or the upper chilled margin of Unit 4. It is likely that both are present.

Thin Section Description:

8-9 cm (Piece 1B): Altered glassy basalt from glassy sill margin.

Phenocrysts: Plagioclase (An61) 1%, 0.1-0.2 mm, euhedral, slightly zoned; clinopyroxene (augite) 5%, 0.05-0.5 mm, euhedral microphenocrysts.

Groundmass: Plagioclase 10%, <0.03 mm, microlite and crystallites, clinopyroxene 10%, <0.02 mm, quench crystals and microlites; magnetite (Ti) 5%, <0.01 mm, subhedral; glass 69%, almost all altered.

Alteration: Clays and chlorite replaces almost all glass, some quench phases, and clinopyroxene phenocrysts.

Texture: Variolitic to hyalopilitic.

26-29 cm: Glassy altered basalt near chilled margin of lowest sill in core.

Phenocrysts: Plagioclase (An55-60) 3%, 0.15-0.25 mm, euhedral; clinopyroxene (augite) 4%, 0.2-0.5 mm, euhedral and subhedral; glomerophyric clusters.

Groundmass: Plagioclase 10%, <0.02 mm long, microlite and crystallite; clinopyroxene 50%, <0.003 mm, quench crystals, some crystallites; magnetite (Ti) 12%, <0.008 mm; glass 21%, altered.

Alteration: Clays and chlorite (30%) replacing quench crystals, plagioclase, and glass.

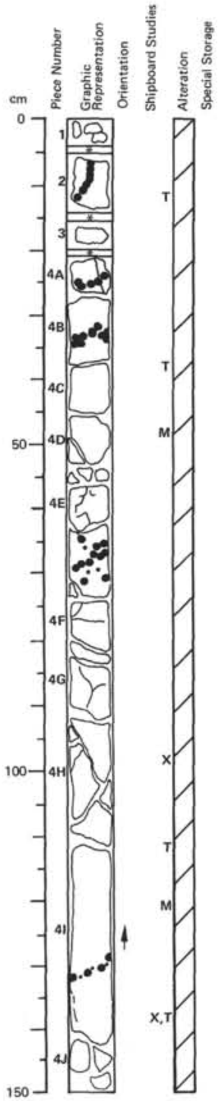
Texture: Hyalopilitic.

Shipboard Geochemistry (XRF, %):

Interval	**26-29 cm**
SiO_2	48.71
TiO_2	1.74
Al_2O_3	15.02
FeO	12.78
MnO	–
MgO	6.95
CaO	10.81
Na_2O	–
K_2O	0.19
P_2O_5	–
Total	–
LOI	2.65
FeO ÷ MgO	1.83
CaO ÷ Al_2O_3	0.72
FeO ÷ TiO_2	7.34

Paleomagnetism/Physical Properties:

Interval	**36 cm**
NRM Intensity (10^{-3} emu/cc)	0.2
NRM Incl. (°)	–48.4
MDF (Oe.)	210.0
Stable Incl. (°)	–47.7
Vp ∥ (km/s)	–
D (g/cc)	–
P (%)	–



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	22	1

Depth: 588.0 to 589.5 m

MAJOR ROCK TYPE—MASSIVE BASALT SILL (DOLERITE)

Macroscopic Description:

Massive, moderately to slightly altered dolerite sill with veins of celadonite and celadonite plus clay. From 0.0-90.0 cm (Pieces 1-4G) is aphyric and is a chilled margin and transitional zone of sill. Grain size becomes coarser toward center of the section, and from 90.0-~135.0 cm is aphanitic to slightly porphyritic basalt. The lower sill boundary at 135.0 cm is sharpe. The 135.0 cm interval is the boundary between sill interior and slightly aphyric basalt from 135.0-145.0 cm. Aphyric basalt is greenish gray (5G 4/1), and aphanic basalt is medium bluish gray (5B 5/1). At chilled margins clinopyroxene ≫ plagioclase, while at the transitional zone clinopyroxene ≈ plagioclase. The ratio of (clinopyroxene)/(plagioclase) microphenocrysts may decrease toward the interior of the sill.

Thin Section Description:

10-12 cm (Piece 1): Altered basalt from marginal portion of sill.

Phenocrysts: Plagioclase (An63) 3%, 0.4-0.6 mm; clinopyroxene (augite) 5%, 0.2-0.4 mm.

Groundmass: Plagioclase (An60 zoned to An28) 27%, 0.1-0.2 mm; clinopyroxene (augite) 20%, <0.2 mm; magnetite 10%, <0.04 mm; glass 15%, interstitial patches totally replaced; amphibole (2%?).

Alteration: Green clays, chlorite (total of 35%), and amphibole (2%?) are replacing glass and all minerals.

Texture: Intersertal.

35-37 cm: Slightly phyric altered basalt next to glassy margin of sill (top).

Microphenocrysts: Plagioclase (An58) <1%, rare tabular forms; clinopyroxene 2%, 0.8 mm.

Groundmass: Plagioclase laths, fine grained mesostasis; clinopyroxene, equidimensional, radial-fibrous, fine grained mesostasis; magnetite 12%, dust-like; glass ~30%, mesostasis and pseudomorphs.

Alteration: Carbonate (trace) and clays (30%) in mesostasis and pseudomorphs replacing glass and pyroxene.

Texture: Interstitial.

110-112 cm: Slightly phyric altered basalt from sill interior.

Microphenocrysts: Plagioclase (trace); clinopyroxene ~3%, ~1.2 mm, equidimensional, include plagioclase laths.

Groundmass: Plagioclase (An60) 47%, 0.02 x 0.6 mm, microlites; clinopyroxene 20%, ~0.06 mm, equidimensional; magnetite 10%, ~0.05 mm, interstitial; glass 20%, interstitial, altered to dark clay.

Alteration: Clays (20%) in interstitial groundmass replacing glass.

Texture: Intersertal to microdoleritic.

133-141 cm: Heavily altered aphyric basalt from chilled margin of sill (bottom).

Phenocrysts: Trace clinopyroxene.

Groundmass: Plagioclase, clinopyroxene, and glass, all are highly altered; magnetite ~7%.

Alteration: Clays (85%) replacing all minerals and glass in entire rock.

Texture: Intersertal.

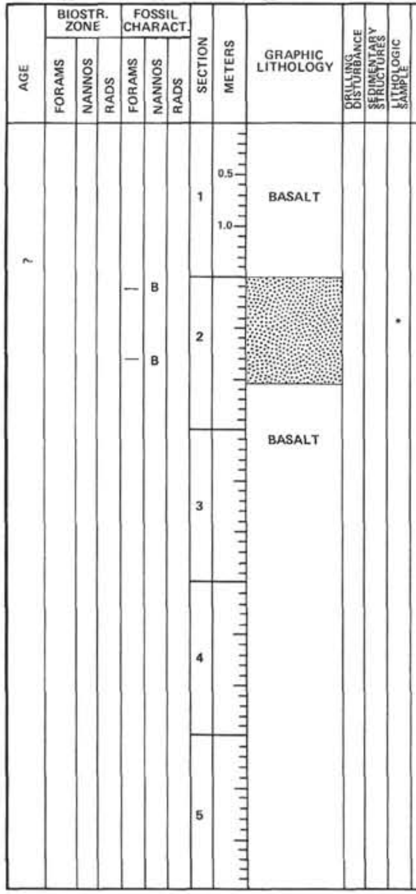
Shipboard Geochemistry (XRF, %):

Interval	**95-100 cm**	**137-139 cm**
SiO_2	48.80	48.80
TiO_2	1.66	2.14
Al_2O_3	13.60	16.92
FeO	13.46	12.14
MgO	7.47	7.38
CaO	11.50	9.94
K_2O	0.06	0.63
LOI	0.44	2.67
FeO ÷ MgO	1.80	1.64
CaO ÷ Al_2O_3	0.84	0.58
FeO ÷ TiO_2	8.10	5.67

Paleomagnetism/Physical Properties:

Interval	**47 cm**	**120 cm**
NRM Intensity (10^{-3} emu/cc)	3.1	4.2
NRM Incl. (°)	–33.8	–56.3
MDF (Oe.)	>100.0	50.0
Stable Incl. (°)	–32.9	–52.2
Vp ∥ (km/s)	–	–
D (g/cc)	–	–
P (%)	–	–

SITE 462 HOLE A CORE 22 CORED INTERVAL: 588.0 to 597.0 m

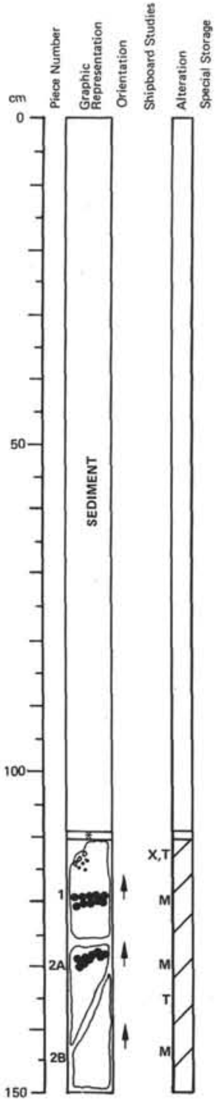


LITHOLOGIC DESCRIPTION

0.0 to 1.5 m and 2.55 m and below is basalt which is described in detail in **"Visual Core Description of Igneous Rock"**.
1.5 to 2.55 m: Dark gray (N3) to greenish black (5G 2/1)
VOLCANICLASTIC SANDSTONE with faint horizontal lamination.

SMEAR SLIDE (%)

	Volcaniclastic siltstone
TEXTURE AND	**2-40**
MINERALS	**(D)**
Sand size	15
Silt size	85
Clay size	–
Feldspar	15
Heavy minerals	10
Clay	–
Volcanic glass (altered)	5
Zeolite	70



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	22	2

Depth: 589.5 to 591.0 m

MAJOR ROCK TYPE—MASSIVE BASALT SILL (DOLERITE)

Macroscopic Description:
Sediment from 0.0-110.0 cm is discussed in "Sedimentary Core Descriptions". Altered, massive basalt (dolerite) sill with veins of celadonite and clay. Each zone is as mentioned in Core 22, Section 1. The 110.0-115.0 cm zone is a chilled margin; the 115.0-~130.0 zone is a transitional zone from the chilled margin above to the aphanitic zone at 130.0-150.0 cm.

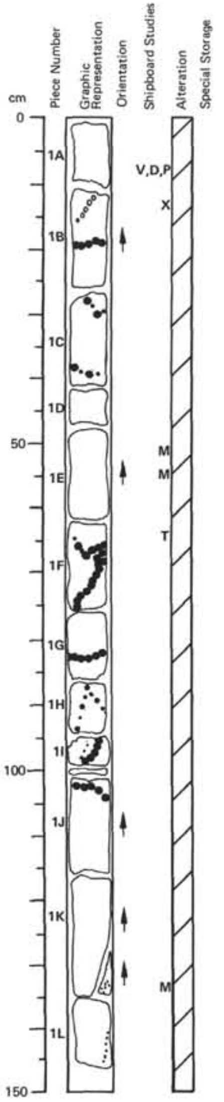
Thin Section Description:
112-114 cm: Altered aphyric basalt near the glassy margin of the sill.
Phenocrysts: Trace of plagioclase and clinopyroxene, 1.6 mm, glomeroporphyric intergrowth.
Groundmass: Plagioclase, clinopyroxene, magnetite, and glass all highly altered.
Alteration: Dark gray chlorite and clay highly altering the groundmass.
Texture: Hyalopilitic and intersertal.
135-137 cm: Slightly altered aphyric basalt from sill interior.
Phenocrysts: Trace plagioclase and clinopyroxene.
Groundmass: Plagioclase (An54-78) 55%, 0.04 x 0.5 mm, microlites, elongated zoned prisms; clinopyroxene 20%, 0.3 mm, equidimensional; magnetite 8%, 0.04 mm, intergranular, dust-like; glass 17%, interstitial.
Alteration: Clays (17%) replacing intergranular glass.
Texture: Intersertal to microdoleritic.

Shipboard Geochemistry (XRF, %):

Interval	**111-115 cm**
SiO_2	49.85
TiO_2	2.08
Al_2O_3	16.78
FeO	11.25
MnO	–
MgO	7.47
CaO	7.60
Na_2O	–
K_2O	0.44
P_2O_5	–
Total	–
LOI	1.11
$FeO \div MgO$	1.50
$CaO \div Al_2O_3$	0.45
$FeO \div TiO_2$	5.40

Paleomagnetism/Physical Properties:

Interval	**119 cm**	**129 cm**	**144 cm**
NRM Intensity (10^{-3} emu/cc)	1.0	0.8	1.6
NRM Incl. (°)	–41.5	–38.0	–56.1
MDF (Oe.)	35.0	–	45.0
Stable Incl. (°)	–22.6	–	–44.0
Vp ∥ (km/s)	–	–	–
D (g/cc)	–	–	–
P (%)	–	–	–



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	22	3

Depth: 591.0 to 592.5 m

MAJOR ROCK TYPE—MASSIVE BASALT SILL (DOLERITE)

Macroscopic Description:
Massive, slightly altered dolerite sill with veins of calcite, celadonite, clay, and celadonite plus clay. Grain size becomes gradually coarser from the top of the section to ~70 cm and then decreases toward the bottom of the section.

Piece 1A = medium to fine grain-size }
Piece 1F = slightly coarse grain-size } aphanitic
Piece 1E = medium to fine grain-size }

Mineral assemblages, alteration and color are the same as mentioned in Core 22, Section 1.

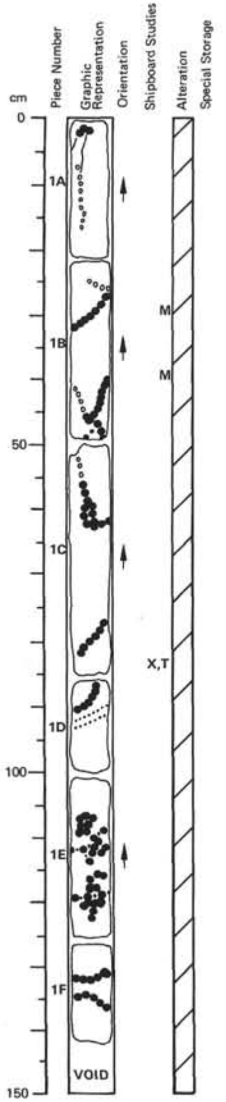
Thin Section Description:
61-68 cm: Aphyric basalt from sill interior.
Phenocrysts: Trace of plagioclase and clinopyroxene.
Groundmass: Plagioclase (An40-77), 0.08-0.6 mm, microlites, elongated prisms, zonated; clinopyroxene 40%, 0.3 mm, equidimensional; magnetite 8%, 0.08 mm, intergranular; glass 20%, interstitial completely altered.
Alteration: Dark brown clays (20%) replace interstitial glass.
Texture: Intersertal to microdolerite.

Shipboard Geochemistry (XRF, %):

Interval	**12-14 cm**
SiO_2	49.00
TiO_2	2.15
Al_2O_3	17.34
FeO	11.65
MnO	–
MgO	6.88
CaO	7.65
Na_2O	–
K_2O	0.39
P_2O_5	–
Total	–
LOI	0.51
$FeO \div MgO$	1.69
$CaO \div Al_2O_3$	0.44
$FeO \div TiO_2$	5.41

Paleomagnetism/Physical Properties:

Interval	**8-10 cm**	**50 cm**	**134 cm**
NRM Intensity (10^{-3} emu/cc)	–	1.6	1.9
NRM Incl. (°)	–	–50.8	–49.1
MDF (Oe.)	–	40.0	–
Stable Incl. (°)	–	–46.2	–
Vp ∥ (km/s)	5.17	–	–
D (g/cc)	2.91	–	–
P (%)	2.6	–	–



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	22	4

Depth: 592.5 to 594.0 m

MAJOR ROCK TYPE—MASSIVE BASALT SILL (DOLERITE)

Macroscopic Description:

Moderately altered massive basalt sill (dolerite) with veins of clay, celadonite, and celadonite plus clay. From 0.0-~90.0 cm medium to fine grain-size (aphanitic). From ~90.0-124.0 cm slightly coarse grain-size (aphanitic); and 125.0-150.0 cm is a transitional zone (slightly aphyric). Mineral assemblages are the same as mentioned in Core 22, Section 1.

Thin Section Description:

81-84 cm: Microdolerite from sill interior.

Phenocrysts: Trace plagioclase and clinopyroxene.

Groundmass: Plagioclase (An52-71) 28%, 0.08 mm x 0.9 mm, microlites, elongated prisms; clinopyroxene 49%, 0.4 mm, equidimensional; magnetite 8%, 0.12 mm, interstitial; glass 15%, altered to clay.

Alteration: Dark brown clay (15%) replacing interstitial glass.

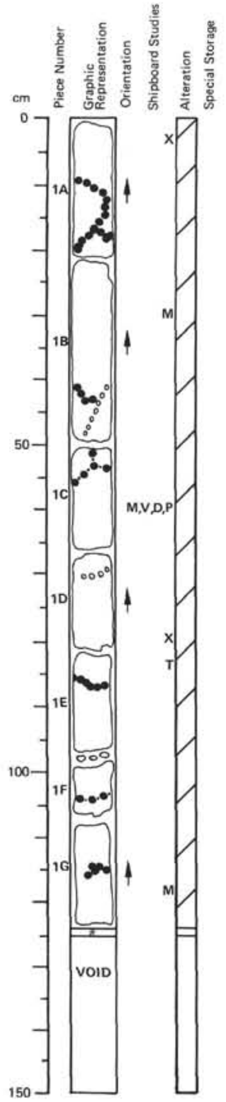
Texture: Microdolerite to intersertal.

Shipboard Geochemistry (XRF, %):

Interval	**83-85 cm**
SiO_2	50.28
TiO_2	1.67
Al_2O_3	13.58
FeO_t	12.69
MnO	–
MgO	6.42
CaO	11.38
Na_2O	–
K_2O	0.12
P_2O_5	–
Total	–
LOI	0.67
FeO ÷ MgO	1.97
$CaO \div Al_2O_3$	0.83
$FeO \div TiO_2$	7.59

Paleomagnetism/Physical Properties:

Interval	**33 cm**	**39 cm**
NRM Intensity (10^{-3} emu/cc)	2.2	1.3
NRM Incl. (°)	–44.0	–58.2
MDF (Oe.)	35.0	–
Stable Incl. (°)	–43.5	–
Vp ∥ (km/s)	–	–
D (g/cc)	–	–
P (%)	–	–



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	22	5

Depth: 594.0 to 595.3 m

MAJOR ROCK TYPE—MASSIVE BASALT SILL (DOLERITE)

Macroscopic Description:

Altered massive dolerite sill with veins of clay, celadonite, and celadonite plus clay. Mineral assembles, alteration and color as mentioned in Core 22, Section 1. From 0.0-25.0 cm is fine grain-size (aphyric to aphanitic); from 25.0-124.0 cm is fine to medium grain-size (aphanitic).

Thin Section Description:

81-85 cm: Microdolerite from sill interior.

Phenocrysts: Trace of plagioclase, ~2.0 mm.

Groundmass: Plagioclase (An52-67) 32%, 0.06 x 0.4 mm, microlites, elongated prisms; clinopyroxene 60%, 0.1 mm, equidimensional; magnetite 8%, 0.1 mm, interstitial, irregular.

Alteration: Dark brown clays (12%) replacing pyroxene.

Texture: Microdolerite.

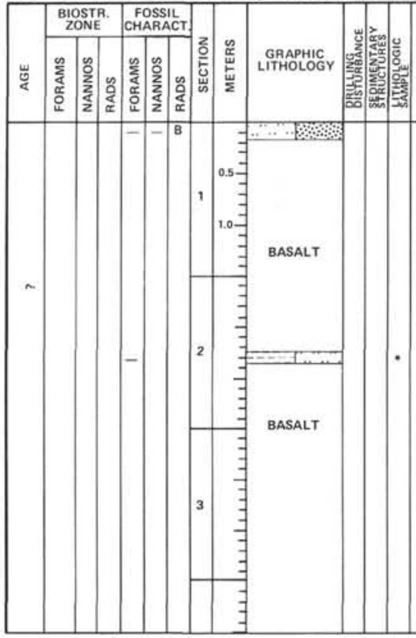
Shipboard Geochemistry (XRF, %):

Interval	**4-6 cm**	**77-79 cm**
SiO_2	49.15	50.15
TiO_2	1.69	1.66
Al_2O_3	13.76	13.91
FeO	13.49	12.43
MnO	–	–
MgO	7.23	6.32
CaO	11.31	11.41
Na_2O	–	–
K_2O	0.23	0.12
P_2O_5	–	–
Total	–	–
LOI	1.03	1.29
FeO ÷ MgO	1.86	1.96
$CaO \div Al_2O_3$	0.82	0.82
$FeO \div TiO_2$	7.98	7.48

Paleomagnetism/Physical Properties:

Interval	**33 cm**	**59-61 cm**	**118 cm**
NRM Intensity (10^{-3} emu/cc)	2.5	–	0.8
NRM Incl. (°)	–52.5	–	–65.1
MDF (Oe.)	?	–	–
Stable Incl. (°)	–42.4	–	–
Vp ∥ (km/s)	–	5.883	–
D (g/cc)	–	2.97	–
P (%)	–	1.2	–

SITE 462 HOLE A CORE 23 CORED INTERVAL: 597.0 to 606.0 m



LITHOLOGIC DESCRIPTION

0.0 to 0.17 m: Dark gray (N3) **VOLCANIC SILTSTONE to CLAYSTONE;** lower baked contact with basalt.

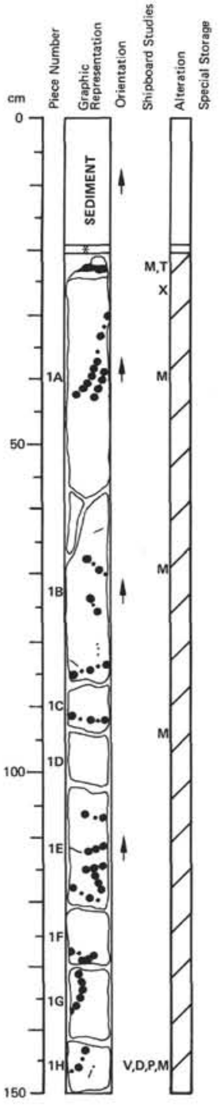
0.17 to 2.25 m: The basalt is described in detail in the **"Visual Core Description of Igneous Rock".**

2.25 to 2.37 m: Medium dark (N4) to dark gray (N3) **VOLCANICLASTIC SILTSTONE to CLAYSTONE;** local horizontal laminations.

2.37 m and below is basalt.

SMEAR SLIDE (%)

	Volcaniclastic sandstone
TEXTURE AND MINERALS	**2-77 (D)**
Sand size	80
Silt size	10
Clay size	10
Feldspar	20
Heavy minerals	1
Clay	10
Volcanic glass (altered)	60
Zeolite	10



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
6 1	4 6 2	A	2 3	1

Depth: 597.0 to 598.5 m

MAJOR ROCK TYPE—MASSIVE BASALT SILL (DOLERITE)

Macroscopic Description:

Moderately altered massive dolerite sill with veins of celadonite and celadonite plus clay. From 0.0-20.0 cm is sediment which is discussed in the "Sedimentary Core Barrel Description".
From 22.0-23.0 cm: Baked sediment (sharp) contact; very dark red (5R 2/6).
From 21.0-23.0 cm (Piece 1A): Basalt is aphyric, hyalopilitic.
From 23.0-30.0 cm (Piece 1A): Basalt is slightly phyric; transitional.
From 30.0-60.0 cm (Piece 1A): Basalt is fine grain-size; aphanitic.
From 60.0-150.0 cm (Pieces 1B-1H): Basalt is fine to medium in grain-size; aphanitic to slightly porphyritic.
Aphyric basalt has microphenocrysts of mainly clinopyroxene and partly plagioclase, and glass. The ratio of clinopyroxene/plagioclase of microphenocrysts decreases toward the interior of the sill.
Aphanitic to slightly porphyritic basalt is made of microphenocrysts of clinopyroxene and plagioclase, and microlites of clinopyroxene, plagioclase, and magnetite.
Aphyric to hyalopilitic basalt is medium dark gray (N4) and aphanitic to slightly porpyritic basalt is medium bluish gray (5B 5/1).
Veins are filled with calcite, chlorite, pyrite and clay (smectite or paragonite).

Thin Section Description:

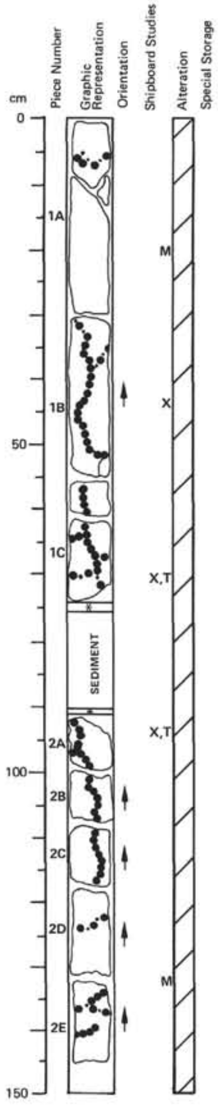
19-21 cm: Moderately altered basalt sill at contact with sediment.
Phenocrysts: Plagioclase (An60-65) 1%, 0.3-0.5 mm; clinopyroxene 5%, pseudomorphs, replaced to calcite, subhedral to euhedral.
Groundmass: Plagioclase 5-6%, and clinopyroxene 5-6%, <0.1 mm, altered to clay and chlorite; magnetite 8%, 0.01 mm; glass 75%, altered.
Alteration: Carbonate (15%) in veins and replacing clinopyroxene phenocrysts. Clays and chlorite (45%) and quartz (1%) in mesostasis replacing glass.
Texture: Aphyric to hyalopilitic.

Shipboard Geochemistry (XRF, %):

Interval	25-29 cm
SiO_2	50.26
TiO_2	1.85
Al_2O_3	14.90
FeO	12.80
MgO	6.58
CaO	9.92
K_2O	0.12
LOI	1.17
FeO ÷ MgO	1.94
CaO ÷ Al_2O_3	0.66
FeO ÷ TiO_2	6.91

Paleomagnetism/Physical Properties:

Interval	22 cm	42 cm	71 cm	94 cm	143-146 cm
NRM Intensity (10^{-3} emu/cc)	0.7	1.2	0.9	1.0	–
NRM Incl. (°)	–60.6	–56.2	–64.7	–59.9	–
MDF (Oe.)	45.0	30.0	30.0	35.0	–
Stable Incl. (°)	–58.7	–41.5?	–51.0	–46.2?	–
Vp ∥ (km/s)	–	–	–	–	5.211
D (g/cc)	–	–	–	–	2.94
P (%)	–	–	–	–	1.8



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
6 1	4 6 2	A	2 3	2

Depth: 598.5 to 600.0 m

MAJOR ROCK TYPE—MASSIVE BASALT SILL (DOLERITE)

Macroscopic Description:

Moderately altered massive dolerite sill with veins of celadonite and celadonite plus clay. Colors and mineral assemblages are as mentioned in Core 23, Section 1.
From 0.0-50.0 cm (Pieces 1A-1B): Basalt has a fine to medium grain-size and is porphyritic.
From 50.0-70.0 cm (Pieces 1B-1C): Basalt has a finer grain-size and is transitional from porphyritic to aphyric.
From 70.0-74.0 cm (Piece 1C): Basalt is slightly aphyric to aphyric.
From 74.0-96.0 cm (Piece 2A): Basalt is aphyric to aphyric.
From 96.0-150.0 cm (Pieces 2A-2D): Grain-size gradually coarsens toward the bottom of this section. Grain-size is fine to medium.

Thin Section Description:

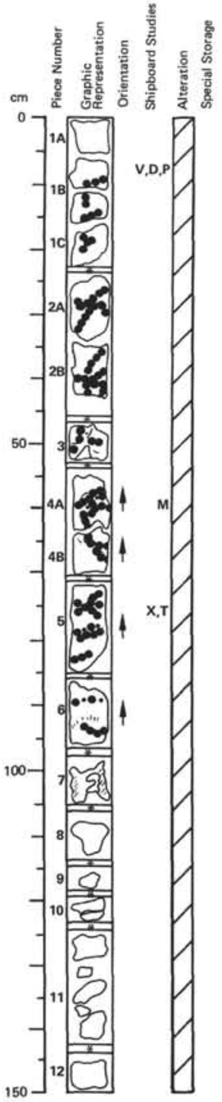
69-71 cm: Moderately altered basalt next to glassy sill.
Phenocrysts: Plagioclase (An65) 0.1%, 1.8 mm, subhedral; clinopyroxene 1-2%, 0.4-0.8 mm, subhedral to euhedral.
Groundmass: Plagioclase 40%, <0.4 mm, subhedral to euhedral, microlite; clinopyroxene 38%, <0.1 mm, subhedral, microlite; magnetite 5%, <0.05 mm, angular; glass 15%, mesostasis.
Alteration: Clays (40%) replaced microlites of plagioclase and clinopyroxene, and glass.
Texture: Intersertal to hyalopilitic.
95-98 cm: Basalt next to glassy margin of sill.
Phenocrysts: Plagioclase (An65) 1%, 0.3-0.4 mm, subhedral; clinopyroxene 3%, 0.3-0.4 mm, euhedral to subhedral, subophitic in some areas.
Groundmass: Plagioclase 30%, <0.2 mm, subhedral, partly microlite; clinopyroxene 35%, <0.1 mm, subhedral, partly microlite; glass 15%, mostly altered.
Alteration: Clays (35-40%) replacing groundmass of clinopyroxene and glass.
Texture: Hyalopilitic.

Shipboard Geochemistry (XRF, %):

Interval	44-47 cm	69-71 cm	95-98 cm
SiO_2	49.03	49.41	49.65
TiO_2	1.70	1.59	1.83
Al_2O_3	13.75	16.86	15.37
FeO	12.38	11.59	12.64
MnO	–	–	–
MgO	7.02	7.24	6.69
CaO	11.20	7.54	10.24
Na_2O	–	–	–
K_2O	0.06	0.35	0.12
P_2O_5	–	–	–
Total	–	–	–
LOI	0.58	2.30	1.49
FeO ÷ MgO	1.76	1.60	1.88
CaO ÷ Al_2O_3	0.81	0.44	0.66
FeO ÷ TiO_2	7.28	7.28	6.90

Paleomagnetism/Physical Properties:

Interval	21 cm	130 cm
NRM Intensity (10^{-3} emu/cc)	2.2	0.6
NRM Incl. (°)	–66.1	–57.0
MDF (Oe.)	35.0	50.0
Stable Incl. (°)	–51.9	?
Vp ∥ (km/s)	–	–
D (g/cc)	–	–
P (%)	–	–



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	23	3

Depth: 600.0-601.5 m

MAJOR ROCK TYPE—MASSIVE BASALT SILL (DOLERITE)

Macroscopic Description:

Moderately altered massive basalt (dolerite) sill with veins of celadonite and celadonite plus clay. Color and mineral assemblages are as mentioned in Core 23, Section 1. Piece 7 at 98.0-104.0 cm is badly altered to clay and (clinopyroxene)/(plagioclase-microphenocrysts) <1.

From 0.0-150.0 cm (all pieces) the basalt has a fine to medium grain-size and is porphyritic.

Thin Section Description:

75-77 cm: Subophitic dolerite from sill interior.

Microphenocrysts: Plagioclase (An65) 4-5%, 0.4-0.5 mm, subhedral to euhedral; clinopyroxene 3-4%, 0.4-0.8 mm, subhedral to euhedral.

Groundmass: Plagioclase ?%, <0.3 mm, subhedral microlite; clinopyroxene ?%, <0.3 mm, subhedral microlite; magnetite ?%, <0.1 mm, angular; apatite ?%, acicular in clinopyroxene and plagioclase.

Alteration: Clays, smectite, chlorite, etc. (35%) often replacing microphenocrysts or microlites of clinopyroxene and plagioclase.

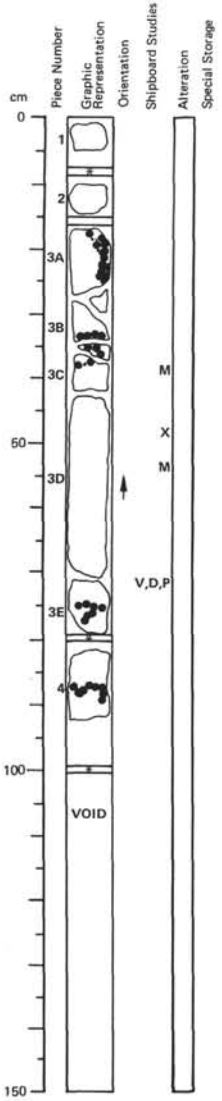
Texture: Subophitic.

Shipboard Geochemistry (XRF, %):

Interval	**75-77 cm**
SiO_2	49.75
TiO_2	2.17
Al_2O_3	17.12
FeO	11.11
MnO	–
MgO	8.53
CaO	7.18
Na_2O	–
K_2O	0.30
P_2O_5	–
Total	–
LOI	0.51
FeO ÷ MgO	1.30
CaO ÷ Al_2O_3	0.41
FeO ÷ TiO_2	5.11

Paleomagnetism/Physical Properties:

Interval	**8-10 cm**	**63v**
NRM Intensity (10^{-3} emu/cc)	0.5	–
NRM Incl. (°)	–73.8	–
MDF (Oe.)	40.0	–
Stable Incl. (°)	–46.9	–
Vp ∥ (km/s)	–	5.167
D (g/cc)	–	2.91
P (%)	–	2.6



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	23	4

Depth: 601.5 to 602.5 m

MAJOR ROCK TYPE—MASSIVE BASALT SILL (DOLERITE)

Macroscopic Description:

Moderately altered massive basalt sill with veins of celadonite and celadonite plus clay. Color and mineral assemblages are as mentioned for Core 23, Section 1.

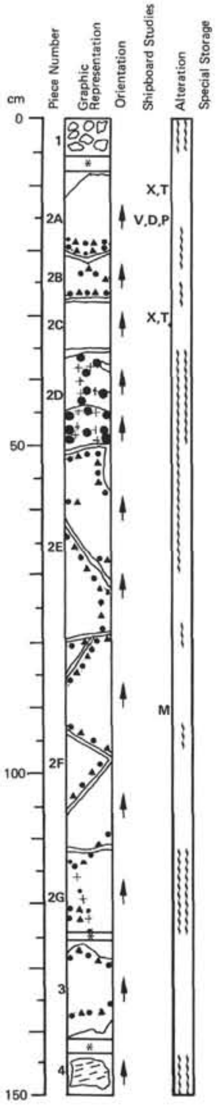
From 0.0-43.0 cm (Pieces 1~3C): Basalt has a fine to medium grain-size and is porphyritic. The ratio of (clinopyroxene)/(plagioclase microphenocrysts) is <1.
From 43.0-92.0 cm (Pieces 1D-4): Basalt has a medium to coarse grain-size and is porphyric with clinopyroxene phenocrysts. The ratio of (clinopyroxene)/(plagioclase, microphenocrysts) is >1.

Shipboard Geochemistry (XRF, %):

Interval	**48-50 cm**
SiO_2	48.41
TiO_2	1.73
Al_2O_3	14.40
FeO	12.22
MnO	–
MgO	6.78
CaO	11.24
Na_2O	–
K_2O	0.08
P_2O_5	–
Total	–
LOI	1.12
FeO ÷ MgO	1.80
CaO ÷ Al_2O_3	0.78
FeO ÷ TiO_2	7.06

Paleomagnetism/Physical Properties:

Interval	**38 cm**	**55 cm**	**70-72 cm**
NRM Intensity (10^{-3} emu/cc)	0.6	0.5	–
NRM Incl. (°)	–62.0	–81.7	–
MDF (Oe.)	20.0	20.0	–
Stable Incl. (°)	–59.0	–61.2	–
Vp ∥ (km/s)	–	–	5.080
D (g/cc)	–	–	2.83
P (%)	–	–	4.3



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	24	1

Depth: 606.0 to 607.5 m

MAJOR ROCK TYPE—MASSIVE BASALT SILL (DOLERITE)

Macroscopic Description:

Massive aphyric microdolerites with veins of celadonite plus pyrite and celadonite plus quartz. Thin veins (0.5-2.0 mm) consist of celadonite and pyrite, but quartz occurs in the thicker veins.

From 0.0-150.0 cm the microdolerites have a fine to medium grain-size and probably represent the same unit as in Core 23, Section 4. Pyroxene is partly altered to chlorite. Intervals from 25.0-32.0 cm and from 80.0-107.0 cm have a finer grain-size.

Thin Section Description:

8-10 cm: Subophitic dolerite from sill interior.

Microphenocrysts: Plagioclase (An60) 5-6%, 0.4-0.9 mm, subhedral; clinopyroxene 3-4%, 0.3-0.4 mm, subhedral to euhedral.

Groundmass: Plagioclase 40%, <0.3 mm, euhedral to subhedral, microlite; clinopyroxene 45%, <0.2 mm, subhedral; magnetite 3-5%, <0.1 mm, angular; trace of quartz and alkali feldspar.

Alteration: Clays (35%) often replace microphenocrysts and microlites of plagioclase and clinopyroxene.

Texture: Subophitic.

27-31 cm: Subophitic dolerite from interior of sill.

Microphenocrysts: Plagioclase (An65) 6-8%, 0.4-1.5 mm, subhedral to euhedral; clinopyroxene 6-8%, 0.3-0.4 mm, subhedral to euhedral, often glomeroporphyritic.

Groundmass: Plagioclase 38%, <0.3 mm,subhedral to euhedral, microlites; clinopyroxene 37%, <0.3 mm, subhedral, microlites; magnetite 10%, <0.1 mm, angular; glass ?%, fresh; trace quartz and alkali feldspar.

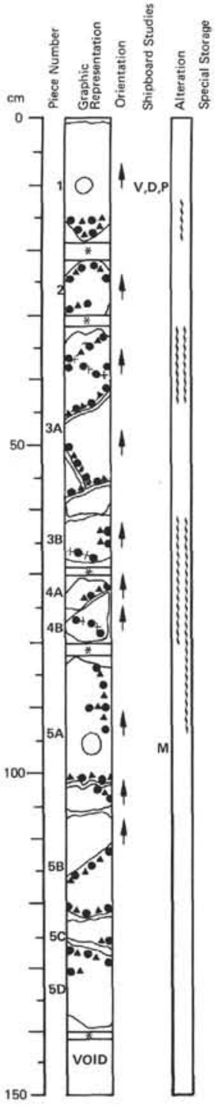
Alteration: Clays (20-30%) replacing microlites of clinopyroxene and plagioclase.

Shipboard Geochemistry (XRF, %):

Interval	8-10 cm	27-31 cm
SiO_2	48.18	49.36
TiO_2	1.73	1.73
Al_2O_3	14.12	14.02
FeO	12.81	12.39
MnO	–	–
MgO	6.83	6.78
CaO	10.78	11.36
Na_2O	–	–
K_2O	0.09	0.10
P_2O_5	–	–
Total	–	–
LOI	1.33	0.81
FeO ÷ MgO	1.87	1.82
CaO ÷ Al_2O_3	0.76	0.81
FeO ÷ TiO_2	7.40	7.16

Paleomagnetism/Physical Properties:

Interval	16-18 cm	87 cm
NRM Intensity (10^{-3} emu/cc)	–	0.9
NRM Incl. (°)	–	–65.2
MDF (Oe.)	–	25.0
Stable Incl. (°)	–	–53.9?
Vp ∥ (km/s)	5.186	–
D (g/cc)	2.85	–
P (%)	4.0	–



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	24	2

Depth: 607.5 to 609.0 m

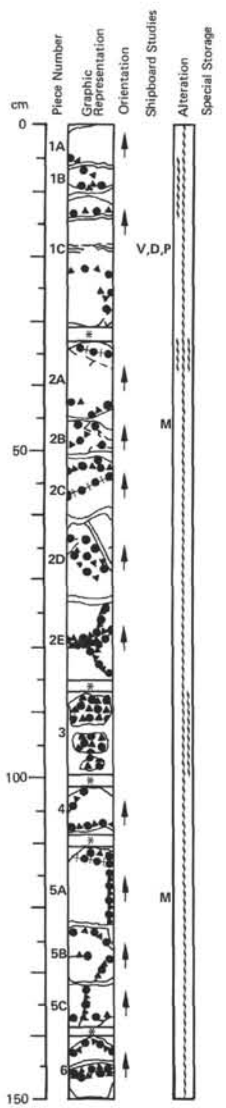
MAJOR ROCK TYPE—MASSIVE BASALT SILL (DOLERITE)

Macroscopic Description:

Massive medium grain-sized microdolerites with veins of celadonite plus pyrite and celadonite plus quartz. This dolerite is of the same unit as in Section 1 of Core 24.

Paleomagnetism/Physical Properties:

Interval	8-11 cm	96 cm
NRM Intensity (10^{-3} emu/cc)	–	1.2
NRM Incl. (°)	–	–62.6
MDF (Oe.)	–	35.0
Stable Incl. (°)	–	–52.7
Vp ∥ (km/s)	5.501	–
D (g/cc)	2.89	–
P (%)	1.8	–



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	24	3

Depth: 609.0 to 610.5 m

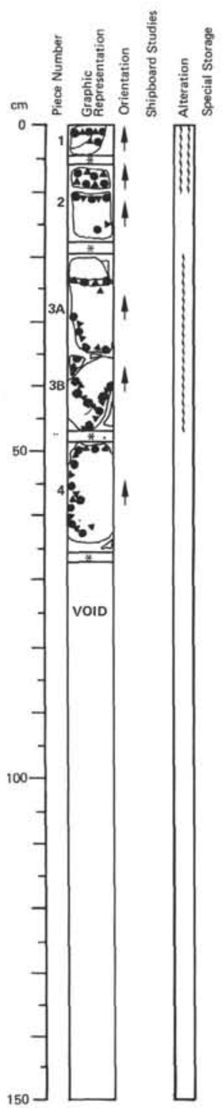
MAJOR ROCK TYPE—MASSIVE BASALT SILL (DOLERITE)

Macroscopic Description:

Massive fine to medium grain-sized microdolerites with veins of celadonite plus pyrite and celadonite plus quartz. Dolerite in intervals from 0.0-30.0 cm, and from 110.0-150.0 cm have a finer grain-size. This dolerite is the same unit as in Core 24, Section 2.

Paleomagnetism/Physical Properties:

Interval	**19-21 cm**	**47v cm**	**118 cm**
NRM Intensity (10^{-3} emu/cc)	–	0.4	3.2
NRM Incl. (°)	–	−68.6	−57.7
MDF (Oe.)	–	15.0	45.0
Stable Incl. (°)	–	−51.3	−51.3
Vp ‖ (km/s)	5.372	–	–
D (g/cc)	2.89	–	–
P (%)	2.8	–	–



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	24	4

Depth: 610.5 to 615.0 m

MAJOR ROCK TYPE—MASSIVE BASALT SILL (DOLERITE)

Macroscopic Description:

Massive fine to medium grain-sized microdolerites with veins of celadonite plus pyrite and celadonite plus quartz. Dolerite from 45.0-65.0 cm has a fine grain-size. Microdolerites of Core 24 belong to a single sill and grain-size variations are common. Coarser pyroxene spots occur within medium grain-sized intervals.

Thin Section Description:

51-54 cm: Subophitic dolerite from sill interior.

Microphenocrysts: Plagioclase (An60-65) 3%, subhedral to euhedral; clinopyroxene 5-6%, 0.4 mm, subhedral to euhedral, often occurs in aggregates.

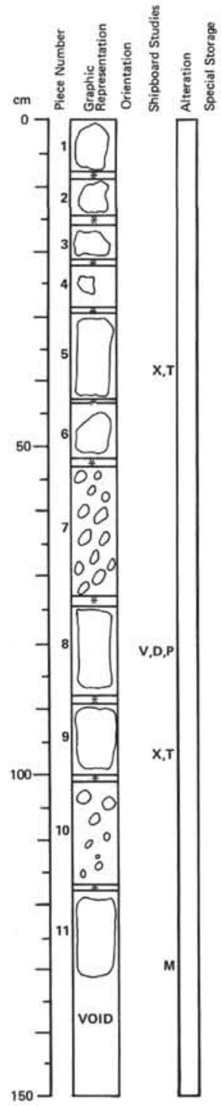
Groundmass: Plagioclase 40%, <0.3 mm, subhedral to euhedral, microlite; clinopyroxene 40%, <0.2 mm, subhedral, microlite; magnetite 10%, <0.1 mm, angular.

Alteration: Clays (20%) replace microlites of plagioclase and clinopyroxene.

Texture: Subophitic.

Shipboard Geochemistry (XRF, %):

Interval	**51-54 cm**
SiO_2	50.38
TiO_2	1.64
Al_2O_3	14.84
FeO	13.25
MnO	–
MgO	6.53
CaO	11.36
Na_2O	–
K_2O	0.12
P_2O_5	–
Total	–
LOI	0.81
FeO ÷ MgO	2.02
CaO ÷ Al_2O_3	0.76
FeO ÷ TiO_2	8.07



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
6 1	4 6 2	A	2 5	1

Depth: 615.0 to ~616.0 m

MAJOR ROCK TYPE—MASSIVE BASALT SILL (DOLERITE)

Macroscopic Description:

From 0.0-50.0 cm dolerite is massive, medium grain-sized with phenocrysts of plagioclase (< 1%) and clinopyroxene (< 1%), both clinopyroxene and plagioclase phenocrysts are <0.77 mm in size, and the color index is higher than before, and appears to be created by alteration.

From 50.0-73.0 cm are dolerite fragments, some of which have a fine grain-size, suggesting a sill boundary within these section intervals.

From 73.0-130.0 cm the dolerite is medium grain-sized, with ~ 1% clinopyroxene phenocrysts. Most of these phenocrysts are <0.5 mm in size, but some are ~ 1.0 mm in size. This dolerite is more leucocratic than the previous unit.

Thin Section Description:

39-42 cm: Altered dolerite next to glassy margin of sill.

Microphenocrysts: Plagioclase (An60) 3%, 0.4-0.7 mm, subhedral; clinopyroxene 3%, 0.2-0.5 mm, subhedral, some form aggregates.

Groundmass: Plagioclase 50%, <0.2 mm, subhedral to euhedral, microlite; clinopyroxene (augite) 35%, <0.2 mm, subhedral; magnetite (Ti) 3-5%, <0.08 mm, angular; glass 5%, altered to clays; trace quartz, interstitial glass patches; amphibole 15%, rimming clinopyroxene.

Alteration: Clays (40%) replacing microlites of plagioclase and clinopyroxene, and clay and chlorite replace glass.

Texture: Intersertal, to intergranular, subophitic.

99-102 cm: Altered dolerite next to glassy margin of sill.

Microphenocrysts: Plagioclase (An70) 1%, 0.5-0.6 mm, subhedral, partly subophitic; clinopyroxene 3%, 0.5-0.6 mm, subhedral, partly subophitic.

Groundmass: Plagioclase (An62) 45%, <0.4 mm, subhedral to euhedral, partly microlite; clinopyroxene (augite) 48%, <0.3 mm, subhedral; magnetite 2%, <0.05 mm, angular; glass ?%, altered, interstitial patches.

Alteration: Clays (25%) replacing clinopyroxene in spots throughout the rock.

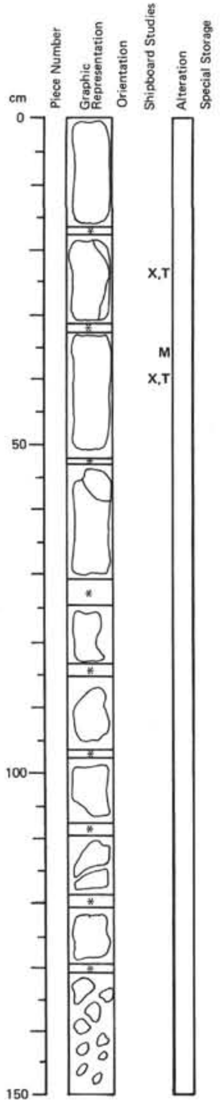
Texture: Intersertal to intergranular, to microdoleritic.

Shipboard Geochemistry (XRF, %):

Interval	**39-42 cm**	**99-102 cm**
SiO_2	50.61	48.40
TiO_2	2.00	1.63
Al_2O_3	16.16	13.55
FeO	10.48	13.38
MnO	–	–
MgO	6.64	6.75
CaO	9.14	11.56
Na_2O	–	–
K_2O	0.20	0.60
P_2O_5	–	–
Total	–	–
LOI	2.16	0.59
FeO ÷ MgO	1.57	1.98
CaO ÷ Al_2O_3	0.56	0.85
FeO ÷ TiO_2	5.24	8.20

Paleomagnetism/Physical Properties:

Interval	**83-86 cm**	**128 cm**
NRM Intensity (10^{-3} emu/cc)	–	1.4
NRM Incl. (°)	–	–55.0
MDF (Oe.)	–	50.0
Stable Incl. (°)	–	–49.3
Vp ∥ (km/s)	5.517	–
D (g/cc)	2.91	–
P (%)	3.2	–



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
6 1	4 6 2	A	B 1	1

Depth: 616.0 to 626.0 m
(Bit Core)

MAJOR ROCK TYPE-—MASSIVE BASALT SILL (DOLERITE)

Macroscopic Description:

Massive dolerite sill. Most pieces have a relatively coarse grain-size doleritic rock with a few (< 1%) clinopyroxene phenocrysts (~ 1 mm in size). Between 20.0-30.0 cm is a piece with the coarsest grain-size. Vein material and alteration are not visible to the unaided eye.

None of the pieces are oriented and their relative stratigraphic position is not known either.

Thin Section Description:

23-26 cm: Altered dolerite from interior of sill.

Phenocrysts: Trace of plagioclase; clinopyroxene (augite) < 1%, <0.5 mm.

Groundmass: Plagioclase (An55 zoned to An25) 30%, 0.1-0.3 mm; clinopyroxene (augite) 38%, <0.25 mm; magnetite (Ti) 5%, 0.1-0.3 mm, subhedral; glass 7%, totally replaced, interstitial patches; amphibole 5%, minute needles replacing clinopyroxene.

Alteration: Clays (15%) replacing glass, clinopyroxene, and plagioclase.

Texture: Microdolerite.

40-43 cm: Altered diabase from sill interior.

Phenocrysts: Trace clinopyroxene (augite), <0.5 mm.

Groundmass: Plagioclase (An60 zoned to An30, rare An70) 20%, 0.1-0.3 mm; clinopyroxene (augite) 35%, <0.2 mm; magnetite (Ti) 10%, <0.20 mm; glass 10%, totally replaced glass patches; trace quartz, alkali feldspar, amphibole(?); and apatite.

Alteration: Brown clays (25%) replacing glass, plagioclase, and clinopyroxene.

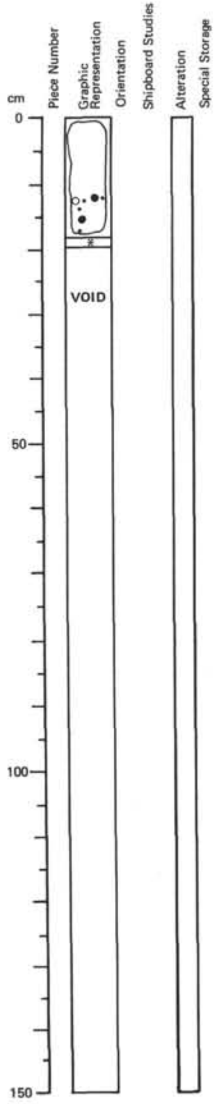
Texture: Microdoleritic.

Shipboard Geochemistry (XRF, %):

Interval	**23-26 cm**	**40-43 cm**
SiO_2	49.81	49.85
TiO_2	1.66	1.64
Al_2O_3	13.37	13.34
FeO	12.48	12.91
MnO	–	–
MgO	6.75	6.47
CaO	11.21	11.08
Na_2O	–	–
K_2O	0.08	0.08
P_2O_5	–	–
Total	–	–
LOI	0.79	1.02
FeO ÷ MgO	1.84	1.99
CaO ÷ Al_2O_3	0.83	0.83
FeO ÷ TiO_2	7.51	7.87

Paleomagnetism/Physical Properties:

Interval	**37 cm**
NRM Intensity (10^{-3} emu/cc)	1.2
NRM Incl. (°)	–71.1
MDF (Oe.)	25.0
Stable Incl. (°)	–43.0?
Vp ∥ (km/s)	–
D (g/cc)	–
P (%)	–



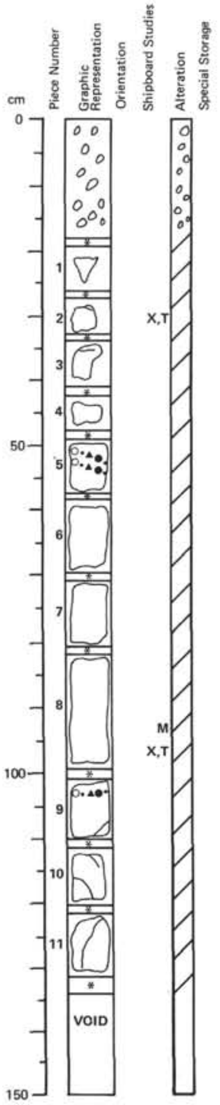
VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	B1	2

(Core-Catcher sample of Bit Core)

MAJOR ROCK TYPEMASSIVE BASALT SILL (DOLERITE)

Macroscopic Description:
Massive dolerite sill with 1% clinopyroxene phenocrysts (~1.0 mm), and veins of celadonite.



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	27	1

Depth: 626.0 to 627.3 m

MAJOR ROCK TYPE—MASSIVE BASALT SILL (DOLERITE)

Macroscopic Description:
Massive dolerite sill with veins. In the 20.0-48.0 cm interval, dolerite (1) has a finer grain-size, (2) is more meloncratic (higher color index) than below 48.0 cm, (3) has a few phenocrysts (< 1%, < 0.5 mm) of plagioclase plus clinopyroxene, and (4) has a few clay veins.
In the 48.0-130.0 cm interval, dolerite has (1) a vein of calcite, green clay, pyrite, and celadonite at 52.0 cm, (2) a few percent of clinopyroxene phenocrysts (< 0.5 mm) with rare plagioclase phenocrysts, and (3) many amoeboid clay patches (~ 1-2 mm).
From 48.0-~85.0 cm, the grain-size is coarser than above 48.0 cm, and grain-size below 85.0 cm decreases downward.

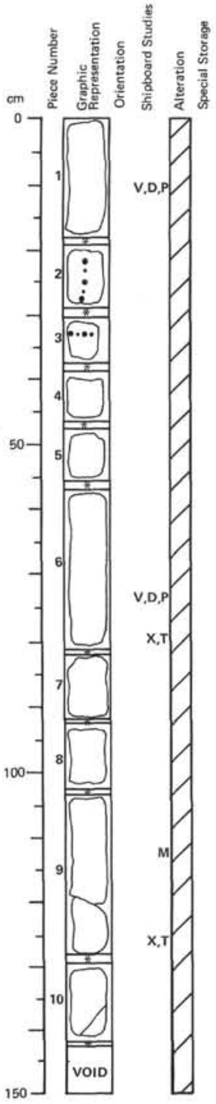
Thin Section Description:
31-33 cm: Altered dolerite with granophyric patches from the interior of the sill.
Phenocrysts: Trace clinopyroxene (augite), < 0.5 mm.
Groundmass: Plagioclase (An58 zoned to An27) 25%, 0.1-0.3 mm; clinopyroxene (augite) 15%, < 0.2 mm; magnetite (Ti) 10%, < 0.2 mm, subhedral; quartz and alkali feldspar 2-3%, glomerophyric intergrowths and subhedral quartz crystals; amphibole (actinolite? plus hornblende) 15%, needles and patches.
Alteration: Green clays (20%) and chlorite (15%) are replacing plagioclase.
Texture: Diabasic.
97-100 cm: Altered coarse grained, with granophyres, dolerite from the interior of the sill.
Phenocrysts: Clinopyroxene (augite) < 1%, 0.6-0.7 mm, subhedral.
Groundmass: Plagioclase (An87 with rims of An35) 23%, 0.2-0.5 mm; clinopyroxene (augite) 35%, 0.4-0.5 mm; magnetite (Ti) 7%, < 0.2 mm, euhedral and subhedral; quartz and alkali feldspar 2-3%, granophyric; amphibole (actinolite? plus hornblende).
Alteration: Amphibole, chlorite, and brown clay (total 35%) in patches and distributed through rock. Amphibole is rimmed with chlorite.
Texture: Diabasic.

Shipboard Geochemistry (XRF, %):

Interval	31-33 cm	97-100 cm
SiO_2	48.21	49.43
TiO_2	1.72	1.52
Al_2O_3	14.35	13.39
FeO	12.60	12.77
MnO	–	–
MgO	6.57	6.70
CaO	10.75	11.14
Na_2O	–	–
K_2O	0.12	0.11
P_2O_5	–	–
Total	–	–
LOI	2.60	1.16
FeO ÷ MgO	1.91	1.90
$CaO \div Al_2O_3$	0.75	0.83
$FeO \div TiO_2$	7.32	8.40

Paleomagnetism/Physical Properties:

Interval	91 cm
NRM Intensity (10^{-3} emu/cc)	1.3
NRM Incl. (°)	−61.9
MDF (Oe.)	40.0
Stable Incl. (°)	−50.2
Vp ∥ (km/s)	–
D (g/cc)	–
P (%)	–



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	27	2

Depth: 627.3 to 628.7 m

MAJOR ROCK TYPE––MASSIVE BASALT SILL (DOLERITE)

Macroscopic Description:

Massive altered dolerite sill with clay and celadonite and clay veins. From 0.0-100.0 cm, grain-size decreases downward. From 100.0-130.0 cm is a zone of finer grain-size, and below 130.0 cm grain-size increases downward.

Thin Section Description:

77-80 cm: Altered granophyre dolerite from the sill interior.

Groundmass: Plagioclase (An70 zoned to An40) 25%, 0.2-0.9 mm; clinopyroxene (augite) 33%, 0.2-0.8 mm; magnetite (Ti) 12%, <0.2 mm; alkali feldspar 1-2%, granophyric patches; trace amphibole.

Alteration: Brown clays and amphibole (total 30%) in patches replacing plagioclase and clinopyroxene.

Texture: Diabase, coarse grained.

125-128 cm: Altered granophyric dolerite from the sill interior.

Groundmass: Plagioclase (An50-AN30) 30%, 0.1-0.6 mm, subhedral to euhedral; clinopyroxene (augite) 37%, 0.2-0.5 mm, pale brown; magnetite (Ti) 10%, <0.3 mm, euhedral to anhedral; quartz and alkali feldspar 3%, granophyric aggregates; trace apatite.

Alteration: Brown clays and amphibole (total 20%) replacing plagioclase and clinopyroxene.

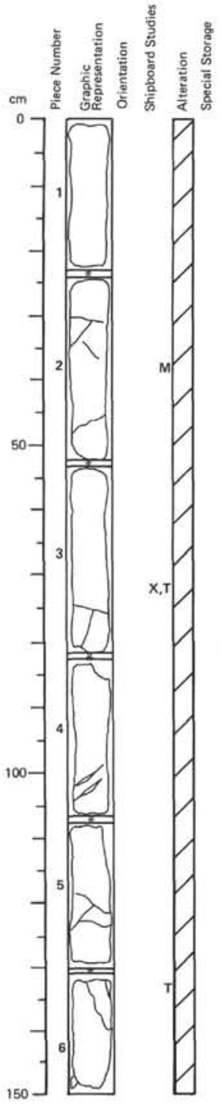
Texture: Diabasic.

Shipboard Geochemistry (XRF, %):

Interval	78-80 cm	125-129 cm
SiO_2	49.56	48.61
TiO_2	1.62	1.62
Al_2O_3	13.26	13.25
FeO	13.03	13.23
MnO	–	–
MgO	6.01	6.17
CaO	11.34	11.13
Na_2O	–	–
K_2O	0.12	0.16
P_2O_5	–	–
Total	–	–
LOI	0.51	0.36
FeO ÷ MgO	2.16	2.14
CaO ÷ Al_2O_3	0.85	0.84
FeO ÷ TiO_2	8.04	8.16

Paleomagnetism/Physical Properties:

Interval	10-12 cm	71-74 cm	112 cm
NRM Intensity (10^{-3} emu/cc)	–	–	1.2
NRM Incl. (°)	–	–	–56.3
MDF (Oe.)	–	–	55.0
Stable Incl. (°)	–	–	–47.0
Vp ∥ (km/s)	5.918	5.797	–
D (g/cc)	3.00	2.99	–
P (%)	1.1	1.4	–



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	27	3

Depth: 628.7 to 630.2 m

MAJOR ROCK TYPE––MASSIVE BASALT (DOLERITE)

Macroscopic Description:

Massive, very sparsely plagioclase and clinopyroxene phyric, slightly altered dolerite. Increasing grain-size and more melanocratic downward.

Thin Section Description:

71-74 cm: Microdolerite from sill interior.

Phenocrysts: Plagioclase (An52-70) trace, 1.0 mm, elongated prisms and tables; slightly corroded; clinopyroxene ~ 1%, equidimensional, slightly corroded.

Groundmass: Plagioclase (An62) 20%, 0.1-0.6 mm, microlites; clinopyroxene 61%, 0.02-0.3 mm, equidimensional; magnetite 8%, 0.2 mm, intergranular; trace of quartz and alkali feldspar, 0.1-0.4 mm; intergranular granophyric aggregates; trace of apatite, thin needles in quartz.

Alteration: Pale grayish green clays (20%).

Texture: Microdoleritic to doleritic.

133-136 cm: Microdolerite from sill interior.

Microphenocrysts: Trace of plagioclase, 1.6 mm, tables, coarse zoned grains; trace clinopyroxene, 1.6 mm, equidimensional.

Groundmass: Plagioclase (An62) 30-45%, 0.4 mm, microlites; clinopyroxene 43-58%, 0.02-0.3 mm, equidimensional; magnetite 12%, 0.2 mm, intergranular; trace of quartz, 0.1-0.3 mm and trace of alkali feldspar, 0.1 mm, intergranular isolated grains and granophyric aggregates; trace of apatite, <0.02 mm, needles in quartz.

Alteration: Pale grayish green clays (20%) is intergranular and replaces plagioclase.

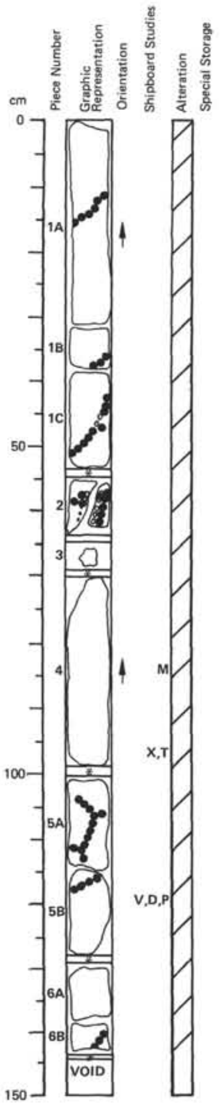
Texture: Microdolerite and dolerite.

Shipboard Geochemistry (XRF, %):

Interval	71-74 cm
SiO_2	49.31
TiO_2	1.60
Al_2O_3	13.03
FeO	13.00
MnO	–
MgO	6.55
CaO	10.88
Na_2O	–
K_2O	0.08
P_2O_5	–
Total	–
LOI	0.67
FeO ÷ MgO	1.98
CaO ÷ Al_2O_3	0.83
FeO ÷ TiO_2	8.12

Paleomagnetism/Physical Properties:

Interval	38 cm
NRM Intensity (10^{-3} emu/cc)	0.7
NRM Incl. (°)	–62.7
MDF (Oe.)	60.0
Stable Incl. (°)	–50.0?
Vp ∥ (km/s)	–
D (g/cc)	–
P (%)	–



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG		SITE			HOLE	CORE		SECT.	
6	1	4	6	2	A	2	8		1

Depth: 630.0 to 631.4 m

MAJOR ROCK TYPE—–MASSIVE BASALT SILL (DOLERITE)

Macroscopic Description:
Slightly altered massive medium bluish gray (5B 5/1) dolerite sill with veins, which are filled with calcite, celadonite, pyrite, and clay (smectite or paragonite). Microphenocrysts are plagioclase and clinopyroxene and microlites are plagioclase, clinopyroxene, and magnetite. The ratio of "clinopyroxene to plagioclase microphenocrysts" is about 1. Microcysts of clinopyroxene are partly altered to clays.

Pieces 1A, 2, 3, 4 (70-85 cm), 5A, 5B, and 6A are aphanite to porphyritic and the grain-size is fine to medium.

Pieces 1B, 1C, 4 (85-100 cm), and 6B are porphyritic and grain-size is medium to slightly coarse.

Thin Section Description: Dolerite from sill interior (?).

Groundmass: Plagioclase (An43-63) 35-45%, 0.2-0.6 mm, microlites; clinopyroxene 43-53%, equidimensional; magnetite 10%, 0.6 mm, intergranular quartz and alkali feldspar 2%, 0.4-0.8 mm, granophyre intergrowths; trace of apatite, thin needles in quartz.

Alteration: Dark brown clays (12%) replacing pyroxene.

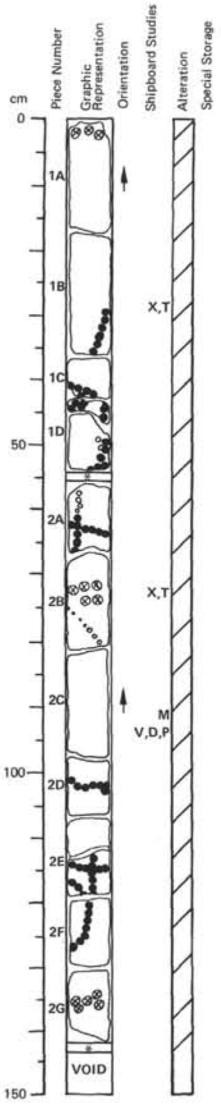
Texture: Doleritic to microdoleritic.

Shipboard Geochemistry (XRF, %):

Interval	**96-98 cm**
SiO_2	50.17
TiO_2	1.73
Al_2O_3	13.25
FeO	12.83
MnO	–
MgO	5.94
CaO	11.11
Na_2O	–
K_2O	0.08
P_2O_5	–
Total	–
LOI	0.28
FeO ÷ MgO	2.15
CaO + Al_2O_3	0.84
FeO ÷ TiO_2	7.41

Paleomagnetism/Physical Properties:

Interval	**84 cm**	**119-121 cm**
NRM Intensity (10^{-3} emu/cc)	0.7	–
NRM Incl. (°)	–58.8	–
MDF (Oe.)	30.0	–
Stable Incl. (°)	–20.8	–
Vp ∥ (km/s)	–	5.973
D (g/cc)	–	2.98
P (%)	–	1.3



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG		SITE			HOLE	CORE		SECT.	
6	1	4	6	2	A	2	8		2

Depth: 631.4 to 632.8 m

MAJOR ROCK TYPE- –MASSIVE BASALT SILL (DOLERITE)

Macroscopic Description:
Slightly altered massive dolerite sill with veins. Veins are filled with calcite, celadonite, pyrite, and clay.

From 0.0-72.0 cm, 76.0-134.0 cm, and 138.0-142.0 cm, dolerite has a medium to slightly coarse grain-size and is porphyritic (as mentioned in Core 28, Section 1).

From 0.0-3.0 cm, 72.0-76.0 cm, and 134.0-138.0 cm, dolerite has a coarse grain-size and spherulitic plagioclase aggregate (2-3 m = ⊕). The upper boundaries of these zones are sharp but lower boundaries are gradual (granophyre).

Thin Section Description:

28-30 cm: Microdolerite from sill interior.

Groundmass: Plagioclase (An60-80) 45%, microlites, prisms; clinopyroxene 33%, 0.08-0.4 mm, equidimensional; magnetite 7%, 0.04-0.4 mm, intergranular; glass 15%, 0.7 mm, interstitial variolitic aggregates; trace quartz, ~0.1 mm, interstitial.

Alteration: Clays (20%) replacing interstitial glass.

Texture: Spotted microdoleritic to doleritic.

73-75 cm: Variolitic dolerite from sill interior.

Groundmass: Plagioclase (An52-62) 38%, 0.06-4.0 mm, elongated prisms and tables, microlites; clinopyroxene 18%, 0.4-5.0 mm, corroded elongated prisms, including plagioclase microlite; magnetite 6%, 0.1-1.2 mm, intergranular; glass 38%, 1-8 mm, interstitial variolitic to hyalopilitic mesostasis.

Alteration: Clays (10%) replacing glass.

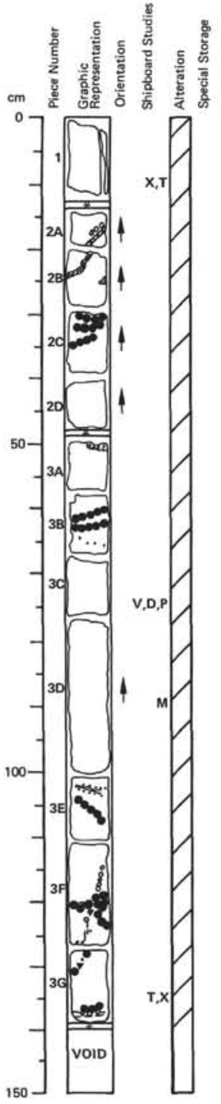
Texture: Spotted dolerite to variolite.

Shipboard Geochemistry (XRF, %):

Interval	**28-30 cm**	**73-75 cm**
SiO_2	50.56	48.50
TiO_2	1.66	2.18
Al_2O_3	13.50	12.27
FeO	12.78	15.57
MnO	–	–
MgO	6.54	6.13
CaO	11.39	9.76
Na_2O	–	–
K_2O	0.05	0.08
P_2O_5	–	–
Total	–	–
LOI	0.44	0.83
FeO ÷ MgO	1.95	2.53
CaO ÷ Al_2O_3	0.84	0.79
FeO ÷ TiO_2	7.69	7.41

Paleomagnetism/Physical Properties:

Interval	**85 cm**	**89-92 cm**
NRM Intensity (10^{-3} emu/cc)	2.4	–
NRM Incl. (°)	–60.5	–
MDF (Oe.)	30.0	–
Stable Incl. (°)	–51.7	–
Vp ∥ (km/s)	–	6.031
D (g/cc)	–	2.99
P (%)	–	1.3



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	28	3

Depth: 632.8 to 634.2 m

MAJOR ROCK TYPE—MASSIVE BASALT SILL (DOLERITE)

Macroscopic Description:
Slightly altered massive dolerite with veins of quartz, calcite plus celadonite and pyrite, and clay. Alteration and quartz veins occur in Pieces 2A, 2B, and 3. Alteration in Pieces 3C, 3F, and 3G proceeds along veins (with pyrite). From 0.0-65.0 cm, dolerite is porphyric and has medium to slightly coarse grain-size. From 65.0-140.0 cm, dolerite is aphanitic to slightly porphyritic and has fine to medium grain-size.

Thin Section Description:

8-10 cm: Variolitic microdolerite from sill interior.

Groundmass: Plagioclase (An60-72) 40%, 0.1-0.8 mm, microlites, prisms; clinopyroxene 38%, 0.08-0.4 mm, equidimensional; magnetite 7%, intergranular; glass 15%, interstitial variolitic aggregates.

Alteration: Brown clays (20%) replacing interstitial glass.

Texture: Microdolerite to variolite.

134-136 cm: Microdolerite from sill interior.

Microphenocrysts: Trace of plagioclase, 1.2 mm, elongated prisms; clinopyroxene ~ 1%, 0.5 mm, equidimensional, corroded.

Groundmass: Plagioclase (An68-65) 35-40%, microlites; clinopyroxene 58-53%, 0.03 mm, equidimensional; magnetite 7%, 0.2 mm, intergranular.

Alteration: Clay (15%) forming brown pseudomorphs of all minerals and pale green groundmass.

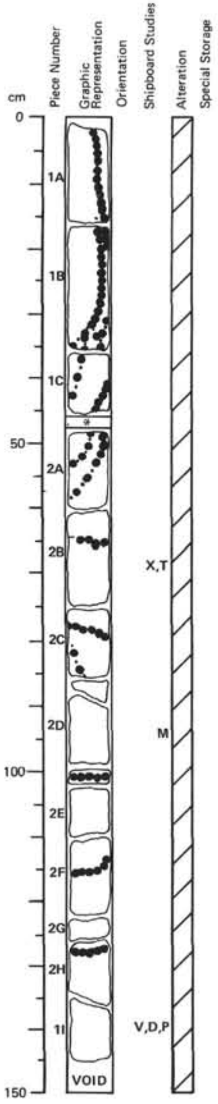
Texture: Microdolerites.

Shipboard Geochemistry (XRF, %):

Interval	8-10 cm	134-136 cm
SiO_2	48.89	51.18
TiO_2	1.37	1.67
Al_2O_3	13.69	13.49
FeO	12.17	12.79
MnO	–	–
MgO	6.66	6.49
CaO	11.86	11.30
Na_2O	–	–
K_2O	0.08	0.04
P_2O_5	–	–
Total	–	–
LOI	0.59	0.52
FeO ÷ MgO	1.82	1.97
CaO ÷ Al_2O_3	0.86	0.84
FeO ÷ TiO_2	8.88	7.65

Paleomagnetism/Physical Properties:

Interval	75-77 cm	90 cm
NRM Intensity (10^{-3} emu/cc)	–	0.8
NRM Incl. (°)	–	–64.9
MDF (Oe.)	–	30.0
Stable Incl. (°)	–	–31.7?
Vp ∥ (km/s)	5.953	–
D (g/cc)	2.99	–
P (%)	7.0	–



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	28	4

Depth: 634.2 tc 635.6 m

MAJOR ROCK TYPE—MASSIVE BASALT (DOLERITE)

Macroscopic Description:
Moderately altered massive dolerite with veins of quartz, calcite plus celadonite and pyrite, and clay. The sill is the same as in Core 28, Section 1. From 0.0-150.0 cm, dolerite has a fine to medium grain-size and is aphanitic to slightly porpyritic. Alteration in Pieces 1A-2A proceeds along vein (with pyrite).

Thin Section Description:

68-70 cm: Microdolerite from sill interior.

Microphenocrysts: Plagioclase (An72) 2%, 0.8-1.2 mm, elongated prisms; clinopyroxene 1%, 1.2 mm, equidimensional, corroded.

Groundmass: Plagioclase (An48-68) 45%, 0.04-0.4 mm, microlites; clinopyroxene 35%, 0.1 mm, equidimensional; magnetite 8%, 0.07 mm, intergranular; glass 12%, 0.1-1.3 mm, interstitial hyalopilitic aggregates.

Alteration: Clays (20%) replacing all minerals forming brown pseudomorphs and pale greenish gray groundmass.

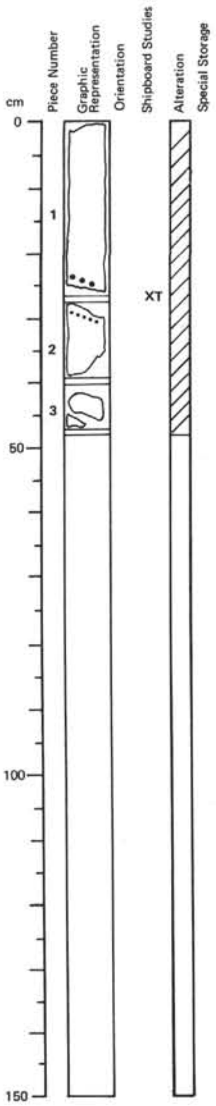
Texture: Spotted microdoleritic to hyalopilitic.

Shipboard Geochemistry (XRF, %):

Interval	68-70 cm
SiO_2	49.73
TiO_2	1.65
Al_2O_3	13.17
FeO	13.09
MnO	–
MgO	6.29
CaO	10.88
Na_2O	–
K_2O	0.14
P_2O_5	–
Total	–
LOI†	0.42
FeO ÷ MgO	2.08
CaO ÷ Al_2O_3	0.82
FeO ÷ TiO_2	7.93

Paleomagnetism/Physical Properties:

Interval	95 cm	139-142 cm
NRM Intensity (10^{-3} emu/cc)	1.5	–
NRM Incl. (°)	–68.8	–
MDF (Oe.)	60.0	–
Stable Incl. (°)	–56.5	–
Vp ∥ (km/s)	–	5.819
D (g/cm^3)	–	2.99
P (%)	–	5.3



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	28	5

Depth: 635.6 to 636.0 m

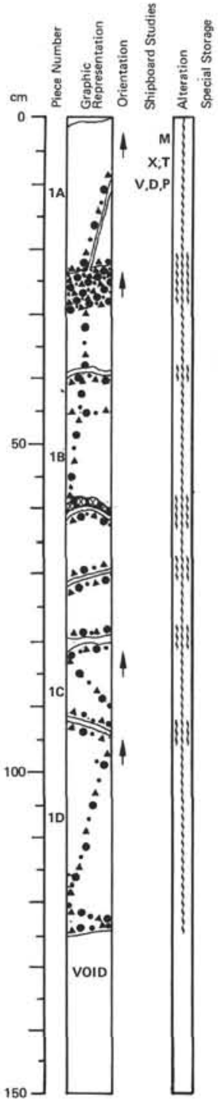
MAJOR ROCK TYPE—MASSIVE BASALT SILL (BASALT)

Macroscopic Description:
Slightly altered, massive dolerite with veins. From 0.0 to 27.0 cm and from 33.0 to 48.0 cm is fine to medium grain-sized and is aphanitic to slightly porphyritic. From 27.0 to 33.0 cm is medium to slightly coarse grain-sized and is plagioclase-porphyritic and is partly glomeroporphyritic.

Thin Section Description:
26-28 cm: Microdolerite from sill interior.
Phenocrysts: Rare relics of resorbed coarse grains of plagioclase and clinopyroxene.
Groundmass: Plagioclase (An52) 55%, 0.4-1.2 mm, microlites; clinopyroxene 40%, 0.2-0.8 mm, intergranular, corroded, elongated; magnetite 5%, 0.04-0.08 mm, dust-like.
Alteration: Palegrayish-green clays (30%) replacing all minerals.

Shipboard Geochemistry (XRF, %):

Interval	**26-28 cm**
SiO_2	49.86
TiO_2	1.75
Al_2O_3	12.96
FeO	13.22
MgO	6.65
CaO	10.35
Na_2O	–
K_2O	0.08
P_2O_5	–
Total	–
LOI†	0.62
FeO ÷ MgO	1.98
CaO ÷ Al_2O_3	0.79
FeO ÷ TiO_2	7.55



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
6 1	4 6 2	A	2 9	1

Depth: 636.0 to 637.25 m

MAJOR ROCK TYPE- -MASSIVE BASALT (DOLERITE)

Macroscopic Description:

Massive medium grain-sized dolerite with thin pyrite-clay-celadonite veins. Appears to be the same sill as in Core 28. X X X = coarse grained dolerite, vein-like separation occurs at 59.0-61.0 cm. In the thicker veins, pyrite is a cubic and pentagon-dodecahedric as compared with thin films in previous cores.

Pyroxene in groundmass is slightly altered to pale grayish-green clay.

From 49.0-61.0 cm, a coarse grain-sized (plagioclase up to 5 mm, and altered pyroxene up to 4 mm) vein-like dolerite separation bearing coarse (3-5 mm) quartz-feldspar (granophyric aggregates). Margins of this separation are fine grain-sized and enriched in dark minerals.

Thin Section Description:

6-9 cm: Subophitic dolerite from sill interior.

Microphenocrysts: Plagioclase (An55) 5%, 0.4-0.8 mm, subhedral to euhedral; clinopyroxene 7-10%, 0.4-0.9 mm, subhedral.

Groundmass: Plagioclase 40%, <0.4 mm, euhedral to subhedral, microlite; some spherulitic aggregates; clinopyroxene 40%, <0.4 mm, subhedral; magnetite 5-~8%, <0.1 mm, angular; trace quartz and alkali feldspar; trace apatite.

Alteration: Clays and chlorite (10-15%) in spotted locations replacing clinopyroxene and plagioclase.

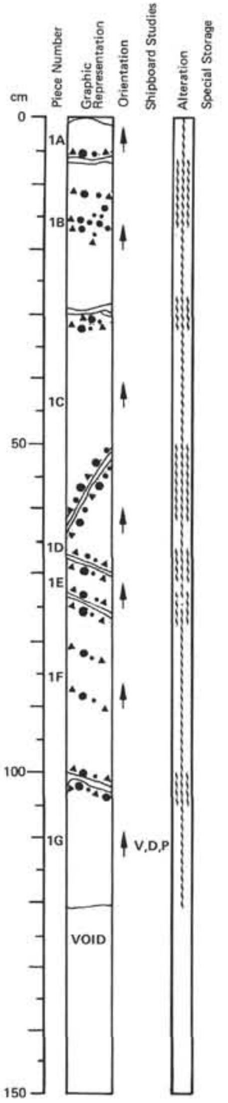
Texture: Subophitic.

Shipboard Geochemistry (XRF, %):

Interval	6-9 cm
SiO_2	49.84
TiO_2	1.63
Al_2O_3	13.13
FeO	12.71
MnO	–
MgO	6.78
CaO	11.15
Na_2O	–
K_2O	0.07
P_2O_5	–
Total	–
LOI†	0.99
FeO ÷ MgO	1.87
CaO ÷ Al_2O_3	0.87
FeO ÷ TiO_2	7.79

Paleomagnetism/Physical Properties:

Interval	1 cm	9-11 cm
NRM Intensity (10^{-3} emu/cc)	8.9	–
NRM Incl. (°)	–63.0	–
MDF (Oe.)	80.0	–
Stable Incl. (°)	–55.7	–
Vp ∥ (km/s)	–	5.873
D (g/cm^3)	–	2.96
P (%)	–	2.9



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
6 1	4 6 2	A	2 9	2

Depth: 637.25 to 638.45 m

MAJOR ROCK TYPE---MASSIVE BASALT (DOLERITE)

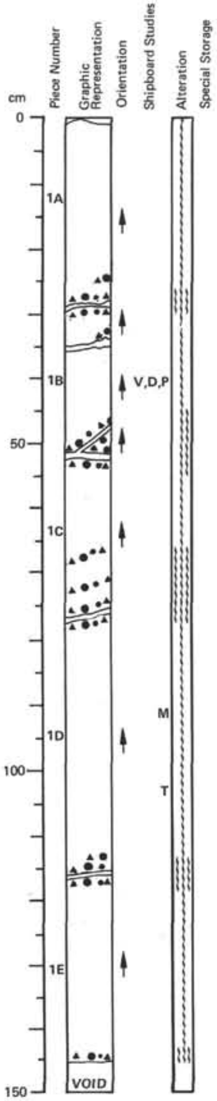
Macroscopic Description:

Massive medium grain-sized dolerites with veins of pyrite plus celadonite and clay. Dolerite of Section 2 is slightly more coarse grained and enriched in dark clay spots as compared with Section 1, Core 29. Two systems of fractures are distinctly developed: 30° and 60° inclinations relative to a vertical axis.

Physical Properties:

Interval	117-119 cm
Vp ∥ (km/s)	5.679
D (g/cm^3)	*
P (%)	*

*Cracked



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	29	3

Depth: 638.45 to 639.9 m

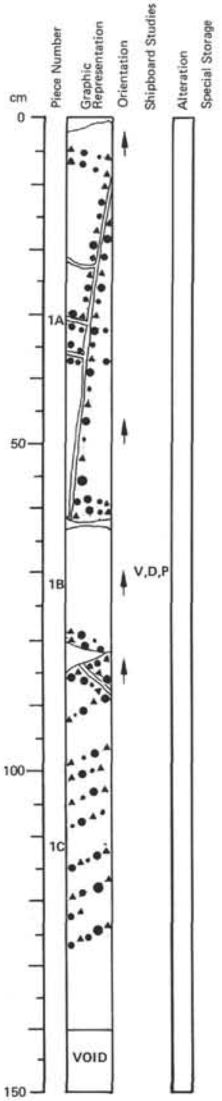
MAJOR ROCK TYPE---MASSIVE BASALT (DOLERITE)

Macroscopic Description:
Massive medium grain-sized dolerites with veins of pyrite plus celadonite and clay. Two systems of fractures are distinctly developed: 30° and 60° inclinations relative to vertical axis.

Thin Section Description:
102-105 cm: Subophitic dolerite from sill interior.
Phenocrysts: Plagioclase (An55) 15%, 0.7-1.0 mm, subhedral to euhedral, almost microphenocrysts with partly phenocrysts; clinopyroxene 15%, 0.6-1.0 mm, subhedral to euhedral, almost microphenocrysts with partly phenocrysts; magnetite 3-5%, 0.7 mm, partly skeletal ?
Groundmass: Plagioclase (An60) 15%, <0.4 mm, euhedral, microlite; clinopyroxene 30%, <0.4 mm, subhedral, microlite; magnetite 5%, <0.4 mm, skeletal; quartz 1-2%, and trace alkali feldspar form micropegmatite; trace kaersutite and apatite (acicular).
Alteration: Clays and chlorite (~5%) in spotted locations replacing clinopyroxene.
Texture: Subophitic to ophitic.

Paleomagnetism/Physical Properties:

Interval	44-46 cm	91 cm
NRM Intensity (10^{-3} emu/cc)	–	9.0
NRM Incl. (°)	–	–59.4
MDF (Oe.)	–	70.0
Stable Incl. (°)	–	–54.0
Vp ∥ (km/s)	6.062	–
D (g/cm^3)	2.95	–
P (%)	3.6	–



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	29	4

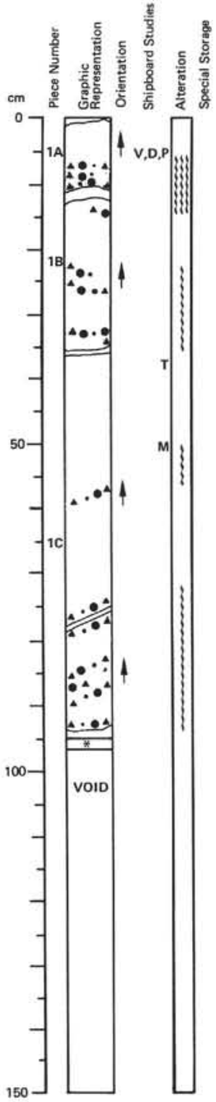
Depth: 639.9 to 641.3 m

MAJOR ROCK TYPE---MASSIVE BASALT (DOLERITE)

Macroscopic Description:
Massive medium grain-sized dolerites with veins of pyrite plus celadonite and clay. Same dolerite as in Core 29, Section 3. From 80.0-140.0 cm, dolerite has slightly finer grain-size and does not have dark coarse spots.

Physical Properties:

Interval	70-73 cm
Vp ∥ (km/s)	6.145
D (g/cm^3)	2.98
P (%)	2.9



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

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

Depth: 641.3 to 642.25 m

MAJOR ROCK TYPE—MASSIVE BASALT SILL (DOLERITE)

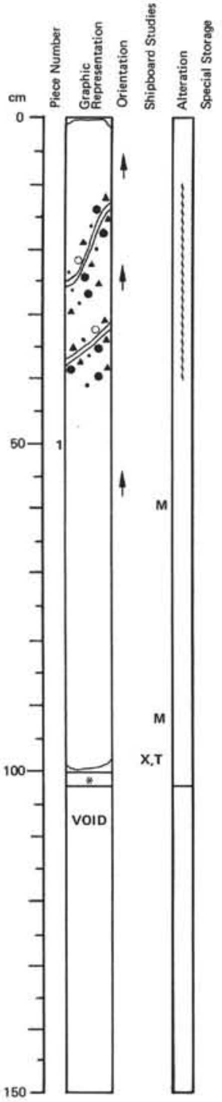
Macroscopic Description:
Massive medium grain-sized (as in 80.0-140.0 cm of Core 29, Section 4) dolerite with veins of pyrite plus clay and celadonite. A thick vein, at 7.0-9.0 cm, includes a later occurrence of calcite, in addition to the pyrite, clay, and chlorite normally forming the veins.

Thin Section Description:
37-~40 cm: Massive dolerite sill from sill interior.
Phenocrysts: Plagioclase (An50) 1-3%, 0.7-0.8 mm, subhedral; clinopyroxene 10-12%, 0.7-1.2 mm, euhedral to subhedral; magnetite 2-4%, 0.6-1.0 mm, skeletal.
Groundmass: Plagioclase 36%, <0.3 mm, subhedral to euhedral; clinopyroxene 40%, <0.3 mm, subhedral; magnetite 4-6%, <0.2 mm, skeletal; quartz and alkali feldspar 1-2%, micropegmatite; kaersutite + 1%; trace of apatite.
Alteration: Clays (10%) in spotted locations, replacing plagioclase and clinopyroxene; chlorite (5%) replaces some plagioclase.
Texture: Intergranular to subophitic.

Paleomagnetism/Physical Properties:

Interval	**6-8 cm**	**49 cm**
NRM Intensity (10^{-3} emu/cm^3)	–	7.4
NRM Incl. (°)	–	–66.2
MDF (Oe.)	*	75.0
Stable Incl. (°)	*	–53.6
Vp ∥ (km/s)	5.257	–
D (g/cm^3)	2.99	–
P (%)	2.7	–

*Across 4.0 mm vein



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG		SITE			HOLE	CORE		SECT.	
6	1	4	6	2	A		2 9		6

Depth: 642.25 to 645.0 m

MAJOR ROCK TYPE—MASSIVE BASALT SILL (DOLERITE)

Macroscopic Description:
Massive medium grain-sized (as in Core 29, Section 5) dolerite with veins. See Core 29,

Veins are typically composed of a combination of pyrite, clay, and celadonite, and thicker veins also include calcite.

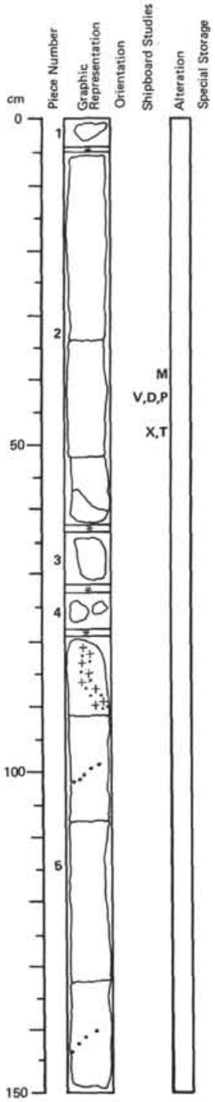
Thin Section Description:
97-100 cm: Subophitic dolerite from sill interior.
Phenocrysts: Plagioclase (An60-63) 2-3%, 0.5-0.9 mm, subhedral to euhedral, partly phenocrysts; clinopyroxene 5-7%, 0.5-0.9 mm, subhedral, partly phenocrysts; magnetite 1-2%, 0.7 mm, skeletal, partly phenocrysts.
Groundmass: Plagioclase 41%, <0.3 mm, euhedral to subhedral, microlite; clinopyroxene 40%, <0.3 mm, skeletal; magnetite 5%, <0.2 mm, skeletal; quartz and alkali feldspar 1-2%, micropegmatite; trace kaersutite and apatite.
Alteration: Clays (15%) replacing clinopyroxene; chlorite (5%) replacing plagioclase.
Texture: Intergranular to subophitic.

Shipboard Geochemistry (XRF, %):

Interval	**97-100 cm**
SiO_2	49.38
TiO_2	1.47
Al_2O_3	13.14
FeO	12.37
MnO	–
MgO	7.04
CaO	11.18
Na_2O	–
K_2O	0.29
P_2O_5	–
Total	–
LOI	0.20
FeO ÷ MgO	1.75
CaO ÷ Al_2O_3	0.85
FeO ÷ TiO_2	8.41

Paleomagnetism/Physical Properties:

Interval	**86 cm**
NRM Intensity (10^{-3} emu/cc)	8.2
NRM Incl. (°)	–68.6
MDF (Oe.)	70.0
Stable Incl. (°)	–57.9
Vp ∥ (km/s)	–
D (g/cm^3)	–
P (%)	–



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	30	1

Depth: 645.0 to 646.5 m

MAJOR ROCK TYPE—–MASSIVE BASALT SILL (DOLERITE)

Macroscopic Description:
Massive uniformly medium grain-sized (as in Core 29, Section 6) dolerite with veins. Dolerite has 3% clinopyroxene (<0.5 mm) phenocrysts in a homogeneous matrix of plagioclase, clinopyroxene, and opaque minerals. No apparent alteration of the groundmass. From 80-90 cm, dolerite has a quartz, chalcedony or zeolite vein, which is white with clay margins. In addition, thin (<0.1 mm) clay veins occur at inclinations of 15-20° from horizontal.

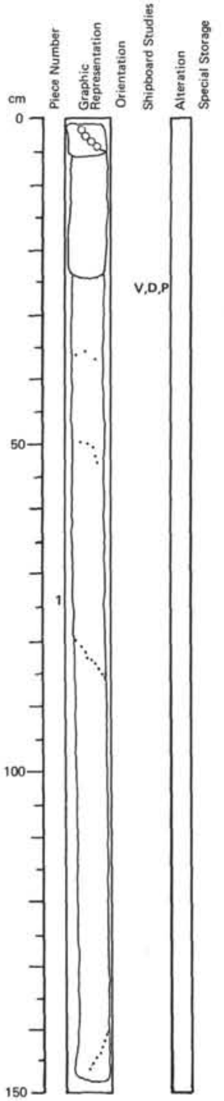
Thin Section Description:
48-50 cm: Dolerite from sill interior.
Phenocrysts: Plagioclase (An 50-60) 10%, 0.4-1.8 mm, subhedral to euhedral, partly phenocryst but partly microphenocrysts; clinopyroxene 8-9%, 0.4-1.3 mm, subhedral; magnetite 4%, 0.4 mm, skeletal.
Groundmass: Plagioclase 30%, <0.4 mm, euhedral to subhedral, microlite; clinopyroxene 40%, <0.4 mm, subhedral, microlite; magnetite 3%, <0.2 mm, microlite; quartz and alkali feldspar ~%, micropegmatites Kaersutite ~ 1%.
Alteration: Clays (5-6%) replacing clinopyroxene in spotted locations. Chlorite (5-6%) replacing plagioclase and hornblende in spotted locations.
Texture: Subophitic to intergranular.

Shipboard Geochemistry (XRF, %):

Interval	**48-50 cm**
SiO_2	49.78
TiO_2	1.50
Al_2O_3	13.55
FeO	12.53
MnO	–
MgO	7.42
CaO	10.97
Na_2O	–
K_2O	0.42
P_2O_5	–
Total	–
LOI	0.32
FeO ÷ MgO	1.68
CaO ÷ Al_2O_3	0.80
FeO + TiO_2	8.35

Paleomagnetism/Physical Properties:

Interval	**39 cm**	**42-44 cm**
NRM Intensity (10^{-3} emu/cm^3)	7.3	–
NRM Incl. (°)	–67.0	–
MDF (Oe.)	55.0	–
Stable Incl. (°)	–38.3	–
Vp ∥ (km/s)	–	6.198
D (g/cm^3)	–	?
P (%)	–	?



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	30	2

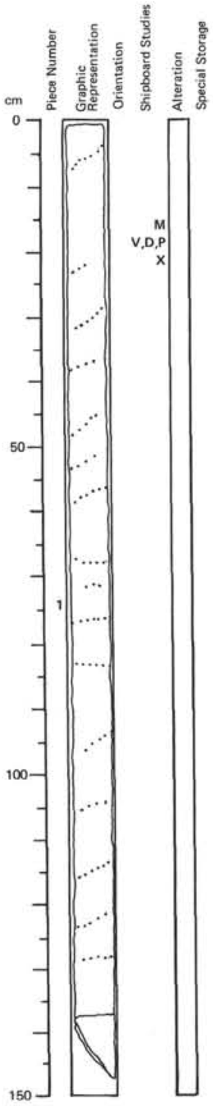
Depth: 646.5 to 648.0 m

MAJOR ROCK TYPE—–MASSIVE BASALT SILL (DOLERITE)

Macroscopic Description:
Massive, uniformly medium grain-sized dolerite with veins. Same sill as in Core 30, Section 1. Dolerite has ~3% clinopyroxene (<0.5 mm) phenocrysts in a homogeneous matrix of plagioclase, clinopyroxene, and opaque minerals. No apparent alteration of the groundmass. There are three vein types: (1) calcite veins (0.0-5.0 cm); (2) white quartz, chalcedony, or zeolite vein which has clayey margins; and (3) thin (<0.1 mm) clay veins.

Paleomagnetism/Physical Properties:

Interval	**23 cm**	**34-36 cm**
NRM Intensity (10^{-3} emu/cm^3)	7.9	–
NRM Incl. (°)	–	–
MDF (Oe.)	45.0	–
Stable Incl. (°)	–65.1	–
Vp ∥ (km/s)	–	6.107
D (g/cm^3)	–	2.95
P (%)	–	3.0



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG		SITE			HOLE	CORE		SECT.
6	1	4	6	2	A	3	0	3

Depth: 648.0 to 649.5 m

MAJOR ROCK TYPE—MASSIVE BASALT SILL (DOLERITE)

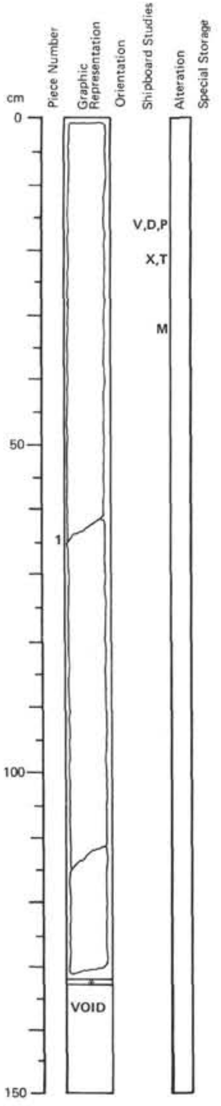
Macroscopic Description:
Massive uniformly medium grain-sized dolerite with veins. Same sill as in Sections 1 and 2 of Core 30. Dolerite has ~3% clinopyroxene (<0.5 mm) phenocrysts in a homogeneous matrix of plagioclase, clinopyroxene, and opaque minerals. No apparent alteration of the groundmass. There are three vein types: (1) calcite veins; (2) white quartz, chalcedony (140 cm), or zeolite vein which has clayey margins; and (3) thin abundant clay veins (<0.1 mm), regularly spaced at 2.0-3.0 cm intervals, and they dip 15-25° relative to horizontal.

Shipboard Geochemistry (XRF, %):

Interval	**21-23 cm**
SiO_2	49.44
TiO_2	1.61
Al_2O_3	13.01
FeO	12.82
MnO	–
MgO	6.86
CaO	10.85
Na_2O	–
K_2O	0.30
P_2O_5	–
Total	–
LOI†	0.32
FeO ÷ MgO	1.72
CaO ÷ Al_2O_3	0.83
FeO ÷ TiO_2	7.96

Paleomagnetism/Physical Properties:

Interval	**11 cm**	**19-21 cm**
NRM Intensity (10^{-3} emu/cm^3)	7.2	–
NRM Incl. (°)	–73.8	–
MDF (Oe.)	–	–
Stable Incl. (°)	–	–
Vp ∥ (km/s)	–	6.154
D (g/cm^3)	–	2.99
P (%)	–	2.2



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG		SITE			HOLE	CORE		SECT.
6	1	4	6	2	A	3	0	4

Depth: 649.5 to 650.8 m

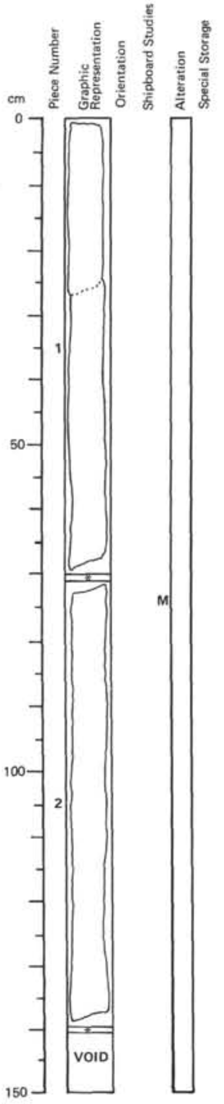
MAJOR ROCK TYPE—MASSIVE BASALT SILL (DOLERITE)

Macroscopic Description:
Massive, uniformly medium grain-sized dolerite with veins. Same sill as in Sections 1-3 of Core 30. Dolerite has ~3% clinopyroxene (<0.5 mm) phenocrysts in a homogeneous matrix of plagioclase, clinopyroxene, and opaque minerals. No apparent alteration of the groundmass. There are three vein types: (1) calcite vein; (2) white quartz, chalcedony, or zeolite vein, which has clayey margins; and (3) thin (<0.1 mm) abundant clay veins, regularly spaced at 2.0-3.0 cm intervals, and they dip 15-25° relative to horizontal.

Thin Section Description:
21-23 cm: Dolerite from sill interior.
Phenocrysts: Plagioclase (An_{40-60}) 6-8%, 0.4-0.7 mm, subhedral, zoned; clinopyroxene 4%, 0.4-0.8 mm, subhedral to euhedral; magnetite ~2%, 0.5-0.8 mm.
Groundmass: Plagioclase 42%, <0.4 mm, subhedral to euhedral; clinopyroxene 40%, <0.4 mm, subhedral; magnetite 3-4%, <0.2 mm, skeletal to acicular; quartz and alkali feldspar ~1%, micropegmatite; kaersutite ~1%, <0.2 mm, and green hornblende.
Alteration: Clays (5-10%) in spots replacing clinopyroxene. Chlorite (6%) in spots replacing plagioclase.
Texture: Subophitic to intergranular.

Paleomagnetism/Physical Properties:

Interval	**14-16 cm**	**32 cm**
NRM Intensity (10^{-3} emu/cm^3)	–	6.4
NRM Incl. (°)	–	–72.2
MDF (Oe.)	–	50.0
Stable Incl. (°)	–	–28.0?
Vp ∥ (km/s)	6.107	–
D (g/cm^3)	3.00	–
P (%)	2.3	–



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG		SITE			HOLE	CORE		SECT.	
6	1	4	6	2	A	3	0		5

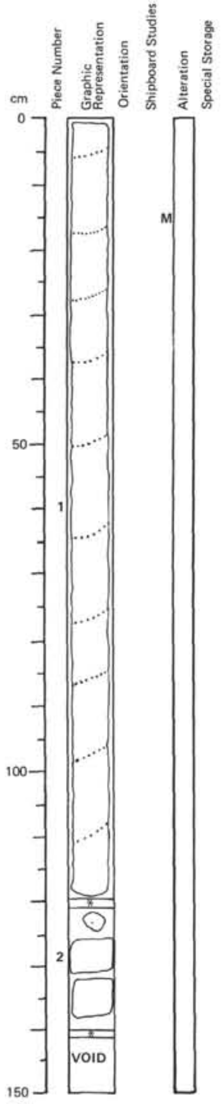
Depth: 650.8 to 652.2 m

MAJOR ROCK TYPE—MASSIVE BASALT SILL (DOLERITE)

Macroscopic Description:
Massive, uniformly medium grain-sized dolerite with veins. Same sill as in Sections 1-4 of Core 30. Dolerite has ~3% clinopyroxene (<0.5 mm) phenocrysts in a homogeneous matrix of plagioclase, clinopyroxene, and opaque minerals. No apparent alteration of the groundmass. There are three vein types: (1) calcite vein; (2) white quartz, chalcedony, or zeolite vein, which has clayey margins; and (3) thin (<0.2 mm, slightly thicker than Core 30, Section 4), abundant clay veins, regularly spaced at 2.0-3.0 cm intervals and they dip 15-25° from the horizontal.

Paleomagnetism/Physical Properties:

Interval	**74 cm**
NRM Intensity (10^{-3} emu/cm^3)	6.0
NRM Incl. (°)	−70.4
MDF (Oe.)	–
Stable Incl. (°)	–
Vp ∥ (km/s)	–
D (g/cm^3)	–
P (%)	–



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG		SITE			HOLE	CORE		SECT.	
6	1	4	6	2	A	3	0		6

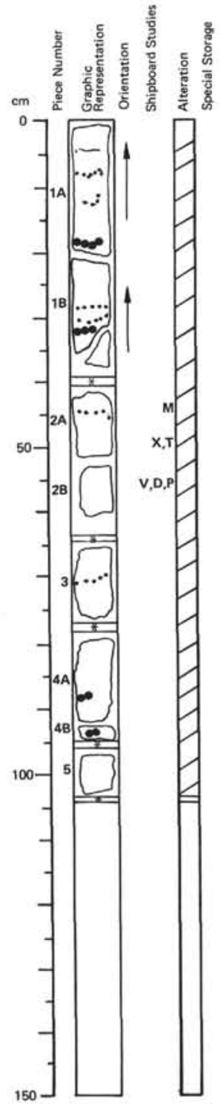
Depth: 652.2 to 653.6 m

MAJOR ROCK TYPE—BASALT SILL (DOLERITE)

Macroscopic Description:
Massive, uniformly medium grain-sized dolerite with veins. Same sill as in Sections 1-5 of Core 30. Dolerite has ~3% clinopyroxene (<0.5 mm) phenocrysts in a homogeneous matrix of plagioclase, clinopyroxene, and opaque minerals. No apparent alteration of the groundmass. There are three vein types: (1) calcite vein; (2) white quartz, chalcedony, or zeolite vein, which has clayey margins; and (3) thin (<0.2 mm, slightly thicker than Core 30, Section 5) abundant clay veins, regularly spaced at 2.0-3.0 cm intervals and they dip 15-25° from the horizontal.

Paleomagnetism:

Interval	**17 cm**
NRM Intensity (10^{-3} emu/cm^3)	5.0
NRM Incl. (°)	−78.6
MDF (Oe.)	70.0
Stable Incl. (°)	−50.0



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	31	1

Depth: 654.0 to 655.0 m

MAJOR ROCK TYPE—BASALT WILL (DOLERITE)

Macroscopic Description:

Massive, slightly altered, fine to medium grain-sized, aphanite to slightly porphyric dolerite with veins. Dolerite has microphenocrysts of plagioclase and clinopyroxene, and microlites of plagioclase, clinopyroxene, and magnetite. Veins are celadonite.

Thin Section Description:

48-50 cm: Dolerite from sill interior.

Microphenocrysts: Plagioclase (An60-50) 8-10%, 0.4-0.7 mm, subhedral; clinopyroxene 3-5%, 0.4-0.7 mm, euhedral to subhedral; magnetite (Ti) 1-2%, 0.4 mm, skeletal.

Groundmass: Plagioclase 40%, <0.3 mm, subhedral to euhedral; clinopyroxene 35%, <0.4 mm; magnetite 4-5%, <0.2 mm, skeletal; quartz and alkali feldspar ~2%, micropegmatite; kaersutite ~1%, 0.1 mm.

Alteration: Clays (3-5%) replacing spots of clinopyroxene. Chlorite (3-6%) replacing spots of plagioclase.

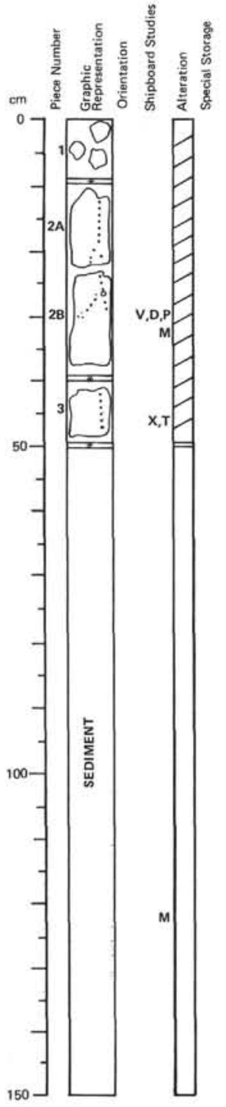
Texture: Subophitic to intergranular.

Shipboard Geochemistry (XRF, %):

Interval	**48-50 cm**
SiO_2	48.68
TiO_2	1.58
Al_2O_3	13.57
FeO	12.45
MnO	–
MgO	6.43
CaO	10.66
Na_2O	–
K_2O	0.39
P_2O_5	–
Total	–
LOI	0.41
FeO ÷ MgO	1.93
CaO ÷ Al_2O_3	0.78
FeO ÷ TiO_2	7.87

Paleomagnetism/Physical Properties:

Interval	**45 cm**	**56-58 cm**
NRM Intensity (10^{-3} emu/cm^3)	3.9	–
NRM Incl. (°)	–65.3	–
MDF (Oe.)	90.0	–
Stable Incl. (°)	–46.0	–
Vp ∥ (km/s)	–	5.880
D (g/cm^3)	–	3.00
P (%)	–	2.2



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	32	1

Depth: 655.5 to 655.85 m

MAJOR ROCK TYPE—BASALT SILL (DOLERITE) AND LOWER SEDIMENT CONTACT

Macroscopic Description:

Massive, moderately altered dolerite with veins of clay. From 0.0-30.0 cm, the dolerite has a fine grain-size and is slightly aphyric. From 30.0-50.0 cm, the dolerite is aphyric with microphenocrysts of plagioclase and clinopyroxene. The ratio of "plagioclase to clinopyroxene microphenocrysts" = 1. Dolerite at 50.0 cm, the lower contact of the sill with sediments, may be chilled (?). See Sedimentary Core Barrel Descriptions for a detailed description of sedimentary rock.

Thin Section Description:

44-46 cm: Dolerite next to glassy margin of a sill.

Microphenocrysts: Plagioclase (An60-65) 1-2%, 0.4-0.8 mm, prismatic; clinopyroxene 2-3%, 0.4-0.8 mm, subhedral, some aggregate.

Groundmass: Plagioclase 42%, <0.2 mm, subhedral; clinopyroxene 42%, <0.05 mm, subhedral; magnetite 2-3%, <0.01 mm, dust-like; glass 5-10%, altered to clay.

Alteration: Clays (10-20%), replacing interstitial glass and clinopyroxene. Chlorite in veins and spots.

Texture: Hyalopilitic to intersertal.

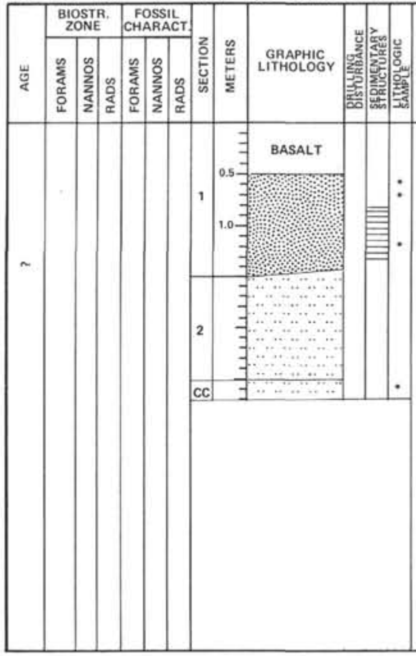
Shipboard Geochemistry (XRF, %):

Interval	**44-48 cm**
SiO_2	48.37
TiO_2	1.66
Al_2O_3	12.56
FeO	11.43
MnO	–
MgO	6.33
CaO	10.70
Na_2O	–
K_2O	0.78
P_2O_5	–
Total	–
LOI†	0.64
FeO ÷ MgO	1.80
CaO ÷ Al_2O_3	0.85
FeO ÷ TiO_2	6.88

Paleomagnetism/Physical Properties:

Interval	**34 cm**	**123 cm**	**31-33 cm**
NRM Intensity (10^{-3} emu/cm^3)	10.7	4.8	–
NRM Incl. (°)	–56.3	–53.8	–
MDF (Oe.)	80.0	325.0	–
Stable Incl. (°)	–52.6	–54.4	–
Vp ∥ (km/s)	–	–	5.672
D (g/cm^3)	–	–	2.92
P (%)	–	–	3.2

SITE 462 HOLE A CORE 32 CORED INTERVAL: 655.5 to 663.0 m



LITHOLOGIC DESCRIPTION

0.0 to 0.5 m: Basalt which is described in the **"Visual Core Description of Igneous Rock".**

0.5 to 2.7 m: Dark gray (N3) to greenish-black (5G 2/1) **ZEOLITIC SILTSTONE**-rich small (mm scale) magnetic concretions are at 0.5 m adjacent to the basalt and showing apparent size grading with finer grains at base. Horizontal lamination present locally. Zeolite vein, subvertical, extends down part of Section 1.

SMEAR SLIDE (%)

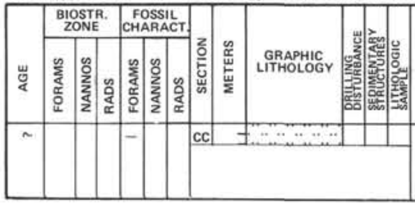
	Ore enriched concretion in volcanic siltstone	Zeolitic volcaniclastic siltstone	Zeolitic volcaniclastic sandstone	Altered volcaniclastic siltstone
TEXTURE AND MINERALS	1-60 (M)	1-74 (D)	1-116 (D)	CC (D)
Sand size	–	–	–	–
Silt size	–	–	–	–
Clay size	–	–	–	–
Clay	45	25*	65*	87
Feldspar	–	–	–	Tr
Opaque	15	5	5	Tr
Volcanic glass	–	–	–	3
Zeolite	40	70	30	10

*Mainly chlorite

THIN SECTION DESCRIPTION

2, 98 cm: Zeolite-cemented hyaloclastite–Sand size 30%; silt size 70%; feldspar 1%; volcanic grains 19%; volcanic glass 40%, slightly altered to clay, angular and blocky-polygonal to subrounded, size range 0.010 mm to 0.120 mm, but most in 0.05 to 0.07 mm, poorly packed, well sorted; some grains of basalt and of plagioclase. Cement is a mosaic of zeolite laths (0.005 x 0.002 mm). Some grains being replaced by clay or zeolite.

SITE 462 HOLE A CORE 33 CORED INTERVAL: 663.0 to 672.0 m

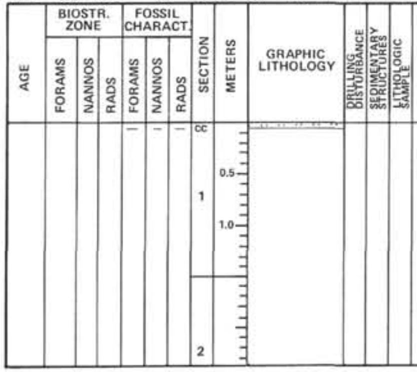


LITHOLOGIC DESCRIPTION

Dark gray (N3) **VOLCANICLASTIC SILTSTONE.**

SMEAR SLIDE (%): Highly altered volcaniclastic siltstone–Clay 90%; mainly chlorite; 10% of volcanic glass (?) or zeolite (?), clear, isotropic particles of different shapes of spherical to subangular.

SITE 462 HOLE A CORE 35 CORED INTERVAL: 681.0 to 685.0 m



LITHOLOGIC DESCRIPTION

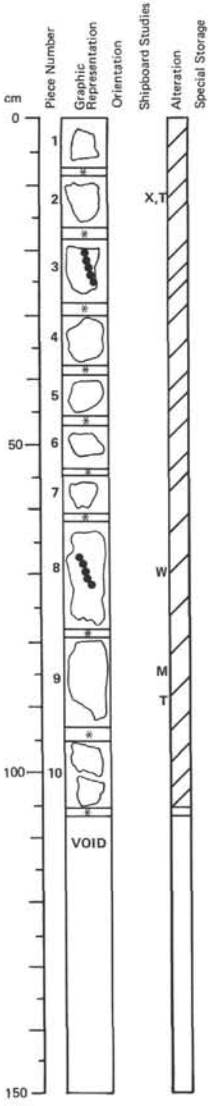
No recovery from Core 34, 672.0 to 681.0 m.

Structureless grayish black (5G 3/1) **VOLCANICLASTIC SILTSTONE.** It is similar to that in Core 33. Origin is probably hyaloclastite.

SMEAR SLIDE (%)

	Volcaniclastic siltstone
TEXTURE AND MINERALS	CC-1 (D)
Sand size	15
Silt size	85
Volcanic glass (altered)	55
Zeolite (cement)	45*

*Zeolite cemented hyaloclastite



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG		SITE			HOLE		CORE		SECT.
6	1	4	6	2	A		B	2	1

MAJOR ROCK TYPE—BASALT SILL (DOLERITE)

Macroscopic Description:

Slightly altered dolerite sill with veins of celadonite.

Orientation and stratigraphic order are not known for the pieces recovered. Textures of pieces are as follows:

Pieces 1 to 2:	Fine to slightly medium grain-size and are holopilitic.
Pieces 3 to 7:	Medium grain-sized and are intersertal.
Pieces 8 to 10:	Medium to slightly coarse grain-size and are intersertal to intergranular.

Pieces 1 through 10 are made of microphenocrysts of clinopyroxene and plagioclase, and microlites of clinopyroxene, plagioclase, and magnetite. In addition, Pieces 1 and 2 also have microlites of glass.

Thin Section Description:

10-12 cm: Fresh interstitial basalt from marginal zone of sill.

Phenocrysts: Plagioclase (An58) 1%, 0.1-0.3 mm, subhedral; clinopyroxene (augite) 4%, 0.1-0.4 mm, subhedral.

Groundmass: Plagioclase (An60) 35%, <0.4 mm, subhedral, skeletal; clinopyroxene (augite) 40%, <0.2 mm, most as quench-textured; magnetite 10%, <0.02 mm; glass 3-4%, interstitial patches.

Alteration: Greenish brown clay (10%) replacing clinopyroxene and glass.

Texture: Intersertal, spherulitic.

90-92 cm: Relatively fresh dolerite from sill interior.

Groundmass: Plagioclase (An58-60) 37%, 0.3-0.7 mm; clinopyroxene (augite) 46%, 0.2-0.8 mm, subhedral; magnetite (Ti) 5%, <0.2 mm; glass 1-2%, altered, variolitic; trace quartz and alkali feldspar in granophyric patches; amphibole 10%, secondary.

Alteration: Brownish green amphibole, chlorite and clay (10%) replacing glass and clinopyroxene.

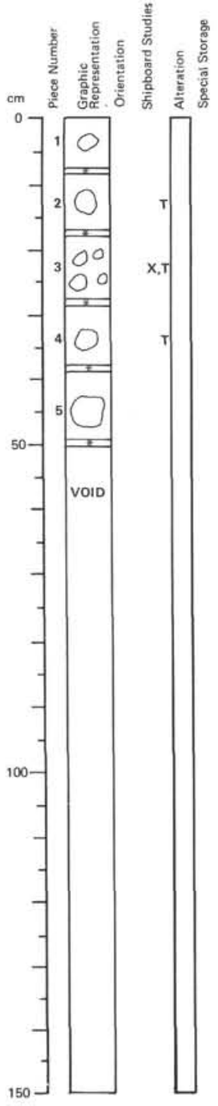
Texture: Subophitic.

Shipboard Geochemistry (XRF, %):

Interval	10-12 cm
SiO_2	49.09
TiO_2	1.21
Al_2O_3	13.87
FeO	11.26
MnO	–
MgO	7.06
CaO	11.77
Na_2O	–
K_2O	0.31
P_2O_5	–
Total	–
LOI	0.43
FeO ÷ MgO	1.59
CaO ÷ Al_2O_3	0.84
FeO ÷ TiO_2	9.30

Paleomagnetism:

Interval	86 cm
NRM Intensity (10^{-3} emu/cc)	7.3
NRM Incl. (°)	–59.5
MDF (Oe.)	40.0
Stable Incl. (°)	–48.8?



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG		SITE			HOLE		CORE		SECT.
6	1	4	6	2	A		3	6	C C

Depth: 689.8 to 690.0 m

MAJOR ROCK TYPE—BASALT SILL (DOLERITE)

Macroscopic Description:

Dolerite sill. There are not any oriented pieces and all pieces except No. 5 are out of stratigraphic order.

Pieces 1-5 are all plagioclase and clinopyroxene phyric with phenocrysts of clinopyroxene (~2%, <0.03 mm) and plagioclase (<1%, <0.2 mm). Textures range from very fine grain-sized or glassy (variolitic?) to holocrystalline microdolerite. These pieces represent marginal and inner crystalline facies of a basaltic sill, respectively.

Alteration is not visible with the unaided eye, except for one clay vein; but these rocks are "green stones", suggesting significant groundmass alteration.

Thin Section Description:

10-12 cm: Altered fine grain-sized basalt from sill margin.

Phenocrysts: Plagioclase (An80) 2%, 0.2-0.4 mm, euhedral zoned, glomerophyric clusters; clinopyroxene (augite) 3%, 0.1-0.3 mm, subhedral, golmerophyric clusters.

Groundmass: Plagioclase 28%, <0.2 mm, skeletal, quench, anhedral; clinopyroxene (augite) 37%, <0.2 mm; magnetite (Ti) ?%, <0.04 mm, skeletal, quench; glass 10-15%.

Alteration: Brownish-green clays (20%) replacing clinopyroxene and glass.

Texture: Hyalopilitic, spherulitic.

21-23 cm: Variolitic basalt from glassy sill margin.

Microphenocrysts: Plagioclase ~1%, 0.2 mm, glomeroporphyric aggregates; clinopyroxene trace, 0.4 mm, glomeroporphyric aggregates.

Groundmass: Plagioclase ~2%, <0.04 mm, laths in variolitic mesostasis; clinopyroxene >1%, 0.08 mm, equidimensional; magnetite 7%, <0.01 mm, dust-like; glass >95%, variolitic mesostasis.

Alteration: Carbonate (1%) replacing clinopyroxene and plagioclase in glomeroporphyritic aggregates. Brown clays (90%) replacing glass mesostasis.

Texture: Variolitic.

34-36 cm: Altered basalt from sill interior.

Phenocrysts: Plagioclase <1%, 0.3-0.5 mm, euhedral and corroded; clinopyroxene (augite) <1%, 0.4 mm, subophitic.

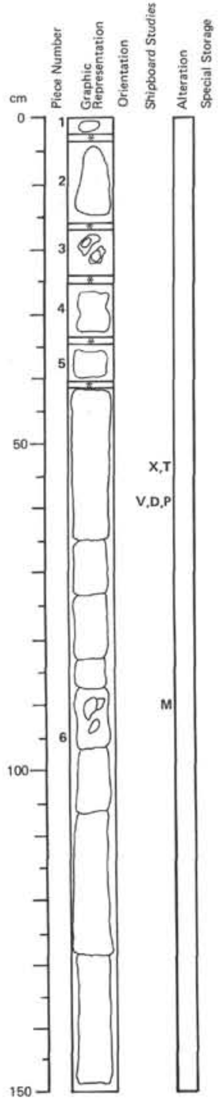
Groundmass: Plagioclase (An65) ?%, 0.1-0.3 mm, laths; clinopyroxene (augite) ?%, 0.1-0.2 mm; magnetite (Ti) ?%, <0.04 mm; amphibole ?%, secondary, replacing clinopyroxene.

Alteration: Brown clays (15%) replacing all minerals.

Texture: Intergranular.

Shipboard Geochemistry (XRF, %):

Interval	21-23 cm
SiO_2	50.66
TiO_2	1.58
Al_2O_3	14.18
FeO	11.54
MnO	–
MgO	7.33
CaO	12.06
Na_2O	–
K_2O	0.31
P_2O_5	–
Total	–
FeO ÷ MgO	1.57
CaO ÷ Al_2O_3	0.85
FeO ÷ TiO_2	7.30



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	38	1

Depth: 691.0 to 692.0 m

MAJOR ROCK TYPE---MASSIVE BASALT SILL (DOLERITE)

Macroscopic Description:
Massive, aphyric, medium to fine grain-sized basalt. A few clinopyroxene phenocrysts (< 1%, ~0.5 mm) in a massive groundmass of plagioclase, clinopyroxene, and opaque minerals. Rock has a few clay spots.
From 0.0-30.0 cm, the grain-size increases downward. From 30.0-150.0 cm, the grain-size is relatively constant.

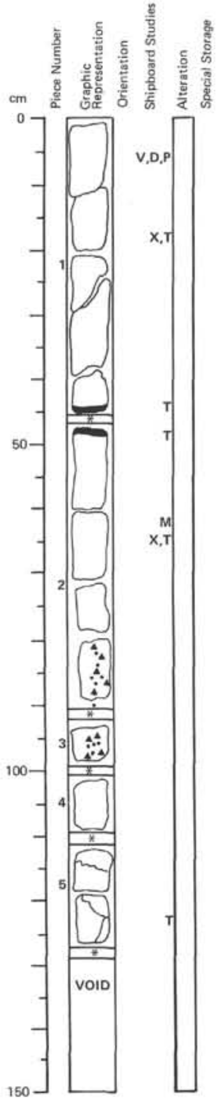
Thin Section Description:
53-55 cm: Fresh dolerite from sill interior.
Groundmass: Plagioclase (An70) 42%, 0.3-0.5 mm, subhedral to anhedral; clinopyroxene (augite) 43%, 0.3-0.5 mm; magnetite (Ti) 10%, <0.5 mm; trace of quartz and alkali feldspar, granphyric; trace apatite.
Alteration: Brown clays (5%) replacing clinopyroxene.
Texture: Subophitic.

Shipboard Geochemistry (XRF, %):

Interval	**53-55 cm**
SiO_2	50.55
TiO_2	1.20
Al_2O_3	13.87
FeO	11.65
MnO	–
MgO	7.21
CaO	12.35
Na_2O	–
K_2O	0.13
P_2O_5	–
Total	–
LOI	0.49
FeO ÷ MgO	1.61
CaO ÷ Al_2O_3	0.89
FeO ÷ TiO_2	9.70

Paleomagnetism/Physical Properties:

Interval	**59-61 cm**	**93 cm**
NRM Intensity (10^{-3} emu/cm^3)	–	20.5
NRM Incl. (°)	–	–51.1
MDF (Oe.)	–	30.0
Stable Incl. (°)	–	–50.3
Vp ∥ (km/s)	5.988	–
D (g/cm^3)	2.96	–
P (%)	3.0	–



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	38	2

Depth:691.0 to 692.0 m

MAJOR ROCK TYPE---MASSIVE BASALT

Macroscopic Description:
Massive basalt. From 0.0-45.0 cm, the basalt grain-size decreases downward to a glassy margin at 44-45 cm. The basalt within 0.0 and 44.0 cm has a few plagioclase and clinopyroxene phenocrysts (<1%, 0.2-0.3 mm) in a homogeneous fine grain-sized matrix. Clay spots of alteration are present from the glassy margin (44.0 mm) upward.
From 48.0-130.0 cm, basalt has a glassy margin 47-48 cm and then downward from 48.0 cm grain-size gradually increases. At a lower portion (~100 cm) the basalt has a grain-size of medium to fine and ~2-3% clinopyroxene phenocrysts. In the upper portion (~60 cm) basalt is made of a few phenocrysts of clinopyroxene and plagioclase (<1%, 0.2-0.5 mm). In the upper portion, plagioclase abundance is approximately equal to clinopyroxene. Downward, glomerophyric clusters become common and abundance of clinopyroxene is greater than plagioclase.
At 80.0-90.0 cm, veins are of pyrite plus calcite. At 110.0-125.0 cm, veins are pyrite plus clay.

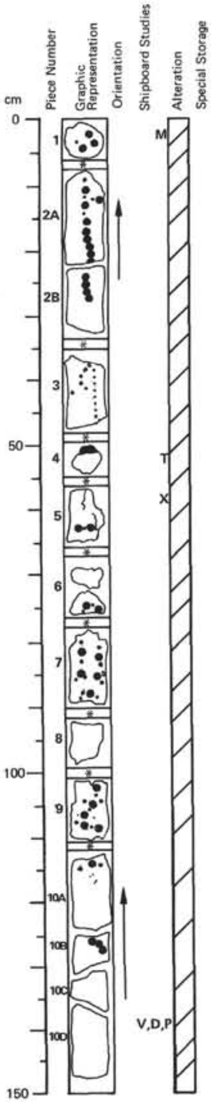
Thin Section Description:
18-20 cm: Relatively fresh dolerite from sill interior.
Groundmass: Plagioclase (An60) 41%, 0.1-0.2 mm; clinopyroxene (augite) 41%, 0.1-0.2 mm; magnetite (Ti) 5%, <0.04 mm; glass ~3%, altered interstitial patches; trace quartz and alkali feldspar granophyric patches.
Alteration: Brown clay (10%) replacing clinopyroxene and glass.
Texture: Dolerite.
42-46 cm: Fresh basalt from glassy sill margin.
Phenocrysts: Plagioclase (An70) 2%, 0.1-0.2 mm, euhedral, glomerophyric clusters; clinopyroxene (augite) 2%, euhedral, glomerophyric clusters.
Groundmass: Plagioclase 30%, <0.04 mm, intergranular; clinopyroxene 61%, <0.04 mm, intergranular; magnetite (Ti) 5%, <0.04 mm.
Alteration: Clays (5-20%) in spotty replacement of glass and clinopyroxene.
Texture: Glassy, variolitic, hyalopilitic, intergranular.
49-51 cm: Fresh glassy basalt from sill interior.
Phenocrysts: Plagioclase (An70) 4%, 0.1-0.3 mm, euhedral, glomerophyric aggregates; clinopyroxene (augite) 2%, 0.1-0.2%, euhedral, glomerophyric aggregates.
Groundmass: Plagioclase, trace, microlites, swallow-tail textured; clinopyroxene trace, quench and skeletal; glass 94%, appears either devitrified or altered, brown, slightly isotropic.
Alteration: Clays and chlorite (?%) replacing groundmass and phenocrysts.
Texture: Glassy to variolitic.
64-67 cm: Basalt from sill interior.
Phenocrysts: Plagioclase (An72) <1%, 0.2 mm, euhedral and subhedral; clinopyroxene (augite) 1%, 0.1 mm, euhedral to subhedral.
Groundmass: Plagioclase (An70-72) 25%, <0.04 mm, subhedral to microlite; clinopyroxene (augite) 44%, <0.04 mm, subhedral to granular to quench texture; magnetite 5%, <0.02 mm; glass 5-10%, altered, variolitic.
Alteration: Brown clay (25%) replacing microlites and glass.
Texture: Intersertal.
126-128 cm: Altered fine grained basalt from sill interior.
Phenocrysts: Plagioclase (An70) <1%, 0.1-0.3 mm, euhedral, glomerophyric clots; clinopyroxene (augite) <1%, euhedral, glomerophyric clots.
Groundmass: Plagioclase (An70) 25%, <0.04 mm, subhedral, lath, microlites; clinopyroxene (augite) 49%, <0.04 mm, subhedral to granular to quench textured; magnetite (Ti) ?%, <0.02 mm; glass (altered).
Alteration: Brown clays (25%) replacing glass and minerals.
Texture: Intersertal.

Shipboard Geochemistry (XRF, %):

Interval	**18-20 cm**	**64-67 cm**
SiO_2	48.79	48.74
TiO_2	1.18	1.20
Al_2O_3	13.47	13.96
FeO	11.69	11.23
MgO	7.11	7.43
CaO	12.00	12.02
K_2O	0.10	0.11
LOI	0.53	0.65
FeO ÷ MgO	1.64	1.51
CaO ÷ Al_2O_3	0.89	0.86
FeO ÷ TiO_2	9.90	9.35

Paleomagnetism/Physical Properties

Interval	**6-8 cm**	**58 cm**
NRM Intensity (10^{-3} emu/cm^3)	–	8.6
NRM Incl. (°)	–	–66.5
MDF (Oe.)	–	85.0
Stable Incl. (°)	–	–42.0
Vp ∥ (km/s)	6.054	–
D (g/cm^3)	2.97	–
P (%)	3.2	–



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	39	1

Depth: 692.0 to 693.5 m

MAJOR ROCK TYPE—–MASSIVE BASALT

Macroscopic Description:
Slightly altered to fresh basalt with veins of chlorite plus pyrite plus clay minerals (smectite > paragonite).
From 0.0-47.0 cm (Pieces 1-3), basalt has a fine to slightly coarse grain-size.
From 50.0-52.0 cm (upper portion of Piece 4), basalt has a chilled glassy margin.
From 55.0-150.0 cm, basalt has a fine to slightly medium grain-size, and grain-size increases downward.
Pieces 1-3 are hyalopilitic to interstitial; have an abundance of clinopyroxene phenocrysts greater than plagioclase phenocrysts; and has microlites of plagioclase, clinopyroxene, magnetite and glass.
Piece 4 is aphyric, has microphenocrysts of clinopyroxene greater than plagioclase microphenocrysts, and glass and microlite groundmass.
Glassy margins are grayish black (N2). Fine grain-sized portions are medium light gray (N4). Slightly medium grain-sized portions are medium gran (N5).

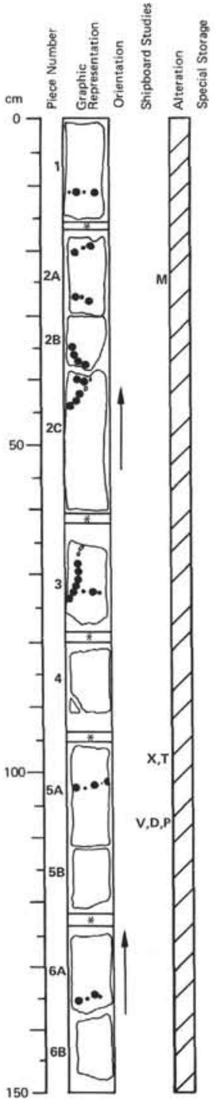
Thin Section Description:
51-54 cm: Slightly phyric variolitic basalt from sill top.
Microphenocrysts: Trace plagioclase (An68), 0.4 mm, elongated prisms, rare tables; clinopyroxene ~ 1%, 0.3 mm, euhedral.
Groundmass: Plagioclase 2%, <0.002 mm, lathes; clinopyroxene trace, <0.002; magnetite 7%, ~0.002 mm, dust-like; glass 91%, altered.
Alteration: Palagonite (91%) replacing glass groundmass.
Texture: Variolitic.

Shipboard Geochemistry (XRF, %):

Interval	**59-61 cm**
SiO_2	49.58
TiO_2	1.19
Al_2O_3	13.78
FeO	11.58
MnO	–
MgO	7.14
CaO	12.04
Na_2O	–
K_2O	0.02
P_2O_5	–
Total	–
LOI	0.17
FeO ÷ MgO	1.62
CaO ÷ Al_2O_3	0.87
FeO ÷ TiO_2	9.73

Paleomagnetism/Physical Properties:

Interval	**4 cm**	**139-141 cm**
NRM Intensity (10^{-3} emu/cm^3)	9.0	–
NRM Incl. (°)	–52.4	–
MDF (Oe.)	50.0	–
Stable Incl. (°)	–38.8	–
Vp ∥ (km/s)	–	5.937
D (g/cm^3)	–	2.96
P (%)	–	3.1



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	39	2

Depth: 693.5 to 695.0 m

MAJOR ROCK TYPE—–MASSIVE BASALT

Macroscopic Description:
Slightly fresh, massive basalt with veins of celadonite plus pyrite plus clay minerals (smectite > paragonite). This is the same unit as in Core 39, Section 1.
From 0.0-50.0 cm (?) (Pieces 1-2C), basalt has slightly medium to medium grain-size, and grain-size increases downward.
From 50.0 (?)-150.0 cm (Pieces 2-6B), basalt has a medium grain-size.

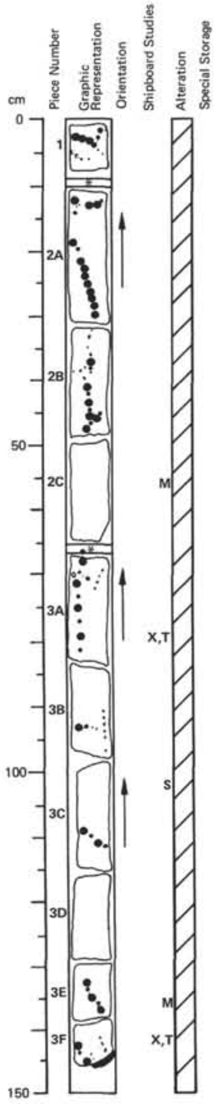
Thin Section Description:
97-99 cm: Microdolerite from sill interior.
Microphenocrysts: Olivine trace, euhedral rhombic clay pseudomorphs; plagioclase (An58-68) trace, zoned tables; clinopyroxene trace, 0.4 mm, equidimensional.
Groundmass: Olivine 5%, 0.2 mm, clay pseudomorphs; plagioclase (An80) ?%, 0.4 mm, elongated prisms; clinopyroxene ?%, 0.008 mm, equidimensional; magnetite 7%, 0.04-0.2, intergranular, dust-like; spinel (Cr), 0.02 mm, euhedral, inclusions in clay pseudomorphs.
Alteration: Clays (5%) pseudomorphs after olivine. Reddish brown palagonite also after olivine.
Texture: Microdoleritic.

Shipboard Geochemistry (XRF, %):

Interval	**97-99 cm**
SiO_2	48.96
TiO_2	1.22
Al_2O_3	13.96
FeO	11.52
MnO	–
MgO	7.22
CaO	12.09
Na_2O	–
K_2O	0.12
P_2O_5	–
Total	–
LOI	0.50
FeO ÷ MgO	1.59
CaO ÷ Al_2O_3	0.86
FeO ÷ TiO_2	9.44

Paleomagnetism/Physical Properties:

Interval	**26 cm**	**107-108 cm**
NRM Intensity (10^{-3} emu/cm^3)	5.8	–
NRM Incl. (°)	–72.0	–
MDF (Oe.)	–	–
Stable Incl. (°)	–	–
Vp ∥ (km/s)	–	5.977
D (g/cm^3)	–	2.95
P (%)	–	3.1



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	39	3

Depth: 695.0 to 696.5 m

MAJOR ROCK TYPE---MASSIVE BASALT

Macroscopic Description:

Fresh to slightly altered massive basalt with veins of celadonite plus pyrite plus clay minerals (smectite > paragonite). This is the same unit as Core 39, Section 2.

From 0.0-115 cm (Pieces 1-3C), basalt has a medium grain-size.

From 115-137 cm (Pieces 3D-3E), basalt has slightly medium to fine grain-size, and grain-size gradually decreases downward.

From 137-146 cm (Piece 3F), basalt, the lower portion of which (144-145 cm) is a chilled margin.

Thin Section Description:

76-78 cm: Microdolerite near sill bottom.

Groundmass: *Olivine ?%, 0.08-0.2 mm, euhedral clay pseudomorphs; plagioclase (An72-85)* ?%, 0.2 mm; clinopyroxene ?%, 0.08 mm, interstitial, some radiated aggregates; magnetite 5%, 0.04-0.1, dust-like, rare laths; glass 10%, 0.3-0.4 mm, interstitial variolitic aggregates.

Alteration: Clays (1%) form grayish-brown euhedral pseudomorphs of olivine. Reddish brown clays (10%), replacing palagonite of variolitic aggregates.

Texture: Microdolerite.

142-144 cm: Aphyric basalt from sill bottom.

Groundmass: Olivine trace, 0.1 mm, euhedral clay pseudomorphs; plagioclase 3%, <0.04 mm, laths; clinopyroxene 1%, 0.04, equidimensional; magnetite 5%, <0.02 mm, dust-like; glass 91%, groundmass.

Alteration: Clays (91%), in mesostasis, replacing glass and reddish brown palagonite.

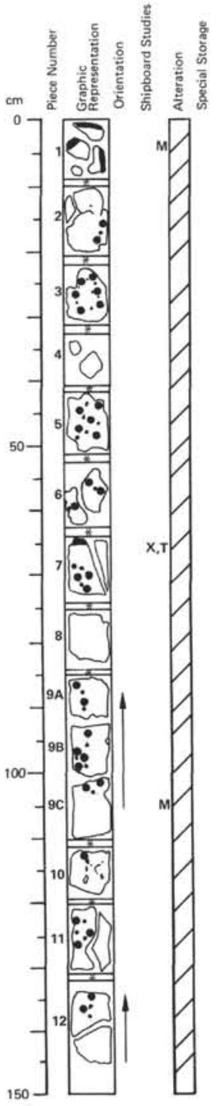
Texture: Variolitic.

Shipboard Geochemistry (XRF, %):

Interval	**76-78 cm**	**142-144 cm**
SiO_2	48.18	48.83
TiO_2	1.23	1.19
Al_2O_3	13.84	14.16
FeO†	10.92	11.16
MnO	–	–
MgO	7.33	7.09
CaO	12.41	12.21
Na_2O	–	–
K_2O	0.03	0.04
P_2O_5	–	–
Total	–	–
LOI	0.59	0.92
FeO ÷ MgO	1.48	1.57
CaO ÷ Al_2O_3	0.89	0.86
FeO ÷ TiO_2	8.87	9.37

Paleomagnetism/Physical Properties:

Interval	**57 cm**	**105-107 cm**	**136 cm**
NRM Intensity (10^{-3} emu/cm^3)	8.3	–	10.0
NRM Incl. (°)	–60.2	–	–53.9
MDF (Oe.)	35.0	–	50.0
Stable Incl. (°)	–36.3	–	–40.0
Vp ∥ (km/s)	–	6.054	–
D (g/cm^3)	–	2.97	–
P (%)	–	2.6	–



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	39	4

Depth: 696.5 to 698.0 m

MAJOR ROCK TYPE—MASSIVE BASALT

Macroscopic Description:

Slightly fresh massive basalt with veins of celadonite plus pyrite plus clay minerals (smectite > paragonite). Three units are observed:

Unit A occurs from 0.0-64.0 cm (Pieces 1-6). From 0.0-9.0 cm (Piece 1) is a glassy chilled basalt margin. From 9.0-64 cm (Pieces 2-6), basalt has minor downward changes of grain-size from fine to slightly medium.

Unit B occurs from 64-120 cm (Pieces 7-10). From 64-66 cm (upper part of Piece 7) is a glassy chilled basalt margin. From 66-93(?) cm (Pieces 7, lower part, to upper part of Piece 9A), basalt increases in grain-size from fine to slightly medium. From 93(?)-120 cm (Pieces 9A, lower part, to Piece 10), basalt has a decreasing grain-size from slightly medium to fine.

Unit C occurs from 120-150 cm (Pieces 11-12); is without a chilled margin, and grain-size increases downward from fine to slightly medium grain-size.

Thin Section Description:

67-70 cm: Aphyric basalt from sill top.

Groundmass: Olivine trace, 0.1 mm, euhedral clay pseudomorphs; plagioclase 3%, <0.04 mm, laths; clinopyroxene 1%, 0.04 mm; equidimensional; magnetite 5%, <0.02 mm, dust-like; glass 91%, groundmass.

Alteration: Clays (91%) in mesostasis, replacing glass and reddish brown palagonite.

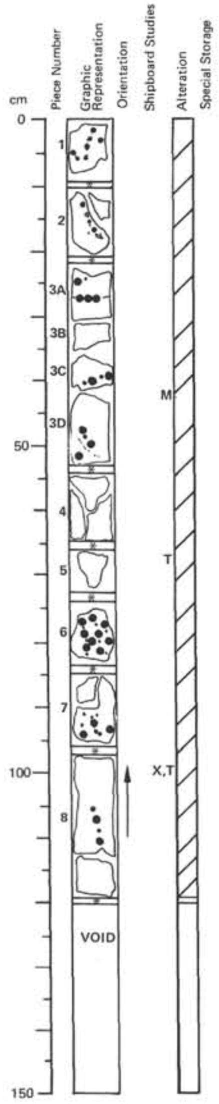
Texture: Variolitic.

Shipboard Geochemistry (XRF, %):

Interval	**4-6 cm**	**67-70 cm**
SiO_2	48.88	48.33
TiO_2	1.20	1.21
Al_2O_3	13.86	14.36
FeO	11.60	11.26
MnO	–	–
MgO	7.39	7.78
CaO	12.23	12.36
Na_2O	–	–
K_2O	0.09	0.06
P_2O_5	–	–
Total	–	–
LOI†	0.30	0.36
FeO ÷ MgO	1.56	1.44
CaO ÷ Al_2O_3	0.88	0.86
FeO ÷ TiO_2	9.66	9.30

Paleomagnetism:

Interval	**106 cm**
NRM Intensity (10^{-3} emu/cm^3)	10.3
NRM Incl. (°)	–38.2
MDF (Oe.)	65.0
Stable Incl. (°)	–26.5



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	39	5

Depth: 698.0 to 699.0 m

MAJOR ROCK TYPE—MASSIVE BASALT

Macroscopic Description:

Slightly fresh massive basalt with veins of celadonite plus pyrite plus clay minerals (smectite > paragonite). This section represents one unit continued from Core 39, Section 4.

Unit A(?) occurs from 0.0-75 cm. From 0.0-43 cm (Pieces 1-3B), basalt has an increasing grain-size from slightly medium to medium. From 43-75 cm (Pieces 3C-5), basalt grain-size decreases from medium to fine.

Unit B(?) occurs from 75-120 cm (Pieces 6-8). From 75-95 cm (Pieces 6-7), basalt has a grain-size increasing downward from fine to slightly medium. From 95-120 cm (Pieces 7-8), basalt grain-size decreases downward from slightly medium to fine.

Thin Section Description:

66-68 cm: Aphyric basalt from sill interior near bottom.

Phenocrysts: Plagioclase trace, 0.06 mm, microlites; clinopyroxene ~ 1%, 0.2 mm, euhedral.

Groundmass: Olivine trace, 0.2 mm, arounded clay pseudomorphs; plagioclase 5%, 0.2 mm, laths; clinopyroxene 2%, 0.05 mm, equidimensional; magnetite trace, <0.04 mm, dust-like; glass 92%, mesostasis altered.

Alteration: Clays 92%) mesostasis, replacing glass and olivine.

Texture: Variolitic.

98-100 cm: Aphyric basalt from sill bottom.

Microphenocrysts: Olivine 1%, ~0.2 mm; plagioclase (An80), 0.7 mm, tables, rare megacrysts; clinopyroxene 1%, 0.4 mm, euhedral.

Groundmass: Plagioclase (An68) 2%, laths; clinopyroxene 1%, equidimensional; magnetite trace, <0.02 mm, dust-like; glass 95%, mesostasis, altered.

Alteration: Clays (95%) altered glass mesostasis.

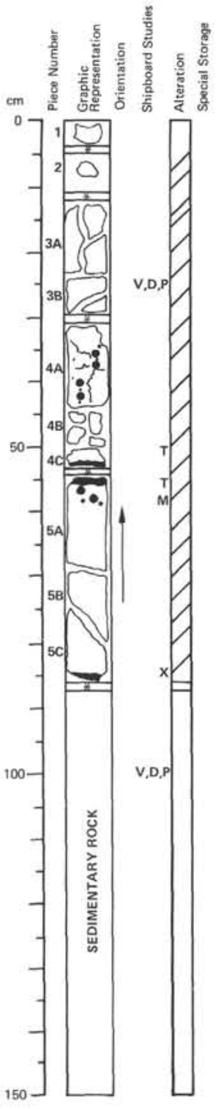
Texture: Variolitic.

Shipboard Geochemistry (XRF, %):

Interval	**98-100 cm**
SiO_2	48.43
TiO_2	1.22
Al_2O_3	13.98
FeO	10.79
MnO	—
MgO	7.10
CaO	12.10
Na_2O	—
K_2O	0.08
P_2O_5	—
Total	—
LOI†	0.33
FeO ÷ MgO	1.51
CaO ÷ Al_2O_3	0.86
FeO ÷ TiO_2	8.84

Paleomagnetism:

Interval	**44 cm**
NRM Intensity (10^{-3} emu/cm^3)	16.7
NRM Incl. (°)	–57.1
MDF (Oe.)	55.0
Stable Incl. (°)	–48.2



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	40	1

Depth: 702.0 to 702.9 m

MAJOR ROCK TYPE—MASSIVE BASALT AND VOLCANICLASTICS

Macroscopic Description:

Slightly fresh massive basalt. Two units occur as follows:

Unit A occurs from 0.0-54.0 cm (Pieces 1-4C). From 0.0-~19.0 cm, basalt has a grain-size increasing downward from fine to slightly medium, and it is slightly aphyric. From ~19.0-30.0 cm (Pieces 3A-3B), basalt has a medium grain-size. From 30.0-54.0 cm (Pieces 4A-4C), basalt has a decreasing grain-size from medium to a chilled margin (bottom 2 cm of Piece 4C).

Unit B occurs from 54.0-85.0 cm (Piece 5). From 55.0-64.0 cm, basalt has a chilled margin (55-57 cm?) and increasing grain-size downward to slightly medium grain-size. From 64.0-71.0 cm, basalt has a slightly medium grain-size. From 71.0-86.0 cm, basalt has a decreasing grain-size downward from slightly medium to a chilled margin (84-86 cm).

Sediment from 86.0-150.0 cm is described in the Sedimentary Core Barrel Descriptions.

Thin Section Description:

50-52 cm: Massive basalt from glassy margin.

Microphenocrysts: Olivine 2%, 0.4 mm, pseudomorphs; plagioclase (An65-70) 1-2%, 0.4-0.6 mm, subhedral, forms aggregates with clinopyroxene; clinopyroxene 2-3%, 0.3-0.4 mm, subhedral.

Groundmass: Plagioclase 20%, <0.15 mm, subhedral; clinopyroxene 30-35%, <0.06 mm, slightly spherulitic to dendritic; magnetite 10%, <0.01 mm, dust-like; glass 25-30%, altered.

Alteration: Clays (30%) in mesostasis, replacing glass, plagioclase, and clinopyroxene.

Texture: Hyalopilitic.

57-60 cm: Massive basalt from glassy margin.

Microphenocrysts: Olivine 1%, 0.2 mm, pseudomorphs; plagioclase (An65) 1%, 0.3-0.4 mm, subhedral; clinopyroxene 1-2%, 0.2-0.3 mm, euhedral, forms aggregates with plagioclase.

Groundmass: Plagioclase 15%, <0.05 mm, anhedral; clinopyroxene 15%, <0.05 mm, subhedral to anhedral; magnetite 7%, <0.01 mm, dust-like; glass 60%, altered.

Alteration: Clays and zeolite (20-30%) replaced glass mesostasis and olivine.

Texture: Hyalopilitic to aphyric.

Shipboard Geochemistry (XRF, %):

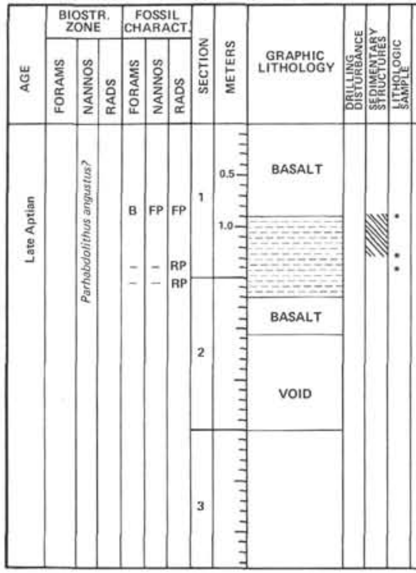
Interval	**86-90 cm**
SiO_2	49.07
TiO_2	1.24
Al_2O_3	14.21
FeO	11.39
MnO	—
MgO	7.48
CaO	12.30
Na_2O	—
K_2O	0.10
P_2O_5	—
Total	—
LOI†	0.58
FeO ÷ MgO	1.52
CaO ÷ Al_2O_3	0.86
FeO ÷ TiO_2	9.18

Paleomagnetism/Physical Properties:

Interval	**25-27 cm**	**60 cm**	**99-101 cm**
NRM Intensity (10^{-3} emu/cm^3)	—	13.7	—
NRM Incl. (°)	—	–62.8	—
MDF (Oe.)	—	70.0	†
Stable Incl. (°)	—	–56.1	—
Vp ∥ (km/s)	5.700	—	2.965
D (g/cm^3)	2.95	—	2.12
P (%)	3.6	—	41.6

† Volcanic claystone

SITE 462 HOLE A CORE 40 CORED INTERVAL: 702.0 to 711.0 m



LITHOLOGIC DESCRIPTION

0.0 to 0.92 m: Basalt is described in **"Visual Core Description of Igneous Rock".**

0.92 to 1.71 m: Dark gray (N3) laminated **CLAYSTONE** containing flecks of plant remains. Some coarser layers are partly zeolitic. Lamination dips 5 to 10° and was apparently produced by soft-sedimentation deformation. Some coarser layers of **VOLCANICLASTIC SILTSTONE.**

1.71 to 2.55 m: Basalt.

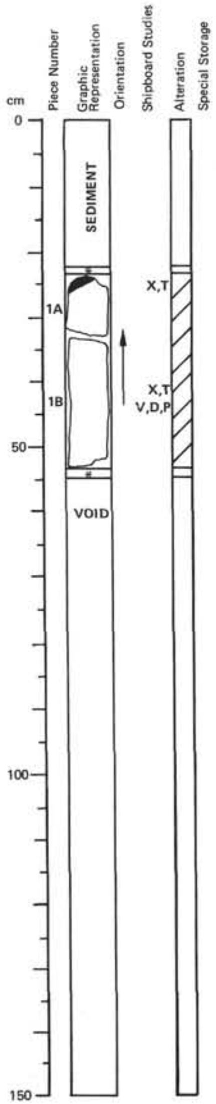
SMEAR SLIDE (%)

	Zeolitic claystone	Claystone	Altered volcaniclastic siltstone	Claystone	Altered volcaniclastic siltstone
TEXTURE AND MINERALS	1-92 (M)	1-128 (D)	1-148 (M)	2-10 (D)	2-18 (M)
Clay	10	78	78	90	50
Feldspar	–	10	–	–	–
Heavy minerals	Tr	Tr	Tr	Tr	Tr
Volcanic glass	Tr	–	20*	–	50*
Pyrite	1	1**	–	–	–
Zeolite	88***	10***	2	–	–
Carbonate unsp.	Tr	–	–	–	–
Calc. nannofossils	1	–	–	–	–
Plant debris	–	1	–	–	–
Opaques	–	–	–	10	–

*Highly altered to clay

**Replacing some plant remains

***Acicular and radial-fibrous aggregates



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	40	2

Depth: 703.8 to 704.1 m

MAJOR ROCK TYPE—MASSIVE BASALT AND VOLCANICLASTICS

Macroscopic Description:

Slightly fresh basalt and volcaniclastics. From 0.0-24.0 cm are volcaniclastic sediments described in the Sedimentary Core Barrel Descriptions.

From 24.0-55.0 cm is single basalt unit Basalt has a chilled margin at 24-26 cm and grain-size increases downward to medium grain-size at 55.0 cm.

Thin Section Description:

23-25 cm: Dolerite sill from glassy margin.

Microphenocrysts: Plagioclase (An70) 10-12%, 0.4-0.8 mm, acicular to subhedral; clinopyroxene 10-12%, 0.2 mm, euhedral to subhedral.

Groundmass: Plagioclase 10%, <0.4 mm, acicular; clinopyroxene 10%, <0.1 mm, subhedral to anhedral; magnetite 5-10%, <0.01 mm, dust-like; glass 45-50%, altered.

Alteration: Clays and zeolite (30%) replacing glass mesostasis. Carbonate (5%) replacing clinopyroxene phenocrysts.

Texture: Aphyric to hyalopilitic.

41-43 cm: Dolerite sill next to glassy margin.

Microphenocrysts: Plagioclase (An55) 20%, 0.4-0.8 mm, prismatic, spherulitic; clinopyroxene 26%, 0.2-0.5 mm, 0.2 mm prevales, subhedral.

Groundmass: Olivine 1%, 0.2 mm, pseudomorphs; plagioclase 25%, <0.3 mm, subhedral to euhedral, partly micro; clinopyroxene 25%, <0.1 mm, subhedral to anhedral, partly micro; magnetite 3-5%, 0.1-0.2 mm, angular to prismatic.

Alteration: Clays and zeolites (10-15%) replacing interstitial clinopyroxene and plagioclase.

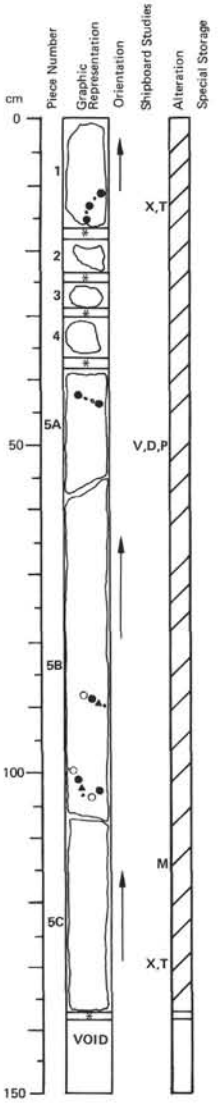
Texture: Intersertal to subophitic.

Shipboard Geochemistry (XRF, %):

Interval	23-25 cm	41-43 cm
SiO_2	49.15	49.74
TiO_2	1.26	1.23
Al_2O_3	14.04	13.76
FeO	11.25	11.88
MnO	–	–
MgO	6.59	6.73
CaO	12.15	12.41
Na_2O	–	–
K_2O	0.25	0.04
P_2O_5	–	–
Total	–	–
LOI†	2.18	2.25
FeO ÷ MgO	1.52	1.76
CaO ÷ Al_2O_3	0.86	0.90
FeO ÷ TiO_2	8.92	9.66

Paleomagnetism/Physical Properties:

Interval	42-44 cm
NRM Intensity (10^{-3} emu/cm^3)	–
NRM Incl. (°)	–
MDF (Oe.)	–
Stable Incl. (°)	–
Vp ∥ (km/s)	5.617
D (g/cm^3)	2.972(?)
P (%)	–



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	41	1

Depth: 711.0 to 712.4 m

MAJOR ROCK TYPE—MASSIVE BASALT SILL (DOLERITE)

Macroscopic Description:

Slightly fresh medium gray (N5) massive dolerite with veins of calcite plus celadonite, plus pyrite, plus smectite. Grain-size gradually increases downward, from medium to slightly coarse grain-size. Dolerite is intergranular to subophitic. Dolerite is made of microphenocrysts of plagioclase and clinopyroxene, whose ratio (plagioclase/clinopyroxene) is approximately one. It has a groundmass of plagioclase, clinopyroxene, and Ti-magnetite microlites.

Thin Section Description:

10-12 cm: Dolerite from sill interior.

Microphenocrysts: Plagioclase (An65) 40%, 0.3-0.8 mm, 0.8 mm is acicular type, 0.3 mm subhedral phenocrysts; clinopyroxene 40%, 0.2-0.3 mm, subhedral; magnetite (Ti) 5%, 0.2 mm, angular.

Groundmass: Plagioclase, 5%, <0.1 mm, subhedral, partly microlitic; clinopyroxene 5%, <0.1 mm, subhedral, partly microlitic; magnetite 2%, <0.1 mm, dust-like, partly microlitic.

Alterations: Clays (3-8%) and chlorite (3%) replacing interstitial plagioclase.

Texture: Intergranular to subophitic.

130-133 cm: Dolerite from sill interior.

Microphenocrysts: Plagioclase (An65) 10%, 0.3-0.8 mm, acicular and also subhedral, megacrystals (An75-80) of 2.0-2.5 mm; clinopyroxene 10%, 0.3-0.4 mm, subhedral.

Groundmass: Plagioclase 35%, <0.2 mm, subhedral, microlitic; clinopyroxene 40%, <0.2 mm, subhedral, microlitic; magnetite 4-5%, <0.2 mm, angular, microlitic, associated with alteration; trace of quartz and alkali feldspar, micropegmatite.

Alteration: Carbonate (5-10%) replacing spots in plagioclase. Chlorite (3%) occurs within interstitial minerals.

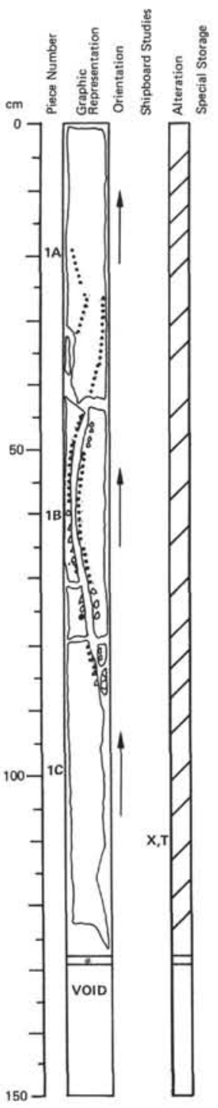
Texture: Intersertal to intergranular.

Shipboard Geochemistry (XRF, %):

Interval	10-12 cm	130-133 cm
SiO_2	50.09	49.84
TiO_2	1.23	1.22
Al_2O_3	13.56	13.67
FeO	12.15	12.16
MnO	–	–
MgO	7.17	7.24
CaO	12.04	12.36
Na_2O	–	–
K_2O	0.04	0.04
P_2O_5	–	–
Total	–	–
LOI†	0.71	0.59
FeO ÷ MgO	1.69	1.69
CaO ÷ Al_2O_3	0.88	0.90
FeO ÷ TiO_2	9.87	9.96

Paleomagnetism/Physical Properties:

Interval	51-53 cm	115 cm
NRM Intensity (10^{-3} emu/cm^3)	5.9	–
NRM Incl. (°)	–67.2	–
MDF (Oe.)	45.0	–
Stable Incl. (°)	–58.6?	–
Vp ∥ (km/s)	–	5.889
D (g/cm^3)	–	3.00
P (%)	–	3.3



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	41	2

Depth: 712.4 to 713.7 m

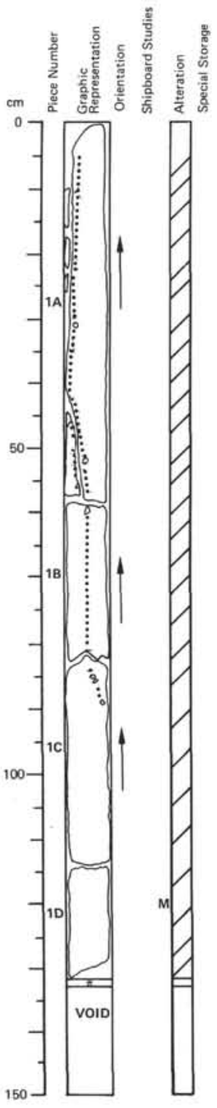
MAJOR ROCK TYPE—MASSIVE BASALT SILL (DOLERITE)

Macroscopic Description:
Slightly altered, homogeneous, slightly coarse grain-sized, subophitic, medium gray (N5), massive dolerite with veins. Veins are filled with calcite plus celadonite plus pyrite plus smectite, but chlorite with pyrite is prevailing. Dolerite is the same unit as in Core 41, Section 1.

Thin Section Description:
110-112 cm: Massive dolerite from sill interior.
Phenocrysts: Plagioclase 10% (An60-65), acicular and anhedral; clinopyroxene 10%, ~0.4 mm.
Groundmass: Plagioclase ?%, <0.3 mm, subhedral to anhedral, microlitic; clinopyroxene ?%, <0.3 mm subhedral, microlitic; magnetite 4-5%, <0.2 mm, angular, associated with alteration; trace of quartz and alkali feldspar, micropegmatite; trace of green hornblende, absorbed at margin of clinopyroxene.
Alteration: Clays (5-10% spottily replacing plagioclase. Chlorite (3-5%) also occurs interstitially.
Texture: Subophitic to intersertal.

Shipboard Geochemistry (XRF, %):

Interval	**110-112 cm**
SiO_2	50.41
TiO_2	1.21
Al_2O_3	13.62
FeO	11.70
MnO	–
MgO	6.79
CaO	11.97
Na_2O	–
K_2O	0.02
P_2O_5	–
Total	–
LOI†	0.67
FeO ÷ MgO	1.72
CaO ÷ Al_2O_3	0.88
FeO ÷ TiO_2	9.66



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	41	3

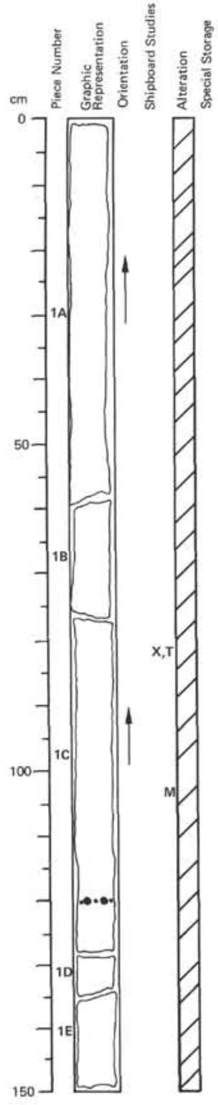
Depth: 713.7 to 715.0 m

MAJOR ROCK TYPE—MASSIVE BASALT SILL (DOLERITE)

Macroscopic Description:
massive dolerite with veins. Veins are filled wtih
massive dolerite with veins. Veins are filled with calcite plus celadonite plus pyrite plus smectite; however, celadonite plus pyrite veins are prevalent. Dolerite is the same unit as in Core 41, Section 1.

Paleomagnetism/Physical Properties:

Interval	**120 cm**
NRM Intensity (10^{-3} emu/cm^3)	6.3
NRM Incl. (°)	–70.7
NRM Decl.	206.0
MDF (Oe.)	–
Stable Incl. (°)	–
Vp ∥ (km/s)	5.980
D (g/cm^3)	2.99
P (%)	3.1



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	41	4

Depth: 715.0 to 716.5 m

MAJOR ROCK TYPE—MASSIVE BASALT SILL (DOLERITE)

Macroscopic Description:

Moderately altered, subophitic to intergranular medium gray (N5) massive dolerite with veins. Veins are filled with calcite plus celadonite plus pyrite plus smectite; however, chlorite plus pyrite veins are prevalent. Dolerite is the same unit as in Core 41, Section 1. Grain-size decreases downward from slightly coarse to medium. Microphenocrysts of plagioclase are less common in the upper part of the section than in the lower part. Dolerite is sparsely to spotted altered to clay (zeolite).

Thin Section Description:

80-82 cm: Massive dolerite from sill interior.

Microphenocrysts: Plagioclase (An60) 5-6%, 0.4-0.8 mm, subhedral; clinopyroxene 5-8%, 0.4 mm, subhedral to anhedral; magnetite (Ti) 1%, 0.8-1.0 mm, skeletal, associated with green hornblende.

Groundmass: Plagioclase 40%, <0.3 mm, subhedral, microlite; clinopyroxene 40%, <0.3 mm, subhedral, microlite; magnetite 5-6%, <0.3 mm, skeletal and dust-like, associated with alteration; trace of quartz and alkali feldspar, micropegmatite; trace of green hornblende.

Alteration: Clays (5-10%) and chlorite (3-5%) replacing spots of plagioclase.

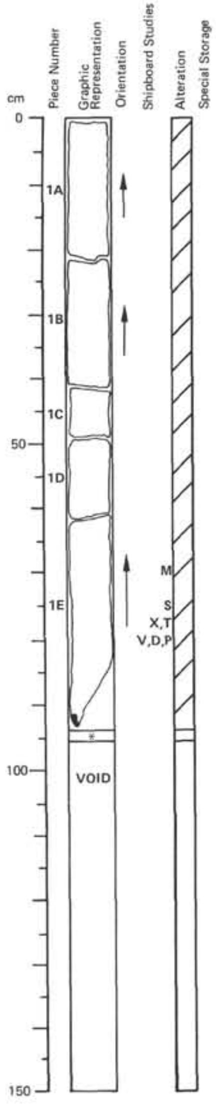
Texture: Subophitic to intergranular.

Shipboard Geochemistry (XRF, %):

Interval	**80-82 cm**
SiO_2	50.04
TiO_2	1.21
Al_2O_3	13.64
FeO	11.09
MnO	–
MgO	7.36
CaO	12.04
Na_2O	–
K_2O	0.05
P_2O_5	–
Total	–
LOI†	0.70
FeO ÷ MgO	1.50
CaO ÷ Al_2O_3	0.88
FeO ÷ TiO_2	9.16

Paleomagnetism/Physical Properties:

Interval	**103 cm**
NRM Intensity (10^{-3} emu/cm^3)	5.1
NRM Decl.	30.0
NRM Incl. (°)	–73.2
MDF (Oe.)	40.0
Stable Incl. (°)	–67.2
Vp ∥ (km/s)	–
D (g/cm^3)	–
P (%)	–



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	41	5

Depth: 716.5 to 717.4 m

MAJOR ROCK TYPE—MASSIVE BASALT SILL (DOLERITE)

Macroscopic Description:

Slightly altered, homogeneous medium grain-size, intergranular to intersertal, medium gray (N5) massive dolerite. Dolerite is the same unit as in Core 41, Section 1.

Thin Section Description:

78-80 cm: Massive dolerite from sill interior.

Microphenocrysts: Plagioclase (An55-60) 10-13%, 0.5-1.0 mm, subhedral, partly phenocrysts; clinopyroxene 10%, 0.4-0.5 mm, subhedral; magnetite (Ti) 1-2%, 0.4 mm, skeletal.

Groundmass: Plagioclase 35%, <0.4 mm, subhedral, microlite; clinopyroxene 35%, <0.3 mm, subhedral to anhedral, microlite; magnetite 5-8%, <0.2 mm; trace of quartz and alkali feldspar, micropegmatite; trace of green and brown hornblende.

Alteration: Clays (10-15%) and chlorite (3-5%) replacing spots of plagioclase.

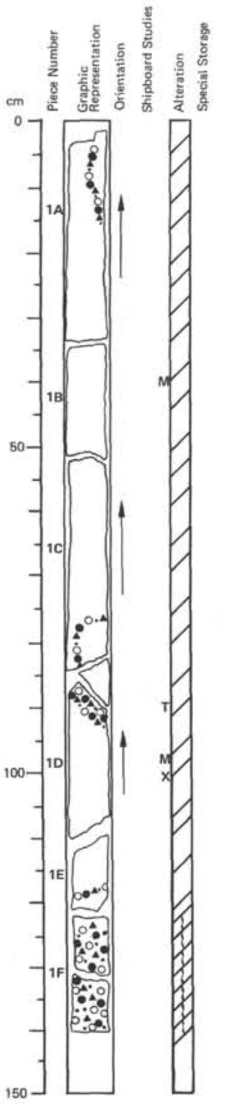
Texture: Subophitic to intergranular.

Shipboard Geochemistry (XRF, %):

Interval	**78-80 cm**
SiO_2	50.28
TiO_2	1.19
Al_2O_3	13.91
FeO	11.04
MnO	–
MgO	7.35
CaO	12.08
Na_2O	–
K_2O	0.09
P_2O_5	–
Total	–
LOI†	1.93
FeO ÷ MgO	1.50
CaO ÷ Al_2O_3	0.87
FeO ÷ TiO_2	9.27

Paleomagnetism/Physical Properties:

Interval	**68 cm**	**80-82 cm**
NRM Intensity (10^{-3} emu/cm^3)	5.8	–
NRM Decl.	69.0	–
NRM Incl. (°)	–77.4	–
MDF (Oe.)	30.0	–
Stable Incl. (°)	–48.4?	–
Vp ∥ (km/s)	–	5.992
D (g/cm^3)	–	2.98
P (%)	–	2.7



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	41	6

Depth: 716.5 to 717.9 m

MAJOR ROCK TYPE—MASSIVE BASALT SILL (DOLERITE)

Macroscopic Description:

Medium gray (N5) massive dolerite sill with veins. Veins are filled with calcite plus celadonite plus pyrite plus smectite.

From 0.0-121 cm (Pieces 1A-1B), basalt has a grain-size decreasing downward from slightly coarse to medium, and is subophitic to intergranular. Pieces 1A-1B are moderately to slightly altered. From 120.0-140.0 cm (Piece 1C), basalt has a badly altered surface (chlorite, zeolite, and pyrite) and thus the basalt's grain-size is not apparent.

Thin Section Description:

90-92 cm: Subophitic dolerite from sill interior.

Microphenocrysts: Plagioclase (An65-70) 15-20%, 0.5-0.8 mm, subhedral, partly phenocryst; clinopyroxene 8-10%, 0.5-0.7 mm, subhedral; magnetite (Ti) 2-4%, 0.4 mm, skeletal.

Groundmass: Olivine 1-2%, 0.2 mm; plagioclase 30%, <0.4 mm, subhedral, microlite; clinopyroxene 30%, <0.4 mm, subhedral, microlite; magnetite 5-8%, <0.2 mm, skeletal; trace of quartz and alkali feldspar micropegmatite; trace of apatite, and brown hornblende.

Alteration: Clays and zeolites (5-10%) replacing spots in plagioclase. Chlorite (3-5%) replacing spots in plagioclase and clinopyroxene.

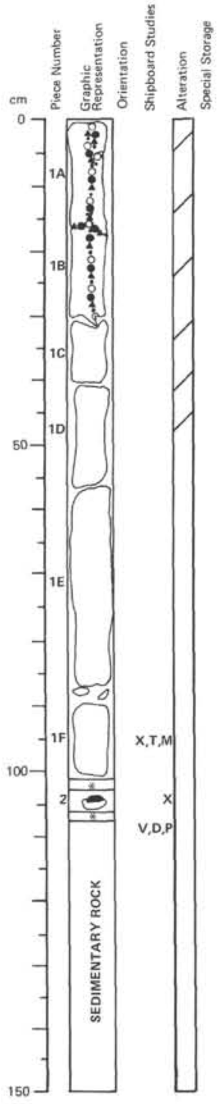
Texture: Subophitic to intergranular.

Shipboard Geochemistry (XRF, %):

Interval	100-102 cm
SiO_2	50.46
TiO_2	1.22
Al_2O_3	13.24
FeO	11.41
MnO	–
MgO	7.03
CaO	11.83
Na_2O	–
K_2O	0.32
P_2O_5	–
Total	–
LOI†	1.03
FeO ÷ MgO	1.62
CaO ÷ Al_2O_3	0.89
FeO ÷ TiO_2	9.35

Paleomagnetism/Physical Properties:

Interval	42 cm	99 cm
NRM Intensity (10^{-3} emu/cm^3)	5.7	4.6
NRM Decl.	350.0	184.0
NRM Incl. (°)	–57.4	–61.6
MDF (Oe.)	30.0	–
Stable Incl. (°)	–36.1	–
Vp ∥ (km/s)	–	–
D (g/cm^3)	–	–
P (%)	–	–



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	41	7

Depth:

MAJOR ROCK TYPE—MASSIVE BASALT SILL (DOLERITE) AND VOLCANICLASTICS

Macroscopic Description:

Slightly altered, medium gray (N5) dolerite with veins. Veins are filled with calcite plus celadonite plus pyrite plus smectite, with chlorite plus pyrite veins prevailing.

From 0.0-105.0 cm, the dolerite has a medium to coarse grain-size with grain-size decreasing downward. Dolerite is aphyric and slightly clinopyroxene-phyric with a few spots of alteration to clay. Contact of basalt and sediment at 105.0 cm.

Thin Section Description:

96-99 cm: Basalt from glassy margin of sill.

Microphenocrysts: Olivine 1-2%, 0.2 mm, pseudomorphs; plagioclase (An65) 3-5%, 0.5-1.5 mm, acicular; clinopyroxene 1%, 0.5 mm, subhedral to euhedral.

Groundmass: Plagioclase 20%, <0.4 mm, acicular, partly microlite; clinopyroxene 10-15%, <0.3 mm, subhedral, partly microlite; glass 50%, altered to clay; magnetite 5-6%, <0.1 mm, dust-like, secondary(?).

Alteration: Clays and zeolites (35-40%) replacing interstitial glass, clinopyroxene, and plagioclase.

Texture: Hyalopilitic to aphyric.

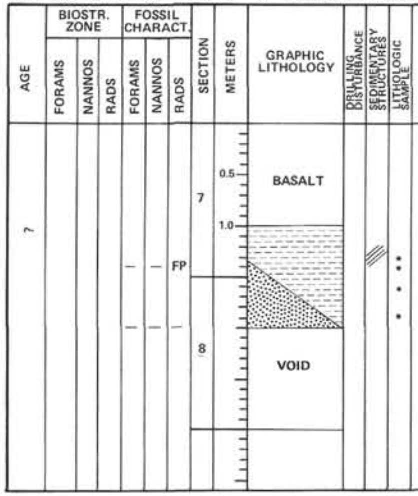
Shipboard Geochemistry (XRF, %):

Interval	96-99 cm	106-109 cm
SiO_2	49.80	49.46
TiO_2	1.23	0.72
Al_2O_3	13.83	11.60
FeO	11.67	14.19
MnO	–	–
MgO	6.59	11.32
CaO	11.75	5.05
Na_2O	–	–
K_2O	0.04	0.56
P_2O_5	–	–
Total	–	–
LOI†	0.51	4.92
FeO ÷ MgO	1.77	1.25
CaO ÷ Al_2O_3	0.85	0.43
FeO ÷ TiO_2	9.48	19.70

Paleomagnetism/Physical Properties:

Interval	94 cm	108-110 cm
NRM Intensity (10^{-3} emu/cm^3)	4.4	–
NRM Decl.	189.0	–
NRM Incl. (°)	–51.3	–
MDF (Oe.)	60.0	–
Stable Incl. (°)	–32.2	*
Vp ∥ (km/s)	–	2.829
D (g/cm^3)	–	2.19
P (%)	–	38.7

SITE 462 HOLE A CORE 41 CORED INTERVAL: 711.0 to 720.0 m



LITHOLOGIC DESCRIPTION

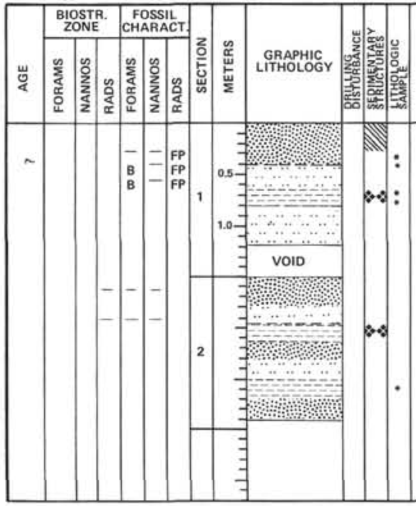
0.0 to 1.0 m: Basalt is described in detail in the **"Visual Core Description of Igneous Rock".**
1.0 to 2.05 m: Greenish gray to dark greenish gray (5G 6/1 to 4/1) **CLAYSTONE** containing mm-scale **MAGNETIC SPHERULES** (porphyroblasts) close to the sediment-basalt contact. These spherules decrease in size, but increase in number downward away from this contact until the basal parts of the sediment are sand- and silt-sized. Near the basalt contact they are subvertical chlorite-zeolite veins.

SMEAR SLIDE (%)

	Claystone	Concretion	Claystone	Claystone
TEXTURE AND MINERALS	7-130 (D)	7-142 (M)	8-9 (D)	8-40 (D)
Clay	99	94	98	95
Feldspar	–	–	–	3
Heavy minerals	Tr	Tr	Tr	–
Opaques	–	–	1	2
Magnetic spherules	–	1	–	–
Pyrite	1	–	–	–
Unspecified	?*	5	–	–

*Acicular intergrowth with clay particles

SITE 462 HOLE A CORE 42 CORED INTERVAL: 720.0 to 723.0 m



LITHOLOGIC DESCRIPTION

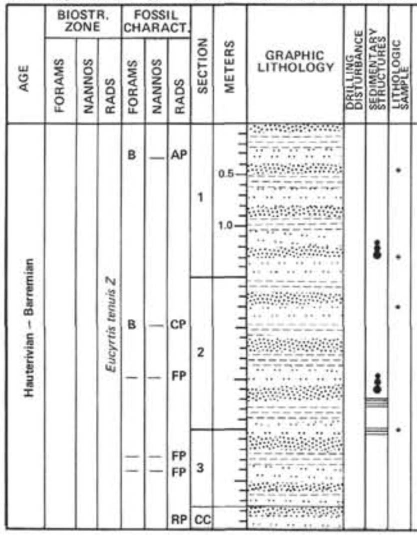
0.0 to 1.2 m: Mostly greenish-black (5G 2/1) **ZEOLITIC VOLCANICLASTIC SANDSTONE to SILTSTONE,** with levels with rounded clasts and interbeds of grayish-black (N2) **CLAYSTONES.** Top 30 cm are deformed, slumped, cross- and horizontally-bedded olive black (5Y 2/1) **CLAYSTONE.**
1.5 to 2.9 m: Greenish-black (5G 2/1) **SANDSTONE** with levels of rounded clasts.

SMEAR SLIDE (%)

	Zeolitic volcan-iclastic siltstone	Claystone	Zeolitic volcan-iclastic siltstone	Volcaniclastic siltstone	Volcaniclastic siltstone
MINERALS	1-36 (D)	1-42 (M)	1-71 (D)	1-78 (M)	2-108 (D)
Clay	39	99	58	50	60
Heavy minerals	<1	–	Tr	Tr	Tr
Volcanic glass	*	<1	2	50	40
Zeolite	60	–	40	?	–
Carbonate unsp.	–	–	–	–	Tr
Fish remains	Tr	–	–	–	Tr

*Altered to clay

SITE 462 HOLE A CORE 43 CORED INTERVAL: 723.0 to 729.0 m

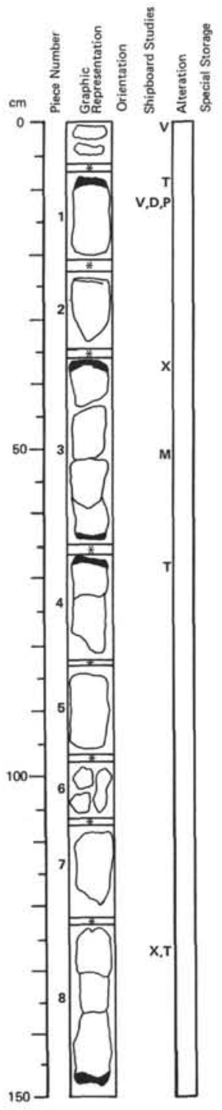


LITHOLOGIC DESCRIPTION

0.0 to 3.95 m: Primarily a series of grain-size graded (coarser at base) and ripple-bedded greenish-black (5GY 2/1) **VOLCANICLASTIC SANDSTONES to SILTSTONES.** Some olive black (5Y 2/1) **CLAYSTONE** layers, 2-3 cm thick. Some grayish-brown (5YR 3/2), light greenish-gray (5G 8/1) and dusky blue (5PB 3/2) **CLAYSTONE** laminae present locally.

SMEAR SLIDE (%)

	Volcaniclastic siltstone	Volcaniclastic siltstone	Volcaniclastic siltstone	Volcaniclastic siltstone
MINERALS	1-42 (D)	1-131 (D)	2-30 (D)	2-147 (D)
Clay	68	49	67	70
Heavy minerals	1	–	Tr	Tr
Volcanic glass	30	50	30	30
Opaque	1	1	3	–



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG		SITE			HOLE	CORE		SECT.	
6	1	4	6	2	A	4	4		1

Depth: 729.0 to 730.5 m

MAJOR ROCK TYPE---BASALT

Macroscopic Description:

Three basalt units occur. These units may be sills with crenulated margins or pillows.

Unit 1 occurs from 9.0-34.0 cm; glassy (9.0-10.0 cm) and fine grain-sized 19.0-34.0 cm basalt.

Unit 2 occurs from 35.0-64.0 cm; glassy (33.0-34.0 cm), fine grain-sized (34.0-63.0 cm), and glassy (63.0-64.0 cm) basalt.

Unit 3 occurs from 66.0-148.0 cm; glassy (66.0-68.0 cm), fine grain-sized (68.0-146.0 cm), and glassy (146.0-148.0 cm) basalt.

The above units have clayey altered spots and glass is partly altered to chlorite.

Near the glassy margins are drusy and ruggy chalcedony-quartz in small spherules. The units have a few clinopyroxene phenocrysts (3-4%) with a variably glassy and holocrystalline matrix of plagioclase, clinopyroxene, and opaque minerals.

Thin Section Description:

37-39 cm: Altered glassy basalt from glassy margin.

Phenocrysts: Olivine 2%, 0.1-0.6 mm, pseudomorphs; plagioclase (An65) 2%, 0.2-0.5 mm; spinel < 1%, <0.02 mm, inclusions in olivine pseudomorphs.

Groundmass: Plagioclase 3%, <0.05 mm, skeletal, microlite, and crystallite; magnetite (Ti) 3%, <0.002 mm, dust-like; glass 90%, spherulitic, variolitic; trace amphibole replacing olivine.

Alteration: Clays (var. %) replacing glass, olivine, and plagioclase. Zeolite (var. %) replacing olivine and plagioclase groundmass, and occurs in veins.

Texture: Glassy to variolitic.

128-130 cm: Olivine-plagioclase, fine grain-sized basalt from pillow/sill interior.

Phenocrysts: Olivine 3%, 0.2-0.5 mm, pseudomorphs; plagioclase (An58 zoned to An30); clinopyroxene (augite) 1%, <0.05 mm; spinel (picotite?), inclusions in olivine pseudomorphs.

Groundmass: Plagioclase 27%, quench microlites, crystallites, etc.; clinopyroxene 50%, quench crystals in groundmass; magnetite (Ti) trace, <0.0125 mm; quartz <2%, secondary, replacing groundmass; amphibole trace, fibrous, brown, replacing olivine.

Alteration: Clays (15%) replacing glass, olivine, plagioclase and in veins. Zeolites and quartz replacing olivine, plagioclase and groundmass.

Texture: Hyalopilitic.

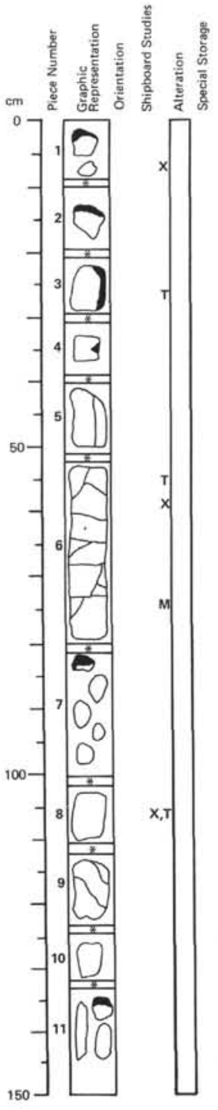
Shipboard Geochemistry (XRF, %):

Interval	**128-130 cm**
SiO_2	49.05
TiO_2	0.91
Al_2O_3	13.83
FeO	10.69
MnO	–
MgO	7.92
CaO	12.62
Na_2O	–
K_2O	0.02
P_2O_5	–
Total	–
LOI†	0.32
FeO ÷ MgO	1.34
CaO ÷ Al_2O_3	0.91
FeO ÷ TiO_2	11.74

Paleomagnetism/Physical Properties:

Interval	**0-2 cm**	**15-17 cm**	**52 cm**
NRM Intensity (10^{-3} emu/cm^3)	–	–	7.4
NRM Decl.	–	–	287.0
NRM Incl. (°)	–	–	–49.9
MDF (Oe.)	–	–	105.0
Stable Incl. (°)	†	–	–43.0
Vp ∥ (km/s)	2.072	4.976	–
D (g/cm^3)	–	2.98	–
P (%)	–	2.0	–

† Claystone



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG		SITE			HOLE	CORE		SECT.	
6	1	4	6	2	A	4	4		2

Depth: 730.5 to 732.0 m

MAJOR ROCK TYPE---BASALT

Macroscopic Description:

Two basalt units (Units 4 and 5). These units may be sills with crenulated margins or pillows.

Unit 4 occurs from 0.0–~80.0 cm; glassy basalt portions are from 0.0-37.0 cm and a fine grain-size basalt from 37.0-80.0 cm.

Unit 4 occurs from 80.0-150(?) cm; glassy basalt portion from ~81.0-83.0 cm and a fine grain-size basalt from 83.0 to about 135.0(?) cm (fragments to 150? cm) where gluss (2 cm) occurs on one of the pieces near the bottom of the section.

Thin Section Description:

27-30 cm: Altered glassy basalt from glassy margin.

Phenocrysts: Olivine 3%, 0.2-0.4 mm, pseudomorphs, euhedral; plagioclase (An80) 2%, 0.2-0.5 mm, euhedral; spinel < 1%, <0.03 mm, inclusions in olivine pseudomorphs.

Groundmass: Plagioclase 5%, <0.01 mm, skeletal crystals and crystallites; magnetite (Ti) <0.002 mm, dust-like, in variolitic zone; glass 90%, mostly replaced by clay, some variolitic; amphibole, secondary, fibrous brown, replacing cores of olivine.

Alteration: Brown clays (51%) replacing glass and olivine. Zeolites replacing glass and plagioclase and also occurs as veins.

Texture: Glassy to variolitic.

53-56 cm: Fine grain-sized basalt pillow interior.

Phenocrysts: Olivine < 1%, <0.2 mm, pseudomorphs; plagioclase (An73-75) 2%, <0.3 mm, patchy distribution; clinopyroxene (augite) 3%, <0.1 mm, sector zoned microphenocrysts; spinel < 1%, <0.03 mm, inclusions in pseudomorphs.

Groundmass: Plagioclase 30%, <0.5 mm, skeletal laths; clinopyroxene 55%, microlites and quench sprays; magnetite (Ti) 10%, <0.02 mm, dust-like.

Alteration: Clays (5-10%) and chlorite (3%) replacing pyroxene, plagioclase and olivine groundmass.

Texture: Intersertal.

106-107 cm: Altered glassy basalt from pillow interior.

Phenocrysts: Olivine 1%, 0.1-0.2 mm, pseudomorphs; plagioclase (An75) 5%, up to 0.5 mm, skeletal, euhedral; spinel < 1%, <0.03 mm, inclusions in olivine pseudomorphs.

Groundmass: Plagioclase 30%, fine quench texture; clinopyroxene 43%, fine quench texture; magnetite (Ti) 15%, <0.02 mm; glass (5-10%), mostly replaced.

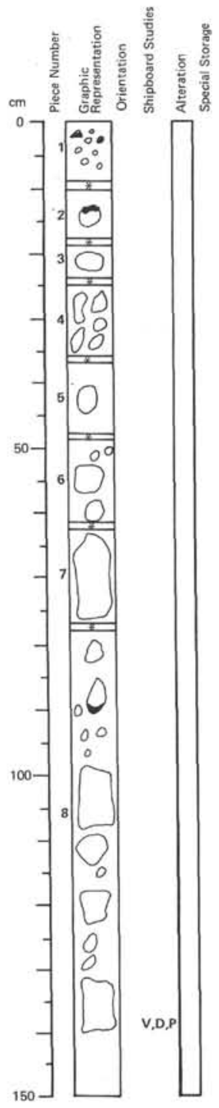
Alteration: Clays (15%) and zeolites (5%) replacing groundmass glass and crystals, and zeolites also occur in veins. Chlorite (1%) replacing plagioclase phenocrysts.

Shipboard Geochemistry (XRF, %):

Interval	**7-9 cm**	**7-9 cm**
SiO_2		50.85
TiO_2		0.96
Al_2O_3		13.47
FeO		12.86
MnO		–
MgO		7.93
CaO		6.66
Na_2O		–
K_2O		0.74
P_2O		–
LOI		7.46
FeO ÷ MgO		1.62
CaO ÷ Al_2O_3		0.49
FeO ÷ TiO_2		13.39

Paleomagnetism/Physical Properties:

Interval	**74 cm**
NRM Intensity (10^{-3} emu/cm^3)	7.8
NRM Decl.	287.0
NRM Incl. (°)	–49.9
MDF (Oe.)	105.0
Stable Incl. (°)	–43.0
Vp ∥ (km/s)	–
D (g/cm^3)	–
P (%)	–



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG		SITE			HOLE	CORE		SECT.	
6	1	4	6	2	A		4	4		3

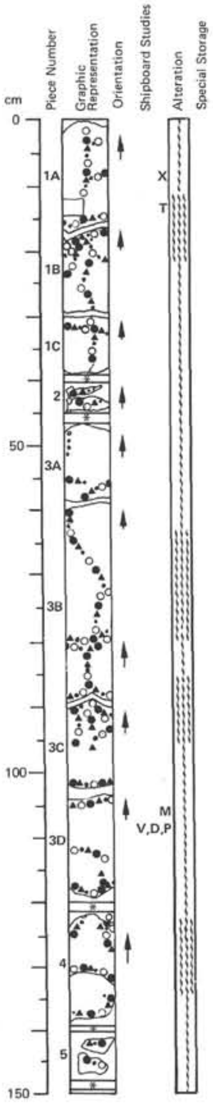
Depth: 732.0 to 733.5 m

MAJOR ROCK TYPE—BASALT

Macroscopic Description:
The basalt (Unit 6) may be a sill with crenulated margins or pillows. Unit 6 occurs from 0.0-76.0(?) cm. Pieces of glassy basalt occur in 0.0-14.0 cm, and fine grain-sized basalt occurs from 14.0-76.0 cm. Below 76.0 cm, all pieces (Piece 8) are Core-Catcher samples whose orientation and stratigraphic position are unknown.

Physical Properties:

Interval	**139-141 cm**
Vp ‖ (km/s)	5.502
D (g/cm^3)	2.95
P (%)	3.5



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG		SITE			HOLE		CORE		SECT.	
6	1	4	6	2	A		4	5		1

Depth: 733.0 to 734.5 m

MAJOR ROCK TYPE—BASALT SILL

Macroscopic Description:
From 0.0-40.0 cm and 92.0-150.0 cm there is fine-grained, slightly phyric, plagioclase plus celadonite-clay-pyrite veins. From 40.0-97.0 cm the basalt has a coarser grain-size and is more chlorite-clay-pyrite veins. From 40.0-97.0 cm the basalt has a coarser grain-size and is more crystalline phyric. There are no glassy spots. From 49.0-51.0 cm there is a vein of coarse (3.0-4.0 mm), crystals like transparent pale greenish zeolite (phillipsite).

Thin Section Description:

12-14 cm: Fine grain-sized basalt from sill interior below pillow complex.

Phenocrysts: Plagioclase 4%, <0.2 mm, clay-amphibole pseudomorphs; clinopyroxene (augite) <1%, 0.5 mm, a single coarse phenocryst; spinel <1%, <0.02 mm, inclusion in olivine pseudomorphs.

Groundmass: Plagioclase (An70) 12%, 1.0 mm long; skeletal and acicular laths; clinopyroxene 59%, spinifex textured sprays; magnetite (Ti) 15%, <0.02 mm.

Vesicles: May be small vesicles (< 1%) filled with calcite.

Alteration: Carbonate (1%) invugs and replacing groundmass. Brown clay (10%) replacing groundmass and plagioclase and olivine phenocrysts.

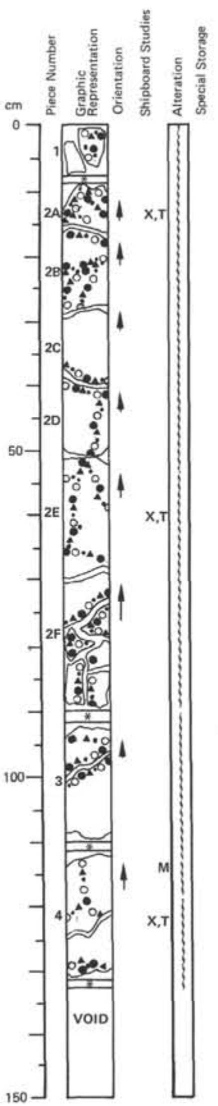
Texture: Spinifex porphyry.

Shipboard Geochemistry (XRF, %):

Interval	**7-8 cm**
SiO_2	50.73
TiO_2	0.93
Al_2O_3	14.30
FeO	10.73
MnO	–
MgO	7.67
CaO	12.38
Na_2O	–
K_2O	0.01
P_2O_5	–
Total	–
LOI†	0.81
FeO ÷ MgO	1.39
CaO ÷ Al_2O_3	0.86
FeO ÷ TiO_2	11.53

Paleomagnetism/Physical Properties:

Interval	**107 cm**	**105-107 cm**
NRM Intensity (10^{-3} emu/cm^3)	4.8	–
NRM Decl.	267.0	–
NRM Incl. (°)	–46.8	–
MDF (Oe.)	80.0	–
Stable Incl. (°)	–34.3	–
Vp ‖ (km/s)	–	5.771
D (g/cm^3)	–	2.92
P (%)	–	3.0



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	45	2

Depth: 734.5 to 735.8 m

MAJOR ROCK TYPE—BASALT SILL

Macroscopic Description:
From 0.0-40.0 cm, and 100.0-130.0 cm, there is fine grain-sized phyric basalts identical to those from the 0.0-40.0 cm interval of the previous section (45-1). From 40.0-100.0 cm, there is a coarser grain-size and more crystalline phyric basalts, which are identical to those from the 40.0-92.0 cm interval of the previous section. In general, veins are calcite, celadonite, clay, and pyrite.

Thin Section Description:

14-17 cm: Fine grain-sized basalt from flow interior (below pillow part).
Phenocrysts: Olivine 5%, pseudomorphs (0.3-0.5 mm); plagioclase (An72-75) 4%, 0.2-0.5 mm.
Groundmass: Plagioclase (An72), 0.5 mm, skeletal and acicular; clinopyroxene 61%, quench texture, sprays and needles; magnetite (Ti) 10%, < 0.005 mm, dust-like; amphibole replacing cores of olivine crystals.
Alteration: Brown clays (5%) and chlorite (trace) replacing groundmass.
Texture: Spinifex to spherulitic.

61-63 cm: Fine grain-sized basalt from sill interior.
Phenocrysts: Olivine trace, unclear pseudomorphs; plagioclase (An70), trace, <0.5 mm, subhedral, corroded.
Groundmass: Plagioclase 30%, <0.3 mm, long acicular laths; clinopyroxene (augite) 50%, <0.1 mm; magnetite (Ti) 10%, <0.1 mm; amphibole (trace), replacing olivine.
Alteration: Brown clays (10%) replacing clinopyroxene; chlorite (trace) replacing olivine.
Texture: Equigranular.

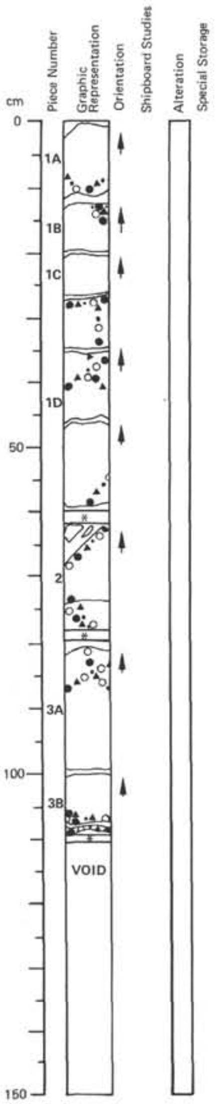
122-124 cm: Fine grain-sized basalt from sill interior.
Phenocrysts: Olivine 3%, <0.05 mm, pseudomorphs (clay and amphibole); plagioclase (An75) 3%, <0.4 mm, euhedral, oscillatory zoning; spinel < 1%, <0.003 mm, inclusions in olivine.
Groundmass: Plagioclase (An75) 15%, <0.5 mm, acicular laths and skeletal crystals; clinopyroxene 64%, tiny spinifex-like growths and sprays; magnetite (Ti) 10%, <0.04 mm, dust-like; amphibole, brown replacing olivine.
Alteration: Brown clay (5%) replacing pyroxene.
Texture: Spinifex-like intergrowth.

Shipboard Geochemistry (XRF, %):

Interval	**14-17 cm**
SiO_2	49.26
TiO_2	0.95
Al_2O_3	14.46
FeO	11.02
MnO	–
MgO	7.70
CaO	12.83
Na_2O	–
K_2O	0.3
P_2O_5	–
Total	–
LOI†	0.26
FeO ÷ MgO	1.43
CaO ÷ Al_2O_3	0.88
FeO ÷ TiO_2	11.60

Paleomagnetism/Physical Properties:

Interval	**115 cm**
NRM Intensity (10^{-3} emu/cm^3)	5.4
NRM Decl.	149.0
NRM Incl. (°)	–42.8
MDF (Oe.)	95.0
Stable Incl. (°)	–33.2
Vp ∥ (km/s)	–
D (g/cm^3)	–
P (%)	–



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	45	3

Depth: 735.8 to 738.0 m

MAJOR ROCK TYPE—BASALT SILL

Macroscopic Description:
From 0.0-110.0 cm, there are medium grain-sized, slightly phyric basalts without glassy spots. They are more crystalline than the middle of the previous section. Veins are calcite-celadonite-clay-pyrite.

Thin Section Description:

50-52 cm: Altered fine grain-sized basalt from sill interior.
Phenocrysts: Olivine 2%, 0.3-0.5 mm, pseudomorphs; plagioclase (An65?) 2%, 0.2-0.4 mm, corroded; spinel < 1%, <0.003 mm, small inclusions in olivine.
Groundmass: Plagioclase (An68) 25%, <0.2 mm, tabular and skeletal laths; clinopyroxene 51%, <0.1 mm, quench and granular; magnetite (Ti) 5%, <0.04 mm, euhedral.
Vesicles: Vesicles are <1%; one vesicle is egg-shaped, 0.4 mm in diameter, and is empty.
Alteration: Brown clays (15%) in patches, replacing all minerals.
Texture: Equigranular.

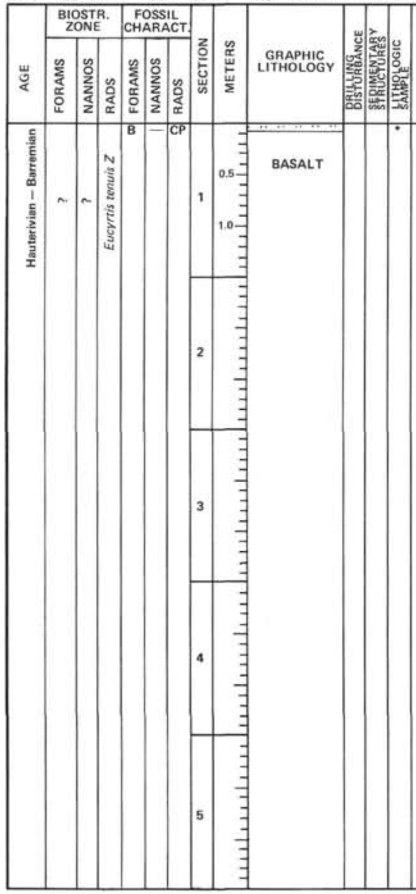
Shipboard Geochemistry (XRF, %):

Interval	**50-52 cm**
SiO_2	50.02
TiO_2	0.93
Al_2O_3	14.20
FeO	10.70
MnO	–
MgO	7.56
CaO	12.50
Na_2O	–
K_2O	0.008
P_2O_5	–
Total	–
LOI†	0.66
FeO ÷ MgO	1.41
CaO ÷ Al_2O_3	0.88
FeO ÷ TiO_2	11.50

Physical Properties:

Interval	**4-6 cm**
Vp ∥ (km/s)	5.903
D (g/cm^3)	2.96
P (%)	2.1

SITE 462 HOLE A CORE 46 CORED INTERVAL: 738.0 to 749.0 m



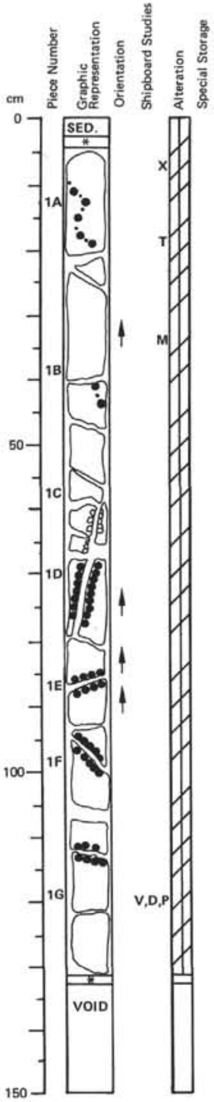
LITHOLOGIC DESCRIPTION

0.0 to 0.03 m: Medium dark gray (N4) **ZEOLITIC VOLCANICLASTIC SILTSTONE.**

0.03 m and below is basalt which is described in **"Visual Core Description of Igneous Rock".**

SMEAR SLIDE (%)

	Zeolitic claystone–siltstone 1-2 (M)
MINERALS	
Quartz	1
Feldspar	2
Clay	80
Opaque	1
Zeolite	16



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG		SITE			HOLE		CORE			SECT.
6	1	4	6	2	A		4	6		1

Depth: 738.0 to 739.3 m

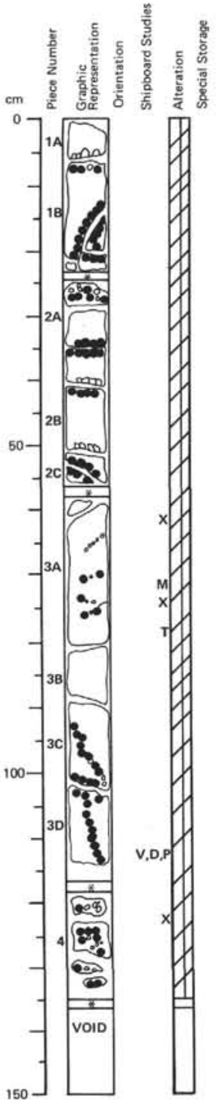
MAJOR ROCK TYPE––BASALT SILL

Macroscopic Description:
Moderately to badly altered massive dolerite sill with veins of celadonite and pyrite (••• in graphic presentation). From 0.0-2.0 cm is sediment which is described in detail in the Sedimentary Core Descriptions. From 5.0-67.0 cm (Piece 1C), the basalt grain-size increases from fine to slightly medium and the basalt is hyalopilitic to intersertal. A distinct upper chilled margin was not found. Microphenocrysts of clinopyroxene are often altered to clay minerals and groundmass also appears to be badly altered. In the groundmass, acicular grains occur. The medium light gray (N5) basalt of microphenocrysts of clinopyroxene and a small amount of plagioclase, and groundmass of plagioclase, clinopyroxene, magnetite, and glass.
From 67.0-131.0 cm, the medium gray (N5) basalt is medium grain-sized and is intersertal to intergranular. Constituent minerals are the same as from 5.0-67.0 cm interval, except there is no glass.

Thin Section Description:
20-22 cm: Fine grain-sized basalt from sill interior.
Phenocrysts: Olivine 3%, 0.3-0.5 mm, pseudomorphs; plagioclase (An68) 2%, 0.2-0.8 mm, euhedral and corroded; spinel <1%, <0.003 mm, inclusions in olivine.
Groundmass: Plagioclase (An70) 25%, 0.1-0.5 mm, bladed and skeletal laths; clinopyroxene (augite) 45%, <0.2 mm, granular and quench; magnetite (Ti) 10%, <0.04 mm.
Alteration: Brown clays (15%) replacing clinopyroxene plagioclase, olivine and magnetite.
Texture: Equigranular.

Paleomagnetism/Physical Properties:

Interval	**33 cm**	**119-121 cm**
NRM Intensity (10^{-3} emu/cm^3)	4.6	–
NRM Decl.	142.0	–
NRM Incl. (°)	–68.8	–
MDF (Oe.)	35.0	–
Stable Incl. (°)	–33.2?	–
Vp ∥ (km/s)	–	5.976
D (g/cm^3)	–	2.93
P (%)	–	2.3



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG		SITE			HOLE		CORE			SECT.
6	1	4	6	2	A		4	6		2

Depth: 739.3 to 740.6 m

MAJOR ROCK TYPE––BASALT SILL

Macroscopic Description:
Moderately to badly altered, slightly medium to medium grain-sized massive dolerite sill. It is the same unit as in Core 46, Section 1. The basalt has the same basic constituent minerals as in Core 46, Section 1, and is intersertal to intergranular. Veins are celadonite plus pyrite.

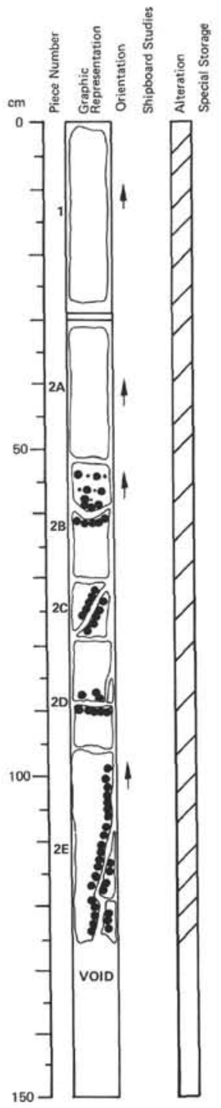
Thin Section Description:
78-80 cm: Fine grain-sized basalt from sill interior.
Phenocrysts: Olivine 5%, 0.2-0.4 mm, partly pseudomorphs; plagioclase (An65) 10%, 0.3-0.6 mm; spinel <1%, 0.003 mm, inclusions in olivine.
Groundmass: Plagioclase (An65-70) 20%, <0.1 m, laths; clinopyroxene (augite) 40%, <0.1 mm, granular; magnetite (Ti) 10%, <0.08 mm.
Alteration: Brown clay (15%) replacing clinopyroxene, olivine, and plagioclase.
Texture: Equigranular.

Shipboard Geochemistry (XRF, %):

Interval	**61-63 cm**	**72-24 cm**	**122-124 cm**
SiO_2	48.93	50.39	49.50
TiO_2	0.93	0.90	0.85
Al_2O_3	14.50	14.31	14.37
FeO	10.15	10.88	9.92
MnO	–	–	–
MgO	7.96	8.07	6.88
CaO	12.57	12.55	11.82
Na_2O	–	–	–
K_2O	0.006	0.007	0.008
P_2O_5	–	–	–
Total	–	–	–
LOI†	0.62	0.96	0.65
FeO ÷ MgO	1.27	1.34	1.44
CaO ÷ Al_2O_3	0.86	0.87	0.82
FeO ÷ TiO_2	10.91	12.08	11.67

Paleomagnetism/Physical Properties:

Interval	**69 cm**	**112-114 cm**
NRM Intensity (10^{-3} emu/cm^3)	6.8	–
NRM Decl.	173.0	–
NRM Incl. (°)	–60.3	–
MDF (Oe.)	55.0	–
Stable Incl. (°)	–27.0	–
Vp ∥ (km/s)	–	6.089
D (g/cm^3)	–	2.94
P (%)	–	1.9



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

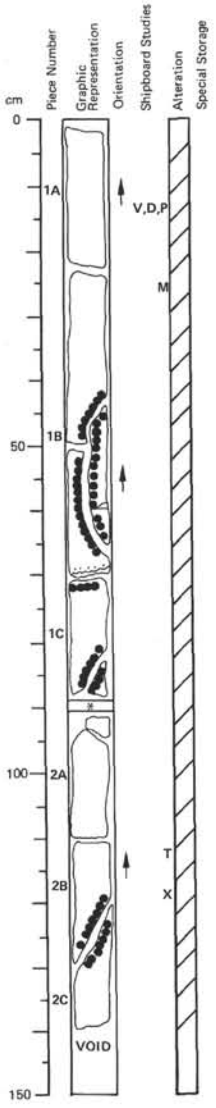
LEG		SITE			HOLE	CORE			SECT.
6	1	4	6	2	A		4	6	3

Depth: 740.6 to 741.9 m

MAJOR ROCK TYPE—-BASALT SILL

Macroscopic Description:

Moderately altered, slightly medium to medium grain-sized, massive dolerite sill. It is the same unit as in Core 46, Section 2. It has the same mineral constituents and is intersertal to intergranular. Veins are pyrite plus celadonite.



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG		SITE			HOLE	CORE			SECT.
6	1	4	6	2	A		4	6	4

Depth: 741.9 to 743.3 m

MAJOR ROCK TYPE—-BASALT SILL

Macroscopic Description:

Moderately altered massive dolerite sill with veins of pyrite plus celadonite. It is the same unit as in Core 46, Section 3.

From 0.0-71.0 cm it has a slightly medium to medium grain-size and is intersertal to intergranular. It has the same constituent minerals as Core 46, Section 1. From 71.0-140.0 cm, basalt has a medium to slightly coarse grain-size and is intergranular to subophitic. This basalt is made of microphenocrysts to phenocrysts of clinopyroxene, plagioclase, and magnetite (?), and microlites of clinopyroxene, plagioclase, and magnetite.

Thin Section Description:

111-114 cm: Basalt from sill interior.

Phenocrysts: Olivine 10%, 0.3-0.5 mm, pseudomorphs; plagioclase (An75) 2%, 0.2-0.4 mm; clinopyroxene (augite) 5%, 0.1-0.2 mm, microphenocrysts; spinel < 1%, < 0.003 mm, inclusions in olivine pseudomorphs.

Groundmass: Plagioclase (~An70) 25%, 0.2-0.4 mm, subhedral laths; clinopyroxene (augite) 35%, 0.1-0.2 mm, granular and subhedral; magnetite (Ti) 8%, < 0.08 mm.

Alteration: Brown clays (15%) in patches replacing rock and also occurs in veins.

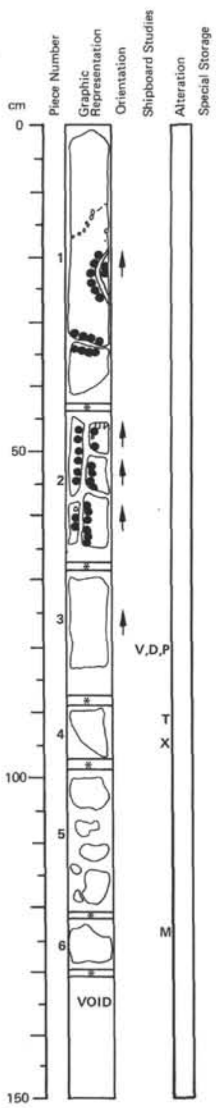
Texture: Intersertal and intergranular.

Shipboard Geochemistry (XRF, %):

Interval	**118-120 cm**
SiO_2	49.09
TiO_2	0.90
Al_2O_3	14.10
FeO	10.75
MnO	–
MgO	7.38
CaO	12.65
Na_2O	–
K_2O	0.003
P_2O_5	–
Total	–
LOI†	0.85
FeO ÷ MgO	1.45
CaO ÷ Al_2O_3	0.89
FeO ÷ TiO_2	11.94

Paleomagnetism/Physical Properties:

Interval	**29 cm**	**13-15 cm**
NRM Intensity (10^{-3} emu/cm^3)	6.3	–
NRM Decl.	342.0	–
NRM Incl. (°)	–68.8	–
MDF (Oe.)	50.0	–
Stable Incl. (°)	–55.0	–
Vp ‖ (km/s)	–	6.068
D (g/cm^3)	–	2.95
P (%)	–	1.8



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG		SITE			HOLE		CORE			SECT.
6	1	4	6	2	A		4	6		5

Depth: 743.3 to 744.6 m

MAJOR ROCK TYPE— -BASALT SILL

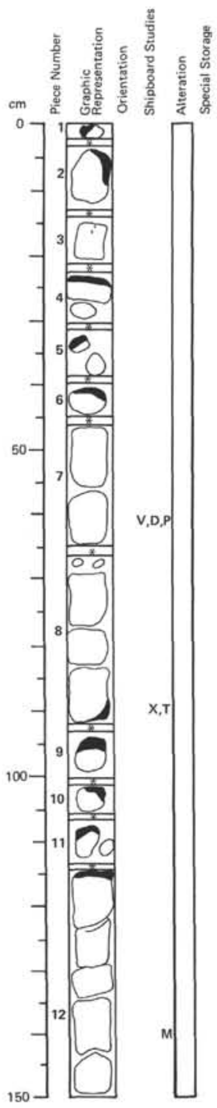
Macroscopic Description:
Moderately altered massive dolerite sill with veins of pyrite plus celadonite. Same mineral constituents as 46-1 and 46-4. It is the same unit as in 46-4.

From 0.0-130.0 cm, the basalt grain-size decreases from slightly coarse to fine. Piece 6 (121-130 cm) may be near a contact with sediment, although a distinct chilled margin is not found.

Thin Section Description:
90-92 cm: Fine grain-sized basalt from sill margin zone.
Phenocrysts: Olivine 4%, 0.1-0.2 mm, pseudomorphs; plagioclase (An70) 3%, 0.2-03 mm, subhedral; spinel < 1%, <0.02 mm, inclusions in olivine pseudomorphs.
Groundmass: Plagioclase (An70) 15%, 0.3-0.5 mm, thin acicular laths; clinopyroxene 68%, quench and very fine granules; magnetite (Ti) 10%, <0.01 mm; glass 5%, altered to smectite; amphibole replacing olivine.
Alteration: Brown clays (5%) replacing clinopyroxene, plagioclase, olivine, and glass.
Texture: Mixed hyalopilitic and intersertal.

Paleomagnetism/Physical Properties:

Interval	**123 cm**	**80-83 cm**
NRM Intensity (10^{-3} emu/cm^3)	5.0	–
NRM Decl.	61.0	–
NRM Incl. (°)	–38.5	–
MDF (Oe.)	120.0	–
Stable Incl. (°)	–31.1	–
Vp ‖ (km/s)	–	5.332
D (g/cm^3)	–	2.89
P (%)	–	4.8



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG		SITE			HOLE		CORE			SECT.
6	1	4	6	2	A		4	7		1

Depth: 747.0 to 748.5 m

MAJOR ROCK TYPE—-BASALT

Macroscopic Description:
Slightly altered basalt with abundant veins of pyrite plus celadonite plus clay. There are ~3-4% small clinopyroxene phenocrysts (0.2-0.4 mm) in the groundmass which varies from glassy to variolitic to equigranular.
Glassy margins are up to 13 mm thick and are very abundant. Textures of the interior crystalline portion is spotted and heterogeneous. Some clay alteration is visible as spots on cut surfaces. Zeolites (phillipsite) are preferentially associated with glass.

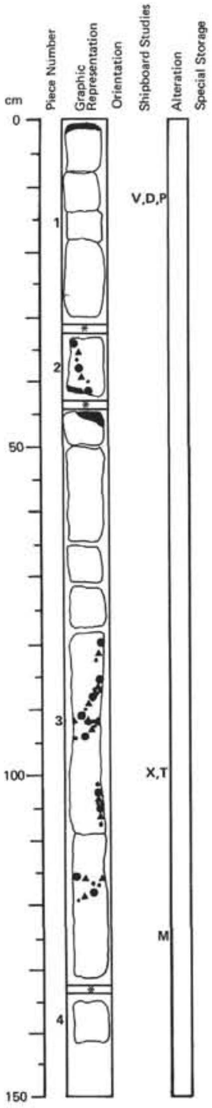
Thin Section Description:
88-90 cm: Contact of variolitic basalt and glassy basalt.
Microphenocrysts: Olivine (trace), 0.7 mm, euhedral altered to orange brown clay; trace of plagioclase.
Groundmass: Olivine trace, ~0.04 mm, equidimensional only in glass basalt; glass 95%, mesostasis, altered; plagioclase ~5%; <0.01 mm.
Alteration: Carbonate (trace) replacing olivine. Reddish brown clays (95%) in mesostasis replacing palagonite and olivine.
Texture: Variolitic and vitrophyric.

Shipboard Geochemistry (XRF, %):

Interval	**88-89 cm**
SiO_2	49.26
TiO_2	0.92
Al_2O_3	14.15
FeO	10.92
MnO	–
MgO	7.79
CaO	11.81
Na_2O	–
K_2O	0.137
P_2O_5	–
Total	–
LOI†	1.97
FeO ÷ MgO	1.40
CaO ÷ Al_2O_3	0.83
FeO ÷ TiO_2	11.86

Paleomagnetism/Physical Properties:

Interval	**140 cm**	**59-61 cm**
NRM Intensity (10^{-3} emu/cm^3)	6.5	–
NRM Decl.	53.0	–
NRM Incl. (°)	–39.0	–
MDF (Oe.)	85.0	–
Stable Incl. (°)	–31.0	–
Vp ‖ (km/s)	–	5.513
D (g/cm^3)	–	2.89
P (%)	–	6.3



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	47	2

Depth: 748.5 to 750.0 m

MAJOR ROCK TYPE—–BASALT

Macroscopic Description:
Slightly altered basalt with abundant veins of pyrite plus celadonite plus clay. There are ~3-4% of small clinopyroxene phenocrysts (0.2-0.4 mm) in the groundmass, which varies from glassy to variolitic, to equigranular. Glassy margins are up to 13 mm thick, but are less abundant than the Core 47, Section 2 unit.

Textures of the interior crystalline portion is spotted and heterogeneous. Some clay alteration is visible as spots on cut surfaces. Zeolites (phillipsite) are preferentially associated with glass. From 45.0-114 cm grain-size increases. Piece 4, from 135.0-142.0 cm has a finer grain-size than above.

Thin Section Description:

98-100 cm: Spinifex microdolerite from pillow interior.

Groundmass: Olivine 5%, 0.04-0.1 mm, subhedral, pseudomorphs; plagioclase 25%, 0.2 mm, small microlites; clinopyroxene 63%, <0.04 mm, spinifex aggregates; magnetite 7%.

Alteration: Greenish brown clays (~5%) replacing olivine.

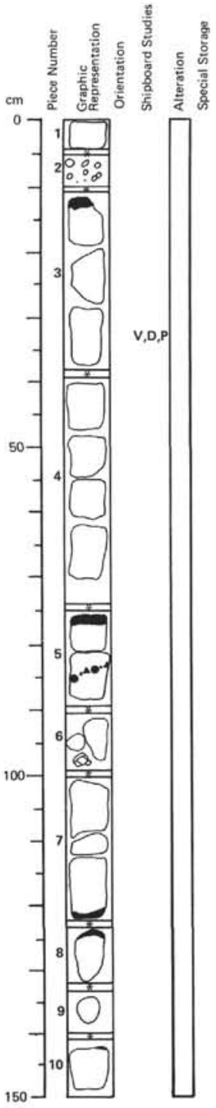
Texture: Microdolerite.

Shipboard Geochemistry (XRF, %):

Interval	**98-100 cm**
SiO_2	49.02
TiO_2	0.90
Al_2O_3	14.04
FeO	10.79
MnO	–
MgO	8.01
CaO	12.69
Na_2O	–
K_2O	0.003
P_2O_5	–
Total	–
LOI†	0.81
FeO ÷ MgO	1.34
CaO ÷ Al_2O_3	0.90
FeO ÷ TiO_2	11.98

Paleomagnetism/Physical Properties:

Interval	**124 cm**	**11-13 cm**
NRM Intensity (10^{-3} emu/cm^3)	7.4	–
NRM Decl.	135.0	–
NRM Incl. (°)	–44.2	–
MDF (Oe.)	85.0	–
Stable Incl. (°)	–29.5	–
Vp ‖ (km/s)	–	5.968
D (g/cm^3)	–	2.96
P (%)	–	2.8



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	47	3

Depth: 750.0 to 751.5 m

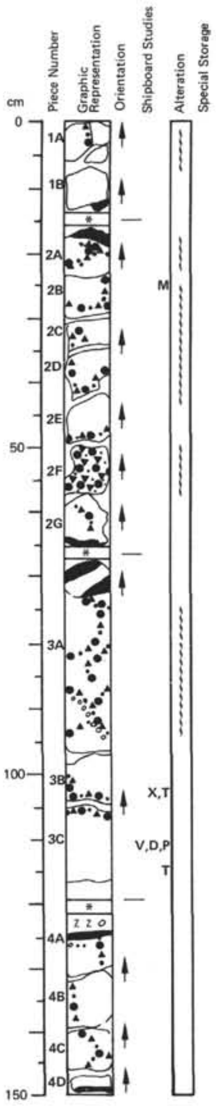
MAJOR ROCK TYPE—–BASALT

Macroscopic Description:
Slightly altered basalt with veins of pyrite plus celadonite plus clay. There are ~3-4% small clinopyroxene phenocrysts (0.2-0.4 mm) in the groundmass, which varies from glassy to variolitic, to equigranular. Glassy margins are up to 13 mm thick. Textures of the interior crystalline portion is spotted and heterogeneous.

Some clay alteration is visible as spots on cut surfaces. Zeolites (phillipsite) are preferentially associated with glass. Zeolite fragments occur at 5.0-10.0 cm from the top of the section. From 77.0-~100.0 cm, basalt grain-size increases, and from ~100.0-~120.0 cm, grain-size decreases.

Physical Properties:

Interval	**36-38 cm**
Vp ‖ (km/s)	5.660
D (g/cm^3)	2.91
P (%)	3.4



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	48	1

Depth: 756.0 to 757.5 m

MAJOR ROCK TYPE—-BASALT

Macroscopic Description:

Slightly phyric pillow basalt with pyrite plus celadonite plus clay veins and transparent and white zeolite veins.

Unit I occurs from 0.0-14.0 cm and it is slightly phyric basalt (plagioclase-clinopyroxene) with vesicles and a glassy rim near the bottom of the unit.

Unit II occurs from 17.0-67.0 cm. From 17.0-27.0 cm basalt is aphanitic with vesicles. From 27.0-64.0 cm basalt is aphanitic with glassy spots. From 44.0-58.0 cm the basalt is more coarse in grain-size without spots. From 58.0-67.0 cm basalt is aphanitic with a lower glassy margin.

Unit III occurs from 79.0-116.0 cm. From 79.0-85.0 cm, and 114.0-116.0 cm, the basalt is aphanitic. From 85.0-114.0 cm, the basalt is more coarse in grain-size.

Unit IV occurs from 123.0-150.0 cm and the basalt is aphanitic near the top (16 cm) and bottom (2 cm), and has a coarser grain-size in the middle.

Thin Section Description:

100-102 cm: Variolitic microdolerite next to glassy margin.

Groundmass: Olivine 3%, 0.1-0.3 mm; plagioclase 49%, 0.3 mm, small microlites, often chains of oriented microlites; clinopyroxene 38%, <0.004 mm, intergranular, spinifex-like; magnetite 7%, dust-like.

Vugs: 5% vugs, 1.0-7.0 mm, in groundmass, with clay and calcite, irregular shape.

Alteration: Carbonate (< 1%) in vugs. Clays (10%) in vugs and as pseudomorphs replacing olivine.

Texture: Microdoleritic with variolitic spots.

116-118 cm: Contact of (A) variolitic basalt and (B) spinifex microdolerite. Thin microdolerite veins penetrate to variolitic rock.

Groundmass: Olivine (A) trace and (B) 2%; plagioclase (A) 2% and (B) 40%; clinopyroxene (A) is – and (B) 49%, (B) spinifex aggregates; magnetite (A) is – and (B) 7%; glass (A) 98% and (B) 2%.

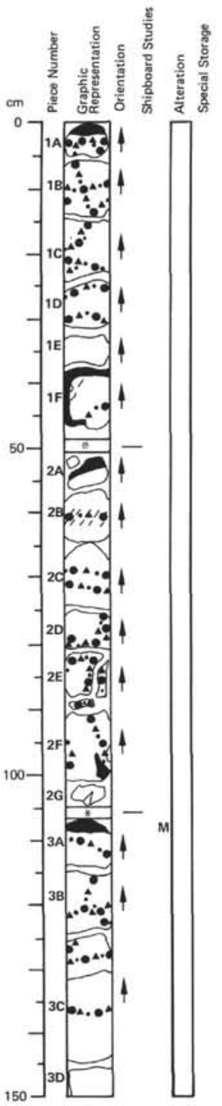
Alteration: Variolitic basalt has a groundmass of glass replaced by clay (98%). The microdolerite has 7% glass which has been replaced by clay.

Shipboard Geochemistry (XRF, %):

Interval	**100-107 cm**
SiO_2	48.53
TiO_2	0.90
Al_2O_3	14.04
FeO	10.68
MgO	7.97
CaO	12.77
K_2O	0.018
LOI†	0.93
FeO ÷ MgO	1.34
CaO ÷ Al_2O_3	0.90
FeO ÷ TiO_2	11.86

Paleomagnetism/Physical Properties:

Interval	**25 cm**	**110-112 cm**
NRM Intensity (10^{-3} emu/cm^3)	7.1	–
NRM Decl.	349.0	–
NRM Incl. (°)	–51.5	–
MDF (Oe.)	175.0	–
Stable Incl. (°)	–42.0	–
Vp ∥ (km/s)	–	5.737
D (g/cm^3)	–	2.96
P (%)	–	2.9



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	48	2

Depth: 757.5 to 759.0 m

MAJOR ROCK TYPE—-BASALT

Macroscopic Description:

Slightly phyric pillow basalt with calcite (rare) plus pyrite plus celadonite plus clay veins and transparent and white zeolite veins. There are three basalt units with glassy margins.

Unit I occurs from 0.0-49.0 cm.

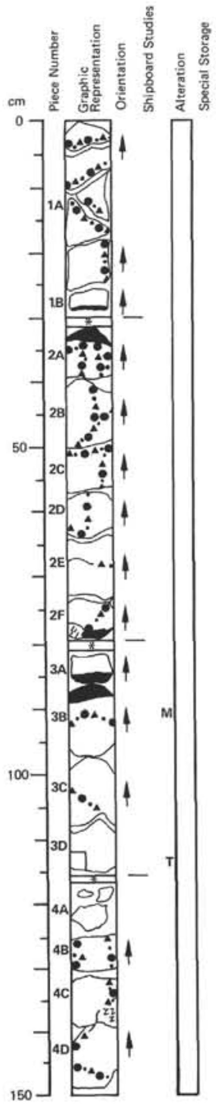
Unit II occurs from 50.0-104.0 cm.

Unit III occurs from 116.0-150.0 cm. These are the same as Piece 4E basalts in Core 48, Section 1.

From 125.0-150.0 cm, basalts have a medium grain-size.

Paleomagnetism:

Interval	**108 cm**
NRM Intensity (10^{-3} emu/cm^3)	6.1
NRM Decl.	115.0
NRM Incl. (°)	–40.8
MDF (Oe.)	100.0
Stable Incl. (°)	–28.3



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG		SITE			HOLE	CORE			SECT.	
6	1	4	6	2	A		4	8		3

Depth: 759.0 to 761.5 m

MAJOR ROCK TYPE—BASALT

Macroscopic Description:

Slightly phyric pillow basalt with calcite (rare) plus celadonite plus clay veins and transparent and white zeolite veins. There are three basalt units with glassy margins.

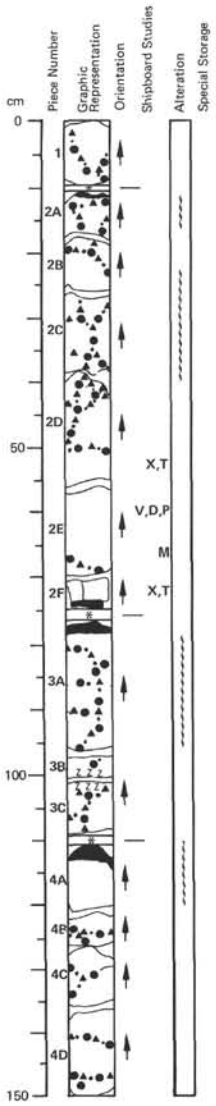
From 0.0-30.0 cm, basalt is the sample unit (Unit III) in the previous section (48-2).
Unit I occurs from 30.0-80.0 cm.
Unit II occurs from 80.0-118.0 cm.
Unit III occurs from 118.0-150.0 cm. These are the same as in Section 48-2.
From 115.0-117.0 cm basalt is aphanitic. From 135.0-137.0 cm there are veins of fibrous-radiating zeolite.

Thin Section Description:

114-116 cm: Variolitic basalt next to glassy margin.
Phenocrysts: Olivine 3%, 0.1-0.6 mm, euhedral clay pseudomorphs; plagioclase trace, elongated prisms.
Groundmass: Plagioclase 3%, laths slightly aligned; magnetite 5%, < 0.02 mm, common dust-like thin chains; glass 92%; sulfides trace, 0.2 mm, interspherolite filling.
Alterations: Clays (92%) in mesostasis replacing glass (reddish brown palagonite).
Texture: Variolitic.

Paleomagnetism:

Interval	**90 cm**	**108 cm**
NRM Intensity (10^{-3} emu/cm^3)	6.7	6.1
NRM Decl.	238.0	115.0
NRM Incl. (°)	–46.0	–40.8
MDF (Oe.)	–	100.0
Stable Incl. (°)	–	–28.3



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG		SITE			HOLE	CORE			SECT.	
6	1	4	6	2	A		4	8		4

Depth: 761.5 to 763.0 m

MAJOR ROCK TYPE—BASALT

Macroscopic Description:

Slightly phyric pillow basalt with calcite (rare) plus celadonite plus clay veins and transparent and white zeolite veins. At 101.0-102.0 cm there is a thick vein of fibrous-radiated pink zeolite with cubic pyrite. These basalts are similar to those in Core 48, Section 4.
From 0.0-10.0 cm is the bottom of the previous unit, (Core 48, Section 3, 117.0-150.0 cm). There are three new basalt units with glassy margins.
Unit I occurs from 10.0-74.0 cm.
Unit II occurs from 76.0-109.0 cm.
Unit III occurs from 111.0-150.0 cm.

Thin Section Description:

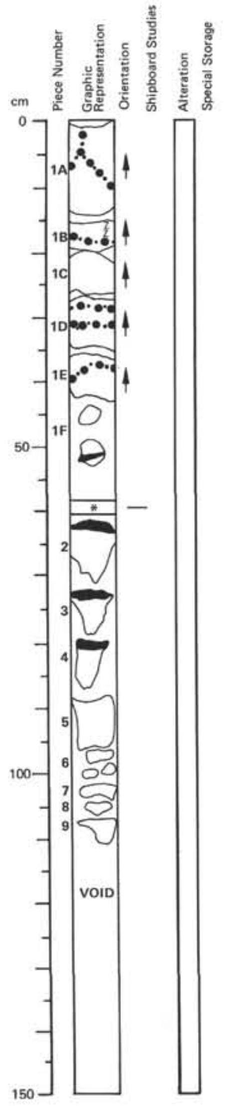
52-54 cm: Microdolerite from sill interior.
Microphenocrysts: Olivine 2%, 0.2 mm, euhedral, clay pseudomorphs; trace plagioclase.
Groundmass: Plagioclase (An62) 32%, 0.4 mm, microlites; clinopyroxene 61%, 0.02-0.04 mm, spinifex-like aggregates; magnetite 5%, 0.02-0.05 mm, dust-like.
Alteration: Clays (2%) forming pseudomorphs after olivine.
Texture: Variolitic.
72-74 cm: Variolitic basalt from glassy margin.
Microphenocrysts: Olivine ~ 1%, 0.2 mm, euhedral clay pseudomorphs; plagioclase (An68-82), 0.8 mm, elongated prisms.
Groundmass: Plagioclase ~2%, < 0.02 mm, small laths, slight alignment; glass 96%, mesostasis altered.
Vesicles: Vugs 1%, 0.4-1.0 mm, along contact, clay and calcite filling, irregular elongated shape.
Alteration: Carbonate (trace) in vugs. Clays (96%) replacing glass mesostasis (palagonite).
Texture: Variolitic.

Shipboard Geochemistry (XRF, %):

Interval	**52-54 cm**	**72-74 cm**
SiO_2	48.70	48.38
TiO_2	0.90	0.92
Al_2O_3	13.83	14.22
FeO	10.90	10.87
MnO	–	–
MgO	8.15	8.36
CaO	12.57	13.05
Na_2O	–	–
K_2O	0.04	0.033
P_2O_5	)	–
Total	–	–
LOI	0.81	0.69
FeO ÷ MgO	1.33	1.30
CaO ÷ Al_2O_3	0.90	0.91
FeO ÷ TiO_2	12.11	11.81

Paleomagnetism/Physical Properties:

Interval	**65 cm**	**61-63 cm**
NRM Intensity (10^{-3} emu/cm^3)	8.5	–
NRM Decl.	242.0	–
NRM Incl. (°)	–44.7	–
MDF (Oe.)	85.0	–
Stable Incl. (°)	–32.7	–
Vp ∥ (km/s)	–	6.026
D (g/cm^3)	–	2.97
P (%)	–	2.1



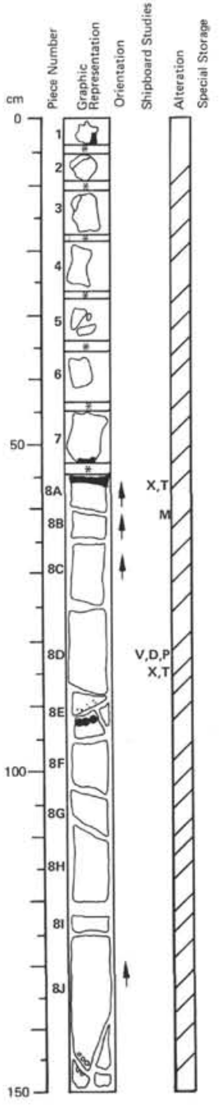
VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

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

Depth: 763.0 to 765.0

MAJOR ROCK TYPE—BASALT

Macroscopic Description:
Slightly phyric pillow basalt with calcite (rare) plus celadonite plus clay veins and zeolite veins. These basalts are similar to those in Core 48.
From 0.0-60.0 cm is the bottom of the unit from the previous section.
From 60.0-110.0 cm (Core-Catcher), these pieces do not have known orientations, and are aphanitic basalts with glassy pillow, fine-grained basalts.



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG		SITE			HOLE	CORE		SECT.	
6	1	4	6	2	A		4 9		1

Depth: 765.0 to 766.5 m

MAJOR ROCK TYPE—BASALT

Macroscopic Description:
Slightly fresh basalt with veins of celadonite plus pyrite.
From 0.0-54.0 cm, Pieces 1-7 were near contact with sediment or lower igneous rock, as they are fine to slightly aphyric (particularly the lower part of Piece 7) hyalopilitic basalt. Microphenocrysts of clinopyroxene are greater than plagioclase.
From 55.0-56.0 cm, the top of Piece 8A is medium light gray (N6) chilled glassy margin. From 56.0-68.0 cm, basalt is fine grain-sized to slightly aphyric and medium light gray (N6). From 68.0-150.0 cm, basalt is medium dark gray (N4), has an increasing grain-size from fine (68-103 cm) to medium (103-150 cm), and is intersertal to intergranular. From 68.0-103.0 cm, microphenocrysts of clinopyroxene ≈ to plagioclase, while from 103.0-150.0 cm, microphenocrysts of clinopyroxene are less than plagioclase.

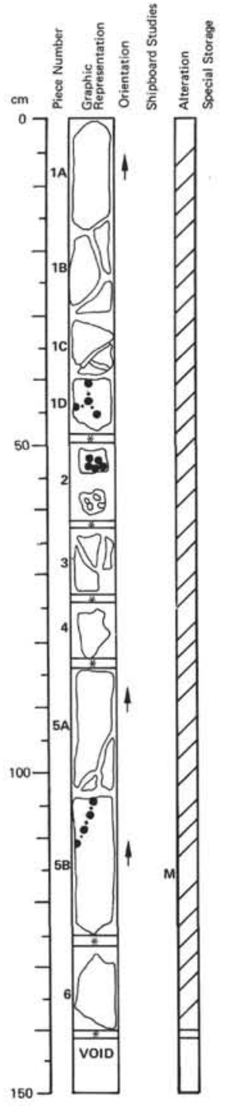
Thin Section Description:
55-57 cm: Contact of (A) glass and (B) variolitic basalt from glassy margin.
Phenocrysts: Olivine (A) trace and (B) 3%, 0.1-0.2 mm, euhedral, (A) fresh and (B) altered; plagioclase (trace); spinel <0.02 mm, inclusions in olivine.
Groundmass: Plagioclase (A) trace and (B) 3%, <0.02 mm, small laths; clinopyroxene (A) trace and (B) 1%, <0.02 mm, spinifex-like nucleous around plagioclase microphenocrysts; glass (A) 99% and (B) 93%, mesostasis in (A) is fresh and in (B) is altered.
Alteration: Clays (93%) replacing (B) mesostasis—glass and olivine.
Texture: (A) Vitrophyric and (B) variolitic.
83-85 cm: Microdolerite from sill interior.
Groundmass: Olivine 3%, 0.4 mm, euhedral clay pseudomorphs; plagioclase 55%, 0.4 mm, small microlites; clinopyroxene 38%, 0.08 mm, equidimensional and spinifex aggregates; magnetite 4%, 0.02 mm.
Alteration: Clays (3%) forming pseudomorphs after olivine.
Texture: Microdoleritic with spinifex-like spots.

Shipboard Geochemistry (XRF, %):

Interval	55-58 cm	83-85 cm
SiO_2	48.80	49.08
TiO_2	0.93	0.92
Al_2O_3	14.07	13.93
FeO	10.85	10.84
MnO	–	–
MgO	7.70	7.96
CaO	12.59	12.37
Na_2O	–	–
K_2O	0.049	0.019
P_2O_5	–	–
Total	–	–
LOI†	0.14	0.85
FeO ÷ MgO	1.40	1.36
CaO ÷ Al_2O_3	0.89	0.88
FeO ÷ TiO_2	11.66	11.78

Paleomagnetism/Physical Properties:

Interval	61 cm	81-83 cm
NRM Intensity (10^{-3} emu/cm^3)	9.6	–
NRM Decl.	96.0	–
NRM Incl. (°)	–44.2	–
MDF (Oe.)	95.0	–
Stable Incl. (°)	–32.8	–
Vp ∥ (km/s)	–	5.811
D (g/cm^3)	–	2.95
P (%)	–	2.5



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	49	2

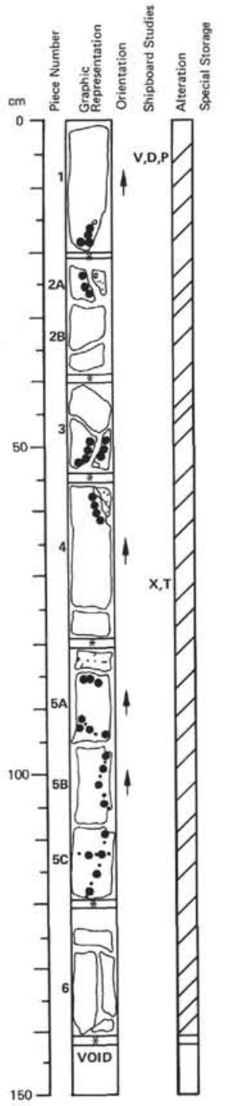
Depth: 766.5 to 767.9 m

MAJOR ROCK TYPE—MASSIVE DOLERITE SILL

Macroscopic Description:
Slightly fresh dolerite sill which is the same as the unit in lower portion of Section 49-1. Veins are pyrite plus celadonite.
From 0.0-150.0 cm basalt has a slightly medium to medium grain-size, and is intersertal to intergranular. From 0.0-74.0 cm, microphenocrysts of clinopyroxene ≈ plagioclase, while from 74.0-150.0 cm microphenocrysts of plagioclase is > clinopyroxene.

Paleomagnetism/Physical Properties:

Interval	**114 cm**
NRM Intensity (10^{-3} emu/cm^3)	7.2
NRM Decl.	184.0
NRM Incl. (°)	–50.4
MDF (Oe.)	55.0
Stable Incl. (°)	(+11.9)?
Vp ∥ (km/s)	–
D (g/cm^3)	–
P (%)	–



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	49	3

Depth: 767.9 to 769.4 m

MAJOR ROCK TYPE—MASSIVE DOLERITE SILL

Macroscopic Description:
Slightly fresh dolerite sill which is the same unit as in Core 49, Sections 1-2.
Veins are pyrite plus celadonite. Grain-size is slightly medium to medium and the basalt is intergranular to intersertal.

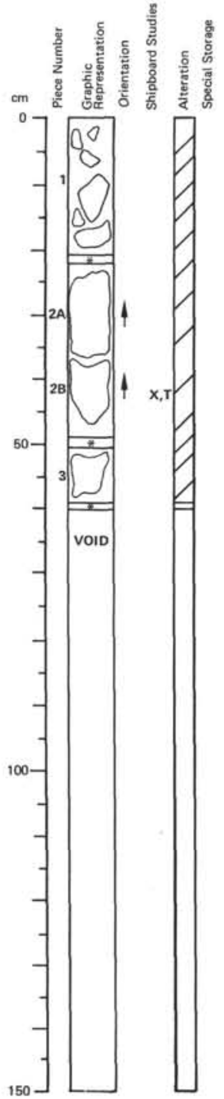
Thin Section Description:
70-72 cm: Microdolerite from sill interior.
Groundmass: Olivine 3%, 0.2-0.7 mm, anhedral dark brown clay pseudomorphs; plagioclase (An85-71) 45%, 0.4 mm, microlites, coarse tables; clinopyroxene 42%, 0.1-0.4 mm, intergranular; magnetite 8%, 0.04-0.12 mm, intergranular.
Alteration: Clays (5%) pseudomorphs after olivine.
Texture: Microdolerite.

Shipboard Geochemistry (XRF, %):

Interval	**70-72 cm**
SiO_2	49.28
TiO_2	0.95
Al_2O_3	13.82
FeO	11.01
MnO	–
MgO	8.08
CaO	12.32
Na_2O	–
K_2O	0.002
P_2O_5	–
Total	–
LOI†	0.98
$FeO \div MgO$	1.36
$CaO \div Al_2O_3$	0.89
$FeO \div TiO_2$	11.58

Physical Properties:

Interval	**6-8 cm**
Vp ∥ (km/s)	5.683
D (g/cm^3)	2.93
P (%)	2.9



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	49	4

Depth: 769.4 to 770.0 m

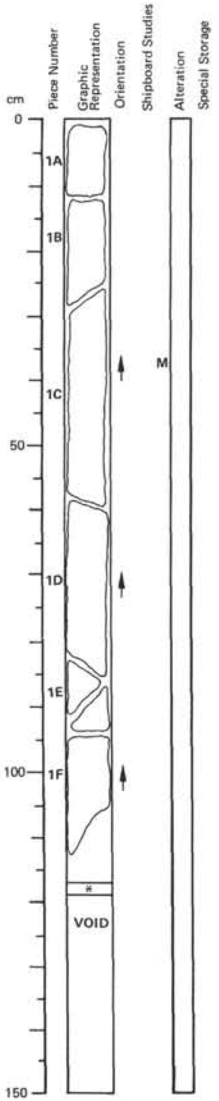
MAJOR ROCK TYPE—MASSIVE DOLERITE SILL

Macroscopic Description:
Slightly fresh massive dolerite, which is the same unit as in Core 49, Section 3. Grain-size is slightly medium to medium, and basalt is intersertal to intergranular.

Thin Section Description:
41-43 cm: Microdolerite from sill interior.
Phenocrysts: Olivine trace, 0.4-1.2 mm, euhedral clay pseudomorphs; plagioclase (An76-55) <1%, 0.4-1.0 mm, tables.
Groundmass: Olivine 2%, 0.1-0.4 mm, anhedral, altered; plagioclase (An62) 56%, 0.1 mm, microlites; clinopyroxene 36%, 0.04-0.1 mm, intergranular, spinifex aggregates; magnetite 6%, 0.06 mm, intergranular.
Alteration: Carbonate (trace) in clay (5%) pseudomorphs after olivine.
Texture: Microdolerite.

Shipboard Geochemistry (XRF, %):

Interval	**41-43 cm**
SiO_2	48.70
TiO_2	0.95
Al_2O_3	13.91
FeO	10.76
MnO	–
MgO	8.43
CaO	12.44
Na_2O	–
K_2O	0.007
P_2O_5	–
Total	–
LOI†	1.20
FeO ÷ MgO	1.27
CaO ÷ Al_2O_3	0.89
FeO ÷ TiO_2	11.32



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	50	1

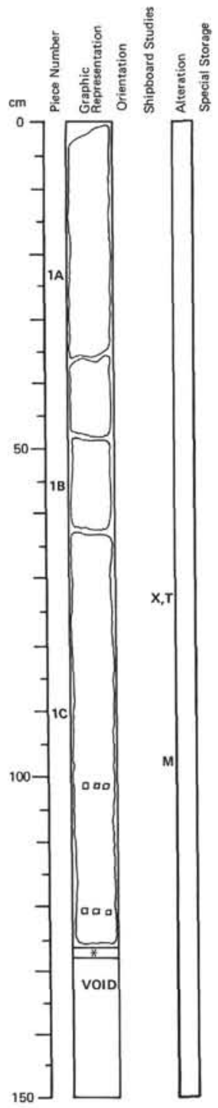
Depth: 774.0 to 775.2 m

MAJOR ROCK TYPE—MASSIVE DOLERITE SILL

Macroscopic Description:
Slightly fresh, medium dark gray (N4) massive dolerite sill which is the same unit as Core 49. The basalt has a homogeneous medium grain-size, is subophitic to intergranular, and has about equal amounts of microphenocrysts of plagioclase (0.8 mm) and clinopyroxene. Clinopyroxene microphenocrysts often form aggregates.
Groundmass is microlites of plagioclase, clinopyroxene, and magnetite.

Paleomagnetism/Physical Properties:

Interval	**38 cm**	**18-20 cm**
NRM Intensity (10^{-3} emu/cm^3)	3.5	–
NRM Decl.	182.0	–
NRM Incl. (°)	–60.4	–
MDF (Oe.)	50.0	–
Stable Incl. (°)	(+12.2)?	–
Vp ‖ (km/s)	–	6.012
D (g/cm^3)	–	2.98
P (%)	–	2.2



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	50	2

Depth: 775.2 to 776.4 m

MAJOR ROCK TYPE——MASSIVE DOLERITE SILL

Macroscopic Description:
Slightly fresh, massive dolerite sill which is the same unit as in Core 50, Section 1. The medium grain-size basalt is subophitic to intergranular. The slightly coarse grain-size basalt is subophitic. Microphenocrysts in the slightly coarse grain-sized basalt are more frequently absorbed than in the medium grain-sized basalt.

From 0.0-35.0 cm, grain-size increases from medium to slightly coarse, and remains slightly coarse to 150 cm, with the exception of granophyric schieran at 101.0-102.0 cm and 119.0-121.0 cm. These granophyric layers are absorbed in the coarse grain-sized basalt, and are made of phenocrysts of plagioclase (1.5 mm) clinopyroxene, magnetite, and a small amount of micropegmatite. Chlorite replaces clinopyroxene (spotty distribution).

Thin Section Description:
71-73 cm: Diabase from sill interior.

Groundmass: Plagioclase (An76) 45%, 0.3-0.7 mm; clinopyroxene (augite) 45%, 0.5-0.8 mm; magnetite (Ti) 5%, <0.2 mm.

Alteration: Chlorite (trace) replacing clinopyroxene. Clays (5%) replacing all minerals.

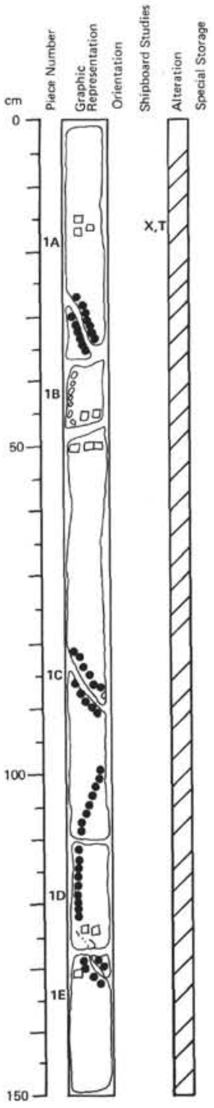
Texture: Subophitic.

Shipboard Geochemistry (XRF, %):

Interval	**71-73 cm**
SiO_2	48.48
TiO_2	0.93
Al_2O_3	13.77
FeO	10.71
MnO	–
MgO	8.51
CaO	12.17
Na_2O	–
K_2O	0.021
P_2O_5	–
Total	–
LOI†	0.92
FeO ÷ MgO	1.28
CaO ÷ Al_2O_3	0.88
FeO ÷ TiO_2	11.73

Paleomagnetism:

Interval	**98 cm**
NRM Intensity (10^{-3} emu/cm^3)	3.5
NRM Decl.	182.0
NRM Incl. (°)	–60.4
MDF (Oe.)	50.0
Stable Incl. (°)	(+12.2)?



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	50	3

Depth: 776.4 to 778.1 m

MAJOR ROCK TYPE——MASSIVE DOLERITE SILL

Macroscopic Description:
Moderately altered, coarse grain-sized, subophitic to ophitic massive dolerite sill, which is the same unit as in Core 50, Section 2. Veins are filled with celadonite, zeolite (phillipsite) and pyrite. Granophyre (▫▫▫▫▫) schlieren occurs at 14.0-18.0 cm (2-3 mm phenocrysts), 47.0-53.0 cm (2-3 mm phenocrysts), and 124.0-133.0 cm (5 mm phenocrysts).

Thin Section Description:
15-17 cm: Dolerite near sill interior.

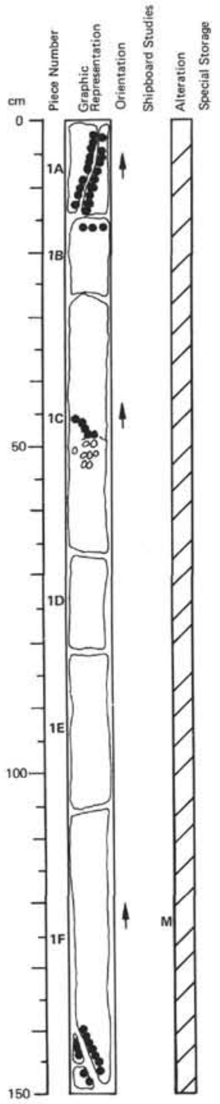
Groundmass: Plagioclase (An65) 40%, 0.5-0.8 mm, euhedral to anhedral; clinopyroxene (augite) 43%, 0.6-0.9 mm, ophitic plates; magnetite 10%, <0.25 mm, trace of quartz and alkali feldspar as an granophyric aggregate; amphibole 2-3%.

Alteration: Brown clays and chlorite (5%) replacing everything.

Texture: Ophitic.

Shipboard Geochemistry (XRF, %):

Interval	**15-17 cm**
SiO_2	49.54
TiO_2	0.99
Al_2O_3	12.77
FeO	11.26
MnO	–
MgO	8.81
CaO	11.33
Na_2O	–
K_2O	0.416
P_2O_5	–
Total	–
LOI†	1.08
FeO ÷ MgO	1.27
CaO ÷ Al_2O_3	0.88
FeO ÷ TiO_2	11.37



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	50	4

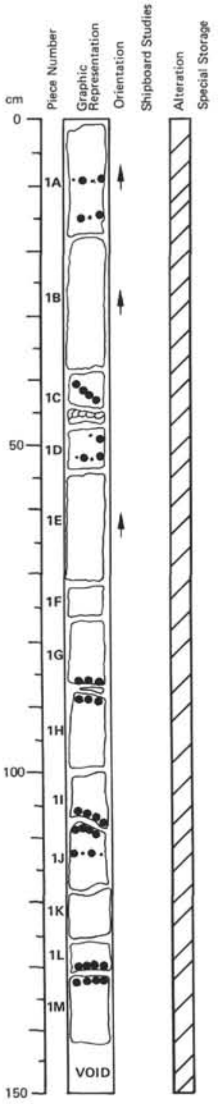
Depth: 778.1 to 778.5 m

MAJOR ROCK TYPE—MASSIVE DOLERITE SILL

Macroscopic Description:
Moderately altered, massive dolerite sill which is the same unit as in Core 50, Section 3. Grain-size decreases from coarse to slightly coarse downward and the basalt is, respectively, subophitic to interstitial. Veins are filled with celadonite, zeolite (phillipsite) and pyrite.

Paleomagnetism/Physical Properties:

Interval	**122 cm**	**21-23 cm**
NRM Intensity (10^{-3} emu/cm^3)	4.9	–
NRM Decl.	205.0	–
NRM Incl. (°)	–59.2	–
MDF (Oe.)	–	–
Stable Incl. (°)	(+10.0)?	–
Vp ‖ (km/s)	–	5.549
D (g/cm^3)	–	2.99
P (%)	–	1.7



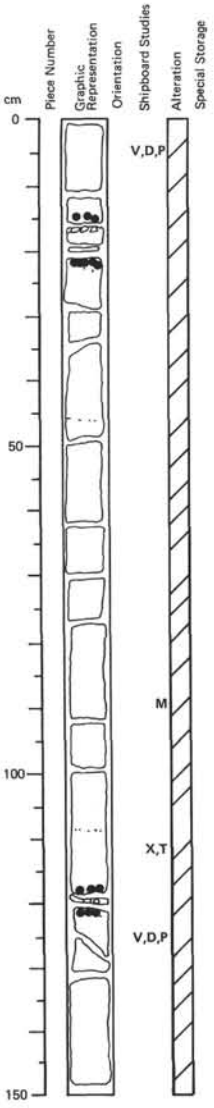
VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	50	5

Depth: 778.5 to – m

MAJOR ROCK TYPE—MASSIVE BASALT SILL

Macroscopic Description:
Slightly altered massive dolerite sill, which is the same unit as in Core 50, Section 4. Grain-size slightly decreases downward from slightly coarse to medium, and the basalt is intergranular to intersertal. Veins are filled with celadonite, zeolite (phillipsite), and pyrite.



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	50	6

Depth: 778.5 m

MAJOR ROCK TYPE—MASSIVE BASALT SILL

Macroscopic Description:
Slightly altered massive sill which is the same unit as in Core 50, Section 5. Grain-size is homogeneously medium, and the basalt is intergranular to interstitial. Veins are filled with celadonite, zeolite (phillipsite), and pyrite.

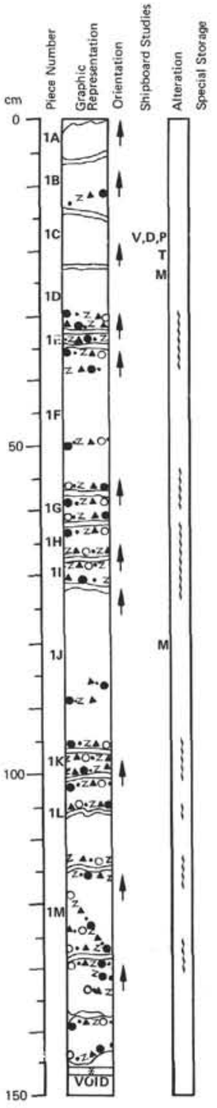
Thin Section Description:
109-111 cm: Granophyric diabase from sill interior.
Groundmass: Plagioclase (An65) 40%, 0.5-0.8 mm, euhedral and anhedral; clinopyroxene (augite) 40%, 0.6-0.9 mm, ophitic plates; magnetite 10%, <0.25 mm; quartz and feldspar 3%, granophyric aggregate; amphibole 2-3%; opalite < 1%.
Alteration: Brown clays and zeolite (5%) replacing all minerals.
Texture: Ophitic.

Shipboard Geochemistry (XRF, %):

Interval	**109-111 cm**
SiO_2	49.27
TiO_2	0.91
Al_2O_3	13.85
FeO	10.95
MnO	–
MgO	8.56
CaO	12.15
Na_2O	–
K_2O	0.015
P_2O_5	–
Total	–
LOI†	2.32
FeO ÷ MgO	1.27
CaO ÷ Al_2O_3	0.87
FeO ÷ TiO_2	12.03

Paleomagnetism/Physical Properties:

Interval	**7-8 cm**	**88 cm**	**124-126 cm**
NRM Intensity (10^{-3} emu/cm^3)	–	3.9	–
NRM Decl.	–	100.0	–
NRM Incl. (°)	–	–69.4	–
MDF (Oe.)	–	–	–
Stable Incl. (°)	–	(+20.3)?	–
Vp ∥ (km/s)	6.124	–	6.027
D (g/cm^3)	2.99	–	2.99
P (%)	1.7	–	1.6



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	51	1

Depth: 778.5 to 780.0 m

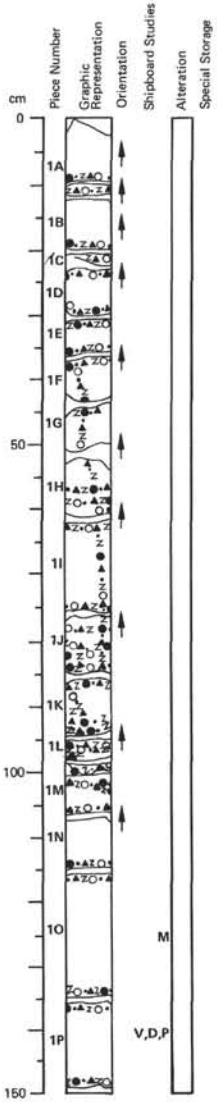
MAJOR ROCK TYPE—MASSIVE BASALT SILL

Macroscopic Description:
Slightly altered, homogeneously medium grain-sized, microdolerite with veins of pyrite plus celadonite plus clay and zeolite. The microdolerite is plagioclase, clinopyroxene, magnetite and olivine (?). The groundmass of microlites is very fresh except for small disseminated pale green clay pseudomorphs after olivine.

Thin Section Description:
20-22 cm: Microdolerite from sill interior.
Groundmass: Olivine 2%, 0.2 mm, euhedral and anhedral, altered; plagioclase (An60-68) 45%, microlites; clinopyroxene 46%, 0.2 mm, equidimensional, coarser grains are irregular; magnetite 7%, 0.1 mm, intergranular; quartz and alkali feldspar trace, ~0.08 mm, intergranular autonomous grains and intergranular granophyric aggregates; sulfides trace, ~0.15 mm, elongated plates.
Alteration: Grayish green clays (5%) pseudomorphs of olivine and plagioclase.
Texture: Microdolerite.

Paleomagnetism/Physical Properties:

Interval	**16-18 cm**	**24 cm**	**81 cm**
NRM Intensity (10^{-3} emu/cm^3)	–	3.5	2.9
NRM Decl.	–	31.0	161.0
NRM Incl. (°)	–	–79.1	–69.3
MDF (Oe.)	–	35.0	–
Stable Incl. (°)	–	(+20.5)?	–
Vp ∥ (km/s)	6.085	–	–
D (g/cm^3)	2.98	–	–
P (%)	1.8	–	–



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	51	2

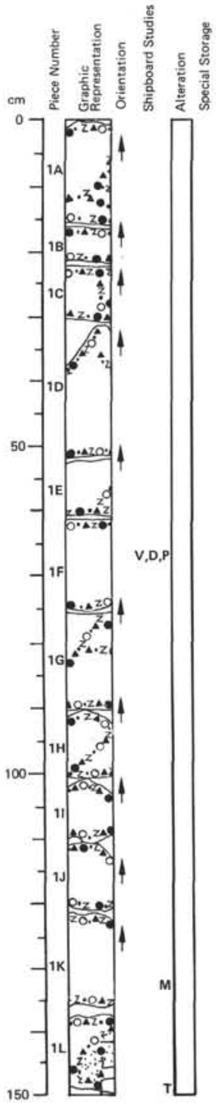
Depth: 780.0 to 781.5 m

MAJOR ROCK TYPE—–MASSIVE BASALT SILL

Macroscopic Description:
Slightly altered, homogeneously medium grain-sized, microdolerite with veins of pyrite plus celadonite plus clay and zeolite (Z Z Z). The microdolerite is plagioclase, clinopyroxene, magnetite and olivine (?). The groundmass of microlites is very fresh except for small disseminated pale green clay pseudomorphs after olivine.

Paleomagnetism/Physical Properties:

Interval	**126 cm**	**135-137 cm**
NRM Intensity (10^{-3} emu/cm^3)	3.7	–
NRM Decl.	44.0	–
NRM Incl. (°)	–71.6	–
MDF (Oe.)	–	–
Stable Incl. (°)	–	–
Vp ∥ (km/s)	–	5.975
D (g/cm^3)	–	2.07
P (%)	–	2.5



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	51	3

Depth: 781.5 to 783.0 m

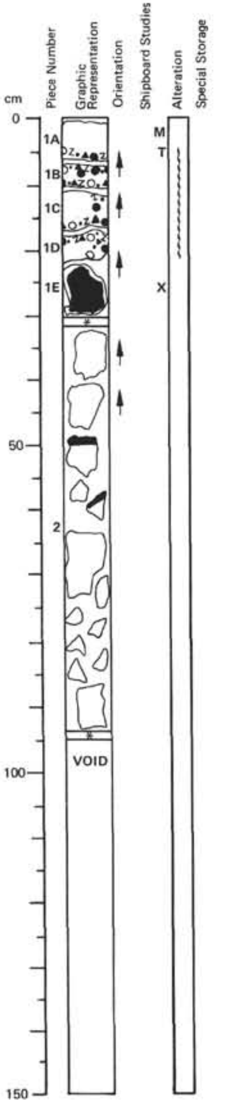
MAJOR ROCK TYPE—–BASALT

Macroscopic Description:
Slightly altered microdolerites with veins of pyrite plus celadonite plus clay and zeolite.
and (B) 60%, (A) 0.1 mm, and (B) <0.02 mm, equidimensional poikilophitic aggregates;
From 0.0-53.0 cm, the medium grain-sized microdolerite is the same as in Core 51, Section 2.
From 53.0-150.0 cm, the microdolerites become more fine in grain-size.
At 140.0-148.0 cm, there is an around aphanite zone. It may have been created by local quenching near the bottom of a sill ( ).

Thin Section Description:
147-150 cm: Contact of (A) microdolerite and (B) aphanitic basalt near the glassy sill bottom.
Microphenocrysts: Olivine (B) 1%, 0.2 mm, euhedral altered; plagioclase (B) trace, 0.4 mm.
Groundmass: Olivine (A) 2% and (B) 1%, (A) 0.3 mm and (B) 0.04 mm, (A) altered, (B) euhedral and intergranular and irregular; plagioclase (A) 55% and (B) 37%, (A) 0.3 mm, and (B) 0.02 mm, (A,B) small microlites, laths, and equidimensional; clinopyroxene (A) 38%, and (B) 60% (A) 0.1 mm, and (B) <0.02 mm, equidimensional poikilophylitic aggregates; magnetite (A) 5%, and (B) 8%, 0.04-0.12 mm, dust-like.
Alteration: Grayish-green brown clay (5%) pseudomorphs replacing olivine.
Textures: (A) Microdoleritic to (B) equigranular.

Paleomagnetism/Physical Properties:

Interval	**67-69 cm**	**134 cm**
NRM Intensity (10^{-3} emu/cm^3)	–	3.7
NRM Decl.	–	180.0
NRM Incl. (°)	–	-59.4
MDF (Oe.)	–	50.0
Stable Incl. (°)	–	(>+9.8)?
Vp ∥ (km/s)	5.841	–
D (g/cm^3)	2.96	–
P (%)	2.8	–



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	51	4

Depth: 783.0 to 787.5 m

MAJOR ROCK TYPE---BASALT

Macroscopic Description:

Slightly altered microdolerites and basalt with veins of pyrite plus celadonite plus clay and zeolites.

From 0.0-23.0 cm is the bottom of a sill and is fine grain-sized to aphanitic basalts.

From 23.0-30.0 cm occurs a coarse piece of dark brown glass, which is altered around the outer surface to chlorite-hematite-clay and is cut by zeolite veins.

From 30.0-95.0 cm are small pieces of (1) aphanitic basalts with glassy margins, and (2) fine to medium grain-sized microdolerites.

Thin Section Description:

5-7 cm: Phyric microdolerite from sill bottom.

Phenocrysts: Olivine 2%, 0.2-0.5 mm, euhedral, altered; plagioclase trace, 0.5 mm.

Groundmass: Olivine ~ 1%, <0.04 mm, irregular, altered; plagioclase 40%, 0.16 mm, small microlites; clinopyroxene 54%, 0.04 mm, equidimensional; magnetite 5%, <0.04 mm, dust-like.

Alteration: Clays (5%) form pseudomorphs after olivine and plagioclase.

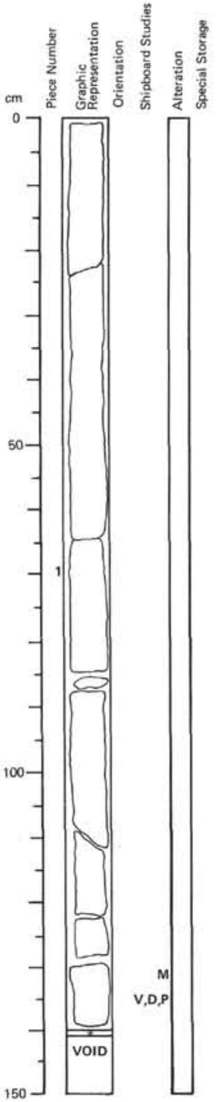
Texture: Microdoleritic.

Shipboard Geochemistry (XRF, %):

Interval	**27-30 cm**
SiO_2	48.89
TiO_2	0.99
Al_2O_3	13.91
FeO	11.23
MnO	–
MgO	7.81
CaO	11.72
Na_2O	–
K_2O	0.118
P_2O_5	–
Total	–
LOI†	1.16
FeO ÷ MgO	1.43
CaO ÷ Al_2O_3	0.84
FeO ÷ TiO_2	11.34

Paleomagnetism/Physical Properties:

Interval	**2 cm**
NRM Intensity (10^{-3} emu/cm^3)	4.3
NRM Decl.	313.0
NRM Incl. (°)	–77.9
MDF (Oe.)	40.0
Stable Incl. (°)	(+19.9)?



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	52	1

Depth: 787.5 to 789.4 m

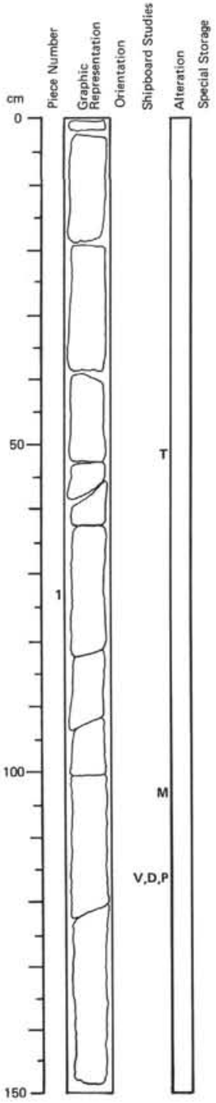
MAJOR ROCK TYPE---BASALT

Macroscopic Description:

Slightly altered, homogeneously coarse grain-sized dolerite with veins of green clay (84.0-87.0 cm), quartz (105.0-112.0 cm), and pyrite. There are minor grain-size variations, but the section appears to be one unit. There are a few patches of brown clay.

Paleomagnetism/Physical Properties:

Interval	**128 cm**	**131-133 cm**
NRM Intensity (10^{-3} emu/cm^3)	10.3	–
NRM Decl.	29.0	–
NRM Incl. (°)	–85.1	–
MDF (Oe.)	35.0	–
Stable Incl. (°)	–58.4	–
Vp ‖ (km/s)	–	5.853
D (g/cm^3)	–	2.95
P (%)	–	2.1



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
6 1	4 6 2	A	5 2	2

Depth: 787.4 to 790.9 m

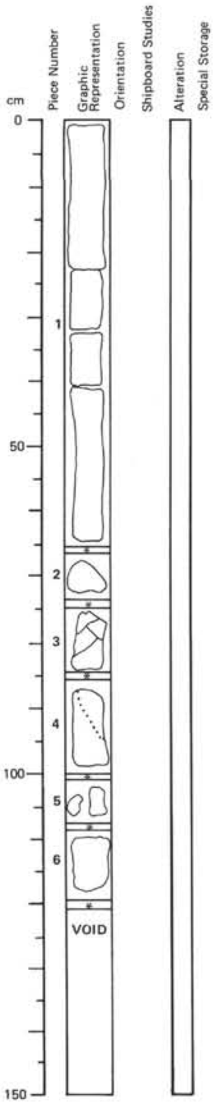
MAJOR ROCK TYPE–––BASALT

Macroscopic Description:
Slightly altered homogeneous coarse grain-sized dolerite with green clay veins. No visible clay patches as in Section 52-1, but clay veins are common.

Thin Section Description:
51-54 cm: Altered dolerite from sill interior.
Groundmass: Olivine 5%, 0.2-0.3 mm, pseudomorphs; plagioclase (An65-68) 40%, 0.2-0.5 mm; clinopyroxene (augite) 40%, 0.2-0.5, ophitic; magnetite (Ti) 5%, 0.04 mm.
Alteration: Green clays (10%) replaces olivine and also occurs in variolitic interstitial patches.
Texture: Dolerite.

Paleomagnetism/Physical Properties:

Interval	**106 cm**	**118-120 cm**
NRM Intensity (10^{-3} emu/cm^3)	4.4	–
NRM Decl.	214.0	–
NRM Incl. (°)	–68.7	–
MDF (Oe.)	35.0	–
Stable Incl. (°)	(+09.9)?	–
Vp ∥ (km/s)	–	5.920
D (g/cm^3)	–	2.94
P (%)	–	1.6



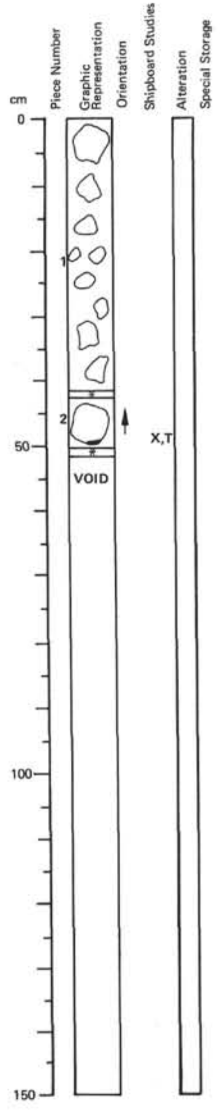
VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

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

Depth: 790.9 to 792.1 m

MAJOR ROCK TYPE–––BASALT

Macroscopic Description:
Slightly altered dolerite with green clay veins. Grain-size decreases downward and the fine grain-sized rock has 1-2% mafic phenocrysts (~0.2-~0.5 mm) in a fine grained gray matrix.



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

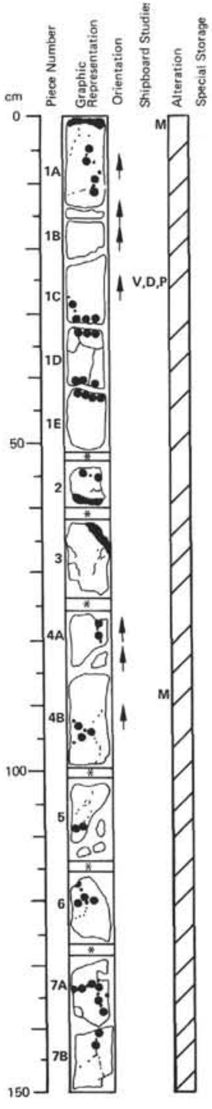
LEG	SITE	HOLE	CORE	SECT.
61	462	A	52	4

Depth: 792.1 to 792.1 m

MAJOR ROCK TYPE—BASALT

Macroscopic Description:
Slightly altered pieces of fine grain-sized basalt similar to the bottom of Core 52, Section 3. Only Piece 2 is oriented. All other pieces are unoriented and out of stratigraphic order. Piece 2 (43-52 cm) has a thin (49-50 cm) piece of glass in contact with fine grain-sized basalt near the bottom of Piece 2.

Thin Section Description:
49-51 cm: Fine grain-sized basalt near chill zone of pillow.
Phenocrysts: Olivine 3%, 0.2-0.7 mm, zeolite, clay and amphibole pseudomorphs; plagioclase (An71) 1%, 0.3-0.8 mm, euhedral; spinel <1%, <0.004 mm, inclusions in olivine pseudomorphs.
Groundmass: Plagioclase 10%, <0.7 mm, thin skeletal laths; clinopyroxene 46%, quench bundles, microlites; glass 30%, devitrified and replaced by brown clay.
Alteration: Clays, zeolites, and amphibole replacing olivine. Brown clays replacing glass.
Texture: Hyalopilitic.



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	53	1

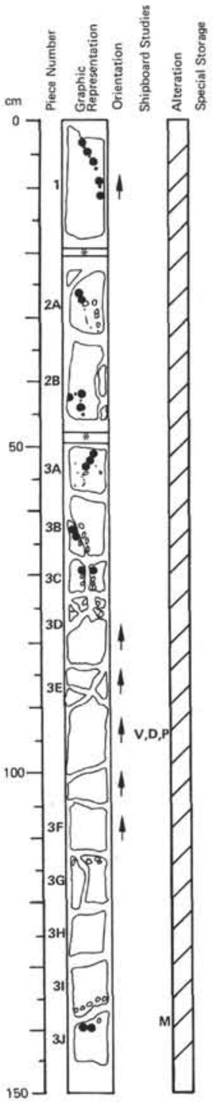
Depth: 792.0 to 793.5 m

MAJOR ROCK TYPE—MASSIVE BASALT

Macroscopic Description:
Slightly altered units of basalt with veins filled with celadonite plus pyrite.
Unit 1 occurs from 0.0-60.0 cm. It has thin (1 cm) glassy margins at the top and bottom of the unit. Grain-size increases from 1.0-25.0 cm to a fine grain-size and decreases from 25.0-59.0 cm. The basalt is aphyric to hyalopilitic. The rock has microphenocrysts of clinopyroxene and plagioclase and (microlitic to) a groundmass of clinopyroxene, plagioclase, and glass.
Unit 2 occurs from 61.0-150.0 cm. It is fine grain-sized basalt with thin (2 cm) upper glassy margins. Grain-size increases downward from 62.0 cm.

Paleomagnetism/Physical Properties:

Interval	3 cm	25-27 cm	88 cm
NRM Intensity (10^{-3} emu/cm^3)	4.4	–	6.9
NRM Decl.	50.0	–	176.0
NRM Incl. (°)	–44.7	–	–37.3
MDF (Oe.)	275.0	–	80.0
Vp ∥ (km/s)	–	5.915	–
D (g/cm^3)	–	2.93	–
P (%)	–	2.0	–



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	53	2

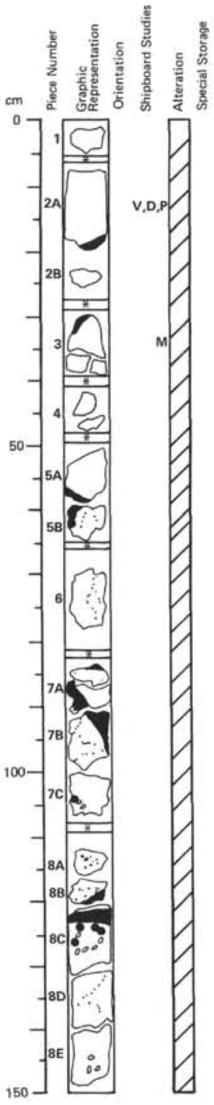
Depth: 793.5 to 795.0 m

MAJOR ROCK TYPE—BASALT SILL

Macroscopic Description:
Slightly altered basalt sill with veins; celadonite plus zeolite plus pyrite. Grain-size increases downward from fine (0.0-112.0 cm) to slightly medium to medium (112.0-150.0 cm), and the basalt is, respectively, hyalopilitic and intersertal. This unit is the same as the lower portion of Core 53, Section 1.

Paleomagnetism/Physical Properties:

Interval	**95-97 cm**	**139 cm**
NRM Intensity (10^{-3} emu/cm^3)	–	13.3
NRM Decl.	–	134.0
NRM Incl. (°)	–	–55.7
MDF (Oe.)	–	80.0
Stable Incl. (°)	–	–26.8
Vp ∥ (km/s)	6.052	–
D (g/cm^3)	2.94	–
P (%)	1.9	–



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	54	1

Depth: 797.5 to 799.0 m

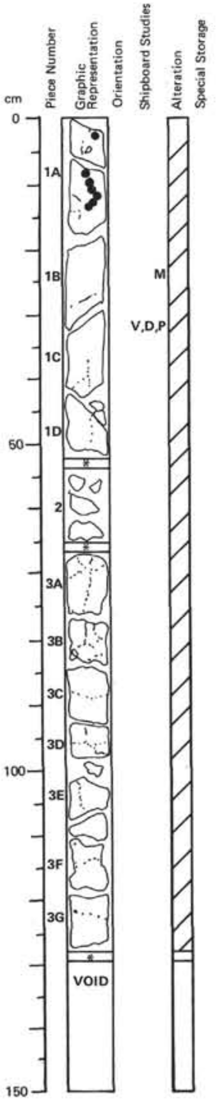
MAJOR ROCK TYPE—PILLOW BASALT

Macroscopic Description:
Slightly altered, five units of pillow lava. In these units, the widths of the glassy margins are about 1-2 cm. The inner part of each unit is slightly medium to fine in grain-size (aphanitic). The pillow lavas are made of olivine, clinopyroxene, and plagioclase microphenocrysts and a groundmass of clinopyroxene, plagioclase, magnetite, and glass.

Unit 1 is from 0.0-20.0 cm (Pieces 1-2A), and it has only a lower chilled margin, and is without an upper part.
Unit 2 is from 20.0-58.0 cm (Pieces 3-5A) and has a lower and upper glassy margin.
Unit 3 is from 58.0-90.0 cm (Pieces 5B-7A) and has a lower and upper glassy margin.
Unit 4 is from 90.0-120.0 cm (Pieces 7B-8B) and has a lower and upper glassy margin.
Unit 5 is from 120.0-next section (Core 54, Section 2), and only has a glassy upper margin.

Paleomagnetism/Physical Properties:

Interval	**13-15 cm**	**32 cm**
NRM Intensity (10^{-3} emu/cm^3)	–	3.9
NRM Decl.	–	95.0
NRM Incl. (°)	–	–44.9
MDF (Oe.)	–	240.0
Stable Incl. (°)	–	–25.4?
Vp ∥ (km/s)	5.936	–
D (g/cm^3)	2.93	–
P (%)	2.3	–



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG		SITE			HOLE	CORE		SECT.	
6	1	4	6	2	A	5	4		2

Depth: 799.0 to 800.3 m

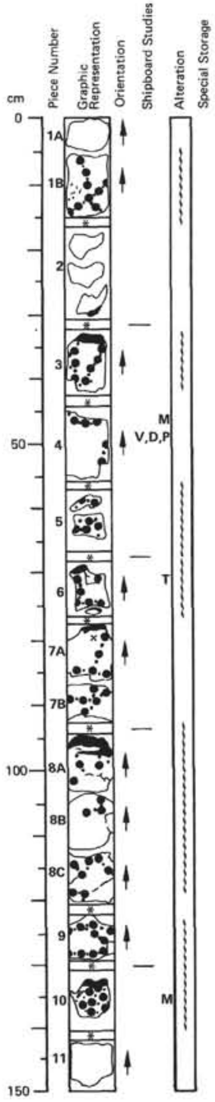
MAJOR ROCK TYPE—PILLOW BASALT

Macroscopic Description:
Slightly altered, two units of pillow lava, with veins of (phillipsite?) zeolite and celadonite. The inner part of each unit is slightly medium to fine in grain-size (aphanitic). The pillow lavas are made of olivine, clinopyroxene, and plagioclase microphenocrysts and a groundmass of clinopyroxene, plagioclase, magnetite, and glass.

Unit 5 occurs from 0.0-66.0 cm and is a continuation of the basalt unit of Core 54, Section 1, and it does not have a distinct lower glassy margin.
Unit 6 occurs from 66.0-130.0 cm (?) and does not have a distinct glassy margin.

Paleomagnetism/Physical Properties

Interval	**23 cm**	**30-32 cm**
NRM Intensity (10^{-3} emu/cm^3)	7.3	–
NRM Decl.	73.0	–
NRM Incl. (°)	–48.9	–
MDF (Oe.)	80.0	–
Stable Incl. (°)	–35.5?	–
Vp ∥ (km/s)	–	5.838
D (g/cm^3)	–	2.93
P (%)	–	2.3



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG		SITE			HOLE	CORE		SECT.	
6	1	4	6	2	A	5	5		1

Depth: 801.0 to 802.5 m

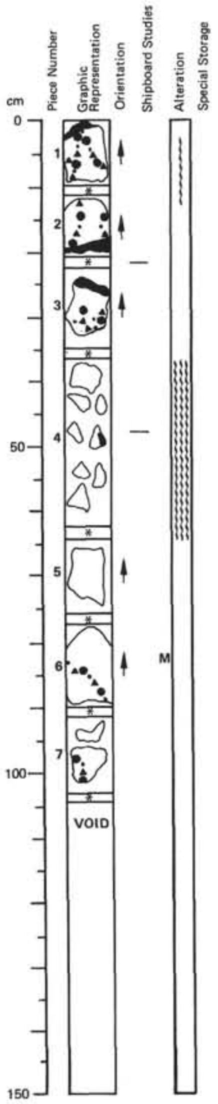
MAJOR ROCK TYPE—BASALT

Macroscopic Description:
Slightly altered, four units of microdolerites divided by glassy margins. Texture near the glassy margins is micro-equigranular with vesicles, which grades to microdolerites in the interior of the units.
Unit 1 is from 0.0-30.0 cm.
Unit 2 is from 30.0-93.0 cm.
Unit 3 is from 93.0-130.0 cm.
Unit 4 is from 130.0-150.0 cm.
All rocks are slightly aphyric and include olivine, pyroxene, plagioclase, magnetite, and glass. Clay pseudomorphs of olivine. Veins are zeolite druses (X X X X), pyrite plus celadonite plus clay (•••••••), and autonomous calcite plus clay (••••••••).

Thin Section Description:
69-71 cm: Glassy to fine grained basalt from pillow margin.
Phenocrysts: Olivine 2%, 0.1-0.2 mm, clay-zeolite pseudomorphs; plagioclase (An70-75) 2%, 0.2-0.9 mm; spinel <1%, <0.003 mm, inclusions in olivine pseudomorphs.
Groundmass: Plagioclase (variable %), skeletal microlites; clinopyroxene (variable %), quench textured bundles; glass (variable %), variably devitrified or replaced by clay.
Alteration: Clays, zeolites, chlorite (variable %), replacing plagioclase, olivine, and glass.
Texture: Variolitic to hyalopilitic.

Paleomagnetism/Physical Properties:

Interval	**48-51 cm**	**50 cm**	**144 cm**
NRM Intensity (10^{-3} emu/cm^3)	–	6.6	7.2
NRM Decl.	–	314.0	314.0
NRM Incl. (°)	–	–51.2	–39.9
MDF (Oe.)	–	120.0	110.0
Stable Incl. (°)	–	–42.8	–33.2
Vp ∥ (km/s)	5.776	–	–
D (g/cm^3)	2.95	–	–
P (%)	2.2	–	–



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG		SITE			HOLE	CORE			SECT.	
6	1	4	6	2	A		5	5		2

Depth: 802.5 to 806.5 m

MAJOR ROCK TYPE—BASALT

Macroscopic Description:

Slightly altered, three units of microdolerites divided by glassy margins. Veins are pyrite plus celadonite plus clay.

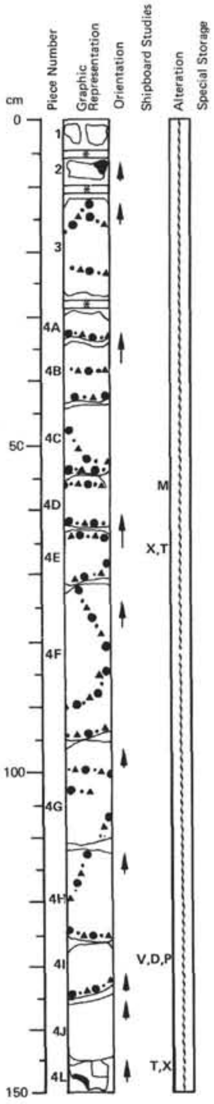
Unit 1 occurs from 0.0-35.0 cm, and it is the same unit as in the previous section (55-1).

Unit 2 occurs from 35.0-62.0 cm and it is of small pieces, some of which have glassy margins.

Unit 3 occurs from 62.0-104.0 cm and it is medium grain-sized, slightly phyric, microdolerites similar to those from the interior of sills.

Paleomagnetism:

Interval	**83 cm**
NRM Intensity (10^{-3} emu/cm^3)	6.8
NRM Decl.	197.0
NRM Incl. (°)	–48.0
MDF (Oe.)	105.0
Stable Incl. (°)	–38.2



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG		SITE			HOLE	CORE			SECT.	
6	1	4	6	2	A		5	6		1

Depth: 806.5 to 808.0 m

MAJOR ROCK TYPE—BASALT

Macroscopic Description:

Slightly altered, dolerites, with veins of pyrite plus celadonite plus clay. Grain-size gradually changes from aphanitic (0 cm) microdolerite or basalt to medium grain-sized (75 cm) dolerites and gradually back to aphanitic (150 cm) microdolerite or basalt.

Thin Section Descriptions

65-68 cm: Microdolerite from sill interior.

Microphenocrysts: Olvine 5%, 0.3 mm, euhedral altered; plagioclase (An67) trace, 0.5 mm, elongated prisms; clinopyroxene trace, 0.3 mm, poikilitic tables surrounded by fine-grained aggregates.

Groundmass: Plagioclase (An65) 35%, 0.2 mm, microlites; clinopyroxene 60%, 0.04 mm, equigranular, spinifex aggregates; magnetite 5%, 0.08 mm, dust-like.

Alteration: Clays (5%), pseudomorphs after olivine microphenocrysts.

Texture: Microdoleritic.

145-147 cm: Aphyric basalt from sill bottom.

Groundmass: Olivine 1%, 0.1 mm, glomeroporphyritic clusters; plagioclase 5%, <0.02 mm, laths; clinopyroxene trace; magnetite 5%, <0.02 mm, dust-like; glass 89%, mesostasis altered.

Alteration: Clays (90%) replacing glass mesostasis.

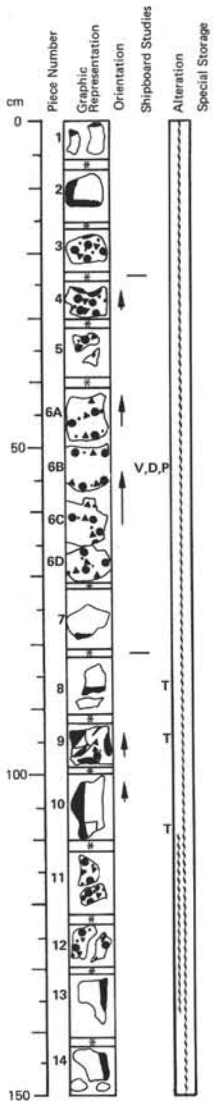
Texture: Intersertal to variolitic.

Shipboard Geochemistry (XRF, %):

	65-68 cm	**145-147 cm**
	(Altered Basalt)	
SiO_2	49.53	49.98
TiO_2	0.95	0.99
Al_2O_3	13.65	14.08
FeO	10.92	10.71
MnO	—	—
MgO	7.58	7.98
CaO	12.41	12.57
Na_2O	—	—
K_2O	0.004	0.004
P_2O_5	—	—
Total	—	—
LOI†	1.25	0.31
$FeO \div MgO$	1.44	1.34
$CaO \div Al_2O_3$	0.90	0.89
$FeO \div TiO_2$	11.49	10.81

Paleomagnetism/Physical Properties:

Interval	**57 cm**	**129-131 cm**
Intensity (10^{-3} emu/cc)	12.0	—
NRM Incl. (°)	2.42	—
NRM Decl.	–54.6	—
MDF (Oe.)	50.0	—
Stable Incl. (°)	–32.7	—
Vp ǁ (km/s)		5.904
D (g/cm^3)	—	2.97
P (%)	—	2.5



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
6 1	4 6 2	A	5 6	2

Depth: 808.0 to 809.5 m

MAJOR ROCK TYPE—BASALT

Macroscopic Descriptions:

Slightly altered basalt and microdolerite with veins of pyrite plus celadonite plus clay. There are three cooling units (0 to 25 cm, 25 to 80 cm, and 80 to 150 (?) cm).

From 0 to 25 cm, and 72 to 150 cm there are small pieces of altered pillowed basalts. Elongation of glassy pillow both subhorizontally and subvertically. Glassy zones are 1 to 2 cm thick.

From 25 to 72 cm, fine grain-sized basalt (25 cm) grades downward to microdolerite (50 cm) and fine grain-sized basalt (72 cm).

From 92 to 98 cm occurs a thick vein in the glassy margin. The vein is coarse fan-shaped crystalline, transparent zeolite.

Thin Section Descriptions:

96-98 cm: Zeolite vein in glass. Clays (15%) in vein margins. Zeolite (85%) in vein interior, fibrous.

107-109 cm: Contact of glass and variolitic basalt.

Microphenocrysts: Olivine 1%, 0.2 mm, euhedral, altered; plagioclase 1%, 0.5 mm, spinal trace, inclusions in olivine.

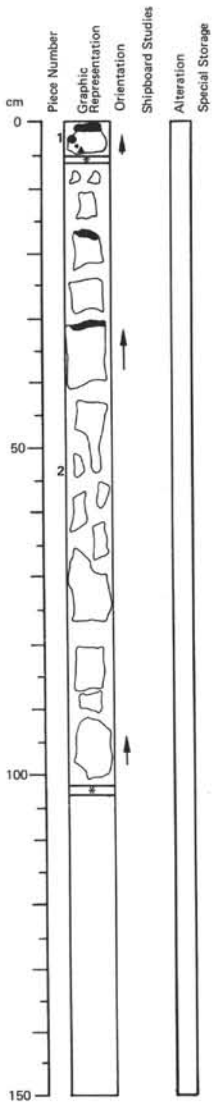
Groundmass: Plagioclase 5%, <0.02 mm, laths; glass 93%, mesostasis, altered in variolitic basalt, fresh in vitrophyre.

Alteration: Clays (93%) replace glass of mesostasis.

Texture: Variolitic and vitrophyric

Paleomagnetism:

Interval	**52 cm**
Intensity (10^{-3} emu/cc)	18.0
NRM Decl.	264.0
NRM Incl. (°)	–50.0
MDF (Oe.)	110.0
Stable Incl. (°)	–40.2



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

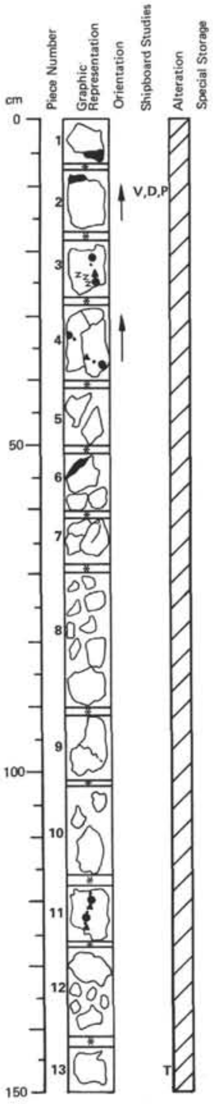
LEG	SITE	HOLE	CORE	SECT.
6 1	4 6 2	A	5 6	3

Depth: 809.5 to 815.5 m

MAJOR ROCK TYPE—PILLOW BASALTS

Macroscopic Description:

Slightly altered fragments of pillowed basalts and fine grain-sized microdolerites. Stratigraphic position of pieces unknown. Some coarse vugs are opal.



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	57	1

Depth: 815.5 to 817.0 m

MAJOR ROCK TYPE---PILLOW BASALT

Macroscopic Descriptions:
Slightly fresh pillow basalt with cracks or veins of pyrite-celadonite-clay and zeolite.

From 0 to 7 cm (piece 1) is a lower margin (glassy 5 to 7 cm) of a pillow lava.

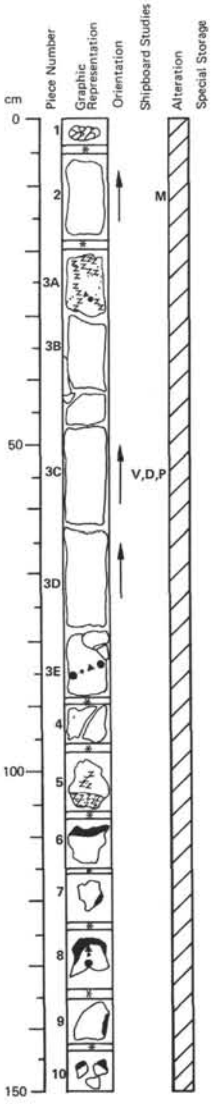
From 7 to 52 cm is a single unit of pillow lava, but without a lower glassy margin.

From 52 to 150 cm is the upper portion of a pillow lava. From 52 to 54 cm is the upper glassy margin, which is aphyric to hyalopilitic. The core of the unit is aphanitic to intersertal with plagioclase and clinopyroxene microphenocrysts. Pieces 7, 9, 11 and 13 are the interpart of the pillow lava, and Pieces 8, 10, and 12 are small crushed particles, which are almost fine to slightly medium grain-sized basalt.

Thin Section Description:
146-148 cm: Fine grain-sized basalt from sill or flow interior.
Phenocrysts: Olivine 4%, 0.1-0.2 mm, clay-zeolite pseudomorphs; plagioclase (An70) trace, 0.2-0.3 mm, euhedral, skeletal, spinel trace, <0.003 mm, inclusions in olivine pseudomorphs.
Groundmass: Plagioclase 25%, <0.2 mm, skeletal laths and microlites; clinopyroxene (augite) 56%, <0.1 mm, quench bundles and granules; magnetite (Ti) 10%, <0.01 mm, glass 5-10%.
Alteration: Clays (5%), zeolites (variable), chlorite (variable) replacing glass, olivine and plagioclase.
Texture: Intersertal to equigranular.

Paleomagnetism/Physical Properties:

Interval	**13 cm**	**10-12 cm**
Intensity (10^{-3} emu/cm^3)	8.5	—
NRM Decl.	227.0	—
NRM Incl. (°)	−42.1	—
MDF (Oe.)	100.0	
Stable Incl. (°)	−31.3	—
Vp ∥ (km/s)	—	6.085
D (g/cm^3)	—	3.01
P (%)	—	2.4



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	58	1

Depth: 824.5 to 826.0 m

MAJOR ROCK TYPE---BASALT

Macroscopic Descriptions:
Slightly altered basalt with veins of celadonite plus pyrite plus clay and zeolite.

From 1 to 3 cm (Piece 1) is zeolite (analcite?) in a basalt cavity. Crystals average 1-2 mm long with a maximum of 5 mm.

From 5 to 78 cm is slightly medium grain-sized, intersertal basalt.

From 78 to 88 cm (Piece 3E) is slightly fine grain-sized, hyalopilitic basalt, with microphenocrysts of plagioclase and clinopyroxene.

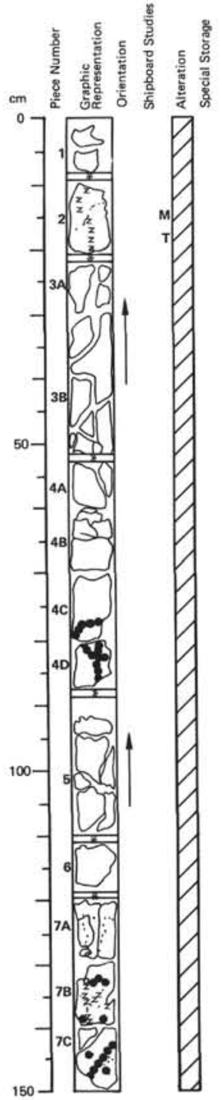
From 90 to 95 cm (Piece 4) is fine grain-sized basalt with microphenocrysts of plagioclase and clinopyroxene.

From 97 to 106 cm (Piece 5) is fine grain-sized aphyric basalt with a glassy margin (~2 cm thick). Zeolite vein and spots are present.

From 106 to 150 cm is a different unit than above, and is crushed; fine grain-sized fragments with glassy margins (1 to 2 cm thick). Piece 7 has a zeolite and iron oxide veins.

Paleomagnetism/Physical Properties:

Interval	**13 cm**	**53-55 cm**
Intensity (10^{-3} emu/cm^3)	5.6	—
NRM Decl.	155.0	—
NRM Incl. (°)	−68.9	—
MDF (Oe.)	—	—
Stable Incl. (°)	—	—
Vp ∥ (km/s)	—	5.873
D (g/cm^3)	—	2.96
P (%)	—	3.2



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

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

Depth: 826.0 to 827.5 m

MAJOR ROCK TYPE—BASALT

Macroscopic Descriptions:

Slightly altered basalt with veins of zeolite and celadonite. These basalts are the same unit as the lower one in Section 58-1.

From 0 to 20 cm is fine grain-sized (anhedral) clinopyroxene basalt.

From 20 to 150 cm is fine to slightly medium grain-sized, hyalopilitic to intersertal basalt. This basalt has microphenocrysts of clinopyroxene and plagioclase, and a groundmass of microlites of clinopyroxene, plagioclase, magnetite, and glass (?).

Thin Section Description:

19-21 cm: Altered basalt from sill interior.

Phenocrysts: Olivine <1%, 0.1-0.2 mm, clay and chlorite pseudomorphs; plagioclase <1%, 0.1-0.3 mm, clay pseudomorphs; clinopyroxene (augite) <1%, 0.1-0.3 mm, anhedral.

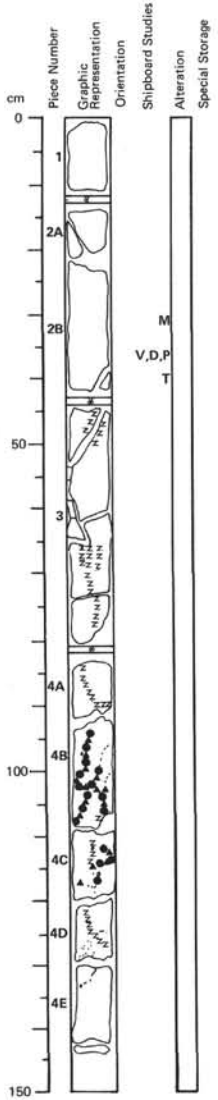
Groundmass: Plagioclase 20%, <0.5 mm, skeletal laths; clinopyroxene 58%, quench sprays, granules; magnetite (Ti) 7%, <0.1 mm.

Alteration: Brown clays plus chlorite (15%) replacing all minerals.

Texture: Intersertal to equigranular.

Paleomagnetism

Interval	**15 cm**
Intensity (10^{-3} emu/cm^3)	40
NRM Decl.	154
NRM Incl. (°)	−53.8
MDF (Oe.)	85
Stable Incl. (°)	−38.9



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
6 1	4 6 2	A	5 8	3

Depth: 827.5 to 829.0 m

MAJOR ROCK TYPE—BASALT

Macroscopic Description:

Fresh basalt with veins of zeolite and celadonite plus pyrite.

From 0 to 35 cm is slightly fine grain-sized aphanitic basalt with angular-clinopyroxene microphenocrysts.

From 35 to 45 cm slightly medium to medium grain-sized, aphanitic basalt. Microphenocrysts are larger and more abundant than above (0 to 35 cm).

From 45 to 60(?) cm is fine grain-sized, aphyric basalt with clinopyroxene microphenocrysts.

From 60(?) to 145 cm, grain-size gradually increases from fine to slightly fine aphanitic basalt.

Thin Section Description:

41-43 cm: Altered dolerite from sill interior.

Phenocrysts: Olivine trace, 0.1 mm, clay pseudomorphs.

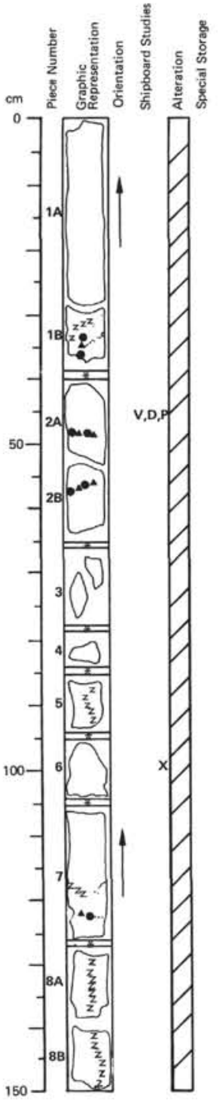
Groundmass: Plagioclase (An57) 30%, 0.1-0.3 mm, subhedral laths; clinopyroxene (augite) 48%, 0.1-0.2 mm, subophitic; magnetite (Ti) 7%, <0.1 mm, skeletal.

Alteration: Green clay (15%) replacing clinopyroxene and olivine.

Texture: Subophitic.

Paleomagnetism/Physical Properties

Interval	**30 cm**	**36-38 cm**
Intensity (10^{-3} emu/cm^3)	3.7	—
NRM Decl.	102.0	—
NRM Incl. (°)	−61.0	—
MDF (Oe.)	—	—
Stable Incl. (°)	—	—
Vp ‖ (km/s)	—	5.640
D (g/cm^3)	—	2.93
P (%)	—	4.9



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	58	4

Depth: 829.0 to 830.5

MAJOR ROCK TYPE—BASALT

Macroscopic Descriptions:

Fresh to slightly fresh basalt with veins of zeolite and pyrite-celadonite.

From 0 to 85 cm is fine to slightly medium grain-sized, clinopyroxene phyric aphanitic basalt.

From 85 to 115 cm is fine grain-sized slightly aphyric basalt with microphenocrysts (clinopyroxene).

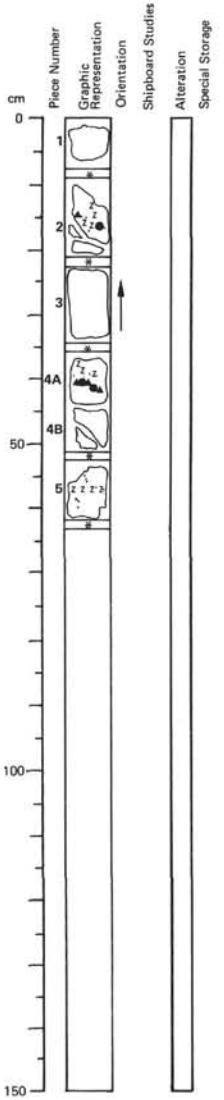
From 115 to 150 cm is fine to slightly medium grain-sized clinopyroxene phyric aphanitic basalt.

Shipboard Geochemistry (XRF, %):

	Altered Basalt 99-101 cm
SiO_2	48.57
TiO_2	1.02
Al_2O_3	14.06
FeO	10.96
MnO	—
MgO	7.87
CaO	12.62
Na_2O	—
K_2O	0.004
P_2O_5	—
Total	—
LOI†	0.51
FeO ÷ MgO	1.39
CaO ÷ Al_2O_3	0.89
FeO ÷ TiO_2	10.74

Paleomagnetism/Physical Properties:

Interval	**5 cm**	**47-49 cm**
Intensity (10^{-3} emu/cm^3)	4.7	—
NRM Decl.	107.0	—
NRM Incl. (°)	−57.5	—
MDF (Oe.)	—	—
Stable Incl. (°)	—	—
Vp ∥ (km/s)	—	5.552
D (g/cm^3)	—	2.92
P (%)	—	4.9



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

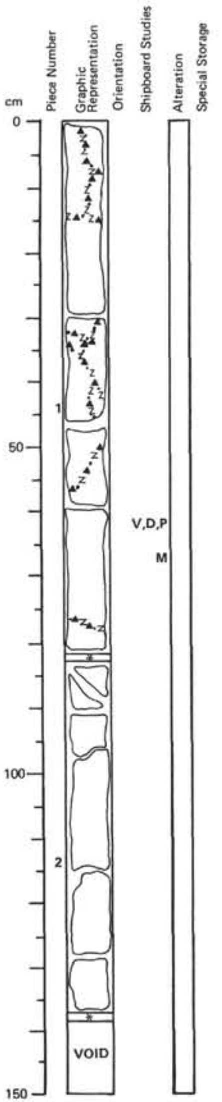
LEG	SITE	HOLE	CORE	SECT.
61	462	A	58	5

Depth: 830.5 to 831.1 m

MAJOR ROCK TYPE—BASALT

Macroscopic Description:

Fresh, fine to slightly medium grain-sized clinopyroxene phyric aphanitic basalt. Veins are zeolite and pyrite plus celadonite.



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	59	1

Depth: 833.5 to 834.9 m

MAJOR ROCK TYPE—BASALT SILL

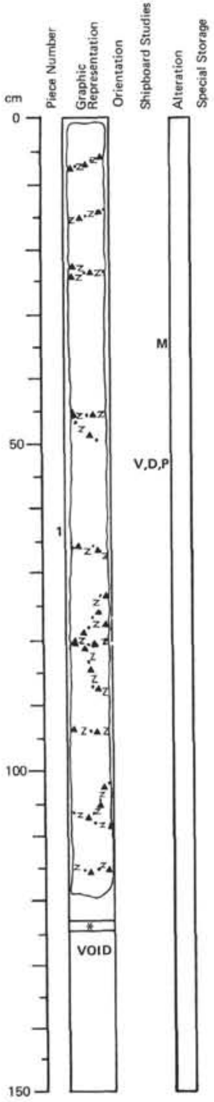
Macroscopic Description:
Slightly altered, dolerite sill with veins of clay, zeolite and pyrite. A portion of one cooling unit (intrusive) is represented in this section.

Grain-size is slightly coarser than the fine grain-sized basalt (gradually decreases) in the lower portion of the section.

A few (1-2%) phenocrysts of clinopyroxene (1.0 mm) occur in a matrix of doleritic to fine grain-sized, equigranular textured basalt. The coarse grained matrix is plagioclase, augite, opaques, and alteration products. Clay patches occur in the coarse-grained portions.

Paleomagnetism/Physical Properties:

Interval	**68 cm**	**62-64 cm**
Intensity (10^{-3} emu/cm^3)	9.2	—
NRM Decl.	219.0	—
NRM Incl. (°)	–56.5	—
MDF (Oe.)	—	—
Vp ‖ (km/s)	—	3.021
D (g/cm^3)	—	2.98
P (%)	—	3.0



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	59	2

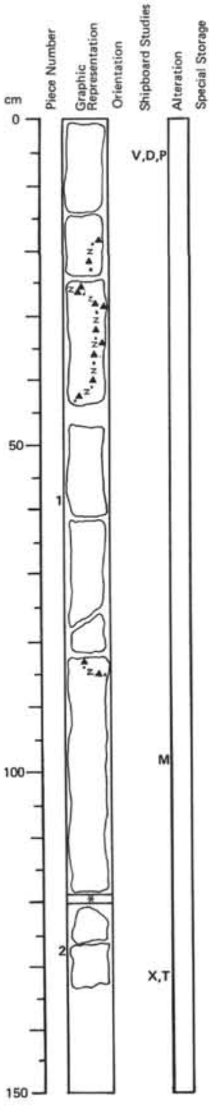
Depth: 834.9 to 836.1 m

MAJOR ROCK TYPE- –BASALT SILL

Macroscopic Description:
Slightly altered fine grain-sized dolerite sill. Grain-size decreases slightly in a downward direction. Mafic phenocrysts (1-2%, 0.2-0.5 mm) in a fine grained gray matrix.

Paleomagnetism/Physical Properties:

Interval	**36 cm**	**57-59 cm**
Intensity (10^{-3} emu/cm^3)	3.4	—
NRM Decl.	120.0	—
NRM Incl. (°)	–72.4	—
MDF (Oe.)	—	—
Stable Incl. (°)	?	—
Vp ‖ (km/s)	—	6.030
D (g/cm^3)	—	2.97
P (%)	—	2.3



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	59	3

Depth: 836.1 to 837.5 m

MAJOR ROCK TYPE—BASALT SILL

Macroscopic Description:
Slightly altered medium to coarse grain-sized dolerite. Mafic phenocrysts (1-2%, 0.2-0.5 mm) in a fine grained matrix. Same unit as 59-2.

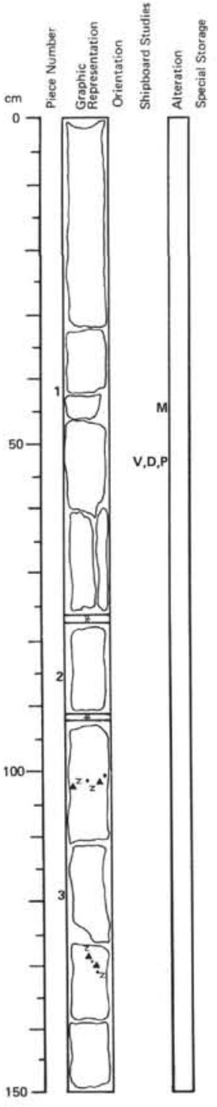
Thin Section Description:
132-134 cm: Dolerite from sill interior.
Phenocrysts: Olivine 1%, 0.1-0.5 mm, clay-chlorite pseudomorphs; plagioclase (A_n60) 1%, 0.2-0.6 mm, subhedral laths.
Groundmass: Plagioclase (An60) 40%, 0.1-0.2 mm, subhedral? clinopyroxene (augite) 43%, granular and subhedral; magnetite (Ti) 5%, <0.1 mm; quartz and alkali feldspar trace, granophyre (?); apatite (trace), masses of acicular crystals.
Alteration: Carbonate (variables %) and brown and green clays (10%) replacing clinopyroxene and olivine.
Texture: Ophitic.

Shipboard Geochemistry (XRF, %):

	Altered Basalt 132-134 cm
SiO_2	49.54
TiO_2	0.98
Al_2O_3	13.51
FeO	11.13
MnO	—
MgO	7.98
CaO	12.22
Na_2O	—
K_2O	0.16
P_2O_5	—
Total	—
LOI†	0.82
FeO ÷ MgO	1.39
CaO ÷ Al_2O_3	0.90
FeO ÷ TiO_2	11.35

Paleomagnetism/Physical Properties

Interval	**6-8 cm**	**99 cm**
Intensity (10^{-3} emu/cm^3)	4.8	—
NRM Decl.	145.0	—
NRM Incl. (°)	−67.0	—
MDF (Oe.)	—	—
Stable Incl. (°)	?	—
Vp ‖ (km/s)	—	5.952
D (g/cm^3)	—	2.97
P (%)	—	2.3



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	59	4

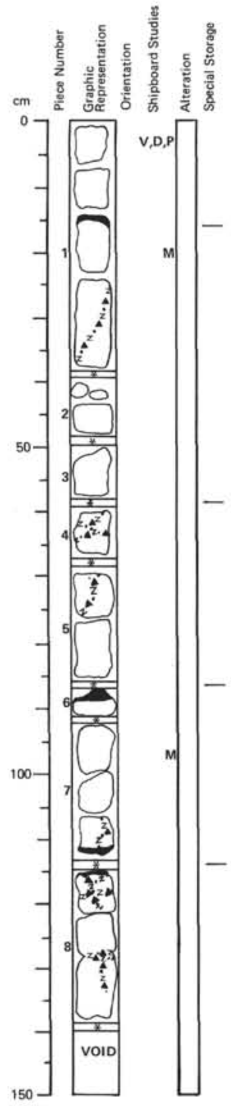
Depth: 837.5 to 839.0 m

MAJOR ROCK TYPE—BASALT SILL

Macroscopic Description:
Slightly altered medium to coarse grain-sized dolerite. Mafic phenocrysts (1-2%, 0.2-0.5 mm) in a fine grained matrix. Same unit as in 59-2 and 59-3.

Paleomagnetism/Physical Properties:

Interval	**45 cm**	**49-51 cm**
Intensity (10^{-3} emu/cm^3)	4.8	—
NRM Decl.	171.0	—
NRM Incl. (°)	−57.6	—
MDF (Oe.)	—	—
Stable Incl. (°)	?	—
Vp ‖ (km/s)	—	6.038
D (g/cm^3)	—	2.93
P (%)	—	2.6



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

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

Depth: 839.0 to 840.4 m

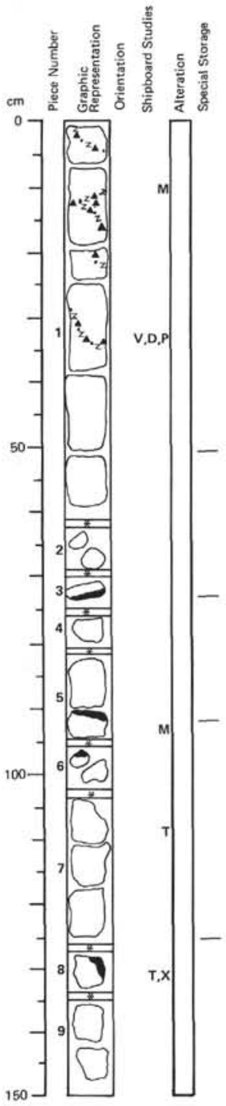
MAJOR ROCK TYPE---PILLOW BASALT

Macroscopic Descriptions:
From 0 to 14 cm is the bottom of the dolerite sill (unit?) from Section 59-4.

From 14 to 150 cm are four Pillow basalt units (14-59 cm, 59-85 cm, 85-113 cm, and 113-150 cm). These are fine grain-sized pillow basalt with veins of zeolite, pyrite and green clays. Glassy margins (1-2 cm thick) occur at 15 cm, 89 cm, and 113-115 cm. The interior basalt is made of a few phenocrysts (1%) of clinopyroxene (<0.5 mm) in a glassy to variolitic and equigranular matrix of aphanitic dark and light gray basalt. Some coarser ground fragments have spotted textures.

Paleomagnetism/Physical Properties:

Interval	**4-6 cm**	**20 cm**	**97 cm**
Intensity (10^{-3} emu/cm^3)	—	14.2	10.8
NRM Decl.	—	240.0	39.0
NRM Incl. (°)	—	−55.2	−44.4
MDF (Oe.)	—	110.0	95.0
Stable Incl. (°)	—	−37.2	−36.9
Vp ∥ (km/s)	6.096	—	—
D (g/cm^3)	2.95	—	—
P (%)	2.7	—	—



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

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

Depth: 840.4 to 841.9 m

MAJOR ROCK TYPE---PILLOW BASALT

Macroscopic Description:
From 0 to 50 cm is the bottom of the fine grain-sized basalt unit in the bottom of Section 59-5.

From 50 to 150 cm are four pillow basalt units (50-74 cm, 74-90 cm, 90-125 cm, and 125-150 cm). Glassy margins (1-2 cm thick) occur at 74 cm, 90 cm, 95 cm, and 125 cm.

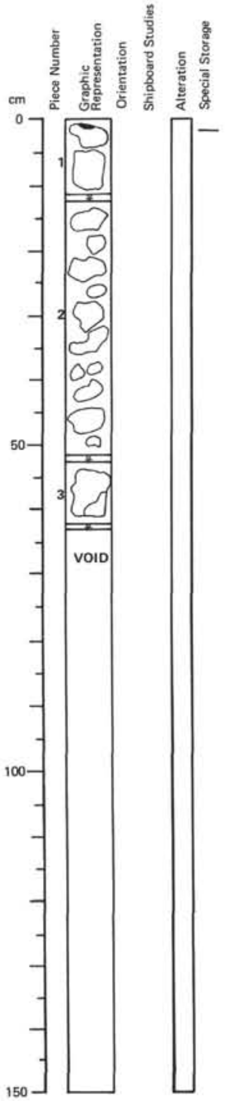
Thin Section Descriptions:
108-111 cm: Altered basalt from interior of flow.
Phenocrysts: Olivine trace, clay-pseudomorph; plagioclase (An68) 1%, 0.2-0.5 mm; clinopyroxene (augite) <1%, 0.1-0.3 mm, microphenocrysts.
Groundmass: Plagioclase (A 65) ?%, 0.1-0.2 mm, subhedral to anhedral; clinopyroxene (augite) ?%, <0.1-0.15 mm, quench phase and granules; magnetite (Ti) 5%, <0.005 mm, granules.
Alteration: Brown clays (10%) replacing all minerals.
Texture: Mixed intersertal to intergranular.
131-133 cm: Glassy basalt from flow margin.
Phenocrysts: Olivine trace, clay pseudomorphs; plagioclase (An65) 1%, <0.2 mm, euhedral tables clinopyroxene (augite) 1%, 0.1-0.15 mm, euhedral to subhedral with zoning; spinel <1%, <0.003 mm, inclusions in plagioclase.
Groundmass: Glass 88%, altered variolitic fine quench masses; magnetite (Ti) 10%, <0.002 mm, dust-like; secondary amphibole replacing clinopyroxene and other minerals.
Alteration: Clays (variable %) replacing quench phase, glass, and phenocrysts.
Texture: Variolitic.

Shipboard Geochemistry (XRF, %):

	Altered Basalt 131-133 cm
SiO_2	50.18
TiO_2	1.01
Al_2O_3	13.70
FeO	11.43
MnO	—
MgO	7.78
CaO	12.60
Na_2O	—
K_2O	0.029
P_2O_5	—
Total	—
LOI†	0.29
FeO ÷ MgO	1.46
CaO ÷ Al_2O_3	0.91
FeO ÷ TiO_2	11.31

Paleomagnetism/Physical Properties

Interval	**11 cm**	**33-35 cm**	**104 cm**
Intensity (10^{-3} emu/cm^3)	6.4	—	8.0
NRM Decl.	89.0	—	23.0
NRM Incl. (°)	−52.0	—	−46.7
MDF (Oe.)	70.0	—	130.0
Stable Incl. (°)	−37.0	—	−44.2
Vp ∥ (km/s)	—	5.654	—
D (g/cm^3)	—	—	—
P (%)	—	—	—



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

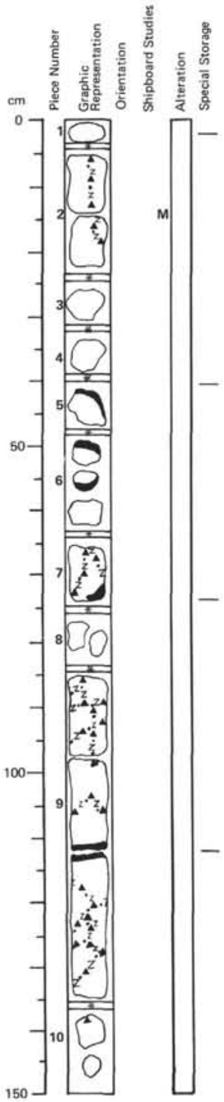
LEG	SITE	HOLE	CORE	SECT.
61	462	A	59	7

Depth: 841.9 to 842.5 m

MAJOR ROCK TYPE—PILLOW BASALT

Macroscopic Description:

Fine grain-sized pillow basalt. Veins of pyrite, zeolite, and clay. A thin glassy margin (1-2 cm) occurs at the top of the section. This section is similar to the 59-6 section. These fragments (Pieces 1 and 2) were in the core-catcher and their stratigraphic orientation is unknown.



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	60	1

Depth: 842.5 to 844.0 m

MAJOR ROCK TYPE—PILLOW BASALT

Macroscopic Descriptions:

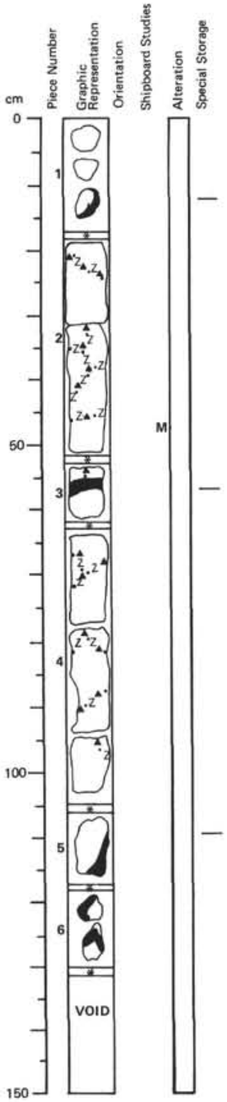
Three units of pillow basalts with glassy margins (1-2 cm thick) occur from 0-40 cm, 40-74 cm, 74-113 cm, and 113-150 (?) cm.

These units range in texture from glassy to equigranular. Basalts have sparse (1%) phenocrysts (0.2-0.4 mm) of clinopyroxene in a light gray aphanitic groundmass. The coarser fragments have holocrystalline groundmass of plagioclase, clinopyroxene, opaques, plus alteration products.

0-4 cm has a coarse grain-size, and 85-104 cm has a slightly coarse grain-size. Spots and veins of pyrite, clay, and phillipsite, which are more abundant than previous cores.

Paleomagnetism:

Interval	**17 cm**
Intensity (10^{-3} emu/cm^3)	6.0
NRM Decl.	201.0
NRM Incl. (°)	–48.9
MDF (Oe.)	110.0p
Stable Incl. (°)	–37.0



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG		SITE			HOLE		CORE		SECT.	
6	1	4	6	2	A		6	0		2

Depth: 844.0 to 845.3 m

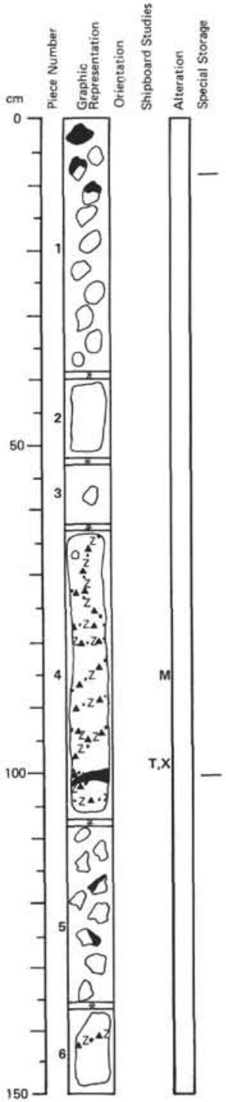
MAJOR ROCK TYPE—PILLOW BASALT

Macroscopic Description:
Four units of pillow basalts, with glassy margins (1-2 cm thick) occur from 0-14 cm, 14-55 cm, 55-105 cm, and 105-150(?) cm. These units range in texture from glassy to equigranular. Basalts have sparse (1%) phenocrysts (0.2-0.4 mm) of clinopyroxene in a light gray aphanitic groundmass. The coarser fragments have holocrystalline groundmass of plagioclase, clinopyroxene, opaques, plus alteration products.

From 18-43 cm is a slightly coarser grain-sized region. Spots and veins of pyrite, clay, and phillipsite, and a concentration of phillipsite occurs at 77 cm.

Paleomagnetism:

Interval	**47 cm**
Intensity (10^{-3} emu/cm^3)	4.9
NRM Decl.	355.0
NRM Incl. (°)	−62.5
MDF (Oe.)	75.0
Stable Incl. (°)	−42.3



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG		SITE			HOLE		CORE		SECT.	
6	1	4	6	2	A		6	0		3

Depth: 845.3 to 846.8 m

MAJOR ROCK TYPE—PILLOW BASALT

Macroscopic Description:
Two units of pillow basalts with glassy margins (1-2 cm thick) occur from 0(?)-102 cm, 102-150(?) cm. These units range in texture from glassy to equigranular. Basalts have sparse (1%) phenocrysts (0.2-0.4 mm) of clinopyroxene in a light gray aphanitic groundmass. The coarser fragments have holocrystalline groundmass of plagioclase, clinopyroxene, opaques, plus alteration products.

From 31-65 cm is a slightly coarser grain-sized region. Spots and veins of pyrite, clay, and phillipsite.

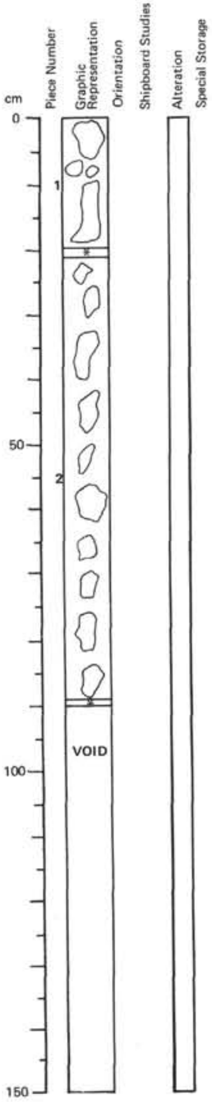
Thin Section Descriptions:
99-101 cm: Slightly phyric basalt from sill bottom.
Phenocrysts: Olivine 1%, 0.3 mm, euhedral, altered; plagioclase (A 85) 1%, 0.4 mm.
Groundmass: Plagioclase 5%, <0.005 mm, small laths; clinopyroxene 1%, 0.08 mm, irregular; magnetite 3%, 0.06 mm, dust-like; glass 89%, altered.
Alteration: Clays (20%) greenish-brown pseudomorphs after olivine, and reddish-brown pseudomorphs after glass.
Texture: Hyalopilitic to intersertal.

Shipboard Geochemistry (XRF, %):

	Altered Basalt 99-101 cm
SiO_2	47.90
TiO_2	1.01
Al_2O_3	13.70
FeO	10.87
MnO	—
MgO	7.35
CaO	12.51
Na_2O	—
K_2O	0.021
P_2O_5	—
Total	—
LOI†	0.36
FeO ÷ MgO	1.47
CaO ÷ Al_2O_3	0.91
FeO ÷ TiO_2	10.76

Paleomagnetism:

Interval	**95 cm**
Intensity (10^{-3} emu/cm^3)	5.5
NRM Decl.	112.0
NRM Incl. (°)	−57.5
MDF (Oe.)	85.0p(?)
Stable Incl. (°)	−45.4



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	60	4

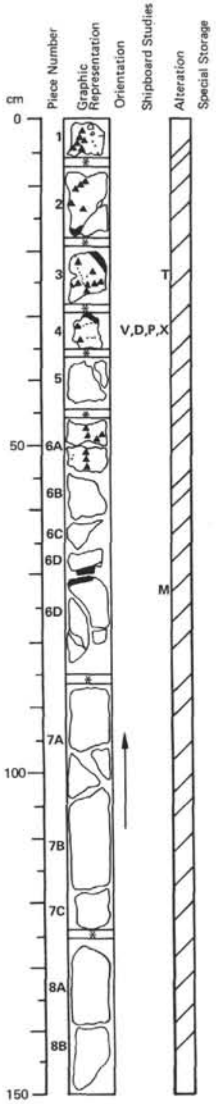
Depth: 846.8 to 847.6 m

MAJOR ROCK TYPE—BASALT

Macroscopic Description:

Fine to coarse grain-sized basalt. Basalts have sparse (1%) phenocrysts (0.2-0.4 m) of clinopyroxene in a light gray aphanitic groundmass. Most of the fragments (20-90 cm) are coarser basalts with a holocrystalline groundmass of plagioclase, clinopyroxene, opaques, plus alteration products.

From 20-90 cm are fragments from the core-catcher and their orientation and stratigraphic position are unknown.



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	61	1

Depth: 851.5 to 853.0 m

MAJOR ROCK TYPE—PILLOW-LIKE BASALT

Macroscopic Description:

Slightly altered pillow-like basalt with veins of zeolite (phillipsite) and pyrite.

From 0-20 cm grain-size decreases downwards from slightly medium grain-size basalt to a glassy lower margin (1-2 cm thick). The main basalt is aphanitic with sparse spots of clinopyroxene microphenocrysts.

From 20-70 cm is fine grain-sized basalt with upper (20-24 cm) and lower (68-70 cm) glassy margins (1-2 cm thick).

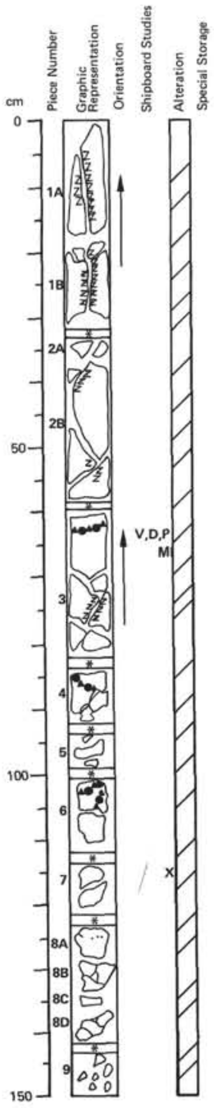
From 70-150 cm is an upper (1-2 cm thick) glassy margin and the basalt has a gradually increasing grain-size (downward) to fine grain-size at 85 cm and slightly medium to medium at 150 cm. The coarser grain-sized basalt is intersertal.

Shipboard Geochemistry (XRF, %):

	Altered Basalt 30-32 cm
SiO_2	47.49
TiO_2	1.01
Al_2O_3	13.64
FeO	11.11
MnO	—
MgO	7.35
CaO	12.36
Na_2O	—
K_2O	0.021
P_2O_5	—
Total	—
LOI†	0.63
FeO ÷ MgO	1.51
CaO ÷ Al_2O_3	0.90
FeO ÷ TiO_2	11.00

Paleomagnetism/Physical Properties:

Interval	32-34 cm	71 cm
Intensity (10^{-3} emu/cm^3)	—	6.3
NRM Decl.	—	57.0
NRM Incl. (°)	—	–57.0
MDF (Oe.)	—	140.0p
Stable Incl. (°)	—	–43.1
Vp ⊥ (km/s)	5.881	—
D (g/cm^3)	2.93	—
P (%)	4.2	—



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG		SITE			HOLE	CORE		SECT.	
6	1	4	6	2	A	6	1		2

Depth: 853.0 to 854.5 m

MAJOR ROCK TYPE—PILLOW-LIKE BASALT

Macroscopic Description

Slightly altered pillow-like basalt with veins filled with zeolite and celadonite and pyrite. The unit is a continuation of the preceding section (61-1).

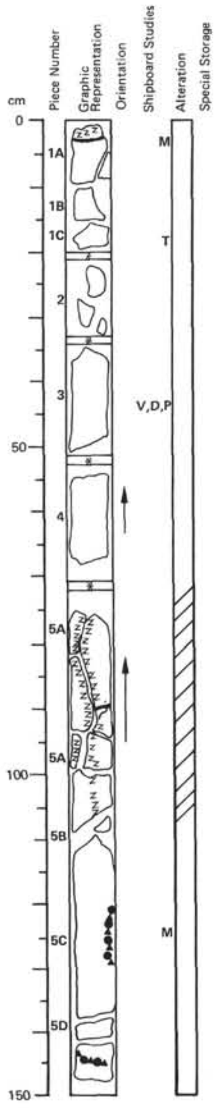
From 0-122 cm is a single basalt unit with a lower glassy margin (1-2 cm thick). From 0-57 cm is medium grain-sized; 57-100 cm is slightly medium to slightly fine grain-sized; and 100-122 cm is fine grain-sized without a glassy lower margin. From 122-143 cm is a single fine grain-sized basalt unit without glassy margins. From 143-150 cm are small (drill?) crushed particles.

Shipboard Geochemistry (XRF, %):

	Altered Basalt 115-118 cm
SiO_2	47.81
TiO_2	1.03
Al_2O_3	13.87
FeO	10.98
MnO	—
MgO	7.55
CaO	12.36
Na_2O	—
K_2O	0.042
P_2O_5	—
Total	—
LOI†	0.01
FeO ÷ MgO	1.45
CaO ÷ Al_2O_3	0.89
FeO ÷ TiO_2	10.66

Paleomagnetism/Physical Properties:

Interval	64-66 cm	67 cm
Intensity (10^{-3} emu/cm^3)	—	7.3
NRM Decl.	—	157.0
NRM Incl. (°)	—	–52.9
MDF (Oe.)	—	—
Stable Incl. (°)	—	—
Vp ‖ (km/s)	5.734	—
D (g/cm^3)	2.92	—
P (%)	4.0	—



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG		SITE			HOLE	CORE		SECT.	
6	1	4	6	2	A	6	1		3

Depth: 854.5 to 856.0 m

MAJOR ROCK TYPE—BASALT

Macroscopic Description:

Slightly altered basalt with veins of celadonite, pyrite, and zeolite. This section is the same unit as in Section 61-2.

From 0-70 cm is an upper glassy margin (2-3 cm) and the lower portion is basalt with microphenocrysts of clinopyroxene and olivine. Grain-size from 3-10 cm is fine; from 10-20 cm is slightly fine (increasing), and from 21-68 cm is slightly medium to medium. From 75-150(?) cm is medium grain-sized equigranular, plagioclase and clinopyroxene basalt. From 0-70 cm and Piece 56 (~110 cm) are fresh, and 15-110 cm (Piece 5A) is slightly altered with abundant veins.

Thin Section Descriptions:

16-18 cm: Microdolerite from sill interior.

Phenocrysts: Olivine 1%, 0.4 mm, euhedral; plagioclase 1%, 0.6 mm, zoned.

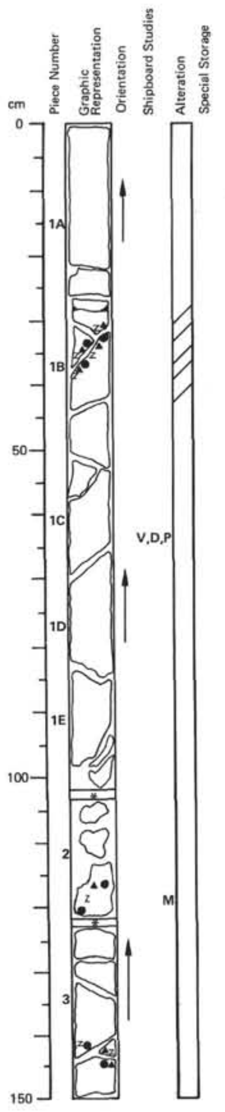
Groundmass: Plagioclase (52%), 0.3 mm, microlites; clinopyroxene 39%, 0.12 mm, intersertal; magnetite 7%, 0.1 mm, irregular; glass ~ 1%(?).

Alteration: Carbonate (trace) and clays (5%) replacing interstitial.

Texture: Microdoleritic.

Paleomagnetism/Physical Properties:

Interval	3 cm	45-47 cm	122 cm
Intensity (10^{-3} emu/cm^3)	7.2	—	6.5
NRM Decl.	320.0	—	213.0
NRM Incl. (°)	–44.3	—	–57.3
MDF (Oe.)	140.0p	—	—
Stable Incl. (°)	–35.6	—	—
Vp ‖ (km/s)	—	5.849	—
D (g/cm^3)	—	2.93	—
P (%)	—	3.1	—



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	61	4

Depth: 856.0 to 857.5 m

MAJOR ROCK TYPE—BASALT

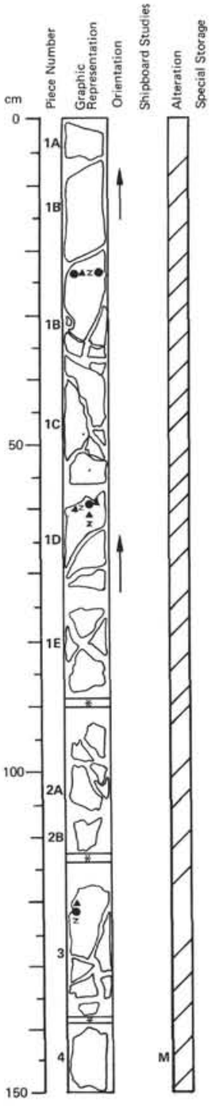
Macroscopic Description:

Two basalt units with celadonite, pyrite, and zeolite veins.

From 0-100 cm is a single basalt unit continued from the previous section. Grain-size from 0-70 cm is medium (equigranular); from 70-98 cm grain-size decreases to fine; and at 98-100 cm is fine grain-sized chilled lower margin. From 100-150(?) cm is a single basalt unit. From 100-121 cm is the upper chilled margin of fine grain-sized basalt, and from 123-150 cm, grain-size increases slowly from slightly fine to slightly medium grain-sized basalt with sparse spots of clinopyroxene phenocrysts. From 30-55 cm is slightly altered, and from 0-30 cm and from 55-150 cm is slightly fresh.

Paleomagnetism/Physical Properties:

Interval	**60-62 cm**	**119 cm**
Intensity (10^{-3} emu/cm^3)	—	60.0
NRM Decl.	—	122.0
NRM Incl. (°)	—	−75.0
MDF (Oe.)	—	75.0
Stable Incl. (°)	—	−47.8
Vp∥ (km/s)	5.851	—
D (g/cm^3)	2.94	—
P (%)	4.1	—



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	61	5

Depth: 857.5 to 859.0 m

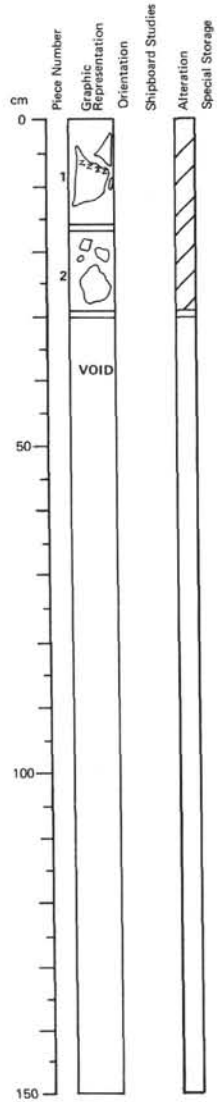
MAJOR ROCK TYPE—BASALT

Macroscopic Description:

Slightly altered, homogeneously slightly medium grain-sized, clinopyroxene phyric basalt, with veins of celadonite, pyrite, and zeolite. Same unit as the lower portion of Section 61-4.

Paleomagnetism:

Interval	**144 cm**
Intensity (10^{-3} emu/cm^3)	5.1
NRM Decl.	180.0
NRM Incl. (°)	−52.7
MDF (Oe.)	—
Stable Incl. (°)	—



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

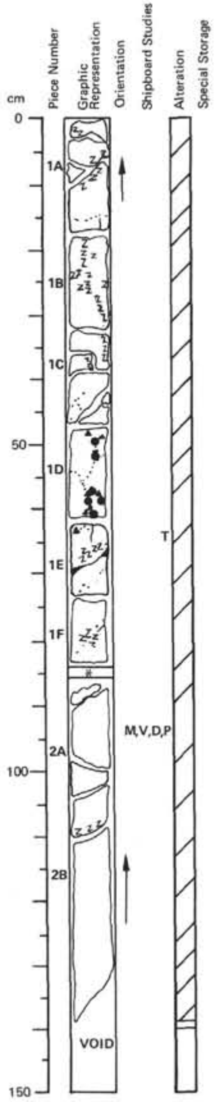
LEG	SITE	HOLE	CORE	SECT.
61	462	A	61	6

Depth: 859.0 to 859.3 m

MAJOR ROCK TYPE—BASALT

Macroscopic Description:

Slightly altered homogeneously slightly medium grain-sized clinopyroxene phyric basalt, with veins of celadonite, pyrite, and zeolite. Same unit as Section 61-5.



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	62	1

Depth: 860.5 to 860.9 m

MAJOR ROCK TYPE—PILLOW BASALT

Macroscopic Description:

Slightly altered pillow basalt with veins of celadonite, zeolite (phillipsite) and pyrite.

From 0-27 cm is fine grain-sized. From 27-60 cm and 70-84 cm is slightly medium grain-sized, equigranular basalt with sparse spots of clinopyroxene microphenocrysts (< 1.0 mm) in an apanitic groundmass. The 60-70 cm interval is fine grain-sized. From 85-104 cm is slightly medium grain-sized, equigranular basalt with sparse spots of clinopyroxene phenocrysts (1-3 mm). From 105-140 cm is slightly medium grain-sized, equigranular basalt.

Thin Section Description:

63-65 cm: Glomeroporphyritic basalt from boundary of two sills.

Phenocrysts: Olivine 1%, 0.2 mm, rounded, altered; plagioclase (An67-72) 3%, 1.2 mm, elongated prisms, zoned tables; clinopyroxene trace, 0.4 mm, equigranular.

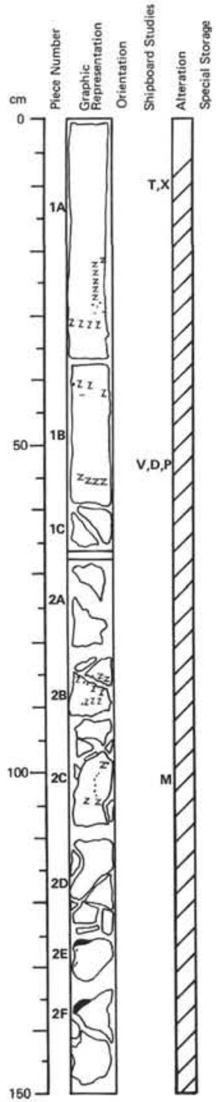
Groundmass: Plagioclase (variable %), laths microlites; clinopyroxene (variable %), irregular; glass 80%, mesostasis.

Alteration: Clay (20%) pseudomorphs after glass and olivine.

Texture: Intersertal to microdoleritic.

Paleomagnetism/Physical Properties:

Interval	**94 cm**	**94-96 cm**
Intensity (10^{-3} emu/cm^3)	9.9	—
NRM Decl.	108.0	—
NRM Incl. (°)	–62.2	—
MDF (Oe.)	—	—
Stable Incl. (°)	—	—
Vp $\parallel$ (km/s)	—	5.887
D (g/cm^3)	—	2.95
P (%)	—	3.4



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	62	2

Depth: 861.9 to 863.4 m

MAJOR ROCK TYPE—PILLOW BASALT

Macroscopic Description:
Three slightly altered pillow basalt units with veins of celadonite, pyrite and zeolite.

From 0-66 cm is a single unit of basalt and is a continuation of Section 62-1. From 0-46 cm is slightly medium grain-sized equigranular basalt. From 46-62 cm is slightly medium grain-sized, equigranular basalt with clinopyroxene microphenocrysts (< 1.0 mm). From 62-66 cm is fine grained-sized basalt. From 68-133 cm is a single basalt unit; from 68-73 cm is fine grain-sized, aphyric basalt. From 73-130 cm is slightly medium grain-sized, equigranular basalt with clinopyroxene microphenocrysts (< 1.0 mm). From 130-133 cm is fine grain-sized basalt. From 133-150(?) cm is a single basalt unit. From 133-137 cm is fine grain-sized aphyric basalt. From 137-150(?) cm is slightly medium grain-sized, equigranular basalt with microphenocrysts of clinopyroxene (< 1.0 mm).

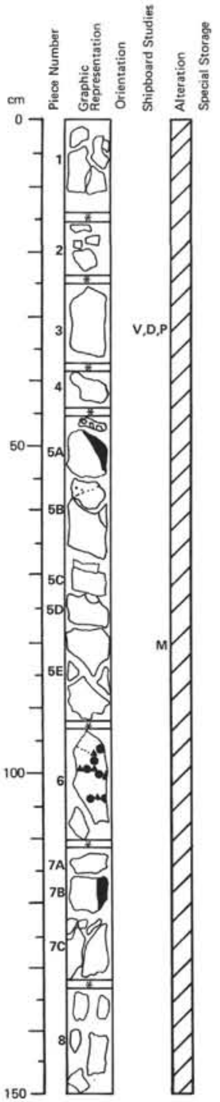
Thin Section Description:
10-12 cm: Glassy microdolerite near upper portion of sill interior.
Groundmass: Olivine 1%, 0.4 mm, rounded; plagioclase 59%, 0.4 mm, microlites; clinopyroxene 32%, 0.2 mm, equigranular; magnetite 5%, 0.08 mm, dust-like; glass 3%, interstitial.
Alteration: Clay (5%) pseudomorphs after interstitial glass and olivine.
Texture: Microdoleritic.

Shipboard Geochemistry (XRF, %):

	Altered Basalt 10-12 cm
SiO_2	50.18
TiO_2	1.04
Al_2O_3	14.07
FeO	10.99
MnO	—
MgO	7.55
CaO	12.88
Na_2O	—
K_2O	0.018
P_2O_5	—
Total	—
LOI†	1.01
FeO ÷ MgO	1.45
CaO ÷ Al_2O_3	0.91
FeO ÷ TiO_2	10.56

Paleomagnetism/Physical Properties:

Interval	52-54 cm	100 cm
Intensity (10^{-3} emu/cm^3)	—	8.0
NRM Decl.	—	175.0
NRM Incl. (°)	—	−53.0
MDF (Oe.)	—	90.0
Stable Incl. (°)	—	−36.4
Vp ∥ (km/s)	5.778	—
D (g/cm^3)	2.93	—
P (%)	4.9	—



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	62	3

Depth: 863.4 to 864.5 m

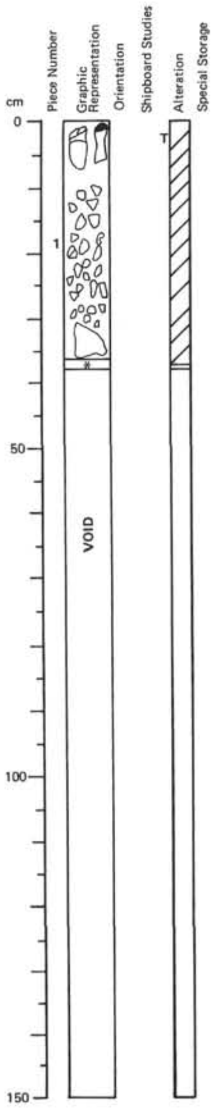
MAJOR ROCK TYPE—PILLOW BASALT

Macroscopic Description:
Three slightly altered pillow basalt units with pyrite, celadonite, zeolite veins.

From 0-45 cm is a single unit of basalt which is continued from the lower unit of the previous section (62-2). From 0-38 cm is slightly medium to slightly fine grain-sized basalt, with spots of clinopyroxene microphenocrysts. From 39-45 cm is fine grain-sized basalt. From 45-110 cm is a single unit of basalt. From 45-55 cm is a zeolite vein or cavity in a thin glassy chilled margin. From 47-73 cm (below thin glassy margin) there is an increasing size of the clinopyroxene phenocrysts in basalt. From 73-100 cm these phenocrysts have a decreasing grain-size. From 100-110 cm is a fine grain-sized basalt. From 110-150(?) cm is a single unit of basalt. From 110-122 cm is fine grain-sized basalt with a vertical thin (~ 2 cm) glassy margin. From 122-150(?) cm is fine grain-sized basalt with rare spots of clinopyroxene microphenocrysts.

Paleomagnetism/Physical Properties:

Interval	32-34 cm	81 cm
Intensity (10^{-3} emu/cm^3)	—	7.0
NRM Decl.	—	1.0
NRM Incl. (°)	—	−65.3
MDF (Oe.)	—	120.0p
Stable Incl. (°)	—	−50.3
Vp ∥ (km/s)	5.639	—
D (g/cm^3)	2.97	—
P (%)	3.2	—



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

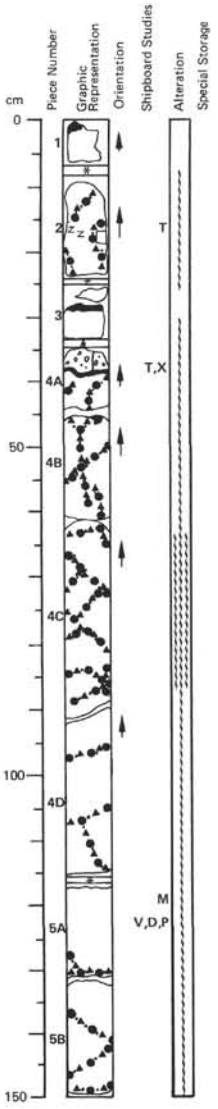
LEG	SITE	HOLE	CORE	SECT.
61	462	A	62	4

Depth:

MAJOR ROCK TYPE—PILLOW BASALT

Macroscopic Description:

Small (drill?) crushed particles. One relatively large piece has glassy margin. Other pieces are fine grain-sized basalt with rare spots of clinopyroxene microphenocrysts (<1.0 mm).



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	63	1

Depth: 864.5 to 866.0 m

MAJOR ROCK TYPE—BASALT

Macroscopic Description:

Three microdoleritic units with veins of pyrite, celadonite and clay, and veins of zeolite. Three units, from 0-25 cm, 25-45 cm, and 45-150(?) cm are medium grain-size microdolèrites with upper and lower margins of glassy and aphanitic basalt with vesicles. From 10-24 cm (Piece 2) are thin deridrite veins of fine grain-sized, more crystalline microdolerites in aphanitic basalts. From 35-38 cm is an ash-like coarse-grained rock (○○○○○) with coarse crystals of fresh plagioclase and clinopyroxene. These crystals are surrounded by altered aphanitic material.

Thin Section Description:

36-38 cm: Contact of variolitic and hyalopilitic basalts at a glassy margin.

Groundmass: Olivine (2%) in variolitic basalt; glass (?%).

Alteration: Clays (90%) in mesostasis replacing glass and olivine.

Texture: Variolitic.

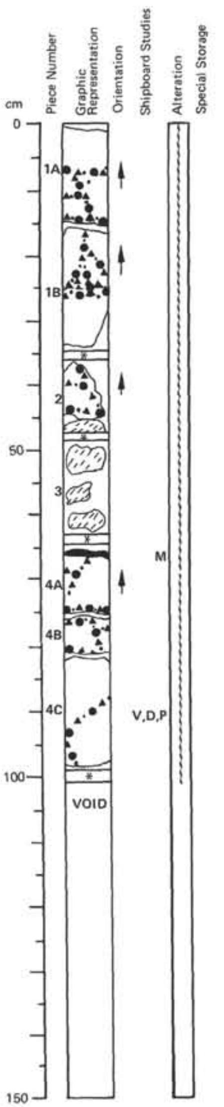
Comments: Glassy spotted zone occurs on the contact. Interior of spots are infilled by microdolerite aggregates.

Shipboard Geochemistry (XRF, %):

	Altered Basalt 36-38 cm
SiO_2	49.19
TiO_2	1.33
Al_2O_3	9.02
FeO	13.93
MnO	—
MgO	10.46
CaO	10.90
Na_2O	—
K_2O	0.74
P_2O_5	—
Total	—
LOI†	2.08
FeO ÷ MgO	1.33
CaO ÷ Al_2O_3	1.20
FeO ÷ TiO_2	10.47

Paleomagnetism/Physical Properties:

Interval	**123 cm**	**124-146 cm**
Intensity (10^{-3} emu/cm^3)	8.5	—
NRM Decl.	179.0	—
NRM Incl. (°)	−52.8	—
MDF (Oe.)	55.0	—
Stable Incl. (°)	−20.2(?)	—
Vp ∥ (km/s)	—	5.819
D (g/cm^3)	—	2.95
P (%)	—	4.0



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
6 1	4 6 2	A	6 3	2

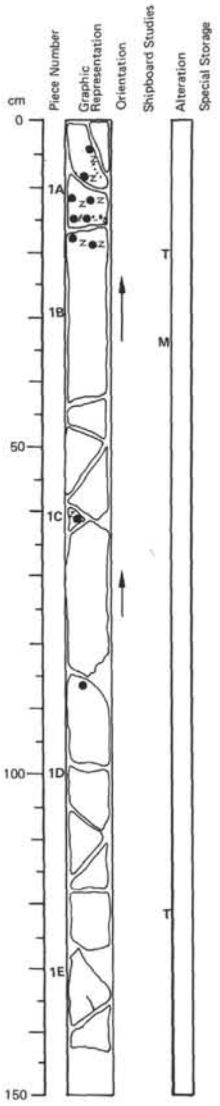
Depth: 866.0 to 869.5 m

MAJOR ROCK TYPE—BASALT

Macroscopic Description:
Two units of microdolerite (0-64 cm, 64-100 cm) with veins of pyrite plus celadonite and clay. These are similar to the dolerite in Section 63-1. There is a chilled contact at 65-85 cm. From 65-85 cm are thin dendritic veins of fine grain-sized crystalline microdolerites in aphanitic (quenched) rocks of the chilled margin.

Paleomagnetism/Physical Properties:

Interval	**66 cm**	**88-90 cm**
Intensity (10^{-3} emu/cm^3)	5.9	—
NRM Decl.	327.0	—
NRM Incl. (°)	–58.7	—
MDF (Oe.)	60.0	—
Stable Incl. (°)	–51.0	—
Vp ∥ (km/s)	—	5.646
D (g/cm^3)	—	2.93
P (%)	—	4.9



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
6 1	4 6 2	A	6 4	1

Depth: 869.5 to 871.0 m

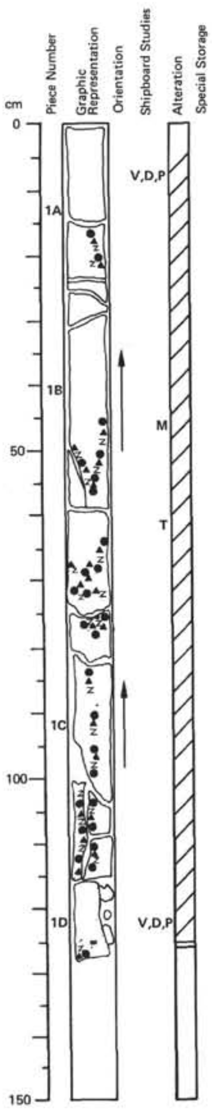
MAJOR ROCK TYPE—BASALT (SILL)

Macroscopic Description:
Fresh massive basalt (sill) with veins of celadonite and zeolite. From 0-141 cm is slightly medium grain-sized and equigranular with sparse spots of clinopyroxene microphenocrysts (<1.0 mm) in an aphanitic groundmass. The lower part of the section has slightly less clinopyroxene microphenocrysts than the upper portion.

Thin Section Description:
20-22 cm: Altered basalt from sill interior.
Groundmass: Plagioclase (An68-70) 38%, 0.2-0.4 mm; clinopyroxene (augite) 40%, <0.2 mm; magnetite (Ti) 5%, <0.08 mm, irregular; glass 7%, small interstitial patches, altered.
Alteration: Brown clays (10%) replacing glass and clinopyroxene.
Texture: Microdoleritic..
122-125 cm: Altered dolerite from fine grain-sized zone of sill interior.
Groundmass: Plagioclase (An68-71) 40%, 0.2-0.4 mm, subhedral; clinopyroxene (augite) 45%, 0.1-0.2 mm, subhedral; magnetite (Ti) 5%, <0.08 mm, skeletal.
Alteration: Brown clays (10%) replacing clinopyroxene.
Texture: Microdoleritic.

Paleomagnetism/Physical Properties:

Interval	**33 cm**
Intensity (10^{-3} emu/cm^3)	7.3
NRM Decl.	269.0
NRM Incl. (°)	–67.3
MDF (Oe.)	—
Stable Incl. (°)	—
Vp ∥ (km/s)	—
D (g/cm^3)	—
P (%)	—



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	64	2

Depth: 871.0 to 872.3 m

MAJOR ROCK TYPE—MASSIVE BASALT SILL

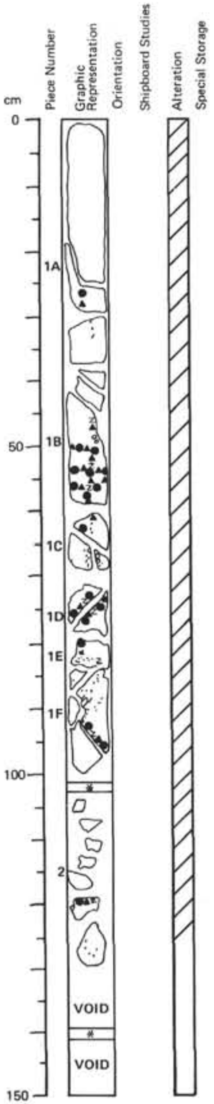
Macroscopic Description:
Slightly altered massive basalt sill with veins of celadonite, pyrite and zeolite. This is the same unit as in Section 64-1. From 0-150 cm grain-size gradually changes from slightly medium to medium to slightly coarse, and textures are equigranular to subophitic. Basalt is made of microphenocrysts of clinopyroxene and plagioclase, and microlites of clinopyroxene, plagioclase, and magnetite.

From 115-127 cm the clinopyroxene microphenocyrsts are altered to chlorite or clays.

Thin Section Description:
60-62 cm: Altered dolerite from sill interior.
Groundmass: Plagioclase (An75-77) 35%, subhedral; clinopyroxene (augite) 45%, 0.2-0.35 mm, subhedral; magnetite (Ti) 5%, <0.1 mm; glass 5%, interstitial patches.
Alteration: Clays (15%) replacing clinopyroxene and glass.

Paleomagnetism/Physical Properties:

Interval	**7-9 cm**	**45 cm**	**121-123 cm**
Intensity (10^{-3} emu/cm^3)	—	6.1	—
NRM Decl.	—	229.0	—
NRM Incl. (°)	—	–70.3	—
MDF (Oe.)	—	—	—
Stable Incl. (°)	—	—	—
Vp ∥ (km/s)	6.086	—	5.372
D (g/cm^3)	2.99	—	2.92
P (%)	2.0	—	4.3



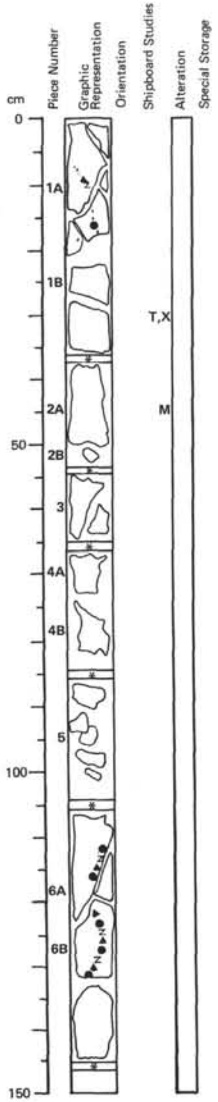
VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	64	3

Depth: 872.3 to 873.6 m

MAJOR ROCK TYPE- –MASSIVE BASALT SILL

Macroscopic Description:
Slightly altered massive basalt sill with veins of celadonite, pyrite, and zeolite.
From 0-60 cm basalts are intergranular to subophitic, have a slightly coarse grain-size, and have sparse spots of clinopyroxene phenocrysts (1-1.5 m). From 60-130 cm grain-size decreases from slightly coarse to medium, and the size of the clinopyroxene phenocrysts spots are less than above this interval (< 1.0 mm).



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	64	4

Depth: 873.6 to 875.0 m

MAJOR ROCK TYPE—MASSIVE BASALT SILL

Macroscopic Description:

Slightly altered massive basalt sill with veins of pyrite, celadonite and zeolite.

Two basalt units (0-35 cm, 35-150 ? cm) may occur. From 0-35 cm is a single unit of basalt and grain-size decreases gradually from slightly medium to fine. This unit is the same as that in Section 64-3. Basalt has sparse spots of clinopyroxene (< 1.0 mm). From 35-150(?) cm is a single unit of basalt. From 35-150 cm is basalt with clinopyroxene microphenocrysts. From 35-105 cm grain-size increases from slightly fine to slightly coarse. From 105-150(?) cm grain-size decreases from slightly coarse to medium.

Thin Section Description:

30-32 cm: Altered basalt from fine grain-sized zone of sill interior.

Phenocrysts: Olivine < 1%, 0.3-0.5 mm, clay pseudomorphs; plagioclase (An_{64-66}) < 1%, 0.3-0.5 mm; clinopyroxene (augite) < 1%, 0.5-0.2 mm, microphenocrysts.

Groundmass: Plagioclase (An_{65}) 40%, <0.2 mm, subhedral; clinopyroxene (augite) 43%, <0.2 mm, subhedral; magnetite (Ti) 10%, <0.04 mm.

Alteration: Brown clays (7%) replacing all minerals.

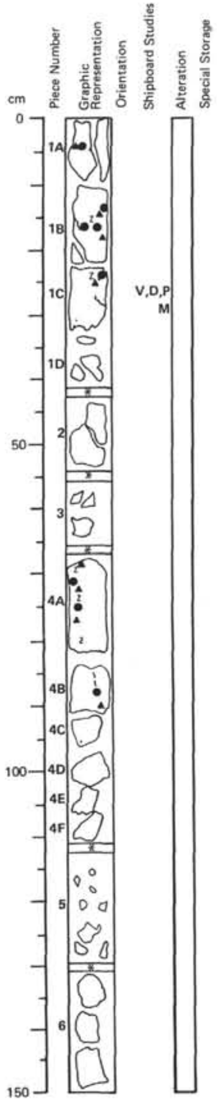
Texture: Mixed equigranular and microdiabasic.

Shipboard Geochemistry (XRF, %):

	Altered Basalt 30-32 cm
SiO_2	49.18
TiO_2	1.02
Al_2O_3	14.23
FeO	10.76
MnO	—
MgO	7.47
CaO	12.56
Na_2O	—
K_2O	0.11
P_2O_5	—
Total	—
LOI†	0.31
FeO ÷ MgO	1.44
CaO ÷ Al_2O_3	0.88
FeO ÷ TiO_2	10.54

Paleomagnetism

Interval	45 cm
Intensity (10^{-3} emu/cm^3)	7.1
NRM Decl.	277.0
NRM Incl. (°)	–52.7
MDF (Oe.)	70.0
Stable Incl. (°)	–40.0



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	64	5

Depth: 875.0 to 876.5 m

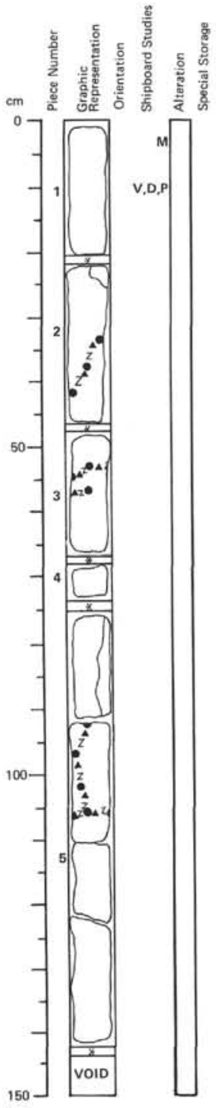
MAJOR ROCK TYPE—MASSIVE BASALT SILL

Macroscopic Description:

Slightly altered massive basalt with veins of pyrite, celadonite, and zeolite. Three basalt units (0-40 cm, 40-110 cm, and 110-150 ? cm) may occur. From 0-40 cm is the same unit as in Section 64-4, and grain-size decreases from medium to fine. From ~40-110 cm is a single unit of medium grain-sized basalt with fine grain-sized margins (~5 cm thick). The basalt, has spots of clinopyroxene microphenocryst< 1% mm. From 110-150 cm is a single unit of basalt with fine grain-sized upper margin (110-130 cm, of drill(?) crushed particles) and a core (below 130 cm) of medium grain-sized basalt with clinopyroxene microphenocrysts.

Paleomagnetism/Physical Properties:

Interval	27-29 cm	30 cm
Intensity (10^{-3} emu/cm^3)	—	6.5
NRM Decl.	—	13.0
NRM Incl. (°)	—	–55.7
MDF (Oe.)	—	60.0
Stable Incl. (°)	—	–46.0(?)
Vp ∥ (km/s)	5.394	—
D (g/cm^3)	2.91	—
P (%)	5.5	—



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
6 1	4 6 2	A	6 5	1

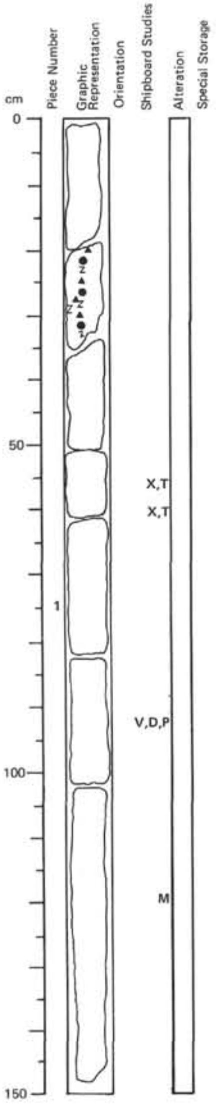
Depth: 876.5 to 878.0 m

MAJOR ROCK TYPE---MASSIVE BASALT SILL

Macroscopic Description:
Slightly altered massive and homogeneous medium grain-sized subophitic and dolerite with veins of celadonite, pyrite and zeolite. This section belongs to a single cooling unit. The dolerite has < 1% clinopyroxene phenocrysts (0.7 mm) in a groundmass of plagioclase, clinopyroxene, opaque minerals, and alteration products. There are a few clay-replacement patches and alteration mainly occurs as heavy veining.

Paleomagnetism/Physical Properties:

Interval	4 cm	10-12 cm
Intensity (10^{-3} emu/cm^3)	19.4	—
NRM Decl.	196.0	—
NRM Incl. (°)	–74.6	—
MDF (Oe.)	—	—
Stable Incl. (°)	—	—
Vp ∥ (km/s)	—	5.982
D (g/cm^3)	—	2.95
P (%)	—	2.7



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
6 1	4 6 2	A	6 5	2

Depth: 878.0 to 879.5 m

MAJOR ROCK TYPE—MASSIVE BASALT SILL

Macroscopic Description:
Slightly altered massive and homogeneous medium grain-sized subophitic dolerite with veins of celadonite, pyrite, and zeolite. This section belongs to a single cooling unit and is the same unit as in Section 65-1. The dolerite has < 1% clinopyroxene phenocrysts (0.2 mm) in a groundmass of plagioclase, clinopyroxene, opaque minerals, and alteration products. There are a few clay-replacement patches and alteration mainly occurs as heavy veining.

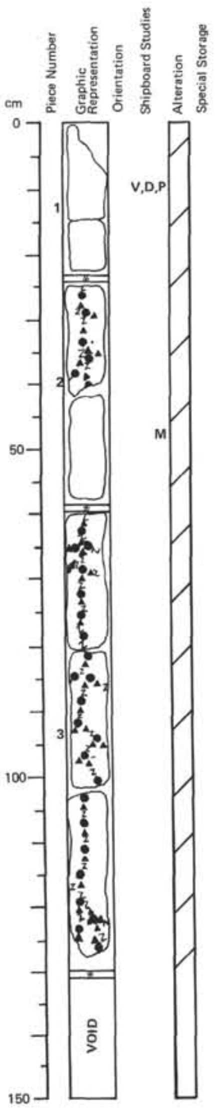
Thin Section Description:
60-62 cm: Altered dolerite from sill interior.
Phenocrysts: Olivine trace, 0.3-0.5 mm, clay pseudomorphs (clinopyroxene?).
Groundmass: Plagioclase (An^{63}) 40%, 0.2-0.4 mm, subhedral to euhedral; clinopyroxene (augite) 45%, 0.2-0.4 mm, subhedral; magnetite (Ti) 5%, <0.1 mm, skeletal; glass 2%, interstitial patches.
Alteration: Clays (10%) replacing all minerals.
Texture: Subophitic.

Shipboard Geochemistry (XRF, %):

	Altered Basalt **60-62 cm**
SiO_2	50.11
TiO_2	1.01
Al_2O_3	14.02
FeO	11.25
MnO	—
MgO	7.67
CaO	12.25
Na_2O	—
K_2O	0.074
P_2O_5	—
Total	—
LOI†	0.55
FeO ÷ MgO	1.46
CaO ÷ Al_2O_3	0.87
FeO ÷ TiO_2	11.02

Paleomagnetism/Physical Properties:

Interval	93-95 cm	122 cm
Intensity (10^{-3} emu/cm^3)	34.1	—
NRM Decl.	202.0	—
NRM Incl. (°)	–72.7	—
MDF (Oe.)	—	—
Stable Incl. (°)	—	—
Vp ∥ (km/s)	—	6.038
D (g/cm^3)	—	2.97
P (%)	—	2.2



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	65	3

Depth: 879.5 to 880.0 m

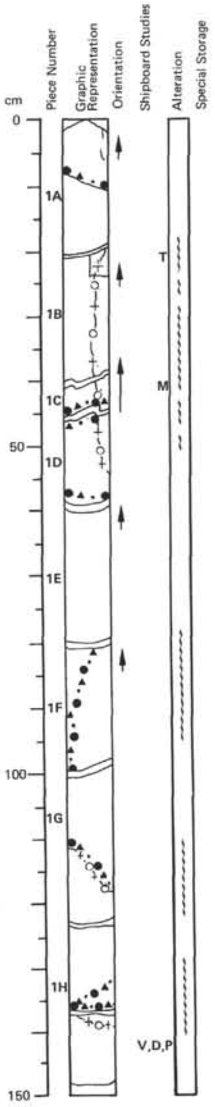
MASSIVE ROCK TYPE—MASSIVE BASALT SILL

Macroscopic Description:

Slightly altered massive and homogeneous medium grain-sized subophitic dolerite. Veins of pyrite, celadonite, and zeolite are more abundant than in Section 65-2. This section belongs to a single cooling unit and is the same unit as Section 65-1. The dolerite has < 1% clinopyroxene phenocrysts (0.2 mm) in a groundmass of plagioclase, clinopyroxene, opaque minerals, and alteration products. There are a few clay-replacement patches and alteration occurs as heavy veining.

Paleomagnetism/Physical Properties:

Interval	**10-12 cm**	**46 cm**
Intensity (10^{-3} emu/cm^3)	28.8	—
NRM Decl.	175.0	—
NRM Incl. (°)	–69.4	—
MDF (Oe.)	—	—
Stable Incl. (°)	—	—
Vp ∥ (km/s)	—	5.876
D (g/cm^3)	—	2.97
P (%)	—	2.4



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	66	1

Depth: 883.0 to 884.5 m

MAJOR ROCK TYPE—MASSIVE DOLERITE SILL

Macroscopic Description:

Slightly altered massive and homogeneous medium grain-sized subophitic dolerite with celadonite-pyrite-clay veins and calcite-opal veins. This section belongs to a single cooling unit and is the same unit as Section 65-1. The dolerite has < 10% clinopyroxene phenocrysts (0.2 mm) in a groundmass of plagioclase, clinopyroxene, opaque minerals, and alteration products. There are a few clay-replacement patches and alteration occurs as heavy veining.

Thin Section Description:

20-22 cm: Massive basalt sill near sill interior.

Microphenocrysts: Plagioclase (An_{65}) 5-6%, 0.4-0.5 mm, tabular and prisms; clinopyroxene 3-4%, 0.4 mm, subhedral, some pale greenish.

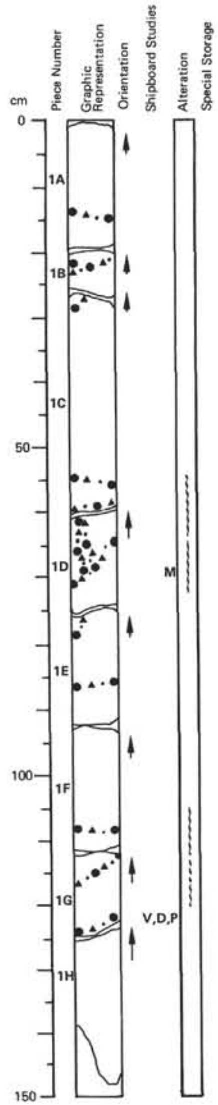
Groundmass: Plagioclase 40%, 0.3 mm, subhedral, microlites; clinopyroxene 45%, 0.3 mm, subhedral, microlites; magnetite 3-5%, < 0.2 mm, 2 types: (1) large skeletal (associated with altered zone, secondary?), and (2) small dust-like.

Alteration: Clays (5-10%) replacing plagioclase and clinopyroxene. Veins are filled by calcite on the outer sides and zeolites on the inner part, and sometimes clay minerals occur between them.

Texture: Subophitic to intergranular.

Paleomagnetism/Physical Properties:

Interval	**40 cm**	**142-144 cm**
Intensity (10^{-3} emu/cm^3)	22.2	—
NRM Decl.	150.0	—
NRM Incl. (°)	–77.2	—
MDF (Oe.)	—	—
Stable Incl. (°)	—	—
Vp ∥ (km/s)	—	5.962
D (g/cm^3)	—	2.97
P (%)	—	2.5



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
6 1	4 6 2	A	6 6	2

Depth: 884.5 to 886.0

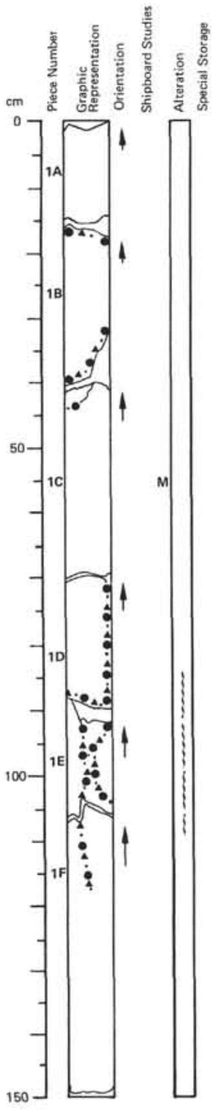
MAJOR ROCK TYPE—MASSIVE DOLERITE SILL

Macroscopic Description:

Slightly altered massive and homogeneous medium grain-sized subophitic dolerite with celadonite-pyrite-clay veins. This section belongs to a single cooling unit and is the same unit as Section 65-1. The dolerite has < 1% clinopyroxene phenocrysts (0.2 mm) in a groundmass of plagioclase, clinopyroxene, opaque minerals, and alteration products. There are a few clay-replacement patches and alteration occurs as heavy veining.

Paleomagnetism/Physical Properties:

Interval	68 cm	124-146 cm
Intensity (10^{-3} emu/cm^3)	23.0	—
NRM Decl.	180.0	—
NRM Incl. (°)	–83.3	—
MDF (Oe.)	—	—
Stable Incl. (°)	—	—
Vp ∥ (km/s)	—	5.809
D (g/cm^3)	—	2.98
P (%)	—	2.0



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
6 1	4 6 2	A	6 6	3

Depth: 886.0 to 887.5 m

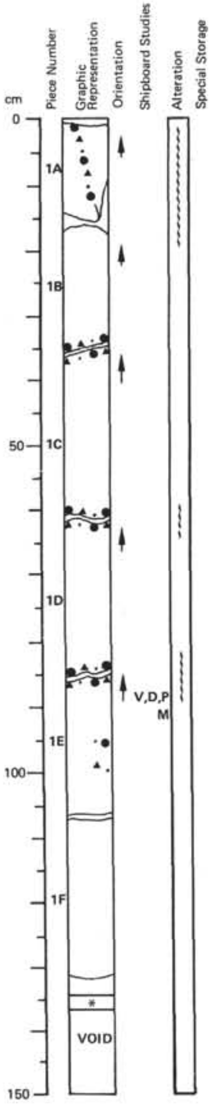
MAJOR ROCK TYPE—MASSIVE DOLERITE SILL

Macroscopic Description:

Slightly altered and homogeneous medium grain-sized subophitic dolerite with celadonite-pyrite-clay veins. This section belongs to a single cooling unit and is the same as Section 65-1. The dolerite has < 1% clinopyroxene phenocrysts (0.2 mm) in a groundmass of plagioclase, clinopyroxene, opaque minerals, and alteration products. There are a few clay-replacement patches and alteration occurs as heavy veining.

Paleomagnetism

Interval	57 cm
Intensity (10^{-3} emu/cm^3)	22.4
NRM Decl.	153.0
NRM Incl. (°)	–75.6
MDF (Oe.)	—
Stable Incl. (°)	—



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	66	4

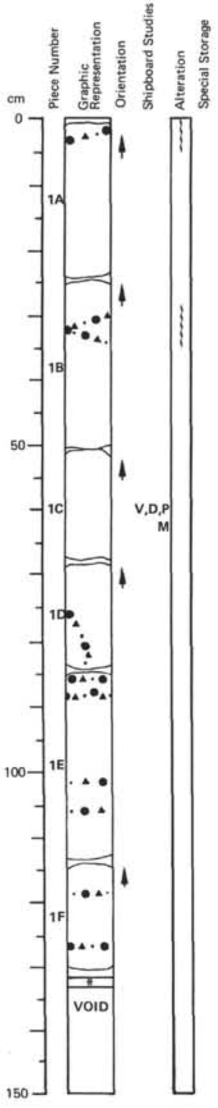
Depth: 887.5 to 888.3 m

MAJOR ROCK TYPE—MASSIVE DOLERITE SILL

Macroscopic Description:
Slightly altered subophitic dolerite with celadonite-pyrite-clay veins. From 0-110 cm is homogeneously medium grain-sized and from 110-130 cm is slightly more fine grain-sized microdolerite. This section belongs to a single cooling unit and is the same as Section 65-1. The dolerite has < 1% clinopyroxene phenocrysts (0.2 mm) in a groundmass of plagioclase, clinopyroxene, opaque minerals, and alteration products. There are a few clay-replacement patches and alteration occurs as heavy veining.

Paleomagnetism/Physical Properties:

Interval	91-93 cm	93 cm
Intensity (10^{-3} emu/cm^3)	—	23.3
NRM Decl.	—	172.0
NRM Incl. (°)	—	−80.9
MDF (Oe.)	—	—
Stable Incl. (°)	—	—
Vp ∥ (km/s)	5.995	—
D (g/cm^3)	2.97	—
P (%)	2.5	—



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	66	5

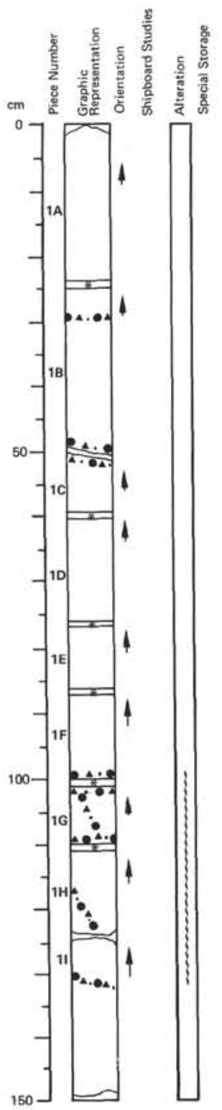
Depth: 888.3 to 889.6 m

MAJOR ROCK TYPE—MASSIVE DOLERITE SILL

Macroscopic Description:
Slightly altered subophitic microdolerite with celadonite-pyrite-clay veins.
Grain-size is medium as in 110-130 cm of Section 66-4. This section belongs to a single cooling unit and is the same unit as in Section 65-1. The microdolerite has < 1% clinopyroxene phenocrysts (0.2 mm) in a groundmass of plagioclase, clinopyroxene, opaque minerals and alteration products. There are a few clay-replacement patches and alteration occurs as heavy veining.

Paleomagnetism/Physical Properties:

Interval	62-64 cm	64 cm
Intensity (10^{-3} emu/cm^3)	—	17.6
NRM Decl.	—	175.0
NRM Incl. (°)	—	−75.1
MDF (Oe.	—	—
Stable Incl. (°)	—	—
Vp ∥ (km/s)	5.891	—
D (g/cm^3)	3.00	—
P (%)	1.5	—



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	66	6

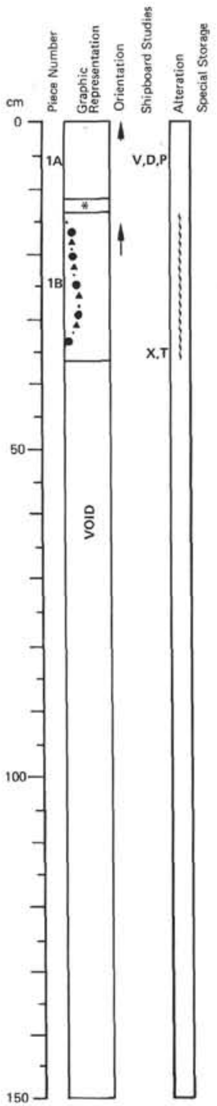
Depth: 889.6 to 897.1 m

MAJOR ROCK TYPE—MASSIVE DOLERITE SILL

Macroscopic Description:
Slightly altered subophitic microdolerite with celadonite-pyrite-clay veins. Grainsize is medium as in 110-130 cm of Section 66-4. This section belongs to a single cooling unit and is the same unit as in Section 65-1. The microdolerite has < 1% clinopyroxene phenocrysts (0.2 mm) in a groundmass of plagioclase, clinopyroxene, opaque minerals and alteration products. There are a few clay-replacement patches and alteration occurs as heavy veining.

Paleomagnetism/Physical Properties

Interval	**70-72 cm**	**75 cm**
Intensity (10^{-3} emu/cm^3)	—	19.9
NRM Decl.	—	171.0
NRM Incl. (°)	—	−78.0
MDF (Oe.)	—	—
Stable Incl. (°)	—	—
Vp ∥ (km/s)	6.098	—
D (g/cm^3)	3.00	—
P (%)	1.5	—



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	66	7

Depth: 887.1 to 892.0 m

MAJOR ROCK TYPE—MASSIVE DOLERITE SILL

Macroscopic Description:
Slightly altered subophitic microdolerite with celadonite-pyrite-clay veins. Grainsize is medium as in 110-130 cm of Section 66-4. This section belongs to a single cooling unit and is the same unit as in Section 65-1. The microdolerite has < 1% clinopyroxene phenocrysts (0.2 mm) in a groundmass of plagioclase, clinopyroxene, opaque minerals and alteration products. There are a few clay-replacement patches and alteration occurs as heavy veining.

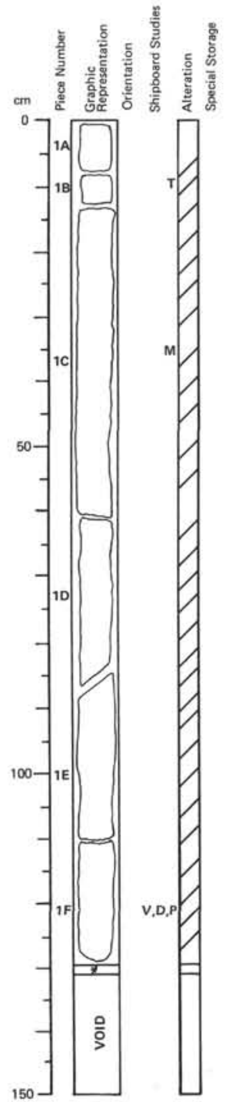
Thin Section Description:
33-35 cm: Massive dolerite sill from sill interior.
Microphenocrysts: Plagioclase 25%, 0.4-1.0 mm, in part tabular to prismatic; clinopyroxene 15%, 0.5-1.0 mm, partly subhedral; magnetite 3%, skeletal.
Groundmass: Plagioclase 25%, <0.3 mm, microlites; clinopyroxene 25%, 0.4 mm, microlites; magnetite 3%, <0.2 mm, skeletal and dust-like? quartz and alkali feldspar form micropegmatite (3-4%), skeletal magnetite associated; trace of green hornblende and opatite.
Alteration: Clays (5-6%) replacing plagioclase; chlorite (1-3%) in spots replacing clinopyroxene.
Texture: Subophitic to intergranular.

Shipboard Geochemistry (XRF, %):

	Altered Basalt 33-35 cm
SiO_2	49.67
TiO_2	0.99
Al_2O_3	13.81
FeO	11.29
MnO	—
MgO	8.10
CaO	12.34
Na_2O	—
K_2O	0.045
P_2O_5	—
Total	—
LOI†	0.70
$FeO \div MgO$	1.39
$CaO \div Al_2O_3$	0.89
$FeO \div TiO_2$	11.40

Physical Properties:

Interval	**4-6 cm**
Vp ⊥ (km/s)	5.992
D (g/cm^3)	2.98
P (%)	2.1



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	67	1

Depth: 892.0 to 893.3 m

MAJOR ROCK TYPE—MASSIVE DOLERITE SILL

Macroscopic Description:
Slightly altered massive dolerite sill with veins of greenish white clay. A few (< 1%) phenocrysts of clinopyroxene in a coarse grained doleritic matrix of plagioclase, clinopyroxene, magnetite, and alteration products. Alteration consists of clay-patches in the rock and veins.

Thin Section Description:

8-10 cm: Massive dolerite sill from sill interior.

Phenocrysts: Plagioclase (An_{60}) 15%, 0.8-1.2 mm, prismatic; clinopyroxene 30%, 0.8-1.2 mm, anhedral; magnetite +1.3%, 0.4-0.8 mm, skeletal.

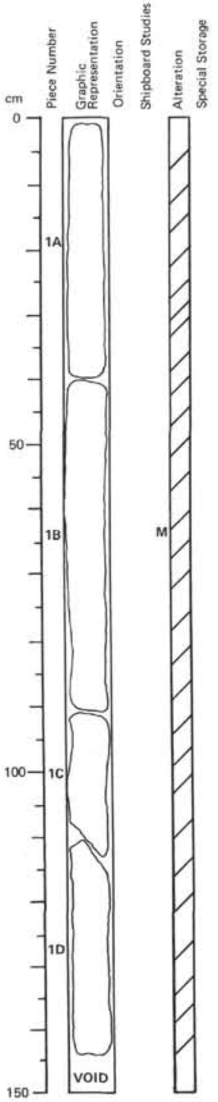
Groundmass: Plagioclase 15%, <0.7 mm, prismatic to tabular, microlitic; clinopyroxene 30%, <0.7 mm, anhedral to subhedral, microlitic; magnetite 4%, <0.4 mm, skeletal and dust-like; quartz-alkali feldspar form micropegmitite (4%), skeletal magnetite is associated; trace green hornblende and apatite.

Alteration: Clays (5-10%) occur in spots replacing plagioclase. Chlorite (3-5%) in spots replacing clinopyroxene.

Texture: Ophitic to intergranular.

Paleomagnetism/Physical Properties:

Interval	34 cm	119-121 cm
Intensity (10^{-3} emu/cm^3)	17.3	—
NRM Decl.	180.0	—
NRM Incl. (°)	–76.1	—
MDF (Oe.)	—	—
Stable Incl. (°)	—	—
Vp ∥ (km/s)	—	6.108
D (g/cm^3)	—	3.00
P (%)	—	2.1



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	67	2

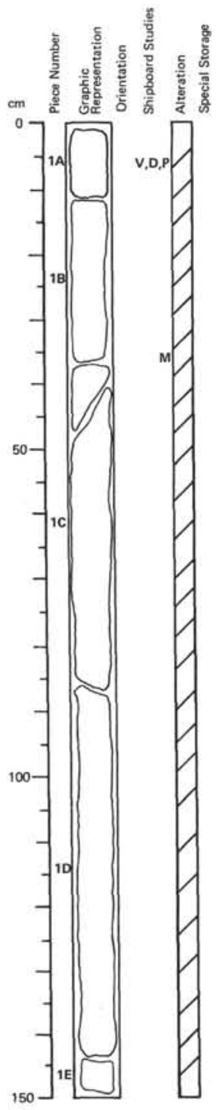
Depth: 893.3 to 894.8 m

MAJOR ROCK TYPE—MASSIVE DOLERITE SILL

Macroscopic Description:
Slightly altered massive dolerite sill with veins of green and white clay. It is the same unit as in Section 67-1. A few (< 1%) phenocrysts of clinopyroxene in coarse grained doleritic matrix of plagioclase, clinopyroxene, magnetites, and alteration products. Alteration consists of clay-patches in the rock and veins.

Paleomagnetism

Interval	64 cm
Intensity (10^{-3} emu/cm^3)	13.0
NRM Decl.	191.0
NRM Incl. (°)	–80.0
MDF (Oe.)	40.0
Stable Incl. (°)	<–70.3



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
6 1	4 6 2	A	6 7	3

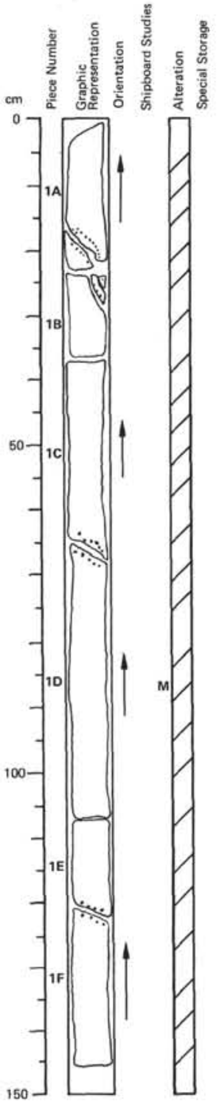
Depth: 894.8 to 896.3 m

MAJOR ROCK TYPE—MASSIVE DOLERITE SILL

Macroscopic Description:
Slightly altered massive dolerite sill with veins of gree and white clay. This is the same unit as in Section 67-1. A few (< 1%) phenocrysts of clinopyroxene in coarse grain-sized dolerite matrix of plagioclase, clinopyroxene, magnetite, and alteration products. Alteration consists of clay-patches in the rock and veins.

Paleomagnetism/Physical Properties:

Interval	**2-4 cm**	**36 cm**
Intensity (10^{-3} emu/cm^3)	—	18.6
NRM Decl.	—	191.0
NRM Incl. (°)	—	−81.8
MDF (Oe.)	—	—
Stable Incl. (°)	—	—
Vp ⇕ (km/s)	6.127	—
D (g/cm^3)	3.00	—
P (%)	2.1	—



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
6 1	4 6 2	A	6 7	4

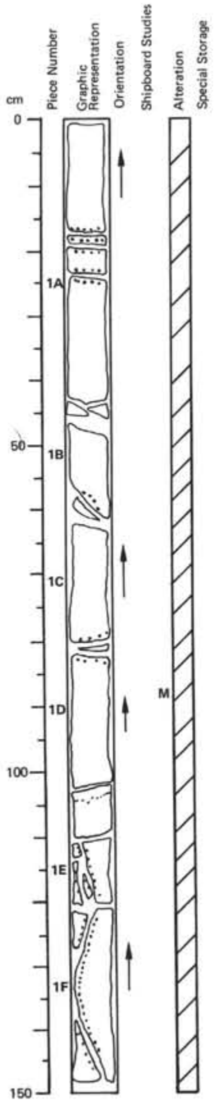
Depth: 896.3 to 897.8 m

MAJOR ROCK TYPE—MASSIVE DOLERITE SILL

Macroscopic Description:
Slightly altered massive dolerite sill with veins of green and white clay. It is the same unit as in Section 67-1. A few (< 1%) phenocrysts of clinopyroxene in coarse grain-sized dolerite matrix of plagioclase, clinopyroxene, magnetite, and alteration products. Alteration consists of clay-patches in the rock and veins.

Paleomagnetism

Interval	**87 cm**
Intensity (10^{-3} emu/cm^3)	17.3
NRM Decl.	227.0
NRM Incl. (°)	−73.7
MDF (Oe.)	—



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG		SITE			HOLE	CORE		SECT.
6	1	4	6	2	A	6	7	5

Depth: 897.8 to 899.3 m

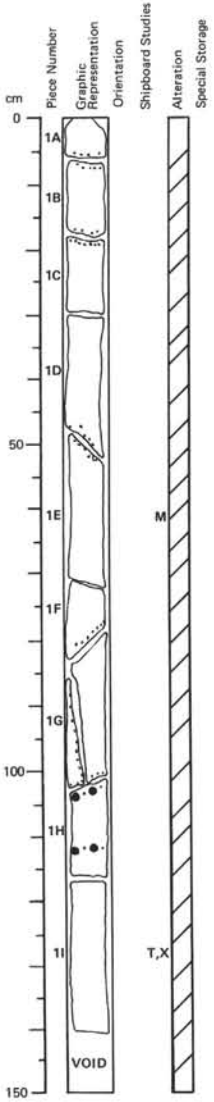
MAJOR ROCK TYPE—MASSIVE DOLERITE SILL

Macroscopic Description:

Slightly altered massive dolerite sill with veins of green and white clay. It is the same unit as in Section 67-1. A few (< 1%) phenocrysts of clinopyroxene in coarse grain-sized dolerite matrix of plagioclase, clinopyroxene, magnetite, and alteration products. Alteration consists of clay-patches in the rock and veins.

Paleomagnetism

Interval	**88 cm**
Intensity (10^{-3} emu/cm^3)	17.1
NRM Decl.	187.0
NRM Incl. (°)	–76.8
MDF (Oe.)	—
Stable Incl. (°)	—



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG		SITE			HOLE	CORE		SECT.
6	1	4	6	2	A	6	7	6

Depth: 899.3 to 900.8 m

MAJOR ROCK TYPE—MASSIVE DOLERITE SILL

Macroscopic Description:

Slightly altered massive dolerite sill with veins of green and white clay. It is the same unit as in Section 67-1. A few (< 1%) phenocrysts of clinopyroxene in coarse grain-sized dolerite matrix of plagioclase, clinopyroxene, magnetite, and alteration products. Alteration consists of clay-patches in the rock and veins.

Thin Section Description:

124-126 cm: Massive dolerite sill near sill interior.

Phenocrysts: Olivine trace, 1.0 mm, clay-pseudomorphs; plagioclase (An60) 5-6%, 0.4-0.5 mm, tabular and prismatic; clinopyroxene 3-4%, 0.4 mm, subhedral, some types are pale greenish.

Groundmass: Olivine 1-3%, 0.4 mm, chlorite-pseudomorphs co-existing with magnetite; plagioclase 40%, 0.3 mm, subhedral, microlite; clinopyroxene 45%, 0.3 mm, subhedral, microlite; magnetite 3-5% <0.2 mm; Type 1 is skeletal and Type 2 is dust-like, skeletal type is associated with alter zones.

Alteration: Clays (1%) replacing plagioclase. Chlorite (2-4%) replaces olivine and clinopyroxene.

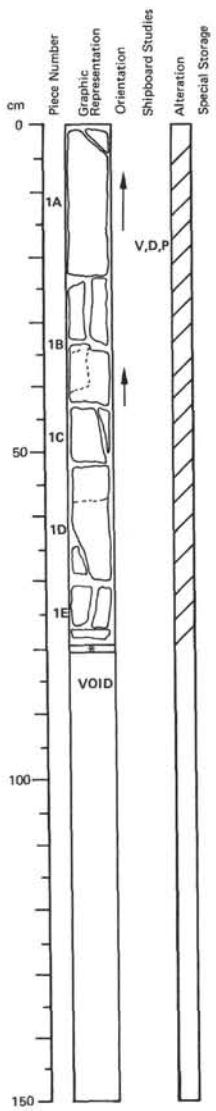
Texture: Subophitic to intergranular.

Shipboard Geochemistry (XRF, %):

	Altered basalt 124-126 cm
SiO_2	49.67
TiO_2	0.99
Al_2O_3	13.81
FeO	11.29
MnO	—
MgO	8.10
CaO	12.34
Na_2O	—
K_2O	0.045
P_2O_5	—
Total	—
LOI†	0.70
FeO ÷ MgO	1.39
CaO ÷ Al_2O_3	0.89
FeO ÷ TiO_2	11.40

Paleomagnetism:

Interval	**61 cm**
Intensity (10^{-3} emu/cm^3)	22.4
NRM Decl.	223.0
NRM Incl. (°)	–71.9
MDF (Oe.)	—
Stable Incl. (°)	—



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG		SITE			HOLE	CORE		SECT.	
6	1	4	6	2	A		6	7		7

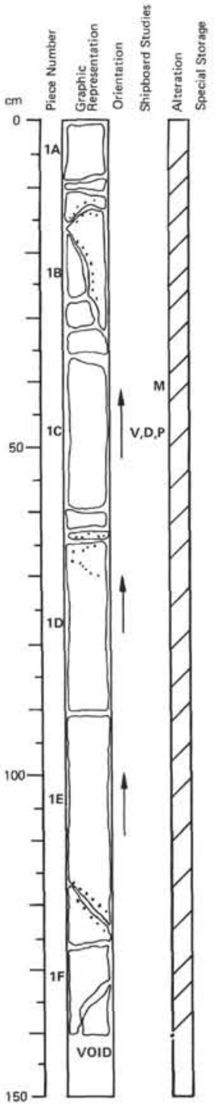
Depth: 900.8 to 901.0 m

MAJOR ROCK TYPE—MASSIVE DOLERITE SILL

Macroscopic Description:
Slightly altered massive dolerite sill with veins of green and white clay. It is the same unit as in Section 67-7. A few (< 1%) phenocrysts of clinopyroxene in coarse grain-sized dolerite matrix of plagioclase, clinopyroxene, magnetite, and alteration products. Alteration consists of clay-patches in the rock and veins.

Physical Properties:

Interval	**17-19 cm**
Vp ∥ (km/s)	5.954
D (g/cm^3)	3.00
P (%)	1.9



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG		SITE			HOLE	CORE		SECT.	
6	1	4	6	2	A		6	8		1

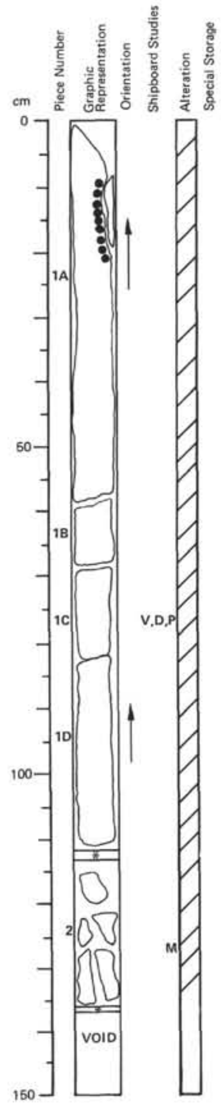
Depth: 901.0 to 902.4 m

MAJOR ROCK TYPE—MASSIVE DOLERITE SILL

Macroscopic Description:
Slightly altered, subophitic to intergranular, medium to slightly coarse grain-sized massive dolerite sill with veins of celadonite. This dolerite is composed of microphenocrysts of clinopyroxene (< 1.0 mm) and plagioclase (< 1.0 mm) and microlites of clinopyroxene, plagioclase, and magnetite. Clinopyroxene microphenocrysts often form aggregates.

Paleomagnetism/Physical Properties:

Interval	**43 cm**	**48-50 cm**
Intensity (10^{-3} emu/cm^3)	25.9	—
NRM Decl.	191.0	—
NRM Incl. (°)	−75.7	—
MDF (Oe.)	—	—
Stable Incl. (°)	—	—
Vp ∥ (km/s)	—	6.136
D (g/cm^3)	—	2.97
P (%)	—	1.3



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	68	2

Depth: 902.4 to 903.8 m

MAJOR ROCK TYPE—MASSIVE DOLERITE SILL

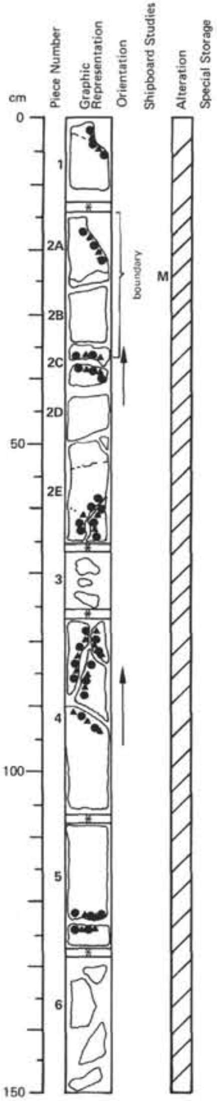
Macroscopic Description:

Slightly altered massive dolerite sill with veins of mainly celadonite. Same unit as Section 68-1.

From 0-105 cm grain-size decreases slowly from slightly coarse to medium, and textures change from intersertal to subophitic. At 105 cm grain-size abruptly changes to fine and remains so through 111 cm (possible boundary). There are sparse spots of clinopyroxene microphenocrysts (1.0-1.5 mm, hyalpilitic). From 111-150 cm are brecciated particles of fine-grained dolerite.

Paleomagnetism/Physical Properties:

Interval	74-76 cm	126 cm
Intensity (10^{-3} emu/cm^3)	—	10.8
NRM Decl.	—	218.0
NRM Incl. (°)	—	–72.6
MDF (Oe.)	—	45.0
Stable Incl. (°)	—	<–40.0
Vp ∥ (km/s)	6.199	—
D (g/cm^3)	3.00	—
P (%)	1.1	—



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	68	3

Depth: 903.8 to 905.3 m

MAJOR ROCK TYPE—-MASSIVE DOLERITE SILL

Macroscopic Description:

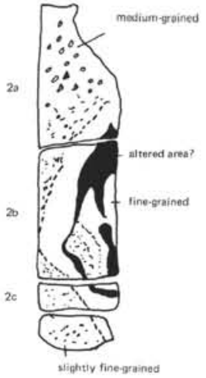
Slightly altered massive dolerite sill with veins of mainly celadonite and rare pyrite.

From 0-11 cm is slightly fine grain-sized. From 13-42 cm see sketch below with a possible cooling boundary at 42 cm. From 43-50 cm is slightly fine grain-sized. From 50-116 cm grain-size slowly increases from slightly fine to medium. From 116(?)-150 cm grain-size decreases slowly.

Paleomagnetism:

Interval	26 cm
Intensity (10^{-3} emu/cm^3)	14.7
NRM Decl.	78.0
NRM Incl. (°)	–85.6
MDF (Oe.)	70.0
Stable Incl. (°)	–48.2

Massive dolerite sill



1: slightly fine-grained

2a and ~2c: see figure

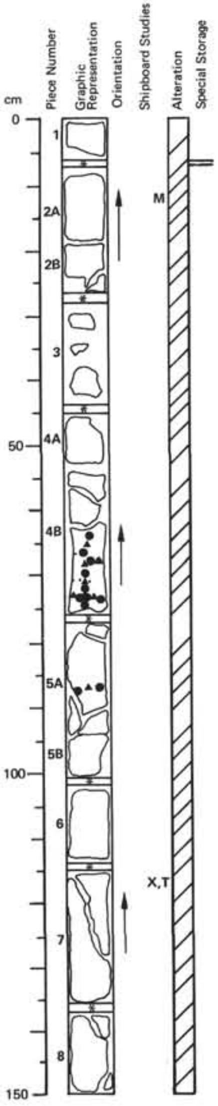
boundary

2d: slightly fine-grained

2e: ~4 (End): increasing grain size,
slightly fine-grained to medium-grained

4~b: decreasing grain-size

Alteration: slightly altered veins are filled by mainly chlorite (rare pyrite).



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	68	4

Depth: 905.3 to 906.8 m

MAJOR ROCK TYPE—MASSIVE DOLERITE SILL

Macroscopic Description:

Slightly altered massive dolerite sill with celadonite-pyrite veins. It is the same unit as Section 68-3.

From 0-6 cm this piece is continued from the previous section and is slightly fine grain-sized with clinopyroxene microphenocrysts (<1.0 mm). From 7-27 cm is fine grain-sized. From 28-150 cm grain-size slowly increases from slightly medium to slightly coarse.

Thin Section Description:

116-118 cm: Altered fine grained diabase from sill interior.

Groundmass: Plagioclase (An70) 40%, 0.2-0.4 mm; clinopyroxene (augite) 40%, 0.153 to 0.3 mm, subhedral; magnetite (Ti) 5%, <0.1 mm; glass 5%, interstitial glassy patches replaced by brown clay; trace apatite.

Alteration: Brown clays (10%) replacing glass, and some of all altered minerals.

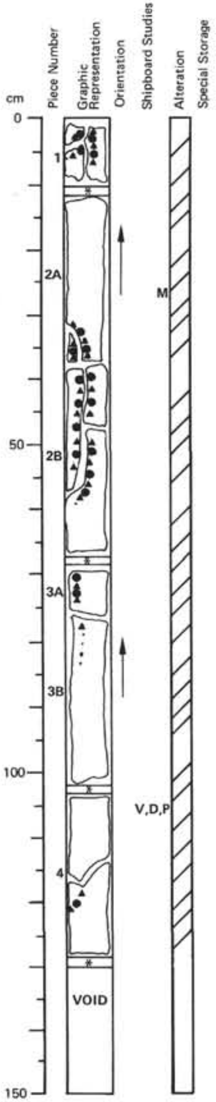
Texture: Subophitic.

Shipboard Geochemistry (XRF, %):

	Altered basalt 116-118 cm
SiO_2	49.05
TiO_2	1.01
Al_2O_3	13.94
FeO	10.99
MnO	---
MgO	7.46
CaO	12.36
Na_2O	---
K_2O	0.034
P_2O_5	---
Total	---
LOI†	1.07
FeO ÷ MgO	1.47
CaO ÷ Al_2O_3	0.88
FeO ÷ TiO_2	10.88

Paleomagnetism/Physical Properties:

Interval	**13 cm**	**107-109 cm**
Intensity (10^{-3} emu/cm^3)	17.5	---
NRM Decl.	230.0	---
NRM Incl. (°)	−77.0	---
MDF (Oe.)	---	---
Stable Incl. (°)	---	---
Vp∥ (km/s)	---	5.934
D (g/cm^3)	---	2.93
P (%)	---	2.2



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A.	68	5

Depth: 906.8 to 908.0 m

MAJOR ROCK TYPE—MASSIVE DOLERITE SILL

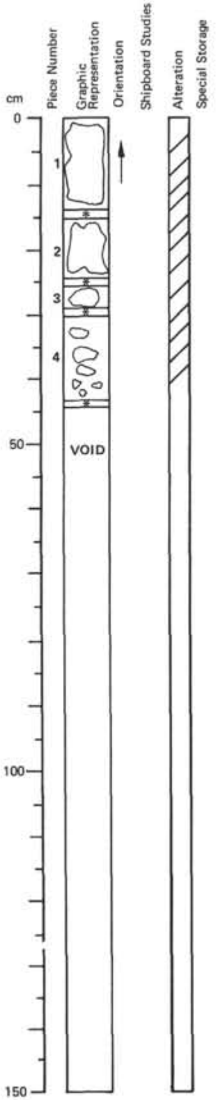
Macroscopic Description:

Slightly altered massive dolerite sill with celadonite veins. It is the same unit as in Section 68-4.

From 0-130 cm grain-size slightly decreases from slightly coarse to medium. The coarse grained dolerite is equigranular.

Paleomagnetism/Physical Properties:

Interval	**28 cm**	**108-110 cm**
Intensity (10^{-3} emu/cm^3)	27.1	---
NRM Decl.	195.0	---
NRM Incl. (°)	−68.9	---
MDF (Oe.)	---	---
Stable Incl. (°)	---	---
Vp ∥ (km/s)	---	6.160
D (g/cm^3)	---	2.98
P (%)	---	1.4



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	68	6

Depth: 908.0 to 908.5 m

MAJOR ROCK TYPE––MASSIVE DOLERITE SILL

Macroscopic Description:

Slightly altered massive dolerite sill.

From 0-114 cm is fine grain-sized. From 15-30 cm is slightly fine grain-sized. From 30-44 cm are crusted small particles of fine grain-sized rock. A possible sill boundary occurs at 44 cm.

Thin Section Description:

23-25 cm: Altered basalt from fine grain-sized portion of sill interior.

Phenocrysts: Plagioclase (An68) 1%, 0.2-0.3 mm, euhedral to subhedral, replaced; clinopyroxene (augite) 1%, 0.1-0.3 mm, euhedral to subhedral.

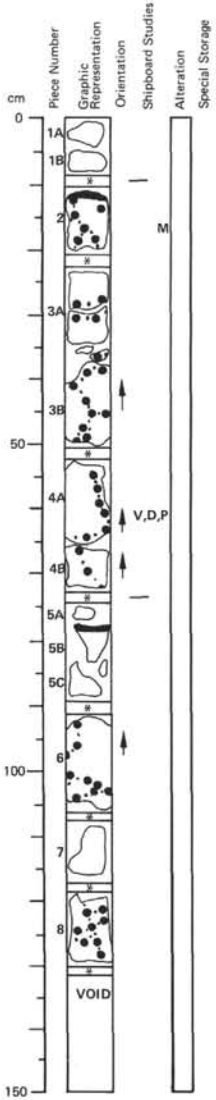
Groundmass: Magnetite (Ti) 5%, <0.004 mm, dust-like; glass 93%, being replaced; sparse plagio microlites, and quench clinopyroxene.

Alteration: Carbonate (variable %) replacing plagioclase and glass. Brown clays (?%) replaces all minerals.

Texture: Hyalopilitic.

Paleomagnetism:

Interval	**18 cm**
Intensity (10^{-3} emu/cm^3)	6.7
NRM Decl.	170.0
NRM Incl. (°)	–74.4
MDF (Oe.)	90.0
Stable Incl. (°)	–38.6



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	69	1

Depth: 910.0 to 911.3 m

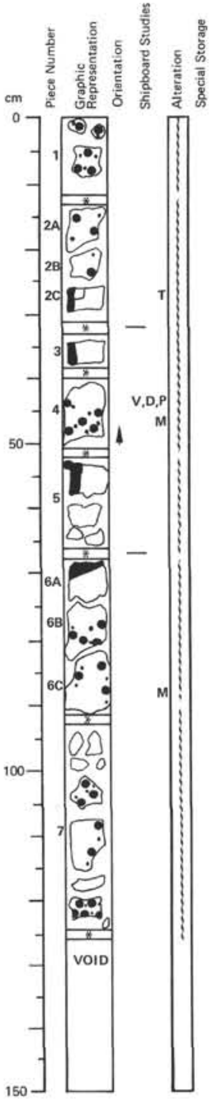
MAJOR ROCK TYPE––MICRODOLERITE SILLS

Macroscopic Description:

Three units (0-10 cm, 10-73 cm, and 73-150 cm) of highly altered microdolerites with celadonite-clay veins. These units are medium grain-sized in the sill interiors with fine grain-sized to glassy margins near the contacts.

Paleomagnetism/Physical Properties:

Interval	**18 cm**	**60-62 cm**
Intensity (10^{-3} emu/cm^3)	6.7	—
NRM Decl.	170.0	—
NRM Incl. (°)	–74.4	—
MDF (Oe.)	90.0	—
Stable Incl. (°)	–38.6	—
Vp ∥ (km/s)	—	5.605
D (g/cm^3)	—	2.93
P (%)	—	3.0



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	69	2

Depth: 911.3 to 912.5 m

MAJOR ROCK TYPE—MICRODOLERITE SILLS

Macroscopic Description:

Highly altered microdolerites with veins of celadonite-clay.

From 0-65 cm is the bottom of the sill unit from Section 69-1. From 65-124 cm is a sill unit of small pieces of fine grain-sized microdolerites.

Thin Section Description:

28-30 cm: Glassy basalt from glassy margin of flow.

Phenocrysts: Olivine 1%, 0.3-0.5 mm, questionable pesudomorphs; plagioclase (An70-72) 2%, 0.2-0.4 mm, euhedral; clinopyroxene (augite) 2%, 0.1-0.2 mm.

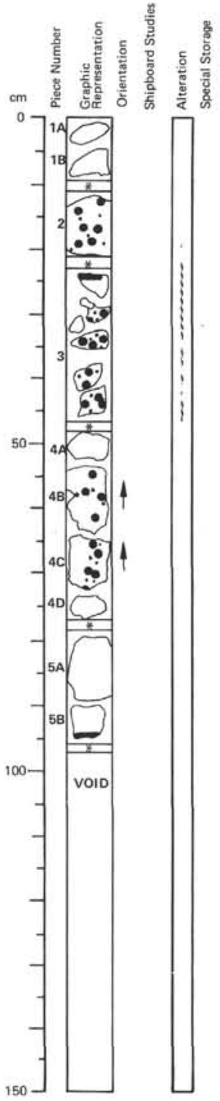
Groundmass: Plagioclase (variable %) small microlites and crystallites; clinopyroxene (variable %), quench phase; magnetite (Ti) 5%, <0.008 mm, dust-like; glass 7%, highly replaced by clay.

Alteration: Brown clays replacing groundmass and phenocrysts.

Texture: Glassy to variolitic.

Paleomagnetism/Physical Properties:

Interval	43-45 cm	45 cm	89 cm
Intensity (10^{-3} emu/cm^3)	—	14.1	7.1
NRM Decl.	—	34.0	24.0
NRM Incl. (°)	—	−54.2	−52.3
MDF (Oe.)	—	125.0	110.0
Stable Incl. (°)	—	−42.9	−39.0
Vp ∥ (km/s)	5.766	—	—
D (g/cm^3)	2.97	—	—
P (%)	1.7	—	—



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	69	3

Depth: 912.5 to 919.0 m

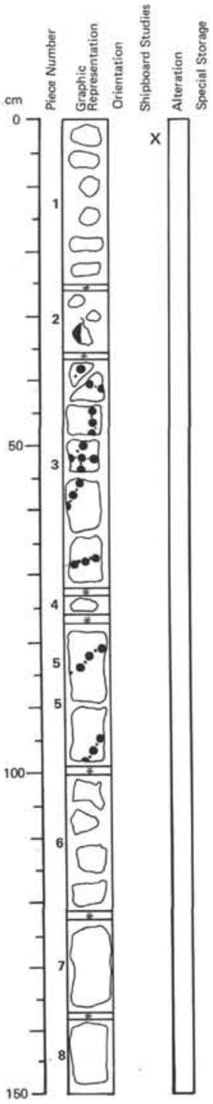
MAJOR ROCK TYPE—MICRODOLERITES

Macroscopic Description:

Two units (0-21 cm and 21-95 cm) of highly altered microdolerites with veins of celadonite-clay. The sills are fine grain-sized and glassy near the margins, and medium grain-sized in the sill's interior.

Physical Properties:

Interval	77-79 cm
Vp ∥ (km/s)	5.780
D (g/cm^3)	2.97
P (%)	1.8



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG		SITE			HOLE	CORE		SECT.	
6	1	4	6	2	A	7	0		1

Depth: 919.0 to 920.5 m

MAJOR ROCK TYPE—BASALT UNITS

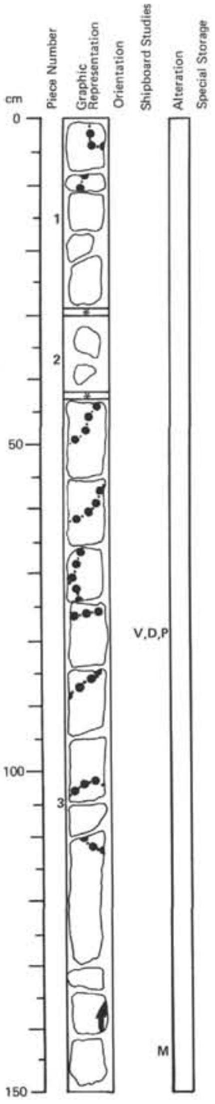
Macroscopic Description:
Two units (~25-100 cm and 100-150 cm) of slightly altered basalt.

From 0-25 cm are hyaloclastite and hyaloclastite breccia (see Sedimentary Description) which may be cavings debris from the upper part of the hole. From 25-100 cm is a single unit of glassy to fine grain-sized aphanitic basalt. Interior portions of the flow units are more coarse grain-sized and have a phaneritic matrix of plagioclase, clinopyroxene, opaque minerals and alteration products. A few clay spots are visible in the phaneritic fragments.

From 100-150(?) cm may be another unit(?). The boundary at 100 cm is suggested by a finer grain-size at the bottom of fragment 5B; however, this fine grain-sized apophyses could simply be a grain-size heterogeneity within a single unit.

Shipboard Geochemistry (XRF, %):

	Altered basalt
	2-4 cm
SiO_2	90.69
TiO_2	0.02
Al_2O_3	1.25
FeO	1.84
MnO	—
MgO	1.01
CaO	2.17
Na_2O	—
K_2O	1.73
P_2O_5	—
Total	—
LOI†	2.95
FeO + MgO	1.82
CaO + Al_2O_3	1.73
FeO + TiO_2	92.0



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG		SITE			HOLE	CORE		SECT.	
6	1	4	6	2	A	7	0		2

Depth: 920.5 to 922.0 m

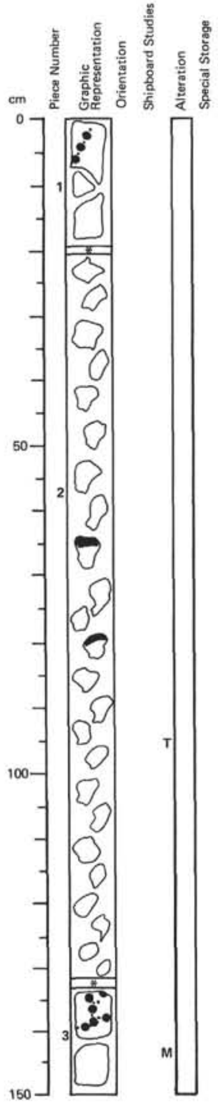
MAJOR ROCK TYPE—BASALT

Macroscopic Description:
Two units (0-133 cm and 133-150 ? cm) of slightly altered basalt.

From 0-7 cm are fine grain-sized apophyses in a medium grain-sized piece. From 7-150 cm grain-size gradually increases, and the middle and bottom portions are phaneritic. A few small clinopyroxene phenocrysts are visible, as are spots of clay, chalcedony, and pyrite. A patch of chalcedony occurs at 137 cm.

Paleomagnetism/Physical Properties:

Interval	**77-79 cm**	**144 cm**
Intensity (10^{-3} emu/cm^3)	—	12.0
NRM Decl.	—	216.0
NRM Incl. (°)	—	−71.3
MDF (Oe.)	—	40.0
Stable Incl. (°)	—	35.6
Vp ‖ (km/s)	5.759	—
D (g/cm^3)	2.95	—
P (%)	2.6	—



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG		SITE			HOLE		CORE		SECT.
6	1	4	6	2	A		7	0	3

Depth: 922.0 to 923.5 m

MAJOR ROCK TYPE—BASALT

Macroscopic Description:

Two(?) units (?0 cm to 20 cm? and 20? to 150 cm?) of altered basalt.

From 0-20 cm is probably the same unit as in Section 70-2. From 20-150 cm may represent one or more possible units. Several of the fragments are out of order. Each handful of fragments was placed in stratigraphic position as it was withdrawn from the linerless core band, but within each handful of fragments no relative stratigraphic position can be inferred.

Many of the fragments have abundant alteration spots of chalcedony, zeolite, green clay, and pyrite. Grain-size variations are frequent and without apparent pattern. The interval may represent a few units(?).

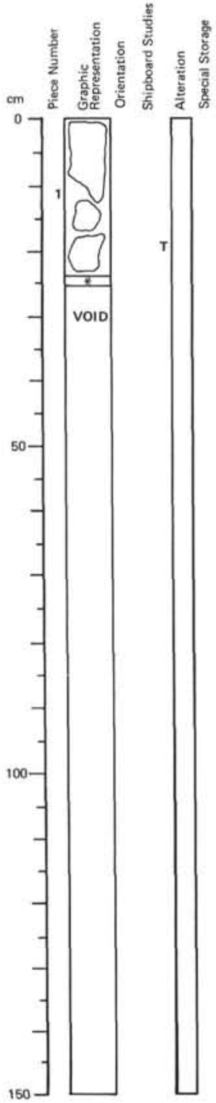
Thin Section Description:

95-97 cm: Alteration vein in altered variolitic basalt from flow interior.

The rock is clinopyroxene-plagioclase, altered, variolitic basalt. The vein is dominantly (99.9%) a high bivofringent, fibrous mineral which looks like disordered hydro-mica, but could be clay. Brown, low birofringent zeolite is also present. Green clays (0.1%) create alteration patches in vein and replace the rock.

Paleomagnetism

Interval	**145 cm**
Intensity (10^{-3} emu/cm	27.4
NRM Decl.	192.0
NRM Incl.	–55.4
MDF (Oe.)	50.0
Stable	–37.1



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG		SITE			HOLE		CORE		SECT.
6	1	4	6	2	A		7	0	4

Depth: 923.5 to 923.8 m

MAJOR ROCK TYPE—BASALT

Macroscopic Description:

Altered medium grain-sized, sub-phaneritic basalt with patchy texture typical of the flow units. From 17-23 cm fine grain-sized apophyses occur in medium grain-sized basalt.

Thin Section Description:

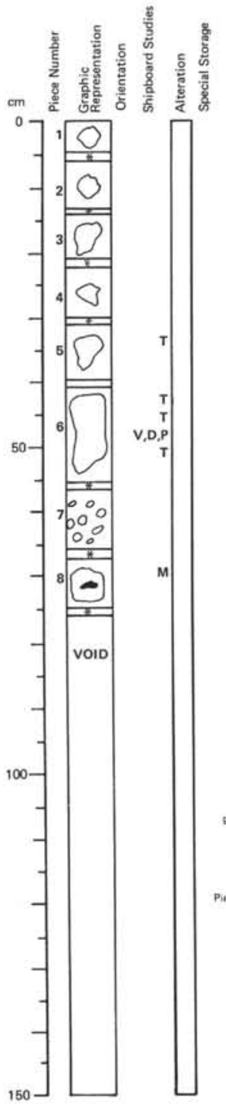
17-20 cm: Altered fine grain-sized basalt apophyses in medium grain-sized basalt.

Phenocrysts: Plagioclase (An65) 2%, 0.1-0.2 mm, euhedral-subhedral; clinopyroxene (augite) 3%, 0.1-0.2 mm, euhedral-subhedral.

Groundmass: Plagioclase (An65) 42%, the coarse grained rock is <0.08 mm and equigranular to subophitic, the fine-grained rock is 0.002 mm and granular; clinopyroxene (augite) 43%, the coarse-grained rock is <0.04 mm and equigranular to subophitic, fine-grained rock is 0.007 mm and granular; magnetite (Ti) dust-like, <0.04 mm, 15% in the fine grained rock and 10% in the coarse grained rock.

Alteration: Brown clays (10%) replacing all minerals.

Texture: Variable granular fine grained rock and equigranular coarse grained rock.



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG		SITE			HOLE		CORE			SECT.
6	1	4	6	2	A		7	1		1

Depth: 928.0 to 928.7 m

MAJOR ROCK TYPE—–BASALT

Macroscopic Description:

Altered basalt, basaltic breccia, and possible pillow brecciated basalt.

Thin Section Description:

34-36 cm: Basalt intrusive breccia from brecciated zone of pillow(?) margin (clinopyroxene-plagioclase phyric variolitic vitrophyric basalt).

Phenocrysts: Clinopyroxene-plagioclase.

Groundmass: Swirly mixture of hyalopilitic and vitrophyric spherulitic basalt. Intruded and brecciated by (now) coarse grained, liquid. The coarse grained basalt is similar in texture to other basalt apophyses found elsewhere. Alteration vein transect previously formed breccia; brecciation was probably caused by intrusion of later liquid.

Texture: Variolitic-vitrophyric basalt.

44-47 cm: Basalt pillow (?) from interior, coarser grained portion of a pillow. Clinopyroxene-plagioclase, variolitic-vitrophyric basalt.

Phenocrysts: Clinopyroxene-plagioclase.

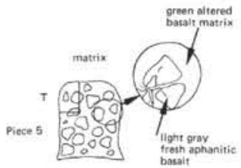
Groundmass: Continuous and monotonic variation in grain-size from variolitic to equigranular texture.

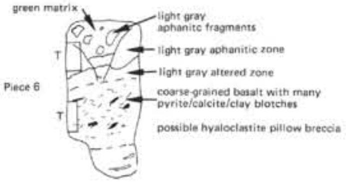
Texture: Variolitic to equigranular.

50-52 cm: Basalt pillow interior of coarse grained portion: clinopyroxene-plagioclase phyric equigranular basalt with clay-filled, rounded vugs (abundant).

Paleomagnetism/Physical Properties:

Interval	**44-46 cm**	**69 cm**
Intensity (10^{-3} emu/cm^3)	—	5.0
NRM Decl.	—	334.0
NRM Incl. (°)	—	−53.2
MDF (Oe.)	—	95.0
Stable Incl. (°)	—	−24.2(?)
Vp ∥ (km/s)	4.159	—
D (g/cm^3)	—	—
P (%)	—	—



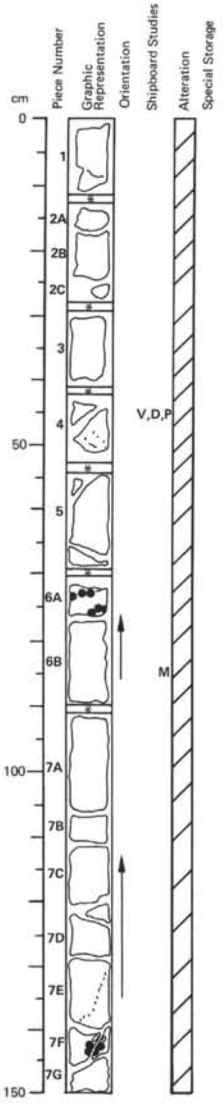


1 Pyrite+Ca+Clay alteration pocket

2 ▩- Dark gray aphanitic basalt

3 ☐- Light gray slightly more crystalline basalt(?)

4 ▨- Light green altered basalt with clay veinlets



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG		SITE			HOLE		CORE			SECT.
6	1	4	6	2	A		7	2		1

Depth: 931.0 to 932.5 m

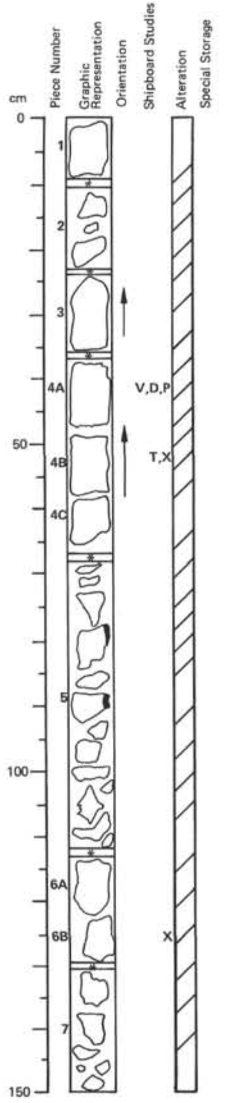
MAJOR ROCK TYPE—–MASSIVE BASALT

Macroscopic Description:

Slightly fresh homogeneous, massive medium to slightly coarse grain-sized subophitic to intergranular basalt with veins of mainly celadonite. This basalt has phenocrysts and microphenocrysts (± 1 mm) of plagioclase, clinopyroxene, and magnetite (?). It has microlites of plagioclase, clinopyroxene, and magnetite.

Paleomagnetism/Physical Properties:

Interval	**43-45 cm**	**85 cm**
Intensity (10^{-3} emu/cm^3)	—	21.8
NRM Decl.	—	211.0
NRM Incl. (°)	—	−68.5
MDF (Oe.)	—	—
Stable Incl. (°)	—	—
Vp ∥ (km/s)	5.757	—
D (g/cm^3)	2.96	—
P (%)	3.0	—



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG		SITE			HOLE		CORE		SECT.
6	1	4	6	2	A		7	2	2

Depth: 932.5 to 934.0 m

MAJOR ROCK TYPE---MASSIVE BASALT SILL

Macroscopic Description:
Two units (0 ? -90 cm and 90-150 ? cm) of slightly altered massive dolerite sills.

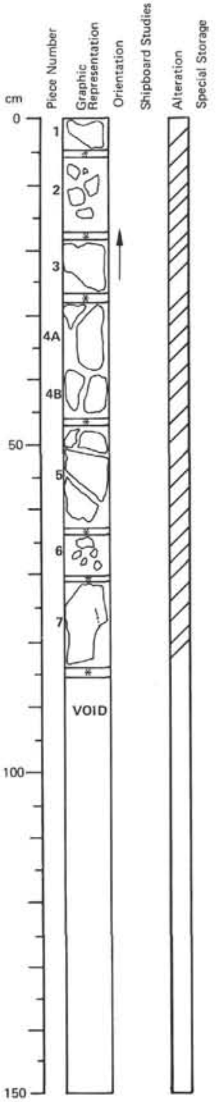
From 0-78 cm is slightly coarse grain-sized and is ophitic to intergranular. From 78-88 cm the grain-size gradually decreases to slightly fine. Texture is hyalopilitic. From 88-92 cm is fine grain-sized basalt with sparse clinopyroxene microphenocrysts. From 92-95 cm is slightly fine grain-sized with sparse clinopyroxene microphenocrysts. From 95-150 cm is slightly coarse to medium grain-sized.

Shipboard Geochemistry (XRF, %):

	Altered basalt	
	53-55 cm	**124-126 cm**
SiO_2	49.78	49.25
TiO_2	1.05	1.06
Al_2O_3	13.74	13.79
FeO	11.55	10.68
MnO	---	---
MgO	7.93	7.53
CaO	12.15	12.40
Na_2O	---	---
K_2O	0.09	0.09
P_2O_5	---	---
Total	---	---
LOI†	0.93	0.76
$FeO \div MgO$	1.45	1.40
$CaO \div Al_2O_3$	0.88	0.89
$FeO \div TiO_2$	11.00	10.07

Physical Properties:

Interval	**44-46 cm**
$Vp_{\parallel}$ (km/s)	6.017
D (g/cm^3)	2.97
P (%)	1.7



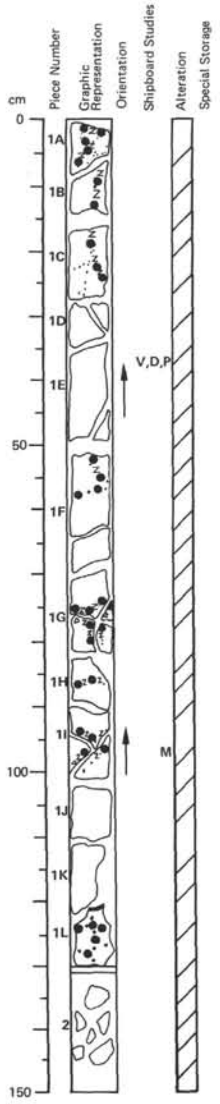
VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG		SITE			HOLE		CORE		SECT.
6	1	4	6	2	A		7	2	3

Depth: 934.0 to 934.8 m

MAJOR ROCK TYPE---MASSIVE BASALT SILL

Macroscopic Description:
Slightly altered, slightly coarse grain-sized massive dolerite sill. Same unit as in Section 72-2.



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG		SITE			HOLE	CORE		SECT.	
6	1	4	6	2	A	7	3		1

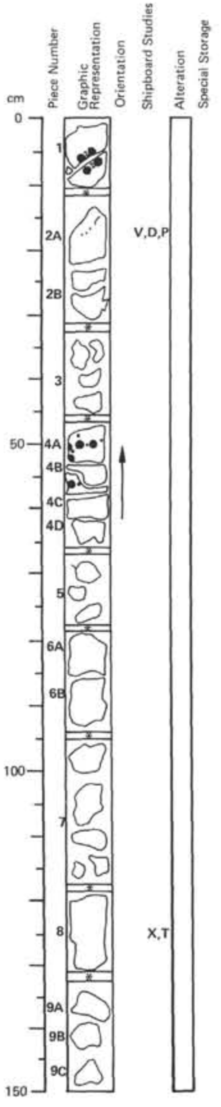
Depth: 937.0 to 938.5 m

MAJOR ROCK TYPE—MASSIVE DOLERITE SILL

Macroscopic Description:
Slightly altered, slighly coarse to coarse grain-sized, ophitic to equigranular massive dolerite sill with veins of celadonite and zeolite. This dolerite is composed of phenocrysts of plagioclase,

Paleomagnetism/Physical Properties:

Interval	**37-39 mc**	**103 cm**
Intensity (10^{-3} emu/cm^3)	—	21.7
NRM Decl.	—	175.0
NRM Incl. (°)	—	–81.1
MDF (Oe.)	—	—
Stable Incl. (°)	—	—
Vp ∥ (km/s)	5.452	—
D (g/cm^3)	2.93	—
P (%)	3.8	—



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG		SITE			HOLE	CORE		SECT.	
6	1	4	6	2	A	7	3		2

Depth: 938.5 to 940.0 m

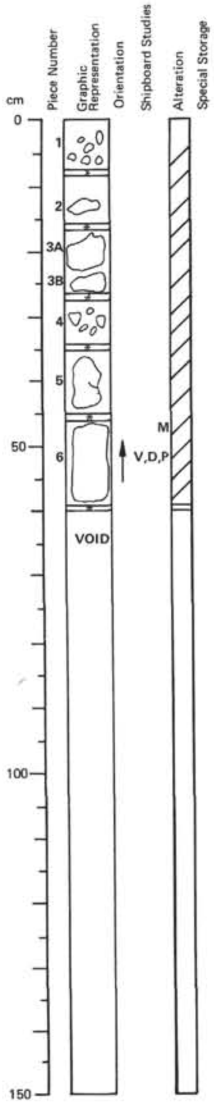
MAJOR ROCK TYPE—MASSIVE DOLERITE SILL

Macroscopic Description:
Slightly altered, slightly coarse to coarse grain-sized massive dolerite sill with veins of zeolite and celadonite. This is the same unit as Section 73-1.

Thin Section Description:
124-126 cm: Altered dolerite from sill interior.
Groundmass: Plagioclase (An70-72) 40%, 0.3-0.6 mm, subhedral; clinopyroxene (augite) 40%, 0.3-0.6 mm, subhedral; magnetite (Ti) 10%, 0.2-0.5 mm, dust-like and skeletal; trace of granophyric, intergrowth of quartz and alkali feldspar; trace of apatite.
Alteration: Brown clays (10%) replacing all minerals.
Texture: Subophitic.

Physical Properties:

Interval	**19-21 cm**
Vp ∥ (km/s)	5.511
D (g/cm^3)	2.94
P (%)	3.1



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG		SITE			HOLE	CORE			SECT.	
6	1	4	6	2	A		7	3		3

Depth: 940.0 to 940.6 m

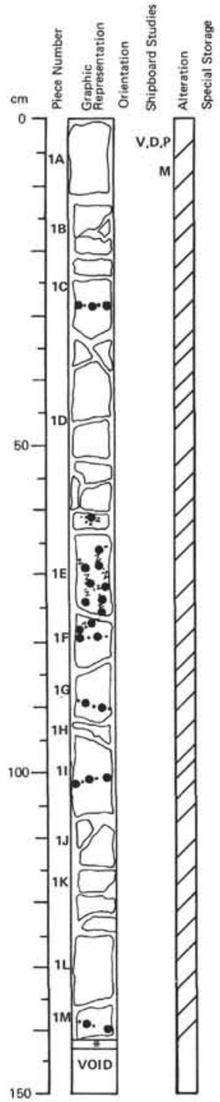
MAJOR ROCK TYPE—DOLERITE SILL

Macroscopic Description:
Two units (0 ? -27 cm, and 27-150 ? cm) of slightly altered massive dolerite sills.

From 0-7 cm are crushed (drill crushed?) particles of coarse to slightly coarse grain-sized basalt. From 7-15 cm is coarse to slightly coarse grained basalt. From 15-23 cm is coarse grain-sized basalt with megacrysts of clinopyroxene. The margins of these crystals are replaced to clay mineral. From 37-45 cm basalt is slightly medium grain-sized, and from 45-60 cm it is medium grain-sized.

Paleomagnetism/Physical Properties:

Interval	**47 cm**	**52-54 cm**
Intensity (10^{-3} emu/cm^3)	26.7	—
NRM Decl.	155.0	—
NRM Incl. (°)	−64.6	—
MDF (Oe.)	—	—
Stable Incl. (°)	—	—
Vp ∥ (km/s)	—	5.896
D (g/cm^3)	—	2.96
P (%)	—	2.8



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG		SITE			HOLE	CORE			SECT.	
6	1	4	6	2	A		7	4		1

Depth: 946.0 to 947.4 m

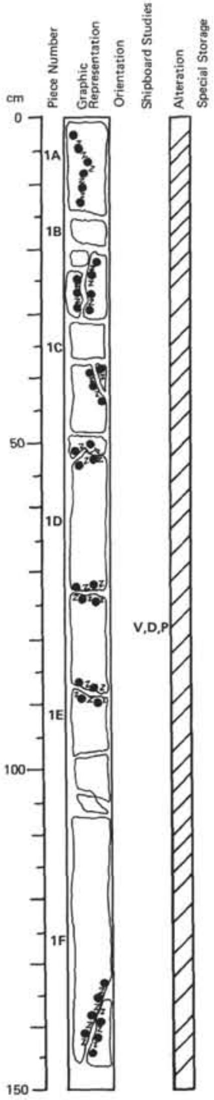
MAJOR ROCK TYPE—MASSIVE DOLERITE SILL

Macroscopic Description:
Slightly altered massive dolerite sill with veins. Dolerite is medium grain-sized subophitic to interstitial, and has rare microphenocrysts of clinopyroxene.

From 33-75 cm common veins and altered patches occur, which are made of zeolite, chlorite, pyrite, and a small amount of magnetite.

Paleomagnetism/Physical Properties:

Interval	**5-7 cm**	**8 cm**
Intensity (10^{-3} emu/cm^3)	—	22.8
NRM Decl.	—	223.0
NRM Incl. (°)	—	−73.1
MDF (Oe.)	—	—
Stable Incl. (°)	—	—
Vp ∥ (km/s)	5.850	—
D (g/cm^3)	2.94	—
P (%)	3.7	—



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	74	2

Depth: 947.4 to 948.9 m

MAJOR ROCK TYPE—MASSIVE DOLERITE SILL

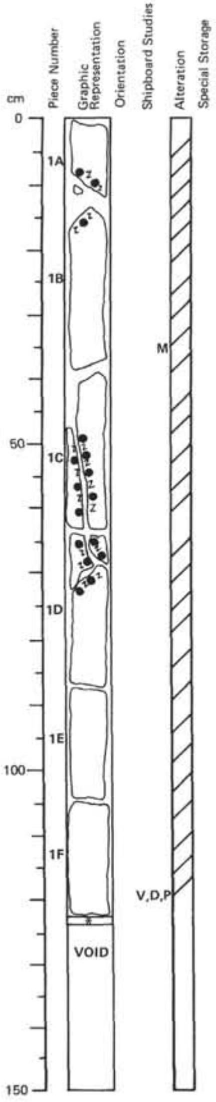
Macroscopic Description:

Slightly altered massive dolerite sill with veins of celadonite and zeolite.
Same units as in Section 74-1.

From 0-14 cm is medium grain-sized. From 14-150 cm is medium to slightly coarse grain-sized and is ophitic to intergranular.

Physical Properties:

Interval	**79-81 cm**
Vp ∥ (km/s)	5.999
D (g/cm^3)	2.95
P (%)	3.3



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	74	3

Depth: 948.9 to 950.1 m

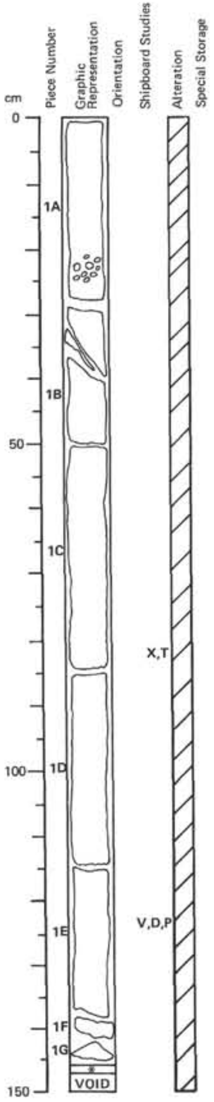
MAJOR ROCK TYPE—

Macroscopic Description:

Slightly altered, slightly coarse grain-sized massive dolerite sill with veins of celadonite and zeolite. It is the same unit as Section 74-2.

Paleomagnetism/Physical Properties:

Interval	**37 cm**	**118-120 cm**
Intensity (10^{-3} emu/cm^3)	17.5	—
NRM Decl.	214.0	—
NRM Incl. (°)	–71.1	—
MDF (Oe.)	—	—
Stable Incl. (°)	—	—
Vp ∥ (km/s)	—	6.075
D (g/cm^3)	—	2.97
P (%)	—	3.1



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	74	4

Depth: 950.1 to 951.6 m

MAJOR ROCK TYPE—MASSIVE DOLERITE SILL

Macroscopic Description:

Slightly altered, slightly coarse grain-sized massive dolerite sill. It is the same unit as in Section 74-3.

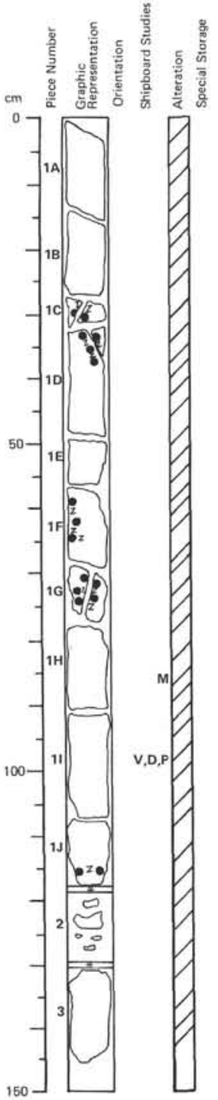
From 23-28 cm the basalt contains granophyric schlieren.

Shipboard Geochemistry (XRF, %):

	Altered basalt 72-74 cm
SiO_2	50.54
TiO_2	1.02
Al_2O_3	14.02
FeO	11.63
MnO	—
MgO	7.82
CaO	12.63
Na_2O	—
K_2O	0.04
P_2O_5	—
Total	—
LOI†	0.90
FeO ÷ MgO	1.48
CaO ÷ Al_2O_3	0.90
FeO + TiO_2	11.40

Physical Properties:

Interval	123-125 cm
Vp ∥ (km/s)	5.902
D (g/cm^3)	2.94
P (%)	3.7



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	74	5

Depth: 951.6 to 953.0 m

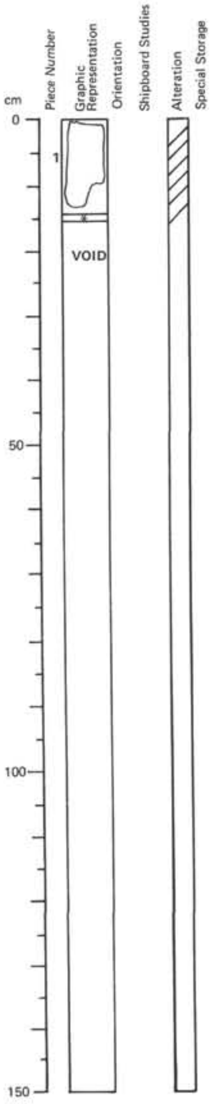
MAJOR ROCK TYPE—MASSIVE DOLERITE SILL

Macroscopic Description:

Slightly altered, slightly coarse grain-sized massive dolerite sill with veins of celadonite plus zeolite. It is the same unit as Section 74-4.

Paleomagnetism/Physical Properties:

Interval	86 cm	94-96 cm
Intensity (10^{-3} emu/cm^3)	15.1	—
NRM Decl.	223.0	—
NRM Incl. (°)	−71.9	—
MDF (Oe.)	—	—
Stable Incl. (°)	—	—
Vp ∥ (km/s)	—	5.978
D (g/cm^3)	—	2.96
P (%)	—	4.6



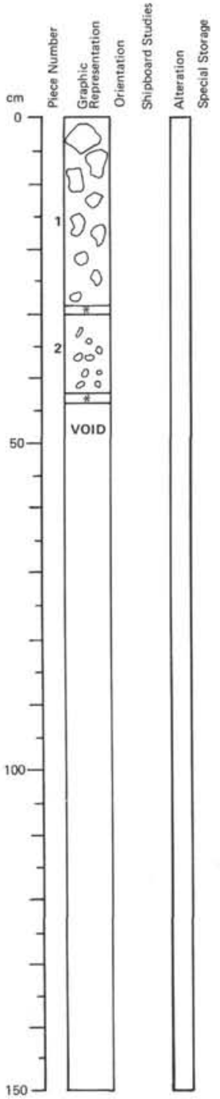
VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
6 1	4 6 2	A	7 4	6

Depth: 953.0 m

MAJOR ROCK TYPE––MASSIVE DOLERITE SILL

Macroscopic Description:
Slightly altered, slightly coarse grain-sized massive dolerite sill. It is the same unit as Section 74-5.



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
6 1	4 6 2	A	X 1	1

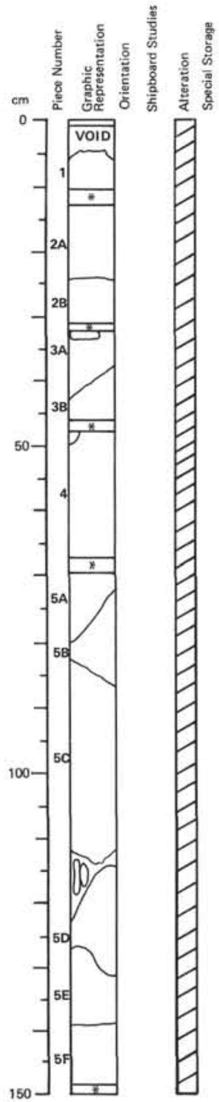
Depth: 953.0 to ? m

MAJOR ROCK TYPE––BASALT DOLERITE AND SEDIMENTARY ROCK FRAGMENTS

Macroscopic Description:
There are eight fragments (0-20 cm) of basaltic rock which are medium grain-sized dolerite similar to that of Core 73. One fragment is fine grain-sized which is similar to that of Core 72.

From 30-43 cm are small pieces (0.5-2.0 cm) of sedimentary rock.

None of these fragments has a known orientation or a known stratigraphic position. These were collected in "tool" fishing operation.



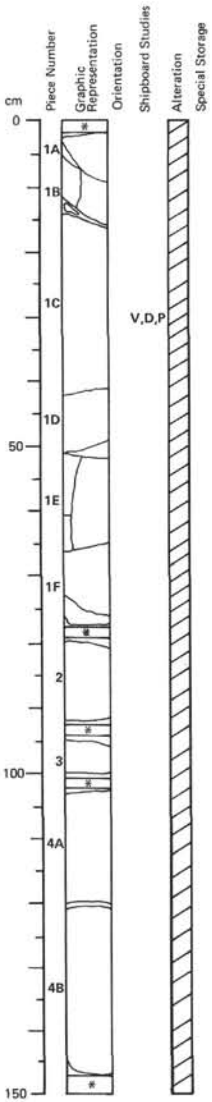
VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	75	1

Depth: 953.0 to 954.5 m

MAJOR ROCK TYPE—DOLERITE

Slightly altered, gray (N5), homogenous dolerite with joints lined with dark greenish black celadonite. Microphenocrysts of pyroxene and plagioclase occur in a holocrystalline medium grain-sized doleritic groundmass.



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	75	2

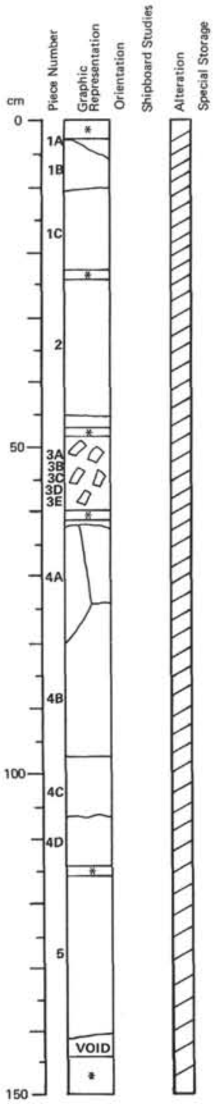
Depth: 954.5 to 956.0 m

MAJOR ROCK TYPE—DOLERITE

Macroscopic Description:
Gray (N5), very slight alteration (perhaps weathering), homogenous dolerite with joints which are frequently coated with slickensides and a greenish-black coating. Pyroxene and plagioclase microphenocrysts occur in a holocrystalline medium grain-sized groundmass.

Physical Properties:

Interval	**31-33 cm**
Vp ∥ (km/s)	6.232
Vp ⊥ (km/s)	6.254
D (g/cm^3)	2.96
P (%)	3.39



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

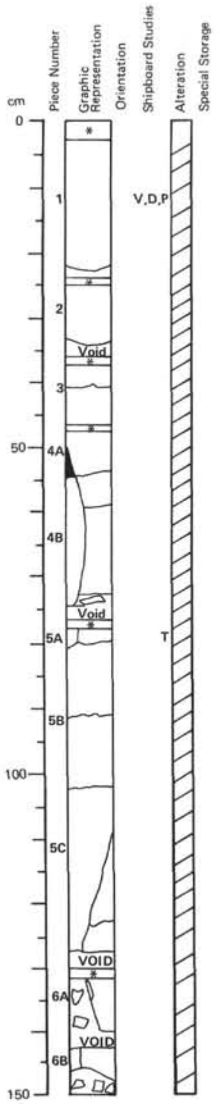
LEG	SITE	HOLE	CORE	SECT.
61	462	A	75	3

Depth: 956.0 to 957.5 m

MAJOR ROCK TYPE—DOLERITE

Macroscopic Description:
Gray (N5), slightly altered, homogeneous dolerite with rare veins (thin layers on most joints). Microphenocrysts of pyroxene and feldspar (laths) in a holocrystalline medium grain-sized doleritic groundmass.

Piece 5 was placed in shrink tubing for cutting. The heat required to shrink the tubing may affect magnetic studies.



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	75	4

Depth: 957.5 to 958.0 m

MAJOR ROCK TYPE—DOLERITE

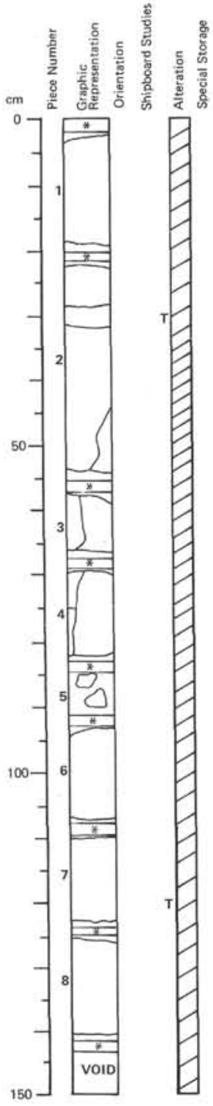
Macroscopic Description:
Gray (N5), slightly altered homogeneous dolerite with joints. Alteration occurs particularly along the joints and most joints are lined with pale green fibrous mineral. Jointing is irregular, but more common than in Sections 75-1 through 75-3. The dolerite has microphenocrysts of pyroxene and plagioclase in a holocrystalline, medium grain-sized groundmass.

Rock numbers 1, 4B, and 5C were put in shrink tubing (thus heated), which may affect paleomagnetics.

Thin Section Description:
78-80 cm: Dolerite from sill interior.
Groundmass: Plagioclase 54%, 0.5 x 0.005 mm, laths; clinopyroxene 37%, 0.2 x 0.2 mm, equidimensional; magnetite and ilmenite 7%.
Alteration: Clays (3.1%) replacing all minerals.
Texture: Subophitic.

Physical Properties:

Interval	**10-13 cm**
Vp ‖ (km/s)	6.18
Vp ⊥ (km/s)	6.29
D (g/cm^3)	2.98
P (%)	2.7



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

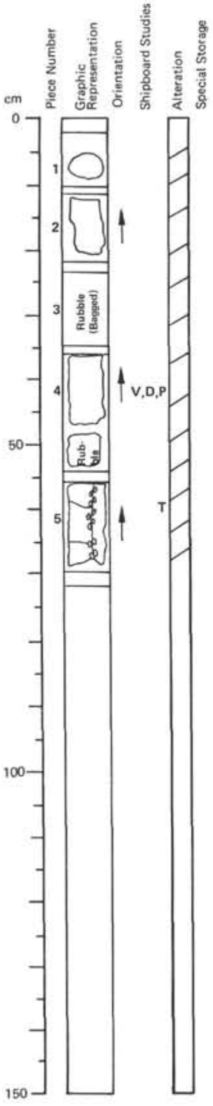
LEG	SITE	HOLE	CORE	SECT.
61	462	A	75	5

Depth: 953.0 to 958.0 m

MAJOR ROCK TYPE—-DIABASE

Macroscopic Description:
Gray (N5) dolerite which has a pyroxene-plagioclase groundmass and pyroxene microphenocrysts. It is homogeneous except for a few patches of slightly more mafic-rich regions, mostly near the base of Piece 7 and the top of Piece 8. Distinct slickenside development at the base of Piece 4 with some pyrite crystals. Slickensides are dark green to black.

Thin Section Description:
31-32 cm: Dolerite from flow or sill interior.
Groundmass: olivine <0.05% replaced by clay; plagioclase 54%; clinopyroxene 36%; magnetite and ilmenite 5%.
Alteration: Clays (5%) replacing olivine and glass (?).
Texture: Subophitic.
122-124 cm: Dolerite from flow or sill interior.
Groundmass: Plagioclase 58%; clinopyroxene 31%; magnetite and ilmenite 6%.
Alteration: Clays (5%) replacing glass (?).
Texture: Subophitic.



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	76	1

Depth: 958.0 to 967.0 m

MAJOR ROCK TYPE—-BASALT

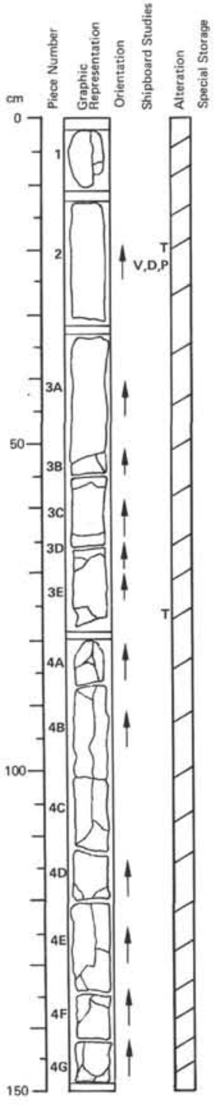
Macroscopic Description:
Fresh to slightly altered basalt, which is made of pyroxene phenocrysts set in holocrystalline groundmass of pyroxene and plagioclase.

From 0-47 cm basalt is homogeneous and has a doleritic texture. From 55-70 cm is finer in grain-size than above, but does not appear to exhibit any internal texture variation. Piece 5 (55-70 cm) contains a green alteration mineral, pyrite, and zeolite along a fracture zone.

Thin Section Description:
59-61 cm: Dolerite from flow or sill interior.
Phenocrysts: Olivine completely altered to clays.
Groundmass: Plagioclase 38%, 0.1-6.0 mm, laths; clinopyroxene 39%, 0.05-0.3 mm, 2V = 45-50°, equigranular, partially altered; magnetite and ilmenite 7%; glass completely altered to clay.
Alteration: Carbonate (trace) in veins. Clays (17%) replace glass, olivine, and occurs in the interstices. Zeolites and some pyrite occur in veins.
Texture: Subophitic.

Physical Properties:

Interval	43-45 cm
Vp ∥ (km/s)	5.96
Vp ⊥ (km/s)	6.10
D (g/cm^3)	2.98
P (%)	3.3



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	77	1

Depth: 967.0 to 968.5 m

MAJOR ROCK TYPE—BASALT

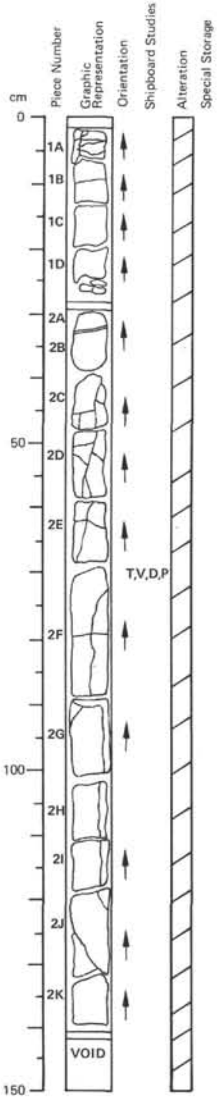
Macroscopic Description:
Two units (0-78 cm, and 78-150 cm) of gray (N5) holocrystal basalt with veins filled with a green mineral, abundant pyrite (up to 7 mm), zeolite (?), and calcite (?). The basalt is holocrystalline and is made of plagioclase plus pyroxene.

The basalt appears identical to basalt described in Core 76 except that grain-size decreases from the top of Core 77, Section 1, to the bottom of Piece 3E (78 cm), the grain-size increases from the top of Piece 4A (80 cm) to 150 cm. The interval between Pieces 3E and 4A is interpreted as a contact separating two cooling units. Glass is not found, however, the basalt is highly fractured, which are now veins. (Optical study of white vein material in Piece 4F reveals calcite, but no zeolite.)

Thin Section Description
21-23 cm: Dolerite from flow or sill interior.
Groundmass: Plagioclase 40%, 0.2 x 0.02 mm, laths; clinopyroxene 47%, 0.02 to 0.08 mm, equidimensional; magnetite and ilmenite 5%.
Alteration: Clays (8%) in scattered locations replacing mainly clinopyroxene.
Texture: Subophitic.
75-77 cm: Basalt from interior of sill (?).
Phenocrysts: Olivine 1-2%, 0.1-0.2 mm; plagioclase < 1%, 0.05-0.1 mm; clinopyroxene < 1%, 0.05-0.1 mm.
Groundmass: Olivine 2%; plagioclase 42%; clinopyroxene 42%; magnetite and ilmenite 14%; glass is altered to clay.
Alteration: Clays (1%) replacing olivine.
Texture: Intergranular to weakly variolitic.

Physical Properties:

Interval	20-23 cm
Vp ∥ (km/s)	5.87
Vp ⊥ (km/s)	5.87
D (g/cm^3)	2.97
P (%)	3.1



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	77	2

Depth: 958.5 to 960.0 m

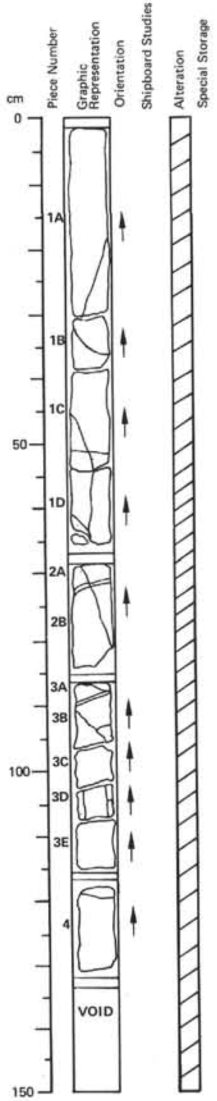
MAJOR ROCK TYPE—BASALT

Macroscopic Description:
Gray (N5-N6) homogeneous grain-sized basalt with numerous fractures and veins filled with pyrite and zeolite(?). Little or no obvious alteration of rock away from veins. Basalt is holocrystalline and is made of interlocking plagioclase and pyroxene forming a doleritic texture.

Thin Section Description:
70-73 cm: Dolerite from flow or sill interior.
Phenocrysts: Olivine completely altered to brown clay.
Groundmass: Plagioclase 40%, 0.05-0.3 mm, laths, slightly altered zoned clinopyroxene 40%, 0.04-0.15 mm, subhedral, moderately altered; magnetite and ilmenite 8%; glass completely altered.
Alteration: Clays (13%) replacing olivine phenocrysts and interstitial olivine and glass.
Texture: Subophitic to variolitic.

Physical Properties:

Interval	70-73 cm
Vp ∥ (km/s)	5.78
Vp ⊥ (km/s)	5.76
D (g/cm^3)	2.97
P (%)	4.7



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

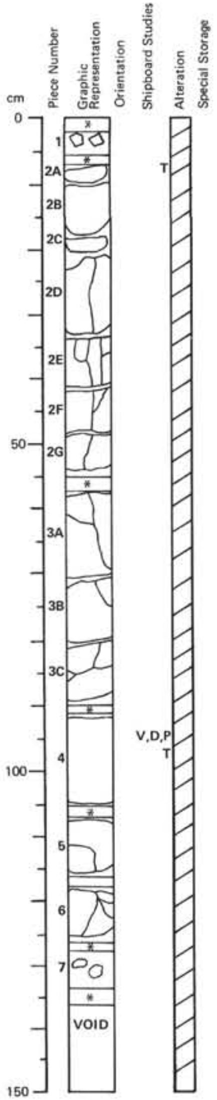
LEG	SITE	HOLE	CORE	SECT.
61	462	A	77	3

Depth: 960.0 to 961.5 m

MAJOR ROCK TYPE—BASALT

Macroscopic Description:

Gray (N5), fresh to slightly altered homogeneous grain-sized basalt with numerous fractures and veins consisting of pyrite, zeolite (?), and dark green alteration mineral. Basalt consists of plagioclase and pyroxene forming a doleritic texture.



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	78	1

Depth: 976.0 to 977.5 m

MAJOR ROCK TYPE—DOLERITE

Macroscopic Description:

Gray (N6) slightly altered homogeneous fine grain-sized dolerite with scattered augite microphenocrysts. Many fractures lined with greenish black coating and calcite crystals. Some fractures contain pyrite.

Thin Section Description:

5-9 cm: Dolerite from flow or sill interior.

Phenocrysts: Olivine is completely altered.

Groundmass: Plagioclase 35%, 0.1-0.6 mm, laths, generally fresh, slightly zoned; clinopyroxene 43%, 0.06-0.4 mm, subhedral, generally fresh; magnetite and ilmenite 6%; glass is completely altered.

Alteration: Clays (17%) replacing glass and olivine.

Texture: Subophitic to intersertal.

96-98 cm: Dolerite from sill or flow interior.

Phenocrysts: Olivine altered to brown clay.

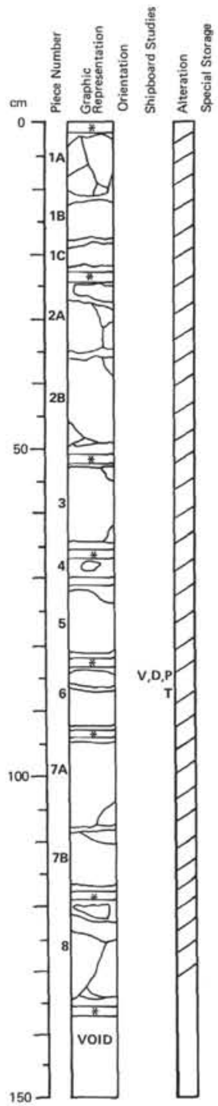
Groundmass: Plagioclase 38%, <0.01-0.4 mm, laths; also fine intergrowths in radiating sheaves; clinopyroxene 44%, 0.01-0.3 mm, equigranular, also fine intergrowths in radiating sheaves; magnetite and ilmenite 8%.

Alteration: Clays (10%) replacing interstitial glass and olivine, and olivine phenocrysts.

Texture: Variolitic to subophitic.

Physical Properties:

Interval	**91-93 cm**
Vp ∥ (km/s)	5.95
Vp ⊥ (km/s)	6.05
D (g/cm^3)	2.95
P (%)	4.4



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG		SITE			HOLE	CORE			SECT.	
6	1	4	6	2	A		7	8		2

Depth: 977.5 to 979.0 m

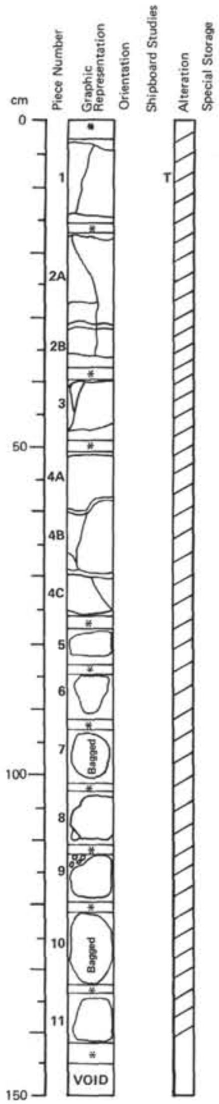
MAJOR ROCK TYPE—DOLERITE

Macroscopic Description:
Gray (N6) slightly altered dolerite with scattered augite microphenocrysts. Dolerite from 0-70 cm is homogeneously fine grain-sized, and from 70-150 cm is slightly coarser grain-sized. Several fractures are lined with a greenish black coating. Some calcite and pyrite crystals also occur along the fractures.

Thin Section Description:
87-89 cm: Dolerite from flow or sill interior.
Groundmass: Plagioclase 41%, 0.35 x 0.05 mm, laths; clinopyroxene 38%, 0.04 to 0.1 mm, equidimensional, magnetite and ilmenite 9%.
Alteration: Clays (12%) replacing glass, olivine, and clinopyroxene.
Texture: Intersertal.

Physical Properties:

Interval	**82-84 cm**
Vp ∥ (km/s)	5.76
Vp ⊥ (km/s)	5.81
D (g/cm^3)	2.95
P (%)	3.4



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

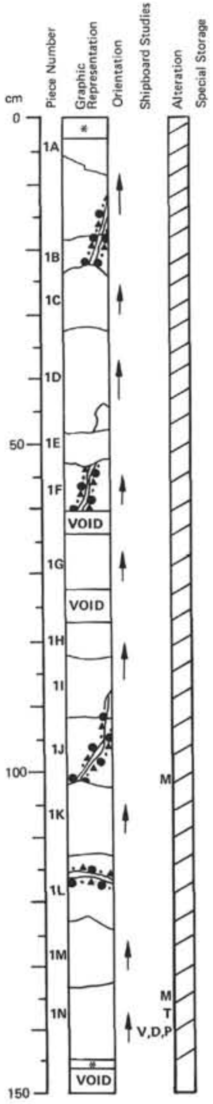
LEG		SITE			HOLE	CORE			SECT.	
6	1	4	6	2	A		7	8		3

Depth: 979.0 to 980.5 m

MAJOR ROCK TYPE—DOLERITE

Macroscopic Description:
Gray (N6) slightly altered, diabase with scattered augite phenocrysts. From 0-75 cm is homogeneously medium grain-sized and from 75-150 cm is finer in grain-size.

Several fractures are lined with a greenish black coating and slickensides are common. Some calcite crystals occur along the fractures. Pieces 2 and 4 were heat treated during fit into shrink tubing.



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG		SITE			HOLE	CORE			SECT.	
6	1	4	6	2	A		7	9		1

Depth: 985.0 to 986.5 m

MAJOR ROCK TYPE---DOLERITE

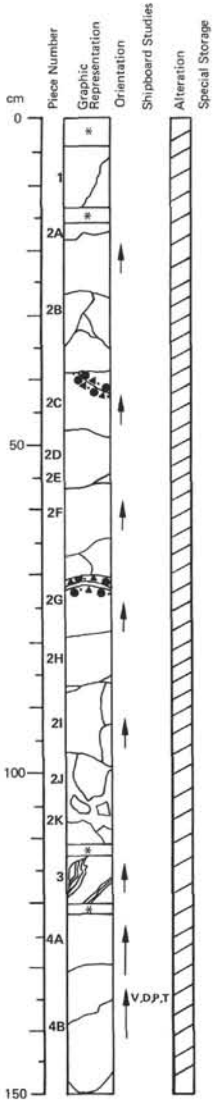
Macroscopic Description:
Moderately altered coarse grain-sized basalt or medium grain-sized basalt with veins of calcite, dark green mineral, and pyrite. Highly fractured and jointed. Grain-size is relatively homogeneous although a slight decrease in grain-size appears to occur in Pieces 1E and 1F; however, a cooling unit boundary is probably not indicated. Small mafic clots appear to be clinopyroxene microphenocrysts.

Pieces 1G and 1H were heat treated.

Thin Section Description:
138-140 cm: Basalt from sill or flow interior.
Phenocrysts: Olivine 0.15-0.2 mm; clinopyroxene 0.1-0.15 mm.
Groundmass: Olivine 1.5%, pseudomorphed by clay; plagioclase 43%; clinopyroxene 39%; magnetite and ilmenite 5%; glass replaced by clay.
Alteration: Clays (12%) replace glass and olivine.
Texture: Intersertal.

Physical Properties:

Interval	**138-140 cm**
Vp ∥ (km/s)	5.67
Vp ⊥ (km/s)	5.86
D (g/cm^3)	2.92
P (%)	6.3



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG		SITE			HOLE	CORE			SECT.	
6	1	4	6	2	A		7	9		2

Depth: 986.5 to 988.0 m

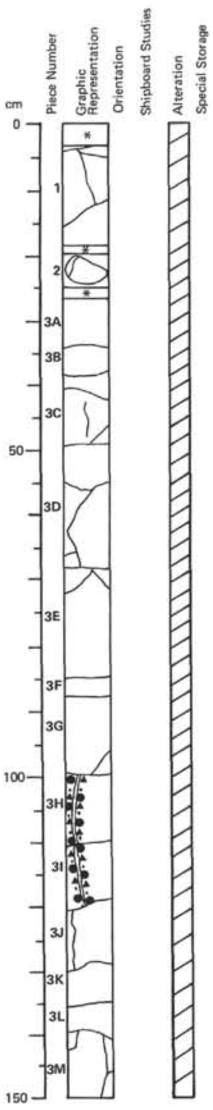
MAJOR ROCK TYPE---DOLERITE

Macroscopic Description:
Slightly altered homogeneous coarse grain-sized basalt or medium grain-sized dolerite. Rare veins of dark green mineral, calcite, and pyrite. Dark mafic minerals appear to be microphenocrysts.

Thin Section Description:
135-137 cm: Basalt.
Phenocrysts: Olivine > 1%, 0.2-0.5 mm, replaced by clay; plagioclase < 1%, 0.1-0.3 mm, anhedral, zoned; clinopyroxene 0.1 to 0.2 mm.
Groundmass: Olivine 1.7%, replaced by clay; plagioclase 42%; clinopyroxene 39%; magnetite and ilmenite 7%; glass (tachylite) replaced by clay.
Alteration: Carbonate (0.3%) replacing feldspar and glass. Clays (10%) replace glass and olivine.
Texture: Intersertal/intergranular.

Physical Properties:

Interval	**135-137 cm**
Vp ∥ (km/s)	5.58
Vp ⊥ (km/s)	5.61
D (g/cm^3)	2.92
P (%)	5.4



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

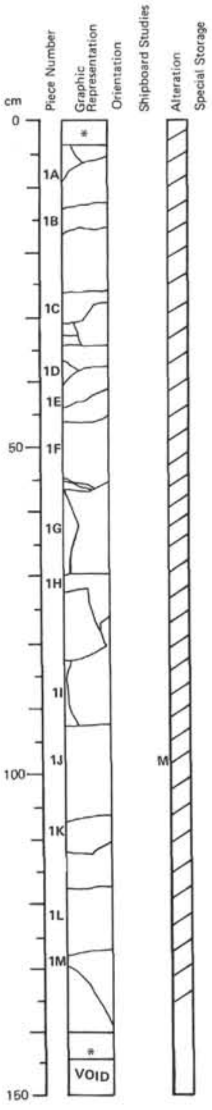
LEG		SITE			HOLE	CORE		SECT.	
6	1	4	6	2	A		7 9		3

Depth: 988.0 to 989.5 m

MAJOR ROCK TYPE—DOLERITE

Macroscopic Description:
Slightly altered coarse grain-sized basalt or medium grain-sized dolerite. Fracture surfaces are coated with a dark greenish black mineral which also is commonly associated with calcite and pyrite. A particularly prominent pyrite vein occurs in Pieces 3H and 3I.

Dolerite is relatively homogeneous in texture and composition; however, Piece 1 may have a slightly finer grain-size than the remainder of the section.



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG		SITE			HOLE	CORE		SECT.	
6	1	4	6	2	A		7 9		4

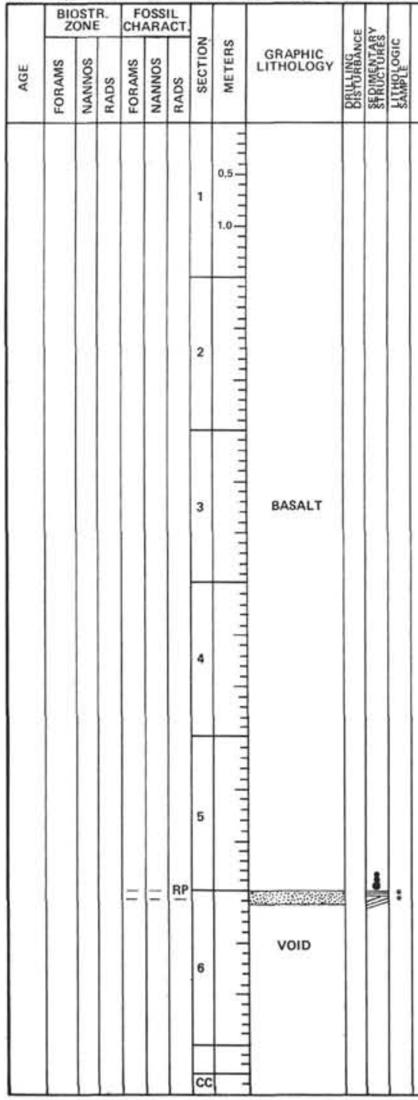
Depth: 989.5 to 991.0 m

MAJOR ROCK TYPE—DOLERITE

Macroscopic Description:
Slightly altered, homogeneous coarse grain-sized basalt or medium grain-sized dolerite. Joint surfaces are covered with a thin coating of dark black green mineral (chlorite?), calcite, and rarely pyrite.

Pieces 1B, 1G, 1H, and 1I were heat treated.

SITE 462 HOLE A CORE 79 CORED INTERVAL: 985.0 to 994.0 m

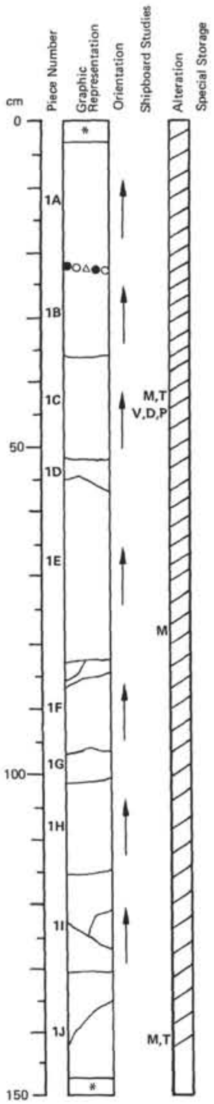


LITHOLOGIC DESCRIPTION

0.0 to 7.50 m: Basalt is described in the **"Visual Core Description of Igneous Rock".**
7.50 to 7.67 m: Grayish red (5R 4/2) **SANDY SILTSTONE** with thin laminations of light greenish gray (5GY 6/1); however, the siltstone is almost entirely altered to clay (smectite?) and is probably a devitrified hyaloclastite.

SMEAR SLIDE (%)

	Devitrified-volcanic-ash claystone 6-7	Devitrified-volcanic-ash claystone 6-12
MINERALS	**(M)**	**(D)**
Feldspar	2?	2?
Heavy minerals	Tr?	Tr?
Clay	98?	98?



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	79	5

Depth: 991.0 to 992.5 m

MAJOR ROCK TYPE––DOLERITE

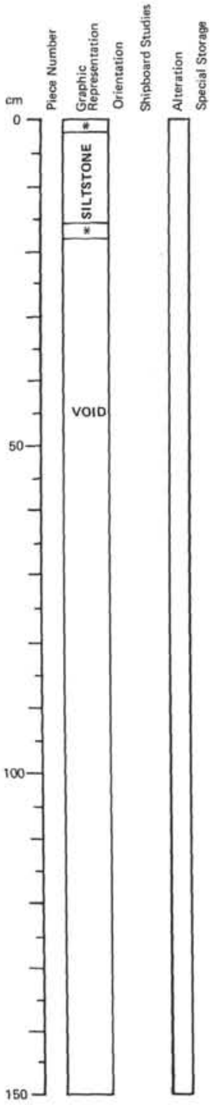
Macroscopic Description:
Slightly altered coarse grain-sized basalt or medium grain-sized dolerite, with rare veins of celadonite, calcite, and pyrite. Grain-size decreases from 0-150 cm, suggesting a possible base to cooling unit. Composition is homogeneous.

Dolerite overlies grayish-red volcanic siltstone in Section 79-6. Red color may be caused by baking.

Thin Section Description:
42-44 cm: Basalt from sill interior.
Phenocrysts: Olivine >1%, 0.1-0.2 mm.
Groundmass: Olivine 1.4%, replaced by clay; plagioclase 46%; clinopyroxene 38%; magnetite and ilmenite 6%; glass replaced by clay.
Alteration: Clays (8%) replacing interstitial glass plus olivine.
Texture: Intergranular.
135-137 cm: Basalt near a base of cooling unit (fine grain-sized margin).
Phenocrysts: Olivine 1-2%, 0.1-0.4 mm, altered to clay; plagioclase <1%, 0.1-0.3 mm; clinopyroxene <1%, 0.05-0.15 mm.
Groundmass: Olivine 2.2%, altered to clay; plagioclase 41%; clinopyroxene 44%; magnetite and ilmenite 9%; glass is altered to clay.
Alteration: Clays replace interstitial glass and create pseudomorphs after olivine.
Texture: Intergranular with variolitic clots.

Physical Properties:

Interval	**42-44 cm**
Vp ∥ (km/s)	5.75
Vp ⊥ (km/s)	5.94
D (g/cm^3)	2.98
P (%)	2.8



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

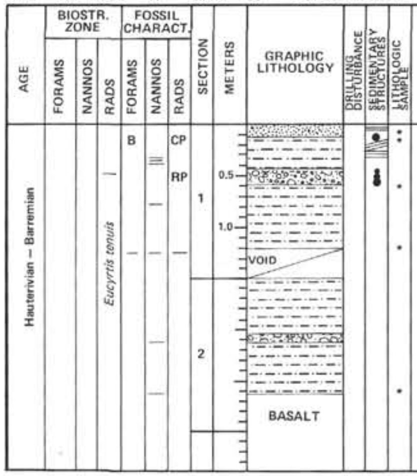
LEG	SITE	HOLE	CORE	SECT.
61	462	A	79	6

Depth: 992.5 to 994.0 m

MAJOR ROCK TYPE–––SILTSTONE

The siltstone is described in the "Sedimentary Core Barrel Descriptions."

SITE 462 HOLE A CORE 80 CORED INTERVAL: 994.0 to 998.0 m



LITHOLOGIC DESCRIPTION

0.0 to 0.12 m: Medium dark gray (N4) very **SANDY SILTSTONE,** with grain-size graded (coarser at base) upwards from lower contact. Sediment is 95% smectite grains.

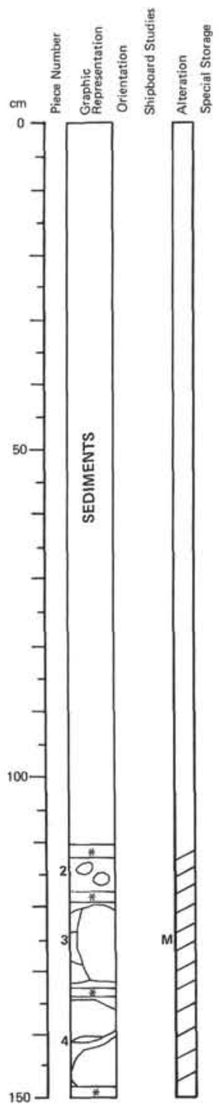
0.12 to 0.39 m: Dark gray (N3) **SANDY MUDSTONE.**

0.39 to 0.58 m: Brownish black (5YR 2/1) interformational **CONGLOMERATE** with angular siltstone clasts. Grain-size gradationally decreases up and down from the coarser center.

0.58 to 2.09 m: Brownish black (5YR 2/1) homogeneous **SANDY SILTSTONE.** Consists of olive green to clear smectite.

2.09 to 2.16 m: Brownish gray to brownish black (5YR 4/1 to 5YR 2/1) intraformational **CONGLOMERATE.** Angular, planar clasts parallel bedding.

2.16 to 2.67 m: Dark gray (N3) **SANDY SILTSTONE** with faint layering in the lower portion. Composition mostly smectite; and rare plagioclase, glass and opaques.



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

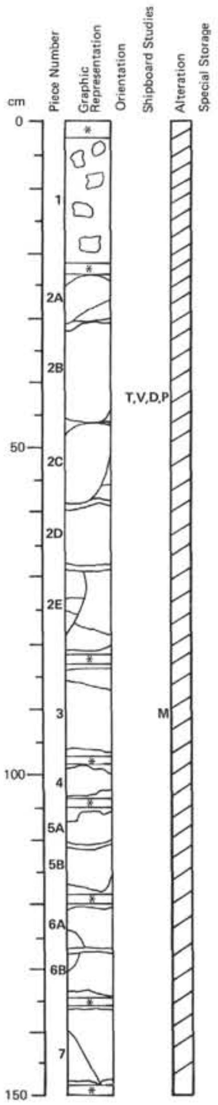
LEG		SITE			HOLE	CORE			SECT.	
6	1	4	6	2	A		8	0		2

Depth: 995.5 to 997.0 m

MAJOR ROCK TYPE—DOLERITE AND SEDIMENTARY ROCK

Macroscopic Description:
The 0-112 cm interval are sediments which are described in detail in "Sedimentary Core Barrel Descriptions".

From 112-150 cm is gray (N5) dolerite. Several fracture surfaces are coated with greenish black mineral (celadonite). From 112-120 cm dolerite is fine grain-sized and from 120-150 cm is medium grain-sized dolerite with scattered augite microphenocrysts.



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG		SITE			HOLE	CORE			SECT.	
6	1	4	6	2	A		8	0		3

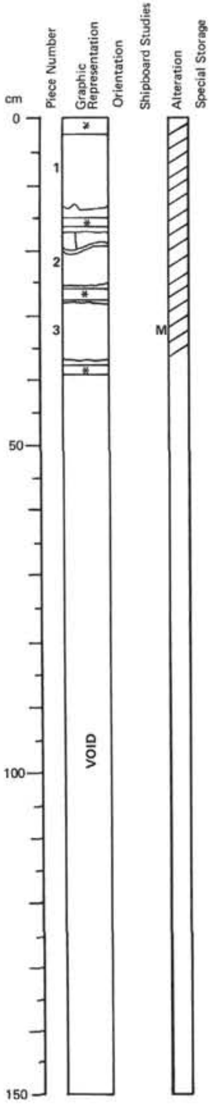
Depth: 994.0 to 998.0 m

MAJOR ROCK TYPE—DOLERITE

Macroscopic Description:
Gray (N6) homogeneous fine grain-sized dolerite with several fractures. Central portions of these fractures are often filled with dark greenish material (celadonite), which is surrounded by a lighter green material. White calcite infrequently occurs in the darker central part of the fractures. Piece 2E has been heat treated.

Physical Properties:

Interval	**42-44 cm**
Vp ∥ (km/s)	5.37
Vp ⊥ (km/s)	5.42
D (g/cm^3)	2.91
P (%)	5.7



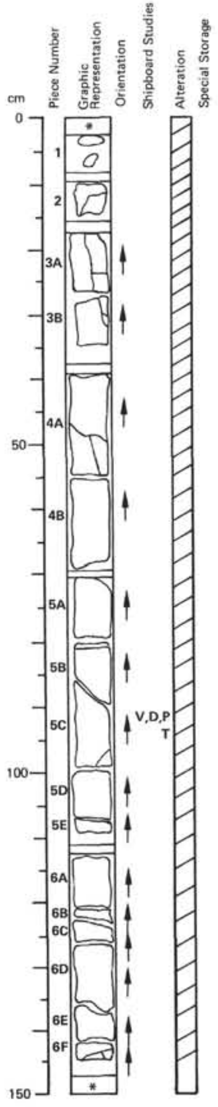
VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	80	4

Depth: 994.0 to 998.0 m

MAJOR ROCK TYPE—DOLERITE

Macroscopic Description:
Gray (N6) fine grain-sized homogeneous dolerite which has scattered augite microphenocrysts. Fractures are less common and fracture surfaces are coated with greenish black coating and fiberous mineral. Some pockets of glassy basalt occur on the fractures at the top of Piece 2. Piece 2 has been heat treated.



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	81	1

Depth: 998.0 to 999.5 m

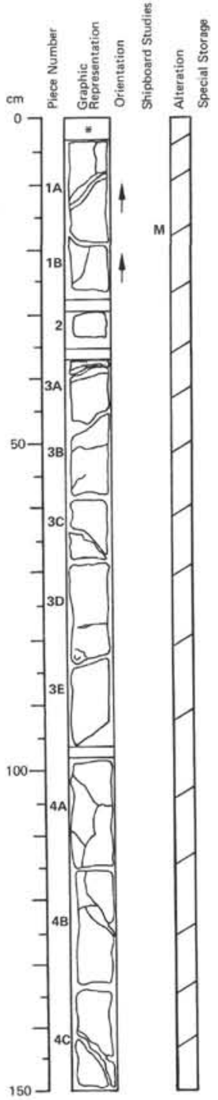
MAJOR ROCK TYPE—BASALT

Macroscopic Description:
Gray (N5) fresh to slightly altered, homogeneous basalt comprising interlocking plagioclase and pyroxene forming a subophitic to doleritic texture. Some fractures are filled with veins consisting of pyrite, calcite, and a dark green mineral (celadonite, smectite?).

Thin Section Description:
92-94 cm: Dolerite from flow or sill interior.
Groundmass: Olivine 1.2%, 0.2-0.3 mm, pseudomorphs of clay; plagioclase 48%, 0.15 x 0.04 mm; clinopyroxene 43%, 0.06 mm; magnetite and ilmenite 6%.
Alteration: Clays (2.6%) replacing olivine.
Texture: Intergranular.

Physical Properties:

Interval	**90-92 cm**
Vp ∥ (km/s)	6.11
Vp ⊥ (km/s)	5.95
D (g/cm^3)	2.98
P (%)	3.2



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

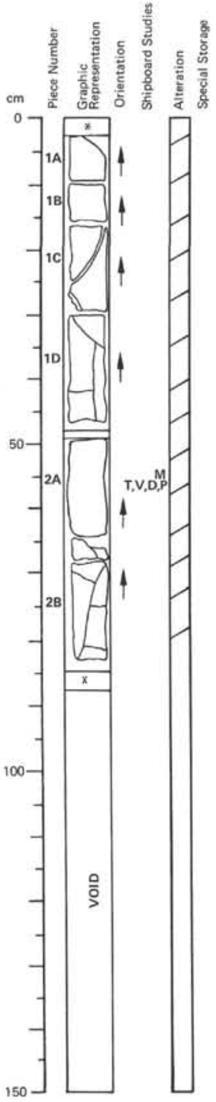
LEG	SITE	HOLE	CORE	SECT.
61	462	A	81	2

Depth: 999.5 to 1001.0 m

MAJOR ROCK TYPE—BASALT

Macroscopic Description:
Gray (N5) fresh to slightly altered homogeneous basalt comprising interlocking plagioclase and pyroxene forming a subophitic to doleritic texture. Some fractures are filled with veins consisting of pyrite, calcite, and a dark green mineral *(celadonite or smectite?)*.

Piece 4C was heated in shrink-tubing for cutting.



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	81	3

Depth: 1001.0 to 1003.0 m

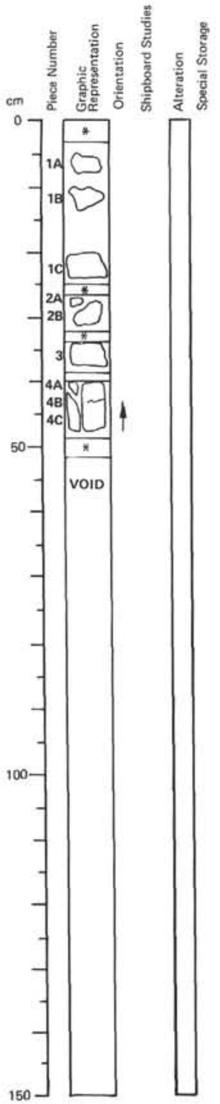
MAJOR ROCK TYPE—BASALT

Macroscopic Description:
Gray (N5) fresh to slightly altered, homogeneous basalt with fractures. Plagioclase and pyroxene form a subophitic to ophitic texture. Pyrite and dark material in some of the fractures.

Thin Section Description:
58-60 cm: Basalt.
Phenocrysts: Olivine, 0.2-0.5 mm, altered to clay; plagioclase 0.2-0.7 mm; clinopyroxene 0.1-0.3 mm.
Groundmass: Olivine 1.3%, altered to clay; plagioclase 43%; clinopyroxene 36%; magnetite andilmenite 13%; glass is altered to clay.
Alteration: Clay (7%) replacing interstitial glass and olivine.
Texture: Intergranular.

Physical Properties:

Interval	**58-60 cm**
Vp ∥ (km/s)	5.81
Vp ⊥ (km/s)	5.91
D (g/cm^3)	2.98
P (%)	3.2



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

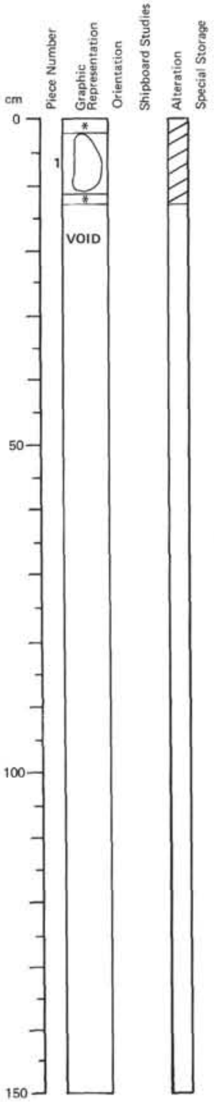
LEG	SITE	HOLE	CORE	SECT.
61	462	A	82	1

Depth: 1003.0 to 1004.0 m

MAJOR ROCK TYPE---BASALT

Macroscopic Description:

From 3-19 cm are drill cuttings from the hole, which surround basalt Pieces 1A and 1B. Pieces 1A-4C are gray (N5) fresh to slightly altered, homogeneous, doleritic basalt. Basalt contains apparent pseudomorphs of olivine phenocrysts set in a subophitic to ophitic groundmass of plagioclase plus pyroxene. Pyrite and a dark green material line fracture surface.



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

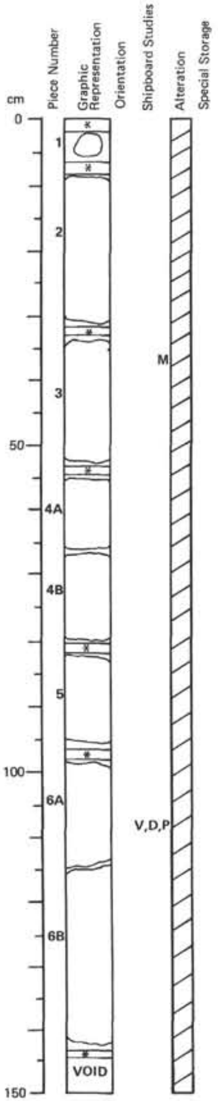
LEG	SITE	HOLE	CORE	SECT.
61	462	A	83	1

Depth: 1004.0 to 1005.5 m

MAJOR ROCK TYPE---DOLERITE

Macroscopic Description:

Gray (N5) fine grain-sized, homogeneous (non-porhyritic) dolerite.



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	84	1

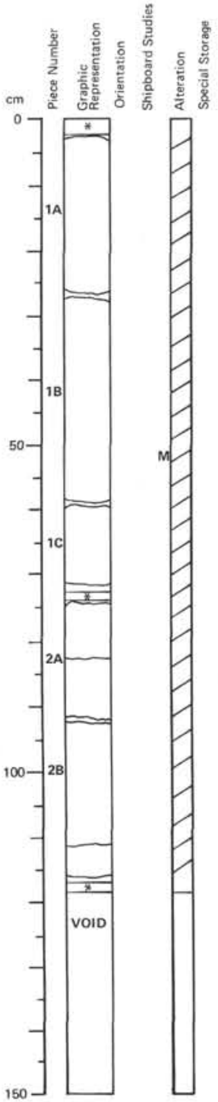
Depth: 1005.5 to 1007.0 m

MAJOR ROCK TYPE---DOLERITE

Macroscopic Description:
Gray (N6) slightly altered, fine grain-sized, homogeneous, non-porphyritic dolerite. Some subhorizontal fractures with greenish black mineral coatings on fracture surfaces.

Physical Properties:

Interval	**107-109 cm**
Vp ∥ (km/s)	6.11
Vp ⊥ (km/s)	6.14
D (g/cm^3)	3.00
P (%)	1.2



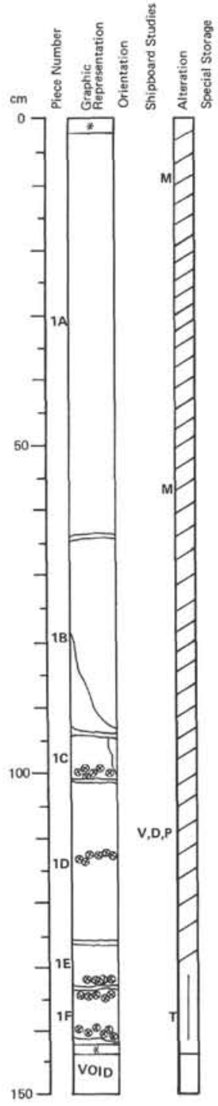
VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	84	2

Depth: 1007.0 to 1008.5 m

MAJOR ROCK TYPE---DOLERITE

Macroscopic Description:
Gray (N5) slightly altered, medium grain-sized dolerite without phenocrysts. Some sub-horizontal fractures with a greenish black mineral coating the fracture surfaces.



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	84	3

Depth: 1008.5 to 1010.0 m

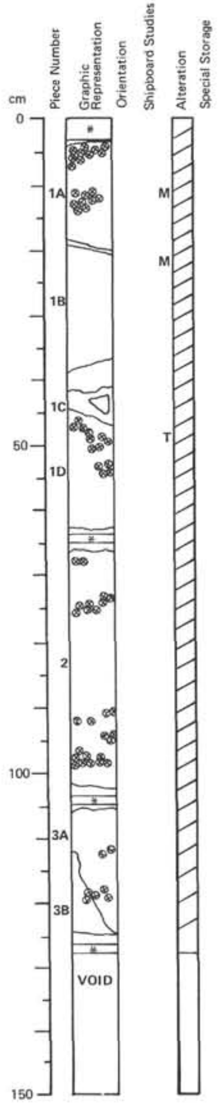
MAJOR ROCK TYPE—DOLERITE

Macroscopic Description:
Gray (N5) mostly fine grain-sized dolerite with scattered (98-100 cm, 110-115 cm, 132-134 cm, and 139-141 cm) coarser mafic mineral concentrations (medium grain-sized dolerite). Fracture surfaces are coated with a greenish-black mineral, some calcite, and biotite (?); slickensides infrequently occur on these fracture surfaces.

Thin Section Description:
138-140 cm: Basalt.
Phenocrysts: Olivine <1%, 0.1-0.2 mm, altered to clay; plagioclase 0.3-0.4 mm; clinopyroxene 0.3-0.4 mm.
Groundmass: Olivine 1.5%, altered to clay; plagioclase 51%, 0.05-0.1 mm; clinopyroxene 35%, 0.05-1.5 mm; magnetite and ilmenite 7%, 0.03-0.05 mm.
Alteration: Clays (6%), olivine and interstitial glass.
Texture: Intergranular.

Physical Properties:

Interval	**108-110 cm**
Vp ∥ (km/s)	6.15
Vp ⊥ (km/s)	5.92
D (g/cm^3)	2.97
P (%)	3.0



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	84	4

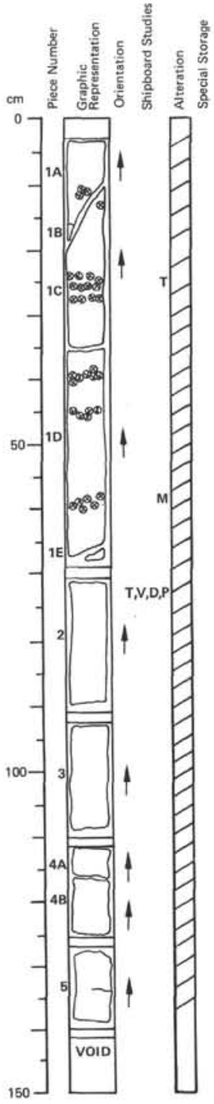
Depth: 1010.0 to 1011.5 m

MAJOR ROCK TYPE—DOLERITE

Macroscopic Description:
Gray (N5) mostly fine grain-sized dolerite with scattered coarser grain-sized mafic mineral concentrations (medium grain-size).

Fracture surfaces are coated with a greenish-black material that contains scattered pyrite.

Thin Section Description:
49-51 cm: Basalt from flow interior.
Groundmass: Plagioclase 39%, 0.15 x 0.04 mm, laths; clinopyroxene 22%, 0.1 mm, equidimensional, badly altered; magnetite and ilmenite 4%.
Alteration: Clays (36%) replacing groundmass.
Texture: Intersertal.



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	84	5

Depth: 1011.5 to 1013.0 m

MAJOR ROCK TYPE—–DOLERITIC BASALT

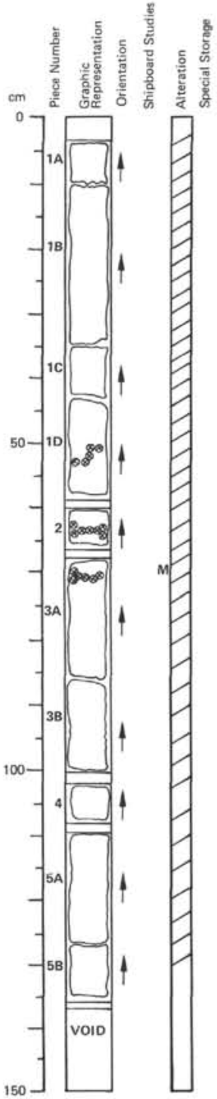
Macroscopic Description:
Gray (N5) fresh to slightly altered, homogeneous dolerite with scattered subhorizontal mafic mineral concentrations. These concentrations are shown by the stippled pattern. Fracture surfaces are commonly coated with a thin layer of dark green clay-like material.

Dolerite comprises plagioclase and pyroxene in a subophitic texture.

Thin Section Description:
75-77 cm: Dolerite from sill or flow margin.
Phenocrysts: Olivine (?) pseudomorphs made of brown clay.
Groundmass: *Plagioclase* 43%, 0.05-0.6 mm, *unaltered, zoned; clinopyroxene* 43%, 0.05-0.4 mm, generally fresh; magnetite and ilmenite 6%, 0.05-0.5 mm; glass to brown clay.
Alteration: Clays (8%) replacing interstitial patches of glass and olivine (?). Clays contain numerous opaques.
Texture: Subophitic.

Physical Properties:

Interval	**75-77 cm**
Vp ∥ (km/s)	6.16
Vp ⊥ (km/s)	6.17
D (g/cm^3)	3.00
P (%)	2.5



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

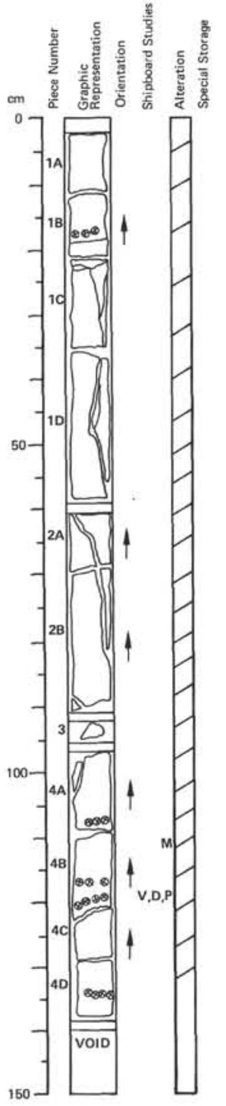
LEG	SITE	HOLE	CORE	SECT.
61	462	A	84	6

Depth: 1013.0 to 1014.5 m

MAJOR ROCK TYPE—DOLERITIC BASALT

Macroscopic Description:
Gray (N5) fresh to slightly altered homogeneous dolerite with scattered, subhorizontal, mafic mineral concentrations. These concentrations are shown by the stippled pattern.

Dolerite is slightly fractured. Fracture surfaces are lined with a dark green clay-like material. Dolerite comprises plagioclase and pyroxene in a subophitic texture.



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	85	1

Depth: 1014.5 to 1016.0 m

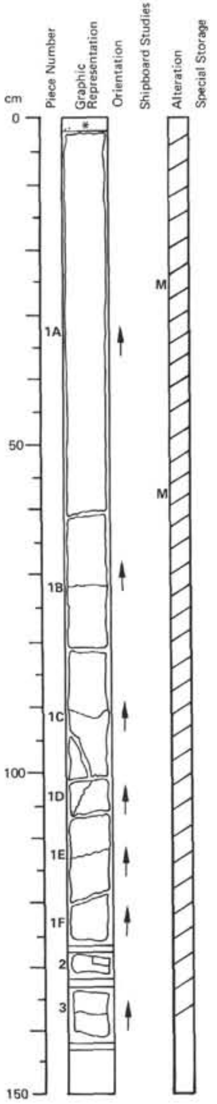
MAJOR ROCK TYPE---DOLERITE

Macroscopic Description:
Gray (N5) fresh to slightly altered uniform dolerite with scattered mafic mineral subhorizontal concentrations. These concentrations are shown by the stippled pattern. Dolerite is made of plagioclase and pyroxene in a subophitic texture.

Fractures are common and some are filled with a dark green clay-like mineral plus pyrite. Pieces 1C and 1D were placed in heat-shrink plastic for cutting.

Physical Properties:

Interval	**118-120 cm**
Vp ∥ (km/s)	6.07
Vp ⊥ (km/s)	6.06
D (g/cm^3)	2.99
P (%)	3.8



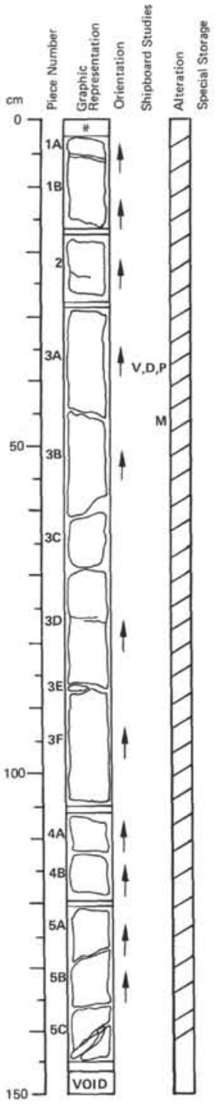
VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	85	2

Depth: 1016.0 to 1017.5 m

MAJOR ROCK TYPE---DOLERITE

Macroscopic Description:
Fresh to slightly altered homogeneous dolerite. Dolerite is made of plagioclase plus pyroxene in a subophitic texture. Fractures are common and some are filled with a light green clay-like material.



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	85	3

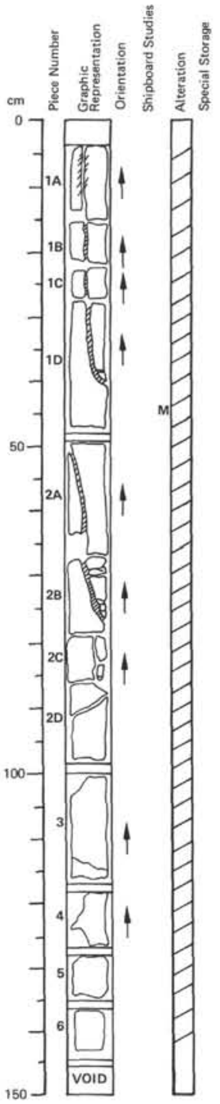
Depth: 1017.5 to 1019.0 m

MAJOR ROCK TYPE—DOLERITE

Macroscopic Description:
Gray (N5) fresh to slightly altered homogeneous dolerite. Dolerite is made of plagioclase and pyroxene in a subophitic texture. Some of the fractures are filled by a dark green clay-like material. Pieces 3C, 3B, and 5C were subjected to heat-shrink tubing.

Physical Properties:

Interval	**34-36 cm**
Vp ∥ (km/s)	6.23
Vp ⊥ (km/s)	6.25
D (g/cm^3)	3.00
P (%)	4.6



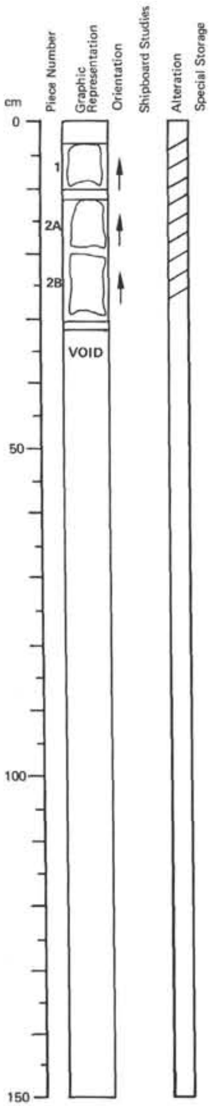
VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	85	4

Depth: 1019.0 to 1020.5 m

MAJOR ROCK TYPE—DOLERITE

Macroscopic Description:
Gray (N5) fresh to slightly altered homogeneous subophitic dolerite. Light green material fills some veins.



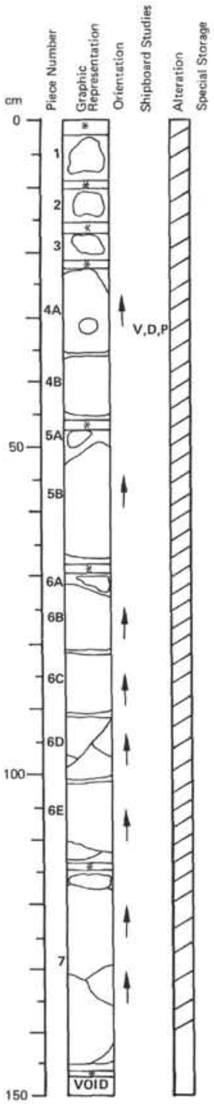
VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	85	5

Depth: 1020.5 to 1022.0 m

MAJOR ROCK TYPE—–DOLERITE

Macroscopic Description:
Fresh to slightly altered uniform subophitic dolerite.



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	87	1

Depth: 1026.0 to 1027.5 m

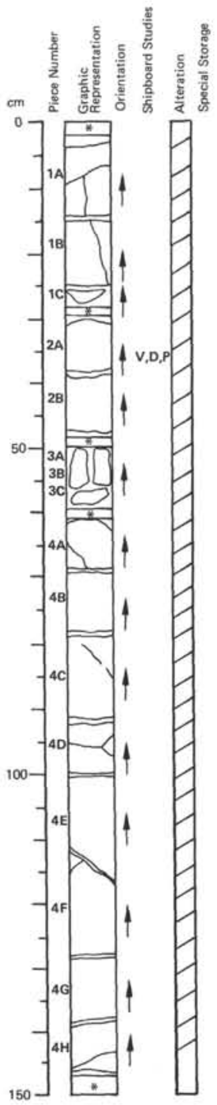
MAJOR ROCK TYPE—–DOLERITE

Macroscopic Description:
Gray (N6) fine grained dolerite with many small scattered mafic mineral concentrations. Fractures are lined with a greenish-black coating, and frequently in slickensides.

Macroscopicly similar rock along entire section.

Physical Properties:

Interval	**31-33 cm**
Vp ∥ (km/s)	5.99
Vp ⊥ (km/s)	6.04
D (g/cm^3)	2.97
P (%)	4.8



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	87	2

Depth: 1027.5 to 1029.0 m

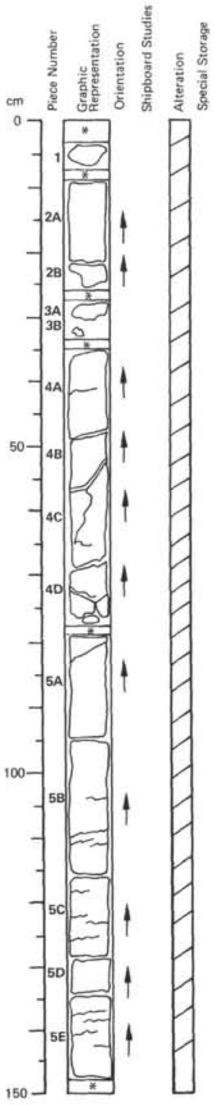
MAJOR ROCK TYPE—DOLERITE

Macroscopic Description:
Gray (N5) fine grain-sized, mostly homogeneous dolerite with scattered, poorly defined concentrations of mafic minerals.

Fracture surfaces are covered with a greenish black coating. Some pyrite crystals are present along the fractures.

Physical Properties:

Interval	**37-39 cm**
Vp ∥ (km/s)	6.00
Vp ⊥ (km/s)	6.07
D (g/cm^3)	2.99
P (%)	4.5



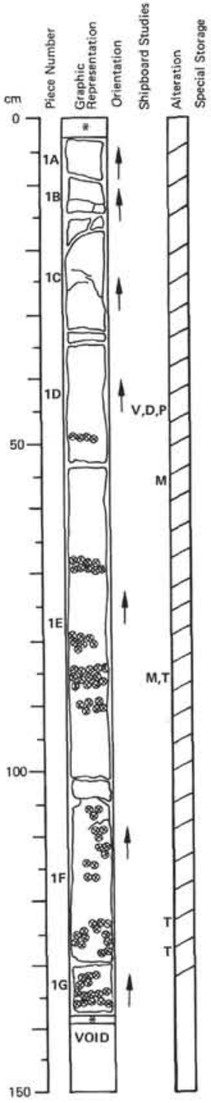
VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	88	1

Depth: 1032.5 to 1036.5 m

MAJOR ROCK TYPE—DOLERITE

Macroscopic Description:
Gray (N5) fresh to altered, uniformly grain-sized dolerite with a subophitic texture. Subhorizontal fractures are common. Most of these fractures are filled with a dark green clay-like material.



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	88	2

Depth: 1034.0 to 1035.5 m

MAJOR ROCK TYPE—DOLERITE

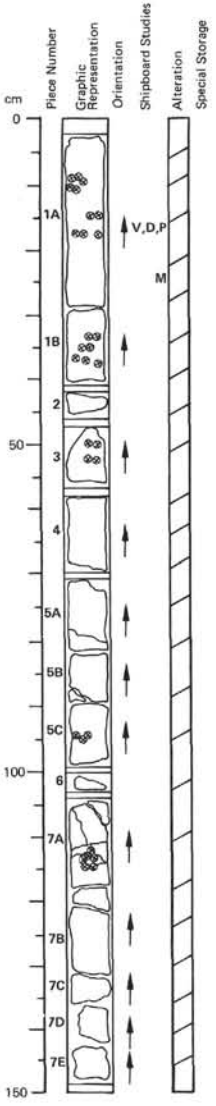
Macroscopic Description:
Fresh to slightly altered dolerite with a subophitic texture. Some portions of the dolerite (signified by x x x in the graphic representation) are coarser in grain-size. These coarse grain-sized portions may be micropegmatites, but contacts are gradational, thus these portions may simply represent local inhomogeneities in the original magma.

Most fractures are filled with a dark green clay-like material.

Thin Section Description:
83-85 cm: Basalt from flow or sill interior.
Phenocrysts: Olivine 1.6% altered to clay.
Groundmass: Plagioclase 50%, 0.2-0.3 mm; clinopyroxene 37%, 0.1-0.3 mm; magnetite and ilmenite 4%; glass altered to clay.
Alteration: Clays (7%) replacing olivine and glass.
Texture: Intergranular.
119-121 cm: Dolerite from flow or sill interior.
Groundmass: Plagioclase 46%, 0.05-0.5 mm, laths, zoned; clinopyroxene 36%, 0.03-0.3 mm, equigranular; magnetite and ilmenite 5%; glass 2%, relatively fresh (also 12% altered to clay).
Alteration: Clays (12%) replacing interstitial glass.
Texture: Subophitic.
125-127 cm: Basalt from sill or flow interior.
Groundmass: Plagioclass 54%, 0.2 x 0.4 mm, laths; clinopyroxene 33%, 0.08 mm, equidimensional; magnetite and ilmenite 3%; alkali feldspar (?) interstitial intergrowths.
Alteration: Clays (11%) replacing (?).
Texture: Intergranular.

Physical Properties:

Interval	**45-48 cm**
Vp ∥ (km/s)	6.11
Vp ⊥ (km/s)	6.05
D (g/cm^3)	3.01
P (%)	3.6



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	88	3

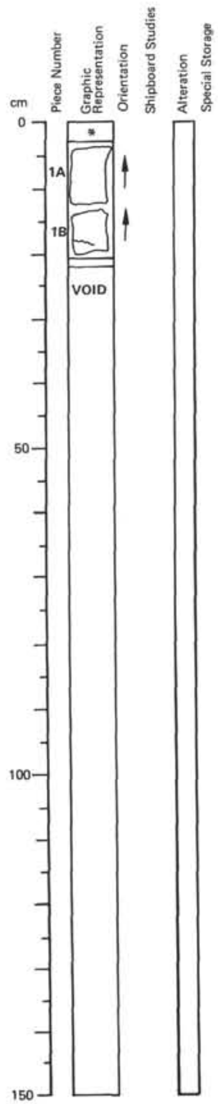
Depth: 1035.5 to 1037.0 m

MAJOR ROCK TYPE—DOLERITE

Macroscopic Description:
Gray (N5) fresh to slightly altered subophitic dolerite. Some areas are coarser grain-sized (x x x) and have gradational contacts. These areas may represent inhomogeneities in the original magma or perhaps micropegmatites. A few fractures are filled with a dark green clay-like material.

Physical Properties:

Interval	**17-20 cm**
Vp ∥ (km/s)	5.96
Vp ⊥ (km/s)	5.89
D (g/cm^3)	2.96
P (%)	4.7



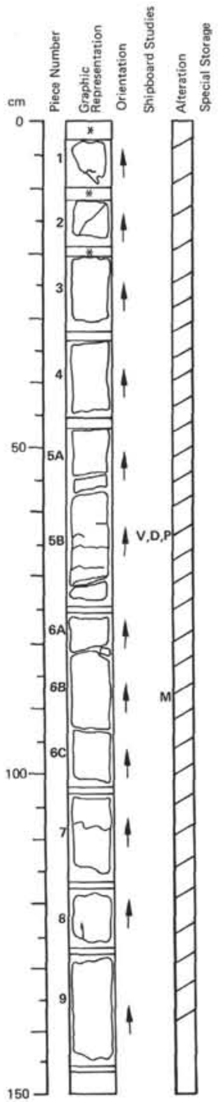
VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	88	4

Depth: 1032.5 to 1036.5 m

MAJOR ROCK TYPE—DOLERITE

Macroscopic Description:
Gray (N5) fresh to slightly altered dolerite with uniform subophitic texture.



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	89	1

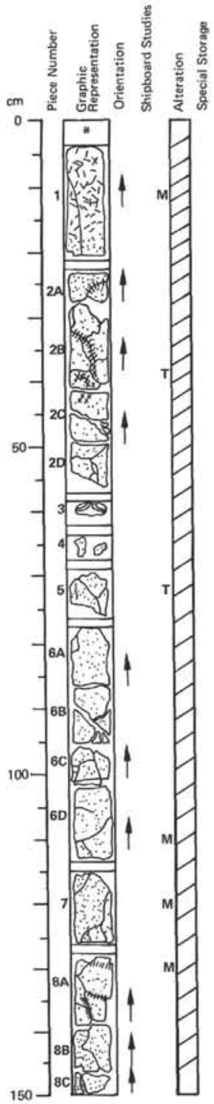
Depth: 1036.5 to 1038.0 m

MAJOR ROCK TYPE—DOLERITE

Macroscopic Description:
Gray (N5) fresh to slightly altered dolerite with a uniform subophitic texture.

Physical Properties:

Interval	**62-64 cm**
Vp ∥ (km/s)	6.08
Vp ⊥ (km/s)	6.07
D (g/cm^3)	2.95
P (%)	4.8



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	89	2

Depth: 1038.0 to 1039.5 m

MAJOR ROCK TYPE—BASALT

Macroscopic Description:
Gray (N6) fresh to slightly altered basalt.

▨ = subophitic
▨ = vein material

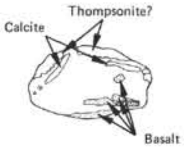
XXX = aphanitic
⊗⊗ = coarse grained areas (altered)

Texture changes from subophitic in the upper part of Piece 1 to aphanitic in the lower part of Piece 1, and remains fine grain-sized through the remainder of the section.

Small dark grains in the basalt may be olivine pseudomorphs.

Fracture frequency increases down the section. Fractures are filled with pyrite, zeolite (?), and a dark green clay-like material. Local patches of zeolite (?); a dark green clay-like material occurs locally, especially in Piece 2B (also indicated by XXX in the graphic representation).

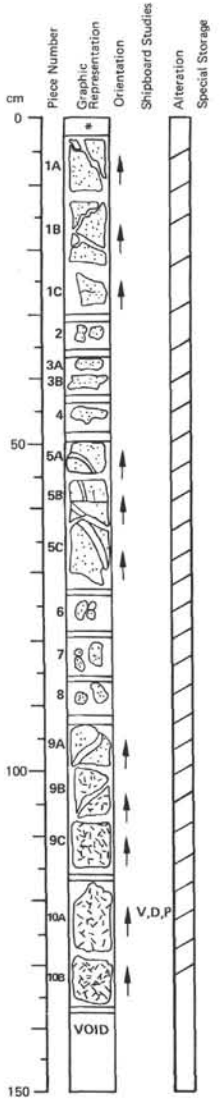
Piece 3 may be a large vein that contains calcite and a transparent white mineral (thompsonite? parallel extinction, low birefringence, good cleavage, refractive indices ~1.51-1.53).



Detail of Piece 3
(actual size)

Pieces 2D, 6, 7, and 8 were placed in heat-shrink tubing prior to cutting with saw.

Thin Section Description:
38-40 cm: Basalt next to glassy margin.
Groundmass: Olivine 0.2%, rare as most is altered to clay; plagioclase 30%, 0.05-0.15 mm; clinopyroxene 31%, 0.05-0.1 mm; magnetite and ilmenite 2%; glass replaced by clay.
Alteration: Carbonate (2%) occurs in veins. Clays (35%) replaced glass and some olivine.
Texture: Intersertal (veined), some variolitic.
72-74 cm: Basalt from flow or sill interior.
Phenocrysts: Plagioclase 1%, 0.4-1.6 mm; clinopyroxene 1%, 0.2-0.3 mm.
Groundmass: Plagioclase 20%, 0.01-0.2 mm, laths; clinopyroxene 17%, 0.01-0.1, equigranular, plagioclase and clinopyroxene occurs in very fine grained variolitic fresh to altered patches; magnetite 12%.
Alteration: Clays (49%) replacing varioles of interstitial glass, pyroxene, and olivine.
Textures: Variolitic with few phenocrysts and intergranular areas.



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	89	3

Depth: 1039.5 to 1041.0 m

MAJOR ROCK TYPE—BASALT

Macroscopic Description:
Gray (N6) fine grained and gray (N5) coarse grained, fresh to slightly altered basalt.

XXX = fine grained

▨ = subophitic

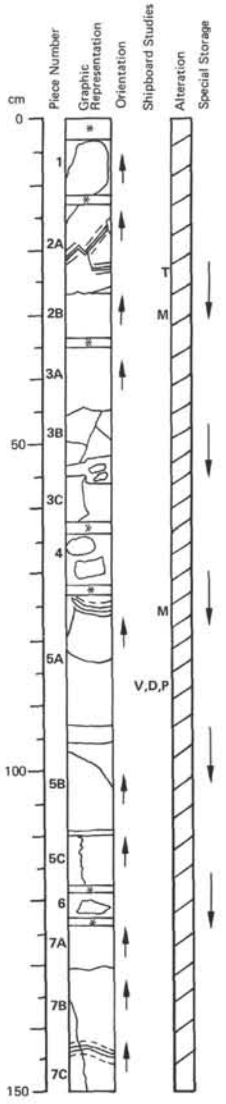
The top of the section is fine grain-sized, grading to coarser grain-size at the bottom of the section where texture becomes subophitic.

Degree of fracturing seems to be associated with grain-size with the fine grain-sized portions being the most highly fractured. Many fractures are filled with pyrite, an unknown white mineral, and a dark green mineral. A very dense-looking (fine grained) light green material is present in Piece 5.

Pieces 5 and 9 were placed in heat-shrink plastic for cutting.

Physical Properties

Interval	121-123 cm
Vp ∥ (km/s)	5.57
Vp ⊥ (km/s)	5.78
D (g/cm^3)	2.96
P (%)	6.8



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	90	1

Depth: 1041.5 to 1043.0 m

MAJOR ROCK TYPE—BASALT

Macroscopic Description:
Medium gray (N5) basalt with greenish black (5GY 2/1) veins and joint-coating. There are some light gray (N8) veins.

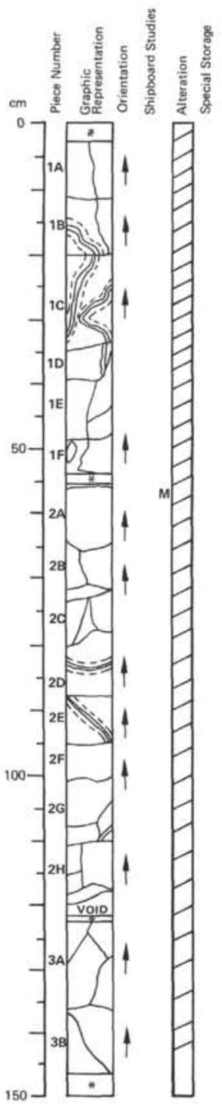
The top of the section is near the top (above this section) of a cooling unit. Grain-size grades from fine grain-size at the top of the section to medium toward the base of the section.

Fractures are frequent and some are filled with chlorite and some zeolite. A pyrite vein occurs at 143 cm.

Thin Section Description:
24-26 cm: Basalt from flow or sill interior.
Groundmass: Plagioclase 49%, 0.3-0.4 mm, laths; clinopyroxene 34%, ~.18 mm, equidimensional; magnetite and ilmenite 6%.
Alteration: Clays (12%) replacing groundmass.
Texture: Intersertal.

Physical Properties:

Interval	**86-88 cm**
Vp ∥ (km/s)	5.54
Vp ⊥ (km/s)	5.84
D (g/cm^3)	2.96
P (%)	6.7



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

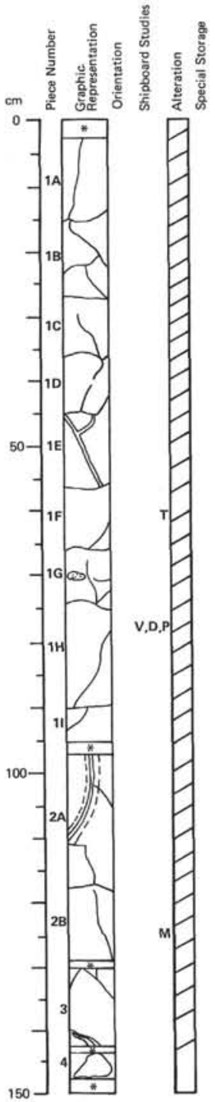
LEG	SITE	HOLE	CORE	SECT.
61	462	A	90	2

Depth: 1043.0 to 1044.5 m

MAJOR ROCK TYPE—BASALT

Macroscopic Description:
Medium gray (N5) medium grain-sized basalt with greenish black (5GY 2/1) veins and joint coatings. There are some very light gray (N8) veins. Small (<0.3 mm to 0.5 mm) greenish black crystals may be replacing olivine or augite phenocrysts.

Fractures are abundant and alteration occurred around joints and veins.



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	90	3

Depth: 1044.5 to 1046.0 m

MAJOR ROCK TYPE—BASALT

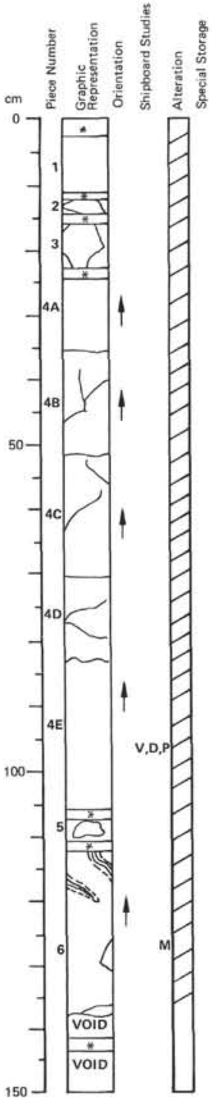
Macroscopic Description:
Medium gray (N6) altered basalt. Basalt is particularly altered along joints. Some veins contain zeolites, celadonite, and rare pyrite. Major veins occur in Pieces 1B, 1E, and 2A.

Grain-size is medium and the basalt is fairly homogeneous throughout the section. Dark segregation (?) in Piece 1G .

Thin Section Description:
60-63 cm: Basalt from flow or sill interior.
Microphenocrysts: Plagioclase, only a few.
Groundmass: Plagioclase 52%, 0.5 x 0.05 mm, laths; clinopyroxene 34%, 0.16 mm, equidimensional; magnetite and ilmenite 7%.
Alteration: Clays (6%) replacing groundmass and perhaps some are pseudomorphs of olivine.
Texture: Intersertal.

Physical Properties:

Interval	**78-80 cm**
Vp ∥ (km/s)	5.75
Vp ⊥ (km/s)	5.66
D (g/cm^3)	2.96
P (%)	6.7



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	90	4

Depth: 1046.0 to 1047.5 m

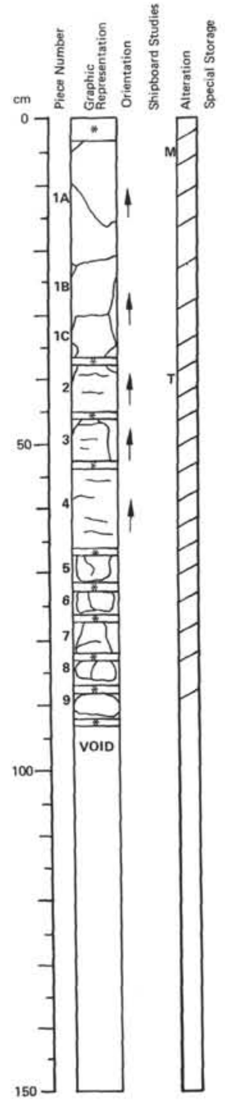
MAJOR ROCK TYPE—BASALT

Macroscopic Description:
Medium gray (N6) basalt with fractures and veins of zeolites (Piece 5), celadonite, and pyrite (Pieces 4A, 4B, and 4C).

Basalt grain-size is medium and is fairly homogeneous throughout the section.

Physical Properties:

Interval	**99-101 cm**
Vp ∥ (km/s)	5.55
Vp ⊥ (km/s)	5.55
D (g/cm^3)	2.92
P (%)	7.5



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

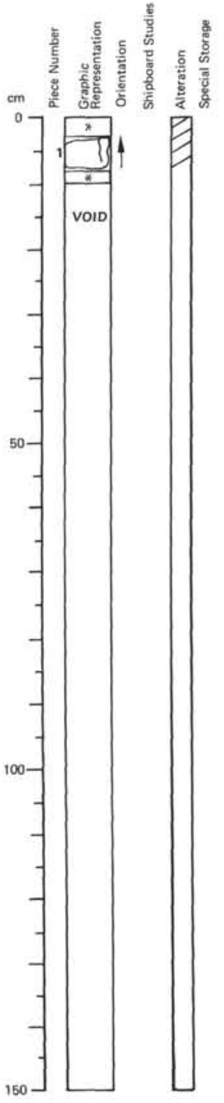
LEG	SITE	HOLE	CORE	SECT.
61	462	A	90	5

Depth: 1047.5 to 1049.0 m

MAJOR ROCK TYPE—BASALT

Macroscopic Description:
Medium gray (N6) medium grain-sized basalt. Basalt is fractured and has horizontal joints in Pieces 3 and 4. Some veins in Piece 1. The entire Core 90 appears to be the same cooling unit.

Thin Section Description:
40-42 cm: Basalt from flow or sill interior.
Groundmass: Plagioclase 53%, 0.2 x 0.02 mm, laths; clinopyroxene 35%, 0.08 mm, equidimensional; magnetite and ilmenite 5%.
Alteration: Clays (8%) replacing groundmass.
Texture: Intersertal.



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
61	462	A	91	1

Depth: 1050.5 to 1059.5 m

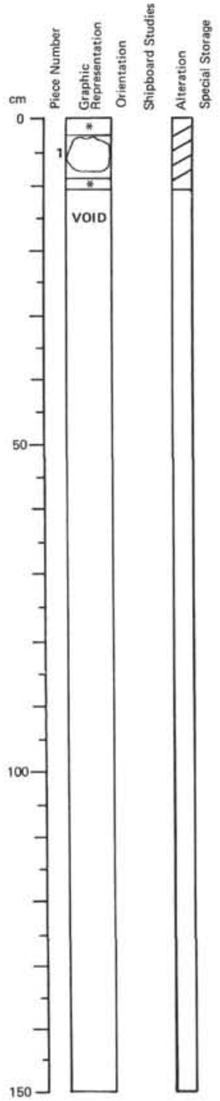
MAJOR ROCK TYPE—BASALT

Macroscopic Description:
Gray (N6) medium grain-sized fractured basalt.

VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

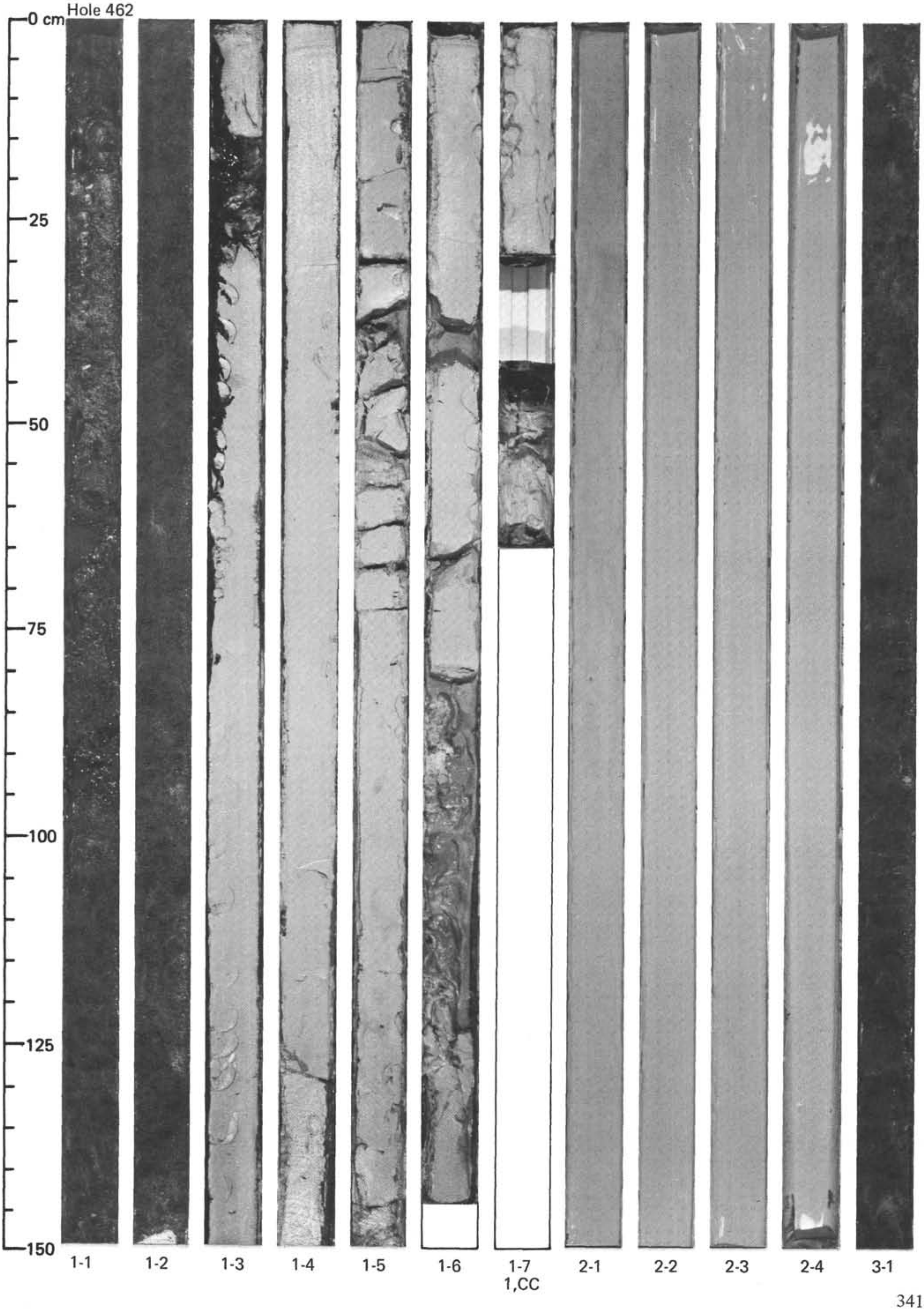
LEG	SITE	HOLE	CORE	SECT.
61	462	A	92	1

Depth: 1059.5 to 1068.5 m



MAJOR ROCK TYPE—DOLERITE

Macroscopic Description:
Gray (N5) medium grain-sized dolerite with a few subparallel fractures.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1-7
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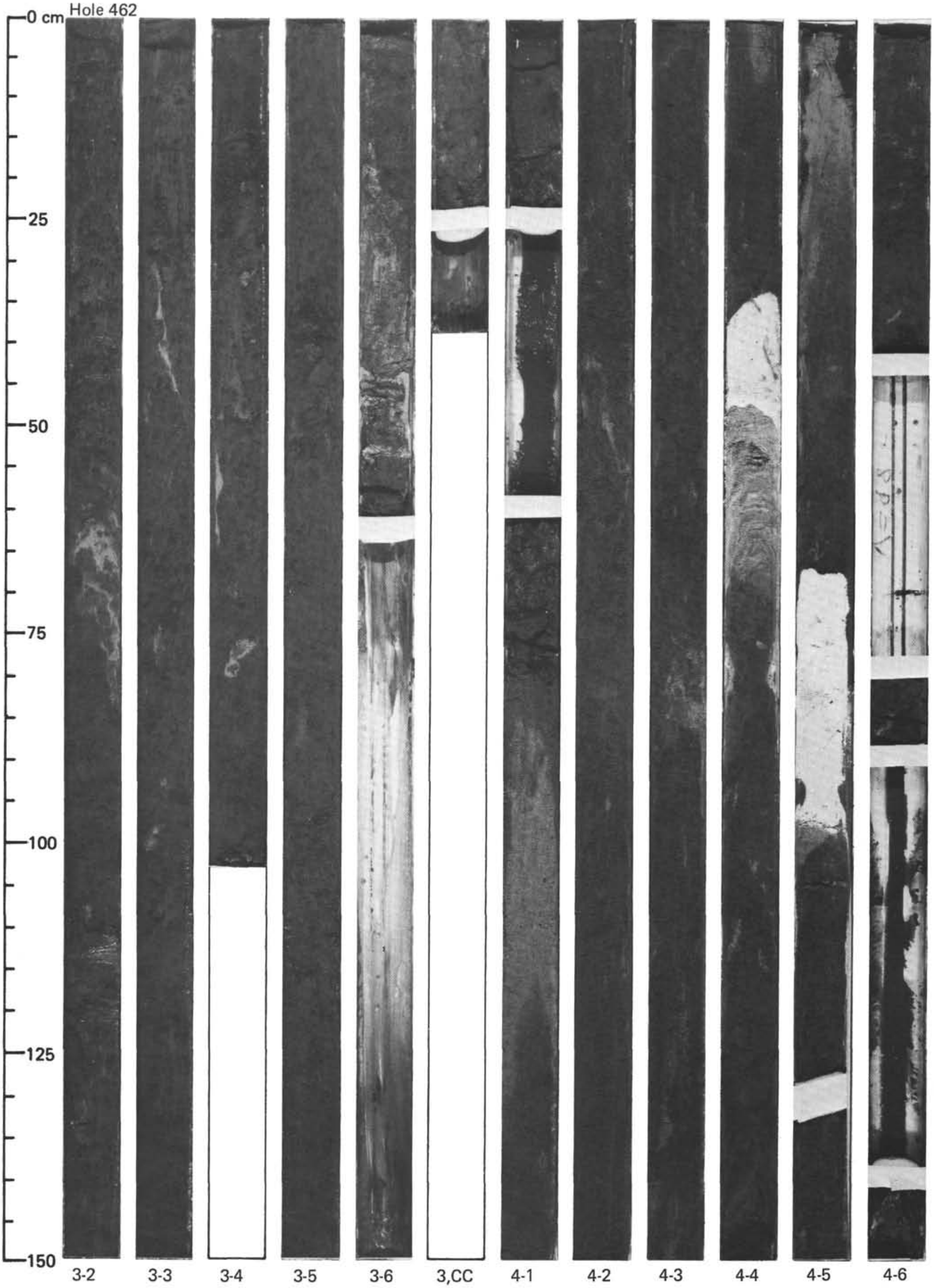
2-3
2-4
3-1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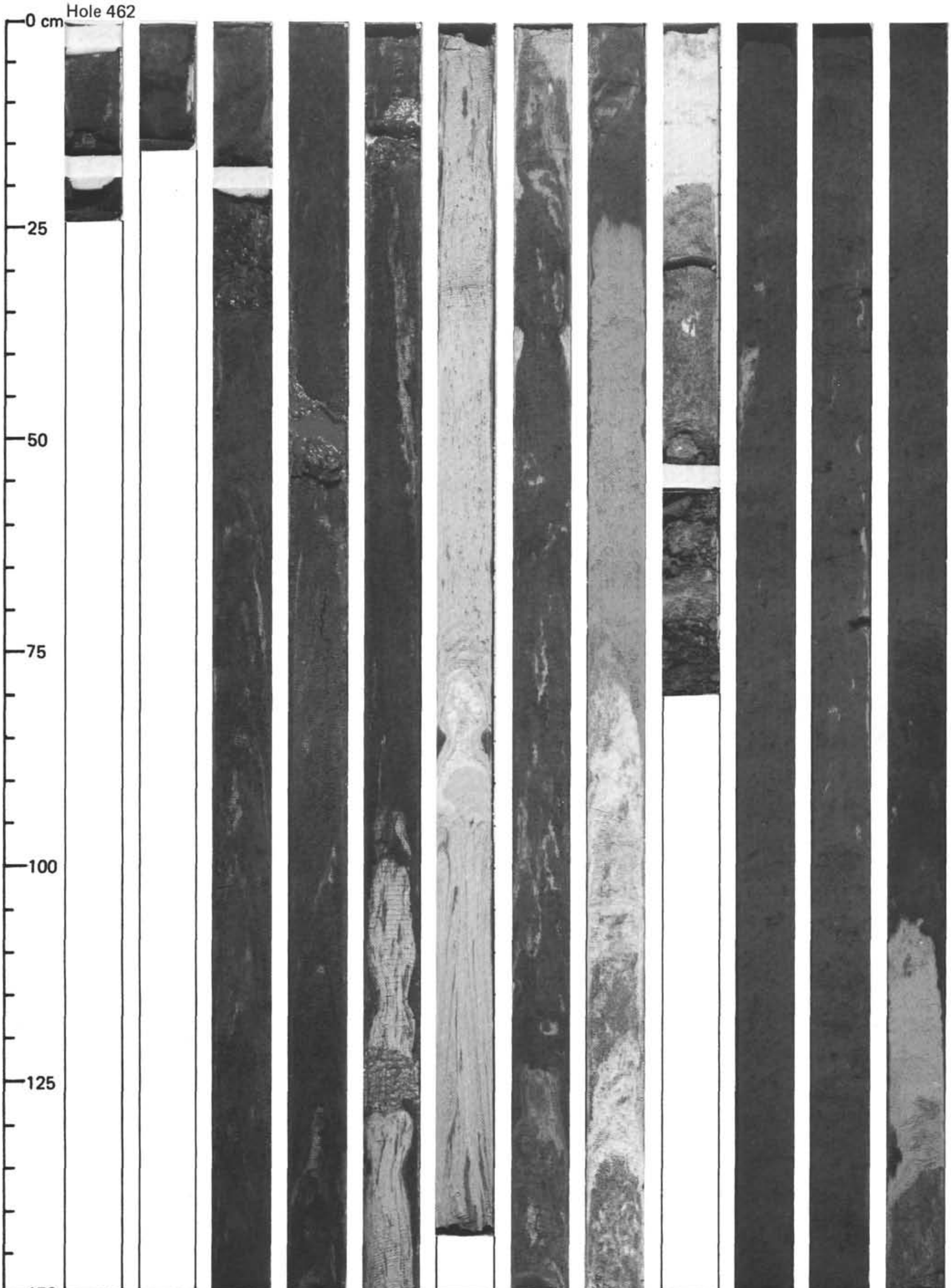
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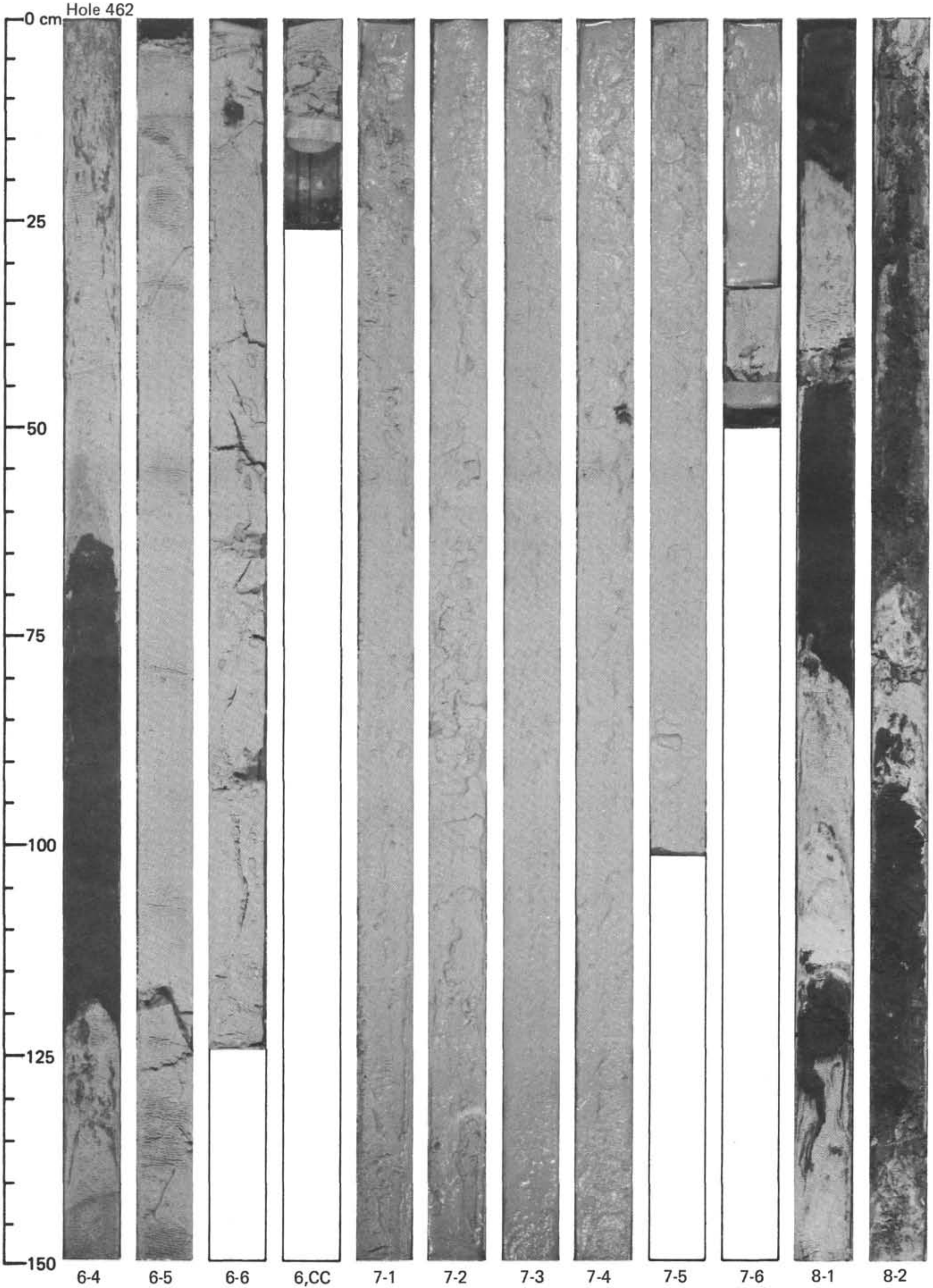
6-3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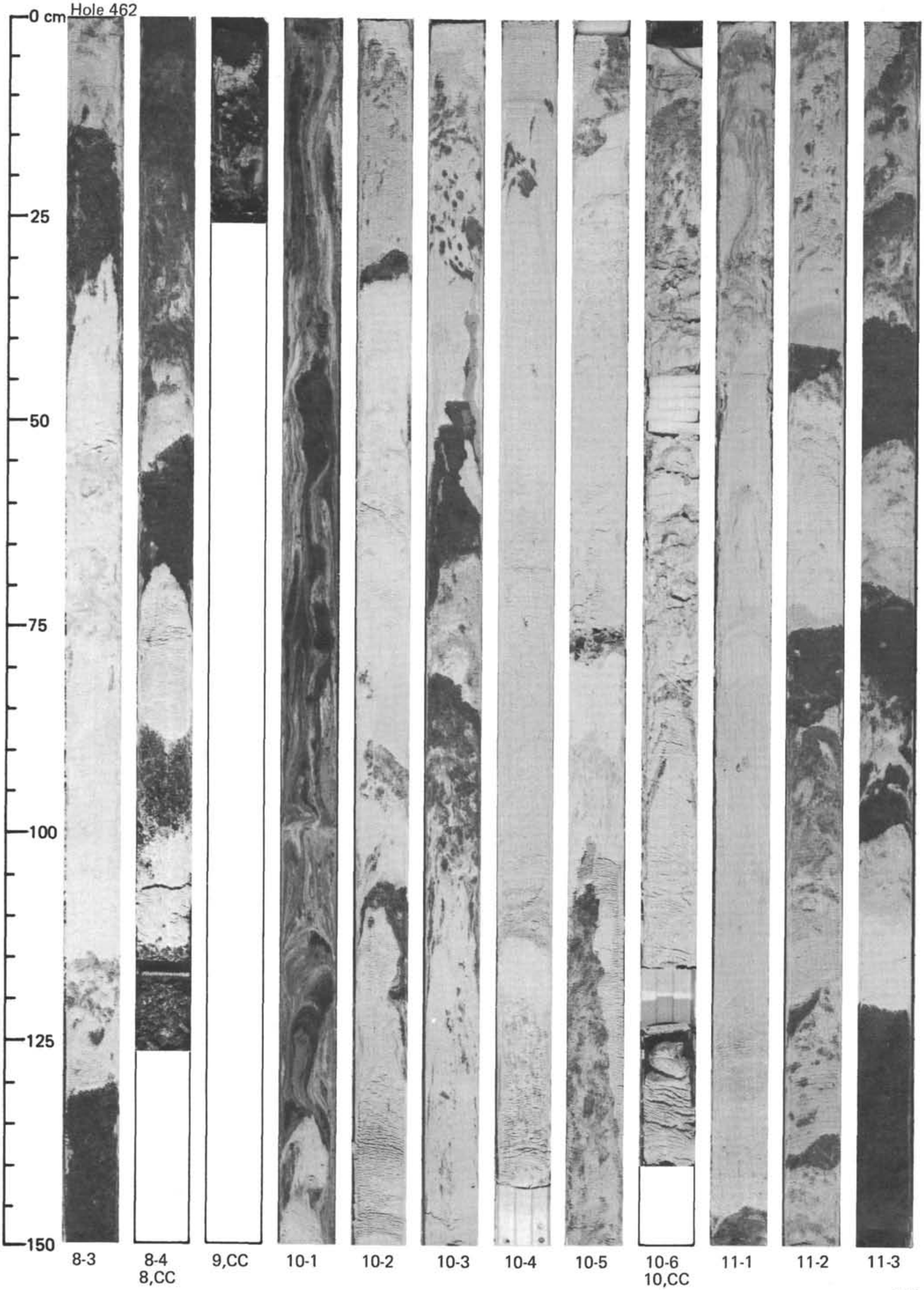
8-2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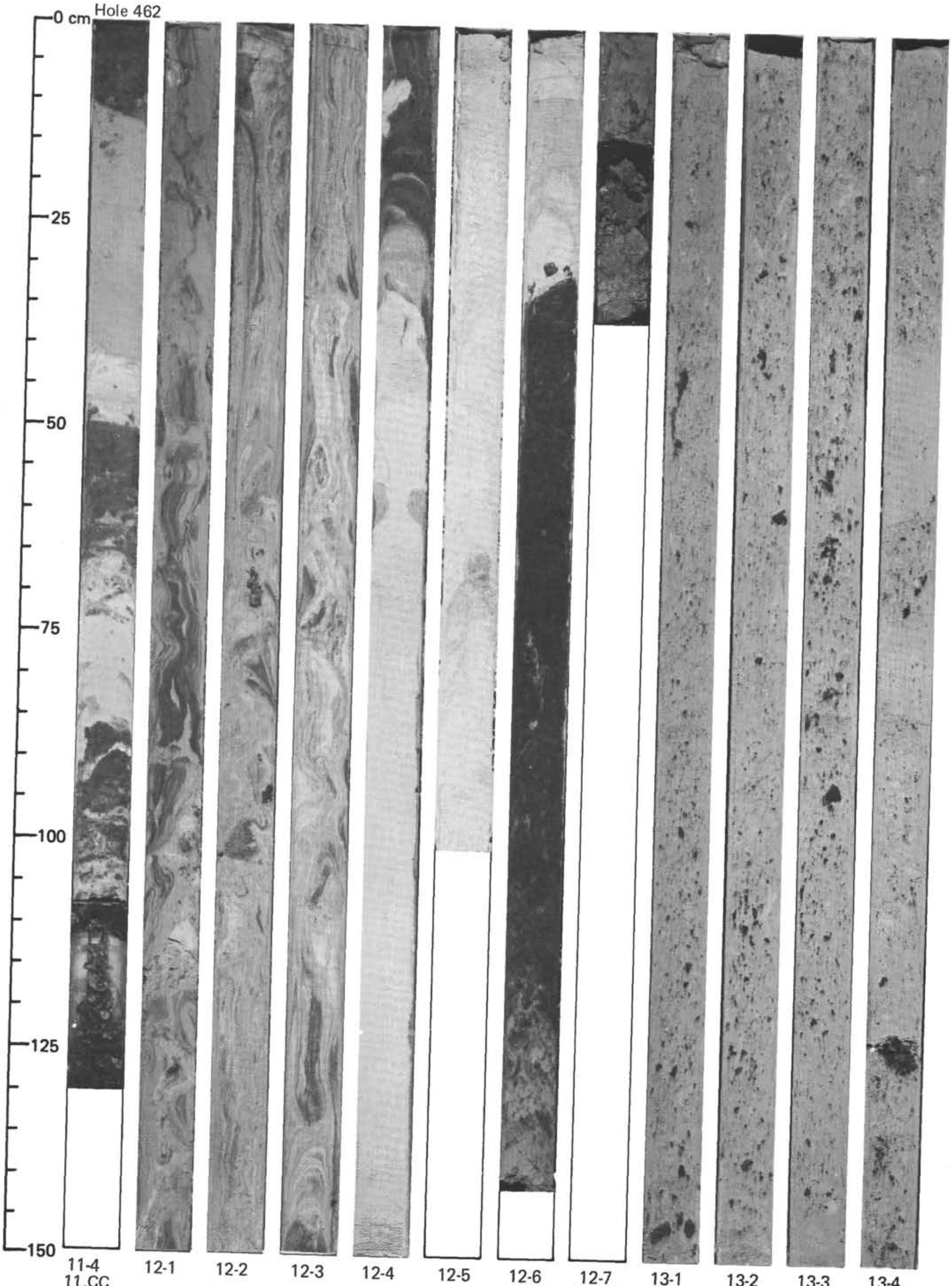
11-3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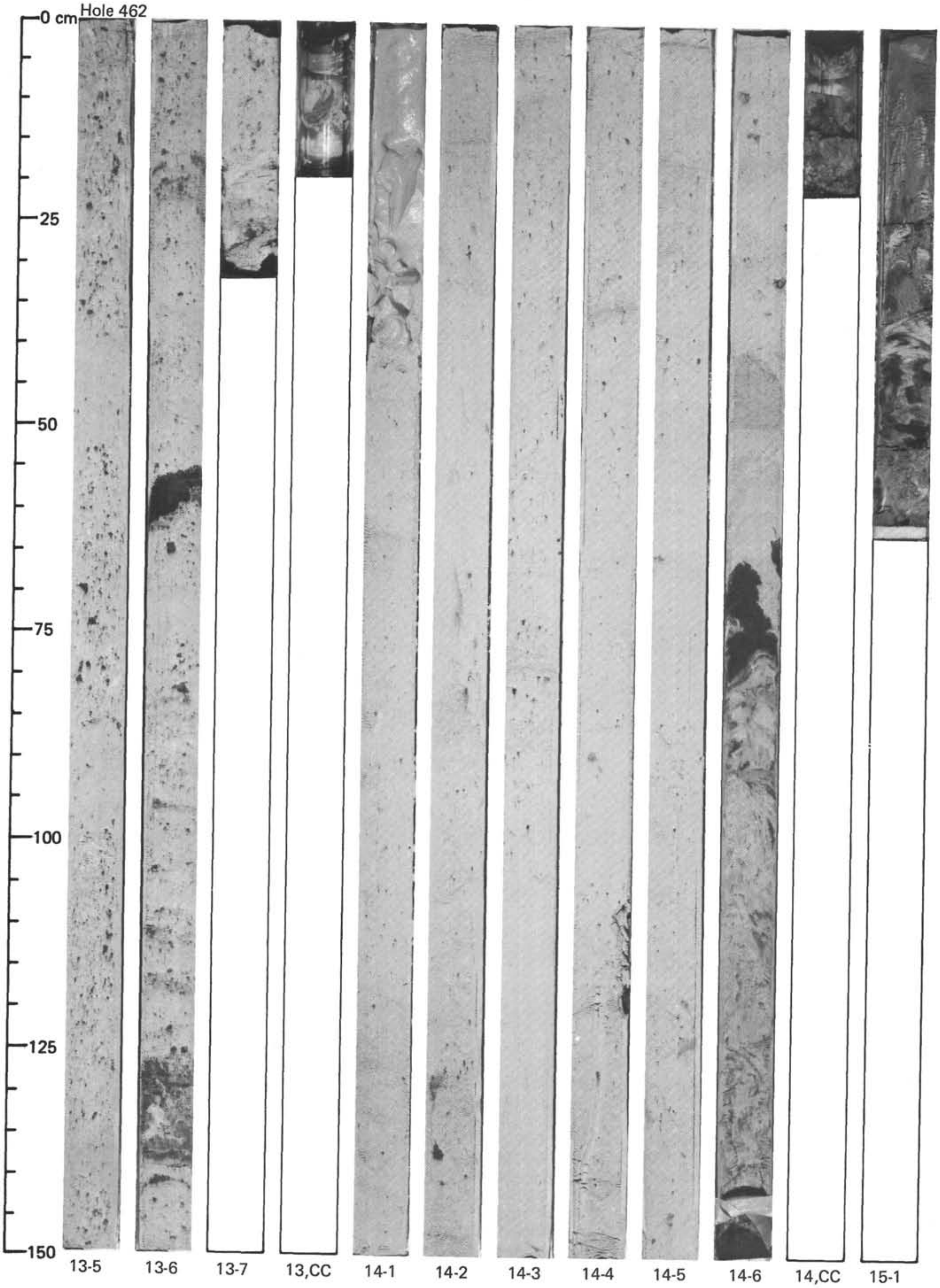
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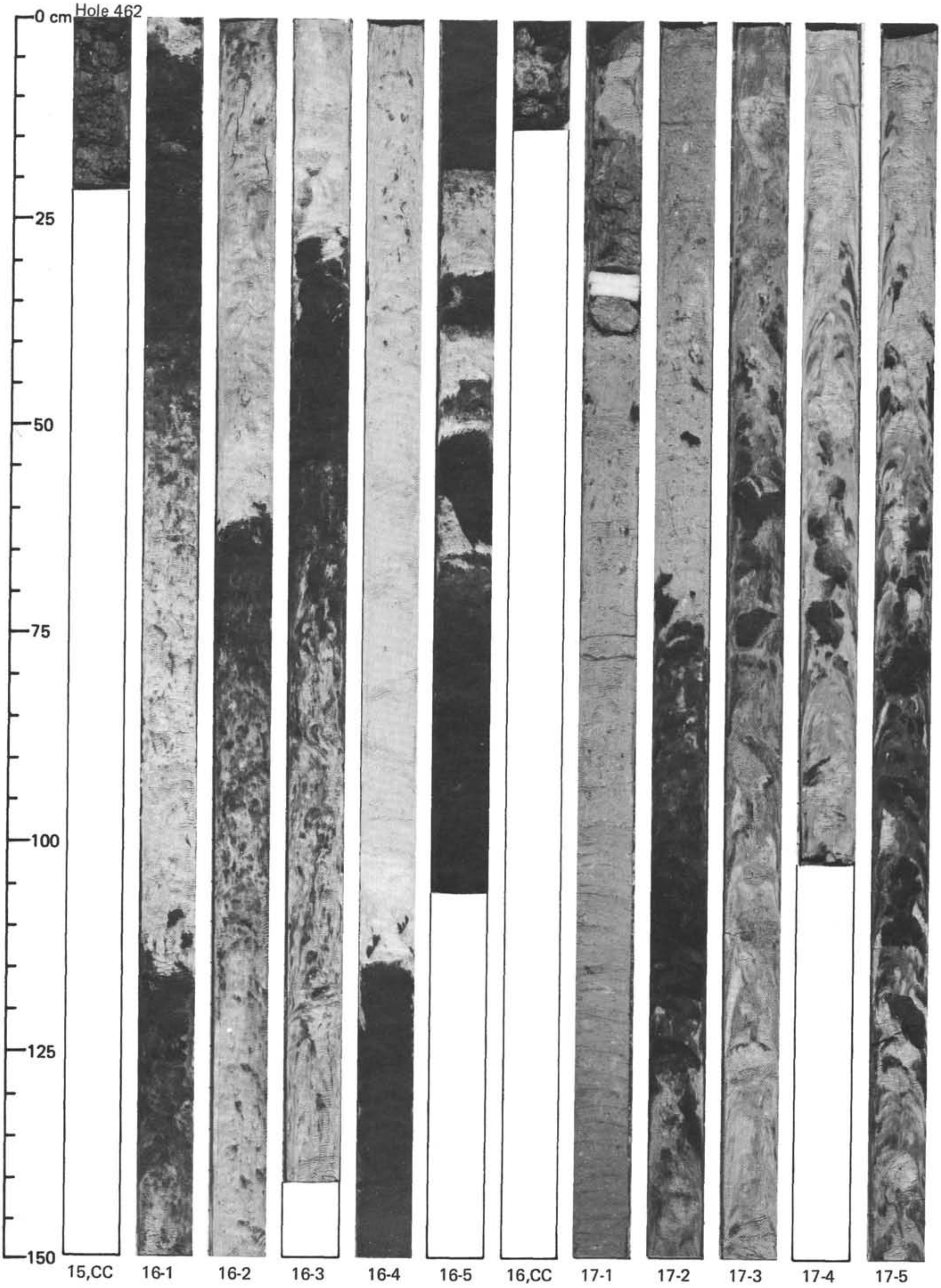
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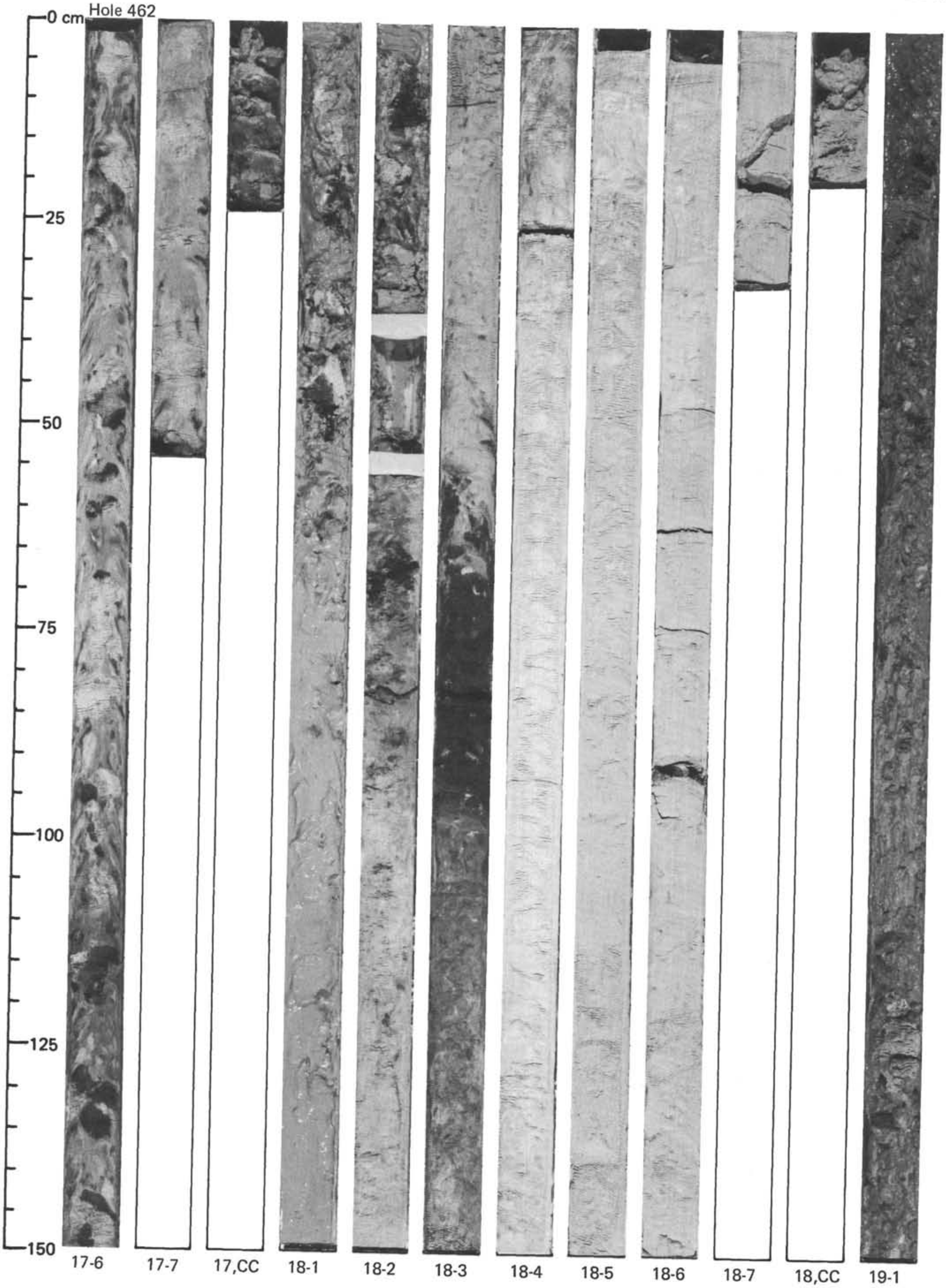
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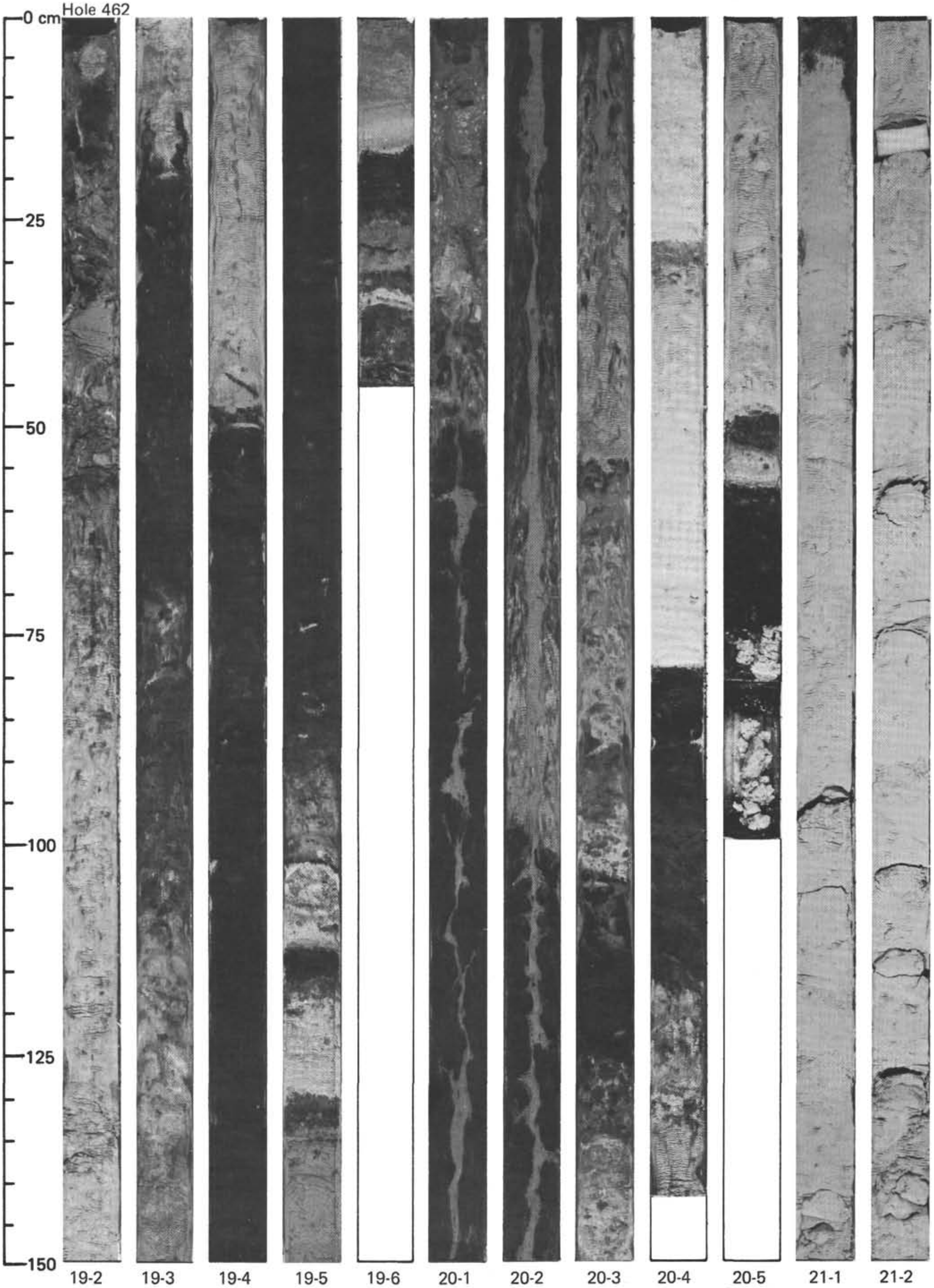
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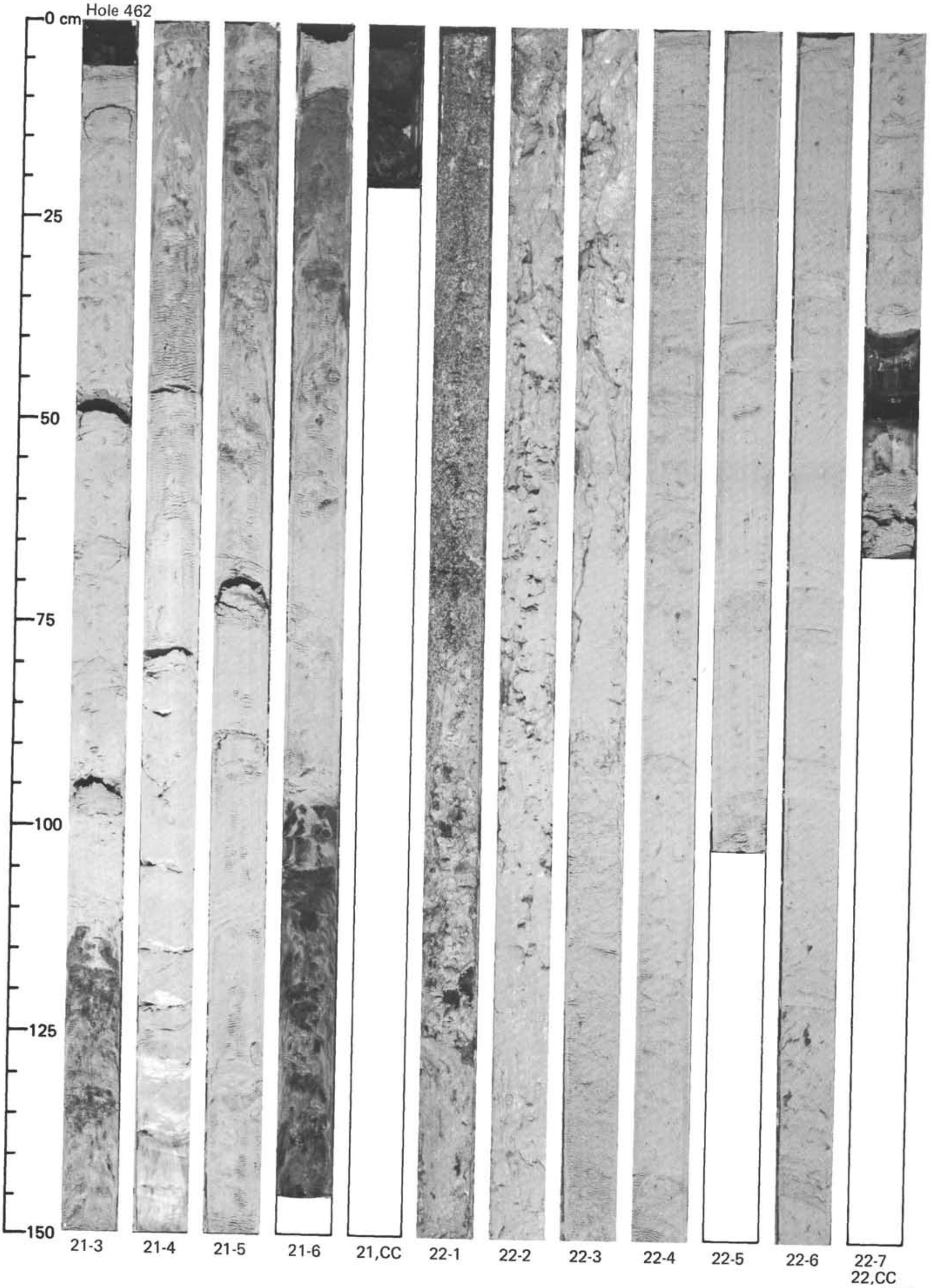
21-2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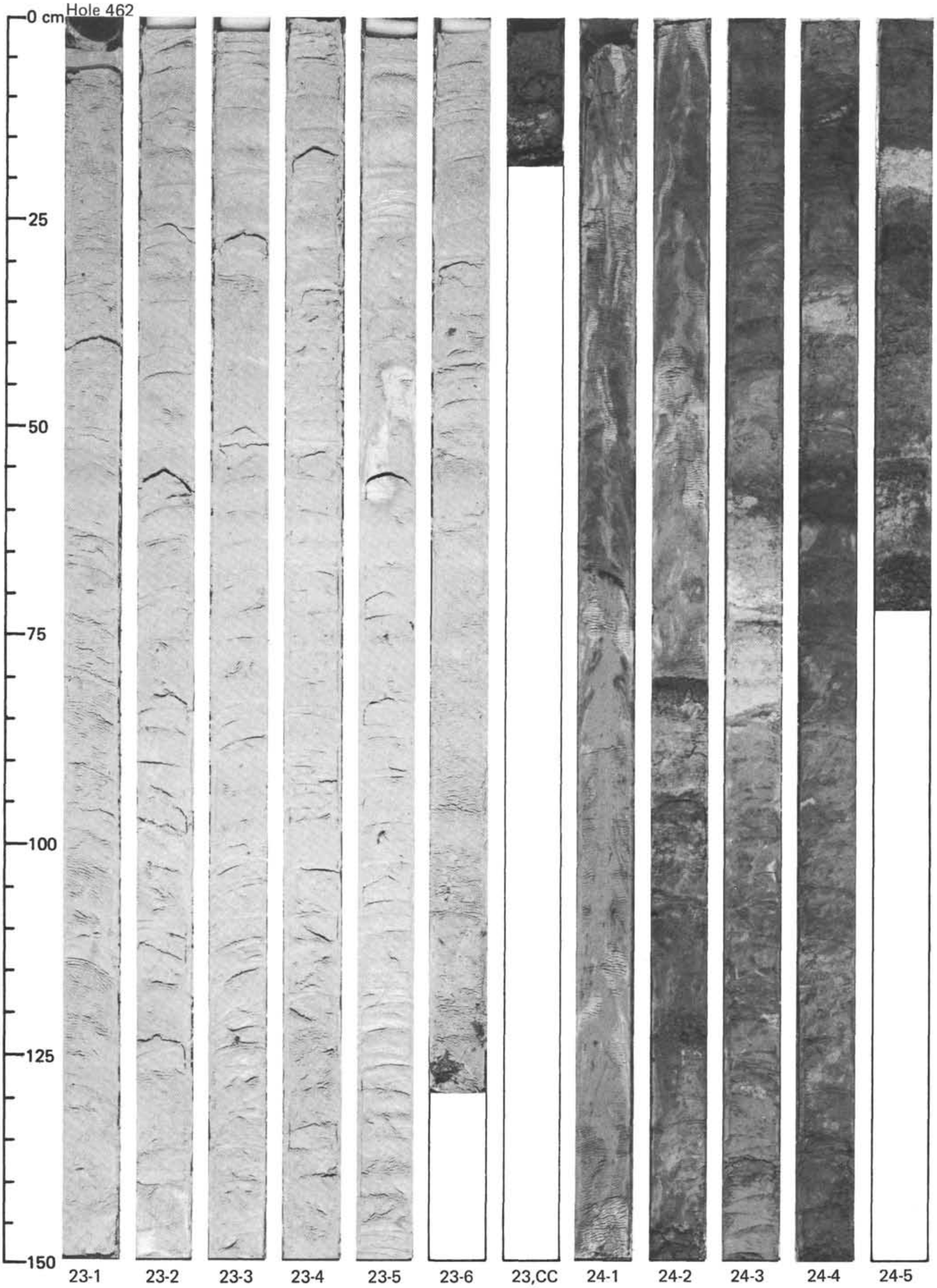
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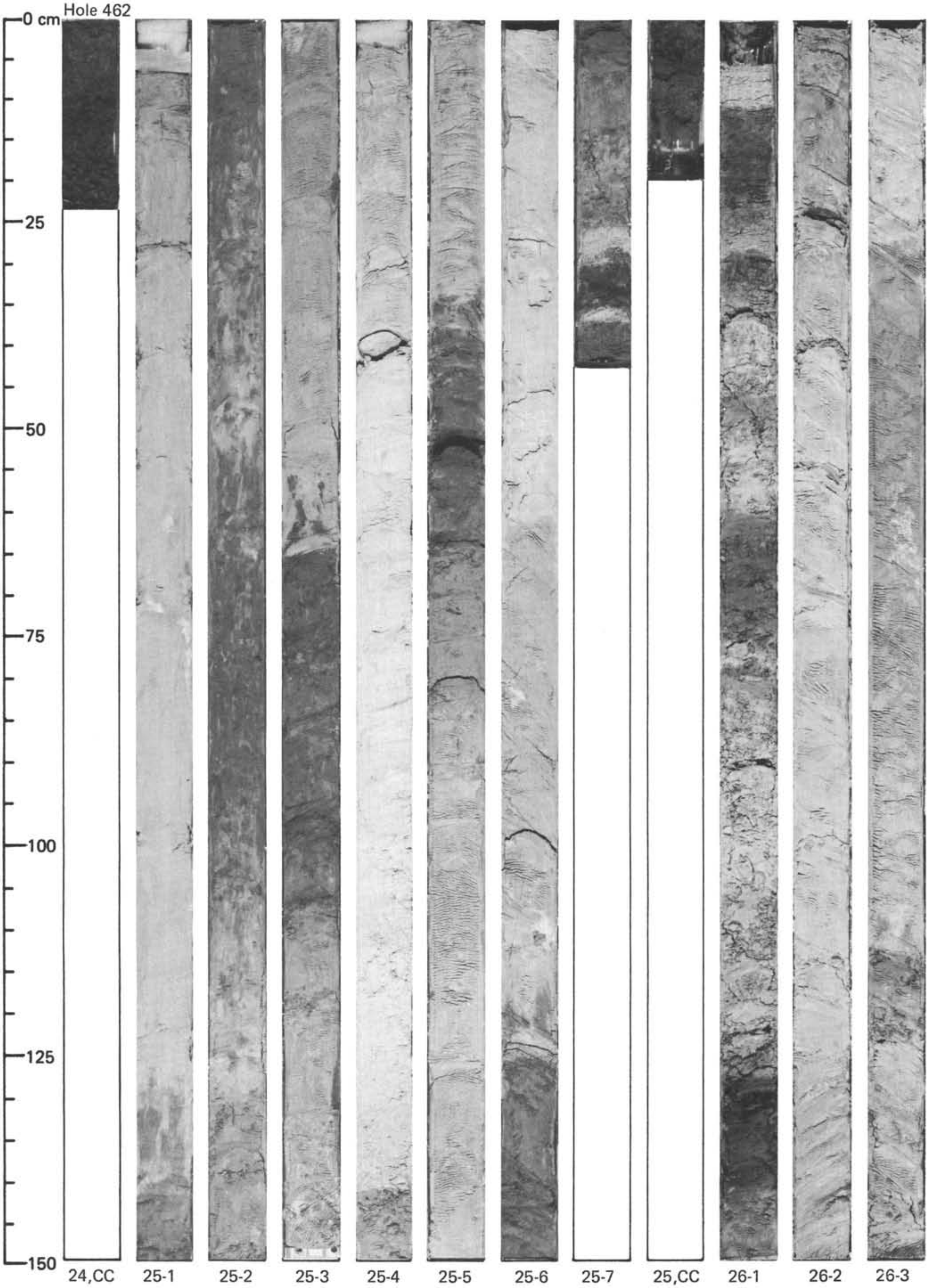
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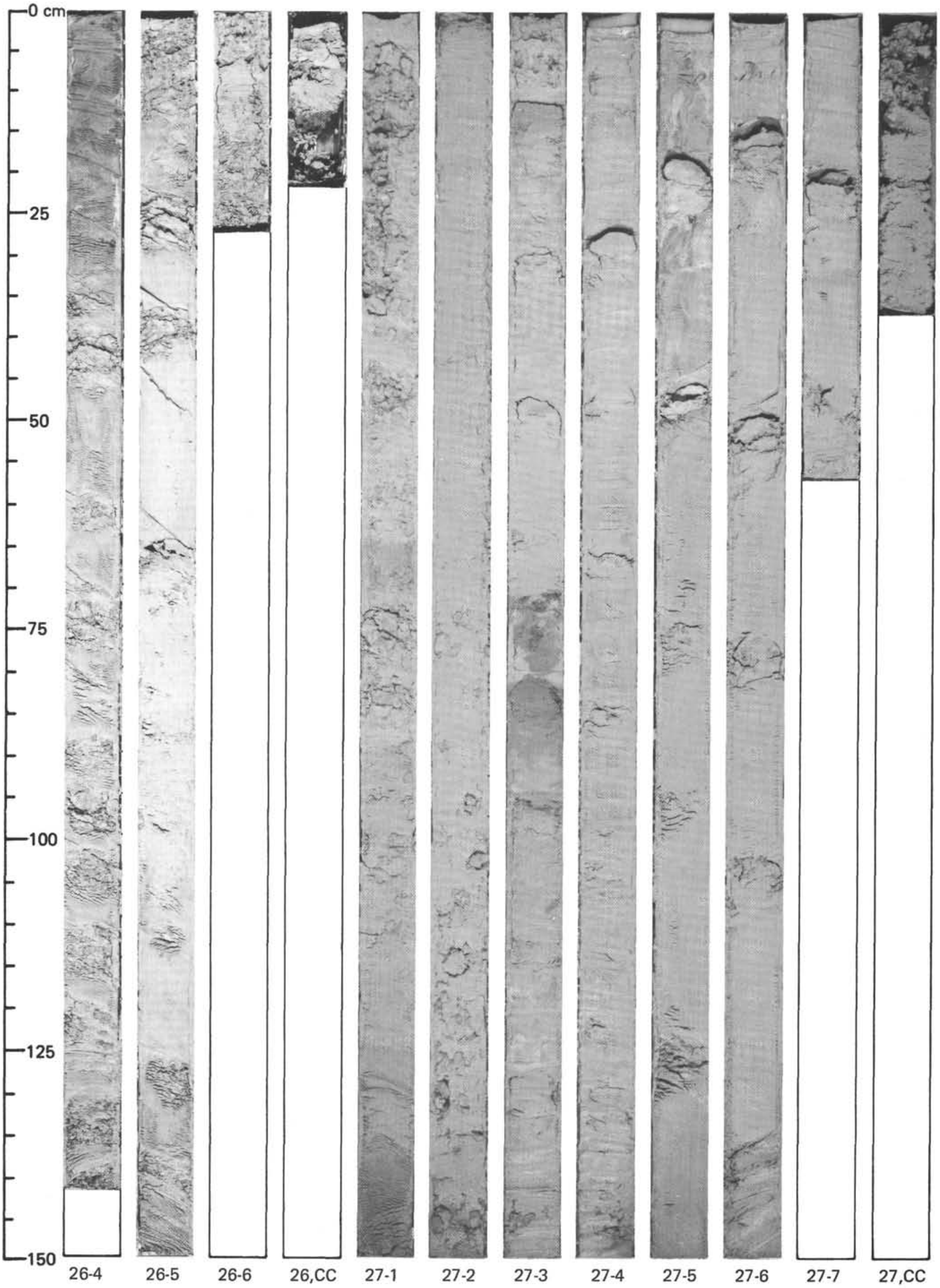
26-3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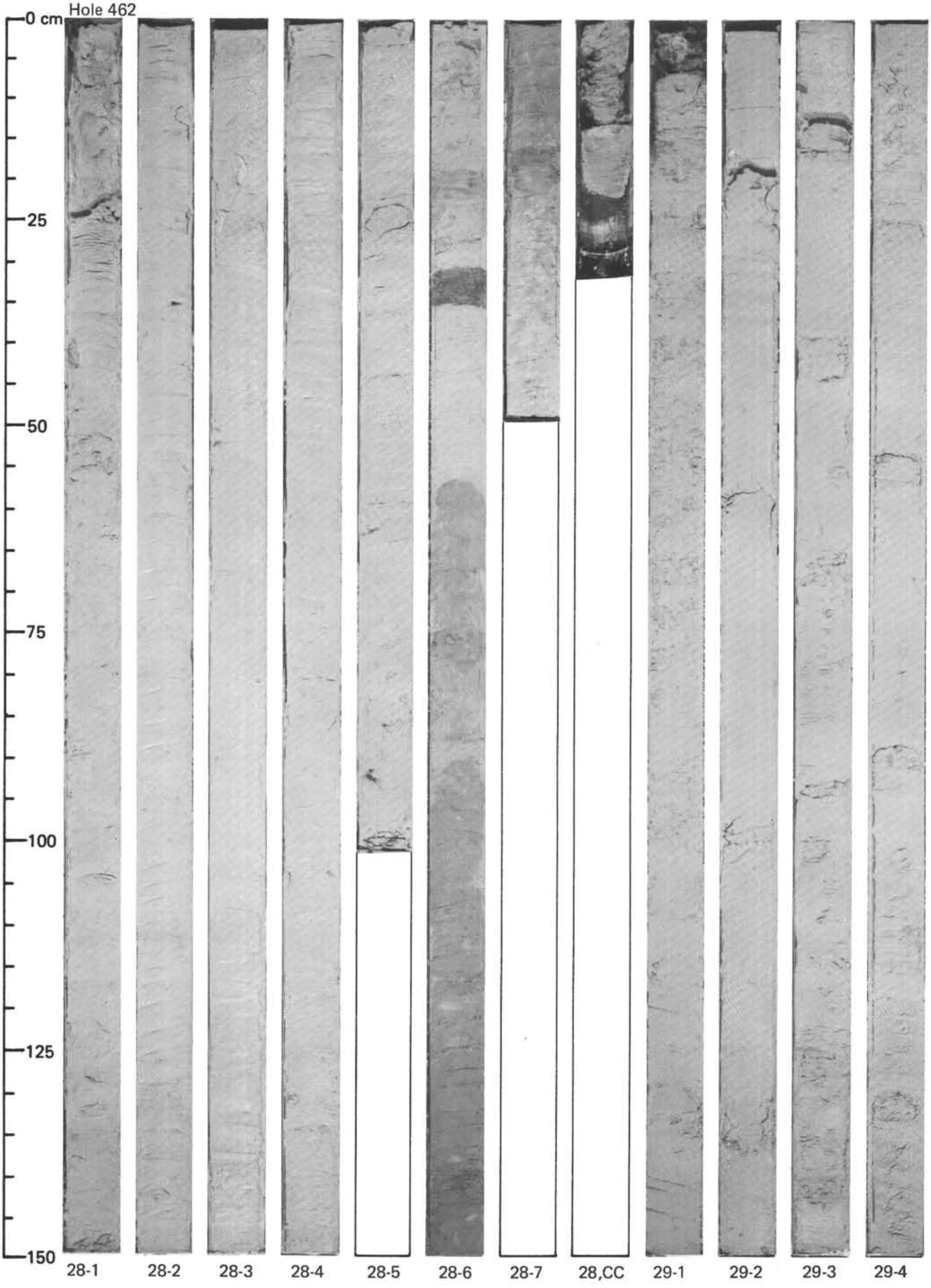
27,CC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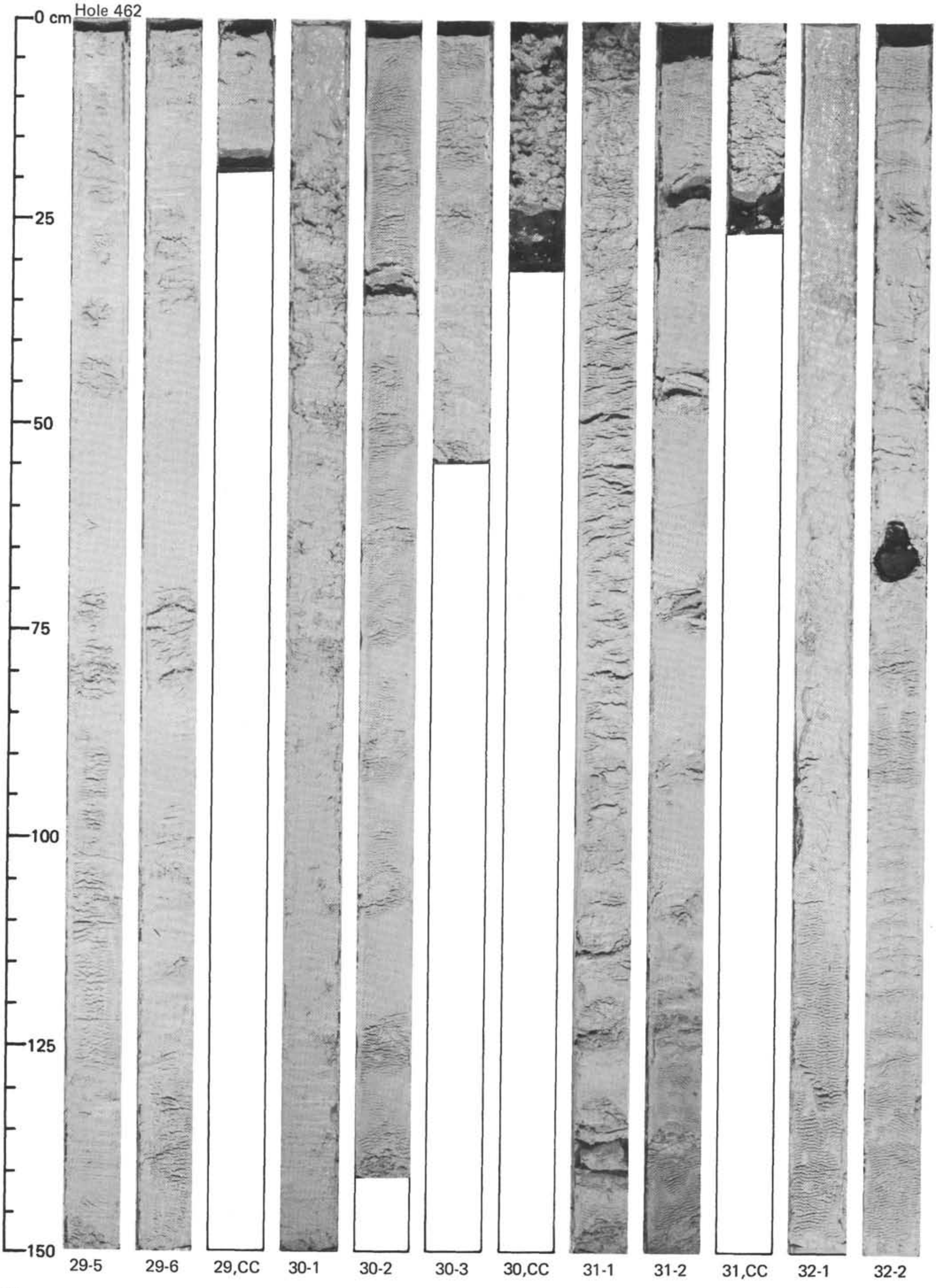
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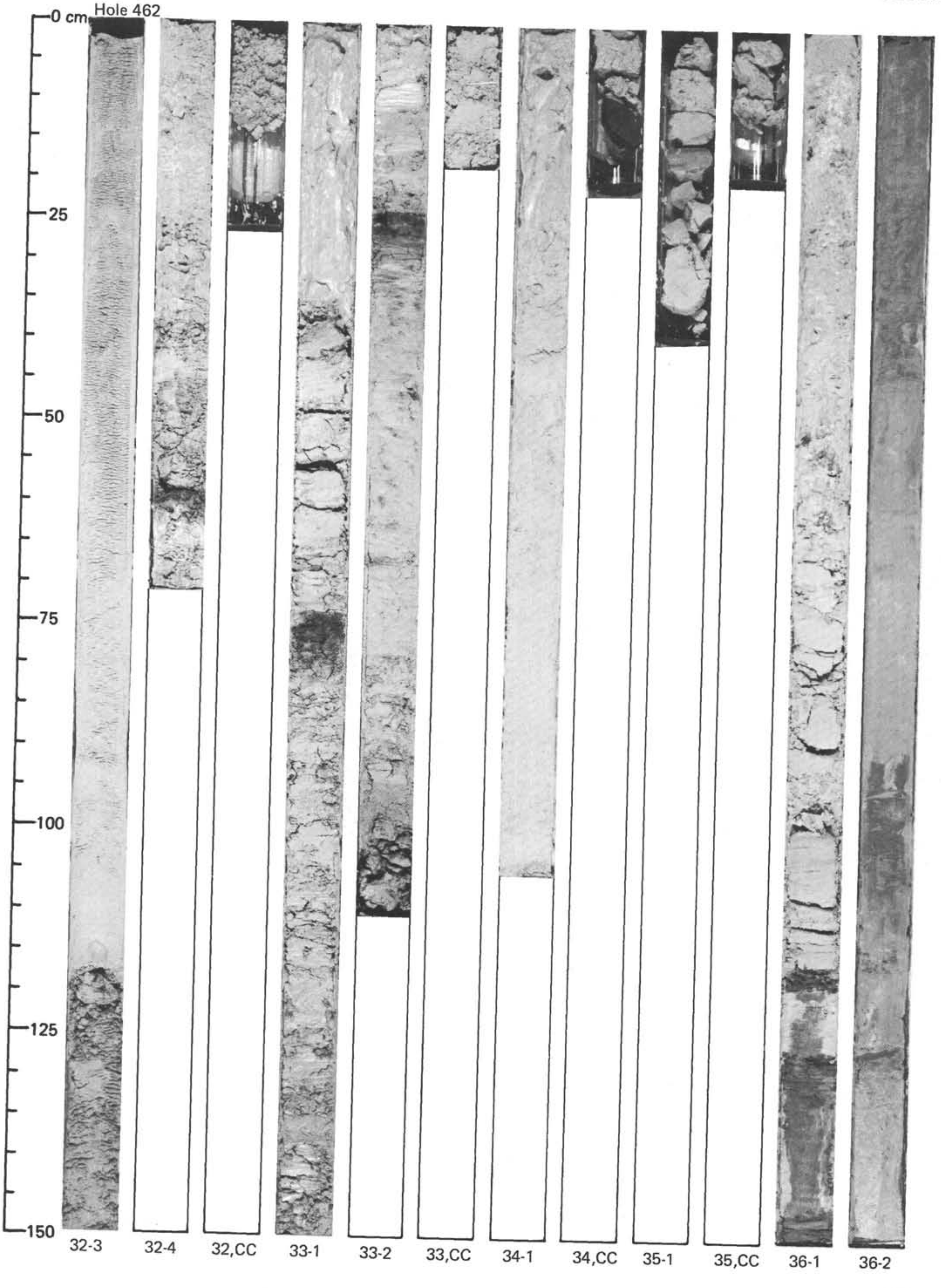
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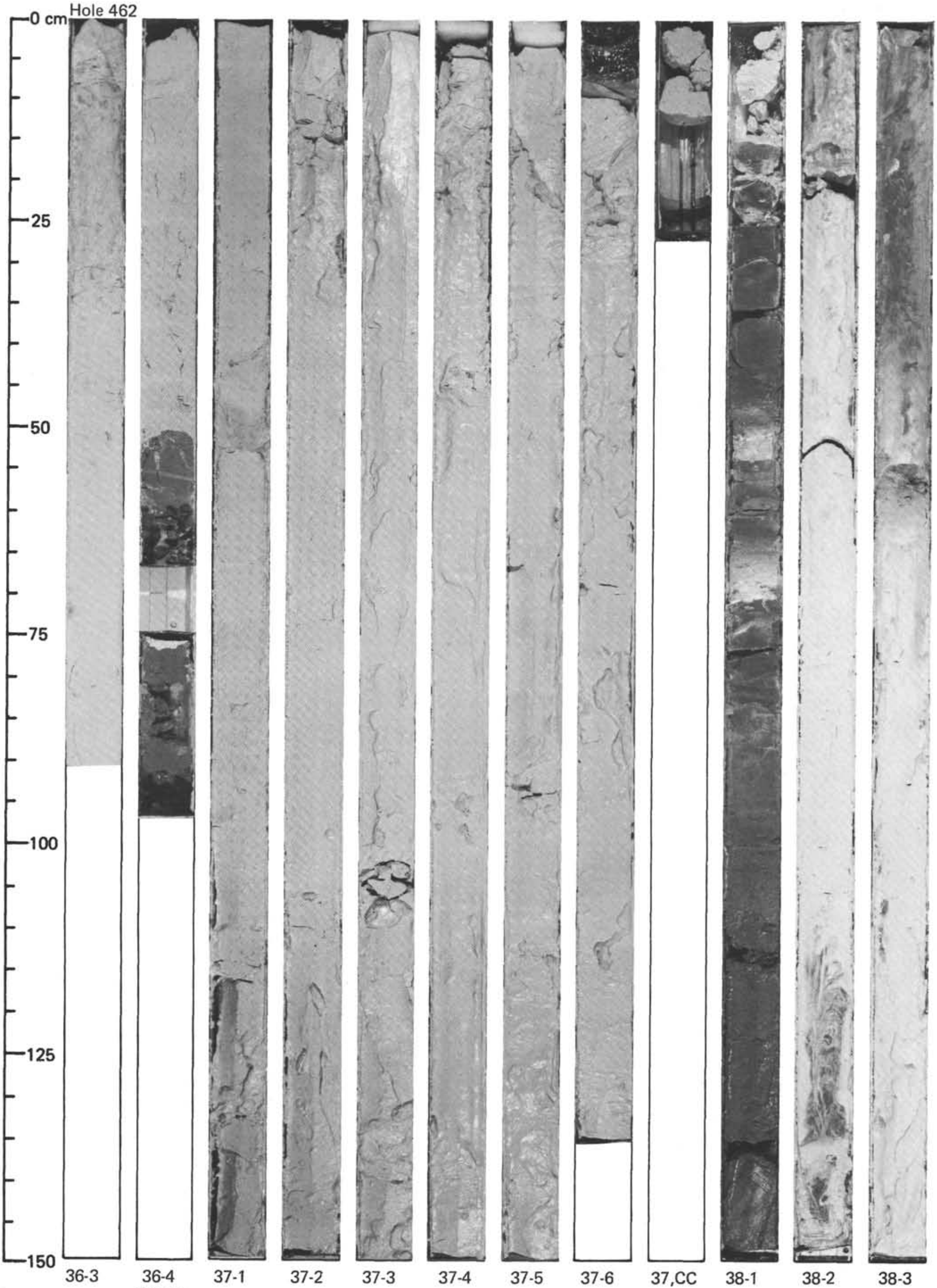
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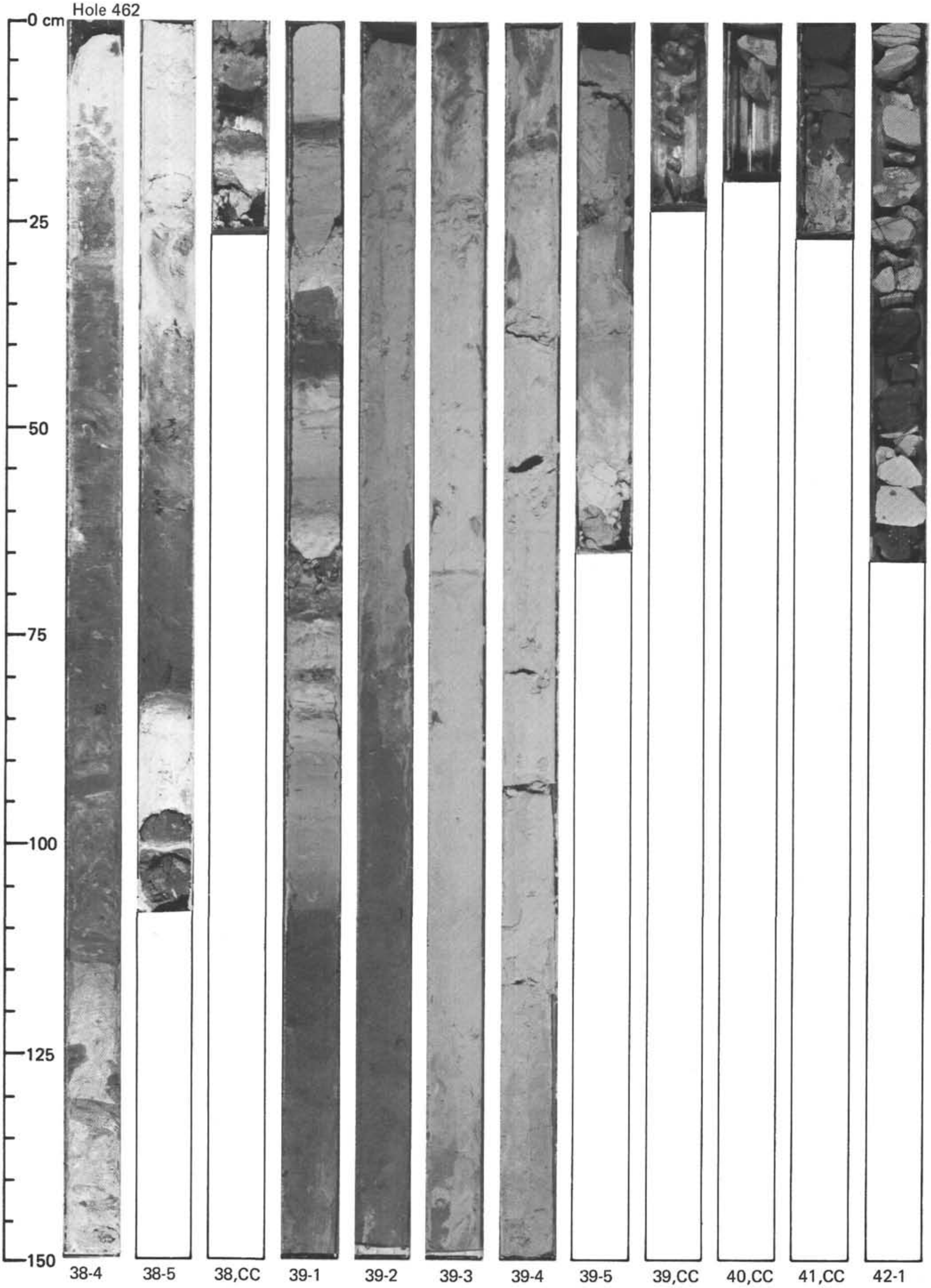
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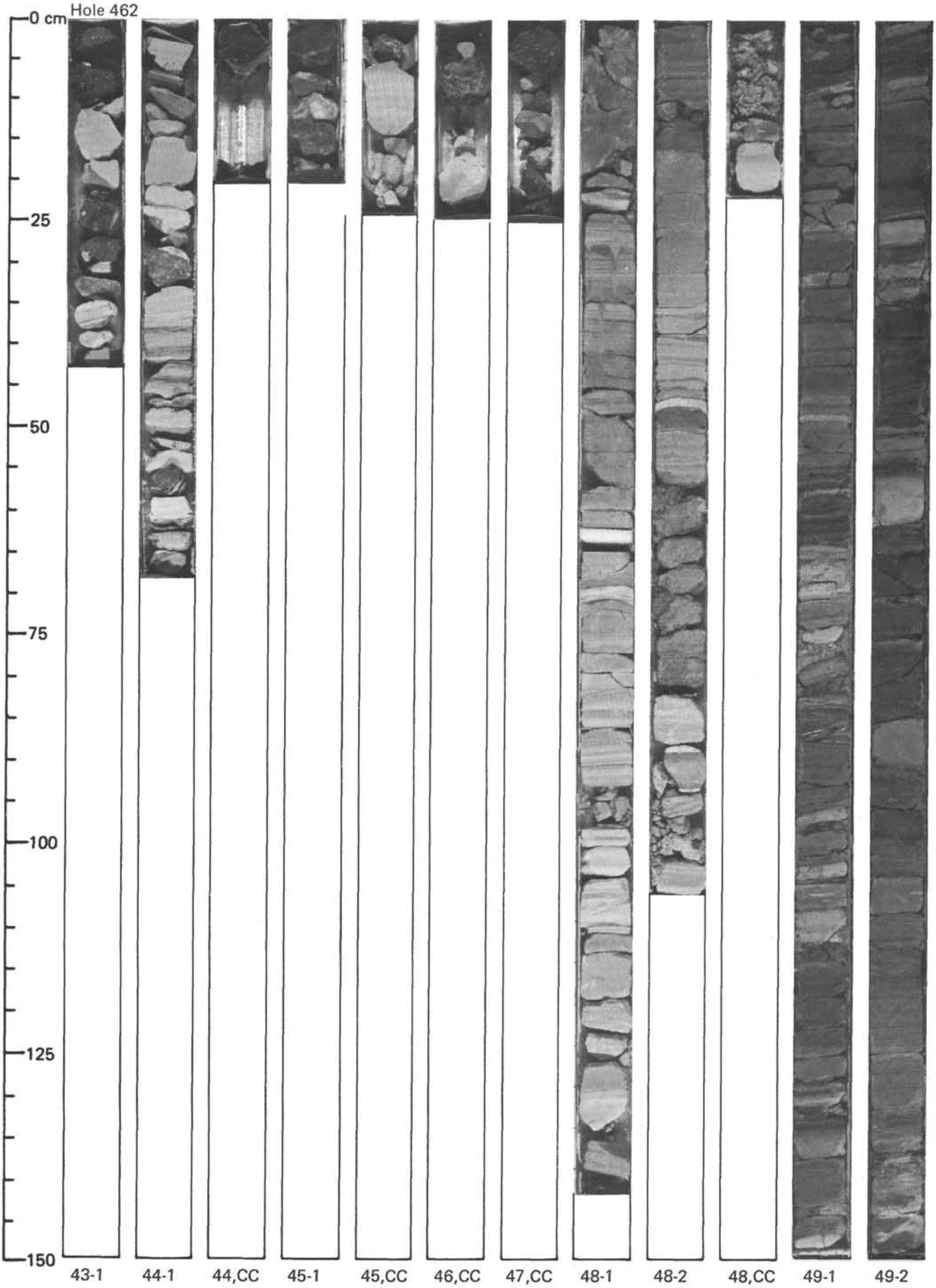
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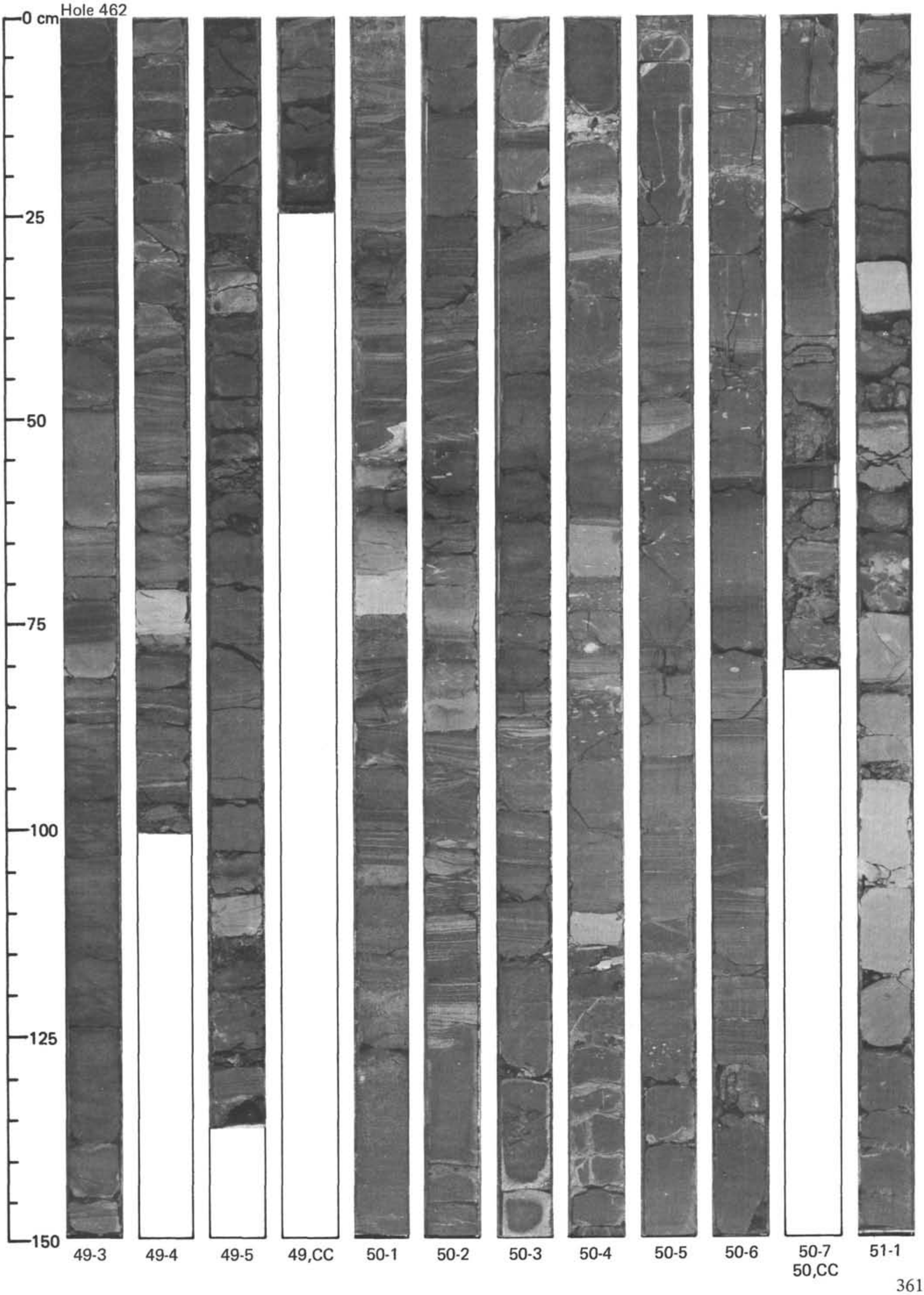
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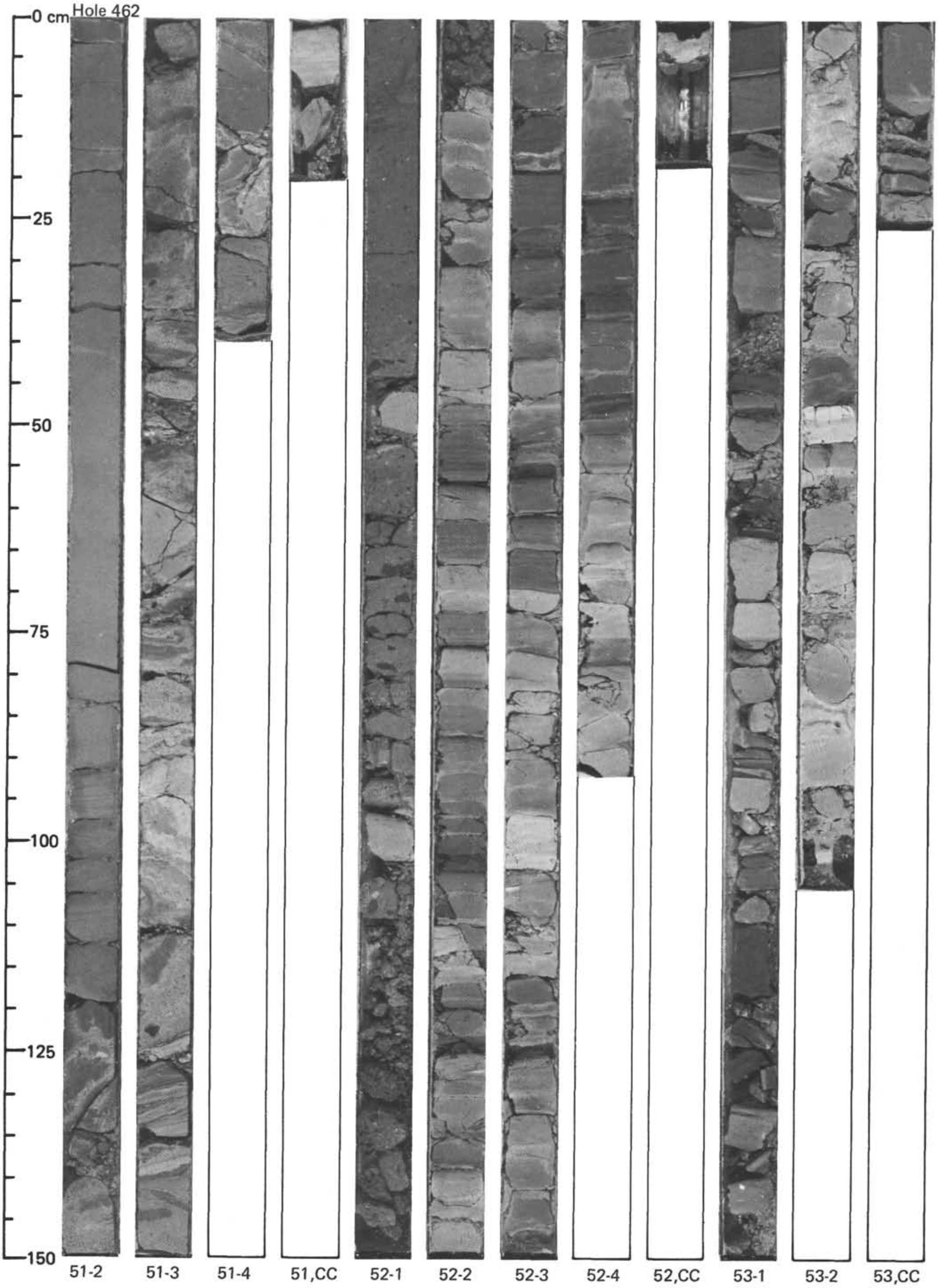
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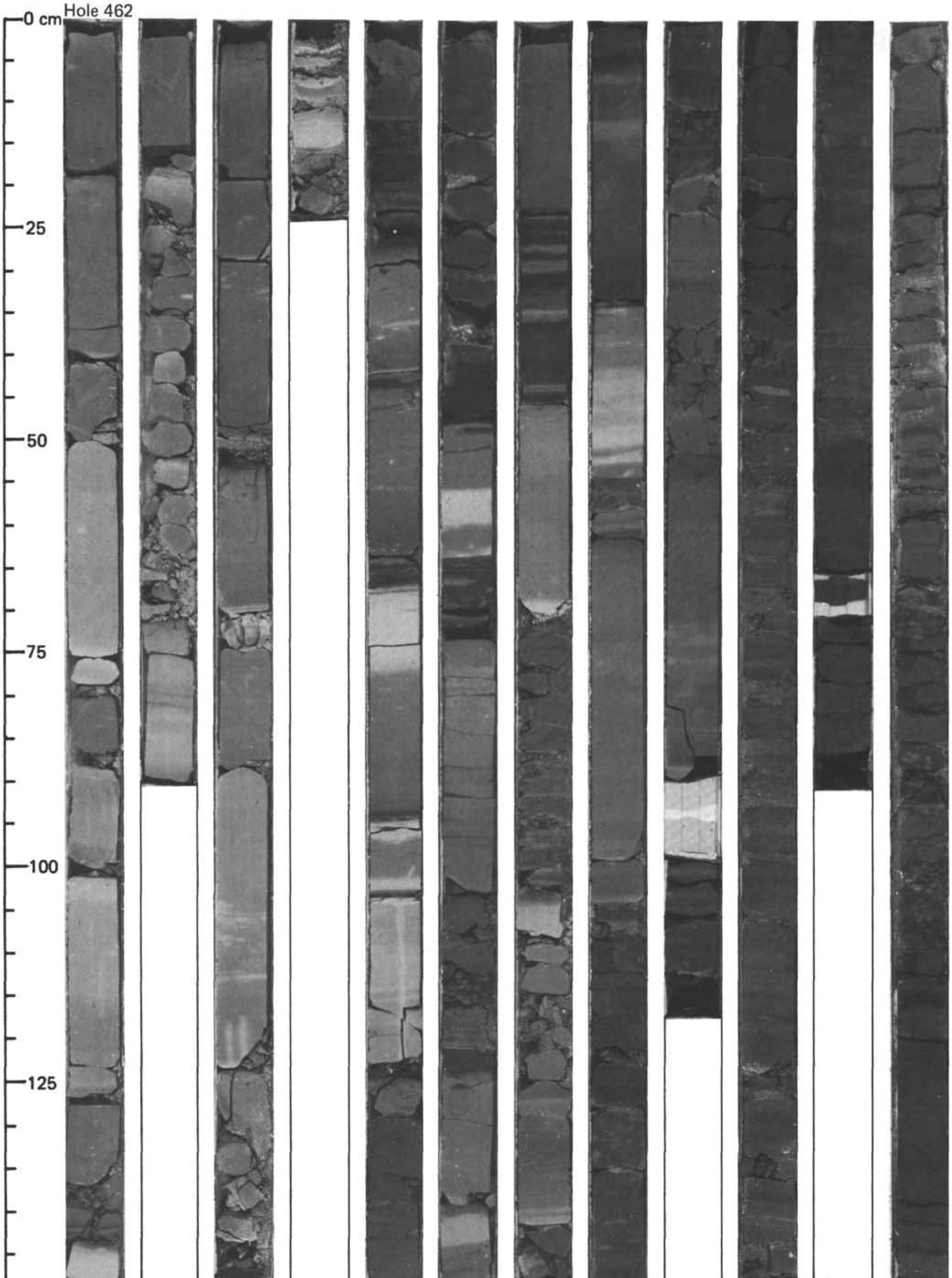
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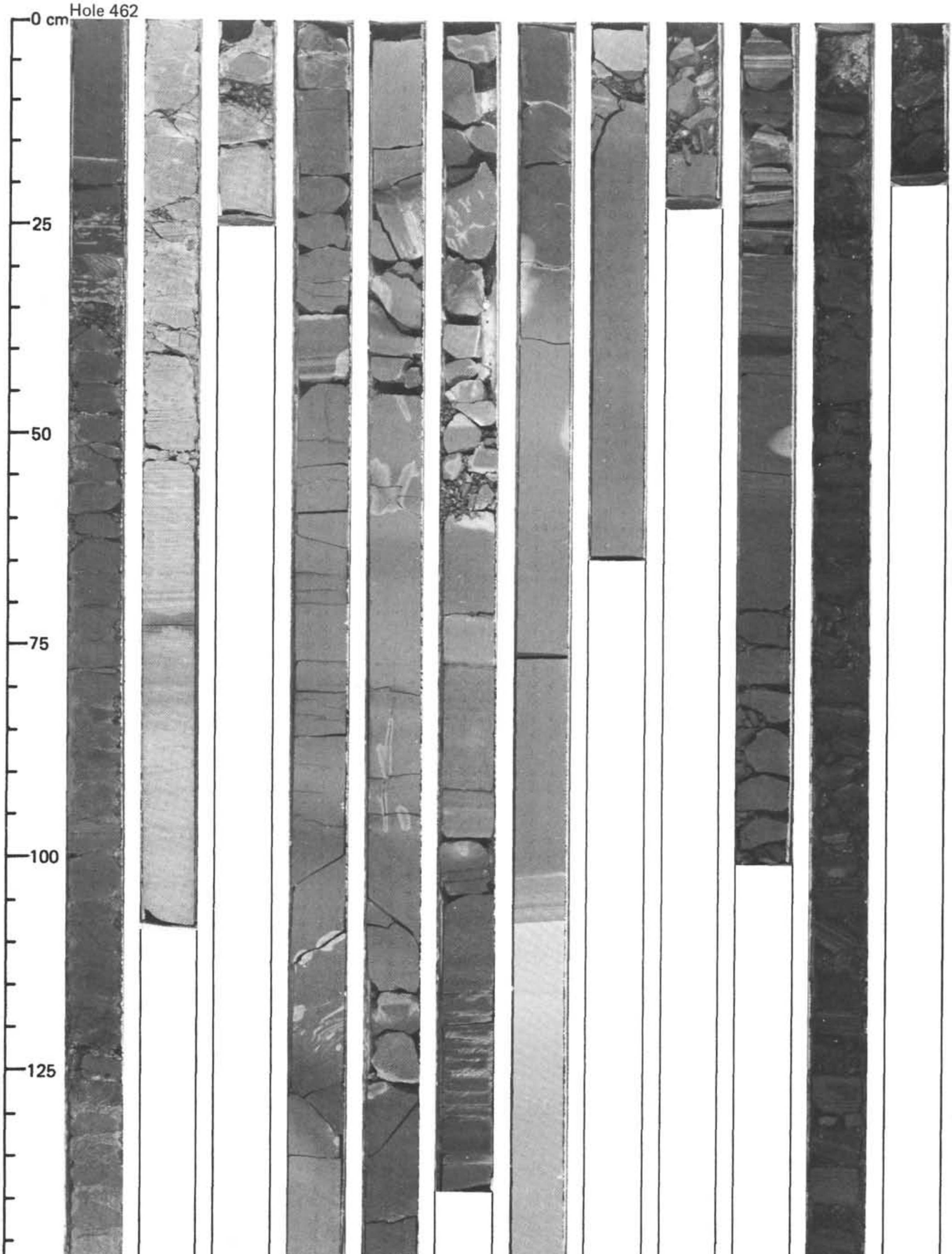
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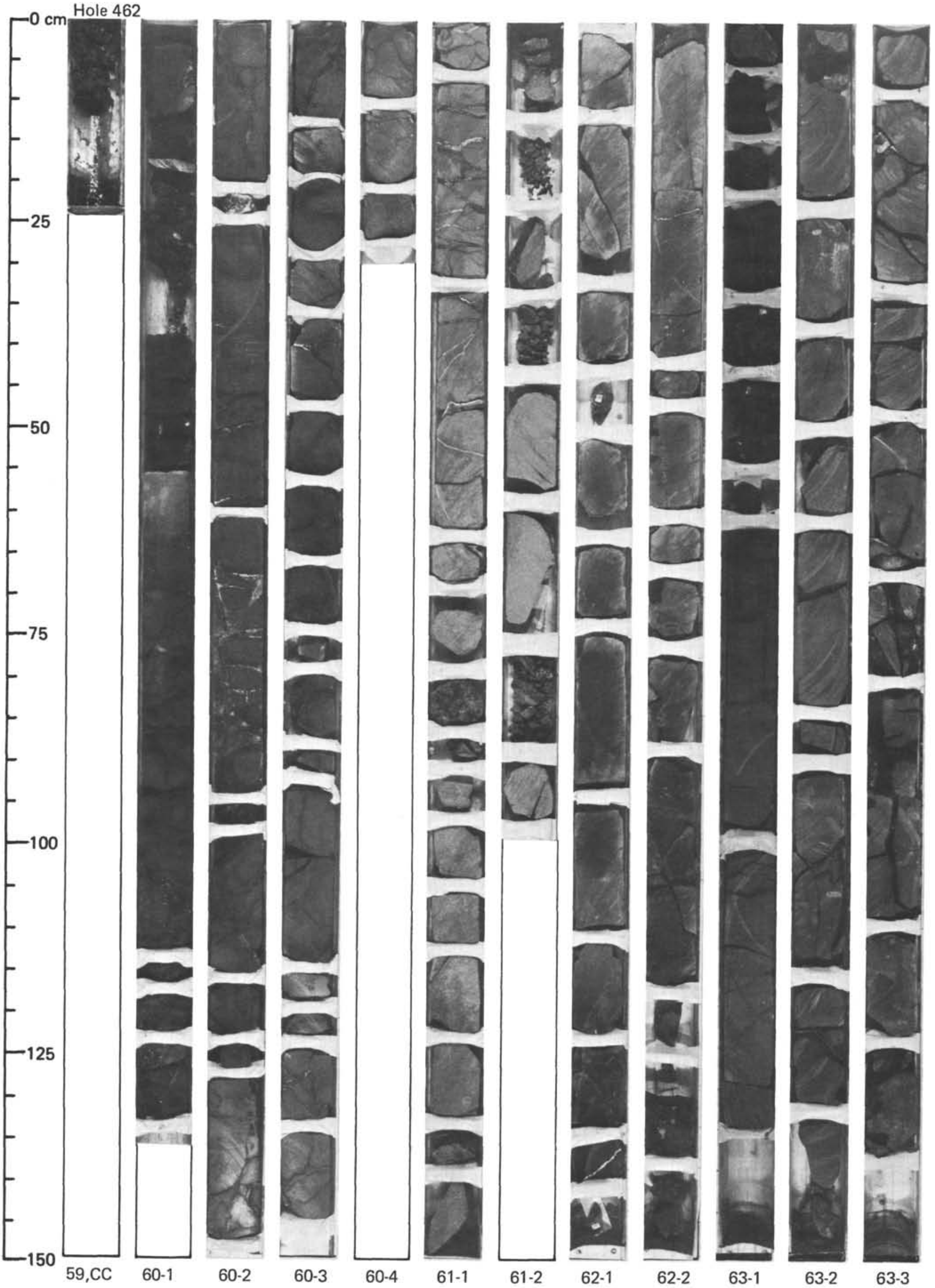
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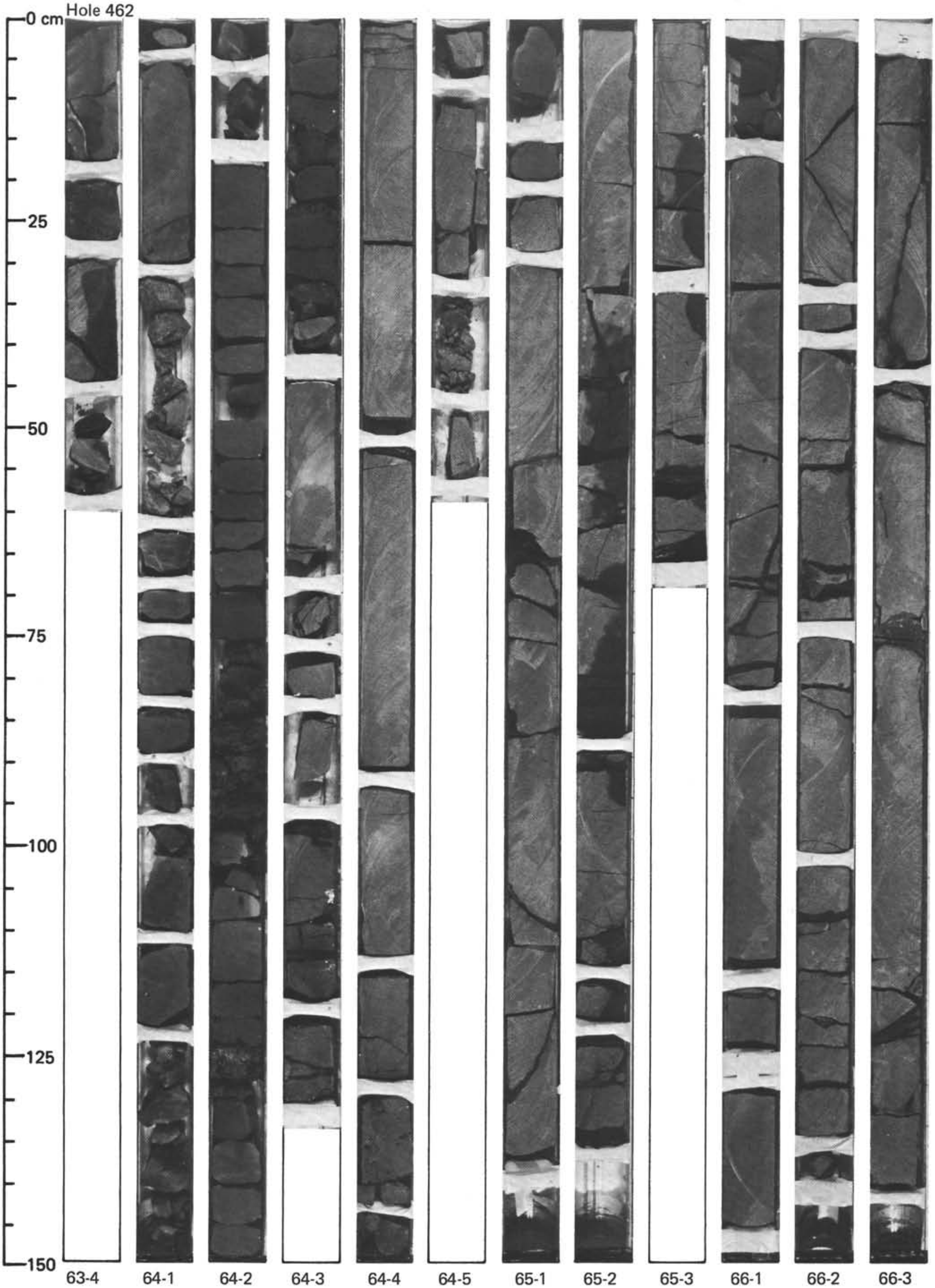
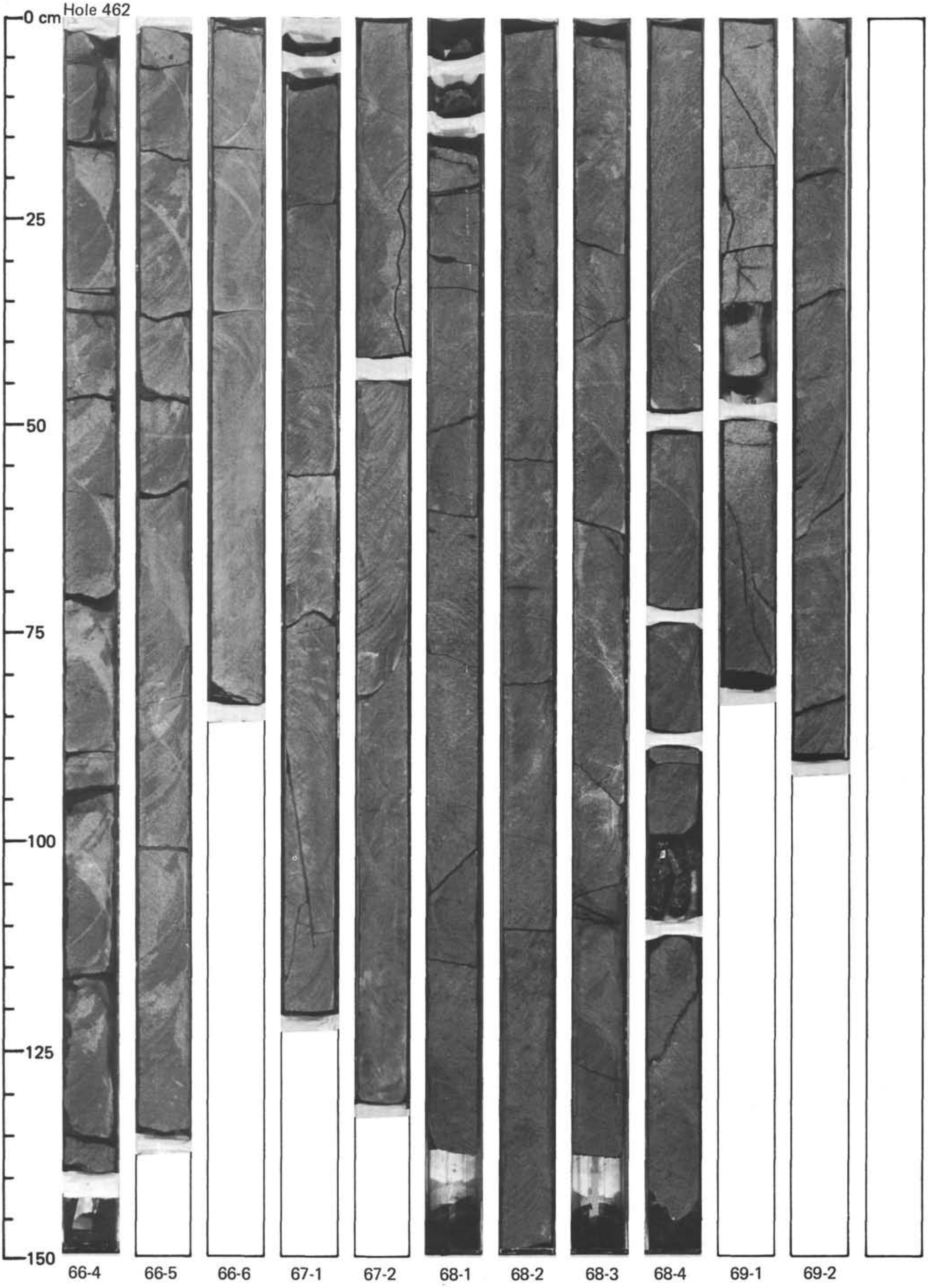
63-2
63-3


Hole 462
0 cm
25
50
75
100
125
150
63-4
64-1
64-2
64-3
64-4
64-5
65-1
65-2
65-3
66-1
66-2
66-3


Hole 462
0 cm
25
50
75
100
125
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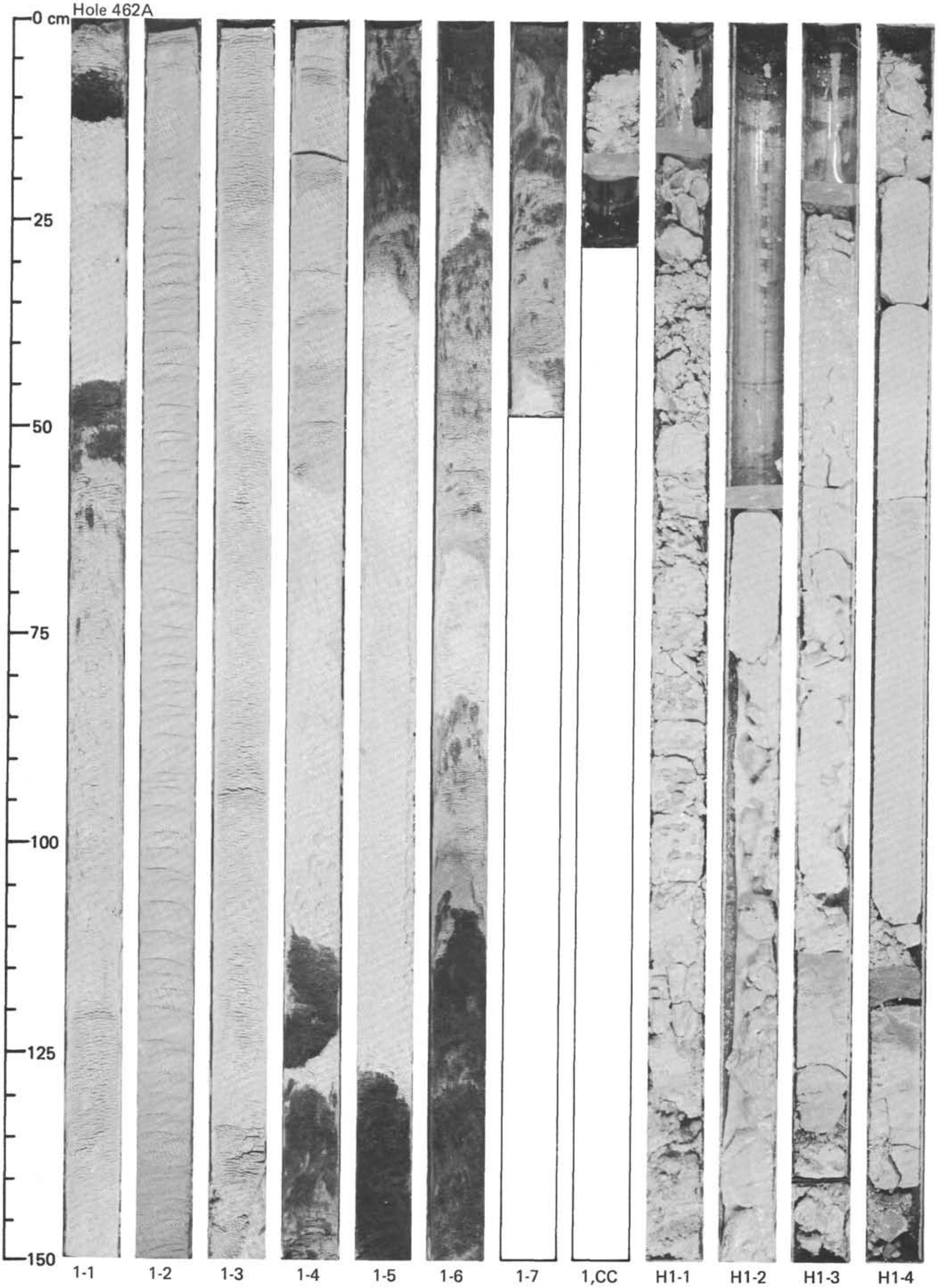
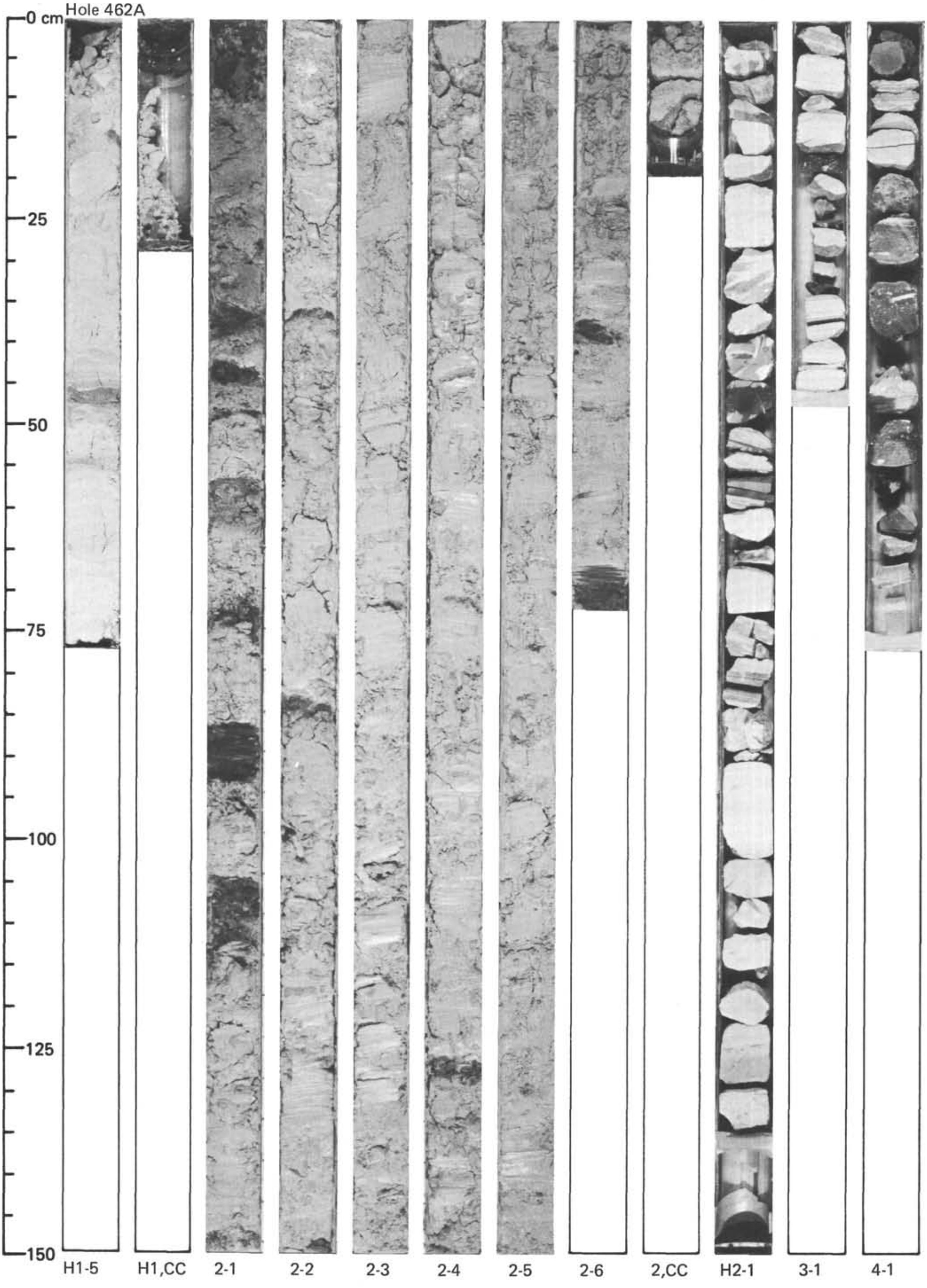
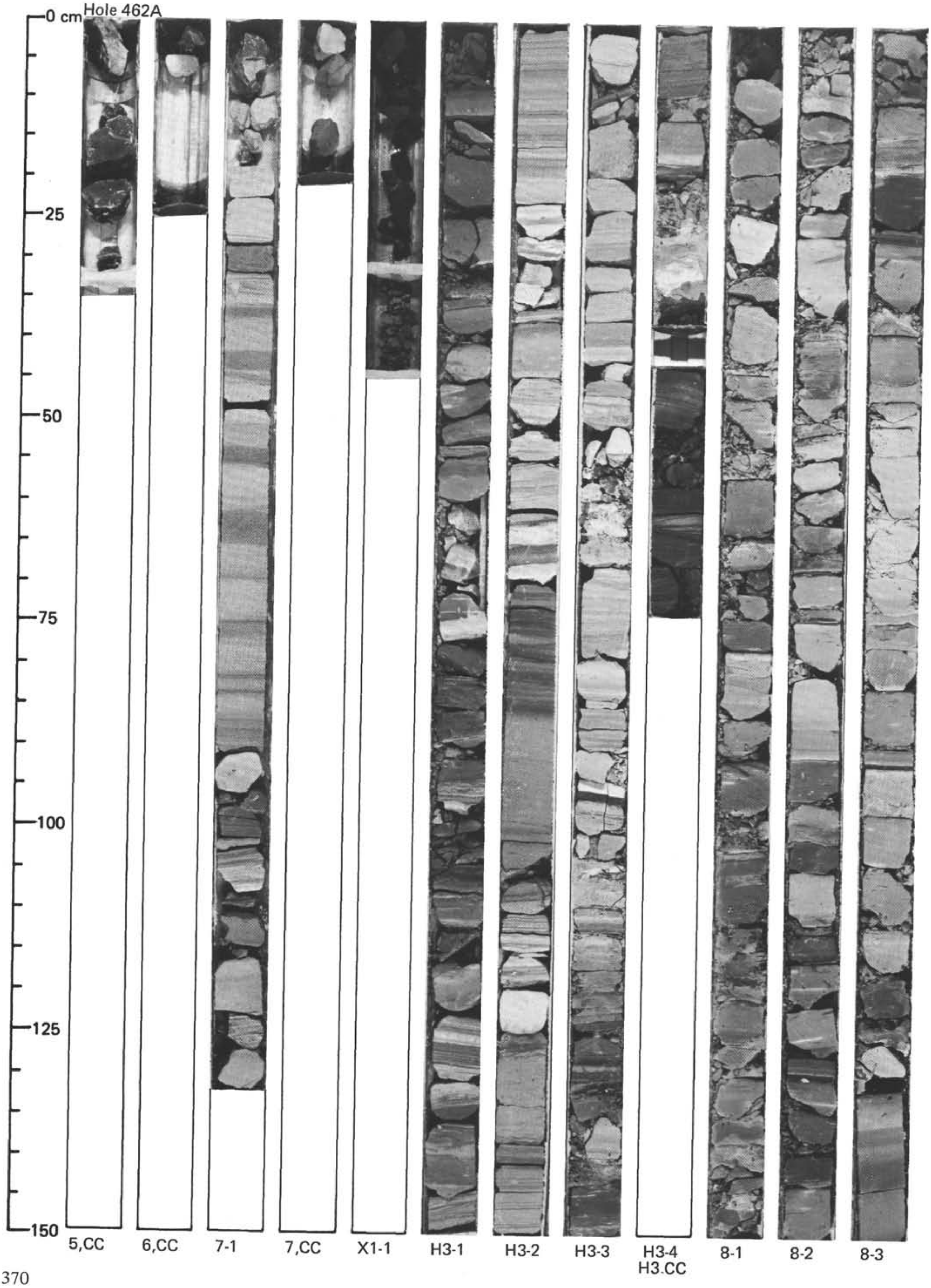
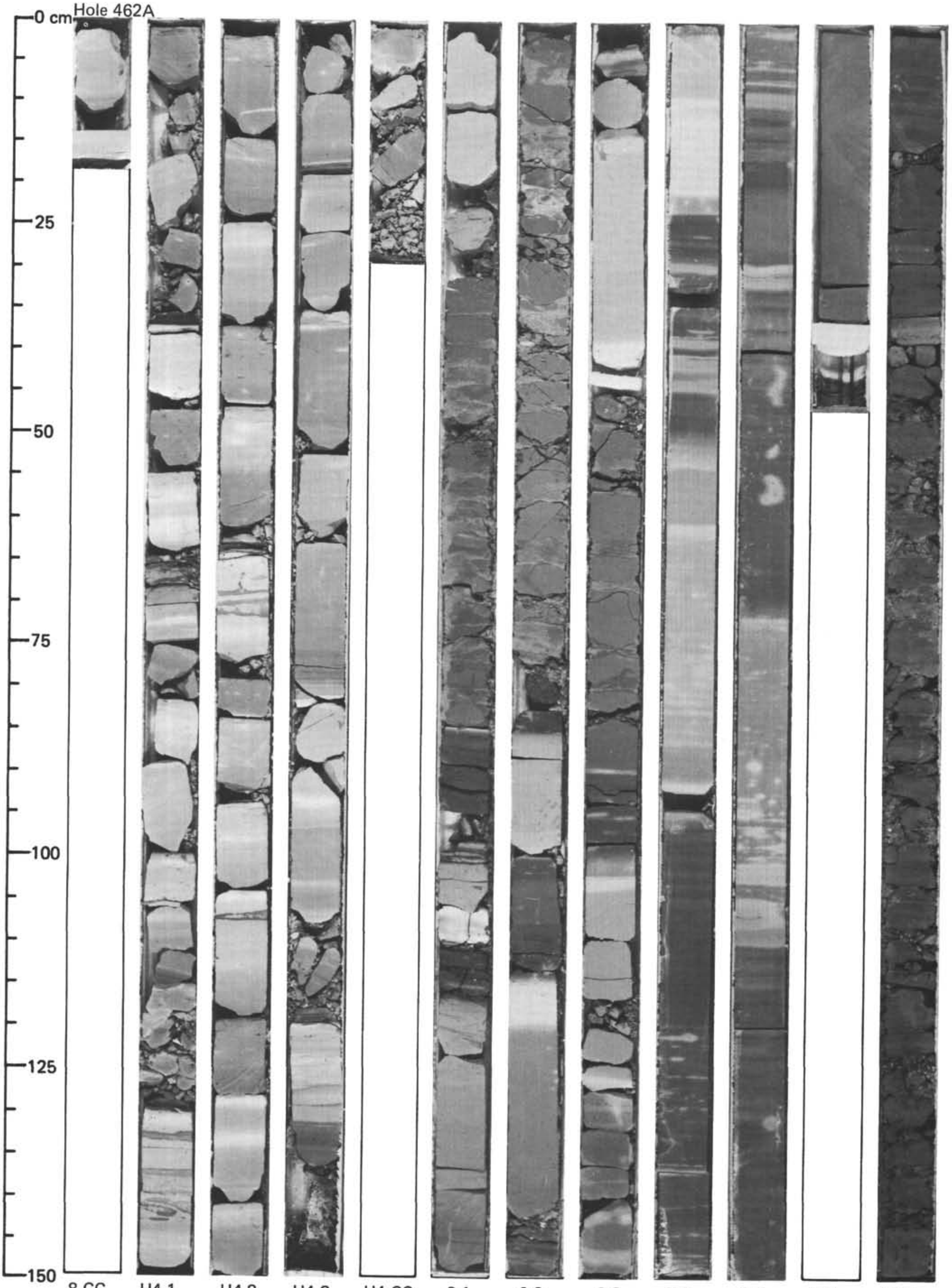
66-4
66-5
66-6
67-1
67-2
68-1
68-2
68-3
68-4
69-1
69-2

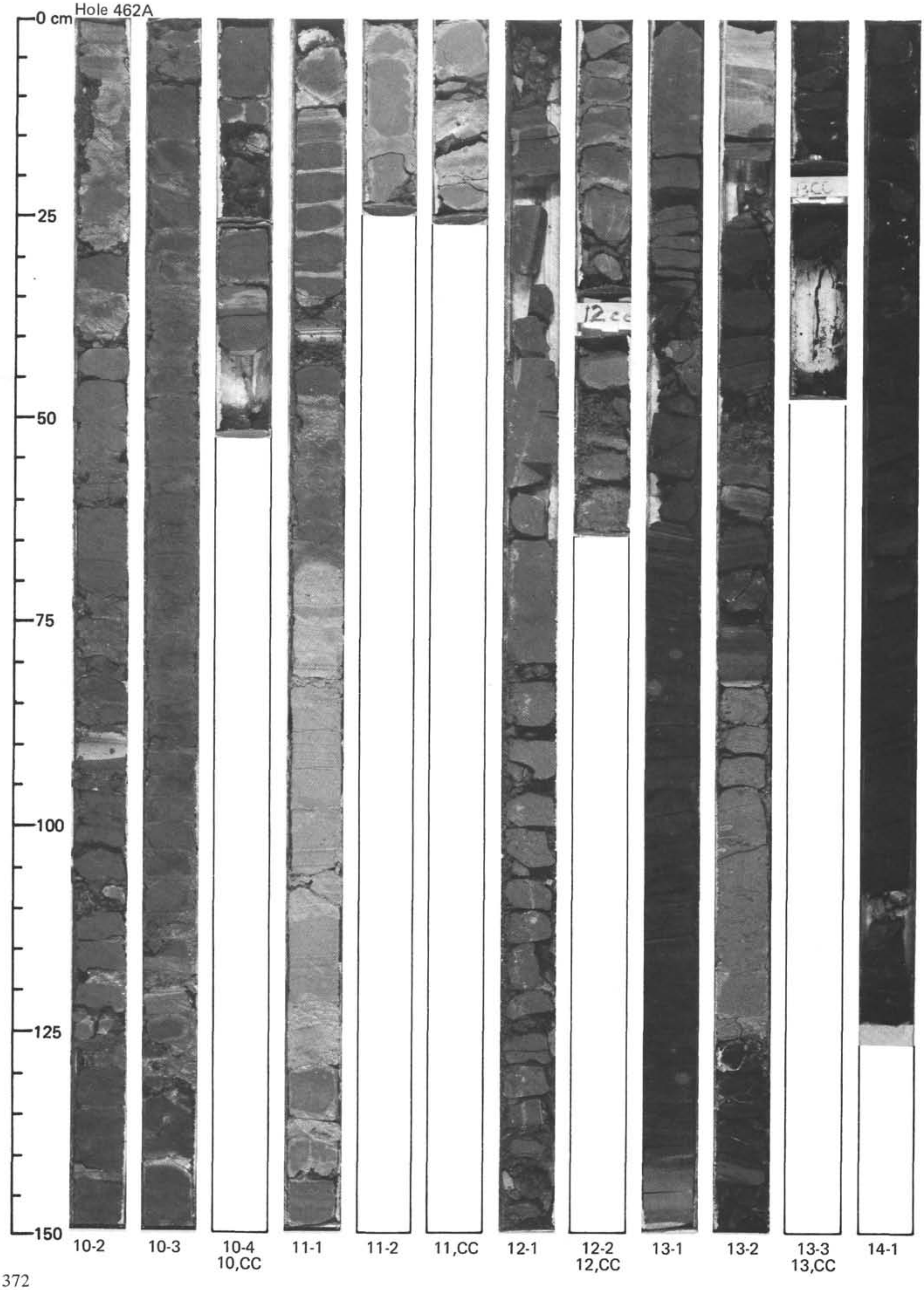

Hole 462A
0 cm
25
50
75
100
125
150
1-1
1-2
1-3
1-4
1-5
1-6
1-7
1,CC
H1-1
H1-2
H1-3
H1-4

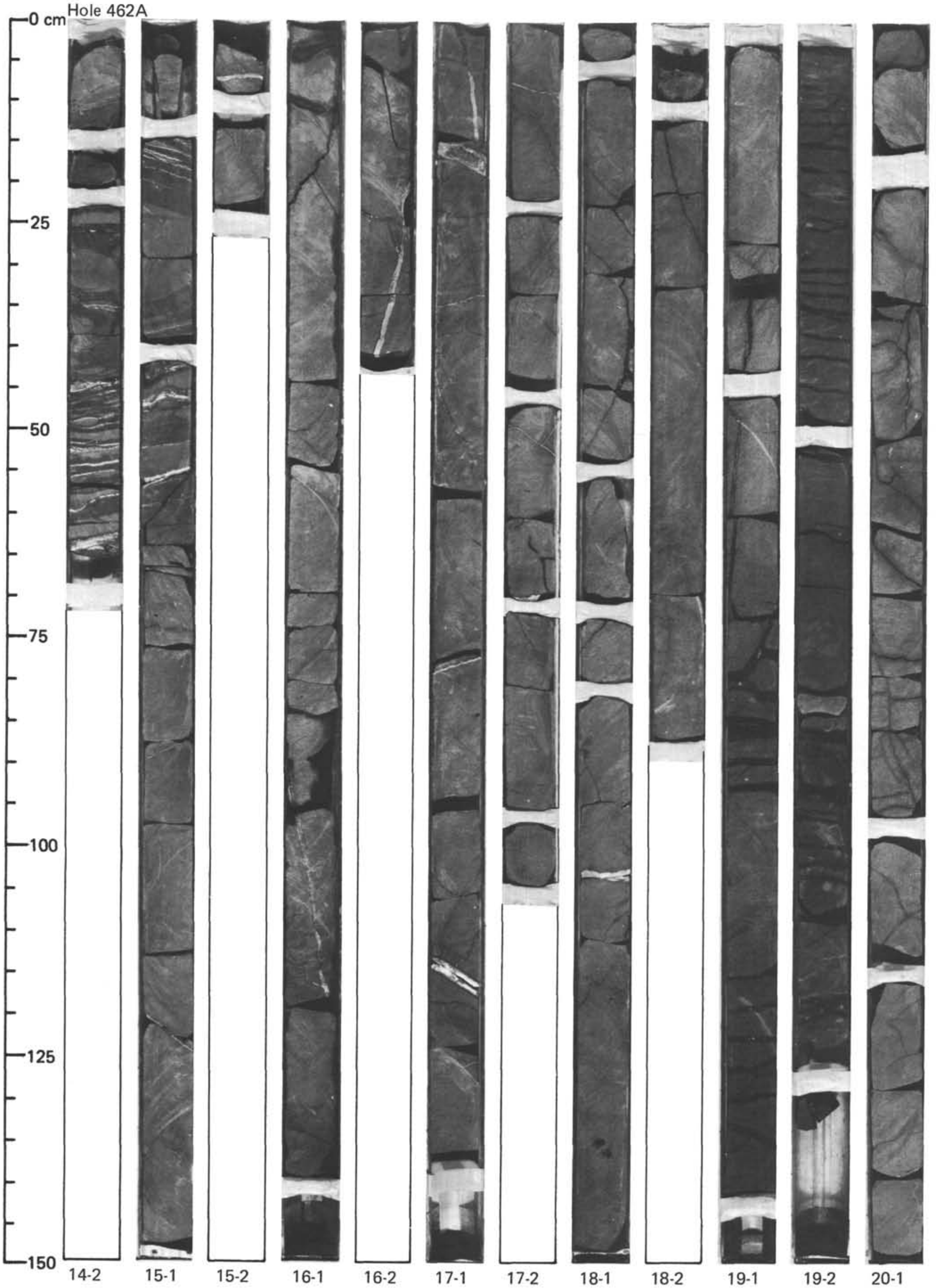

Hole 462A
0 cm
25
50
75
100
125
150
H1-5
H1,CC
2-1
2-2
2-3
2-4
2-5
2-6
2,CC
H2-1
3-1
4-1

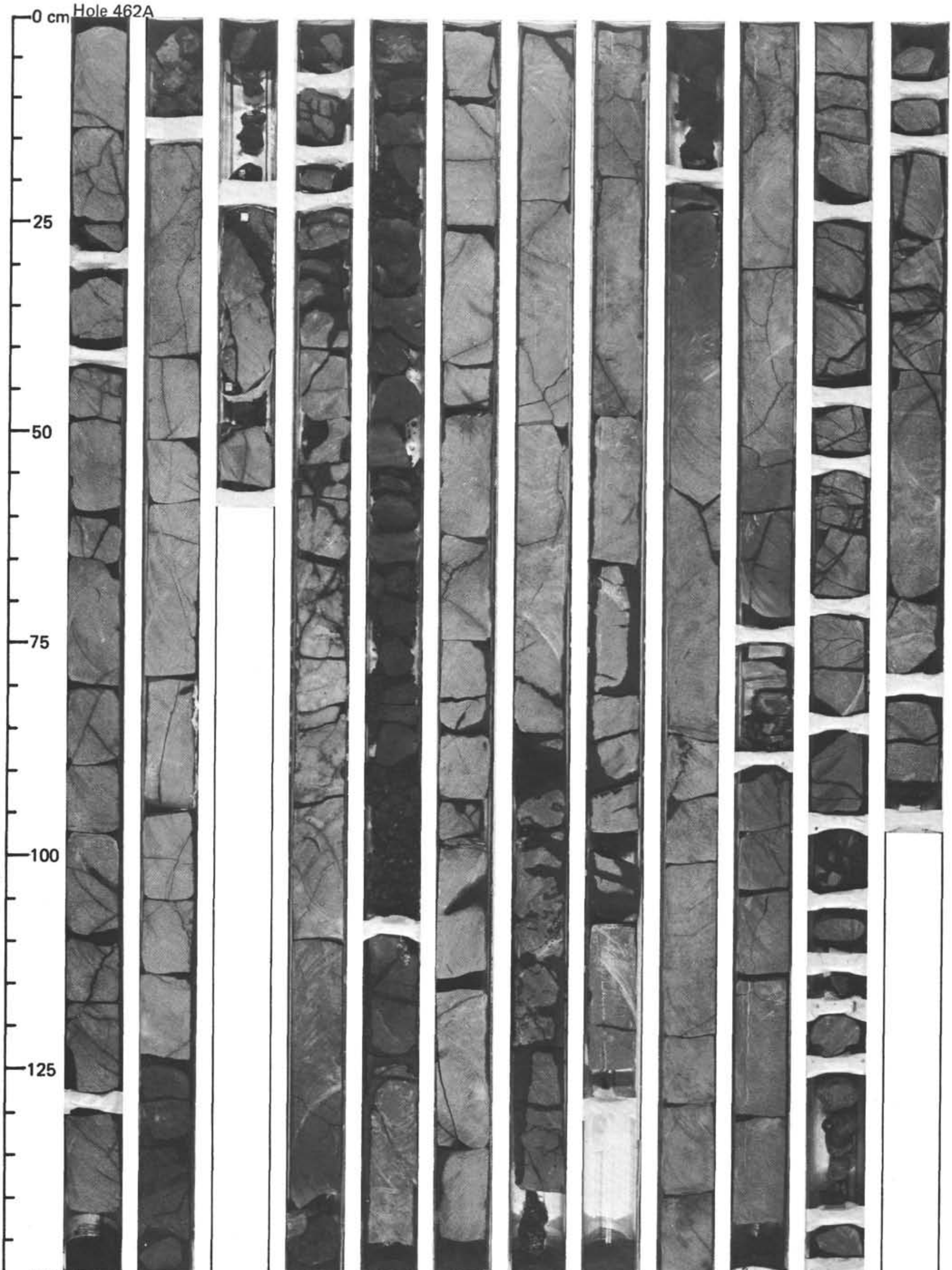

0 cm
Hole 462A
25
50
75
100
125
150
5,CC
6,CC
7-1
7,CC
X1-1
H3-1
H3-2
H3-3
H3-4
H3.CC
8-1
8-2
8-3



0 cm
Hole 462A
25
50
75
100
125
150
8,CC
H4-1
H4-2
H4-3
H4,CC
9-1
9-2
9-3
9-4
9-5
9-6
10-1


Hole 462A
0 cm
25
50
75
100
125
150
10-2
10-3
10-4
10,CC
11-1
11-2
11,CC
12-1
12-2
12,CC
13-1
13-2
13-3
13,CC
14-1


0 cm
Hole 462A
25
50
75
100
125
150
14-2
15-1
15-2
16-1
16-2
17-1
17-2
18-1
18-2
19-1
19-2
20-1


Hole 462A
0 cm
25
50
75
100
125
150
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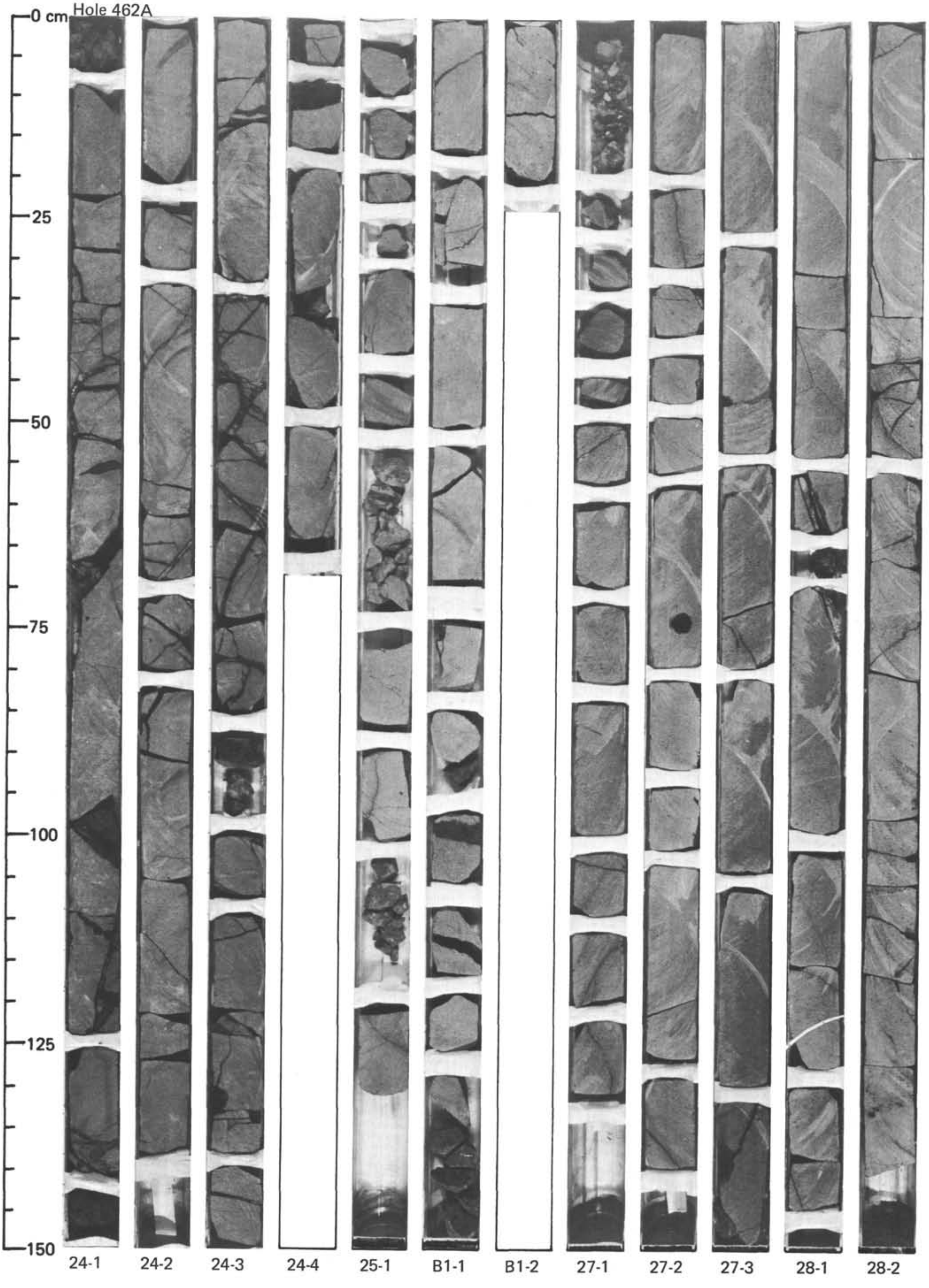
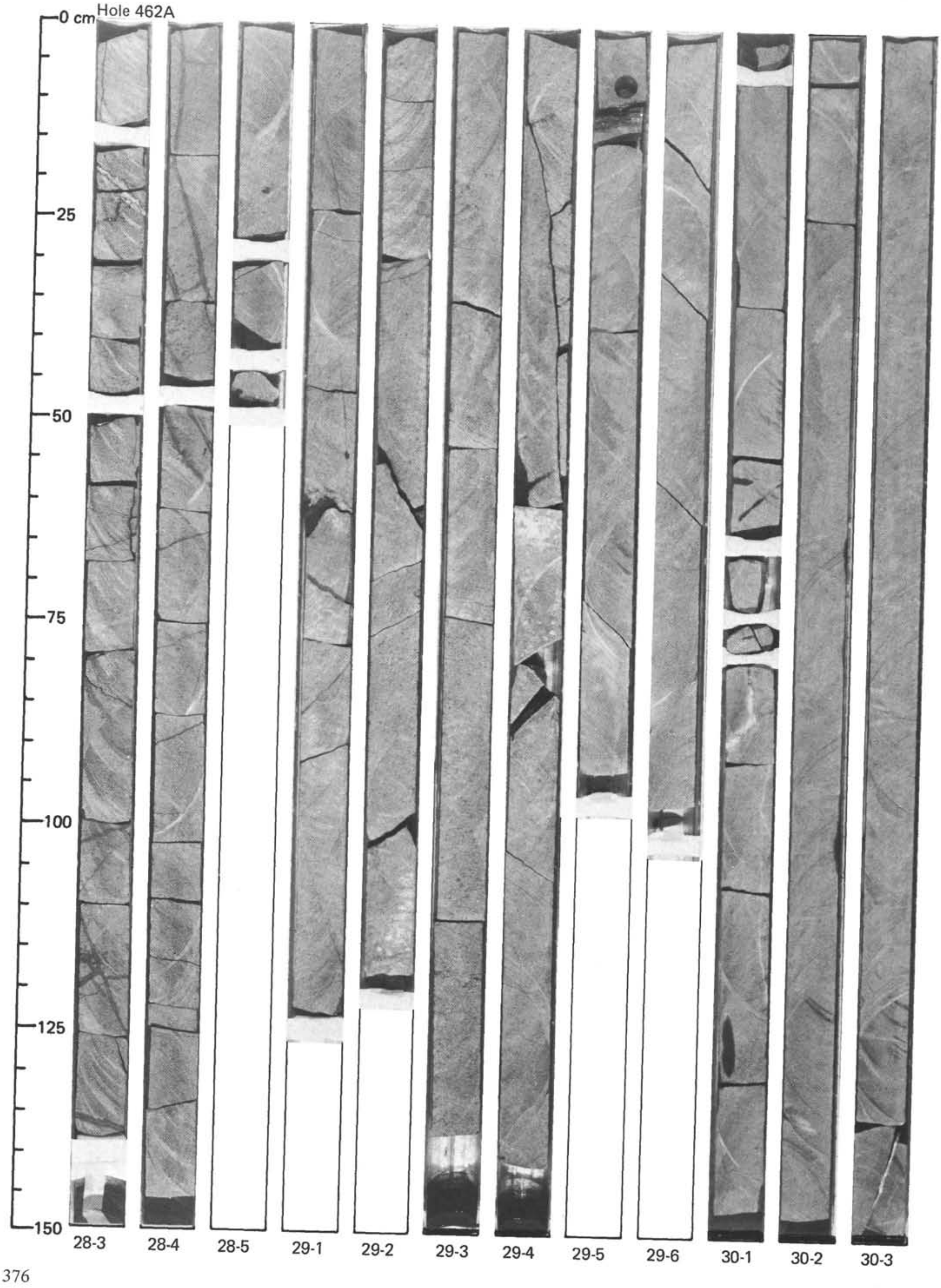
21-1
21-2
22-1
22-2
22-3
22-4
22-5
23-1
23-2
23-3
23-4


0 cm
Hole 462A
25
50
75
100
125
150
24-1
24-2
24-3
24-4
25-1
B1-1
B1-2
27-1
27-2
27-3
28-1
28-2


0 cm
Hole 462A
25
50
75
100
125
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28-3
28-4
28-5
29-1
29-2
29-3
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29-5
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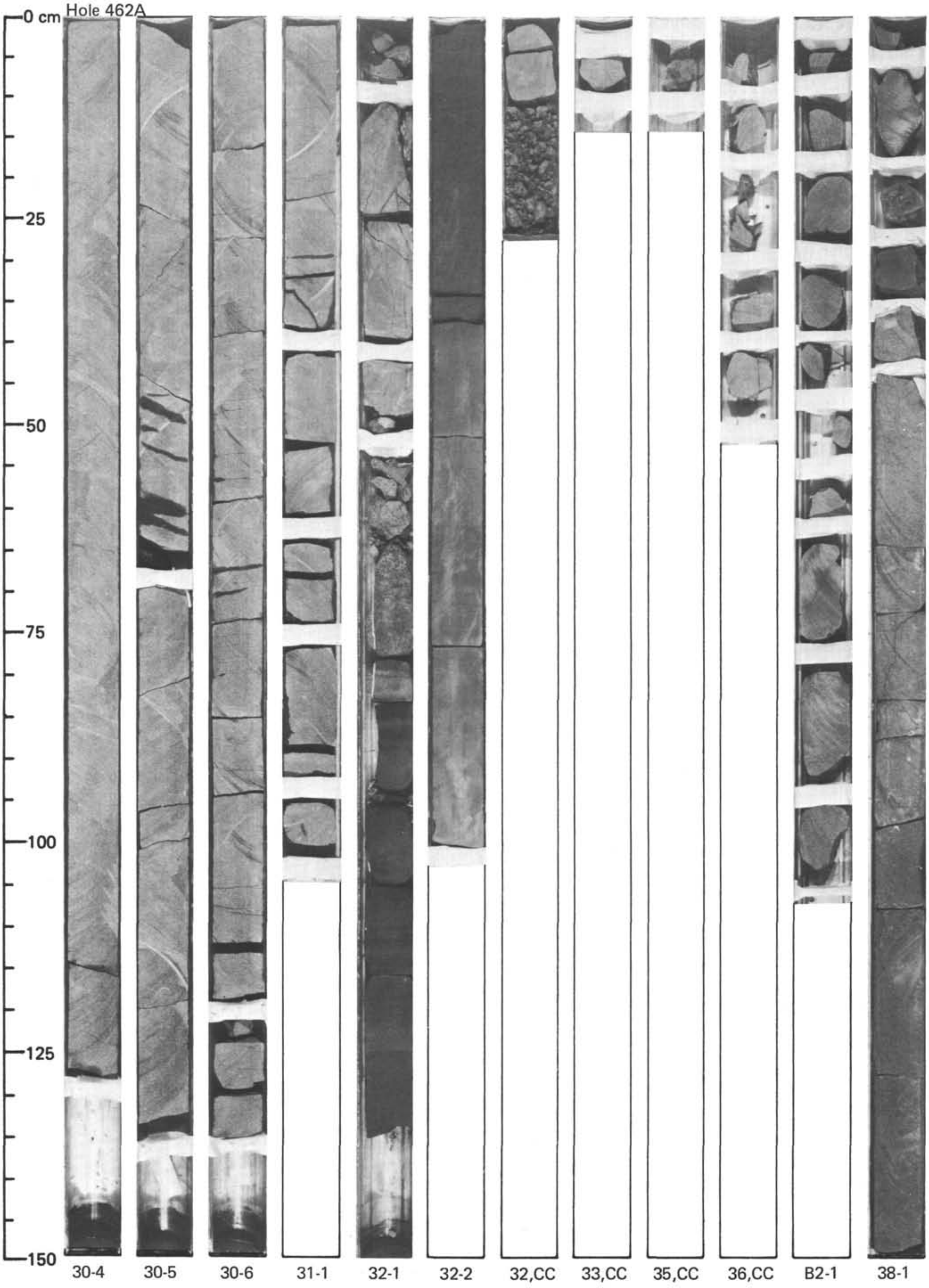
30-1
30-2
30-3


0 cm
Hole 462A
25
50
75
100
125
150
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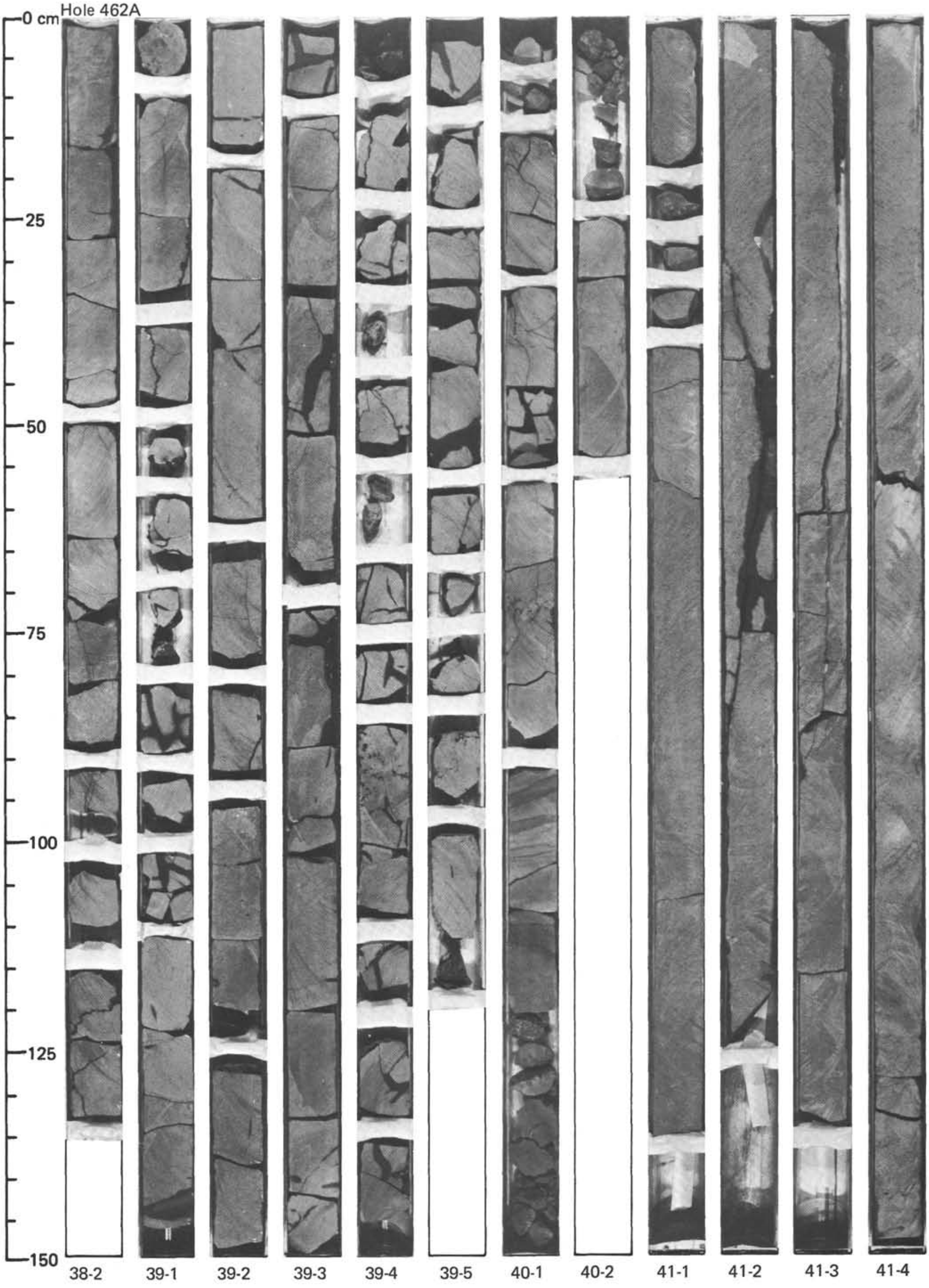
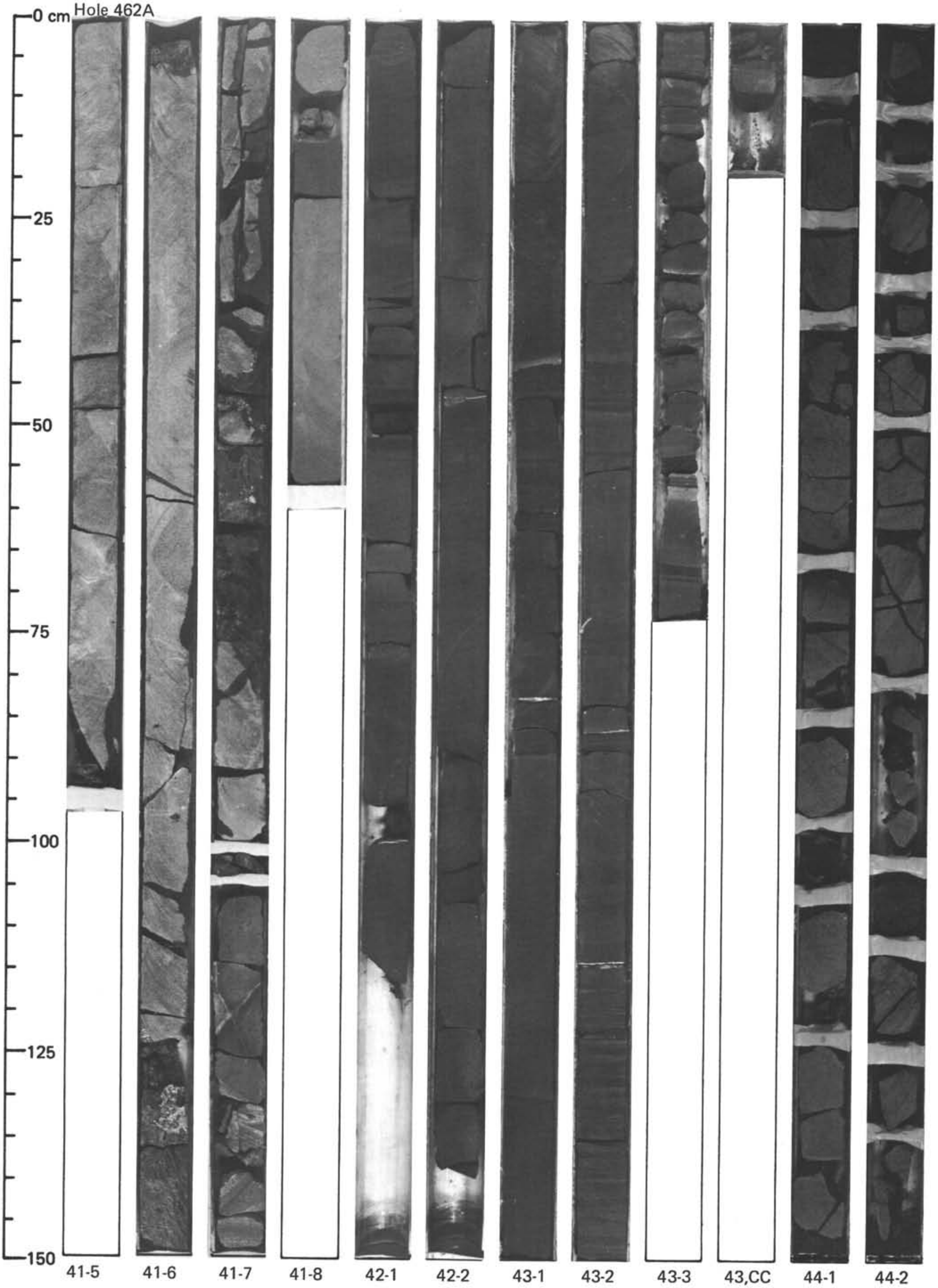
30-5
30-6
31-1
32-1
32-2
32,CC
33,CC
35,CC
36,CC
B2-1
38-1


Hole 462A
0 cm
25
50
75
100
125
150
38-2
39-1
39-2
39-3
39-4
39-5
40-1
40-2
41-1
41-2
41-3
41-4


Hole 462A
0 cm
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125
150
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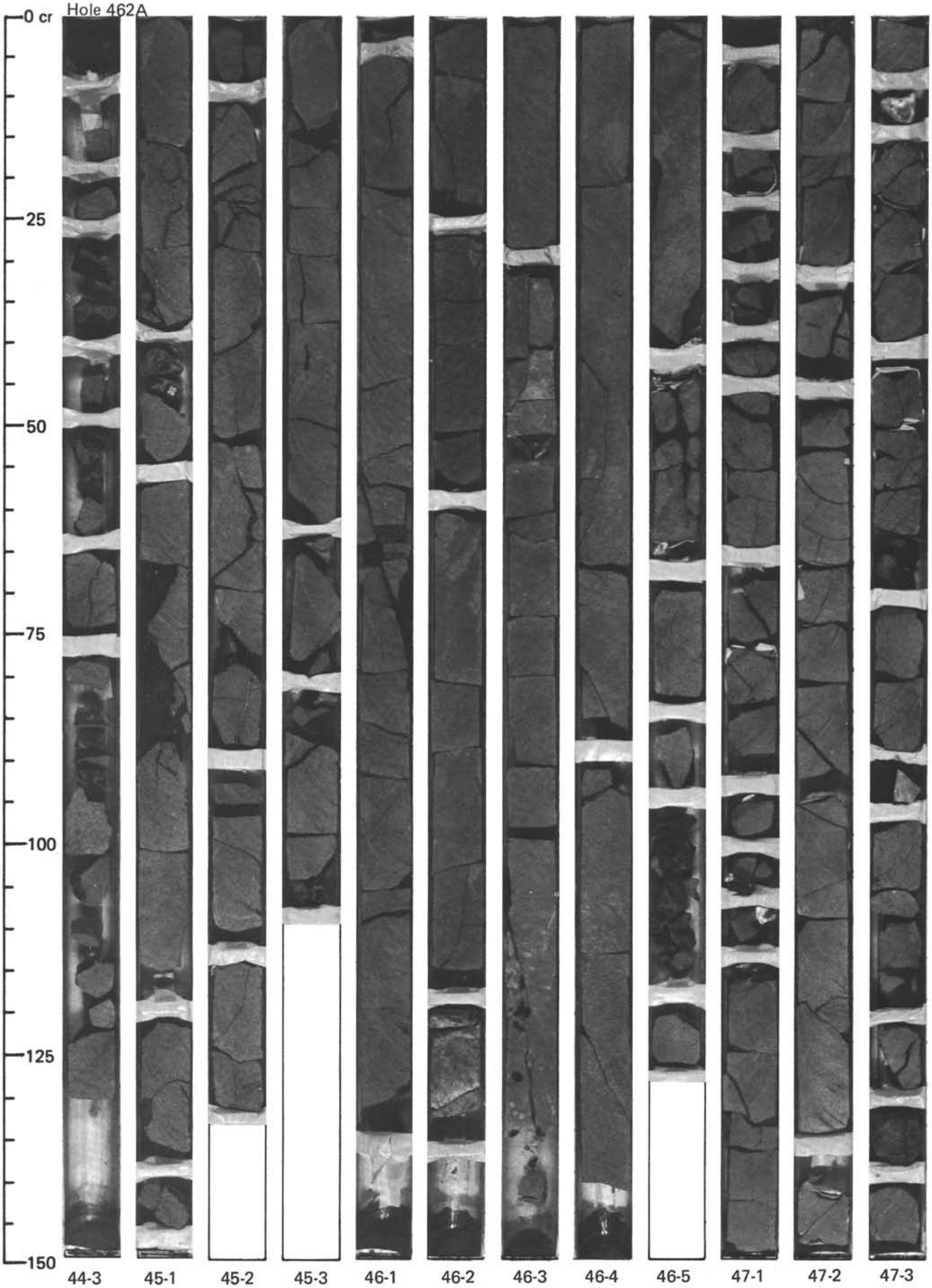
41-6
41-7
41-8
42-1
42-2
43-1
43-2
43-3
43,CC
44-1
44-2


0 cm
Hole 462A
25
50
75
100
125
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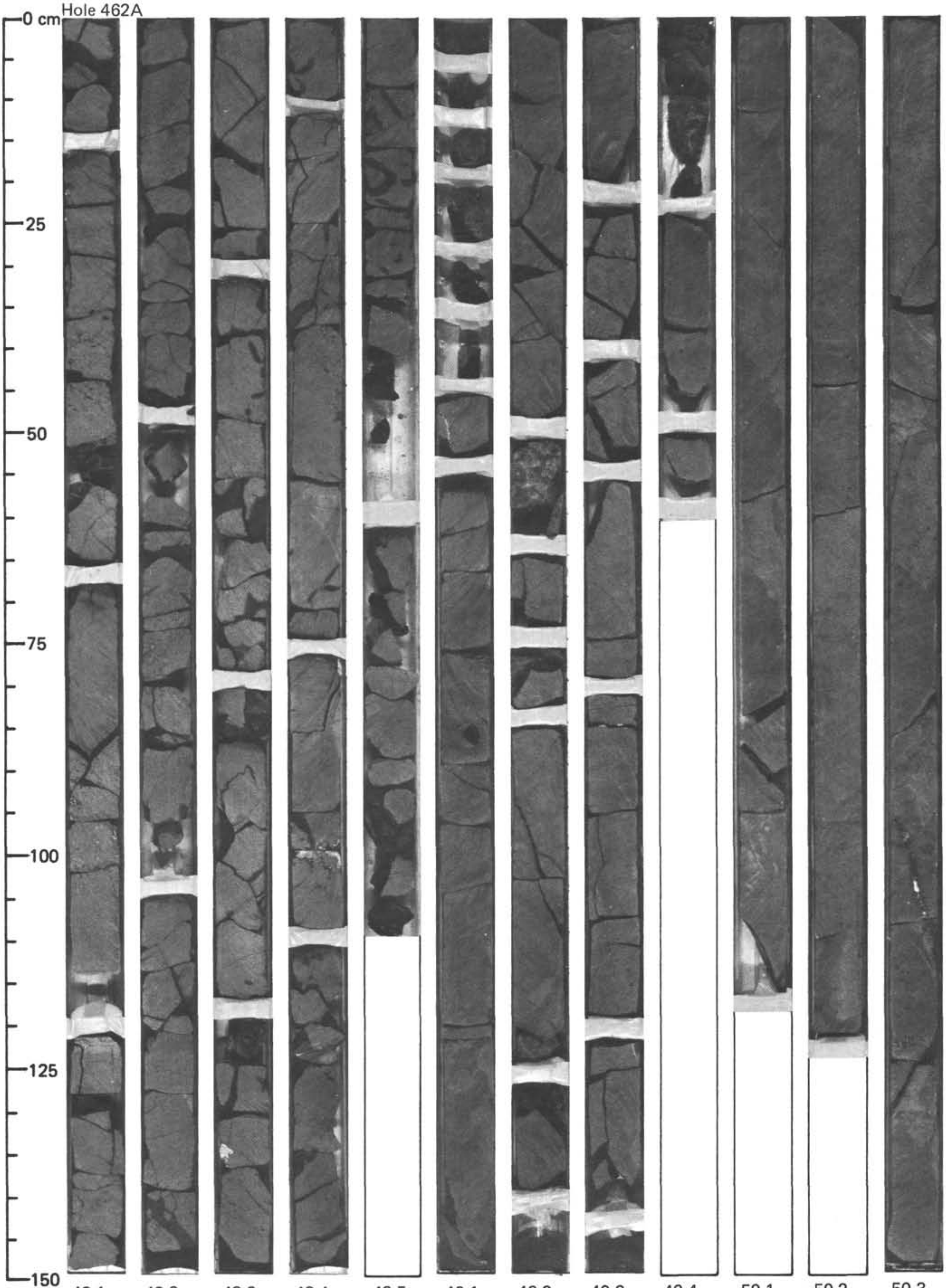
44-3
45-1
45-2
45-3
46-1
46-2
46-3
46-4
46-5
47-1
47-2
47-3


Hole 462A
0 cm
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50
75
100
125
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48-1
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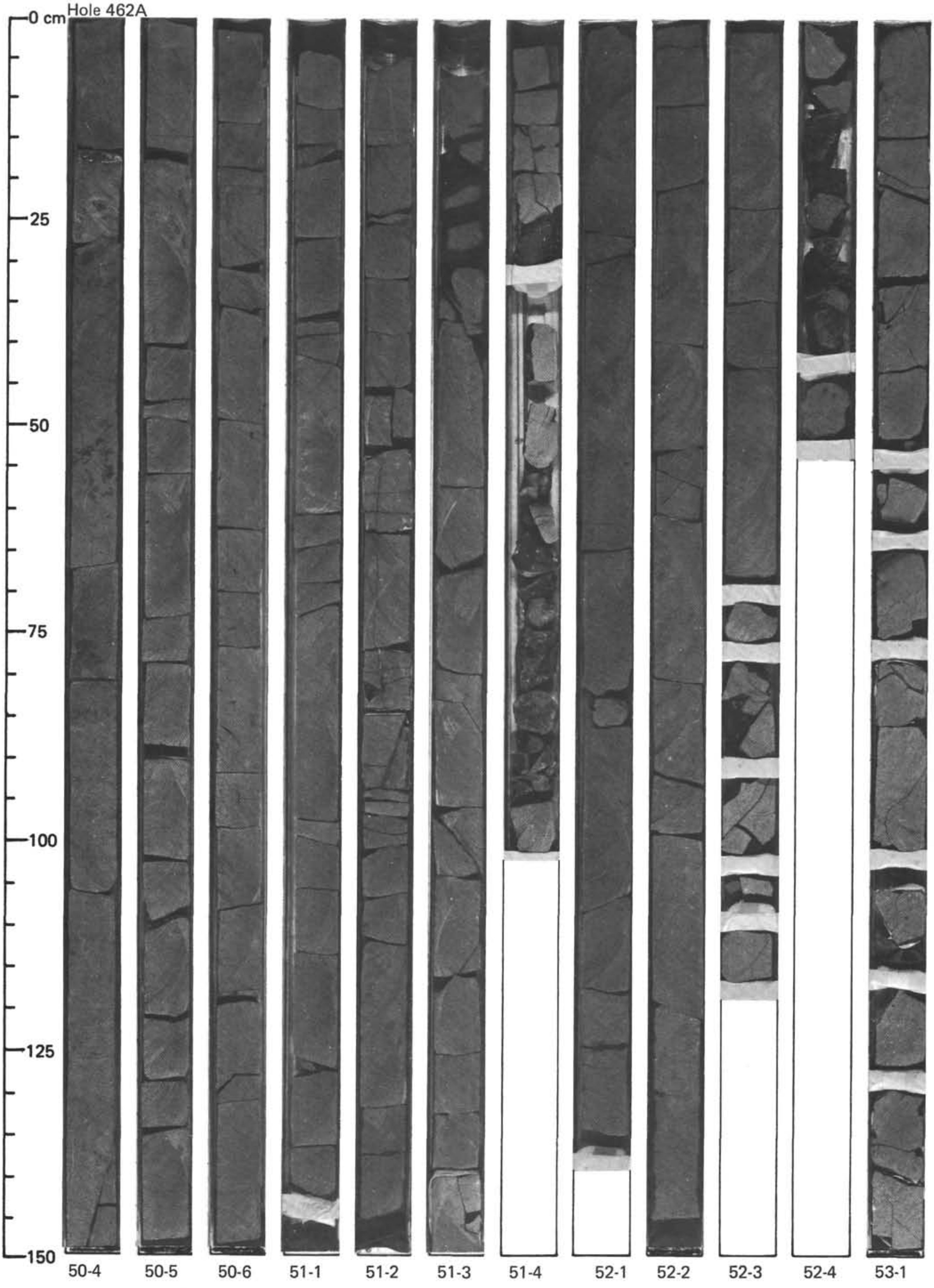
48-3
48-4
48-5
49-1
49-2
49-3
49-4
50-1
50-2
50-3


0 cm
Hole 462A
25
50
75
100
125
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50-6
51-1
51-2
51-3
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52-1
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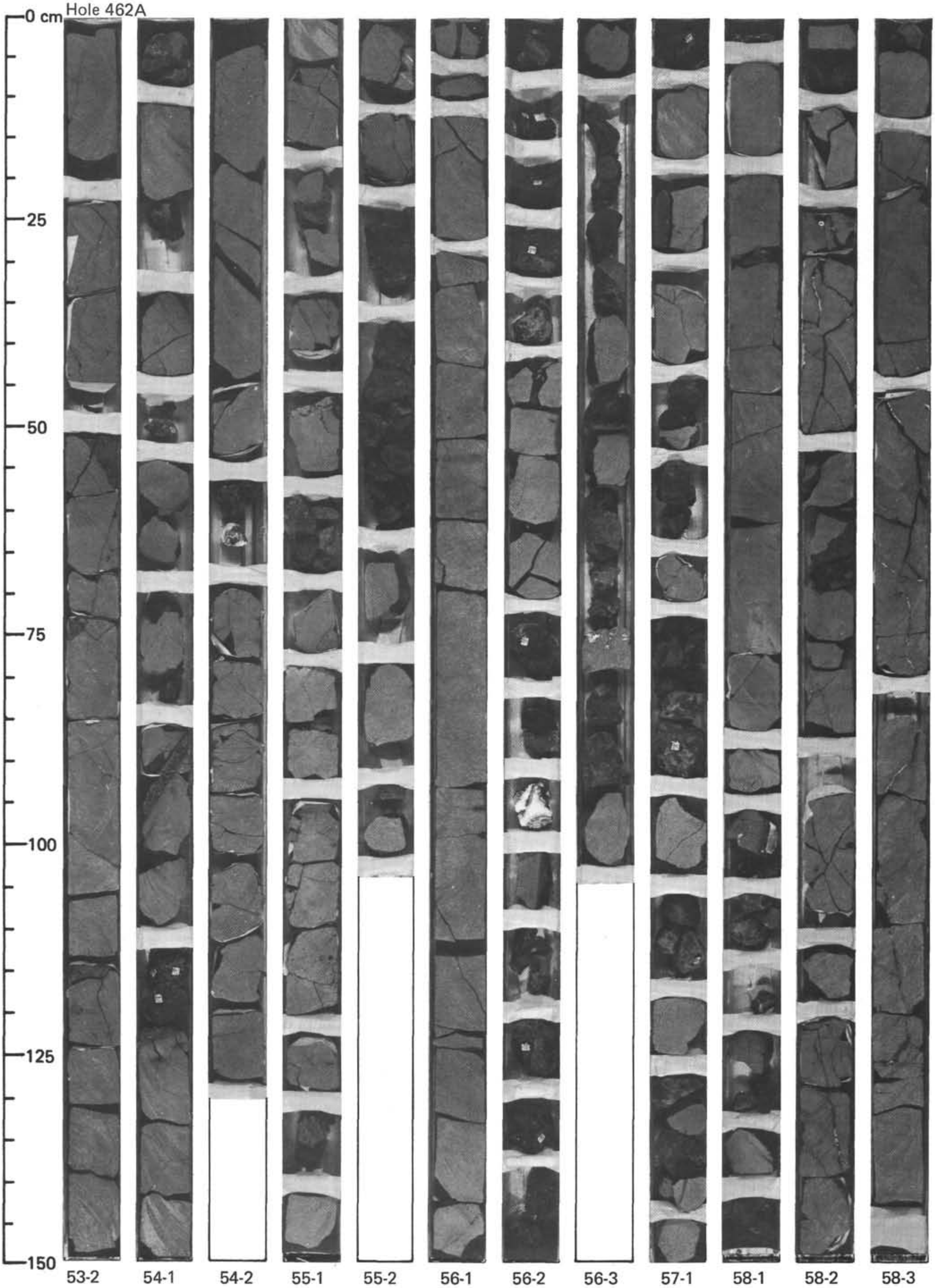
52-3
52-4
53-1


0 cm
Hole 462A
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125
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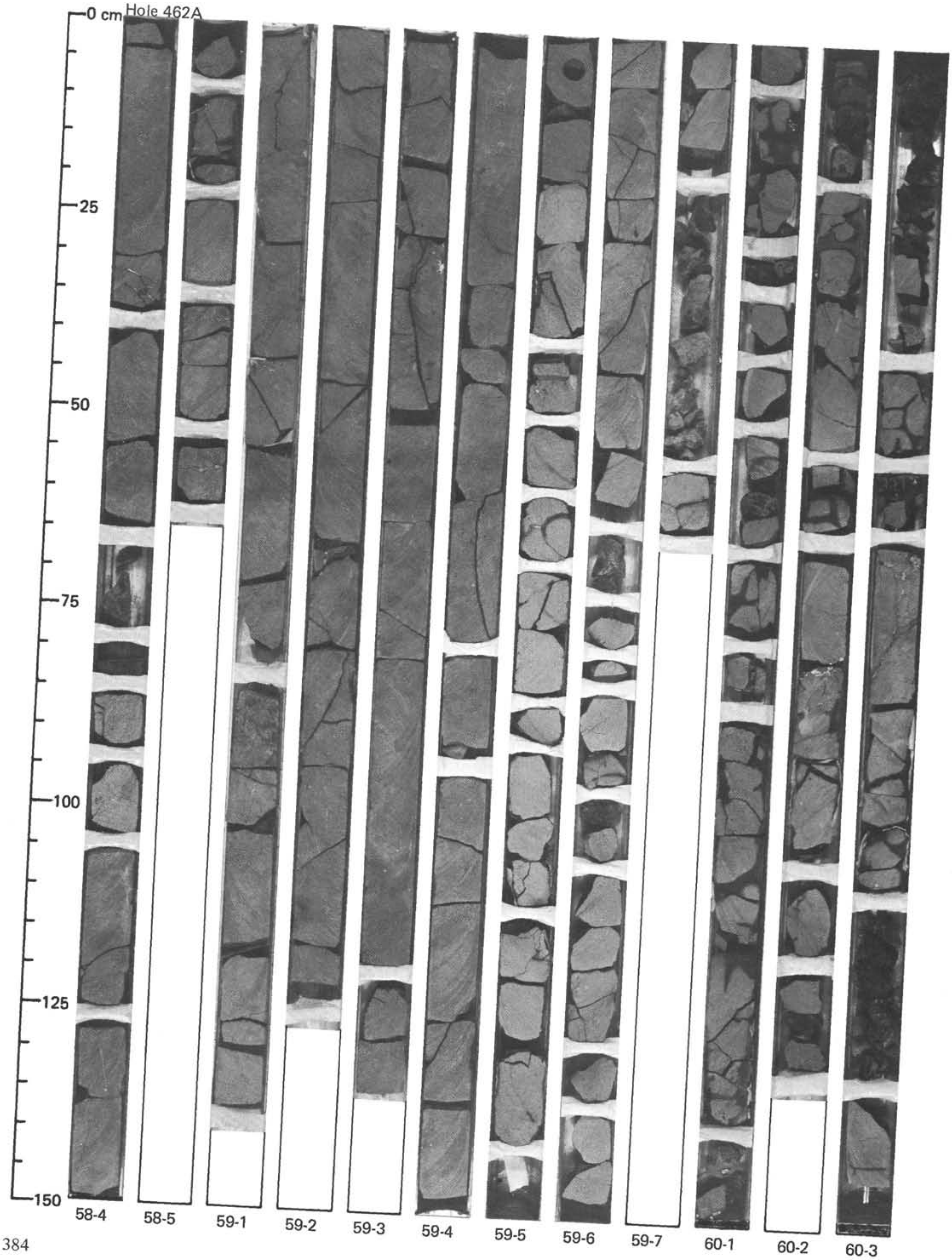
54-2
55-1
55-2
56-1
56-2
56-3
57-1
58-1
58-2
58-3


0 cm
Hole 462A
25
50
75
100
125
150
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58-5
59-1
59-2
59-3
59-4
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59-6
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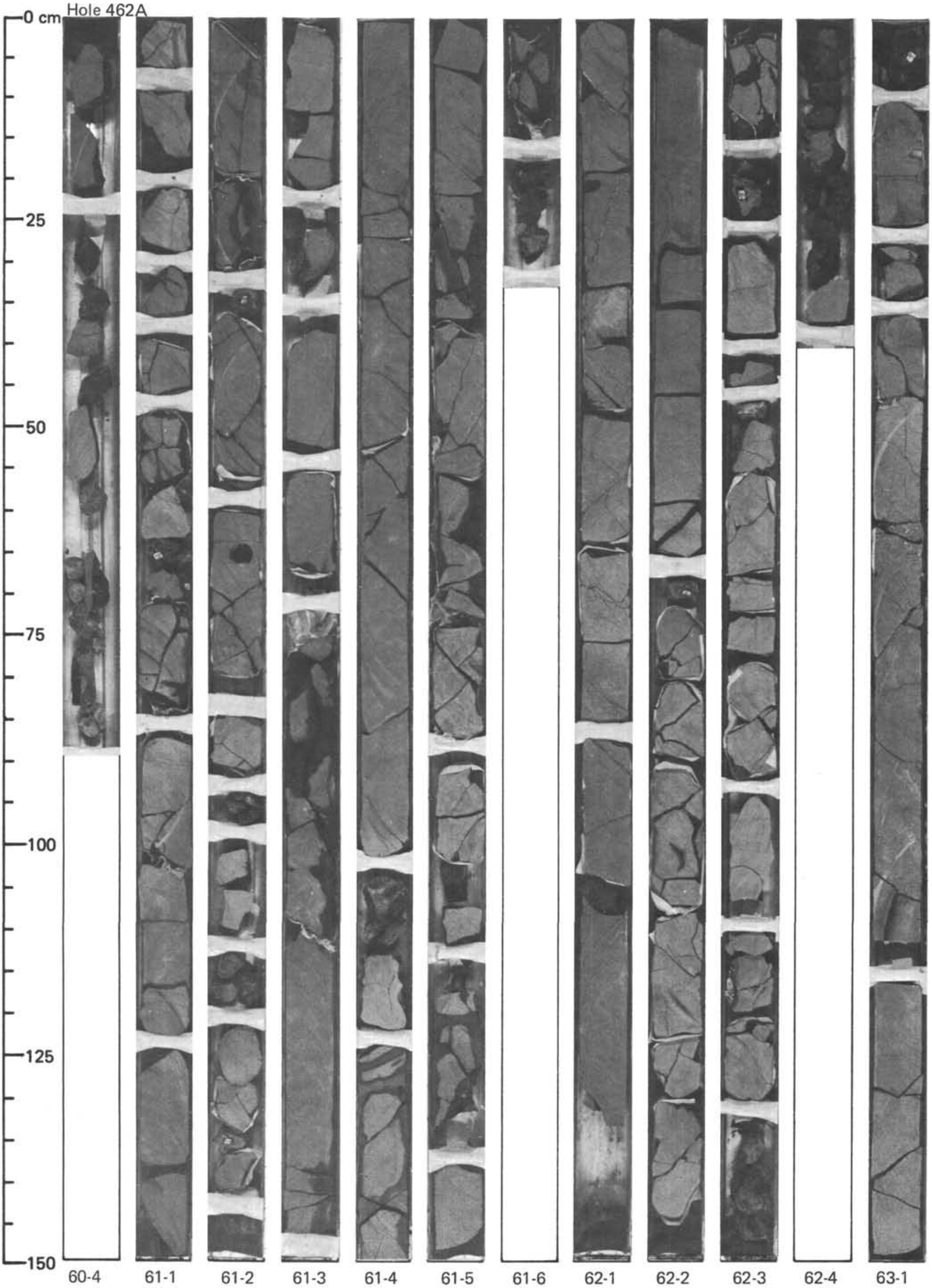
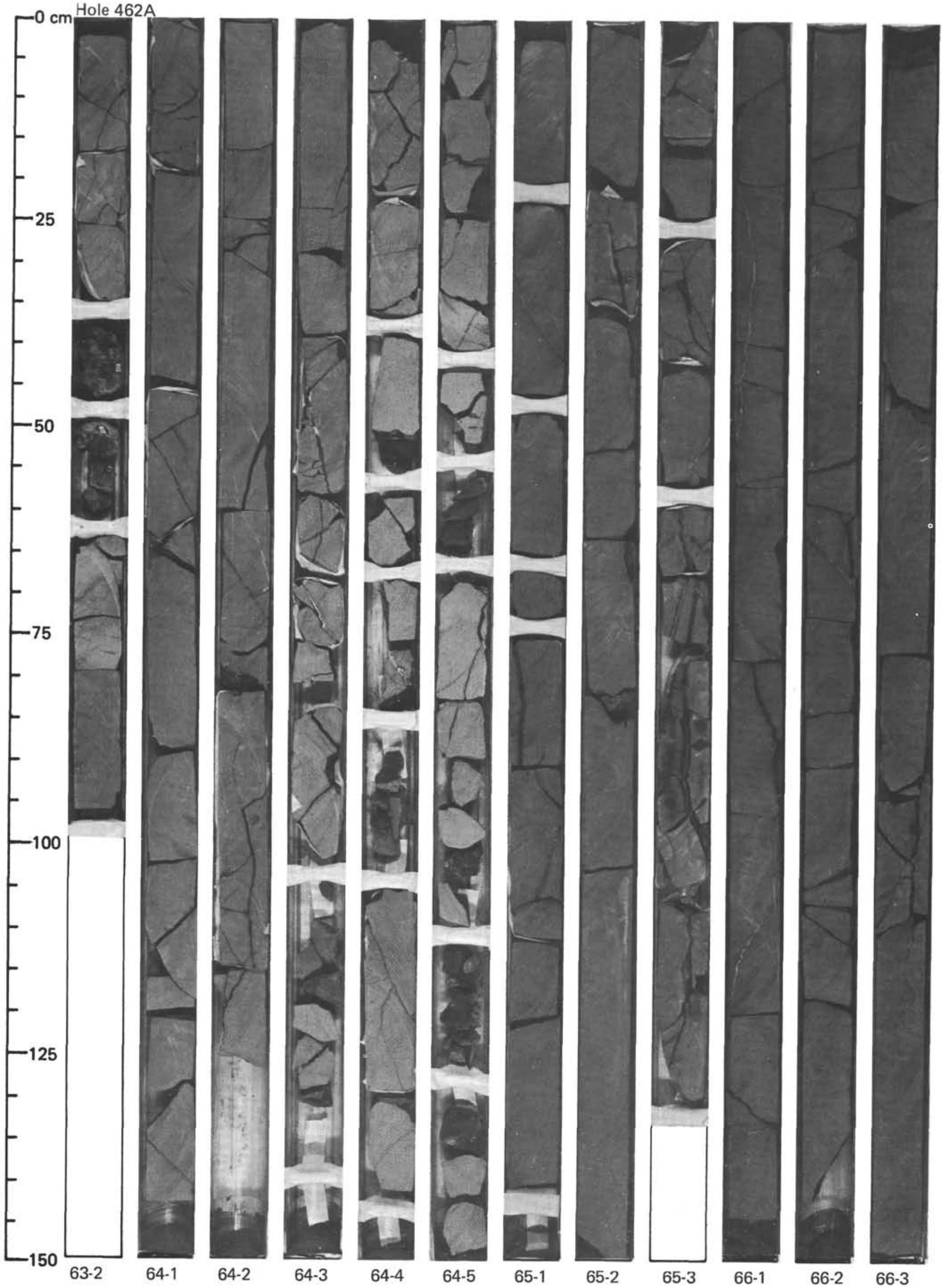
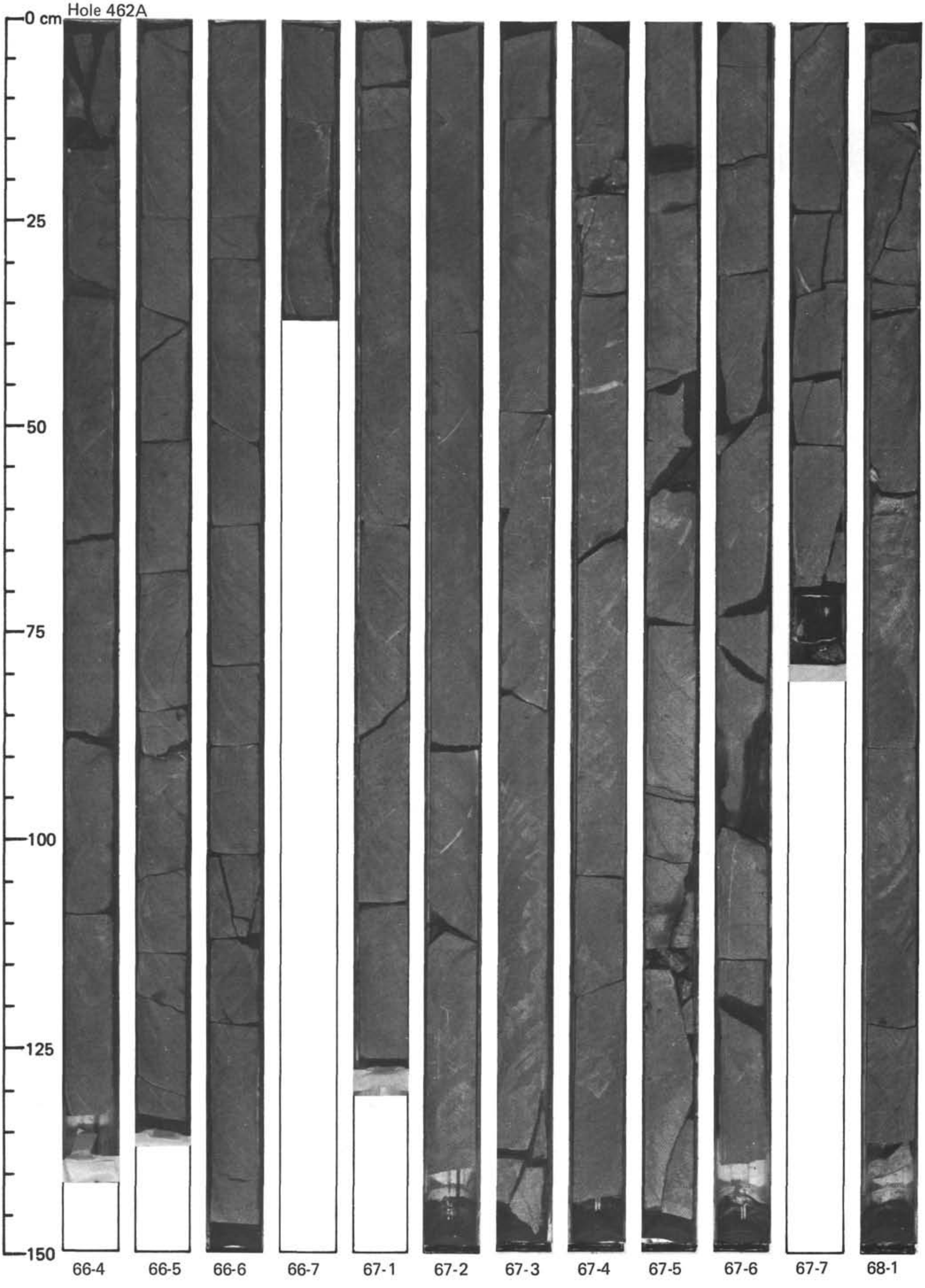
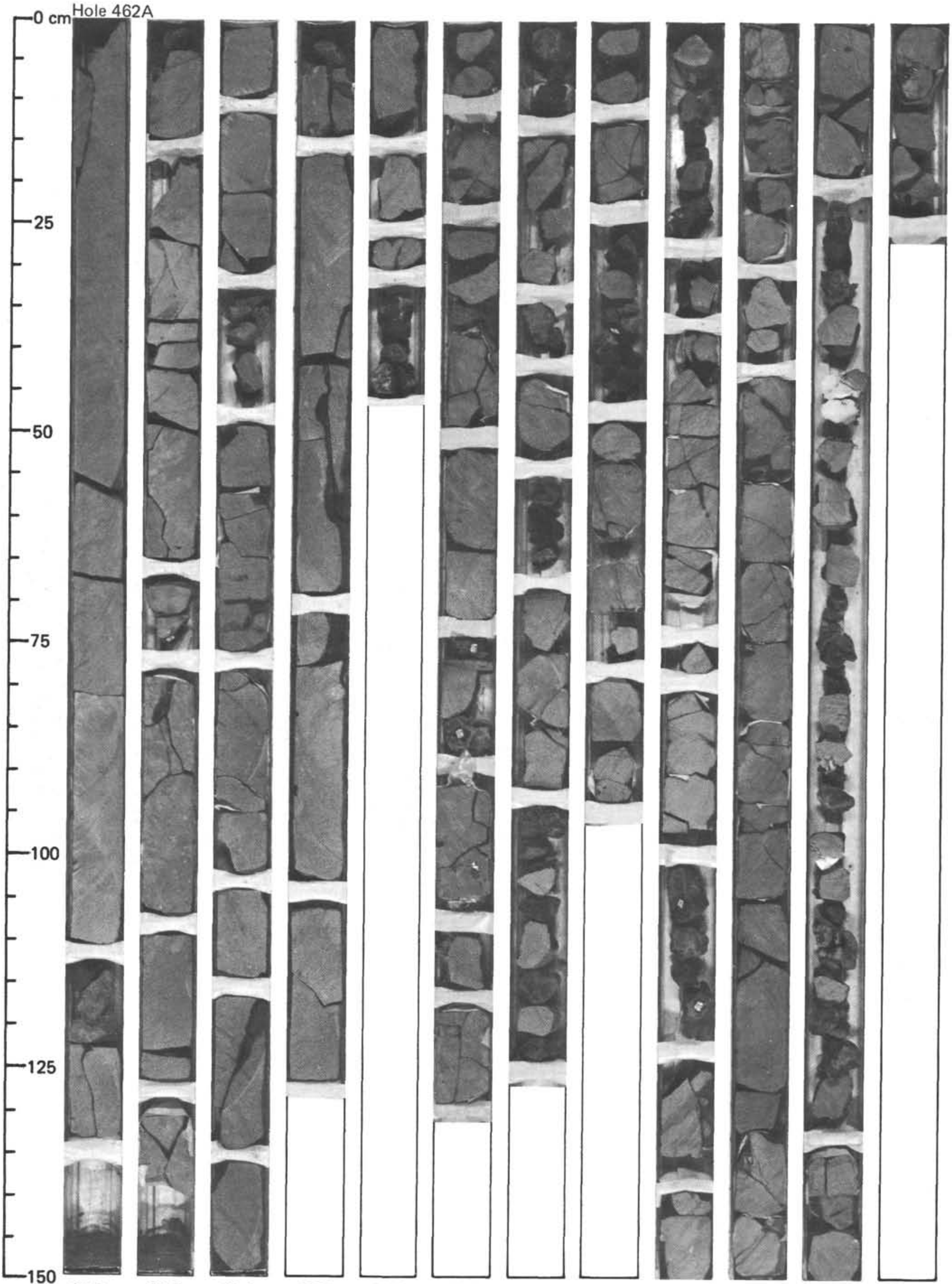
60-1
60-2
60-3

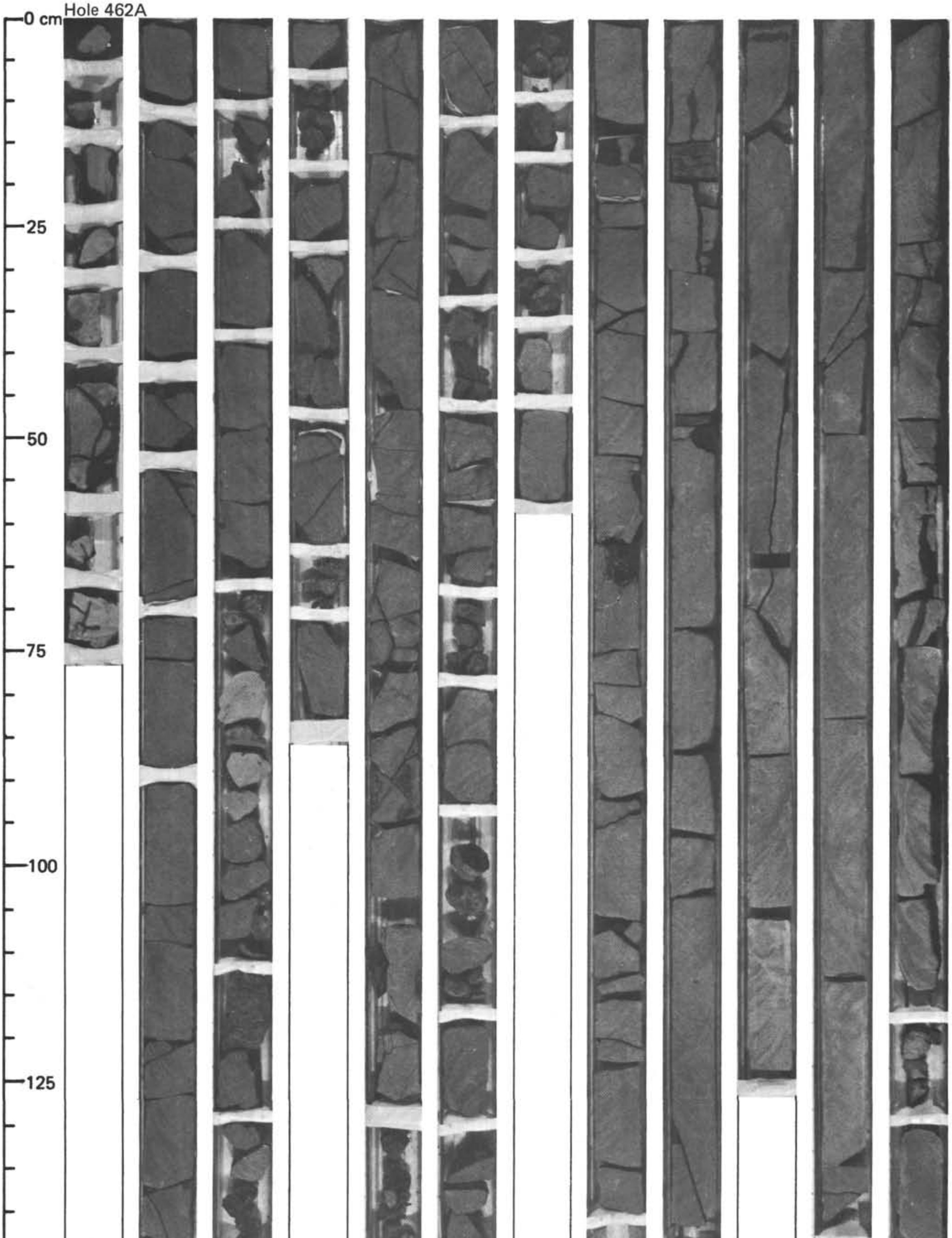

Hole 462A
0 cm
25
50
75
100
125
150
60-4
61-1
61-2
61-3
61-4
61-5
61-6
62-1
62-2
62-3
62-4
63-1

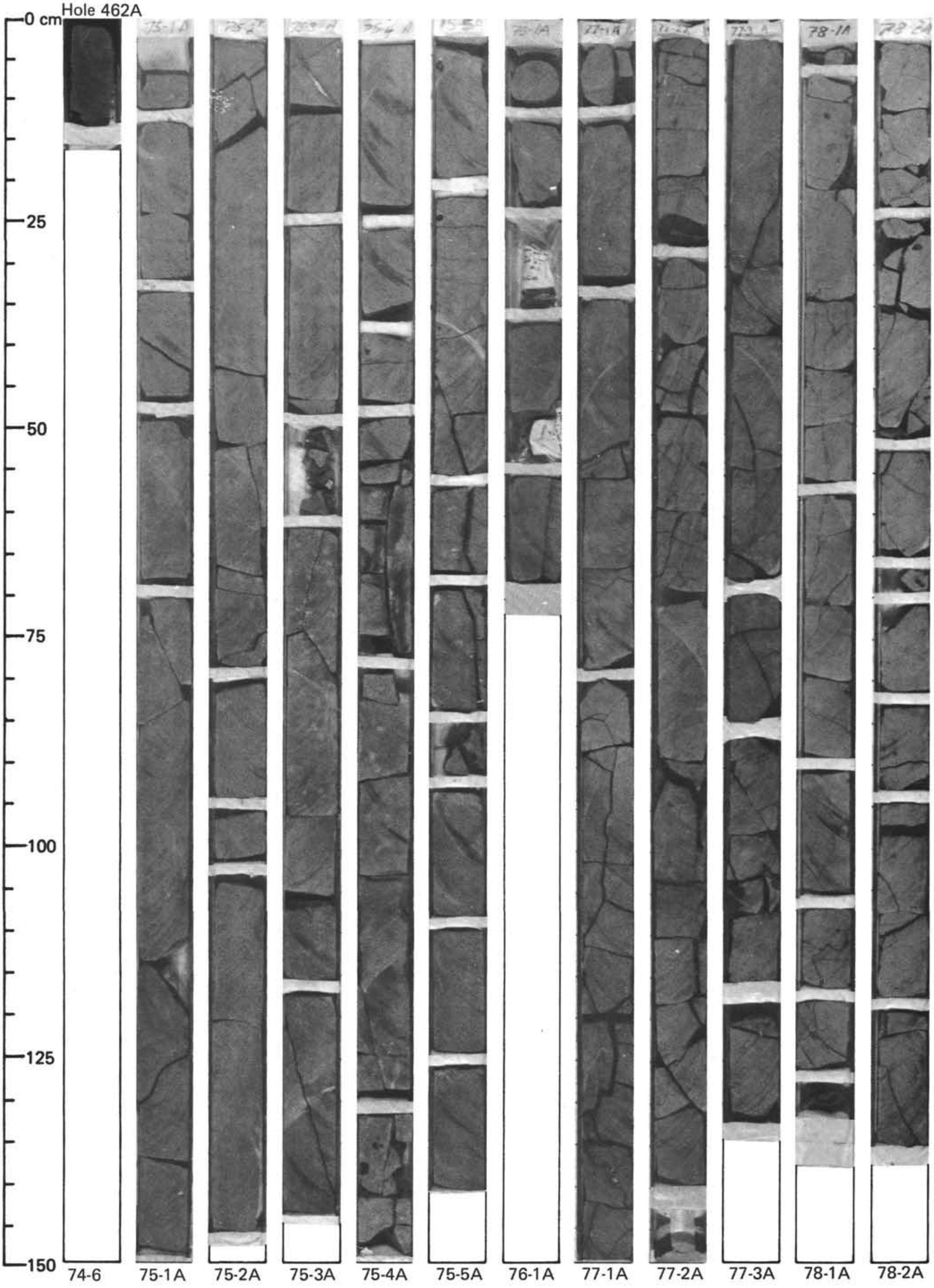

Hole 462A
0 cm
25
50
75
100
125
150
63-2
64-1
64-2
64-3
64-4
64-5
65-1
65-2
65-3
66-1
66-2
66-3

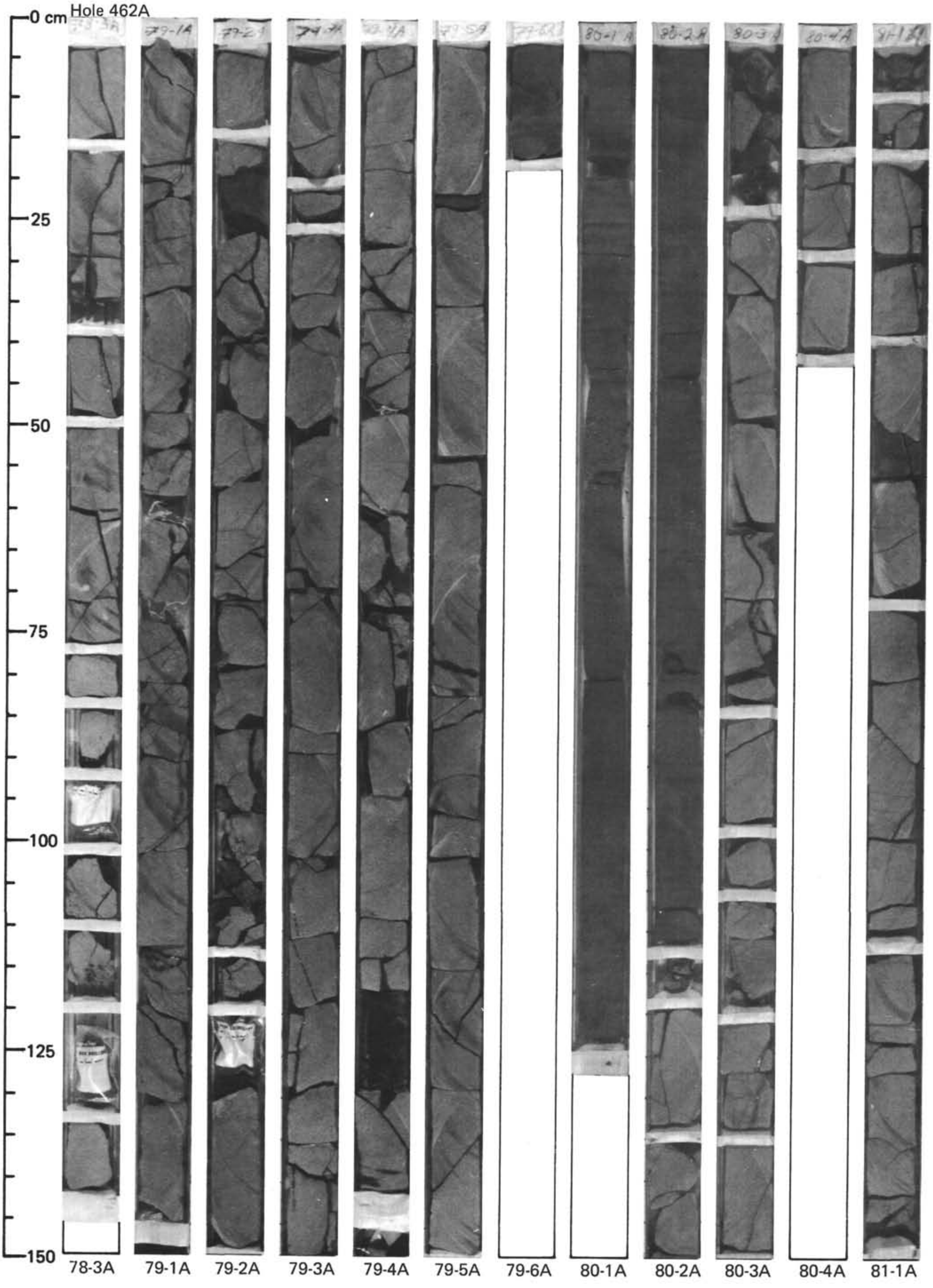


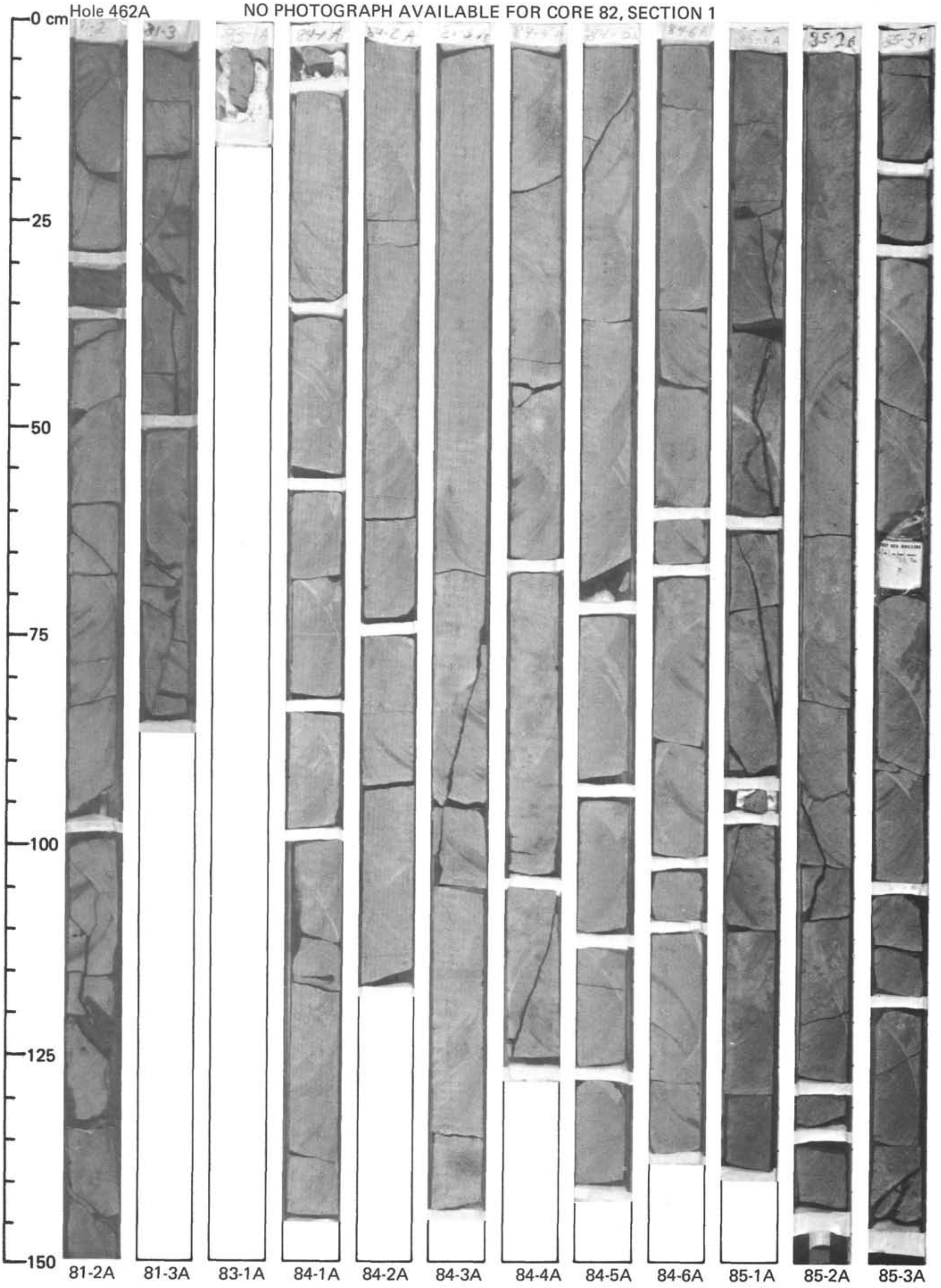
0 cm
Hole 462A
25
50
75
100
125
150
66-4
66-5
66-6
66-7
67-1
67-2
67-3
67-4
67-5
67-6
67-7
68-1

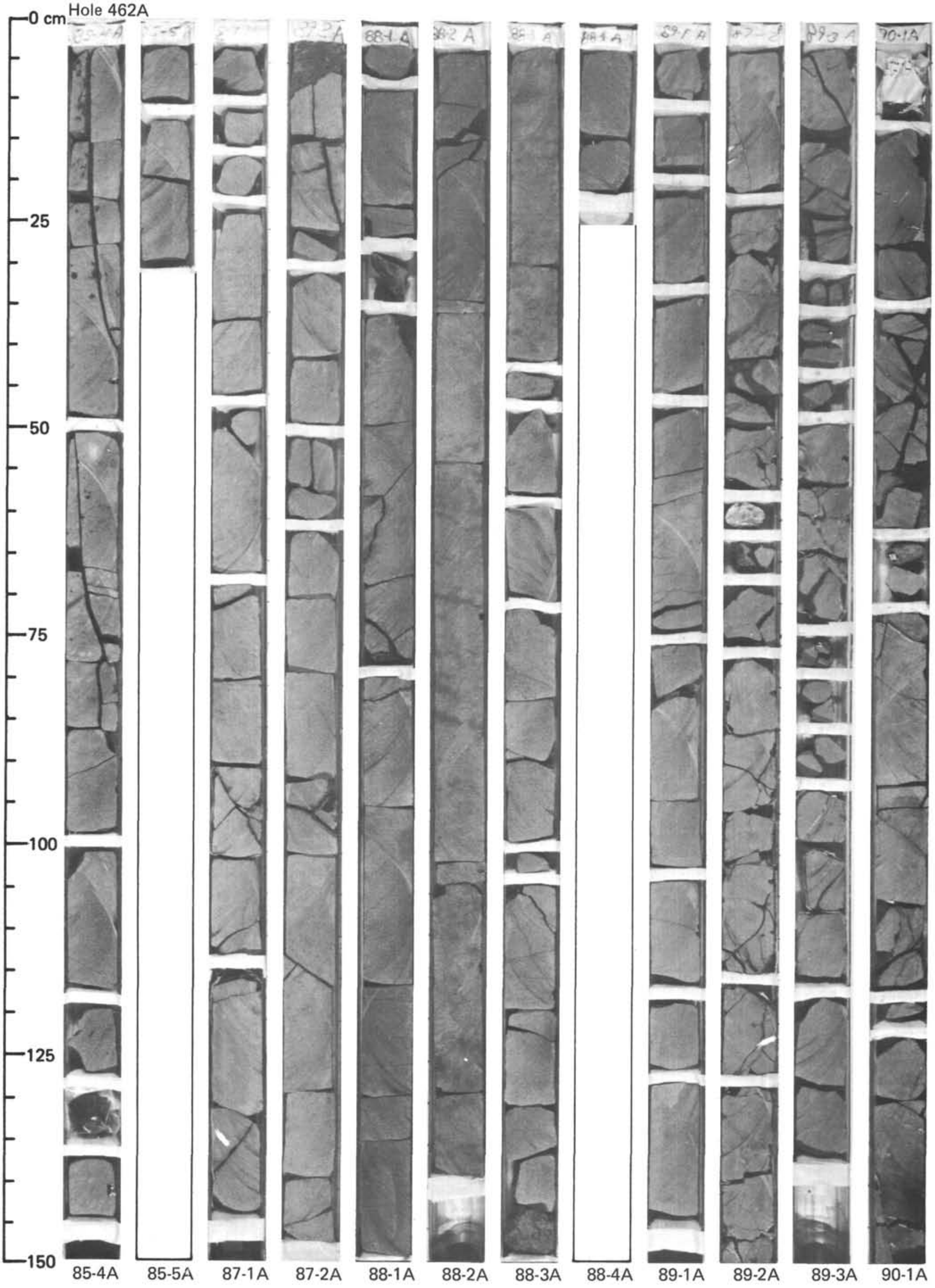

Hole 462A
0 cm
25
50
75
100
125
150
68-2
68-3
68-4
68-5
68-6
69-1
69-2
69-3
70-1
70-2
70-3
70-4

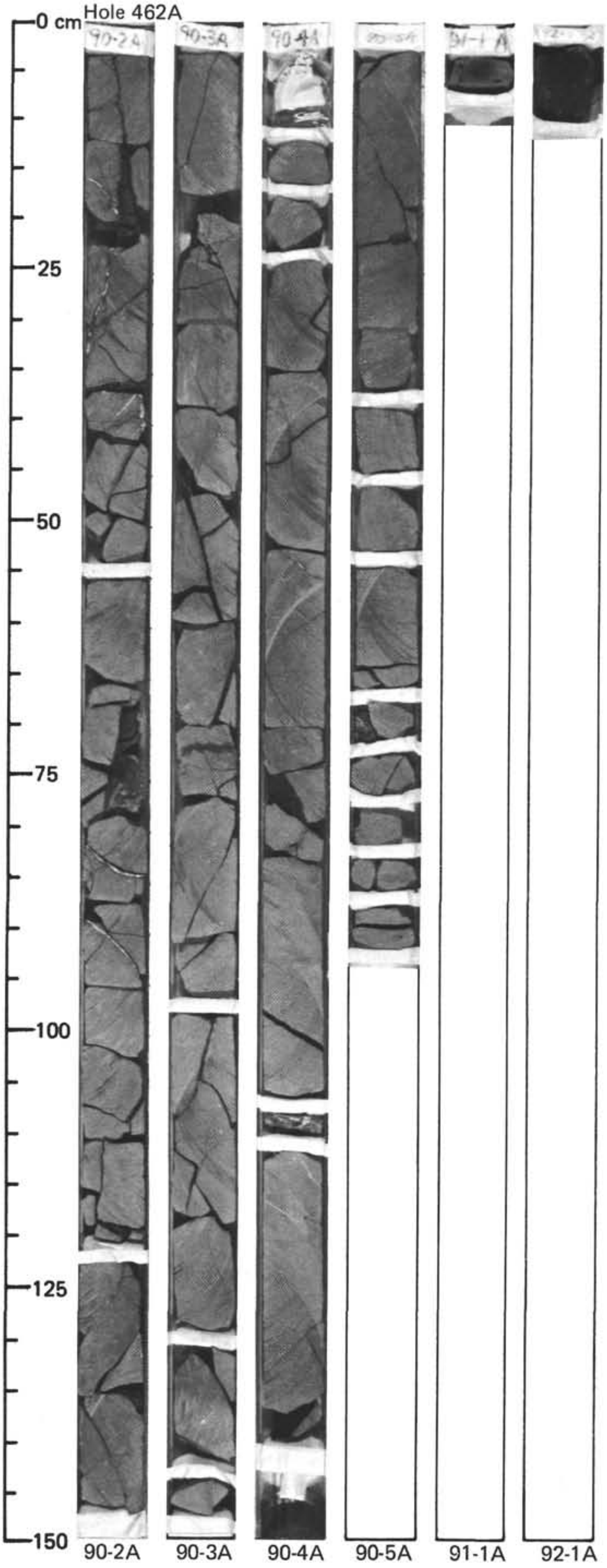

Hole 462A
0 cm
25
50
75
100
125
150
71-1
72-1
72-2
72-3
73-1
73-2
73-3
74-1
74-2
74-3
74-4
74-5


Hole 462A
0 cm
25
50
75
100
125
150
74-6
75-1A
75-2A
75-3A
75-4A
75-5A
76-1A
77-1A
77-2A
77-3A
78-1A
78-2A


Hole 462A
0 cm
25
50
75
100
125
150
78-3A
79-1A
79-2A
79-3A
79-4A
79-5A
79-6A
80-1A
80-2A
80-3A
80-4A
81-1A


Hole 462A
NO PHOTOGRAPH AVAILABLE FOR CORE 82, SECTION 1
0 cm
25
50
75
100
125
150
81-2A
81-3A
83-1A
84-1A
84-2A
84-3A
84-4A
84-5A
84-6A
85-1A
85-2A
85-3A


Hole 462A
0 cm
25
50
75
100
125
150
85-4A
85-5A
87-1A
87-2A
88-1A
88-2A
88-3A
88-4A
89-1A
89-2A
89-3A
90-1A


Hole 462A
0 cm
25
50
75
100
125
150
90-2A
90-3A
90-4A
90-5A
91-1A
92-1A