6. SITE 433: SUIKO SEAMOUNT

Shipboard Scientific Party[1]

SITE DATA, HOLE 433

Date Occupied: 16 August 1977 (1000Z) (16 August 1977 [2100L])

Date Departed: 16 August 1977 (1600Z) (17 August 1977 [0300L])

Time on Hole: 6 hours 0 minutes

Position: 44°46.60′N, 170°01.26′E

Water Depth (sea level): 1861.8 corrected meters, echo sounding

Water Depth (rig floor): 1871.8 corrected meters, echo sounding

Bottom Felt at: 1874.0 meters, drill pipe

Penetration: 45.0 meters

Number of Holes: 1

Number of Cores: 1

Total Length of Cored Section: 5.0 meters

Total Core Recovery: 5.0 meters

Percentage Core Recovery: 100.0

Oldest Sediment Cored:
Depth sub-bottom: 5.0 meters
Nature: Foraminifer-diatom ooze
Chronostratigraphy: Pliocene
Measured velocity: 1.52–1.60 km/s

Basement:
Not Reached

Principal Results: Hole 433 was drilled as a washdown test for a possible multiple re-entry hole at this site. A 5.0-meter core was carefully taken between 1874.0 and 1879.0 meters depth to establish the location of the mudline. A section of foraminiferal nannofossil and diatom nannofossil ooze 45.0 meters thick was then washed down in 18 minutes 30 seconds before resistance was felt at what later proved to be a chalk bed above a volcanic ash layer. Examination of the 5.0-meter core showed that the pelagic oozes are Pleistocene to upper Pliocene. Hole 433 showed that Site 433 was suitable for setting a re-entry cone.

SITE DATA, HOLE 433A

Date Occupied: 16 August 1977 (1600Z) (17 August 1977 [0300L])

Date Departed: 17 August 1977 (1915Z) (18 August 1977 [0615L])

Time on Hole: 27 hours 15 minutes

Position: 44°46.60′N, 170°01.26′E

Water Depth (sea level): 1861.8 corrected meters, echo sounding

Water Depth (rig floor): 1871.8 corrected meters, echo sounding

Bottom Felt at: 1874.0 meters, drill pipe

Penetration: 174.0 meters

Number of Holes: 1

Number of Cores: 21

Total Length of Cored Section: 174.0 meters

Total Core Recovery: 88.59 meters

Percentage Core Recovery: 50.9

Oldest Sediment Cored:
Depth sub-bottom: 163.5 meters
Nature: Reef limestone
Chronostratigraphy: Paleocene
Measured velocity: 4.72–4.74 km/s (limestone)

Basement:
Depth sub-bottom: 163.5 meters
Nature: Basalt
Velocity range: 4.8–5.8 km/s

Principal Results: Hole 433A was drilled as a pilot hole for the re-entry hole. It was continuously cored to a sub-bottom depth of 174.0 meters before a wad of nylon fishing net and polyethylene filament line fouled the stern thrusters and forced us to abandon the hole. We recovered sedimentary rocks ranging from Pleistocene-Pliocene ooze at the surface to consolidated Paleocene limestone at 163.5 meters. Basalt lay directly beneath an erosional contact with limestone, and we cored 10.5 meters of basalt from a single flow type before abandoning the hole.

The sedimentary section was divided into six units. The upper three units, from 0 to 52.5 meters sub-bottom, range from Pliocene pelagic oozes downward to lower Miocene calcareous chalk. Fossils in this section are pelagic, and indicate a similar ecological environment throughout the period of their deposition. Unit 4, from 52.0 to 52.5 meters, consists of altered tuffaceous sandy mud, and contains lower Miocene pelagic fossils. Units 5 and 6 consist of reef carbonate sand, sandy mud with algal nodules, and reef

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calcarenite. The fossils of these units date from the middle Paleocene, and indicate a significant hiatus from Eocene through a major part of the Oligocene. The sediments deposited during this period contain biota of warm shallow-water habitat: benthic foraminifers, coralline algae, bryozoans, and ostracodes. These reef materials lie directly on the eroded surface of an alkalic basalt.

Suiko Seamount was therefore an island with fringing reefs by middle Paleocene time. Hole 433A penetrated shore and lagoonal zones of a back-reef region of a reef complex. The basalt flow at the base of the section was chemically analyzed and studied in thin section on board ship; it is an alkalic basalt of the Hawaiian type.

SITE DATA, HOLE 433B

Date Occupied: 18 August 1977 (0300Z) (18 August 1977 [1400L])

Date Departed: 18 August 1977 (1732Z) (19 August 1977 [0432L])

Time on Hole: 15 hours 32 minutes

Position: 44°46.63′N, 170°01.23′E

Water Depth (sea level): 1861.8 corrected meters, echo sounding

Water Depth (rig floor): 1871.8 corrected meters, echo sounding

Bottom Felt at: 1874.0 meters, drill pipe

Penetration: 186.5 meters

Number of Holes: 1

Number of Cores: 7

Total Length of Cored Section: 58.0 meters

Total Core Recovery: 10.72 meters

Percentage Core Recovery: 18.5

Oldest Sediment Cored:
Depth sub-bottom: 157.0 meters
Nature: Reef sand and reef limestone
Chronostratigraphy: Middle Paleocene
Measured velocity: 1.8–1.9 km/s (sand); 4.7 km/s (limestone)

Basement:
Depth sub-bottom: 163.5 meters
Nature: Basalt
Velocity range: 4.3–5.4 km/s

Principal Results: Hole 433B was a single-bit hole in which we planned to finish the bit-wear tests of a pilot hole for re-entry, inasmuch as Hole 433A had been terminated before completion. We washed the hole down to 157.0 meters sub-bottom to recore the lower portion of reef deposits occurring above basalt in Hole 433A. Reef carbonate sand containing benthic foraminifers, algal nodules, bryozoans, echinoid spines, and ostracodes, and as much as 15 per cent volcanic debris was recovered in the first three cores. The contact between reef calcarenites and basalt was recovered in Core 4. The drill penetrated at least 7.5 meters into the same alkalic basalt flow encountered in Hole 433A, and a total of 23.5 meters beneath the upper surface of the basalt, without further recovery. We then abandoned the hole because of a jammed bit.

Recoring of the lower reef section above basalt allowed close paleontological dating of the oldest sediments above basalt. Nannofossils show that the lowermost sediments are lower to middle Paleocene. The paleontologic data indicate that the oldest sediments on Suiko Seamount are younger than those found on Meiji Seamount (Site 309; Creager, Scholl, et al., 1973) and probably older than those from Ōjin Seamount (Site 430; Takayama et al., this volume).

SITE DATA, HOLE 433C

Date Occupied: 18 August 1977 (1732 Z) (19 August 1977 [0432 L])

Date Departed: 29 August 1977 (1152 Z) (29 August 1977 [2252 L])

Time on Hole: 258 hours 20 minutes

Position: 44°46.63′N, 170°01.23′E

Water Depth (sea level): 1861.8 corrected meters, echo sounding

Water Depth (rig floor): 1871.8 corrected meters, echo sounding

Bottom Felt at: 1874.0 meters, drill pipe

Penetration: 550.5 meters

Number of Holes: 1

Number of Cores: 50

Total Length of Cored Section: 387.5 meters

Total Core Recovery: 250.15 meters

Percentage Core Recovery: 64.6

Oldest Sediment Cored:
Depth sub-bottom: Washed to basement
Nature: Sand interbedded in basaltic basement
Chronostratigraphy: Paleocene

Basement:
Depth sub-bottom: 163.0 meters
Nature: Basalt
Velocity range: 2.43–6.26 km/s

Principal Results: Hole 433C was spudded in as a multiple re-entry hole. The cone was set and the sediments were washed down to the contact between the reef calcarenite and the basalt. The original bit jammed after we had cored part of Flow Unit 1, and in using the chisel bit to free it, we unexpectedly recovered 4.0 meters of beach sand lying between Flow Units 1 and 2. The sand is coarse and well sorted, and consists of about 70 per cent reef debris (foraminifers, coralline algae, bryozoans, coccoliths, etc.) and about 30 per cent volcanogenic debris. Beneath the sand we cored two more flow units of basalt and penetrated 39.5 meters beneath the upper surface of Flow Unit 1. The bit jammed, and was pulled. The second bit penetrated 59 meters of basalt, including Flow Units 4 through 13, before the bit jammed again, and was pulled. The third bit penetrated 179 meters of basalt, and we recovered parts of Flow Units 13 through 45b, before replacing it because of excessive hours of use. The fourth bit penetrated 95 meters of basalt; in this interval, we recovered parts of Flow Units 45b through 67. Then the bit jammed again, and not enough time remained for another re-entry. In all, we penetrated 387.5 meters of basalt; overall recovery was 50.9 per cent.

Visual descriptions, petrographic descriptions, and preliminary XRF analyses of the basalts showed that we had penetrated (proceeding downward) three flows of alkalic basalt and a thick sequence of tholeiitic flows. Many of the flow units are separated by highly vesicular, strongly oxidized, commonly brecciated tops, and less oxidized, commonly glassy bottoms, and were certainly erupted subaerially. Shipboard and shore-based chemical analyses of the fresher parts of the flow units show that both alkalic and tholeiitic basalts are in the compositional range of those known from the southeastern part of the Hawaiian Islands, and are distinctly different from mid-ocean ridge basalts. Their only chemical peculiarity appears to be strong depletion of barium, where the analyses include that element, and equally strong depletion of strontium. It appears that these elements may be slightly depleted at Nintoku as well.

More than 300 samples were measured on board to determine the magnetic inclinations of flow units, and the principal shipboard conclusions have been confirmed by shore-based studies (Kono, this volume). About ten cycles of inclination swings were observed. It seems likely, therefore, that a sufficient number of secular variation cycles have been observed that average inclinations are meaningful. The median inclination in the Suiko basalts from the shipboard measurements is 42°, which corresponds to a median latitude of formation of 25°. It seems very probable, therefore, that the volcanic rocks of Suiko Seamount crystallized at a latitude about 20° south of their present position; and the measurements confirm the overall latitudinal transport required by the hot-spot hypothesis.

Subsequent K-Ar dating of the Suiko basalts (Dalrymple et al., this volume) shows that Suiko volcano is older than Ōjin (Site 430) and Nintoku (Site 432) seamounts to the south. The K-Ar ages are consistent with the age of the oldest sediments above the basalt.

BACKGROUND AND OBJECTIVES

Site 55-2, as originally proposed for Leg 55, represented our northernmost drill site in the Emperor Seamount chain, and was designated not only to provide a point of lithologic information between our proposed Site 55-1 and Site 192 on Meiji Seamouont (Creager, Scholl, et al., 1973), but also as a prime re-entry site for determining the paleolatitude of part of the basaltic edifice of Suiko Seamount.

Our proposed re-entry site on Suiko Seamount was at 45°00′N, 169°45′E, located on a crossing by the R/V *S. P. Lee* in October 1976. The 80-kJ sparker profile taken on the *Lee* showed a sediment pond about 200 meters thick, underlain by a clearly defined acoustic basement, at Site 55-2 on Suiko Seamount (see Figure 1). The site therefore seemed appropriate for a multiple re-entry hole aimed principally at recovery of basalt. The 3.5-kHz profile taken by the *Lee,* however, showed no penetration at the site proper, although a transparent layer 5 to 60 meters thick (at water velocities) first appeared on the *Lee* profile about 10 nautical miles southeast of proposed Site 55-2, and extended several miles along the traverse (Figure 2). In Honolulu, we learned that the R/V *Kana Keoki,* from the University of Hawaii, had just completed a cruise in the northern Emperor chain, and that one of their profile lines (Figure 1) crossed Suiko Seamount quite near our proposed re-entry site. Dr. Loren Kroenke of the Hawaii Institute of Geophysics kindly supplied us a copy of this profile, and made the 3.5-kHz records along this line available for our inspection on extremely short notice. We had no time to copy the 3.5-kHz records before our departure on Leg 55, but we noted that transparent surface material occurred on the *Kana Keoki* profile near its crossing with the *Lee* profile.

After drilling at Sites 430, 431, and 432 — all of which showed little 3.5-kHz penetration, and proved to have sandy or muddy Quaternary materials at the surface of the sea floor, immediately underlain by Eocene sediments — we decided to re-evaluate the location of our prime re-entry site on Suiko Seamount. We resolved to reoccupy the *Lee* profile line, in an attempt to measure sediment thickness above acoustic basement in areas known to show penetration at 3.5 kHz; and we decided to consider Sites 55-2A′, 55-2A, and 55-2B (Figure 1), as well as our original Site 55-2, and to locate our prime site in the area where we encountered the thickest, softest surface materials.

OPERATIONS

Pre-Drilling Site Survey

The R/V *S. P. Lee* crossed Suiko Seamount on 6 October 1976, on a course of 135° true (Figure 1), and obtained an 80-kJ sparker seismic reflection profile (Figure 2). This profile showed the seamount to be a flat-topped guyot, consisting, apparently, of a broad, very slightly domed central platform surrounded by a lower, gently concave upward, topographic and structural depression and an outer, rounded, topographic and acoustic basement ridge. Subsurface structures in the seismic profile suggest that the central platform is composed of reef material laid down on eroded volcanic rock. Fringing reefs may have formed the outer scarps of the central platform. These relatively steep scarps make up an inner buttress that bounds the surrounding depression. This depression is filled with flat-lying well-layered lagoonal(?) sediments that lap onto the outer acoustic basement ridge and appear to be truncated at the base of the inner scarp. The outer edge of the top of the seamount is rounded and appears to consist locally of prograded and ponded sediments.

We proposed two drilling sites (55-2 and 55-2A) for Suiko Seamount; we selected the locations because 100 meters or more of sediments overlay an acoustic basement probably made up of volcanic rock. The prime site (55-2) is at the northwest edge of the seamount (Figure 1), where over 1.5 s of sediment appear to be ponded above the acoustic basement (Figure 2). No transparent layer was shown in the *Lee* 3.5-kHz profile crossing the site. The second site (55-2A) is at the center of the lagoon along the northwest part of the seamount, where the *Lee* 3.5-kHz profile showed an overlying transparent layer of 30 to 60 meters of pelagic ooze. In the subsurface, over 0.5 s of well-layered strata appear to occur, but since no acoustic basement could be defined here, Site 55-2 appeared more promising for emplacement of a re-entry cone and successful drilling of a multiple re-entry hole.

On 30 June 1977, the R/V *Kana Keoki* of the Hawaiian Institute of Geophysics passed over Suiko Seamount on a course of 240° true, and crossed the *Lee* line at a nearly perpendicular angle. About 4 nautical miles

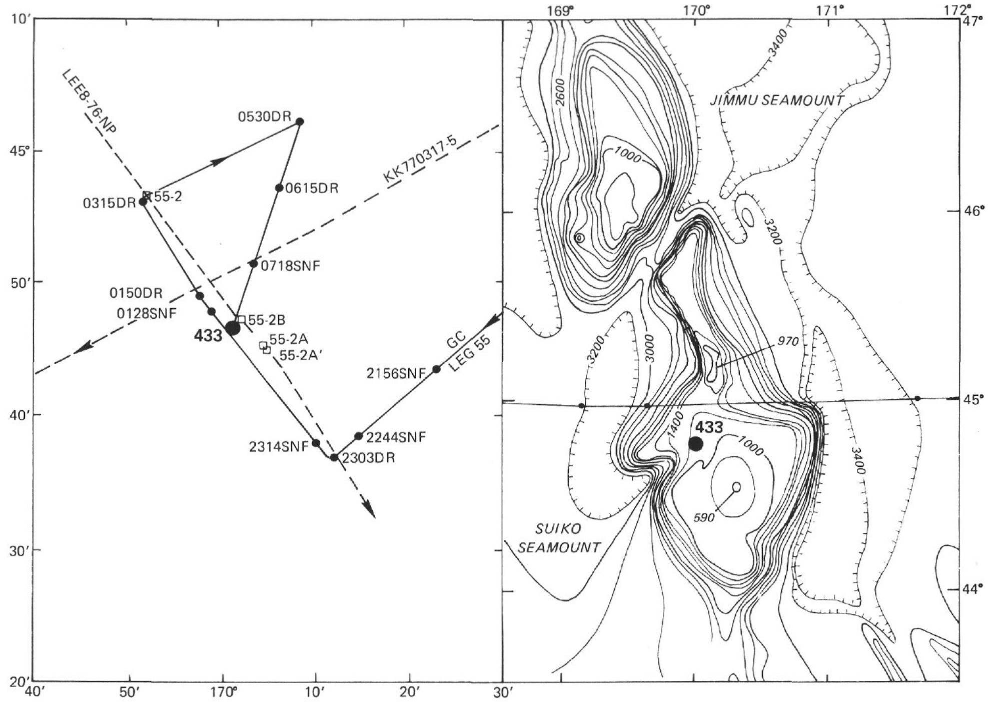


Figure 1. *Bathymetry of the Emperor Seamount chain in the vicinity of Suiko Seamount, showing the tracks of the* Glomar Challenger, *the* Kana Keoki, *and the* S. P. Lee. *Prospective sites are shown by open squares. Depth contours in fathoms. Bathymetry after Chase et al. (1970).*

northwest of Site 55-2A, the *Kana Keoki* obtained an airgun seismic reflection profile (Figure 3); this profile shows the central platform identified in the *Lee* profile to be a narrow, rounded acoustic basement ridge. The lagoon is not as symmetrical in the *Kana Keoki* profile as in the *Lee* profile; it is less well developed and narrower to the northeast of the ridge than to the southwest. Northeast of the central ridge and platform, lagoonal deposits appear to be thin and covered with terrace deposits sloping gently northeast. Near the northeast flank of the ridge, over 0.2 s of sediments overlie a faulted and eroded acoustic basement. To the southwest, a wide structural depression, filled with over 0.45 s of sediments, probably lagoonal, extends from the central ridge for over 10 nautical miles to a gently rounded topographic and acoustic basement ridge that marks the edge of the seamount top. Sediments within the depression lap onto the acoustic basement ridge, which appears to be locally capped with reefs.

We approached Suiko Seamount from Adak, Alaska, on a course of 231° true at 9.6 knots, to intersect the survey line of the *S. P. Lee* at latitude 44°37.2′N, longitude 170°11.9′E (Figure 1). Satellite navigation fixes at 2120Z, 2156Z, and 2244Z, 15 August 1977, showed the *Challenger* on the desired track; we slowed to 6 knots at 2237Z. At 2303Z (1003L, 16 August), we turned to 324° true to reoccupy the *Lee* line. A satellite fix at 2314Z suggested a slight westerly set from the *Lee* track, and another fix at 0128Z, 16 August, confirmed that we had passed about 1.5 nautical miles southwest of the four prospective sites, 55-2, 55-2A, 55-2A′, and 55-2B (Figure 1). We threw a sonobuoy overboard at 0047Z and initiated a wide-angle seismic reflection profile. Reception was poor, however, and we had to terminate the run prematurely. At 0150Z we changed course to 324° true. The seismic reflection profile obtained aboard the *Glomar Challenger* along this track shows the broad central platform to the south, with its steep north-facing scarp bounding the lagoonal(?) sediments of the structural depression. An erosional moat apparently has developed, probably from current scour, at the base of this scarp (Figure 4). Acoustic basement appears to lie beneath 0.18 to 0.20 s of stratified sediments near proposed Sites 55-2A and 55-2A′ (see Figures 1 and 5). The 3.5-kHz profile obtained along this track shows an acoustically well-layered to semitransparent cover of sediments (probably pelagic), overlying a very irregular and faulted strong reflector that acts as an acoustic basement in the 3.5-kHz profile (Figure 6). In the vicinity of Site 433 these sediments are over 0.06 s thick, and appear to be ponded between the scarp on the southeast and an uplifted block of acoustically nontransparent rock to the northwest. The profile, continued northwest, shows acoustically transparent sediments ponded in small basins formed from down-faulted and backward-rotated bedrock steps (see Figure 7).

At 0315Z (1415L), we turned the *Challenger* to 065° true, and at 0322Z passed directly over proposed site 55-2 at about 6 knots. Although we identified ponded sediments at Site 55-2 in the *Challenger* profiles, we found no acoustically transparent sediments similar to those along the previous *Challenger* track. We decided

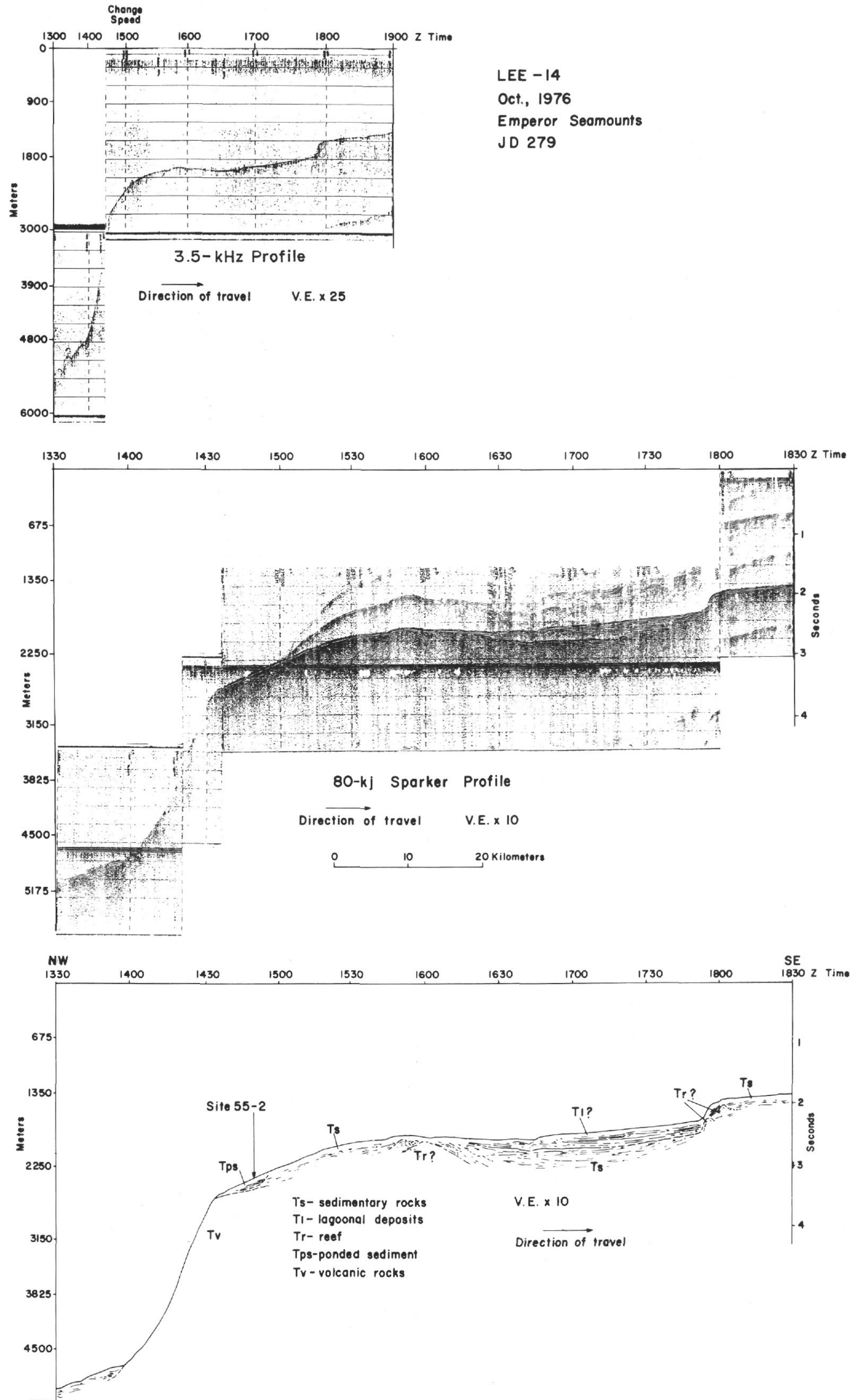


Figure 2. *A portion of U.S. Geological Survey's* S. P. Lee *sparker seismic reflection and 3.5-kHz profiles, showing proposed Site 55-2 and geologic interpretation.*

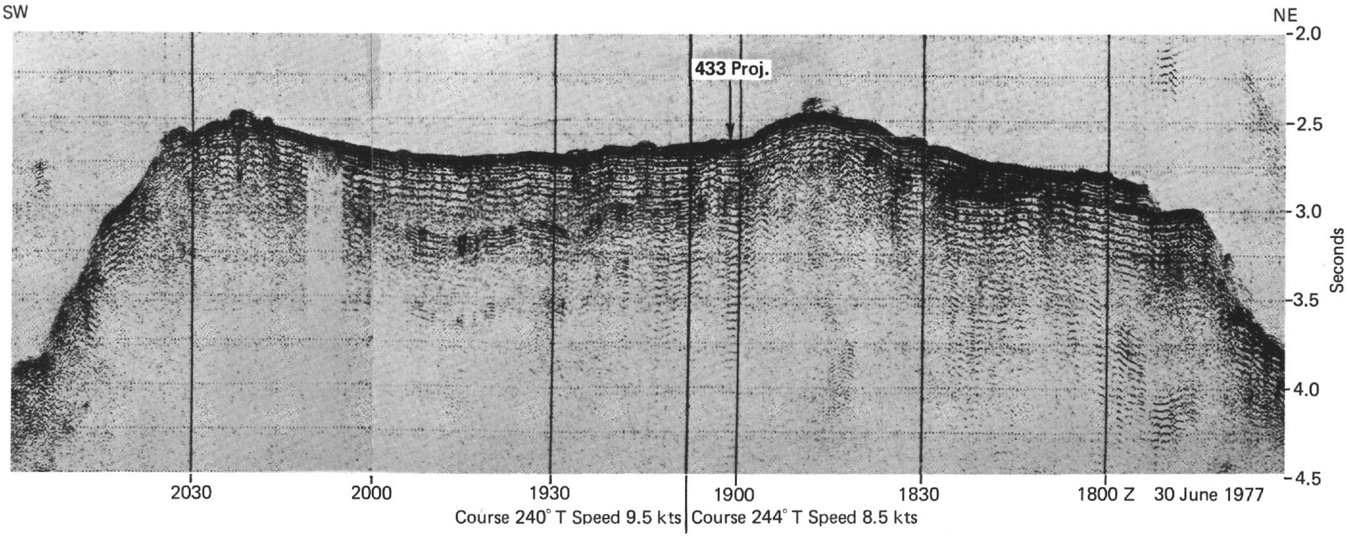


Figure 3. *Hawaii Institute of Geophysics'* Kana Keoki *airgun seismic reflection profile across Suiko Seamount (courtesy Dr. Loren Kroenke, Hawaii Institute of Geophysics).*

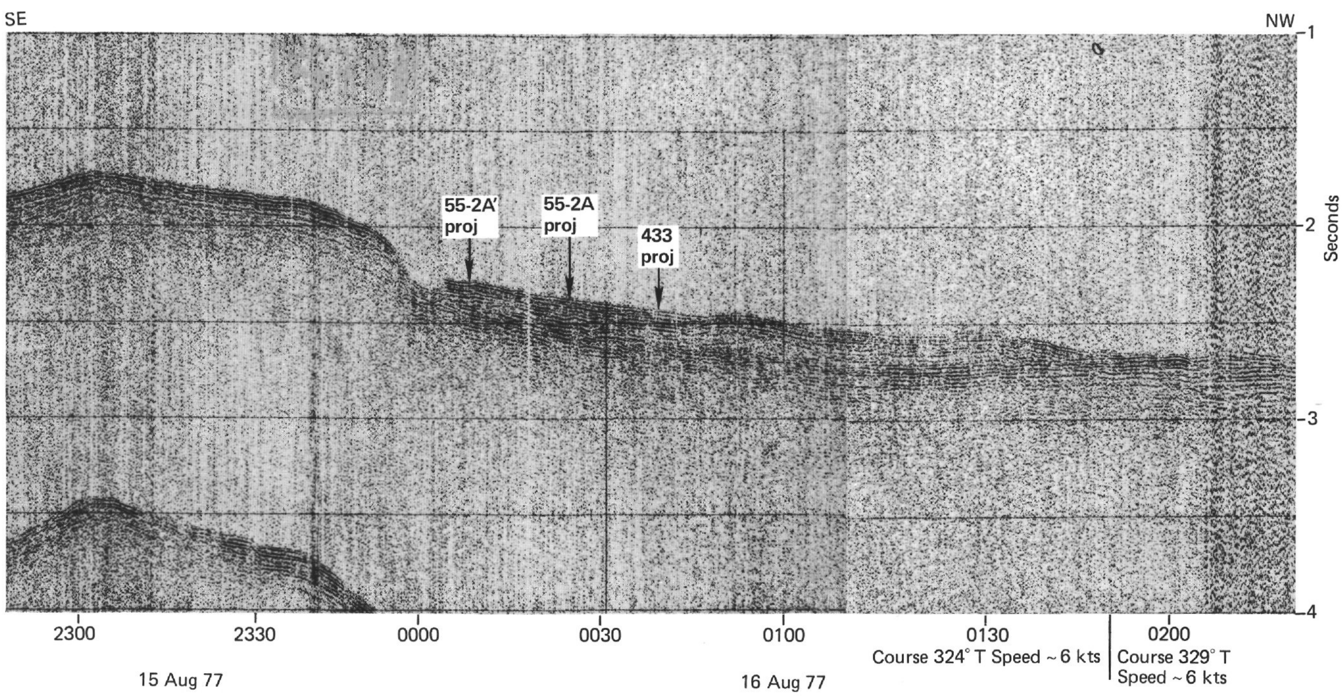


Figure 4. Glomar Challenger *5-s seismic reflection profile across proposed Sites 55-2A ', 55-2A, and 55-2B.*

to drill near Site 55–2B. We changed course at 0530Z (1630L) to 202° true, and at 0615Z to 200° true, to pass over the sediment pond identified in the *Challenger* 3.5-kHz profile (0110Z, dead reckoning position, 16 August; see Figures 1 and 6). A satellite fix at 0736Z showed the *Challenger* to be within 0.2 nautical miles of the intended track. At 0810Z, we changed course slightly to 205° true and dropped at 16-kHz beacon at 0818Z (Figure 8). Our seismic reflection profiles along this traverse show undulating topography on the approach to Site 433 (Figures 9 and 10). A buried acoustic basement ridge exists near this locality and well-stratified sediments appear to lap onto the ridge from both the north and the south. Site 433 is south of this ridge, and appears to have 0.2 s of well-stratified sediments overlying a poorly defined acoustic basement. The 3.5-kHz profile obtained aboard the *Challenger* along this track shows 0.06 s of flat to gently folded, well-stratified sediments lying over a highly faulted, and locally sharply folded, strong reflector that acts as an acoustic basement in the 3.5-kHz profiles (Figure 11).

We continued on course 205° true until 0833Z, then turned east, retrieved the overboard geophysical gear, and headed back toward the beacon (Figure 8). The

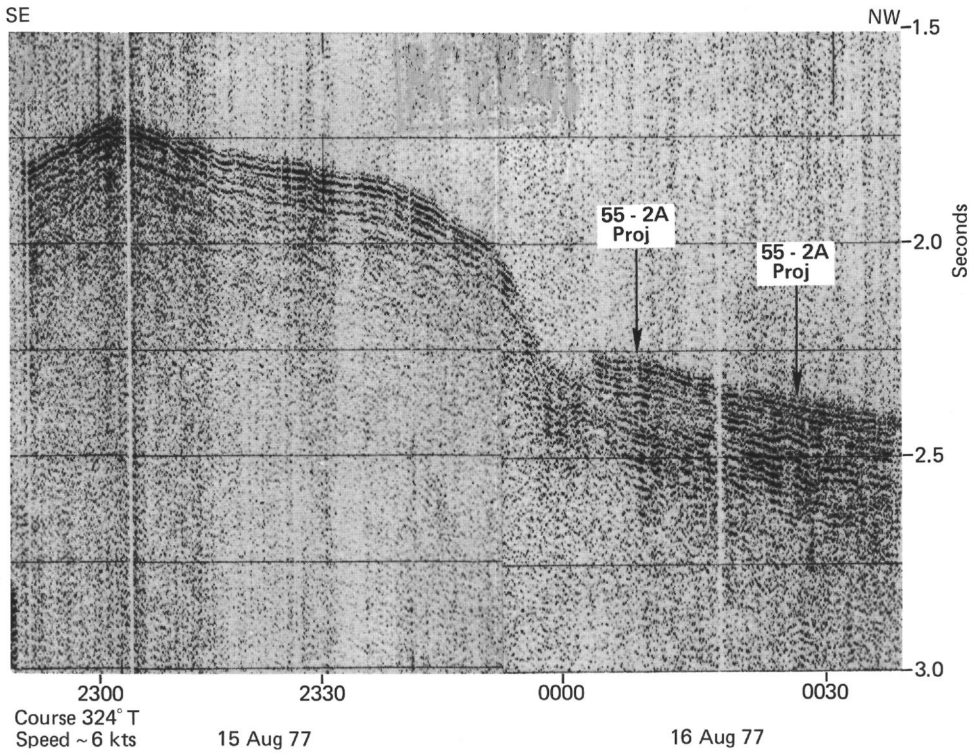


Figure 5. Glomar Challenger *2.5-s seismic reflection profile across proposed Sites 55-2A and 55-2A'.*

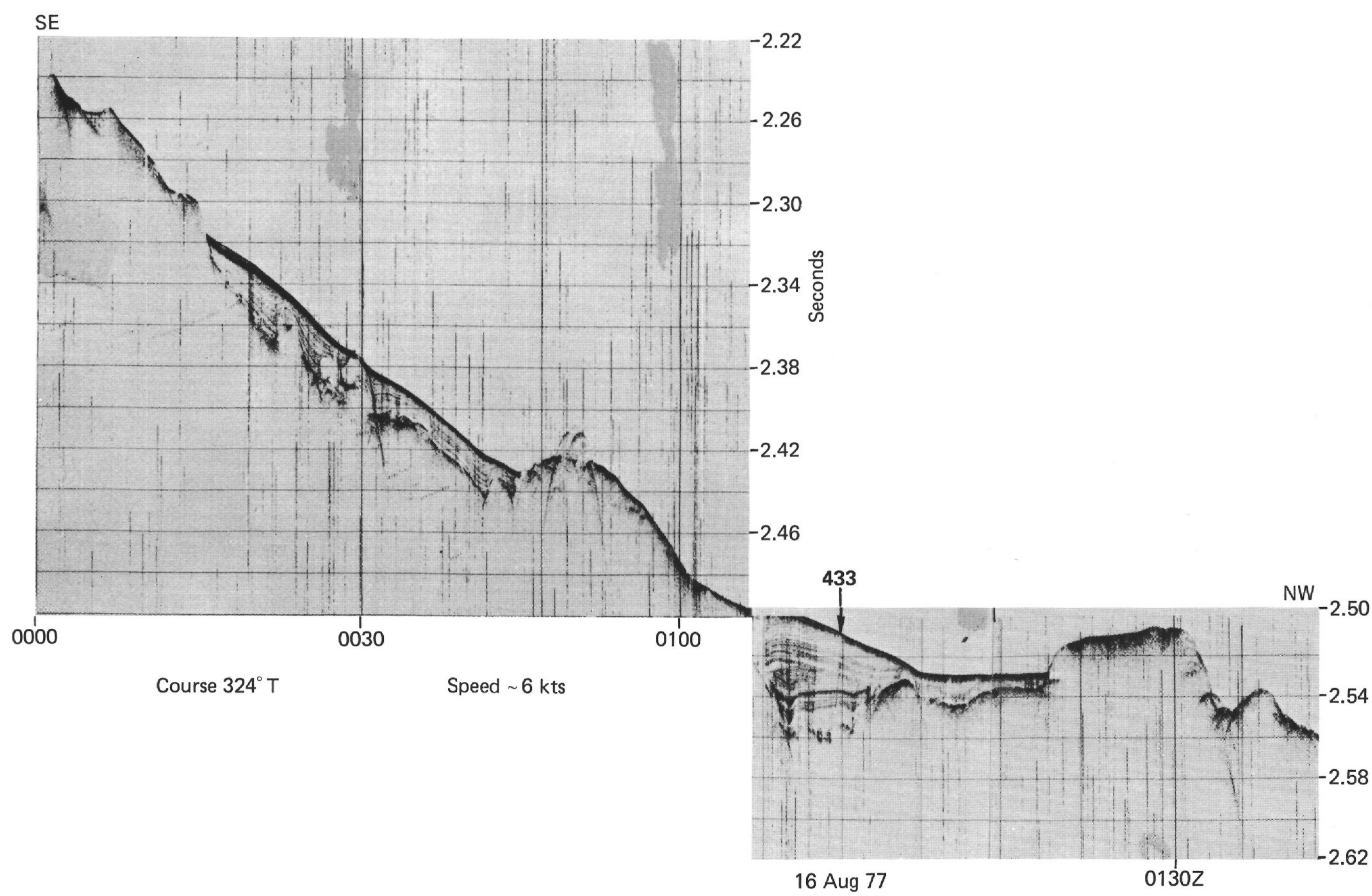


Figure 6. Glomar Challenger *3.5-kHz profile across Site 433, showing pelagic sediment pond.*

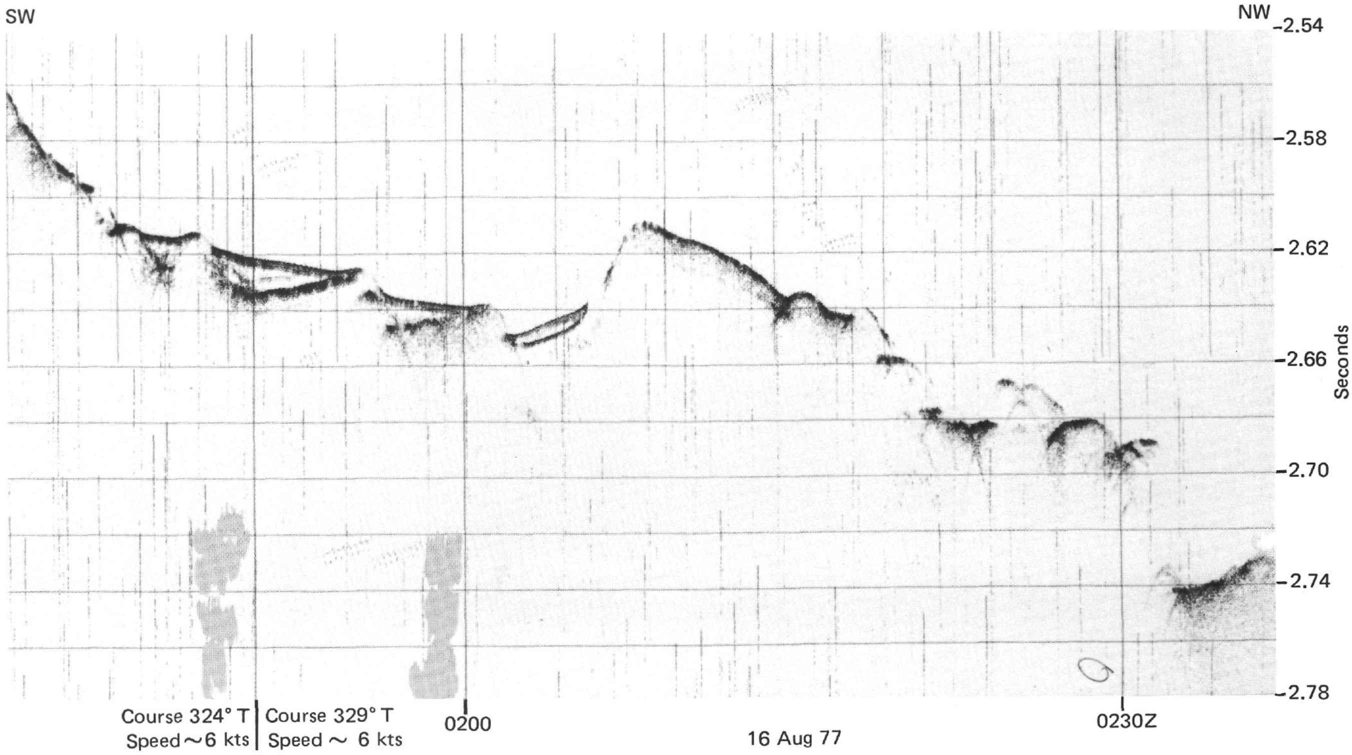


Figure 7. Glomar Challenger *3.5-kHz profile northwest of Site 433, showing pelagic sediments on faulted and backward-rotated bedrock steps.*

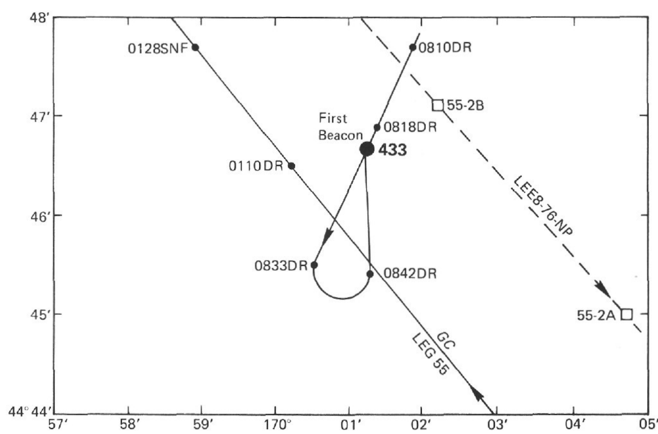


Figure 8. *Detail of Site 433, showing the tracks of the* Glomar Challenger *and the* S.P. Lee. *Prospective sites are shown by open squares. The first beacon (16 kHz) was dropped at 0818 on 16 August. Site 433 was selected 2200 feet, 205° from the first beacon.*

3.5-kHz profile showed that the first beacon had not been dropped in the location of thickest soft sediment, so we offset the *Challenger* 2200 feet (along 205° true) from the 16-kHz beacon, and dropped a second (13.5-kHz) beacon directly over the site of greatest soft-sediment thickness (Figure 11). Subsequent satellite data taken on site shows that Site 433 is about 1.2 nautical miles southwest of prospective Site 55-2B. The *Challenger* 3.5-kHz profile (Figure 12) obtained during travel from the first beacon to the second shows many flat-lying, well-stratified reflectors down to a subsurface depth of 0.06 s (45 m at 1.5 km/s).

Site 433 is in a complexly deformed marginal structural basin associated with a fairly extensive lagoonal complex. This small basin lies along the southwest flank of the central ridge or platform of Suiko Seamount. It is bounded on the south by the steep, north-facing scarp of the central platform and on the north by a horst that separates it from the larger lagoonal complex to the north. The basin itself appears to be a graben, flanked by several faults, and filled with about 45 meters of soft, relatively unconsolidated sediments overlying about 160 meters of more consolidated sediments that rest on acoustic basement.

Drilling Operations

The *Challenger* was positioned over the 13.5-kHz beacon at 1000Z (2100L) on 16 August 1977, and pipe was strapped and dropped almost immediately. We spudded Hole 433 at 1530Z, 16 August (0230L, 17 August), pulled 5.0 meters of core to establish mudline, and carried out a wash test to determine whether the site was suitable for multiple re-entry. After retrieval of Core 1, Hole 433 (Table 1) surface material was washed down to a depth of 45.0 meters in 18.5 minutes, at a rate of nearly 2.5 m/min. Below 45.0 meters, the section would no longer easily wash, because of a dense, altered ash bed (the ash bed presumably also accounts for the deepest reflector in the 3.5-kHz profile record at this site). We completed the washing test and spudded Hole

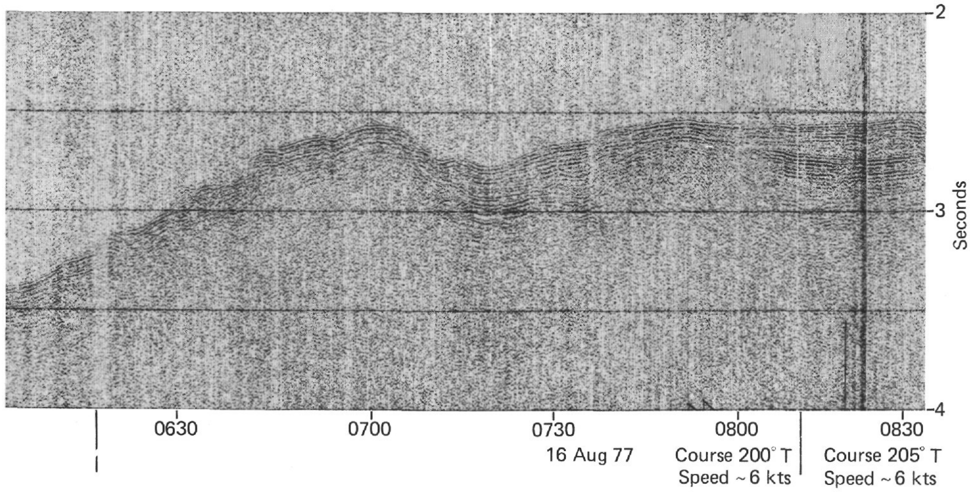


Figure 9. Glomar Challenger *5-s seismic reflection profile, showing a buried acoustic basement ridge at Site 433, with the northern and southern flanks.*

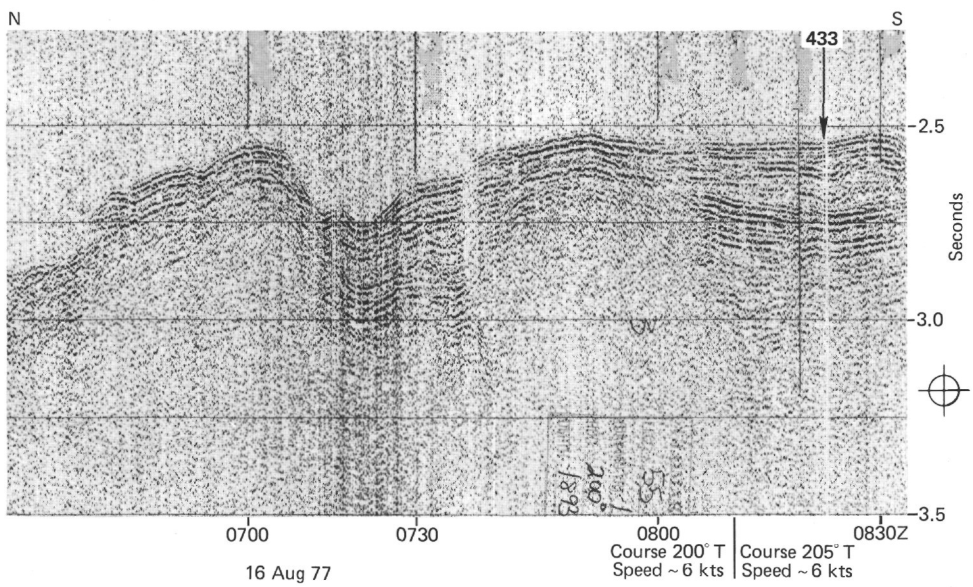


Figure 10. Glomar Challenger *2.5-s seismic reflection profile across Site 433, showing the sediment pond.*

433A, the pilot hole for re-entry, at 1742Z, 16 August (0442L, 17 August).

Hole 433A was continuously cored and penetrated 163.5 meters of sedimentary rocks ranging from Quaternary ooze at the surface to consolidated reef limestone at the base. Recovery was excellent in the pelagic oozes in the upper part of the hole (see Table 2) and very poor in the unconsolidated reef sands and silts in the interval 81 to 157 meters below mudline. We encountered basalt while drilling Core 19, but since the proper core catchers were not in the core barrel, we pulled out at 163.5 meters and used a new barrel (Core 20) to core the remaining 3.0 meters of basalt. We cored an additional 7.5 meters of basalt (Core 21) before warning the drillers to begin backing out of the hole at 1745Z on 17 August (0445L, 13 August) because of excessive amperage on the stern thrusters. We had difficulty with the thruster; although we held the positioning system in manual for some time, we pulled the string above mudline at 1900Z (0600L) and finally recovered the last core at 1940Z (0604L).

Divers ultimately recovered a wad of nylon fishing net and polyethylene filament line from the aft stern thruster after the ship had been allowed to drift several miles off beacon. We tested the thrusters, found them undamaged, and positioned the ship over the 13.5-kHz beacon at Site 433 at 0300Z (1400L), 18 August. Drill pipe was once again run to the bottom to complete the pilot hole, and the bit was respudded for Hole 433B and 0400Z (1500L).

We washed Hole 433B to 28.5 meters below mudline and recored the three 9.5-meter intervals above base-

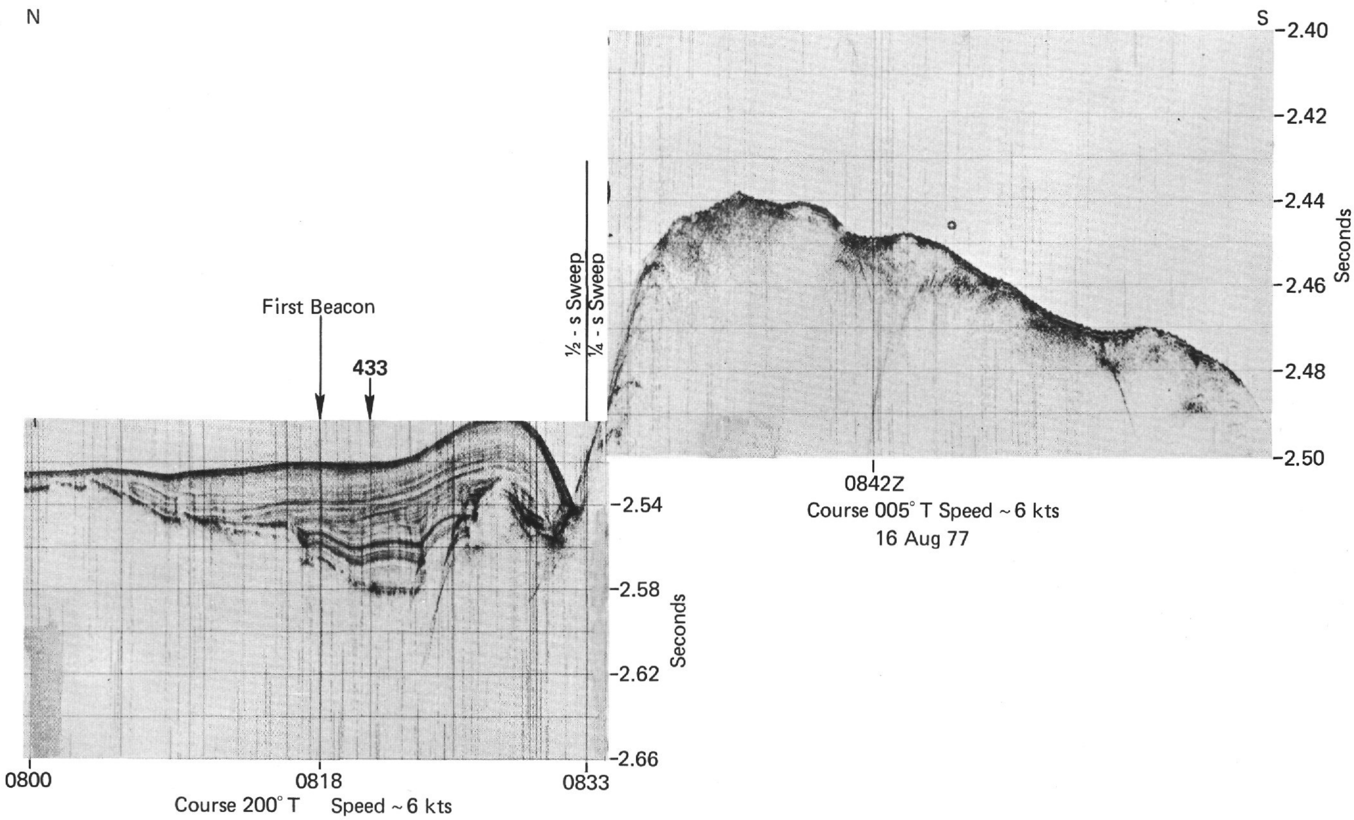


Figure 11. Glomar Challenger *3.5-kHz profile across Site 433, showing the graben basin filled with pelagic sediments.*

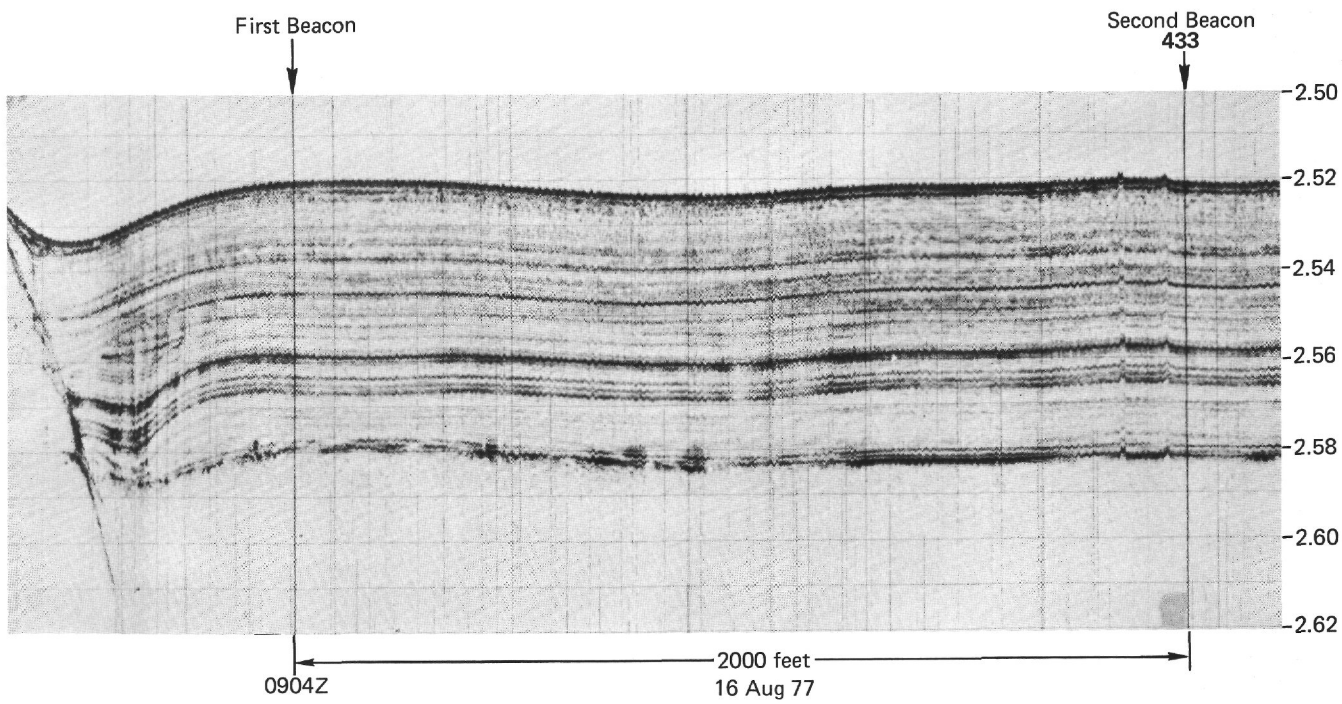


Figure 12. Glomar Challenger *3.5-kHz profile on approach to Site 433, showing well-layered pelagic sediments between the first (16-kHz) and second (13.5-kHz) beacons.*

TABLE 1
Coring Summary, Hole 433

Core	Date (Aug. 1977)	Time (L)	Depth from Drill Floor (m)	Depth below Sea Floor (m)	Length Cored (m)	Length Recovered (m)	Recovery (%)
1	17	0300	1874.0-1879.0	0.0-5.0	5.0	5.0	100.0
Total					5.0	5.0	100.0

TABLE 2
Coring Summary, Hole 433A

Core	Date (Aug. 1977)	Time (L)	Depth from Drill Floor (m)	Depth below Sea Floor (m)	Length Cored (m)	Length Recovered (m)	Recovery (%)
1	17	0508	1874.0-1879.0	0.0-5.0	5.0	1.50	30.0
2	17	0610	1879.0-1885.5	5.0-14.5	9.5	2.26	23.8
3	17	0701	1885.5-1898.0	14.5-24.0	9.5	8.00	84.2
4	17	0800	1898.0-1907.5	24.0-33.5	9.5	8.62	90.7
5	17	0856	1907.5-1917.0	33.5-43.0	9.5	8.51	89.6
6	17	0945	1917.0-1926.5	43.0-52.5	9.5	9.60	101.1
7	17	1100	1926.5-1936.0	52.5-62.0	9.5	8.61	90.6
8	17	1155	1936.0-1945.5	62.0-71.5	9.5	9.60	101.1
9	17	1305	1945.5-1949.5	71.5-75.5	4.0	8.25	206.3
10	17	1535	1949.5-1955.0	75.5-81.0	5.5	9.65	175.5
11	17	1629	1955.0-1964.5	81.0-90.5	9.5	0.10	1.1
12	17	1825	1964.5-1974.0	90.5-100.0	9.5	3.56	37.5
13	17	1923	1974.0-1983.5	100.0-109.5	9.5	0.50	5.3
14	17	2030	1983.5-1993.0	109.5-119.0	9.5	0.45	4.7
15	17	2155	1993.0-2002.5	119.0-128.5	9.5	0.02	0.2
16	17	2245	2002.5-2012.0	128.5-138.0	9.5	0.73	7.7
17	17	2325	2012.0-2021.5	138.0-147.5	9.5	0.03	0.3
18	18	0015	2021.5-2031.0	147.5-157.0	9.5	0.04	0.4
19	18	0107	2031.0-2037.5	157.0-163.5	6.5	0.43	6.9
20	18	0240	2037.5-2040.5	163.5-166.5	3.0	2.30	76.7
21	18	0640	2040.5-2048.0	166.5-174.0	7.5	5.83	77.7
Total					174.0	88.59	50.9

TABLE 3
Coring Summary, Hole 433B

Core	Date (Aug. 1977)	Time (L)	Depth from Drill Floor (m)	Depth below Sea Floor (m)	Length Cored (m)	Length Recovered (m)	Recovery (%)
1	18	1702	2002.5-2012.0	128.5-138.0	9.5	4.01	42.2
2	18	1745	2012.0-2021.5	138.0-147.5	9.5	1.38	14.5
3	18	1839	2021.5-2031.0	147.5-157.0	9.5	0.42	4.4
4	18	1936	2031.0-2040.5	157.0-166.5	9.5	0.66	6.9
5	18	2235	2040.5-2050.0	166.5-176.0	9.5	4.25[a]	44.7
6	19	0215	2050.0-2059.5	176.0-185.5	9.5	0	0
7	19	0423	2059.5-2061.5	185.5-186.5	1.0	0	0
Total					58.0	10.72	18.5

[a]2.75 meters in core barrel, 1.50 meters recovered above bit cores.

ment because recovery had been poor in Hole 433A, and also because we wished to establish the minimum basement age as closely as possible. We found basalt at a sub-bottom depth of 163.0 meters in Core 4. We cut two more 9.5-meter cores in basalt beneath Core 4, but after retrieving Core 5, we found broken core-catcher teeth and a torn basal plastic core liner. We suspected that part of the basalt of Core 5 had fallen back onto the bit cones; this same type of accident had terminated Hole 430A. We drilled Core 6 but recovered nothing; we drilled an additional 1.0 meter of basalt (Core 7), again with no recovery. At 1732Z, 18 August (0432L, 19 August), we decided to pull the string. At 2215Z (0915L), the bit was found to be jammed with basalt fragments above the cones; these fragments were assigned to Core 5 (Table 3).

One of our objectives for the pilot hole was to determine bit life, so as to estimate the durability of the bit during re-entry. Although we had not changed bits while drilling Holes 433, 433A, and 433B, and so had drilled a total of 373.5 meters of sedimentary rocks and 37 meters of basalt, the bit cones showed little wear. Since bit life in the basaltic rocks seemed reasonably long, and since the bit had been through the 50-meter interval below mudline three times, we asked and received permission to set the re-entry cone without performing the 16-inch pipe washing test. The re-entry cone was made up and keelhauled between 2230Z, 18 August (0930, 19 August) and 1800Z (0500L), 19 August. We secured four joints of 16-inch casing and a hedge shoe (a total of 39.25 m of pipe to the cone), dropped the assembly, and spudded in at mudline at 1445Z, 19 August (0145L, 20 August); we washed in the 16-inch casing by 1515Z (0215L), released the cone and string at 1525Z (0245L), and washed the bottom-hole assembly (BHA) in at 163.0 meters to within 0.5 meter of the top of the uppermost basalt flow. The BHA was made up as usual with three bumper subs, the only difference being that three drill collars and a lowering tool were inserted below the lower bumper sub. We placed a slip-type core catcher on the core barrel below two dog-type catchers to prevent the loss of core above the bit cones that had prematurely ended Holes 430A and 433B. The first core (1), containing some harder basal reef limestone and basalt (see Table 4) was cut in 5.0 meters, and came on deck at 1940Z, 19 August (0640L, 20 August). We pulled Core 2 at 2210Z, but recovered only 2 per cent because a twice-drilled basalt fragment jammed in the slip-type core catcher. For Core 3, the barrel arrived on deck empty; we suspected a jammed bit and ran in a chisel bit on the core barrel. To our surprise, the closed core barrel returned containing 4.26 meters of well-sorted, completely unconsolidated "salt and pepper" beach sand, which had apparently forced past the chisel bit through the valve holes in the core barrel. We penetrated 5 to 11 meters of this material between Flow Units 1 and 2, and began to core a dense basalt, recovered in Core 4. For Core 5 we replaced the slip-type core catchers by dog-type core catchers, but achieved little improvement in core recovery. Drilling rates suggest that we may have passed through a second beach sand 4 to 5 meters thick in the lower 3 meters of Core 4 and the upper 2 meters of Core 5. We recovered only 0.12 meter of basalt core in Core 5 and 0.12 meter in Core 6. The barrel returned to the surface empty for Cores 7 and 8, and in spite of vigorous use of the chisel bit, we recovered neither basalt nor sand. However, drilling rates for Core 6 suggested relatively soft layers at 193 to 195 meters; penetration was also relatively easy for the lower part of Core 7 and upper part of Core 8. At 1445Z, 20 August (0145L, 21 August), we decided the bit was plugged above the cones, and pulled the string. The bit arrived on deck at 1850Z (0550L), its teeth and

TABLE 4
Coring Summary, Hole 433C

Core	Date (Aug. 1977)	Time (L)	Depth from Drill Floor (m)	Depth below Sea Floor (m)	Length Cored (m)	Length Recovered (m)	Recovery (%)
1	20	0627	2037.0-2042.0	163.0-168.0	5.0	1.86	37.2
2	20	0910	2042.0-2051.5	168.0-177.5	9.5	0.25	2.6
3	20	1320	2051.5-2055.5	177.5-181.5	4.0	4.26	115.0
4	20	1455	2055.5-2061.0	181.5-187.0	5.5	1.19	21.6
5	20	1733	2061.0-2064.0	187.0-190.0	3.0	0.12	4.0
6	20	2100	2064.0-2070.5	190.0-196.5	6.5	0.70[a]	10.8
7	20	2300	2070.5-2074.5	196.5-200.5	4.0	0	0
8	21	0137	2074.5-2076.5	200.5-202.5	2.0	0	0
9	21	1745	2076.5-2078.5	202.5-204.5	2.0[b]	0.39	19.5
(RE-ENTRY 1)							
10	21	2112	2078.5-2088.5	204.5-214.0	9.5	6.63	69.8
11	21	2325	2088.5-2097.5	214.0-223.5	9.5	4.97	52.3
12	22	0212	2097.5-2104.0	223.5-230.0	6.5	4.88	75.1
13	22	0545	2104.0-2107.0	230.0-233.0	3.0	3.35	111.7
14	22	0730	2107.0-2116.5	233.0-242.5	9.5	4.76	50.1
15	22	1015	2116.5-2126.0	242.5-252.0	9.5	6.00	63.2
16	22	1200	2126.0-2129.5	252.0-255.5	3.5	1.36	38.9
17	22	1800	2129.5-2132.5	255.5-258.5	3.0	0.73	24.3
18	22	2310	2132.5-2135.5	258.5-261.5	3.0	0.25[c]	8.3
19	24	0700	2135.5-2143.5	261.5-269.5	8.0	6.23	77.9
(RE-ENTRY 2)							
20	24	0920	2143.5-2153.0	269.5-279.0	9.5	2.45	25.9
21	24	1230	2153.0-2162.5	279.0-288.5	9.5	5.85	61.6
22	24	1605	2162.5-2172.0	288.5-298.0	9.5	6.02	63.4
23	24	2035	2172.0-2181.5	298.0-307.5	9.5	8.92	93.9
24	25	0010	2181.5-2191.0	307.5-317.0	9.5	8.24	86.7
25	25	0420	2191.0-2200.5	317.0-326.5	9.5	9.55	100.5
26	25	0745	2200.5-2210.0	326.5-336.0	9.5	8.25	86.8
27	25	1135	2210.0-2219.5	336.0-345.5	9.5	8.04	84.6
28	25	1437	2219.5-2229.0	345.5-355.0	9.5	6.10	64.2
29	25	1635	2229.0-2238.5	355.0-364.5	9.5	2.97	31.3
30	25	2015	2238.5-2248.0	364.5-374.0	9.5	2.85	30.0
31	25	2340	2248.0-2257.5	374.0-383.5	9.5	5.93	62.4
32	26	0355	2257.5-2267.0	383.5-393.0	9.5	6.42	67.6
33	26	0710	2267.0-2276.5	393.0-402.5	9.5	6.75	71.5
34	26	1055	2276.5-2286.0	402.5-412.0	9.5	9.64	101.5
35	26	1520	2286.0-2295.5	412.0-421.5	9.5	9.58	100.8
36	26	1950	2295.5-2305.0	421.5-431.0	9.5	7.20	75.8
37	26	2345	2305.0-2314.5	431.0-440.5	9.5	5.94	62.5
38	27	2255	2314.5-2324.0	440.5-450.0	9.5	7.28	76.6
(RE-ENTRY 3)							
39	28	0355	2324.0-2333.5	450.0-459.5	9.5	9.57	100.7
40	28	0645	2333.0-2334.5	459.5-469.0	9.5	8.12	85.5
41	28	1015	2343.0-2352.5	469.0-478.5	9.5	8.17	86.0
42	28	1320	2352.5-2362.0	478.5-488.0	9.5	6.53	68.7
43	28	1825	2362.0-2371.5	488.0-497.5	9.5	3.35	35.3
44	28	2210	2371.5-2381.0	497.5-507.0	9.5	6.34	66.7
45	29	0210	2381.0-2390.5	507.0-516.5	9.5	9.61	101.2
46	29	0520	2309.5-2400.0	516.5-526.0	9.5	7.80	82.1
47	29	0720	2400.0-2409.5	526.0-535.5	9.5	6.45	67.9
48	29	0920	2409.5-2419.0	535.5-545.0	9.5	5.30	55.8
49	29	1110	2419.0-2423.0	545.0-549.0	4.0	2.60	65.0
50	29	1345	2423.0-2424.5	549.0-550.5	1.5	0.40[d]	26.7
Total					387.5	250.15	64.6

[a] 0.12 meters core in bit, 0.58 meters recovered from above bit cones 0550 when string pulled. Not in stratigraphic order.
[b] 8.0 meters total of last 3 cores results from removal of latching tool before re-entry.
[c] 0.25-meter core above bit cones recovered on deck 0330, 23 August, labeled "Core 18, Section 1" before re-entry.
[d] 0.40-meter core above bit cones labeled "Core 50, Section 1," recovered on deck 2130, 29 August.

cones unworn, but with 0.58 meter of basalt jammed above the cones. All pieces save one were apparently identical to the basalt we had been recovering in Cores 4, 5, and 6 (Flow Unit 2); some had been cut as many as three times. The one odd piece was a 5-cm piece of alkalic basalt, but we could not say whether this represented a previously unsampled unit between two sand layers or was the precursor of the next deeper flow unit.

Re-entry preparations started at 1850Z, 20 August, and were completed at 0245Z, 21 August (0550 and 1345L, 21 August). The re-entry tool emerged from the drill string, and we began scanning at 1245Z, (2345L); at 0331Z (1431L), 21 August, the re-entry cone was located and the pipe was dropped. Core 9, the first core of the first re-entry, was on deck at 0645Z (1745L), 21 August 1977. The total time elapsed from the last core on deck cut by bit number 1 (Core 8), Hole 433C, to the first core on deck from bit number 2 (Core 9) after re-entry was 16 hours 8 minutes.

Between 0645Z (1745L) and 2315Z (1015L), 22 August, we penetrated 49.5 meters of basalt and recovered 30.98 meters, for a recovery average of 63 per cent. Core 15, however, came on deck at 2315Z (1015L), 21 August, with a torn plastic liner and damaged core-catcher teeth, symptoms we had by now learned to associate with basalt fragments lodged above the bit cones. Although we did not run the chisel bit immediately, the pump pressure soon began to fluctuate, indicating that the bit was jammed. During the period 2315Z, 21 August (1015L, 22 August) through 1210Z (2310L), we penetrated only 9.5 meters of basalt and recovered only 2.09 meters. During this period we ran in the chisel bit seven times, in vain attempts to clear the bit. By this time the cruise operations manager suspected that an inner barrel latch normally used during logging procedures was allowing the core barrel to become unlatched, and we decided to pull the string to clear the bit and check the latch. Mudline was cleared at 1325Z, 22 August (0025L, 23 August), and the bit was on deck at 1630Z (0330L). The inner cones, when placed in tubing, contained 0.25 meter of basalt whose mineralogy placed it in Core 18; it was logged in as part of this core.

By 1845Z (0545L), we were running string in the hole for re-entry number two; we began scanning at 0245Z (1345L), and finally made re-entry at 1430Z, 23 August (0130L, 24 August), in heavy weather. The first core from the second re-entry was on deck at 2000Z (0700L); a total time of 31 hours 50 minutes elapsed between Cores 18 and 19.

Our second re-entry into Hole 433C on Suiko Seamount proved especially productive. Bit number three penetrated Cores 19 through 37, and drilled 179.0 meters of basalt in 53 hours drilling time, with a recovery of 70.9 per cent. The bit entered the hole in Flow Unit 13, at 261.5 meters sub-bottom, and finally penetrated the upper part of Flow Unit 45, well within the central tholeiitic edifice of this part of Suiko Seamount. Although core diameter of Core 37 was still 5.7 to 5.8 cm, we decided to remove the bit because of its excessive hours of work in hard rocks. The very large increase in percentage recovery (compared with basalt recoveries of 21.2 per cent using the first bit at Hole C and 56.5 per cent with the second bit) and the cessation of failures resulting from plugged bits were attributed to removal of the logging core latch and substitution of the standard core latch before bit number three was lowered. We pulled the string at 1300Z, 26 August (0000L, 27 August), and the bit was on deck at 1500Z (0400L). We began scanning for re-entry number three at 0015Z (1115L), 27 August, and had accomplished re-entry by 0515Z (1615L). Total elapsed re-entry time between recovery of Core 37 and recovery of Core 38 was 23 hours 40 minutes.

Our third re-entry into Hole 433C penetrated 110.0 meters of basalt and recovered 81.37 meters, for a recovery percentage of 74.0. The bit entered in Flow Unit 45b, and penetrated as far as Flow Unit 67. At 0000Z, 29 August (1100L), the pump pressure and drilling rate indicated still another bit plugged with basalt above the cones. We tried repeatedly to clear the bit with the chisel bit attached to the core barrel. Two short cores were pulled, the second one empty. By 0245Z (1345L), the bit valves were hopelessly jammed open. An Eastman inclinometer was run in, and recorded an inclination in the bottom of the hole of 2.5°. The string was pulled and the bit was on deck at 1030Z (2130L). The top of the bit cones were jammed with basalt, and the center of the bit opening was jammed tight by a piece of rag (still recognizable as a pair of size 44 men's underpants) completely entwined about a 5-cm piece of basalt core. The bit teeth were still in very serviceable condition (the underpants were not).

Hole 433C penetrated 550.5 meters, of which 387.5 meters, all basalt, were cored. Recovery was 250.15 meters, or 64.6 per cent of all basalt penetrated.

Total time on Site 433 was 313 hours 52 minutes.

To arrive at Yokohama on schedule we needed to pull string at 0700Z (1800L) on 30 August, and be underway by 1300Z on August (0000L, 31 August). At the time of bit failure we had 28 hours of drill time remaining. Since most of our previous re-entries had consumed about 26 hours, we felt that to re-enter and to request an extension would be pointless (the failure occurred on Sunday, San Diego time), especially since we had recovered core from about 114 flows and thus accomplished all our objectives. We therefore left Site 433 at 1152Z (2252L), 29 August, en route to Yokohama.

On-Site Positioning

The satellite navigation data received during our occupation of Site 433, through the drilling of Holes 433 and 433A, are tabulated in Table 5 and plotted chronologically in Figure 13. Apparent excursions from some average positions are large (as much as 600 feet in some cases); but as previously noted, we do not feel that these distances are real excursions. The excursions do appear to be random and not so consistently offset as those at Holes 431, 431A, and 432, where we lost part of the bottom-hole assembly and twisted the bumper subs. The *Glomar Challenger* was forced to abandon Hole 433A because of thruster problems (see section above); our direction of drift is apparent on Figure 13.

We reoccupied the site before drilling Hole 433B; the positions received between reoccupation and the spudding in of Hole 433C are tabulated in Table 6 and plotted in Figure 14. Again, the apparent excursions from some average position are random and relatively modest during the drilling of Hole 433B. A real excursion probably occurred between the failure of Hole 433 and the setting of the re-entry cone; but we have no evidence of this. Two beacons, heavily weighted, were dropped at Site 433; they did not change position during operation. In retrospect, we can only say that beacon movement along the bottom may have contributed to the loss of Holes 431, 431A, and 432.

TABLE 5
On-Site Satellite Navigation Positions, Holes 433 and 433A

	Time (Z)	Latitude (N)	Longitude (E)	Satellite	Statistics	Altitude
Hole 433						
1	16 Aug. 0922	44°46.635	170°01.239	19	Fair-good	29°
2	1044	44°46.620	170°01.263	20	Excellent	32°
3	1116	44°46.604	170°01.265	13	Good	38°
4	1230	44°46.610	170°01.270	20	Good	38°
5	1652	44°46.589	170°01.241	12	Good	52°
6	1836	44°46.602	170°01.256	12	Good	28°
7	2010	44°46.604	170°01.261	14	Excellent	23°
8	2032	44°46.592	170°01.329	19	Good	64°
9	2156	44°46.588	170°01.267	14	Good	64°
Hole 433A						
9	16 Aug. 2240	44°46.617	170°01.234	20	Fair-good	34°
10	2342	44°46.506	170°01.166	14	Fair	10°
11	17 Aug. 0012	44°46.618	170°01.290	13	Fair-good	14°
12	0358	44°46.603	170°01.259	12	Good	21°
13	0418	44°46.450	170°01.287	46	Fair (suspect)	26°
14	0544	44°46.593	170°01.234	12	Fair-good	68°
15	0648	44°46.588	170°01.263	19	Good	25°
16	0730	44°46.668	170°01.343	12	Fair	11°
17	0808	44°46.589	170°01.243	14	Good	22°
18	0834	44°46.597	170°01.237	19	Good	60°
19	0956	44°46.585	170°01.248	14	Fair-good	68°
20	1120	44°46.579	170°01.215	20	Fair	69°
21	1144	44°46.676	170°01.278	14	Fair-poor	11°
22	1218	44°46.573	170°01.193	13	Fair	13°
23	1306	44°46.590	170°01.254	20	Fair-good	18°
24	1556	44°46.574	170°01.241	12	Fair-good	23°
25	1740	44°46.643	170°01.365	12	Fair-good	65°
	1900-	STERN THRUSTERS OFF, SHIP DRIFTING OFF BEACON				
26	1934	44°46.611	170°01.386	12	Fair	10°

We thought that instabilities in the thermal structure of sea water above seamounts might have caused refraction between beacon and ship, and thus might account for our excursions at Holes 431, 431A, and 432. We examined the expendable bathythermograph (XBT) records taken along the Emperor Seamount chain. These records, taken generally before positioning over the beacon and after leaving a site, and underway between sites, give absolute temperatures from the surface to about 450 meters depth. Examination of 30 of these XBT records shows no correlation between temperature profiles of the upper 450 meters and bottom depth. Profiles taken south of Site 430, at Site 430, and up to 80 nautical miles north of Site 430 show stable concave decreases of water temperature with depth. A profile taken 170 nautical miles north of Site 430 shows at least 10 small irregular inversions of 0.1° to 0.5°C. Two profiles taken at Site 431 have irregular temperature distributions above 150 meters, and a temperature inversion of 0.8° to 1.0°C between depths of 150 and 200 meters. Two drops at Site 432 show a marked 1°C temperature inversion between depths of 90 and 180 meters. This inversion persists in water depths as great as 5755 meters 50 nautical miles north of Site 432. Profiles taken during approach to Site 433 show 1°C temperature inversions beginning at 100 to 150 meters water depth, and persisting to 200 to 300 meters. The thrusters never stopped during drilling at Site 433, but on departure, a similar profile was observed. If temperature-salinity waves or lenses above seamounts directly lead to unacceptable excursions of ship from beacon, they cannot readily be correlated with the simple XBT profiles available to us.

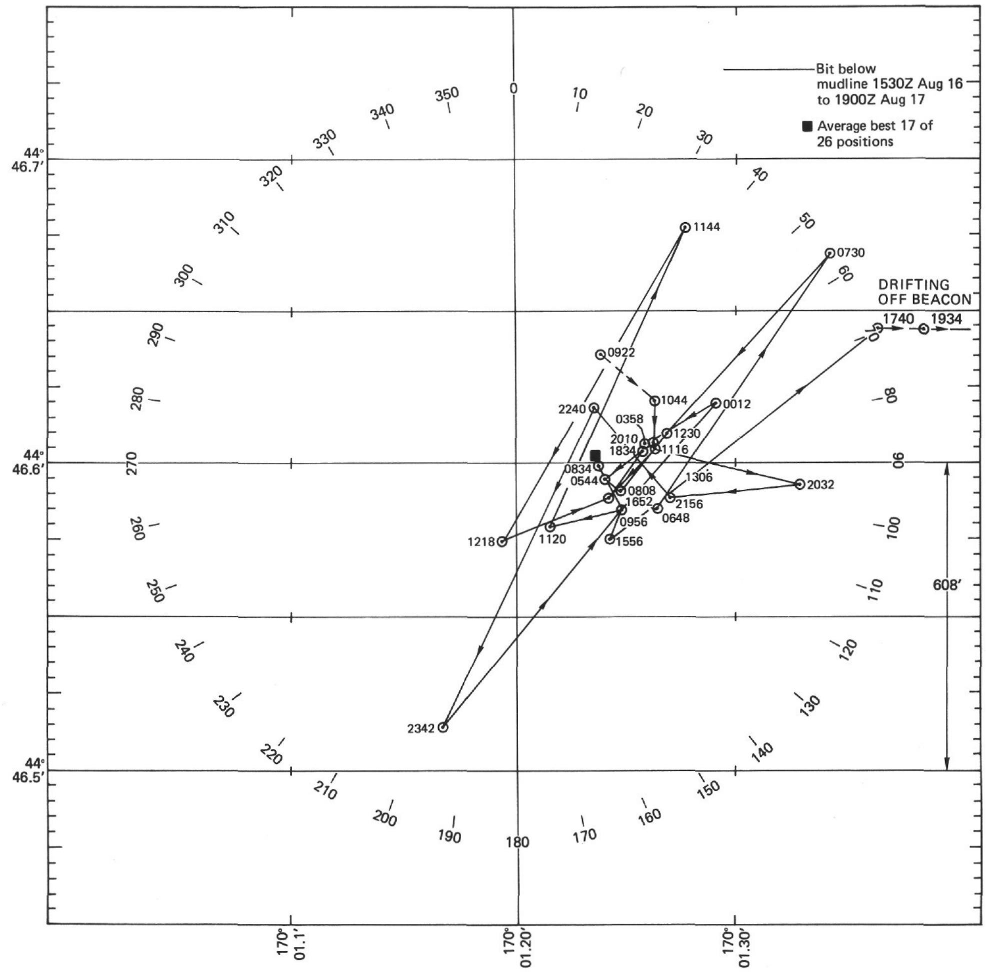


Figure 13. *Mercator plot of satellite navigation locations during drilling of Holes 433 and 433A.*

Post-Drilling Operations

In order to carry the subsurface stratigraphy identified in the Site 433 cores to the fringes of the seamount, and to relate these sedimentary and volcanic units to other geologic features in the area, we decided to cross previously unsurveyed parts of the seamount upon leaving the site. We left Site 433 at 1152Z (2252L) on 29 August 1977, circled toward the west, and came about to pass over the site on a course of 070° true at a speed of 7 knots. At 1232Z (0032L, 30 August), we passed over the 13.5-kHz beacon and continued on a course of 090° true. We maintained this course and speed until the *Challenger* was well past the western edge of the seamount and out over the abyssal plain. At 1532Z (0232L, 30 August), a satellite fix placed the *Challenger* at latitude 44°46.8′N, longitude 170°30.6′E. At 1602Z we changed course to 236° true and steamed back across Suiko Seamount at 6.2 knots. A satellite fix at 1936Z (0636L, 30 August) showed the *Challenger* to be at latitude 44°33.6′N, longitude 170°07.3′E. At 2100Z (0800L, 30 August) we were well out across the western flank of the seamount, and increased speed to about 9.5 knots for the trip to Yokohama.

TABLE 6
On-Site Satellite Navigation Positions, Hole 433B

	Time (Z)	Latitude (N)	Longitude (E)	Satellite	Statistics	Altitude
	18 Aug. 0300,	13.5-kHz BEACON REOCCUPIED				
1	0446	44°46.628	170°01.263	12	Fair-good	53
2	0602	44°46.673	170°01.190	19	Fair-poor	11
3	0634	44°46.679	170°01.252	12	Good	28
4	0904	44°46.663	170°01.235	14	Good	58
5	0934	44°46.675	170°01.248	12	Good	22
6	1030	44°46.667	170°01.217	20	Very good	22
7	1050	44°46.650	170°01.235	14	Very good	26
8	1126	44°46.658	170°01.206	13	Very good	29
9	1158	44°46.712	170°01.268	20	Good	55
10	1648	44°46.598	170°01.157	12	Fair-good	55
11	1832	44°46.592	170°01.164	12	Good	26
12	1854	44°46.607	170°01.157	19	Good	26
13	2010	44°46.626	170°01.145	14	Very good	27
14	2042	44°46.621	170°01.171	19	Fair-good	47
15	2158	44°46.612	170°01.203	14	Good	53
16	19 Aug. 0100	44°46.479	170°01.144	13	Poor	10
17	0140	44°46.463	170°01.065	20	Poor	10
18	0352	44°46.627	170°01.245	12	Fair-good	23
19	0658	44°46.610	170°01.268	19	Very good	32
20	0726	44°46.684	170°01.327	12	Poor	11
21	0820	44°46.597	170°01.283	14	Very good	27
22	0844	44°46.611	170°01.276	19	Very good	45
23	0958	44°46.604	170°01.278	14	Fair-good	56
24	1056	44°46.601	170°01.267	20	Good	47
	RE-ENTRY CONE SPUDDED IN 1445 19 AUGUST					
25	1552	44°46.603	170°01.268	12	Good	24

Seismic reflection profiles obtained along the *Challenger's* eastern course from Site 433 show the continuation of the lagoonal and pelagic sediments to the eastern edge of Suiko Seamount, where they thin and wedge out against an acoustic basement buttress that marks the distal edge of the seamount's top (Figures 15 and 16). The 3.5-kHz profile shows the pelagic sediments becoming thicker to the east of Site 433 and finally thinning near the outer edge (Figure 17). Seismic reflection and 3.5-kHz profiles show little or no sedimentary cover and no pelagic sediments whatever (Figures 18, 19, and 20). Morphologically, the seamount appears to consist solely of the central platform. Protrusions of volcanic rock may occur near the gently rounded crest of the central platform, and steeply down-faulted, terrace-like features exist along the upper eastern flank of the seamount. We found no evidence that the lagoonal sediments drilled at Site 433 continue from the northern edge of the central platform around to the eastern and western edges. The preserved part of the lagoon appears, therefore, to be restricted to the northern part of the seamount.

SEDIMENT LITHOSTRATIGRAPHY

Sediments at the multiple re-entry site on Suiko Seamount were drilled successfully. A complete sequence of continuously cored sediments was recovered in the pilot hole, Hole 433A. The sedimentary cores obtained at Holes 433, 433B, and 433C provided supplementary information. For example, the exposed contact between the lowest sedimentary rock (a calcarenite) and basalt was cored only in Hole 433B; and Unit 6, an intrabasalt sand, was recovered only in Hole 433C. Extreme deformation of the unconsolidated oozes, muds, and sands during coring obliterated sedimentary structures in these soft materials, except in those occurring in lithified zones. After examination of the cores, the sediments were divided into six lithologic units, as follows:

Unit	Lithology	Hole	Cores	Depth below Surface (m)
1	Foraminiferal-nannofossil ooze	433	1 (0-1.3 m)	
			1 (0-0.45 m)	0- 5.0
		433A	2 (0-1.15 m)	
2	Diatom-nannofossil ooze to marly siliceous nannofossil ooze	433	1 (1.3-4.85 m)	
			1 (0.45-15 m)	5.0- 43.0
			2(1.15-2.4 m)	
			3-5	
3	Calcareous ooze to calcareous chalk	433A	6 (0-9.15 m)	43.0- 52.0
4	Tuffaceous sandy mud a) siliceous and b) volcanic	433A	6 (9.15-9.5 m), CC	52.0- 52.5
5	Reef carbonate sand and sandy mud with algal nodules to reef calcarenite	433A	7-19	52.5-163.5
		433B	1-4	
		433C	1	
	Basalt (Flow Unit 1)			163.5-177.5
6	Reef carbonate sand, rich in volcanic material	433C	3	177.5-181.5
	Basalt (Flow Unit 2)			181.5-

Figure 21 shows a composite of these lithologic units.

Sediment Description

Hole 433

Lithologic Units 1 and 2 are represented in Core 1. Unit 1 is an olive (5Y 5/4) to gray (10YR 6/1) foraminiferal nannofossil ooze. Microscopically, it contains foraminifers (25%), calcareous nannofossils (25%), carbonate particles (25%), diatoms (10%), fish remains (5%), sponge spicules (5%), and quartz (5%), plus trace feldspars and micronodules. Unit 2 consists of a grayish brown (10YR 5/2) to olive-gray (5Y 5/2) sandy diatom-nannofossil ooze, and a light brownish gray (2.5Y 6/2) to white (2.5Y 8/2) diatom-nannofossil ooze. The sandy sediment is composed of foraminifers (0 to 20%), diatoms (10 to 30%), calcareous nannofossils (20%), carbonate particles (20%), sponge spicules and silicoflagellates (5%), quartz (10%), feldspars (5%), and clay (10%), plus traces of heavy minerals. The non-sandy sediment is entirely fossiliferous, and contains calcareous nannofossils (65%), carbonate particles (5%), diatoms (25%), and sponge spicules (5%).

Hole 433A

Unit 1 is represented at the tops of both Cores 1 and 2, and is separated into two parts at the bottom of Core 1 by Unit 2. This discrepancy probably occurred during drilling when a wash-down re-entry was made before drilling Core 2, and the overlying sediment of Unit 1 was not completely washed away. Unit 1 is a light brownish gray (2.5Y 6/2) to olive (5Y 4/3) silty to sandy foraminiferal nannofossil ooze. It contains calcareous nannofossils (40 to 50%), foraminifers (10 to 25%), carbonate particles (10 to 20%), diatoms (10%), sponge spicules (5%), quartz (5 to 10%), and feldspar (0 to 5%).

In Cores 1 and 2, Unit 2 is a light gray (2.5Y 7/2) to white (2.5Y 8/2) diatom-nannofossil ooze composed of calcareous nannofossils (65%), carbonate particles (5%), diatoms (25%), and sponge spicules (5%). Unit 2 continues through Cores 3, 4, and 5, but changes gradually from a diatom-nannofossil ooze to a marly siliceous nannofossil ooze. This change is reflected in both the color of the sediment and its composition. The white (5Y 8/1) to light gray (5Y 7/1) diatom-nannofossil ooze of Cores 3 and 4 is composed primarily of calcareous nannofossils (60 to 75%), together with carbonate particles (5%), diatoms (10 to 25%), sponge spicules (5 to 10%), radiolarians (0 to 5%), and clay (0 to 5%). The color of the marly siliceous nannofossil ooze of Cores 4 and 5 is variable, and ranges from white (5Y 8/1) to light gray (5Y 7/1 and 5Y 7/2), from light olive-gray (5Y 6/2) to pale olive (5Y 6/3), and from olive-gray (5Y 5/2 and 5YH 4/2) to olive (5Y 5/3 and 5Y 4/3). The olive to gray coloring coincides with the presence of glauconite (up to 5%) and clay in the ooze. The calcareous nannofossil content of the marly ooze gradually decreases with depth from a maximum of 60 per cent to a minimum of 25 per cent. This decrease is matched by an increase in the amount of unspecific carbonate particles from 5 to 30 per cent and of clay content from 5 to 15 per cent. The siliceous fraction remains relatively

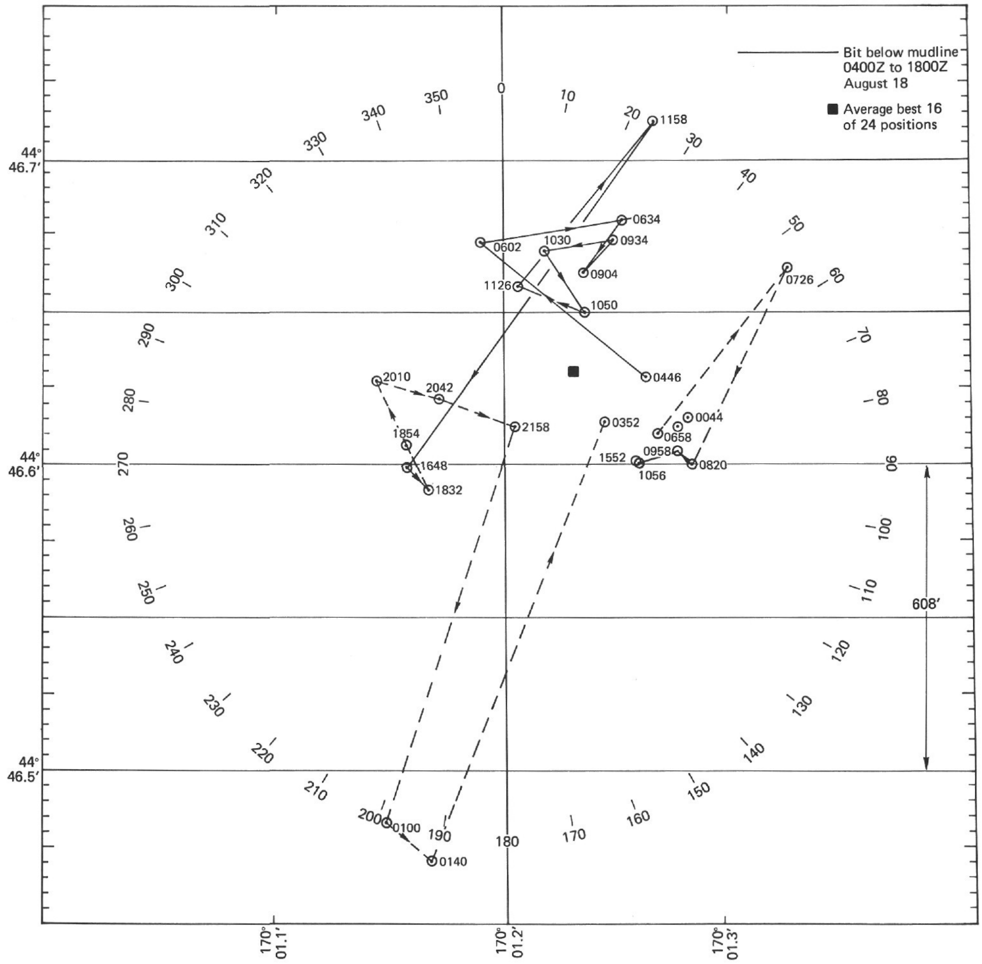


Figure 14. *Mercator plot of satellite navigation locations during drilling of Hole 433B and spudding of Hole 433C.*

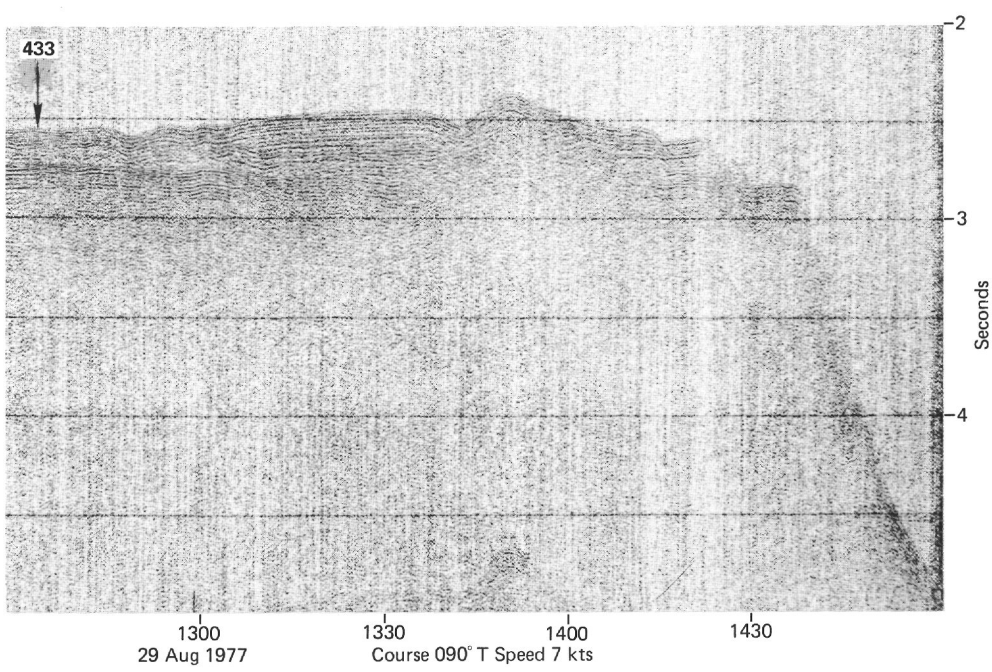


Figure 15. Glomar Challenger *5-s seismic reflection profile on departure from Site 433.*

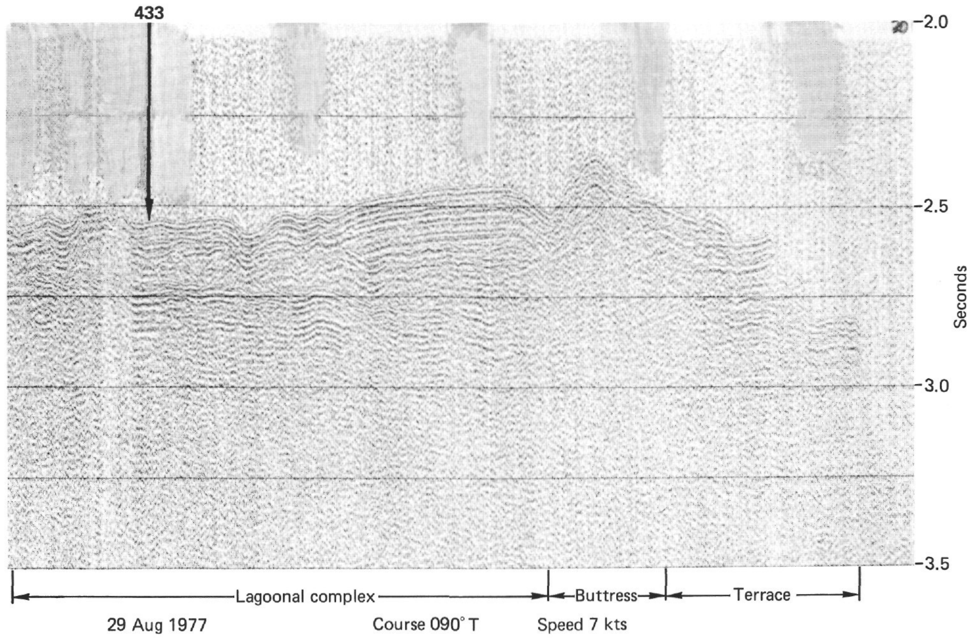


Figure 16. Glomar Challenger *2.5-s seismic reflection profile on departure from Site 433, showing lagoonal complex thickening to the east.*

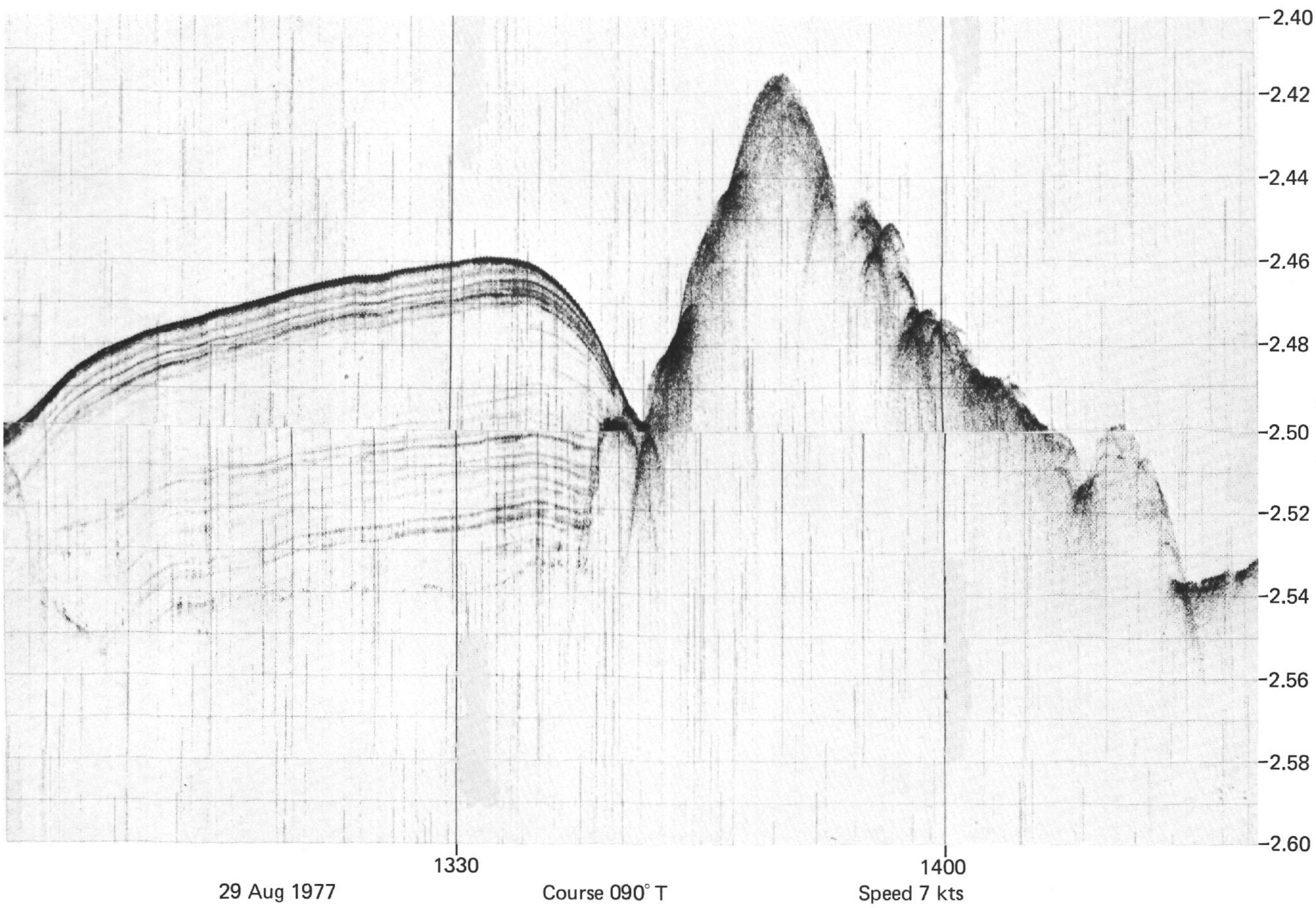


Figure 17. Glomar Challenger *3.5-kHz profile on departure from Site 433, showing thickening of pelagic sediments to the east.*

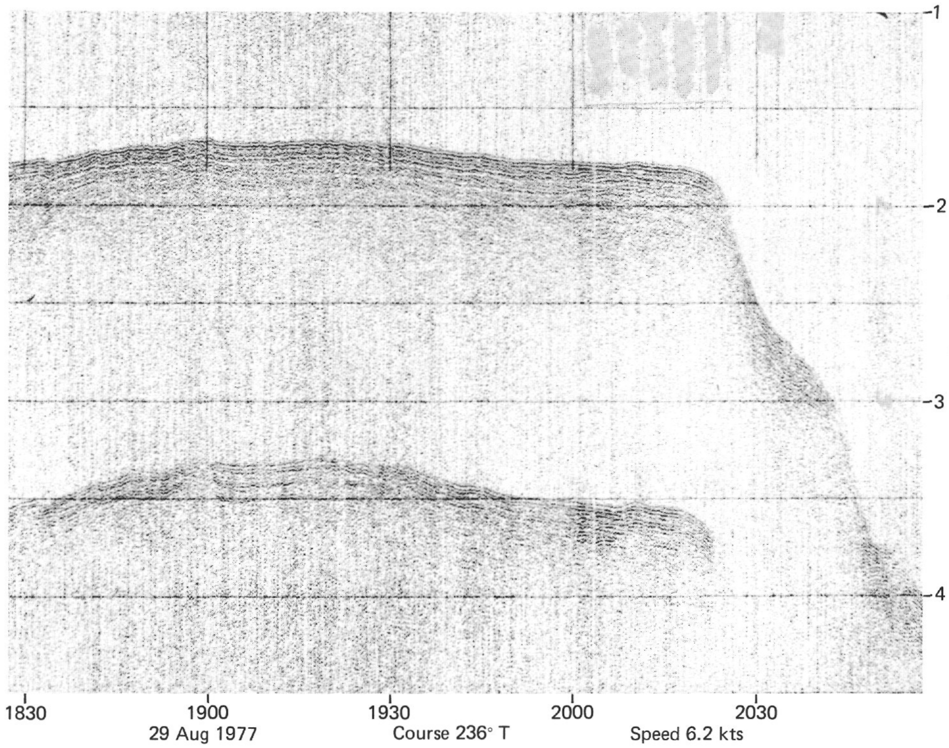


Figure 18. Glomar Challenger *5-s seismic reflection profile across central part of Suiko Seamount enroute to Yokohama, Japan.*

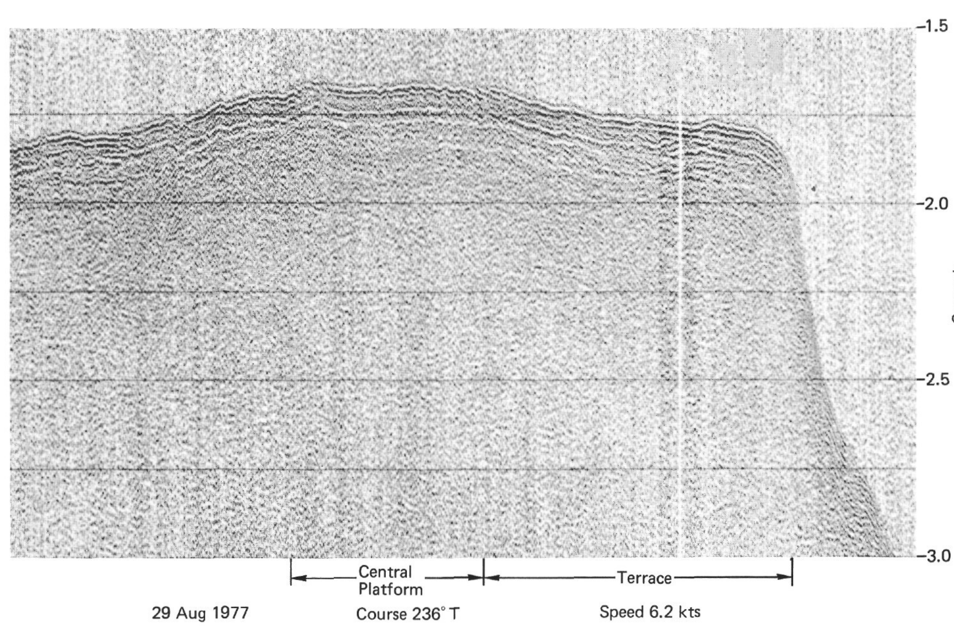


Figure 19. Glomar Challenger *2.5-s seismic reflection profile across the central part of Suiko Seamount, showing absence of lagoonal complexes.*

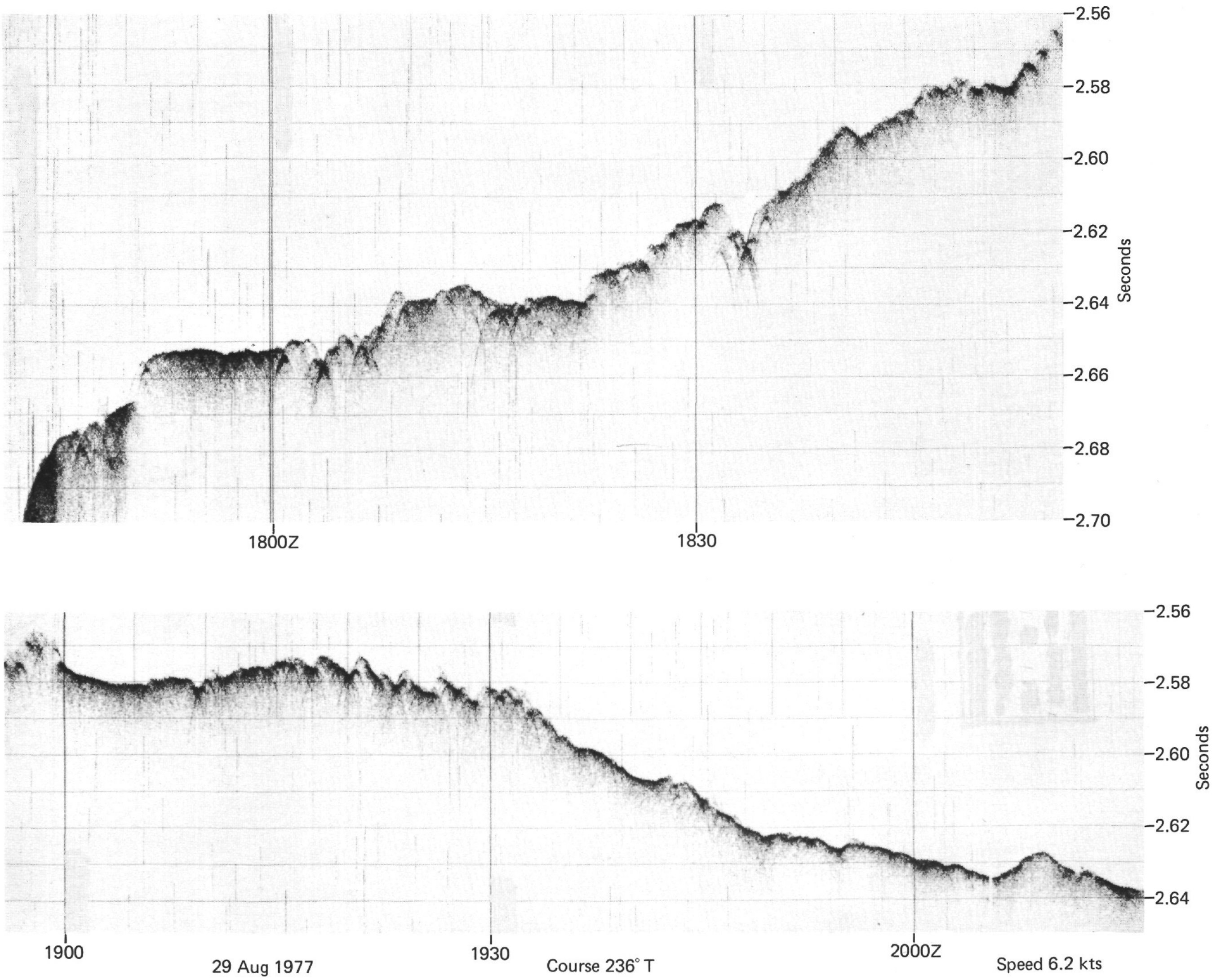


Figure 20. Glomar Challenger *5-kHz profile across the central part of Suiko Seamount, showing the lack of pelagic sediments.*

constant throughout, and consists of diatoms (15 to 20%), radiolarians (5 to 10%), sponge spicules (trace to 5%), and silicoflagellates (trace).

Unit 3, calcareous ooze to calcareous chalk, is confined entirely to Core 6 (0 to 9.15 m). The calcareous ooze is light gray (5Y 7/1), and consists of unspecified carbonate particles (50%), calcareous nannofossils (35%), diatoms (10%) and radiolarians, sponge spicules, and silicoflagellates (5%). A dense, well-crystallized pyrite concretion (olive-gray 5Y 1/2, 3 × 4 × 1 cm) at 8.41 to 8.42 meters separates the ooze from the chalk. The white (7.5YR 8/1) calcareous chalk, although somewhat deformed below its upper boundary, is very firm and compact. It splits apart along parallel planes, which attests to its degree of induration. Viewed microscopically, it contains unspecified carbonate particles (40%), calcareous nannofossils (45%), diatoms (10%), and clay (5%), along with traces of sponge spicules.

Unit 4, a tuffaceous sandy mud in Core 6 (9.15 to 9.50 m plus the core-catcher sample), was very highly deformed during drilling. It can be divided into two sub-units: siliceous and volcanic. The stratigraphic relationship between the two sub-units was obscured during coring. The gray (5Y 5/1) marly siliceous ooze contains diatoms (30%), radiolarians (30%), sponge spicules (15%), carbonate particles (10%), volcanic glass (10%), and clay (5%). The dark gray (5Y 4/1) sandy, volcanic calcareous mud contains calcareous nannofossils (20%), discoasters (10%), diatoms (5%), radiolarians (5%), sponge spicules (5%), clay (20%), volcanic glass (10%), quartz (10%), heavy minerals (10%), and feldspars (5%). This tuffaceous sandy mud probably represents an unaltered volcanic ash layer.

Unit 5, Cores 7 through 19, is a reef carbonate sand and sandy mud containing randomly dispersed algal nodules, often called rhodoliths. Calcarenites containing the same reef detritus occur at the base of the

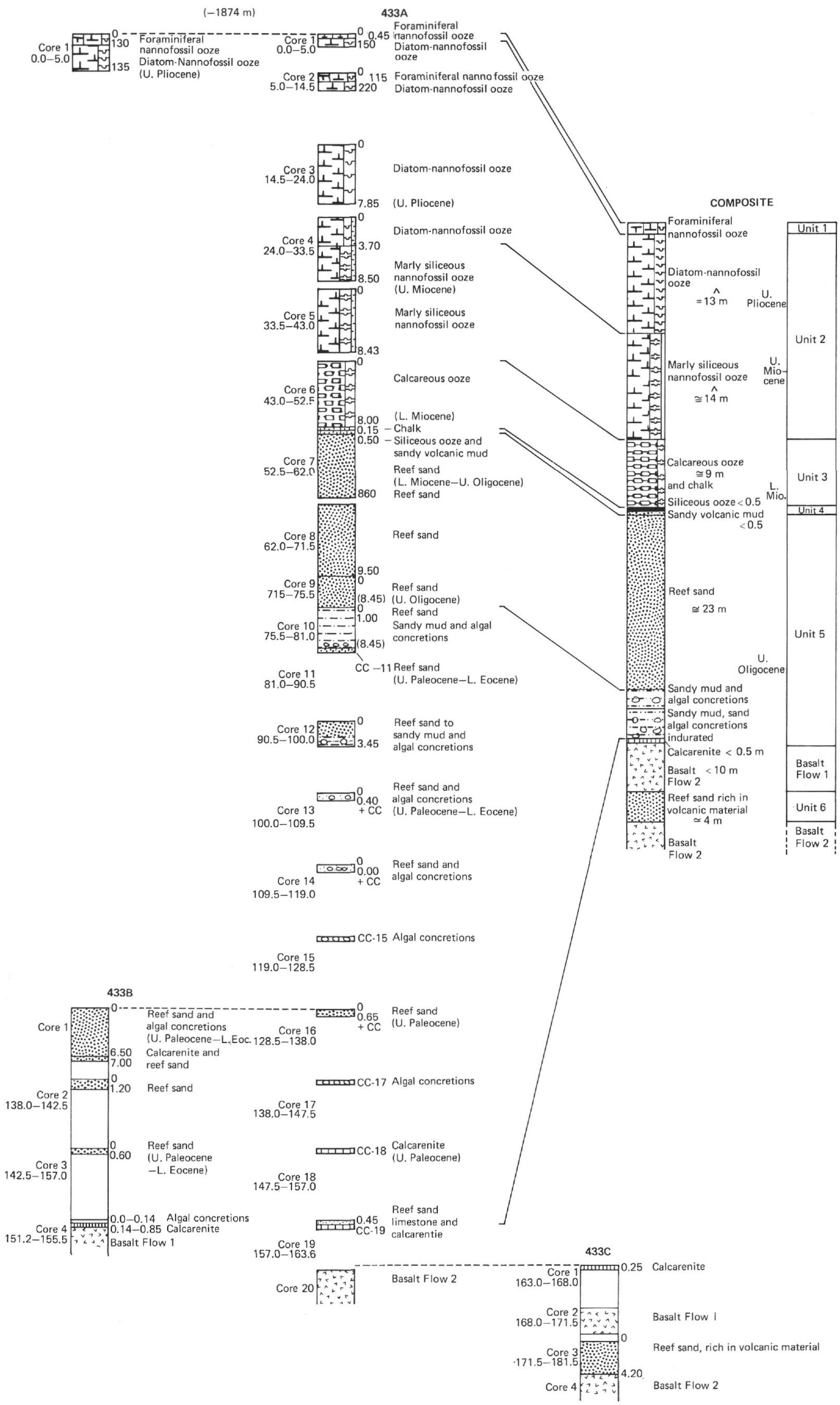


Figure 21. *Composite of sedimentary lithologic units from Site 433.*

lithologic unit. The sand is composed of clastic fragments from a typical reef assemblage. Bryozoans, coralline algae, mollusk shells, sand-size algal nodules, fish teeth, and large foraminifers are represented. The sand is particularly rich in bryozoans. The fine fraction is in general 100 per cent unspecified carbonate.

Size sorting within the sands and muds varies from core to core. In general, sands are poorly to moderately well sorted. The carbonate clasts are usually subangular to rounded, indicating that they have been worked in a high-energy environment. The sand-size range spans the entire classification scale from very fine sand to very coarse sand, and even includes granule-size clasts. On the average, the sand is coarse- to medium-grained. Graded bedding in these cores is an artifact of drilling and settling. The color of the carbonate and mud changes gradually from pale yellow (5Y 8/3) and white (5Y 8/2) to light gray (2.5Y 7/1) to gray (2.5Y N6/1) with increasing depth in the hole. This color change is related to an increase in the percentage of gray reef carbonate clasts. With depth, the contribution of the gray clasts increases to 50 per cent of the total. The contribution of volcanic clasts to the sand particles varies randomly from 0 to 15 per cent.

The sandy carbonate mud (pale yellow, 5Y 8/3) predominates in Core 10. This sediment is a mixture of clay to very fine grained sand particles, and contains algal nodules. It alternates with poorly sorted sand layers rich in nodules. The algal nodules found throughout Unit 5 are round, white to light gray balls frequently retaining smaller nobs on their surface. These nobs may indicate that no long-distance transport has occurred. In cross-section, the algae forming the nodule appears to have grown around a central nucleus, often dark gray. From the nucleus, growth continued outward with production of sequential crinkled laminae over the surface of the semispherical nodule, as shown in Figure 22. The diameter of the nodules varies between 1 and 6 cm, and averages 2 to 3 cm.

Two calcarenites were recovered at the base of Unit 5. In Core 18, the specimen is a gray, poorly cemented, friable calcarenite composed of carbonate sand, small (1 to 3 mm diameter) algal nodules, shells, bryozoans, and coralline algal fragments. A light gray, porous but hard calcarenite composed of similar components was found in Core 19 (Figure 23). In both cases the cement is calcite, but the degree of lithification is more extreme in Core 19. In thin section, the detrital particles of the Core 19 calcarenite are cemented together with micritic calcite. Shell fragments of pelecypods, gastropods, and ostracodes have been partially dissolved, and their molds incompletely filled with recrystallized calcite; micrite along their edges gives way to drusy calcite in their interiors. The cells of the coralline algae are, in particular, filled completely with calcite in a drusy mosaic pattern.

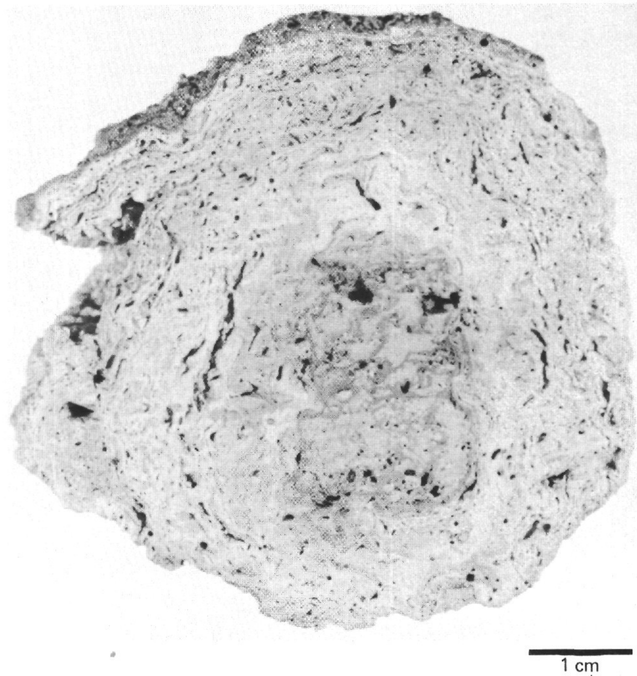


Figure 22. *Cross-sectional view of an algal nodule from Hole 433A, Sample 14, CC.*

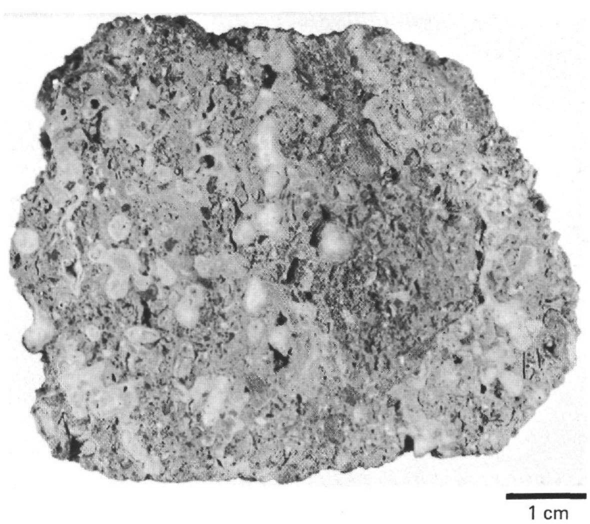


Figure 23. *Light gray porous calcarenite, composed of biogenic carbonate sand, Hole 433A, Sample 19,CC.*

Hole 433B

Gray (2.5Y 6/0) and white (2.5Y 8/0) reefal carbonate sand of Unit 5 occurs in the first three cores from Hole 433B. Its components are the same as those in Hole 433A, given above. The sand is poorly to moderately well sorted. The percentage of volcanic clasts varies from 0 to 15. Glauconite and pyrite crystals occur growing inside the openings of the lattice-like structure of the bryozoans. Pyrite is also present in the fine fraction of the sand. A gray (7.5YR N5), very friable calcarenite occurs in Core 3. Also, the ubiquitous algal nodules of Unit 5 are distributed thoughout the sand. The amount of turning the nodules received during the growth of their progressively accumulated layers is indicated by their shapes, which vary from round to oval to polygonal.

The contact between the basalt and the calcarenites of the lower part of Unit 5 was recovered in Core 4. Above the contact is a 35-cm sequence of calcarenites that become progressively more lithified down-section, approaching the basalt. At the top of the core, broken fragments of the calcarenite occur, along with algal nodules; these are succeeded down the section by a continuously cored section of calcarenite, terminating at the basalt. The calcarenite contains clasts of coralline algae, bryozoans, algal nodules, and basalt. In the upper 20 cm, the clasts range from coarse sand to pebbles. At about 20 cm, a marked change to finer sand components occurs. The sands in this finer fraction are well sorted, and the particles are sub-angular to rounded. Overall, elongated particles tend to be aligned parallel to the plane of bedding. Some reverse size grading seems to occur between 15 and 30 cm: finer clasts grade up into coarse clasts. The sediment directly above the basalt is well rounded, well-sorted sand; the sorting undoubtedly contributes to denser packing of the grains.

Diagenetic changes in the calcarenite are notable. Porosity decreases with depth, as a result of cementation. Euhedral crystals are visible in the pores. At 28 cm, the overall color of the rock changes from light gray (5Y 7/2) to pale yellow (2.5Y 8/4). In thin section, the particles are rimmed with rhombohedral micrite. Gastropods, pelecypods, and foraminifers have been dissolved and their molds filled with micrite and drusy calcite. Near the contact, the coralline algae has dissolved and recrystallized. With increasing depth, the calcite cement changes from predominantly micrite to a drusy mosaic calcite to a recrystallized matrix of microspar calcite at the sediment/basalt boundary.

Directly at the boundary, detrital carbonate sand fills the eroded surface of the basalt and extends into what might have been a large vesicle or fissure. Two generations of cement filling occur in the basalt: the first is a calcite vein filling of cemented basalt clasts and clay, and the second is the calcite-cemented reef carbonate sand.

Hole 433C

Unit 5 is represented by four calcarenite rocks found above the basalt in Core 1. The first two are gray (4.5YR N6) and porous. In thin section, the carbonate reef sand is rimmed and cemented with micrite. The second two calcarenite rocks are dark gray (7.5YR N4) and denser because of almost complete calcite cementation of the pores. In thin section, the cementation has progressed from micrite rims to drusy mosaic calcite to recrystallized microspar. The sand components are fragments of bryozoans and coralline algae, and algal nodules.

Unit 6 was cored only in Hole 433C, below the first basalt flow. The sediment in Core 3 is a well-sorted, coarse to very coarse reef carbonate sand rich in volcanic material. The grains are sub-rounded to rounded fragments of white and gray coralline algae and bryozoans (70%), and basalt and quartz (30%). A second basalt flow underlies the sand.

Discussion

Shallow-water sediments and fauna of coral reef origin have been identified on Kōkō Seamount, the southernmost seamount in the Emperor Seamount chain (Larson, Moberly, et al., 1975). With the recovery of reef carbonate sand and mud at Site 433, the existence of reefs in the Emperor Seamount chain has been extended approximately 10° northward. The coralline algae and bryozoan detritus in the sediments cored on Suiko Seamount indicate that the drilling site is close to the site of an ancient bryozoan-algal reef. The sedimentological evidence, along with geophysical and biostratigraphical data, indicates that the Site 433 drilling was into shore and lagoonal zones on the back-reef region of a reef complex.

An unlithified, well-sorted, reef carbonate beach sand rich in volcanic material occurs sandwiched between the two uppermost basalt flows. This certainly suggests that volcanic activity and reef growth were contemporaneous processes on Suiko. Directly above and in contact with the basalt, a calcarenite composed of reef sand was cored. The calcarenite shows reverse grading, which could be explained as a result of wave grading of sand in a shore zone. The overall tendency of elongated grains to be aligned parallel to the bedding plane also suggests shoreline processes. Offshore, this orientation can result from wave action rolling the grains to and fro, or from longshore currents. Near shore, on the beach face, grain orientation is parallel to the backwash (Blatt et al., 1972).

In the calcarenite, the extent and degree of lithification rapidly decreases up the sedimentary column and ends in unconsolidated sand. The lithification appears to be associated with early-stage diagenesis, such as beach rock formation in the intertidal zone, or cementation in a shallow-water, restricted marine environment. Subtidal cementation of carbonate sands in back reef regions has been reported for the modern reefs of Bermuda (Ginsburg et al., 1971) and Jamaica (Land and Goreau, 1970). A study of the diagenesis of the Suiko shallow-water carbonates has been completed (McKenzie and Bernoulli, this volume).

The reef carbonates in Unit 6 and the lower part of Unit 5 are light gray to gray, and become white to pale yellow in the upper part of Unit 5. Crystals of pyrite and glauconite occur in the pore spaces of the gray bryozoans. These minerals, along with the darker color, can be indicators of reducing conditions. Perhaps these gray sands were deposited in what was, or was to become, an anaerobic environment. Subsequent changes in the circulation pattern within the basin produced oxidizing conditions, and the lighter color of the carbonate sediments resulted. Algal nodules occur randomly spaced throughout Unit 5. We cannot say whether they grew in place or were also part of the detrital input; either is possible.

The reef carbonate sediments are separated stratigraphically from the pelagic sediments by an altered volcanic sand. This layer is the stratigraphically highest evidence of the deposition of volcanic debris at Site 433. The fossil components mixed with the volcanic sand indicate the beginning of pelagic sedimentation. The onset of pelagic sedimentation and the end to the growth of the bryozoan-algae reef fauna on Suiko is marked by a hiatus. The cessation of reef production resulted from a subsidence rate of the seamount greater than the upward growth rate of the reefs, or from a decrease in sea water temperature that inhibited continued reefal growth — or from a combination of both.

BIOSTRATIGRAPHY

Foraminifers and Other Microfossils

Hole 433

Pleistocene-Pliocene

At Hole 433, Core 1 consists of foraminifer-rich sandy ooze and diatom-rich nannofossil ooze. Study of foraminifers in the samples from Section 1 and the upper part of Section 2 (1-1, 40-45 cm and 1-2, 1-3 cm) indicates a Pleistocene date. The assemblage includes very abundant *Neogloboquadrina pachyderma* (dominant left-coiled) and *Globigerina bulloides*. Other members of the assemblage include *Globorotalia inflata* and rare specimens of *G. ronda*, *G. crassaformis*, and *G. scitula*. Absence of *Globorotalia truncatulinoides* makes separation of Pleistocene from Pliocene sediment difficult, but data from diatom stratigraphy (see Koizumi, this volume) apparently place Samples 1-2, 9 cm through 1-1, 74 cm in the upper Pleistocene. Furthermore, the predominance of left-coiled *N. pachyderma* and the abundance of ice-rafted material in several samples of the section (heterogeneous sand and pebble) suggest a cold Pleistocene climate. The samples from the lower sections of Core 1 (1-2, 49-51 cm and 1, CC), however, contain *Globorotalia puncticulata*, *G. inflata*, *G. crassaformis*, *Globigerinoides extremus*, *Neogloboquadrina humerosa*, *N. pachyderma* (right-coiled), *Orbulina universa*, *O. bilobata*, and rare specimens of *Globorotalia ronda*, all indicating the upper Pliocene.

In contrast to the Pleistocene assemblage (see above), this assemblage indicates a relatively warm, subtropical watermass during the Pliocene (for benthic foraminiferal assemblage, see Hole 433A).

Hole 433A

Pleistocene-Pliocene

A foraminiferal assemblage almost identical to that at Hole 433 occurs in Hole 433A. Sample 1, 4-13 cm contains a low-diversity assemblage of small planktonic foraminifers, together with abundant ice-rafted material, indicating a cool Pleistocene environment. Typical species include abundant *Globigerina bulloilides* and *Neogloboquadrina pachyderma* (dominant left-coiled), and fairly abundant *Globorotalia inflata* and *G. crassaformis*. Scarce specimens of *G. ronda* and a single specimen of *G. truncatulinoides* are also present in the assemblage, indicating a Pleistocene date for Sample 1-1, 13 cm. Diatoms (Koizumi, this volume) place Sample 1-1, 1-19 cm in the upper Pleistocene.

In contrast to the underlying Pliocene sediment (Cores 1 through 3), the upper Pleistocene sediment (Sample 1-1, 13 cm) contains lower middle bathyal benthic foraminifers such as *Planulina wuellerstorfi*, *Melonis pompiloides*, *Pyrgo murrhina*, *Oridorsalis umbonatus*, *Gyroidina neosoldanii*, *Cassidulina translucens*, and *C. lomitensis*. Uvigerinids are abundant, and include bathyal species such as *Uvigerina peregrina*, *U. hispida*, and *U. proboscidea*. Scattered specimens belonging to the genera *Siphonodosaria*, *Nodosaria*, *Lagena*, and *Martinottiella* also occur. This assemblage resembles other Quaternary benthic foraminiferal assemblages reported for Sites 430, 431, and 432, and may also indicate a change in bottom temperature, related to bottom currents, since the Pleistocene (see Butt, this volume).

In Hole 433A, Samples 1-1, 59-61 cm through 3, CC contain Pliocene nannofossil ooze. The lower Pliocene assemblage in the samples includes *Globorotalia puncticulata, G. crassaformis, G. conoidea, G. scitula, Neogloboquadrina humerosa, N. pachyderma* (right-coiled), *Globigerina bulloides, G. glutinata,* and *Orbulina universa.* The upper Pliocene assemblage in Samples 3-3, 44-46 cm through 1-1, 59-61 cm includes *Globorotalia inflata, G. puncticulata, G. crassaformis, Globigerina bulloides, G. glutinata, Neogloboquadrina humerosa, N. pachyderma* (right-coiled), *Globigerinoides* cf. *ruber, Orbulina universa,* and *O. bilobata.*

Important benthic species include *Melonis affinis, Oridorsalis umbonatus, Pullenia bulloides, Gyroidina neosaldanii, Pyrgo murrhina, P. depressa, P. serrata, Rectoglandulina rotundata,* and *Laticarinina pauperata.* Other benthic species present but scarce include *Uvigerina peregrina, U. hispida, Cassidulina subglobosa,* specimens of the genera *Dentalina, Nodosaria,* and *Fissurina; Praeglobobulimina siphonodosaria,* and species of *Pleurostomella.* Species of *Stilostomella* are abundant in Miocene through Pliocene sediments.

Miocene

Compared with Pliocene sediments, the Miocene sediments in Hole 433A, Cores 4 through 6, yield scarce to common planktonic foraminifers, but siliceous fossils such as radiolarians are the major constituents of the sand fraction. Detailed study of several samples from Cores 4 through 6 reveals that the lower part of the lower Miocene and some of the middle Miocene are absent. The upper part of the lower Miocene (Zone 6, Blow, 1969) occurs in the lower part of Core 6 (Samples 6, CC; 6-7, 33-35 cm; and 6-6, 144-146 cm). The assemblage includes *Globorotalia peripheroronda, G. scitula, G. continuosa, Globoquadrina praedehiscens, Catapsydrax unicavus, Globigerina venezuelana, Globigerinita incrusta,* and *Globigerinoides* cf. *trilobus.* The upper Miocene occurs in Cores 4 through 6 (Samples 6-6, 49-51 cm; 6-5, 100-102 cm; 6-4, 110-112 cm; 6-2, 141-143 cm; 5-4, 51-53 cm; 5-2, 121-123 cm; 4-6, 2-4 cm; 4-3, 39-41 cm; 4-1, 54-56 cm). Important species include

Globorotalia continuosa, *G. scitula*, *Neogloboquadrina pachyderma* (dominant left-coiled), *Globigerina bulloides*, *G. apertura*, *G. nepenthes*, *Orbulina universa*, and *Sphaeroidinellopsis subdehiscens*. *Globorotalia* cf. *crassaformis* first occurs in Sample 4-1, 2-4 cm, suggesting uppermost Miocene or perhaps the Miocene/Pliocene boundary. The Miocene benthic foraminifers (see below) apparently indicate that Suiko Seamount had subsided to an upper middle bathyal depth (Butt, this volume) during this period. Typical upper Miocene benthic species in Cores 4 through 6 include *Oridorsalis umbonatus*, *Pullenia bulloides*, *Gyroidina soldanii*, *Melonis affinis*, *Planulina kellenbergi*, *Laticarinina pauperata*, *Uvigerina proboscidea*, and *Pyrgo depressa*. Stilostomellas and nodosariids are very abundant in all samples studied. Occasionally, species of the following genera are also present: *Lagena*, *Fissurina*, *Pleurostomella*, *Rectoglandulina*, and *Bolivina*. The lower Miocene benthic species include *Laticarinina pauperata* (small size), *Anomalina globosa*, *Uvigerina holliki*, *Planulina bradyi*, and species belonging to the genera *Osangularia*, *Gyroidina*, *Valvulineria*, *Pullenia*, *Bulimina*, and *Bolivina*.

Paleogene

In Hole 433A, planktonic foraminifers are very rare in Cores 7 through 19 (Unit 5), and fine biostratigraphic subdivision of the Paleogene is extremely difficult. No typical middle Eocene-Oligocene through lower Miocene species are present. Thus, this interval is represented in Hole 433A by a major erosional hiatus, perhaps related to vertical motion of Suiko Seamount. Two to three samples per section of Cores 7 through 19 were examined, but most of the samples are barren of planktonic species, although benthic fossils are abundant in nearly all samples. On the basis of some diagnostic species, it is plausible to suggest that the Paleogene reef sedimentary unit is middle Paleocene to lower Eocene. Because of the soupy nature of the Paleogene sediments at Hole 433A, the samples from Cores 7 through 19 are commonly contaminated with Neogene and Quaternary foraminifers, mixed through downhole contamination. These younger contaminated forms (such as *N. pachyderma* and species of *Oridorsalis*, *Uvigerina*, *Cassidulina*) can be easily distinguished from the Paleogene forms by their good preservation. Cores 16 (Sample 16-1, 7-14 cm) and 14 (Sample 14-1, 40-56 cm) contain *Globorotalia angulata*, *G. aequa*, *G.* cf. *conicotruncata*, *G. aragonensis*, and small specimens belonging to the genus *Acarinina*. Cores 13 (Sample 13, CC and Section 1), 11 (Sample 11, CC), 10 (Sections 7 and 5), and 8 (Sample 8, CC) contain some diagnostic species such as *Globorotalia aragonensis*, *G.* cf. *lensiformis*, and *G.* cf. *pseudobulloides*.

The samples from Core 7 yield some interesting lower Paleogene globorotaliids and two poorly preserved Maestrichtian species of *Globotruncana*. In addition, the samples also contain some lower Miocene species identical to those in Core 6, such as *Catapsydrax unicavus* and *Globorotalia peripheroronda*, and upper Neogene-Quaternary species such as *Neogloboquadrina pachyderma* and *Globigerina bulloides* and several benthic species of the same age. These fossils are more abundant in the upper portion of Core 7. The occurrence of these fossils here is considered to be a result of downhole contamination. The following Paleogene species seem to indicate that Core 7 is middle to upper Paleocene: *Globorotalia aragonensis*, *G.* cf. *angulata*, *G.* cf. *pseudobulloides* (Sample 7, CC); *G.* cf. *compressa*, *G. aragonensis, G. aequa*, *Globigerina linaperta* (Sample 7-2, 110-112 cm); *Globorotalia* cf. *caucasica*, *G. aragonensis*, *Globigerina* cf. *linaperta* (Sample 7-1, 40-42 cm). The occurrence of two poorly preserved *Globotruncana* species (one of them identified as *Globotruncana contusa*) in Section 7-1 may indicate that these Cretaceous forms were reworked into Paleogene sediments, and that Suiko as a volcano was built near a time corresponding to the Cretaceous/Tertiary boundary.

In contrast to the planktonic foraminifers described above, shelf benthic foraminifers are frequent in all the studied samples from Cores 7 through 19. The assemblage includes species of *Lenticulina*, *Vaginulina*, *Cibicides*, and *Ammodiscoides*. Their joint occurrence with abundant bryozoans, calcareous algae, ostracodes, echinoids, serpulids, and gastropods indicates a Paleogene shelf reef environment at Suiko Seamount (see Butt, this volume).

Hole 433B

In Hole 433B, Cores 1 through 3, bryozoan-rich calcareous algae sand, are equivalent to Cores 16 through 19 from Hole 433A. Planktonic foraminifers are very rare and poorly preserved. Samples 1, CC and 1-1, 3-6 cm contain Paleocene species such as *Globigerina linaperta* and *Globorotalia aequa*. As at Hole 433A, samples of the Paleogene sediments at Hole 433B are also contaminated by Quaternary planktonic foraminifers. Benthic foraminifers present include only shallow-water shelf forms such as *Lenticulina*, *Vaginulina*, and *Cibicides*; they are associated with ostracodes and bryozoans. The coarse-grained sandstone is made up chiefly of calcareous algae (*Lithothamnium*), stromatolites, and bryozoan fragments. The thin section of Sample 4-1, 28-32 cm contains scattered fragments of a Paleocene algae called *Elianella elegans* (see Hagn and Butt, this volume). Other biogenic constituents include gastropods, pelecypods, echinoids, and ostracodes. A few calcareous rotaliids occur in the thin section.

Hole 433C

Section 1-1, Hole 433C, contains a sediment/basalt contact similar to that in Hole 433B. The coarse-grained, well-sorted sandstone at the contact consists mainly of calcareous algal and bryozoan fragments, and a few stromatolites. Loose calcareous sand containing abundant volcanic fragments was recovered from Core 3, between the lava Flow Units 1 and 2. The core-catcher sample contains bryozoans and benthic foraminifers (*Lenticulina*); planktonic forms are absent. This biogenic component provides no age information. But the occurrence of the algal fragments, *Elianella ele-*

gans in Sample 1-1, 20-25 cm, suggests the Paleocene (See Hagn et al., this volume).

Calcareous Nannofossils

Hole 433

Only one sample (1, CC) from this hole was examined on shipboard. It contains very abundant and well-preserved calcareous nannofossils, but species diversity is low. *Gephyrocapsa doronicoides* and small undiagnostic placoliths dominate the assemblage. *Coccolithus pelagicus*, *Cyclococcolithus leptoporus*, and *C. macintyrei* are frequent; *Pseudoemiliania lacunosa*, *Helicopontosphaera kamptneri*, and *H. sellii* are extremely rare. The occurrence of *Pseudoemiliania lacunosa* together with *Cyclococcolithus macintyrei* and *Helicopontosphaera sellii*, and the absence of *Gephyrocapsa* specimens and *Reticulofenestra pseudoumbilica*, strongly indicate that this sample is upper Pliocene (NN 16 *Discoaster surculus* Zone to NN 18 *Discoaster brouweri* Zone). Discoasters are unexpectedly rare; only some fragments are recognizable. Because of this general absence of discoasters in the material examined, the precise age of this sample within the upper Pliocene interval is still uncertain.

Hole 433A

On the basis of the calcareous nannofossil assemblages, the sedimentary sequence recovered from Hole 433A can be divided into three microfloral units: assemblage 1 (Cores 1 through 5), assemblage 2 (Cores 6 through 7), and assemblage 3 (Cores 8 through 19). The abundance and state of preservation of the calcareous nannofossils change markedly between assemblages 1 and 2 and between assemblages 2 and 3.

Assemblage 1 (Cores 1 through 5)

Assemblage 1 is characterized by very abundant, well-preserved but comparatively less species-diversified nannofossils, and is represented by six samples. Cores 1 through 3 are quite similar to the material in Hole 433. The coexistence of *Cyclococcolithus macintyrei* and *Pseudoemiliania lacunosa* indicates that Sample 1-1, 4-13 cm, the youngest sample of Hole 433A examined, is upper Pliocene or lower Pleistocene. In particular, a few occurrences of *Gephyrocapsa caribbeanica* strongly indicate that this sample is lowermost Pleistocene. It is therefore likely that most of the Quaternary sediments at this site are either too thin to recover or were eroded away by bottom currents. On similar evidence, we assign Samples 1, CC; 2, CC; and 3, CC to calcareous nannoplankton Zones NN 16 (*Discoaster surculus* Zone) to NN 18 (*Discoaster brouweri* Zone) (upper Pliocene). Sample 4, CC is also characterized by fairly abundant calcareous nannofossils. Though the species diversity is also comparatively low, the preservation is slightly poorer than in previous samples. In this sample, *Discoaster intercalcaris* and *Cyclicargolithus floridanus* occur together. This is significant because in previous studies the extinction of *Cyclicargolithus floridanus* defines the top of the *Coccolithus miopelagicus* Subzone of the *Discoaster exilis* Zone (middle Miocene), while the initial appearance of *Discoaster intercalaris* marks the base of the *Discoaster hamatus* Zone, and the *Catinaster coalitus* Zone is between them. Therefore, the joint occurrence of the two species observed here should be investigated further to determine whether the initial appearance of *Discoaster intercalaris* should be extended or whether the extinction of *Cyclicargolithus floridanus* could have occurred later in time than previously documented. Among the calcareous nannofossil species recovered from Sample 5, CC, the most important species is *Discoaster quinqueramus*, which can be used to assign the sample to NN 11 *Discoaster quinqueramus* Zone (upper Miocene).

Assemblage 2 (Cores 6 through 7)

Calcareous nannofossils in assemblage 2 include common lower Miocene species, moderately well preserved, together with a few Paleocene specimens, and Samples 6, CC and 7, CC are considered to be Paleocene.

Assemblage 3 (Cores 8 through 19)

In assemblage 3, calcareous nannofossils are extremely rare and poorly preserved. The assemblage is marked by very low species diversity. Sample 8, CC is barren, and Sample 10, CC contains no age-diagnostic specimens.

Samples 11, CC through 13, CC contain several lower Paleogene nannofossil species, the combined occurrence ranges of which provide evidence for an upper Paleocene assignment. It is remarkable that in Sample 433A-16, CC, a typical Paleocene species, *Cruciplacolithus tenuis*, was found for the first time during this cruise, together with *Neochiastozygus distentus*, *Toweius eminens*, and *T. craticulus*. Generally, *C. tenuis* occurs abundantly in the sequence ranging from the lower Paleocene NN 2 *Cruciplacolithus tenuis* Zone to the upper Paleocene NN 6 *Heliolithus kleinpellii* Zone. The presence of this species therefore dictates that the sediments above the basalt can be no younger than upper Paleocene. Although Samples 17, CC and 18, CC contain no *Cruciplacolithus tenuis*, their age is considered the same as that of Sample 16, CC, because of the presence of such species as *Neochiastozygus chiastus*, *N. distentus*, and *Toweius eminens*. In Sample 19, CC, these species are completely absent. The upper half of this floral unit — Samples 10, CC; 11, CC; and 13, CC — contain a small number of moderately well preserved coccoliths and discoasters such as *Gephyrocapsa doronicoides*, *Cyclococcolithus leptoporus*, *C. macintyrei*, *Discoaster intercalaris*, *Helicopontosphaera sellii*, *Pseudoemiliania lacunosa*, and *Reticulofenestra pseudoumbilica*. There appears to be uphole contamination of Neogene nannofossils.

Hole 433B

Among three core-catcher samples recovered from this hole, 1, CC and 3, CC contain calcareous nannofossils. The assemblage of Sample 1, CC consists of poorly preserved *Coccolithus pelagicus*, *Neochiastozygus chiastus*, and *Toweius eminens*. Sample 3, CC contains *N. distentus* in addition to the above species, but in a state of poor preservation. These two samples are therefore probably upper Paleocene. Sample 3, CC contains also several moderately well preserved Neogene specimens; they include *Gephyrocapsa doronicoides, Coccolithus pelagicus, Cyclicargolithus floridanus, Cyclococcolithus macintyrei,* and *Reticulofenestra pseudoumbilica.* They are interpreted as resulting from uphole contamination.

Hole 433C

In the well-sorted reef carbonate and volcanic material intercalated between basaltic Flow Units 1 and 2 (Sample 3, CC), only two poorly preserved coccoliths were found: *Coccolithus pelagicus* and another which may belong to genus *Zygodiscus* — it is somewhat similar to *Zygodiscus sigmoides.* If this identification is correct, the sample may be Paleocene.

Radiolarians

Deep-sea sediments containing common to abundant and well-preserved radiolarians were recovered for the first time during Leg 55 at Site 433. Occurrences of radiolarian taxa and their relative abundances are shown in Table 7.

Hole 433

Core 1 from this hole contains *Lamprocyclas heteroporos*, but lacks some typical Quaternary forms expected at this latitude, including *Eucyrtidium matuyamai*, so the sediments in this core would appear to be middle to upper Pliocene. Subsequent shore-based study reveals, however, that approximately the uppermost 2 meters of sediments are upper lower to upper Pleistocene.

Hole 433A

Radiolarians occur continuously in the siliceous and calcareous ooze of the upper 62 meters and among the upper part of the reef carbonate sands of this hole. The topmost 20 cm (approx.) of sediments contains a few specimens of *Lamprocyrtis heteroporos*, but, like the previous hole, lacks *Eucyrtidium matuyamai.* Similar assemblages also occur in Cores 2 and 3. In Cores 4 and 5, *Stichocorys peregrina* and *S. delmontensis* occur together, along with *Theocorys redondoensis*, but without *Lamprocyrtis heteroporos.* Cores 4 and 5 are assigned to the upper Miocene *Stichocorys peregrina* Zone.

In Cores 6 and 7, the assemblage consists of *Cannartus tubarius, Cyrtocapsella japonica, C. tetrapera*, and *Lychnocanoma bipes*, suggesting that the sediments are lower middle to lower Miocene. Apparently there is a hiatus between Cores 5 and 6 encompassing a part of the upper Miocene and at least a major part of middle Miocene. In Core 8 through Core 19 (the deepest core), radiolarians are either rare and poorly preserved or completely absent. Thus, for stratigraphic purposes, this section is considered barren of these siliceous microfossils.

Holes 433B and 433C

Radiolarians are completely absent in samples from Cores 1 to 3 of Hole 433B, and from the reef sands between basalt flows in Core 3 of Hole 433C.

TABLE 7
Occurrence of Radiolarians at Site 433

Sample \ Taxa	*Cycladophora davisiana*	*Lithomitra arachnea*	*Artostrobus annulatus*	*Cornutella profunda*	*Helotholus histricosa*	*Spongopyle osculosa*	*Lamprocyrtis heteroporos*	*Stylatractus universus*	*Druppatractus acquilonius*	*Triceraspyris* spp.	*Cycladophora davisiana cornutoides*	*Dictyophimus gracilipes*	*Clathrocyclas coscinodiscus*	*Stichocorys delmontensis*	*Theocorys redondoensis*	*Strichocorys peregrina*	*Cyrtocapsella japonica*	*Lychnocanoma bipes*	*Collosphaera* spp.	*Lithopera neotera*	*Heliodiscus asteriscus*	*Cannartus tubarius*	*Calocycletta virginis*	*Cyrtocapsella cornuta*	*C. Tetrapera*	*Eucyrtidium* sp.	*Euchitonia furcata*	*Spirema* sp.	Zone
Hole 433																													
1, CC	F	R	F	F	R	R	F			R	R	R																	*Lamprocyrtis heteroporos*
Hole 433A																													
1, CC	R	F	F		F	F	C	F	F	C	F										R						R		*Lamprocyrtis heteroporos*
2, CC	F	F		R	F	F	C	F	F	C	R	R																	
3, CC		C	R	F	F	R	F			F	R		R														R		
4, CC	R	C	C	F	F			F		F		R	F	F	F	C											R		*Stichocorys peregrina*
5, CC		F	R	R				F				R	R	F		C												R	
6, CC																	C	R	C	F	R	R	R	R	F				*Calocycletta virginis*
7, CC		R		F				F	R						F		C	F	F		F			F	A	C	R	C	

A = Abundant
C = Common
F = Few
R = Rare

Silicoflagellates

Hole 433

The uppermost 2.5 meters of Pleistocene sediments, according to diatom and radiolarian data, contain no silicoflagellates. Sample 1-2, 113-115 cm belongs to the *Ebriopsis antiqua antiqua* Zone, whereas Sample 1-3, 94-99 cm belongs to the *Distephanus boliviensis jimlingii* Zone.

Hole 433A

Generally common to abundant, well-preserved silicoflagellates (and ebridians) are continuous in the upper 62 meters of the sediment column (Cores 1 through 7). In Cores 7 to 19, this group of microfossils is completely absent.

Holes 433B and 433C

No silicoflagellate specimens were found in Cores 1 through 3 of Hole 433B, or in Core 3 of Hole 433C. The uppermost 70 cm of sediment from Hole 433C does not contain this group of microfossils. A sediment sample, 433B-1-1, 70–73 cm, belongs to the Pliocene *Ebriopsis antiqua* Zone, but Sample 433B-1-1, 133–135 cm belongs to the lower Pliocene *Distephanus boliviensis jimlingii* Zone. The top of the *Distephanus quinquangellus* Zone occurs between Cores 3 and 4 (Miocene/Pliocene boundary). Silicoflagellates and ebridians are rare in the lower part of Core 6 (lower middle Miocene to lower Miocene section).

SEDIMENT CHEMISTRY

Three water samples from Site 433 were analyzed for pH, alkalinity, salinity, Ca^{++}, Mg^{++}, and Cl^-; a surface sea-water sample was analyzed for a standard, and two samples from Hole 433A (in Cores 4 and 8) were analyzed. These data are presented in Table 8.

A total of 18 samples from Site 433 were analyzed by the carbonate bomb method: 2 from Hole 433, 13 from Hole 433A, 2 from Hole 433B, and 1 from Hole 433C. The data are presented in Tables 9 through 12. Values range from 26 to 100 per cent $CaCO_3$.

A total of 11 samples, all from Hole 433A, were analyzed for water content, porosity, and wet-bulk density using the syringe technique. Ten of these yielded useful results. The data are presented in Table 13. Water contents range from 39.5 to 61.4 per cent, porosities from 64.7 to 83.5 per cent, and wet-bulk densities from 1.29 to 1.64 g/cm^3.

PALEOENVIRONMENT

During the middle Paleocene, at the end of its main shield-building stage, Suiko Seamount submerged and shallow-water sediments began to accumulate. These sediments were carbonate sands containing coralline algae, bryozoans, benthic foraminifers, and ostracodes, and indicate the nearby presence of a bryozoan-algal reef complex. Sedimentation at Site 433 occurred in a small graben basin located within one of the lateral lagoons on the seamount. Subsidence was continuous throughout most of the depositional history. The reef sands grade upward into carbonate muds which are occasionally interbedded with sand layers and algal nodules.

A major hiatus occurred between the end of this Paleocene shallow-water sedimentation and the onset of pelagic sedimentation in the late early Miocene. This hiatus can be interpreted in two ways: (1) continuous sedimentation, then emergence with erosion and subsequent submergence; or (2) a period of non-sedimentation during the interval in which the seamount subsided from a reef environment into the pelagic realm. A second hiatus occurred in the middle Miocene.

The fossils in the pelagic sediments of the lower upper Miocene indicate relatively warm (transitional) waters. From the late Miocene to the present, there was gradual cooling, culminating in modern (sub-arctic) conditions.

LITHOSTRATIGRAPHY OF VOLCANIC ROCKS

Hole 433C penetrated a total of 67 positively identified (numbered) lava flows, from a depth of 165.5 meters sub-bottom (where the driller first felt hard rock) to 550.5 meters sub-bottom. Of these flows, 21 contain one or more sub-units which may be separate lava flows or flow lobes of single lava flows. There are at least 113 possible lava flows. In addition, there appear to be a well-sorted carbonate and basalt beach sand below Flow Unit 1 in Core 3 (see above) and pumice lapilli tuff intervals in Cores 21 and 31. Hole 433A penetrated only the top lava flow in this sequence; Hole 433B penetrated only the top two. Figure 24 shows the positions of the flows in recovered core, the positions of thin sections, XRF analyses, and samples taken for paleomagnetic analyses.

We used several criteria for determining flow unit boundaries: major lithologic changes, the presence of an oxidized flow top, abrupt changes in vesicularity,

TABLE 8
Summary of Shipboard Geochemical Data, Hole 433A

Sample Number	Core-Section, Interval (cm)	Sub-Depth (m)	*p*H	Alkalinity (meq/kg)	Salinity (‰)	Ca^{++} (mmol/l)	Mg^{++} (mmol/l)	CL^- (‰)
A	Surface sea water		7.91	2.50	33.3	9.74	49.66	17.797
1	4-4, 144-150	29.9	7.34	2.36	35.3	11.20	54.05	19.375
2	8-6, 140-150	70.9	7.39	1.92	35.2	11.22	53.75	19.644

TABLE 9
$CaCO_3$ Content – Carbonate Bomb Method, Holes 433 and 433A

Core-Section, Interval (cm)	$CaCO_3$ (%)
Hole 433	
1-1, 101	28
1-3, 91	73
Hole 433A	
2-1, 56	26
2-1, 136	60
3-2, 80	82
3-4, 43	87
4-2, 60-61	15
4-3, 62-63	34
5-1, 70-71	59
5-5, 114-116	60
8-1, 52-53	100

TABLE 10
$CaCO_3$ Content – Carbonate Bomb Method, Hole 433A

Core-Section, Interval (cm)	$CaCO_3$ (%)
5-2, 145-147	69
5-4, 42-44	82
10-6, 80-81	92
13-1, 14-15	97

TABLE 11
$CaCO_3$ Content – Carbonate Bomb Method, Hole 433B

Core-Section, Interval (cm)	$CaCO_3$ (%)
1-1, 41-42	97
1-4, 128-129	94

TABLE 12
$CaCO_3$ Content – Carbonate Bomb Method, Hole 433C

Core-Section, Interval (cm)	$CaCO_3$ (%)
3-1, 89-90	82

brecciated flow tops (probably the most common criteria; see Figures 25a and 25b), vitrophyric zones (Figure 26), and a concentration of (presumably settled) olivine phenocrysts above vitrophyre. In general, subunit boundaries were drawn where there is no major lithologic change but one or more of the other criteria are present but not well developed.

The thickness and vesicularity of the flows, the absence of pillow structure, and the oxidized flow tops indicate that they erupted subaerially. The only evidence for advancement of flows into water is the sand-sized grains of basalt in the beach sand below Flow Unit 2; these may have been produced by phreatic activity as flows entered the sea.

TABLE 13
Water Content/Bulk Density/Porosity of Sediment, Hole 433A

Core-Section, Interval (cm)	Water Content (%)	Porosity (%)	Wet-Bulk Density (g/cm^3)
1-3, 39	48.4	70.7	1.46
1-4, 30	52.2	73.1	1.40
2-1, 40	48.4	71.9	1.48
3-2, 10	51.4	72.0	1.40
3-6, 20	39.7	64.8	1.63
4-6, 60	58.1		
4-4, 144	61.4	83.5	1.36
5-1, 10	56.2	72.5	1.29
5-4, 40	43.1	67.2	1.56
6-2, 80	45.9	72.5	1.58
7-1, 90	39.5	64.7	1.64

IGNEOUS PETROGRAPHY

Introduction

Hole 433A, 433B, and 433C penetrated a nearly continuous section of subaerial basalt flows, starting at a sub-bottom depth of 165.5 meters and ending at 550.5 meters.

The basalt section starts in a thick (>8.5-m) alkalic basalt flow (Flow Unit 1) overlying a beach sand. The beach sand in turn overlies alkalic basalts (Flow Units 2 and 3), which overlie a sequence of tholeiitic picrites and basalts (Flow Units 5 through 18). From Flow Unit 19 downward the flows are all tholeiitic basalts.

In all, 80 thin sections from 58 flow units, or possible flow units, were examined and described on board ship. The results are summarized in Table 14 and the Visual Core Descriptions at the end of this chapter. More detailed petrography is presented in the petrology chapter (Kirkpatrick et al., this volume).

General Descriptions

Flow Unit 1: Flow Unit 1 is a thick (>8.5-m), massive, porphyritic alkalic basalt with moderately abundant (5 to 10%) phenocrysts of plagioclase and microphenocrysts of olivine and sector-zoned clinopyroxene. The groundmass texture is intergranular to subtrachytic and medium grained. Groundmass olivine is relatively abundant, and the rock contains 10 to 15 per cent opaque Fe-Ti oxides. Apatite is common (1 to 2%) and occurs as both stubby prisms and acicular needles. Groundmass plagioclase is generally more than twice as abundant as groundmass pyroxene.

Flow Unit 2: Flow Unit 2 is also an alkalic basalt, and contains phenocrysts of olivine (5%, mostly fresh), clinopyroxene (3%), and plagioclase (2%). Some of the olivine phenocrysts contain subgrain boundaries; these probably represent mantle xenocrysts. The groundmass texture is intersertal, and plagioclase is more abundant than clinopyroxene. Apatite content is about 1 per cent.

Flow Units 4 through 66: All analyzed flows in this interval are tholeiitic basalts or tholeiitic picrites.

The picrites all contain abundant (up to 55%) olivine phenocrysts. In many flows the olivine is still fresh. Only a few flows contain clinopyroxene or plagioclase phenocrysts.

The groundmass of the picrites is usually intergranular or subophitic. Groundmass plagioclase is generally more abundant than groundmass clinopyroxene. Groundmass olivine and Fe-Ti oxides are ubiquitous. Apatite is not present.

The tholeiitic basalts contain phenocrysts of either olivine alone, or of olivine, clinopyroxene, and plagioclase, or are aphyric. About one fourth of the flows contain more than 10 per cent olivine phenocrysts. In general, the older flows are less porphyritic, especially below Flow Unit 41. Groundmass textures in flow interiors are intersertal, intergranular, or diabasic. Groundmass olivine (or former groundmass olivine now altered to iddingsite or clay) is common. Groundmass plagioclase is generally more abundant than groundmass clinopyroxene.

ALTERATION OF VOLCANIC ROCKS

Introduction

This alteration summary is based upon the Visual Core Descriptions and thin-section examinations. Each flow unit was generally sampled in a relatively fresh part for XRF analysis and thin-section study.

All basalts recovered at Site 433 are at least moderately fresh, especially in their massive flow interiors. Olivine has been taken as the major mineralogical indicator of alteration, because plagioclase and clinopyroxene in most rocks are fresh. All basalts have been divided into four groups according to degree of alteration:

1) Slightly altered: olivine, plagioclase, and clinopyroxene fresh; glass devitrified and altered.

2) Moderately altered: olivine mostly altered, with some fresh cores; plagioclase and clinopyroxene fresh; glass altered.

3) Badly altered: olivine totally altered; plagioclase and clinopyroxene slightly (up to 5 to 10%) altered.

4) Badly altered: olivine totally altered; plagioclase and clinopyroxene partially altered (up to 50 to 70%). This division is more detailed and explicit than those in the Visual Core Descriptions.

As discussed in the Petrography section, we have described alteration products as clays (after glass, olivine, vesicles, and fracture filling) iddingsite (after olivine), and zeolites, without accurate sub-classification of these mineral species.

Hole 433A

The single lava flow unit of Hole 433A (Flow Unit 1) can be divided into three parts.

1) A moderately altered massive flow interior (Sections 20-1 and 20-2; Section 21-1, 0-109 cm) that contains a calcareous sandstone vein (Section 20-2, 31-33 cm) with more altered vesicular layers upward and downward from the vein (Section 20-2, 0-54 cm).

2) A moderately to badly altered flow interior (Section 21-1, 109 cm to Section 21-2, 122 cm) with sub-horizontal thin zones altered to clay.

3) A moderately altered massive flow interior (Section 21-2, 124 cm to Section 21-5, 47 cm) with small, badly altered sub-horizontal layers like those of part 2.

Hole 433B

The upper flow unit of this hole (Flow Unit 1) is texturally and mineralogically similar to Flow Unit 1 in Hole 433A, and is thought to be the same lava flow. The alteration is also similar to that in Hole 433A. The unit consists of a moderately altered flow interior with some fresh olivine. More altered and oxidized parts occur near small fractures (Section 5-1, 0-95 cm).

Hole 433C

Flow Unit 1: Very similar to Flow Unit 1 in Holes 433A and 433B, and is thought to be the same lava flow. It consists of a moderately altered flow interior with fresh plagioclase, pyroxene, olivine altered to iddingsite and clays but with some fresh cores, and glass altered to clays (Section 1-1, 26 cm to Section 1-2, 30 cm), and a badly altered part with sub-horizontal streaks of alteration (Section 1-2, 30 cm to Section 2-1) like part 2 of Hole 433A.

Flow Unit 2: A slightly altered massive porphyritic basalt containing fresh plagioclase, pyroxene, mostly fresh olivine phenocrysts and xenocrysts, and in the groundmass 3 to 5 per cent green to brown clays after interstitial glass and olivine grains (?).

Flow Unit 3: This is represented by a single piece from the bit (Section 2). It is a very sparsely phyric, moderately altered basalt with 1 per cent fresh plagioclase phenocrysts and 1 per cent fresh pyroxene phenocrysts. The glass in the groundmass (5 to 10%) is altered to clays and the olivine grains to iddingsite.

Flow Units 4 (a through f): A very badly altered olivine phyric basalt, mostly oxidized (reddish color). Tops and bottoms of each unit are even more altered and more oxidized than the interiors.

Olivine: Phenocrysts are completely altered to iddingsite and clays; iddingsite is more abundant in the oxidized sub-unit tops and bottoms. Groundmass olivine grains are completely altered, usually to iddingsite, but some clays present.

Plagioclase: Laths and microlites partially altered (up to 60 to 70%), especially in vesicular parts and near the sub-unit tops and bottoms.

Clinopyroxene: Partly altered but mostly fresh in the central parts of sub-units.

Glass: Altered to clays and zeolites(?).

Vesicles: Filled and lined by clays and zeolites, sometimes with carbonate in the central parts.

Flow Units 5 through 8: Sparsely olivine phyric basalts, badly altered. The phenocrysts and groundmass olivine are completely altered to iddingsite and clays, glass is altered to clays and zeolites, whereas plagioclase and clinopyroxene are fresh in the flow tops and bottoms and near fractures and vesicles. Alteration de-

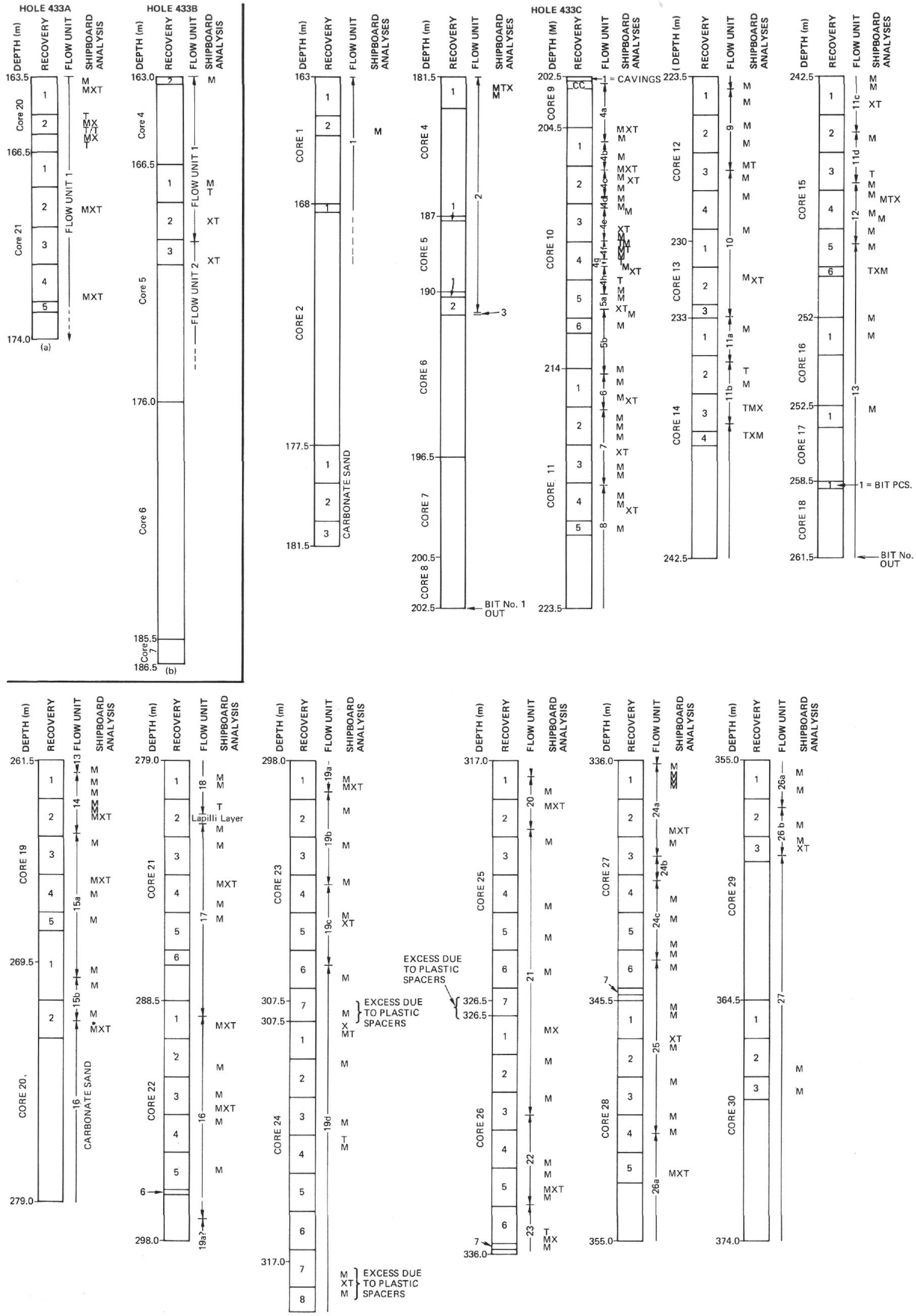


Figure 24. *Coring, recovery, and stratigraphic column for basement rocks of (a) Hole 433A, (b) Hole 433B, (c) Hole 433C, respectively, also showing positions of XRF analyses, thin sections, and paleomagnetic samples.*

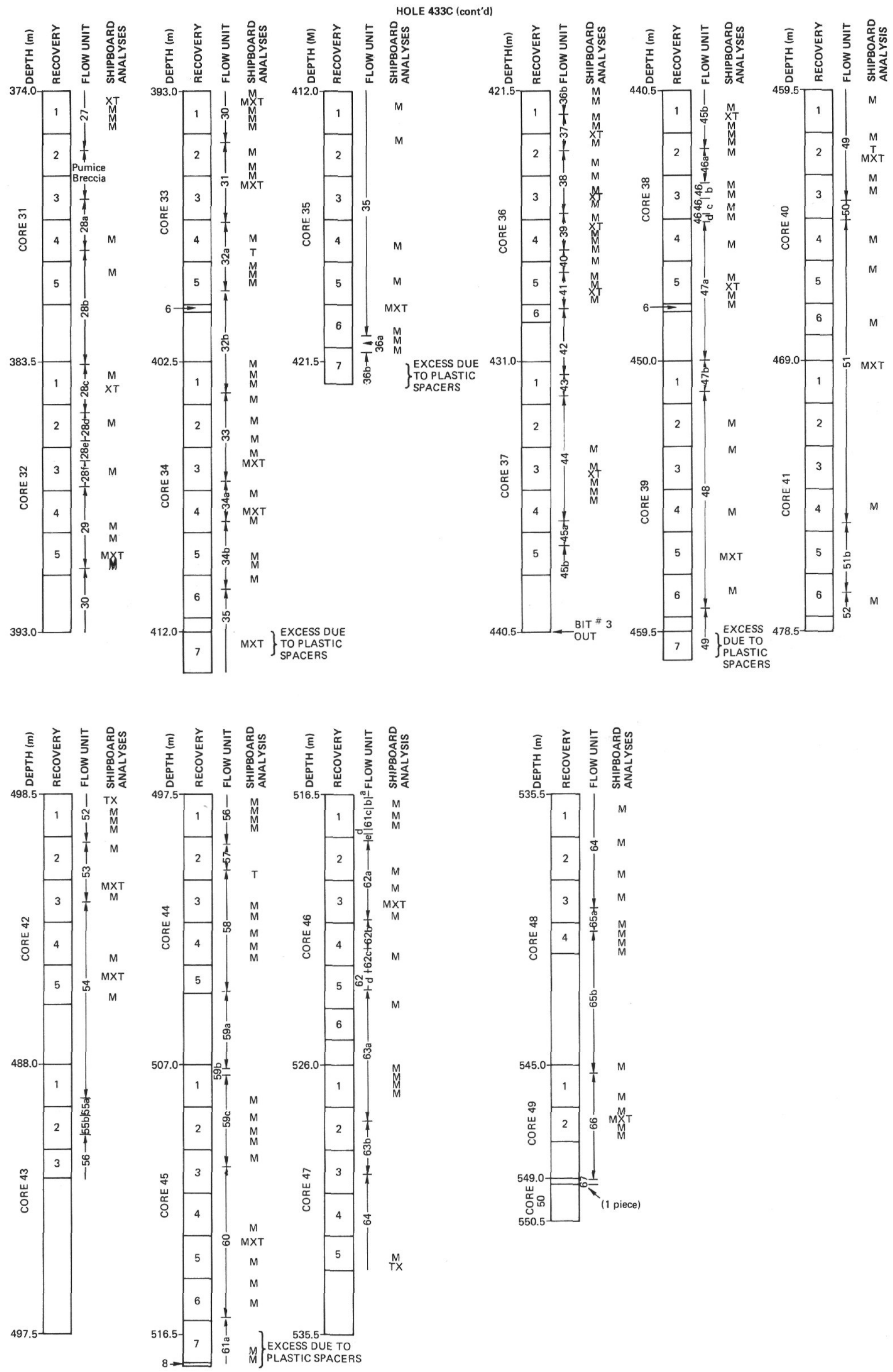


Figure 24. *(Continued).*

creases somewhat down the section. The flow interior of Flow Unit 5 is more altered than the interiors of Flow Units 7 and 8.

Flow Units 9 through 18: The sparsely phyric and aphyric basalts of these flow units are usually badly to moderately altered, and contain fresh plagioclase and clinopyroxene phenocrysts, microphenocrysts, and groundmass grains.

Olivine: Mostly altered to clays with iddingsite rims. In the slightly oxidized flow unit tops and in some flow unit bottoms, iddingsite is more abundant than clay.

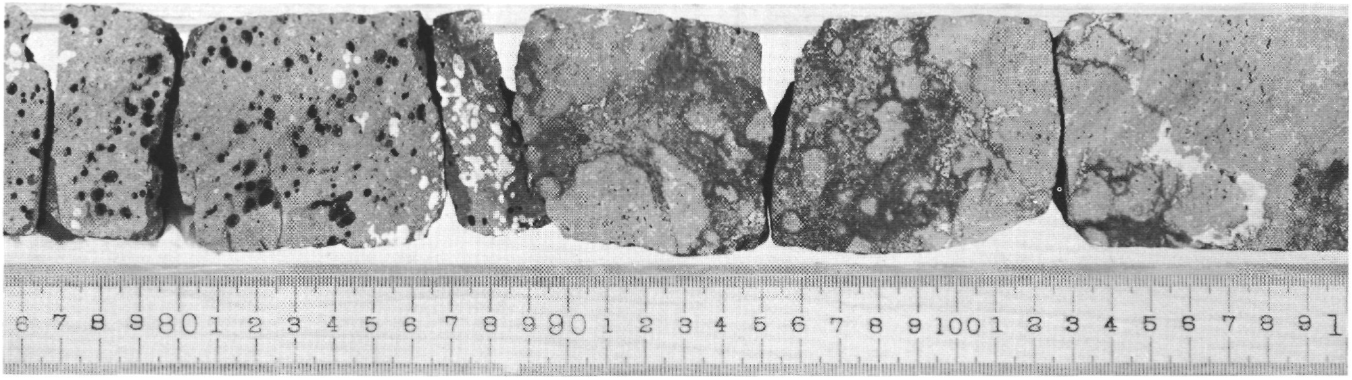


Figure 25a. *Photograph of core, illustrating contact of Flow Sub-unit 63b and Flow Unit 64 in Hole 433C, Section 47-3, at 88 cm. The upper part of Flow Unit 64 is an oxidized autobreccia similar to those found at the tops of many subaerial flows on the Hawaiian Islands.*

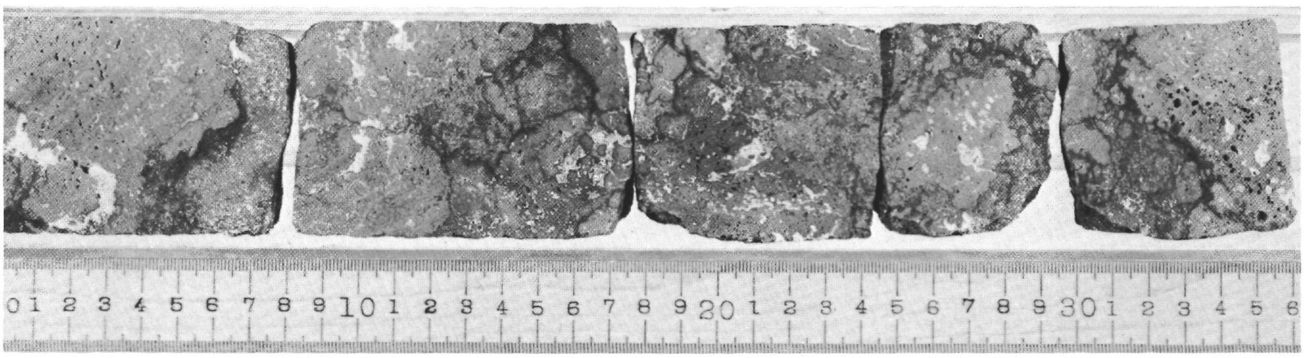


Figure 25b. *Downward continuation of the photograph in Figure 25a.*

Figure 26. *Photograph of core, illustrating the contact between Flow Unit 64 and 65b in Hole 433C, Section 48-8, at 98 cm. The bottom of Flow Unit 64 has a devitrified glassy contact, and shows elongation of vesicles resulting from flow. Note the change in vesicularity and calcite vug filling across the contact.*

There are some fresh olivine phenocryst cores in Flow Unit 9 (Sections 12-2 and 12-3). Clay mineral content is usually not more than 10 per cent (after glass and olivine), but Sub-unit 11b and Flow Units 14 and 15 have dark gray and green spots of almost totally altered groundmass, perhaps near pores (for example, thin sections prepared from Samples 15-3, 92-93 cm; 19-4, 19-22 cm; 20-2, 120-132 cm).

TABLE 14
Petrographic Summary, Site 433

Flow Unit/ Sub-Unit	Core-Section	Interval (cm)	Rock Type (XRF)[a]	Phenocrysts[b] OL	Phenocrysts[b] PX	Phenocrysts[b] PC	Groundmass Texture	Groundmass Grain Size	Groundmass OL	Groundmass PC, PX[c]	Groundmass Fe-Ti Oxides	Alteration Vesicles[b]	Alteration Phenocrysts	Alteration Groundmass
Hole 433A														
1	20-1	38-40	Alkalic basalt	M.6	M.5	M.2	IG	M	M	PC≫PX	A	–	BA CL, ID	MA CL, ID
1	20-2	7-10	Alkalic basalt	M.6	A.5	M.2	IG	M	M	PC≫PX	A	–	BA CL, ID	MA CL, ID
1	20-2	24-32	–	S.3	S.3	M.2	ST	F	A	PC≫PX	A	–		MA CL
1	20-2	32-36	–	VS.3	M.3	S.1	ST	F	VS	PC≫PX	A	–	BA ID	MF CL
1	20-2	60-63	Alkalic basalt	M.4	M.8	M.2	IG	M	M	PC≫PX	A	M.2	BA CL, ID	MA CL, ID
1	21-2	84-86	Alkalic basalt	S.1	–	A.3	ST	M	M	PC≫PX	M	–	F	MF CL
1	21-4	138-140	Alkalic basalt	S.1	VS.1	M.2	ST	F	M	PC≫PX	M	–	F	F
Hole 433B														
1	5-1	124-128	–	M.2	S.3	M.2	IG	M	S	PC≫PX	M	–	BA CL, ID	MA CL
1	5-2	83-85	Alkalic basalt	–	M.5	M.1	IG	F	S	PC≫PX	M	–	F	F CL
2	5-3	86-88	–	A.2	M.1	M.2	ST	M	M	PC≫PX	A	–	F ID	MF CL, ID
Hole 433C														
2	4-1	39-41	Alkalic basalt	M.2	S.1	S.1	IG	M	S	PC≫PX	M	–	BA CL	MF CL
4a	10-1	7-9	Picrite	M.1	–	–	D	M	M	PC≫PX	A	A.1	BA CL	BA CL, ID
4b	10-2	15-18	Picrite	M.1	–	–	D	M	M	PC=PX	A	VA.2	BA CL, ID	BA CL, ID
4c	10-2	56-59	Picrite	M.1	–	–	D	M	M	PC>PX	A	VA.4	BA CL, ID	BA CL, ID
4e	10-3	103-106	Picrite	M.1	–	–	D	M	M	PC>PX	M	VA.2	BA CL, ID	BA CL, ID
4f	10-4	4-6	–	S.1	–	–	IG	M	M	PC≫PX	A	VA.5	BA ID	BA CL, ID
4f	10-4	44-46	–	VA.2	–	–	D	M	M	PC>PX	M	A.3	BA CL, ID	BA CL, ID
4g	10-4	93-95	–	VA.2	–	–	IS	M	VS	PX>PC	A	VA.2	BA CL, ID	BA CL, ID, ZL
4h	10-4	118-120	Picrite	VA.2	–	VS.1	D	M	S	PC>PX	M	A.3	BA CL, ID	CL, ID, ZL
4h	10-5	11-13	–	A.2	–	–	IG	M	M	PC≫PX	A	VA.2	BA CL, ID, CC	BA CL, CC
5a	10-5	119-121	Tholeiite	VS.5	–	–	IG	F	M	PC≫PX	A	VA.1	BA CL, ID	BA CL, ID
6	11-1	135-137	Tholeiite	S.1	–	–	D	A	M	PC≫PX	A	S.2	BA CL, ID, CC	MF CL, ID
7	11-3	31-34	Tholeiite	S.5	–	–	IG	F	M	PC>PX	S	VS.6	BA CL, ID	MA CL, ID
8	11-4	106-109	Tholeiite	M.7	S.2	S.4	IG	M	M	PC>PX	M	A.2	BA CL, ID, CC	MA CL, ID
9	12-3	50-53	Tholeiite	S.3	M.3	M.3	IG	M	VS	PC>PX	A	–	BA CL, ID	BA CL, ID, CC, ZL
10	13-2	47-49	Tholeiite	S.4	S.4	S.4	IG	C	VS	PC>PX	S	–	–	MF CL, ID
11b	14-2	65-67	–	S.15	VS.4	VS.4	D	M	S	PC≫PX	A	A.1	MA CL	MA CL, ID
11b	14-3	57-59	Tholeiite	S.15	VS.4	S.5	D	M	M	PC≫PX	A	M.2	MA CL	MA CL, ID
11c	14-4	21-23	Tholeiite	–	S.1	S.6	D	M	–	PC≫PX	VA	–	MF CL	MF CL
11c	15-1	118-122	Tholeiite	VS.8	S.6	VS.1	D	M	M	PC≫PX	VA	M.2	BA CL, ID	MA CL, ID
11d	15-3	92-93	–	–	S.1	VS.5	ST	M	M	PC≫PX	VA	A.3	BA CL, ID	BA CL, ID
12	15-4	43-46	Tholeiite	VS.3	VS.4	VS.5	ST	M	S	PC>PX	A	M.2	F	MA CL, ID
13	15-6	32-35	Tholeiite	VS.7	S.5	VS.4	ST	F	VS	PC=PX	A	–	F	F CL
14	19-2	53-56	Tholeiite	VS.1	S.1	VS.7	D	M	A	PC≫PX	A	–	BA CL, ID	MA CL, ID
15a	19-4	19-22	Tholeiite	A.1	VS.6	VS.1	D	C	M	PC>PX	M	–	BA CL, ID	MA CL, ID, ZL
16	20-2	129-132	Tholeiite	VS.1	–	VS.5	D	M	A	PC≫PX	A	M.2	F	MA CL, ID, ZL

TABLE 14 – *Continued*

Flow Unit/ Sub-Unit	Core-Section	Interval (cm)	Rock Type (XRF)[a]	Phenocrysts[b]			Groundmass					Alteration		
				OL	PX	PC	Texture	Grain Size	OL	PC, PX[c]	Fe-Ti Oxides	Vesicles[b]	Pheno-crysts	Ground-mass
17	21-4	40-42	Tholeiite	VS.5	VS.7	S.7	IG	M	M	PC≫PX	A	M.2	BA CL, ID	BA CL, ID
18	22-1	96-98	Tholeiite	S.1	–	S.7	IG	M	M	PC≫PX	A	M.1	BA CL, ID	BA CL, ID
18	22-3	133-136	–	S.8	–	S.1	IG	M	M	PC≫PX	M	VA.3	BA CL, ID	MA CL, ID
19a	23-1	4-6	–	M.1	VS.6	–	IS	F	M	PC≫PX	M	A.5	BA CL, ID, ZL	BA CL, ZL, ID
19a	23-1	100-103	Tholeiite	M.1	VS.6	–	IS	F	A	PC≫PX	M	A.1	BA CL, ZL, ID	BA CL, ZL, ID
19c	23-5	5-8	Picrite	A.2	–	–	D	M	M	PC>PX	A	M.2	BA CL, ID	MF CL, ID
19d	24-1	25-28	Picrite	VA.2	VS.6	VS.1	D	M	S	PC=PX	M	M.1	VA CL, ID	MF CL, ID, ZL
19d	24-7	142-143	Picrite	VA.2	–	–	D	M	VS	PC=PX	M	–	F ID	MF CL, ZL, ID
20	25-2	20-23	Tholeiite	S.5	–	–	D	M	A	PC≫PX	A	–	BA CL, ID	BA CL, ID
21	26-1	48-51	Tholeiite	S.1	–	VS.4	D	M	M	PC>PX	A	–	BA CL, ID	BA CL, ID
22	26-5	85-88	Tholeiite	A.1	–	–	D	M	S	PC=PX	M	–	BA CL, ID	BA CL, ID, ZL
23	26-6	109-111	Tholeiite	M.6	–	–	ST	M	A	PC>PX	M	–	BA CL, ID	BA CL, ID
24a	27-2	135-138	Picrite	VA.2	–	–	IG	M	A	PC≫PX	A	–	MA CL, ID	MA CL
25	28-2	21-24	Tholeiite	S.1	M.1	A.2	IG	F	–	PC=PX	M	S.6	F	F CL
26a	28-5	108-110	Tholeiite	M.5	M.5	M.1	ST	M	M	PC>PX	M	–	BA CL, ID	MA CL, ID
26b	29-3	25-27	Tholeiite	VS.1	M.1	M.6	IG	M	–	PC>PX	M	A.1	BA CL, ID	MA CL
27	31-1	14-17	Tholeiite	M.6	VS.2	S.6	IG	F	S	PC=PX	M	–	F CL	F CL
28c	32-1	95-98	Picrite	VA.3	–	–	IG	M	M	PX>PC	M	–	BA CL	MA CL, ID
29	32-5	78-81	Picrite	M.5	–	–	D	M	S	PC=PX	S	–	BA CL	BA CL
30	33-1	34-36	–	A.2	–	S.3	D	M	S	PC=PX	S	–	BA CL, ID	MA CL, ID
31	33-3	12-14	–	A.1	–	–	D	M	S	PC=PX	M	–	BA CL, ID	BA CL, ID
32a	33-4	120-122	–	VA.1	–	–	IS	M	M	PC≫PX	M	A.3	BA CL, ID	BA CL, ID
33	34-3	41-43	–	M.1	–	–	D	M	S	PC=PX	S	–	BA CL, ID	MA CL, ID
34a	34-4	68-70	–	A.1	–	–	D	M	S	PX>PC	M	M.1	BA CL, ID	MA CL, ID
35	34-7	96-98	Tholeiite	M.1	VS.1	S.6	IG	F	S	PX>PC	A	–	BA CL	MF CL, ID
35	35-6	27-29	Tholeiite	M.6	S.5	S.6	ST	M	S	PX>PC	M	–	BA CL, ID	MF CL, ID
37	36-2	14-16	Tholeiite	M.1	–	–	D	M	S	PC=PX	M	VA.2	BA CL, ID	MA CL, ID
38	36-3	81-83	Tholeiite	A.2	–	–	D	M	M	PC>PX	M	–	BA CL, ID	MA CL, CC, ID
39	36-4	52-54	Tholeiite	A.1	–	–	D	M	S	PC>PX	M	–	BA CL	BA CL, ID
41	36-5	122-125	Tholeiite	M.1	–	–	D	M	S	PC=PX	M	VA.1	BA CL, ID	MA CL, ID
44	37-3	103-105	Tholeiite	VS.7	–	–	IG	M	M	PC=PX	M	–	BA CL, ID	MA CL
45b	38-1	77-80	Tholeiite	M.2	–	–	D	M	A	PX>PC	M	–	MF CL	MA CL
47a	38-5	95-100	Tholeiite	–	–	–	D	M	–	PC=PX	A	–	–	MA CL
48	39-5	102-104	Tholeiite	M.7	–	VS.6	IG	F	S	PC=PX	M	–	BA CL, ID	MA CL, ID
49	40-2	92-97	Tholeiite	M.2	–	–	IG	F	VS	PC=PX	A	–	BA CL, ID	MA CL, ID
51a	41-1	15-19	Tholeiite	–	–	–	IG	M	VS	PC>PX	A	–	–	MA CL, ID
52	42-1	2-6	Tholeiite	–	–	–	IG	M	VS	PC=PX	M	–	–	MA CL, ID

TABLE 14 – *Continued*

Flow Unit/ Sub-Unit	Core-Section	Interval (cm)	Rock Type (XRF)[a]	Phenocrysts[b]			Groundmass					Alteration		
				OL	PX	PC	Texture	Grain Size	OL	PC, PX[c]	Fe-Ti Oxides	Vesicles[b]	Phenocrysts	Groundmass
53	42-3	11-15	Tholeiite	–	–	–	IG	M	VS	PC>PX	M	VA.7	–	MA CL, ID
54	42-5	35-38	Tholeiite	–	S.1	M.1	IG	M	VS	PC=PX	M	VS.1	F	MA CL, ID
58	44-2	117-119	–	S.8	VS.8	VS.8	IS	M	MA	PC≫PX	S?	–	BA CL, ID	MA CL, ID
60	45-5	2-4	Tholeiite	S.6	–	MA.1	IG	M	S	PC=PX	M	–	F	MF CL, ID
62a	46-3	72-74	–	VS.8	S.8	S.1	IG	M	M	PX>PC	M	–	MF ID, CL	MA CL, ID
64	47-5	87-89	Tholeiite	S.7	VS.3	S.3	IG	F	S	PC>PX	A	M.7	BA ID	MA CL, ID
66	49-2	31-36	–	–	–	–	D	C	A	PC>PX	M	M.5	–	MA ID, CL

Notes:

Minerals

OL = olivine
PX = pyroxene
PC = plagioclase
CL = clays
ID = iddingsite
CC = calcite
ZL = zeolite

Textures

IG = intergranular
IS = intersertal (includes hayalopilitic and vitrophyric)
D = diabasic
T = trachytic
ST = sub-trachytic

Abundances

VA = very abundant (20-50%)
A = abundant (10-20%)
M = moderately abundant (5-10%)
S = sparse (2-5%)
VS = very sparse (< 2%)
–– = none observed

Alteration

F = fresh (< 5% altered)
MF = moderately fresh (5-10% altered)
MA = moderately altered (10-25% altered)
BA = badly altered (>25% altered)

Grain Size (groundmass only)

C = coarse (>0.5 mm)
M = medium (0.1-0.5 mm)
F = fine (< 0.1 mm)

[a]NA = no XRF analysis of flow unit. Where rock types are given, they are based on XRF analyses, and are placed opposite the nearest thin section.
[b]Average grain size, in mm, follows abundance (e.g., VA.8 means very abundant, average 0.8 mm).
[c]Relative abundance: PC≫PX means that PC is twice as abundant as PX. PC=PX indicates sub-equal amounts (within 5%).
[d]Primarily olivine. Plagioclase and pyroxene phenocrysts are usually fresh even when olivine is totally altered. Alteration products listed in relative order of abundance.

Flow Unit 19 (a through d): Olivine phyric basalts, usually badly altered in the vesicular intervals and near the unit tops and bottoms. The massive interior of Sub-unit 19b is only moderately altered (Section 23–2, 50 cm), as are the interiors of Sub-units 19c (Section 24–5, 60 cm) and 19d (Section 24–8, 100 cm). Flow Sub-unit 19d has a slightly altered part from Section 24–7, 70 cm to Section 24–8, 37 cm.

Flow Units 20 through 24: The sparsely olivine phyric basalts of Flow Units 20 and 21, the olivine phyric basalts of Flow Units 22 and 23, and the picrite basalt of Flow Unit 24 are all altered in a similar way. The massive flow interiors, which usually occur in lower parts of flow units, are moderately altered and sometimes contain some fresh olivine. Vesicular intervals near flow tops and bottoms are badly altered. There are 1- to 2-mm-diameter dark green spots in Flow Units 20 through 22 in which the groundmass is nearly totally altered.

Flow Units 25 through 27: These porphyritic basalts are moderately to badly altered, and contain fresh plagioclase and clinopyroxene, and olivine altered to clays and iddingsite. Massive, fresher basalt usually occurs in the lower one half to one third of each flow unit. For example, Flow Unit 27 can be divided into 6 parts, as follows:

1) A badly altered oxidized top containing olivine phenocrysts altered to iddingsite and less extensively to clays, and plagioclase and pyroxene phenocrysts that are mostly fresh (Section 29-3, 72–102 cm). Vesicles (up to 25%) are mostly lined by clays, but sometimes by quartz crystals.

2) A badly altered flow interior with 5 to 10 per cent clay-lined vesicles. Olivine phenocrysts altered to clays and iddingsite. (Section 30–1 to Section 30–2, 95 cm.)

3) A moderately altered non-vesicular flow interior with some fresh olivine cores (Section 30–2, 95 cm to Section 30–3, 80 cm).

4) A slightly altered massive flow interior with mostly fresh olivine (Section 31–1, 2–30 cm).

5) A moderately to badly altered flow interior in which alteration and vesicles increase (from 1 to 10%) down-section (Section 31–1, 30–110 cm).

6) A badly altered oxidized flow bottom with 25 to 40 per cent vesicles and olivine altered to iddingsite (Section 31–1, 110 cm to Section 31–2, 60 cm).

Flow Units 28 through 39: These olivine phyric basalts (Flow Units 35 and 36 have some plagioclase phenocrysts) are altered, and contain some fresh olivine in the massive flow interiors. In the upper and lower vesicular parts, the olivine is altered to clays with iddingsite rims. Alteration is more extensive in the flow tops and bottoms, where the olivine is altered mostly to iddingsite, and in lesser extent to clays; plagioclase and clinopyroxene are slightly altered to clays.

Flow and Cooling Units 40 through 46: Olivine phyric and sparsely olivine phyric basalts. Most of these units are thin (usually less than 1 m) and badly altered and oxidized, except the thick Flow Unit 44 and Sub-unit 45b, which are moderately to slightly altered, with fresh olivine in the massive flow interiors. Flow Sub-unit 45b contains common phillipsite.

Flow Unit 47 (a and b): Aphyric basalt, moderately to badly altered in the flow interiors, containing 20 to 25 per cent clays glass and olivine(?) in the groundmass. The tops and bottoms are more altered and oxidized.

Flow Units 48 through 50: Olivine phyric basalts. The alteration is similar to that of Flow Units 40 through 46. Flow Unit 50 is badly altered; the interiors of Flow Units 48 and 49 are slightly to moderately altered.

Flow Units 51 through 53: Aphyric basalts; the massive flow interiors moderately altered (up to 10% clays in the groundmass). More altered vesicular parts and oxidized tops and bottoms.

Flow Units 54 through 64: These porphyritic basalts all show similar alteration. The thin cooling units (55a, 55b, 61b through 61e, 62b through 62d) and the tops and bottoms of the thicker flow units are usually badly altered and oxidized. Glass is altered to clays, and olivine is mostly altered to iddingsite, less extensively to clays. Plagioclase and clinopyroxene are slightly altered. In the massive interiors of Flow Units 54, 56 through 60, Subunits 62a and 63a, and Flow Unit 64, glass is completely altered to clays, and the olivine is partially altered to iddingsite. The freshest massive flow interiors are always near the flow bottoms.

Flow Units 65 and 66: Aphyric basalts. The thin Flow Sub-units 65a and 65b and the top of Flow Unit 66 are badly altered and slightly oxidized. Flow Unit 67 is fresher (moderately to slightly altered) and contains some fresh olivine grains.

Discussion

1) Alteration decreases visibly downward from the top and upward from the bottom of each flow unit.

2) The thin flow units are usually more altered than the thick ones.

3) The freshest part of each flow unit is situated in a massive flow interior, which as a rule is nearer the bottom than the top. The upper altered zones are commonly 3 to 5 times thicker than the bottom ones.

4) Many flow units have reddish oxidized tops and bottoms; the top oxidized zones are thicker than the bottom zones. The top zone is sometimes up to 2 meters thick; the bottom oxidized zones are usually not more than 0.1 meter thick.

The volcanic sequence of Site 433 can be divided into four groups according to degree of alteration.

1) Slightly to moderately altered: Flow Units 1 through 3.

2) Very badly altered: Flow Sub-units 4a through 4f.

3) Moderately altered: Flow Units 5 through 8, in which the alteration of the massive flow interiors decreases somewhat down-section.

4) Slightly and moderately altered: Flow Units 9 through 66 (in massive flow interiors), where no particular difference in degree of alteration is visible.

Some preliminary conclusions can be drawn from this examination.

1) The comparatively thick upper oxidized zone of each flow unit (up to 2 m) is a result of volcanic eruption under subaerial conditions.

2) All the alteration probably took place after the lava flows cooled, except for the iddingsitization. The fresher part of each flow unit is in the coarse-grained, massive part of flows, which would have been the last to cool.

BASALT CHEMISTRY

Sixty-two basalt samples from Holes 433A, 433B, and 433C were subjected to chemical analysis aboard ship. Table 15 presents the reduced data with all the iron as Fe_2O_3, the dry and reduced normalized analyses and CIPW norms calculated with $Fe^{+3}/Fe_T = 0.15$. The basalts analyzed are alkalic basalts, oceanites (tholeiitic picrites), and fractionated tholeiites.

Effects of Alteration

All the basalts recovered at Site 433 are altered to some extent and have uniformly moderate to high H_2O^+ and CO_2 contents. The relatively rapid drilling rate in these basalts (3.7 m/hr) and the high recovery rate (>50%) necessitated sampling for onboard XRF analyses and for thin sections at the same time, so that there was no opportunity to study such effects as groundmass alteration before selecting samples for chemical analysis. In general, what appeared to be the least altered portion of each flow unit was sampled, and, since most vesicles were filled with clays or carbonates, most of the analyzed samples were selected from the nonvesicular, more massive centers of flows. One consequence of such sampling is that it selectively biases the olivine content to high values, because many flows contain concentrations of that mineral in their massive interiors. Mg/(Mg + Fe) ratios in rocks with high H_2O^+ values tend to be higher than in fresher basalts with the same SiO_2 content. Thus, we suspect that much of the vesicle-filling and groundmass clays are nontronitic members of the smectite group. On the other hand, rocks rich in olivine phenocrysts that have been partly or completely altered to clays tend to have higher SiO_2 contents than would be expected from olivine control, and we suspect these clays to be saponitic. Certain samples (particularly from Flow Sub-unit 4a and Flow Units 10 and 12) show K_2O contents considerably in excess of those expected from the TiO_2, CaO, P_2O_5, Sr, and Zr contents in the same samples. Re-examination of thin sections of these samples shows them to contain olive-green fibrous clays. We suspect that these olive-green "clays" contain K_2O, like those reported by Dalrymple and Clague (1976). Several analyzed rocks also contain colorless to pale green fibrous clay minerals, and in two analyzed flow sub-units (19a and 19d) they are abundant. Again, the K_2O values reported for some samples of these two sub-units are far in excess of those expected from the abundance of their other distinctive oxides and elements. Some other analyzed flow units, however, contain much smaller amounts of clays (Flow Units/ Sub-units 4f, 9, 15, 16, and 22), and do not have suspiciously high K_2O contents. Rocks with appreciable CO_2 contents were observed to contain carbonate minerals, presumably calcite, and, indeed the CaO contents of analyzed basalts that contain CO_2 appear somewhat high.

Classification

All three holes penetrated Flow Unit 1, and 6 chemical analyses, all very similar, were made from samples of it. The unit is at least 8.5 meters thick, and may be as much as 14.5 meters thick. Chemically the rock is a typical Hawaiian alkalic basalt. Its major-element contents are very close to those of average Hawaiian alkalic basalt (MacDonald and Katsura, 1964; MacDonald, 1968), and it falls well within the alkalic basalt field in the $Na_2O + K_2O$ versus SiO_2 plot (Figure 27). It is different only in its low Ba and Sr contents and high P and Zr contents (Jackson et al., 1976; see Table 16). Flow Unit 2 is also a typical alkalic basalt, except, again, for its very low Ba and Sr contents. Flow Unit 3 was not sampled for analysis, but it has a trachytic texture and is probably alkalic as well.

Sub-units 4a through 4f are picritic (olivine-rich) rocks which appear to be related to the tholeiitic basalts. They plot (except for 4d, which contains abundant zeolites) in the tholeiitic field on the alkalis-silica plot, and have tholeiite trace-element ratios. All contain phenocrysts of olivine, but no pyroxene phenocrysts.

Flow Unit 5 has the chemical abundances expected of a tholeiite, except for K_2O, which is that of an alkalic basalt. Indeed, its TiO_2, P_2O_5, Sr, and Zr values are much too low for any known oceanic island rock with a K_2O content of nearly 1 per cent. Olive-green fibrous clay minerals occur as vesicle fillings in this rock, and we attribute the excess potassium to a K-rich clay. This flow unit is probably an altered tholeiite.

Proceeding from Flow Unit 5 to the bottom of the hole at 550.5 meters, all the rocks are tholeiitic basalts. Most of the tholeiitic basalts fall well within the tholeiitic field on the total alkalis-silica plot (Figure 27), and all have incompatible-element abundances and ratios similar to Hawaiian tholeiitic basalts. Those analyses that do not fall in the tholeiitic field (Flow Units/Sub-units 5, 11b, 12, 17, 18, 19d, and 66) have all apparently gained K_2O or lost silica during alteration.

The interval beginning with Flow Sub-unit 4a appears to represent the upper part of the tholeiitic, shield-building suite which forms the underpinning of all subareally exposed volcanoes in the Hawaiian chain. The tholeiites at Suiko, like those of all southeastern Hawaiian volcanoes (MacDonald and Katsura 1964, table 9) have their own chemical peculiarities, which appear to include lower than average TiO_2, P_2O_5, Sr values, but most fall within the range reported for Hawaiian tholeiitic basalts (Figures 28, 29, and 30).

PALEOMAGNETISM

Introduction

At Site 433 (Suiko Seamount), basalts were obtained from Holes 433A, 433B, and 433C. Holes 433A and 433B were single-bit holes, and only one flow unit was drilled. Paleomagnetism was studied in nine samples from Hole 433A and three samples from Hole 433B. Reentry Hole 433C penetrated nearly 400 meters of the basement, and at least 67 flow units were recovered. In total, 302 samples from this hole were measured between 20 and 31 August. In order to complete paleomagnetic experiments in such a short time, some simplification of the experimental procedures was inevitable; but to keep the standard of data as high as possible, we took care to satisfy, as far as possible, *all* the minimum conditions listed below.

1) The number of samples from each unit was four or more, preferably five or more.

2) At least two pilot samples each from Flow Units 1 through 22 (one each from Flow Units 23 through 66) were demagnetized progressively at peak fields of 25, 50, 100, 150, 200, 300, 400, and 500 Oe (the step of 25 Oe was eliminated after Flow Unit 21). If more than half the original remanence remained at the 500 Oe step, additional AF demagnetization was carried out at 100-Oe steps thereafter, until the median demagnetizing field (MDF) was reached.

3) After measurement of the NRM, other samples were demagnetized at a minimum of two different peak fields, the higher of which was 300 Oe or greater.

4) Near the MDF of each sample, the demagnetizing step did not exceed 100 Oe if the estimated MDF was less than 400 Oe, or 200 Oe if it was between 400 and 800 Oe.

5) Measurement of susceptibility was as described in the summary for Site 430.

For some of the flow units, it was impossible to satisfy condition 1 above, because the recovered flow units were too thin or too brecciated or in small pieces. When a substantial difference occurred in the inclinations of what were thought to be sub-units within a single flow unit (26a and 26b, etc.), or when such a difference occurred at some previously unnoticed place in a single flow unit (28a and 28b, etc.), an additional sample was measured to establish the reality of the difference and to satisfy condition 1. But this again was by no means possible in all cases, because of the limitation of available time.

Condition 3 was included to make sure that in AF demagnetization of a sample we were really picking out the stable component from the NRM, and not some spurious effect caused by the demagnetization experiment. It also served to show that the demagnetization was sufficient to obtain the primary component, since the effects of secondary components are negligibly small in the higher demagnetizing fields.

Because of condition 4, the MDF was determined for most of the present samples with estimated error of less than 10 Oe. In any case, the error in MDF does not exceed 25 Oe.

Because the data thus far accumulated are rather voluminous, thorough discussion of the results will be presented elsewhere (Kono, this volume). As shown by the high MDF and Q_n' ratios, most of the samples have very stable remanences, and there is no doubt that their

TABLE 15
Shipboard Chemical Analyses of Basalts, Site 433

Core/Section/Piece No.	20-1, 1D	20-2, 16	20-2, 2C	21-2, 2C	21-4, 15	5-2, 3C	4-1, 2C	10-1, 1A
Interval (cm)	36-38	10-12	49-51	84-86	138-140	81-83	39-41	7-9
Rock Type	Alkalic Basalt	Alkalic Basalt	Alkalic Basalt	Alkalic Basalt	Alkalic Basalt	Alkalic Basalt	Alkalic Basalt	Picrite
Lithologic Unit	Flow Unit 1	Flow Unit 1	Flow Unit 1	Flow Unit 1	Flow Unit 1	Flow Unit 1	Flow Unit 2	Flow Sub-unit 4a
			Hole 433A			**Hole 433B**	**Hole 433C**	
Major-Element Oxides (%)								
SiO_2	47.18	47.08	46.93	47.32	47.70	47.46	46.99	46.86
TiO_2	3.16	3.33	3.17	3.19	3.21	3.18	2.92	1.70
Al_2O_3	14.33	14.82	13.91	14.29	14.55	14.42	13.73	12.74
Fe_2O_3 (Total)	15.16	15.40	15.48	15.05	14.96	14.98	14.93	14.15
MnO	0.18	0.16	0.21	0.19	0.18	0.18	0.19	0.16
MgO	5.06	4.60	5.39	5.57	5.07	5.45	7.39	14.05
CaO	9.51	8.92	9.77	9.21	9.36	9.88	9.72	7.71
Na_2O	3.30	3.40	3.10	3.20	3.20	1.10	2.80	1.90
K_2O	0.97	1.07	1.03	0.93	0.97	0.86	0.79	0.40
P_2O_5	0.46	0.44	0.48	0.46	0.45	0.44	0.40	0.25
Total	99.31	99.22	99.47	99.41	99.65	99.95	99.86	99.92
Loss on Ignition (%)	1.67	2.93	3.16	2.45	2.27	1.27	1.28	6.49
H_2O^+	0.71	0.93	0.95	1.10	0.99	0.72	1.12	4.17
CO_2	0.09	0.29	0.83	0.10	0.09	0.10	0.05	0.20
Mg/(Mg + Fe)	0.40	0.37	0.41	0.42	0.40	0.42	0.50	0.66
Trace Elements (ppm)								
Ni	48	51	48	47	49	49	120	486
Sr	397	408	379	375	400	406	366	167
Zr	213	216	205	213	216	214	200	96
			Dry and Reduced Analyses					
Adjusted Oxides								
SiO_2	48.25	48.20	47.93	48.34	48.60	48.21	47.77	47.57
Al_2O_3	14.65	15.17	14.21	14.60	14.82	14.65	13.96	12.93
FeO	13.95	14.19	14.23	13.83	13.71	13.69	13.65	12.92
MgO	5.17	4.71	5.50	5.69	5.17	5.54	7.51	14.26
CaO	9.72	9.13	9.98	9.41	9.54	10.04	9.88	7.83
Na_2O	3.37	3.48	3.17	3.27	3.26	3.15	2.85	1.93
K_2O	0.99	1.10	1.05	0.95	0.99	0.87	0.80	0.41
TiO_2	3.23	3.41	3.24	3.26	3.27	3.23	2.97	1.73
P_2O_5	0.47	0.45	0.49	0.47	0.46	0.45	0.41	0.25
MnO	0.18	0.16	0.21	0.19	0.18	0.18	0.19	0.16
Total	99.98	100.00	100.01	100.01	100.00	100.01	99.99	99.99
			CIPW Norms Assuming $\frac{Fe^{+3}}{Fe^{+2} + Fe^{+3}} = 0.15$					
Q								
C								
OR	5.837	6.485	6.189	5.600	5.837	5.129	4.717	2.418
AB	28.453	29.376	26.757	27.601	27.522	26.591	24.063	16.299
AN	21.875	22.469	21.389	22.298	22.828	23.209	22.885	25.356
NE								
WO	9.677	8.260	10.357	8.854	8.932	9.832	9.749	4.919
EN	5.572	4.829	5.869	7.199	7.547	7.380	8.702	17.483
FS	6.428	6.115	6.556	7.446	8.462	7.751	6.917	7.791
FO	5.099	4.817	5.462	4.861	3.713	4.474	6.980	12.586
FA	6.483	6.722	6.725	5.541	4.588	5.179	6.114	6.182
MT	3.371	3.428	3.428	3.341	3.313	3.298	3.299	3.111
IL	6.121	6.461	6.138	6.176	6.196	6.120	5.628	3.279
AP	1.111	1.063	1.158	1.110	1.087	1.063	0.969	0.591
Total	100.026	100.025	100.028	100.027	100.026	100.025	100.024	100.015
SALIC	56.165	58.330	54.335	55.498	56.187	54.928	51.665	44.072
FEMIC	43.861	41.695	45.692	44.528	43.839	45.097	48.358	55.943

TABLE 15 – *Continued*

10-2, 3A	10-2, 7	10-3, 10A	10-4, 8B	10-5, 13A	11-1, 9C	11-3, 2A	11-4, 14	12-3, 1E	13-2, 1H
16-18	58-60	105-107	118-121	118-120	135-137	29-31	110-112	51-53	53-55
Picrite	Picrite	Picrite	Picrite	Tholeiite	Tholeiite	Tholeiite	Tholeiite	Tholeiite	Tholeiite
Flow Sub-unit 4b	Flow Sub-unit 4c	Flow Sub-unit 4e	Flow Sub-unit 4h	Flow Unit 5	Flow Sub-unit 6a	Flow Unit 7	Flow Unit 9	Flow Unit 9	Flow Unit 10
				Hole 433C					
46.70	46.16	45.96	45.94	47.78	47.00	48.00	48.73	48.91	48.00
1.85	1.91	1.97	1.15	1.89	1.89	1.92	2.40	2.35	2.26
13.09	14.10	14.76	8.81	14.14	14.86	15.00	15.33	14.36	14.22
14.16	14.63	14.95	14.10	15.70	13.35	13.03	12.71	12.30	13.16
0.15	0.13	0.15	0.19	0.07	0.18	0.12	0.11	0.14	0.17
14.09	11.34	9.23	20.39	10.81	8.02	8.25	6.95	7.43	7.90
6.54	7.84	8.95	6.70	4.82	10.95	10.54	10.25	11.30	11.16
2.00	2.30	2.20	1.40	2.80	2.50	2.50	2.50	2.50	2.30
0.47	0.44	0.11	0.28	0.83	0.32	0.23	0.63	0.20	0.47
0.21	0.24	0.25	0.15	0.23	0.24	0.22	0.28	0.28	0.28
99.26	99.09	99.13	99.11	99.07	99.31	99.81	99.89	99.77	99.92
10.4	6.59	7.83	14.00	8.74	7.24	5.41	5.66	3.38	2.47
4.62	3.56	2.98	5.52	3.26	2.28	2.19	1.72	1.12	1.42
0.20	0.17	0.37	1.76	0.17	1.31	0.51	0.56	0.47	0.14
0.66	0.61	0.55	0.74	0.57	0.54	0.56	0.52	0.55	0.54
462	375	303	1196	246	156	174	117	103	98
145	202	217	88	151	248	273	288	294	297
102	110	111	60	107	114	115	137	142	139
				Dry and Reduced Analyses					
47.73	47.29	47.08	47.02	49.01	47.97	48.73	49.41	49.63	48.68
13.38	14.44	15.12	9.02	14.50	15.17	15.23	15.54	14.57	14.42
13.02	13.48	13.78	12.99	14.49	12.26	11.90	11.60	11.23	12.01
14.40	11.62	9.45	20.87	11.09	8.19	8.38	7.05	7.54	8.01
6.68	8.03	9.17	6.86	4.94	11.18	10.70	10.39	11.47	11.32
2.04	2.36	2.25	1.43	2.87	2.55	2.54	2.53	2.54	2.33
0.48	0.45	0.73	0.29	0.85	0.33	0.23	0.64	0.20	0.48
1.89	1.96	2.02	1.18	1.94	1.93	1.95	2.43	2.38	2.29
0.21	0.25	0.26	0.15	0.24	0.24	0.22	0.28	0.28	0.28
0.15	0.13	0.15	0.19	0.07	0.18	0.12	0.11	0.14	0.17
99.98	100.01	100.02	100.00	100.00	100.00	100.00	99.98	99.98	99.99
				CIPW Norms Assuming $\frac{Fe^{+3}}{Fe^{+2} + Fe^{+3}} = 0.15$					
				0.450					
2.831	2.653	4.303	1.710	5.010	1.946	1.356	3.776	1.180	2.831
17.227	19.922	18.993	12.074	24.225	21.534	21.450	21.372	21.456	19.678
25.882	27.413	28.931	17.298	22.882	28.914	29.417	29.106	27.716	27.418
2.431	4.468	6.162	6.548		10.386	9.238	8.570	11.384	11.194
18.165	12.413	10.136	19.548	15.490	9.825	13.560	15.199	17.300	14.375
7.949	6.945	7.126	6.350	9.843	7.031	9.064	10.997	11.352	9.823
12.352	11.532	9.350	22.645	8.452	7.380	5.094	1.632	1.014	3.879
5.957	7.110	7.244	8.107	5.919	5.820	3.752	1.302	0.733	2.921
3.140	3.254	3.327	3.139	3.500	2.952	2.865	2.794	2.707	2.894
3.582	3.714	3.827	2.236	3.675	3.658	3.696	4.607	4.512	4.341
0.496	0.591	0.614	0.355	0.567	0.567	0.520	0.662	0.662	0.662
100.013	100.015	100.015	100.010	100.013	100.015	100.013	100.016	100.016	100.017
45.940	49.987	52.228	31.082	52.568	52.394	52.223	54.253	50.352	49.927
54.072	50.027	47.787	68.928	47.446	47.620	47.790	45.762	49.664	50.089

TABLE 15 – *Continued*

Core/Section/Piece No.	14-3, 4A	14-4, 1B	15-1, 13	15-4, 4	15-6, 1C	19-2, 2F	19-4, 1B	20-2, 13
Interval (cm)	55-57	21-23	115-118	46-48	31-32	56-58	17-19	132-134
Rock Type	Tholeiite	Tholeiite	Tholeiite	Tholeiite	Tholeiite	Tholeiite	Tholeiite	Tholeiite
Lithologic Unit	Flow Sub-unit 11b	Flow Sub-unit 11c	Flow Sub-unit 11c	Flow Unit 12	Flow Unit 13	Flow Unit 14	Flow Sub-unit 15a	Flow Unit 16
Hole 433C								
Major-Element Oxides (%)								
SiO_2	48.26	48.62	47.78	47.62	47.91	48.31	48.83	48.24
TiO_2	2.68	2.53	2.65	2.54	2.57	2.45	2.10	2.83
Al_2O_3	15.50	15.23	14.75	13.39	13.87	14.93	15.13	15.80
Fe_2O_3 (Total)	13.97	13.55	14.32	16.88	14.50	13.26	11.98	12.32
MnO	0.09	0.14	0.12	0.11	0.18	0.13	0.13	0.11
MgO	7.20	7.00	7.35	8.30	6.50	7.33	7.70	7.25
CaO	7.39	9.63	8.84	6.59	10.77	10.22	10.72	9.50
Na_2O	3.20	2.90	2.90	2.80	2.50	2.70	2.70	2.90
K_2O	0.80	0.22	0.46	1.24	0.24	0.30	0.24	0.30
P_2O_5	0.31	0.30	0.33	0.24	0.28	0.27	0.26	0.29
Total	99.40	99.12	99.50	99.71	99.32	99.90	99.79	99.54
Loss on Ignition (%)	4.64	3.37	3.28	6.56	1.33	2.78	2.86	3.57
H_2O^+	1.93	1.13	1.37	1.97	0.42	1.21	1.23	1.50
CO_2	0.26	0.19	0.17	0.12	0.09	0.28	0.24	0.30
Mg/(Mg + Fe)	0.51	0.51	0.50	0.49	0.47	0.52	0.56	0.54
Trace Elements (ppm)								
Ni	51	46	44	47	53	78	109	95
Sr	293	298	286	226	304	293	279	339
Zr	157	153	155	149	166	150	131	173
Dry and Reduced Analyses								
Adjusted Oxides								
SiO_2	49.24	49.23	49.24	48.58	48.95	49.01	49.53	49.07
Al_2O_3	15.82	15.42	14.89	13.66	14.17	15.15	15.35	16.07
FeO	12.83	12.34	13.01	15.50	13.33	12.10	10.93	11.28
MgO	7.35	7.09	7.42	8.47	6.64	7.44	7.81	7.37
CaO	7.54	9.75	8.92	6.72	11.00	10.37	10.87	9.66
Na_2O	3.27	2.94	2.93	2.86	2.55	2.74	2.74	2.95
K_2O	0.82	0.22	0.46	1.27	0.25	0.30	0.24	0.31
TiO_2	2.73	2.56	2.67	2.59	2.63	2.49	2.13	2.88
P_2O_5	0.32	0.30	0.33	0.24	0.29	0.27	0.26	0.29
MnO	0.09	0.14	0.12	0.11	0.18	0.13	0.13	0.11
Total	100.01	99.99	99.99	100.00	99.99	100.00	99.99	99.99
CIPW Norms Assuming $\frac{Fe^{+3}}{Fe^{+2} + Fe^{+3}} = 0.15$								
Q								
C								
OR	4.834	1.297	2.713	7.485	1.474	1.769	1.416	1.829
AB	27.606	24.828	24.741	24.138	21.532	23.137	23.146	24.917
AN	26.006	28.172	26.063	20.630	26.424	28.094	28.827	29.638
Ne								
WO	3.853	7.576	6.658	4.617	10.915	8.970	9.734	6.809
EN	10.931	14.276	14.495	10.802	15.227	14.059	14.741	14.136
FS	8.315	10.991	11.241	9.217	13.777	10.134	9.307	8.861
FO	5.138	2.345	2.765	7.174	0.894	3.106	3.278	2.934
FA	4.308	1.990	2.363	6.746	0.892	2.467	2.280	2.027
MT	3.096	2.981	3.140	3.731	3.212	2.923	2.634	2.721
IL	5.173	4.852	5.060	4.906	4.984	4.719	4.038	5.460
AP	0.756	0.709	0.780	0.567	0.685	0.638	0.615	0.686
Total	100.018	100.017	100.019	100.014	100.017	100.016	100.015	100.016
SALIC	58.447	54.297	53.517	52.253	49.430	52.999	53.388	56.383
FEMIC	41.570	45.720	46.502	47.760	50.587	47.016	46.627	43.633

TABLE 15 – *Continued*

21-4	22-1, 10	23-1, 5D	23-5, 1B	24-1, 2	24-7, 3G	25-2, 1B	26-1, 2A	26-5, 1H	26-6, 7A
40-42	94-96	102-104	16-19	12-15	141-144	22-25	42-45	82-85	114-117
Tholeiite (plag. phyric)	Tholeiite	Tholeiite	Tholeiite	Picrite	Picrite	Tholeiite	Tholeiite	Tholeiite	Tholeiite
Flow Unit 17	Flow Unit 18	Flow Sub-unit 19a	Flow Sub-unit 19c	Flow Sub-unit 19d	Flow Sub-unit 19d	Flow Unit 20	Flow Unit 21	Flow Unit 22	Flow Unit 23
Hole 433C									
47.26	47.47	48.45	49.11	46.10	44.73	47.40	47.88	46.94	46.65
2.71	2.77	2.32	1.69	1.33	1.24	2.10	2.10	2.10	2.37
15.73	15.24	13.27	12.84	9.76	8.88	14.71	14.70	13.04	14.75
12.92	13.31	16.00	12.31	14.24	14.04	12.98	12.98	13.67	13.32
0.11	0.16	0.08	0.15	0.18	0.17	0.14	0.14	0.16	0.15
7.58	6.96	9.61	12.54	19.60	22.00	9.56	8.29	12.66	10.88
9.16	9.21	5.01	8.03	6.25	5.33	9.67	10.30	8.98	8.47
3.00	2.90	2.60	2.20	2.60	1.60	2.40	2.50	2.00	2.50
0.45	0.64	1.08	0.27	0.13	1.08	0.16	0.22	0.14	0.14
0.29	0.31	0.06	0.18	0.13	0.14	0.21	0.23	0.23	0.24
99.21	98.97	98.48	99.32	98.48	99.11	99.33	99.34	99.92	99.47
3.67	3.52	8.54	6.33	6.10	4.31	4.12	3.09	4.82	3.14
1.41	1.70	3.28	2.86	4.89	3.36	2.27	1.48	3.47	3.11
0.27	0.30	0.25	0.47	0.52	0.24	0.20	0.18	0.36	0.38
0.54	0.51	0.56	0.67	0.74	0.76	0.59	0.56	0.65	0.62
121	106	252	458	985	1022	150	110	417	225
340	338	179	172	107	125	255	260	251	261
164	170	126	89	74	66	123	117	119	140
Dry and Reduced Analyses									
48.26	48.62	50.01	50.07	47.29	45.74	48.35	48.84	47.63	47.53
16.06	15.61	13.70	13.09	10.01	9.08	15.01	14.99	13.23	15.03
11.88	12.27	14.86	11.30	13.14	12.91	11.91	11.91	12.48	12.22
7.74	7.13	9.92	12.78	20.10	22.49	9.75	8.46	12.85	11.09
9.35	9.43	5.17	8.19	6.41	5.45	9.86	10.51	9.11	8.63
3.06	2.97	2.68	2.24	1.23	1.64	2.45	2.55	2.03	2.55
0.46	0.66	1.11	0.28	0.13	1.10	0.16	0.22	0.14	0.14
2.77	2.84	2.39	1.72	1.36	1.27	2.14	2.14	2.13	2.41
0.30	0.32	0.06	0.18	0.13	0.14	0.21	0.23	0.23	0.24
0.11	0.16	0.08	0.15	0.18	0.17	0.14	0.14	0.16	0.15
99.99	100.01	99.98	100.00	99.98	99.99	99.98	99.99	99.99	99.99
CIPW Norms Assuming $\frac{Fe^{+3}}{Fe^{+2} + Fe^{+3}} = 0.15$									
2.713	3.892	6.544	1.651	0.767	6.487	0.944	1.298	0.826	0.826
25.844	25.076	22.625	18.918	10.387	13.850	20.694	21.536	17.143	21.534
28.672	27.252	22.023	24.788	21.365	14.137	29.433	28.751	26.521	29.093
6.542	7.241	1.326	6.093	3.977	4.983	7.526	9.099	7.133	5.040
9.544	10.643	18.708	23.887	25.313	7.491	15.117	14.721	17.898	13.501
6.209	7.832	13.135	10.156	8.490	2.218	8.508	9.548	8.135	6.693
6.795	4.958	4.163	5.523	17.272	33.923	6.392	4.421	9.839	9.855
4.872	4.021	3.221	2.588	6.385	11.071	3.964	3.160	4.928	5.385
2.865	2.966	3.588	2.721	3.169	3.111	2.880	2.880	3.010	2.952
5.251	5.382	4.529	3.260	2.578	2.407	4.057	4.057	4.037	4.568
0.709	0.756	0.142	0.426	0.307	0.331	0.497	0.544	0.544	0.567
100.017	100.019	100.004	100.011	100.009	100.009	100.013	100.014	100.014	100.014
57.229	56.220	51.193	45.358	32.519	34.474	51.071	51.585	44.489	51.453
42.787	43.798	48.812	54.653	67.490	65.536	48.942	48.429	55.525	48.562

TABLE 15 – *Continued*

Core/Section/Piece No.	27-2, 6B	28.2, 1D	28-5, 6E	29-3, 2C	31-1, 1D	32-1, 3D	32-5, 1C	34-7
Interval (cm)	131-134	19-21	107-109	25-27	15-18	98-101	72-75	95-98
Rock Type	Picrite	Tholeiite	Tholeiite	Tholeiite	Tholeiite	Picrite	Picrite	Tholeiite
Lithologic Unit	Flow Unit 24	Flow Unit 25	Flow Sub-unit 26a	Flow Sub-unit 26b	Flow Unit 27	Flow Unit 28	Flow Unit 29	Flow Unit 35
Hole 433C								
Major Element Oxides (%)								
SiO_2	44.00	49.00	49.35	48.33	46.75	42.90	46.96	47.50
TiO_2	1.08	2.57	2.78	2.95	2.74	0.95	1.78	2.45
Al_2O_3	8.04	13.97	14.11	14.33	14.21	6.55	11.86	14.03
Fe_2O_3 (Total)	14.67	13.24	13.71	13.24	14.02	14.35	13.84	12.50
MnO	0.18	0.16	0.16	0.20	0.17	0.16	0.19	0.26
MgO	26.02	6.89	6.52	6.88	8.70	30.50	15.93	9.47
CaO	4.29	10.29	10.61	10.27	9.95	3.63	7.24	10.13
Na_2O	1.00	2.50	2.60	2.60	2.60	0.60	1.60	2.50
K_2O	0.13	0.19	0.21	0.65	0.41	0.04	0.10	0.44
P_2O_5	0.11	0.25	0.33	0.34	0.35	0.10	0.19	0.31
Total	99.52	99.06	100.38	99.78	99.90	99.78	99.68	99.59
Loss on Ignition (%)	5.89	1.11	1.44	2.27	1.17	7.43	6.15	4.25
H_2O^+	4.46	0.59	Run Twice 0.55/0.63	0.89	1.03	6.01	4.54	1.43
CO_2	0.34	0.17	0.11/0.10	0.19	0.21	0.41	0.31	0.45
Mg/(Mg + Fe)	0.78	0.51	0.49	0.51	0.55	0.81	0.70	0.62
Trace Elements (ppm)								
Ni	1256	70	67	77	182	1494	569	256
Sr	84	300	320	309	340	53	158	281
Zr	59	151	181	185	169	55	91	154
Dry and Reduced Analyses								
Adjusted Oxides								
SiO_2	44.88	50.14	49.84	49.09	47.46	43.62	47.77	48.30
Al_2O_3	8.20	14.29	14.25	14.55	14.43	6.66	12.07	14.27
FeO	13.46	12.19	12.46	12.10	12.81	13.13	12.67	11.44
MgO	26.54	7.05	6.59	6.99	8.83	31.01	16.21	9.63
CaO	4.38	10.53	10.72	10.43	10.10	3.69	7.37	10.30
Na_2O	1.02	2.56	2.63	2.64	2.64	0.61	1.63	2.54
K_2O	0.13	0.19	0.21	0.66	0.42	0.04	0.10	0.45
TiO_2	1.10	2.63	2.81	3.00	2.78	0.97	1.81	2.49
P_2O_5	0.11	0.26	0.33	0.35	0.36	0.10	0.19	0.32
MnO	0.18	0.16	0.16	0.20	0.17	0.16	0.19	0.26
Total	100.00	100.00	100.00	100.01	100.00	99.99	100.01	100.00
CIPW Norms Assuming $\frac{Fe^{+3}}{Fe^{+2} + Fe^{+3}} = 0.15$								
Q								
C		1.221	1.084					
OR	0.767	1.121	1.238	3.892	2.476	0.236	0.590	2.654
AB	8.612	21.619	22.208	22.290	22.290	5.151	13.762	21.452
AN	17.374	26.885	26.401	25.845	26.225	15.284	25.266	26.157
NE								
WO	1.499	9.835	10.237	9.814	8.945	0.974	4.166	9.502
EN	17.587	17.523	16.378	14.699	10.678	16.316	23.833	13.102
FS	4.703	13.275	13.358	10.676	6.776	3.672	9.090	6.907
FO	33.893			1.872	7.894	42.573	11.527	7.593
FA	9.988			1.499	5.521	10.558	4.845	4.411
MT	3.241	2.937	3.009	2.922	3.096	3.169	3.053	2.764
IL	2.085	4.985	5.326	5.685	5.268	1.838	3.430	4.720
AP	0.260	0.615	0.780	0.827	0.851	0.236	0.449	0.757
Total	100.008	100.015	100.019	100.021	100.021	100.007	100.012	100.020
SALIC	26.752	50.845	50.931	52.026	50.991	20.671	39.618	50.263
FEMIC	73.256	49.170	49.088	47.995	49.029	79.336	60.394	49.757

TABLE 15 – *Continued*

35-6, 1D	36-2, 1D	36-3, 1J	36-4, 1F	36-5, 4M	37-3, 1F	38-1, 1G	38-5	39-5, 1C	40-2, 1G
27-29	16-19	79-82	49-52	119-122	101-103	76-79	97-100	102-104	111-113
Tholeiite	Tholeiite	Tholeiite	Tholeiite	Tholeiite	Tholeiite	Tholeiite	Tholeiite	Tholeiite	Tholeiite
Flow Unit 35	Flow Unit 37	Flow Unit 38	Flow Unit 39	Flow Unit 41	Flow Sub-unit 44b	Flow Sub-unit 45b	Flow Unit 47	Flow Unit 48	Flow Unit 49
Hole 433C									
48.46	48.45	48.17	48.23	48.33	49.50	46.60	47.56	48.16	47.80
2.39	2.31	2.24	2.25	2.34	2.24	2.18	2.37	2.22	2.12
13.48	13.34	12.89	12.92	13.71	13.88	13.13	14.85	13.20	12.76
13.31	13.38	13.20	12.94	13.15	12.52	13.88	13.10	13.15	13.13
0.17	0.14	0.16	0.17	0.14	0.15	0.17	0.15	0.16	0.16
8.65	9.55	11.20	11.31	10.15	7.30	12.55	8.82	10.50	11.77
9.98	8.82	8.58	8.32	8.88	10.69	8.50	9.97	9.71	9.29
2.40	2.50	2.40	2.30	2.50	2.40	2.30	2.40	2.10	2.10
0.33	0.51	0.35	0.32	0.22	0.42	0.45	0.18	0.22	0.20
0.32	0.26	0.22	0.24	0.27	0.26	0.23	0.27	0.25	0.24
99.49	99.26	99.41	99.00	99.69	99.36	99.99	99.67	99.67	99.57
2.22	10.18	5.25	4.23	5.21	3.14	3.44	4.05	2.16	2.36
1.11	1.91	2.47	2.54	2.09	0.76	2.49	2.21	1.58	2.09
0.12	0.26	0.26	0.30	0.24	0.21	0.27	0.24	0.18	0.13
0.56	0.59	0.63	0.63	0.60	0.54	0.64	0.57	0.61	0.64
212	258	348	324	260	162	433	156	308	399
277	225	218	214	245	274	259	281	257	237
165	130	139	141	143	129	132	139	132	131
Dry and Reduced Analysis									
49.37	49.48	49.11	49.37	49.13	50.45	47.26	48.35	48.97	48.65
13.73	13.62	13.14	13.22	13.94	14.15	13.32	15.10	13.42	12.99
12.20	12.30	12.11	11.91	12.03	11.49	12.67	11.99	12.03	12.02
8.81	9.75	11.42	11.58	10.32	7.44	12.73	8.97	10.68	11.98
10.17	9.01	8.75	8.52	9.03	10.90	8.62	10.14	9.87	9.46
2.44	2.55	2.45	2.35	2.54	2.45	2.33	2.44	2.14	2.14
0.34	0.52	0.36	0.33	0.22	0.43	0.46	0.18	0.22	0.20
2.43	2.36	2.28	2.30	2.38	2.28	2.21	2.41	2.26	2.16
0.33	0.27	0.22	0.25	0.27	0.27	0.23	0.27	0.25	0.24
0.17	0.14	0.16	0.17	0.14	0.15	0.17	0.15	0.16	0.16
99.99	100.00	100.00	100.00	100.00	100.01	100.00	100.00	100.00	100.00
CIPW Norms Assuming $\frac{Fe^{+3}}{Fe^{+2} + Fe^{+3}} = 0.15$									
					0.616				
2.005	3.066	2.123	1.946	1.297	2.536	2.713	1.062	1.297	1.179
20.607	21.532	20.690	19.845	21.448	20.688	19.674	20.605	18.070	18.072
25.458	24.131	23.745	24.500	25.931	26.287	24.476	29.658	26.307	25.197
9.498	7.814	7.575	6.703	7.104	10.820	6.972	7.844	8.737	8.382
18.687	17.980	18.611	21.329	18.727	18.491	12.088	15.679	20.819	19.980
11.642	10.275	9.003	9.952	9.804	12.842	5.605	9.376	10.716	9.272
2.251	4.381	6.849	5.224	4.850		13.700	4.637	4.011	6.865
1.546	2.759	3.652	2.686	2.798		7.001	3.056	2.275	3.511
2.938	2.966	2.923	2.880	2.908	2.778	3.053	2.894	2.908	2.894
4.606	4.473	4.322	4.359	4.511	4.321	4.188	4.568	4.283	4.094
0.780	0.638	0.520	0.591	0.638	0.638	0.544	0.638	0.591	0.567
100.019	100.016	100.013	100.015	100.016	100.016	100.014	100.016	100.015	100.014
48.071	18.729	46.558	46.291	48.676	50.126	46.863	51.325	45.674	44.449
51.948	51.287	53.455	53.724	51.340	49.890	53.151	48.691	54.341	55.566

TABLE 15 – *Continued*

Core/Section/Piece No.	41-1, 1C	42-1, 1G	42-3, 1B	42-5, 1F	45-5, 1A	46-3	47-5, 6B	49-2, 1D
Interval (cm)	19-21	2-6	14-16	37-39	6-8	72-74	87-89	31-36
Rock Type	Tholeiite	Tholeiite	Tholeiite	Tholeiite	Tholeiite	Tholeiite	Tholeiite	Tholeiite
Lithologic Unit	Flow Unit 51	Flow Unit 52	Flow Unit 53	Flow Unit 54	Flow Unit 60	Flow Sub-unit 62a	Flow Unit 64	Flow Unit 66
				Hole 433C				
Major-Element Oxides (%)								
SiO_2	48.96	49.26	48.80	48.86	48.72	48.96	45.45	46.70
TiO_2	2.39	2.37	1.88	2.02	2.16	2.19	3.12	2.84
Al_2O_3	14.00	13.89	16.25	15.40	14.47	14.72	14.00	15.44
Fe_2O_3 (Total)	13.28	12.91	11.33	11.85	12.90	13.17	14.80	14.40
MnO	0.12	0.13	0.13	0.14	0.21	0.13	0.19	0.16
MgO	7.68	7.68	7.72	6.98	6.69	6.75	6.76	6.19
CaO	10.07	10.14	10.26	10.94	11.15	9.58	10.92	9.77
Na_2O	2.60	2.70	2.70	2.50	2.60	2.80	2.60	2.90
K_2O	0.24	0.25	0.25	0.23	0.18	0.65	0.89	0.52
P_2O_5	0.26	0.26	0.24	0.23	0.21	0.26	0.33	0.32
Total	99.60	99.59	99.56	99.15	99.29	99.21	99.06	99.24
Loss on Ignition (%)	3.08	2.89	2.62	2.33	2.26	3.60	4.65	3.97
H_2O^+	1.08	1.02	1.31	0.88	0.81	1.24	1.74	1.84
CO_2	0.20	0.22	0.21	0.30	0.32	0.19	1.06	0.22
Mg/(Mg + Fe)	0.53	0.54	0.57	0.54	0.51	0.50	0.48	0.46
Trace Elements (ppm)								
Ni	84	83	88	85	84	80	186	133
Sr	267	268	267	270	272	259	294	325
Zr	143	132	105	115	118	140	184	168
				Dry and Reduced Analyses				
Adjusted Oxides								
SiO_2	49.82	50.11	49.58	49.88	49.71	50.02	46.58	47.75
Al_2O_3	14.25	14.13	16.51	15.72	14.77	15.04	14.35	15.79
FeO	12.16	11.82	10.35	10.88	11.85	12.11	13.65	13.25
MgO	7.82	7.81	7.84	7.13	6.83	6.90	6.93	6.33
CaO	10.25	10.32	10.42	11.17	11.38	9.79	11.19	0.99
Na_2O	2.65	2.75	2.74	2.55	2.65	2.86	2.66	2.97
K_2O	0.24	0.25	0.25	0.23	0.18	0.66	0.91	0.53
TiO_2	2.43	2.41	1.91	2.06	2.20	2.24	3.20	2.90
P_2O_5	0.26	0.26	0.24	0.23	0.21	0.27	0.34	0.33
MnO	0.12	0.13	0.13	0.14	0.21	0.13	0.19	0.16
Total	100.00	99.99	99.97	99.99	99.99	100.02	100.00	100.00
				CIPW Norms Assuming $\frac{Fe^{+3}}{Fe^{+2} + Fe^{+3}} = 0.15$				
Q								
C								
OR	1.415	1.475	1.475	1.357	1.062	3.892	5.365	3.125
AB	22.377	23.226	23.150	21.541	22.381	24.147	20.821	25.076
AN	26.223	25.424	31.963	30.716	27.822	26.193	24.471	28.126
NE							0.886	
WO	9.531	10.013	7.552	9.647	11.340	8.563	11.983	8.006
EN	18.089	18.011	14.650	16.915	15.548	14.092	6.320	8.140
FS	12.558	12.120	8.867	11.763	12.444	11.292	5.305	7.415
FO	0.943	0.983	3.396	0.569	1.002	2.140	7.638	5.319
FA	0.721	0.729	2.265	0.436	0.884	1.890	7.066	5.339
MT	2.937	2.851	2.505	2.620	2.865	2.922	3.298	3.197
IL	4.605	4.568	3.622	3.906	4.170	4.245	6.064	5.496
AP	0.615	0.615	0.568	0.544	0.496	0.638	0.803	0.780
Total	100.015	100.015	100.014	100.014	100.013	100.016	100.020	100.019
SALIC	50.015	50.124	56.589	53.613	51.264	54.232	51.544	56.327
FEMIC	50.000	49.891	43.425	46.400	48.749	45.783	48.476	43.692

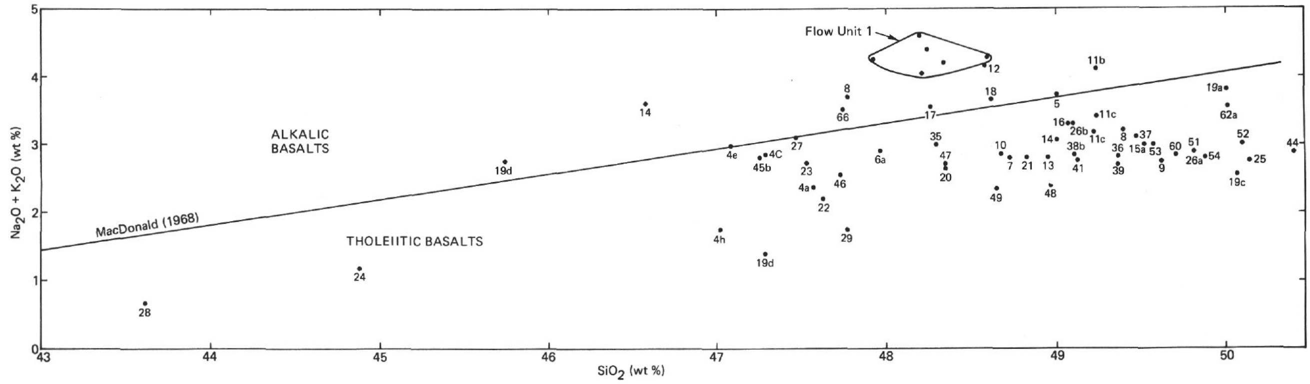


Figure 27. *Total alkalis versus silica for volcanic rocks from Site 433 (dry and reduced analyses).*

TABLE 16
Range and Average Abundance (ppm) of Selected Minor Elements in Basalts of Hole 315A, Compared with Those of Hawaiian Tholeiites and Alkalic Olivine Basalts (after Jackson et al., 1976)

	Hole 315A		Hawaiian Tholeiites		Hawaiian Alkalic Olivine Basalts		
Element	Range	Average	Range	Average	Range	Average	Source
Ba	92-144	117[a]	50-300	120	200-1000	420	e, f, g, h, i, j
Sr	237-275	249[a]	100-1000	383	262-1000	607	e, f, g, h, i, j, k
Co	43.5-55.9	49.3[b]	20-71	48	30-100	66	e, f, g, h, i, j
Cr	75-174 61-145	121[b] 108[c]	150-1500	567	20-1000	433	e, f, g, h, i, j
Cu	70-100	87[d]	50-200	139	30-300	105	e, f, g, h, i, j
Nb	32-44	38[c]	>10	>10	10-40	20	e, f, g, h, i, j
Ni	38-92	66[c]	50-1240	235	15-972	219	e, f, g, h, i, j
P	1091-1397	1314[a]	524-2095	1135	873-3317	1615	l, m
Sc	25.9-34.4	29.9[b]	20-70	32	20-50	30	e, f, g, h, i, j
Ti	13309-17505	15527[a]	10971-22122	14988	11091-24100	18045	l, m
V	170-280	235	150-500	289	30-500	323	e, f, g, h, i, j
Y	39-60	50[c]	15-50	26	19-50	27	e, f, g, h, i, j, k
Zr	165-230	192[c]	70-247	131	70-348	149	e, f, g, h, i, j

[a] X-ray fluorescence analyses.
[b] Radioactivation and radiochemistry analyses.
[c] Quantitative spectrographic analyses.
[d] Semiquantitative spectrographic analyses.
[e] Unpublished semiquantitative spectrographic analyses of E. D. Jackson.
[f] Unpublished semiquantitative spectrographic analyses of R. L. Christiansen.
[g] Unpublished semiquantitative spectrographic analyses of D. A. Swanson.
[h] Unpublished semiquantitative spectrographic analyses of R. I. Tilling.
[i] Unpublished semiquantitative spectrographic analyses of T. L. Wright.
[j] Hubbard (1967).
[k] Schilling (1966).
[l] MacDonald and Katsura (1964).
[m] MacDonald (1968).

directions represent the ambient magnetic field when these basalts erupted and cooled. Results of paleomagnetic measurements on individual samples are summarized in Table 17. This table follows the format used in the site summary chapters for Sites 430 and 432.

The basalts from Suiko Seamount are characterized by unimodal, nearly Gaussian distribution of J_{NRM}, high median demagnetizing field, and moderate to high Q_n' ratio. Shipboard observations using the reflecting microscope showed that the ferromagnetic minerals in these rocks are fresh titanomagnetites with sharp crystal boundaries. Most titanomagnetite grains range from homogeneous and unoxidized to moderately oxidized with exsolution lamellae of ilmenite, but some show higher stages of oxidation with pseudobrookite and hematite (Wilson and Haggarty, 1966). They therefore represent different stages of high-temperature oxidation commonly observed in subaerially erupted volcanic rocks (Buddington and Lindsley, 1964; Ozima and Larson, 1970), but with little trace of low-temperature oxidation resulting in formation of titanomaghemite (Readman and O'Reilley, 1972). These observations have been confirmed by shore-based studies (Kono et al., this volume). In typical mid-oceanic ridge basalts, the effect of low-temperature oxidation becomes apparent at an age of about 1 m.y. (Johnson and Atwater, 1977). By this effect, Curie temperature and MDF are increased, and J_{NRM}, susceptibility, and Q_n' are de-

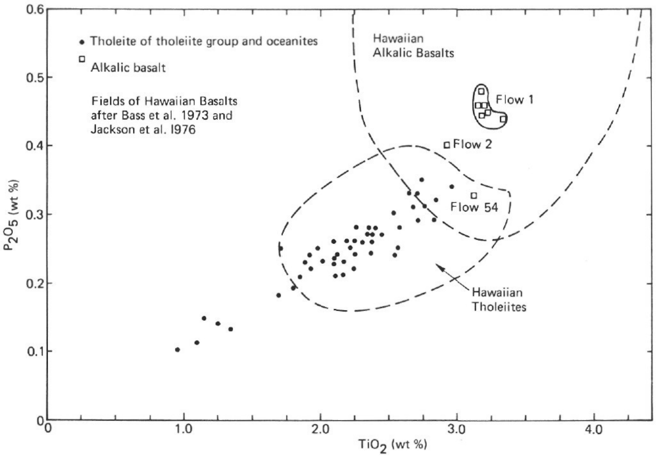


Figure 28. *P_2O_5-TiO_2 plots for basalts from Site 433.*

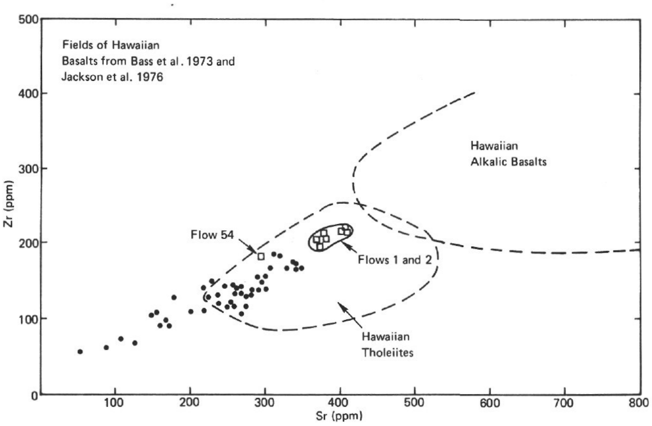


Figure 29. *Zr-Sr plots of basalts from Site 433.*

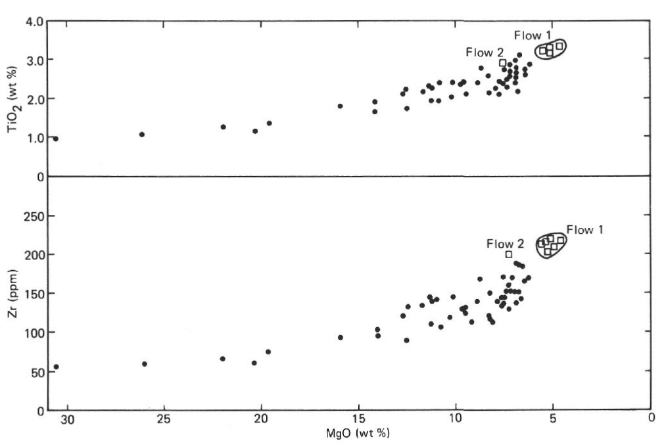


Figure 30. *MgO variation diagrams for Zr and TiO_2 in the basalts cored at Site 433. Symbols are the same as those of Figures 28 and 29.*

creased. Shipboard and shore-based studies have shown, however, that the basalts from Suiko Seamount are similar in magnetic properties to those found on oceanic islands and not similar to mid-oceanic ridge basalts.

Magnetic Stability and Flow Boundaries

Samples from Site 433 were, on the whole, stable to AF demagnetization, and changes of more than about 10° between the original NRM and the stable component were observed in only six flow units: 1, 2, 10, 13, 25, and 27. Directions of stable remanence could be determined for these flows by AF demagnetization between 200 and 300 Oe.

Magnetic stability of most of the other samples was quite high; direction of magnetization changed only a few degrees throughout the AF demagnetization steps. We clearly did obtain the directions of primary magnetic moments representing the true field directions when the rocks formed.

The flow-mean values of inclination, J_{NRM}, MDF, susceptibility, and Q_n' are listed in Table 18. Because the magnetic stability was very high and groupings of inclination were good in most of the flows, it was sometimes possible to detect flow boundaries on the basis of inclination differences at places where the Initial Core Description failed to do so. Two such flow units (28 and 51) were studied closely by taking additional samples, and the existence of boundaries within them was confirmed by magnetic measurements as well as by subsequent visual observations of the core. Some of the units suspected of being sub-flow members (designated as a, b, etc.) also showed distinctly different inclinations. Examples of this kind are Flow Sub-units 26a, 46a, and 62c. In the case of Flow Unit 26, enough samples were measured to warrant separation of the flow unit into Sub-units 26a and 26b, but in other cases (46a and 62c) the samples were omitted from the inclination analyses because the number of samples was only one.

Some samples taken from places too close to the upper flow unit boundaries show inclinations very similar to those of the upper flows, and very different from the mean inclination of the flows to which they belong. This probably represents the effect of reheating, so such samples were excluded from inclination analysis, as indicated in the footnotes of Table 18.

Magnetic Inclination, Secular Variation, and Paleolatitude

Figure 31 shows the change of inclination with depth. The dots and horizontal bars represent the individual flow mean and standard deviations, and the vertical bars represent the vertical extent of flow units with different magnetic inclinations. Although this figure is based only on shipboard data, inclusion of shore-based data does not change the figure except in a few small details (Kono, this volume).

In this figure, we can see that some of the consecutive flow units have very similar inclinations; e.g., Flow Units 4 to 7 and 35 to 38. This may indicate that these units erupted in a short time, say, a few hundred years. At other places, most notably between Flow Units 51-2 and 63, the inclination data define a smooth curve against depth. This certainly reflects the change in the earth's magnetic field, i.e., secular variation. If the characteristics of the geomagnetic secular variation at

TABLE 17
Paleomagnetism, Site 433

Sample (Interval in cm)	Flow Unit	Sub-bottom Depth (m)	J_{NRM} ($\times 10^{-5}$ emu/cm^3)	Inclination of NRM (°)	Stable Inclination (°)	AF (Oe)	MDF (Oe)	Suscept. χ ($\times 10^{-5}$)	Q_n (Oe)[b]
Hole 433A									
20-1, 3-5	1	163.53	4.40	-45.1	-39.2	(300)	259	5.56	1.78
20-1, 36-38	1	163.86	5.89	-64.8	-38.7	(300)	79	3.97	3.33
20-1, 113-115	1	164.63	4.94	-68.6	-41.4	(300)	67	8.48	1.31
20-2, 2-4	1	165.04	5.27	-37.2	-38.6	(THD)[a]		3.95	2.99
20-2, 10-12	1	165.11	7.26	-37.7	-34.6	(300)	294	3.94	4.13
20-2, 14-16	1	165.16	5.76	-37.9	-38.3	(THD)[a]		3.72	3.47
20-2, 24-26	1	165.26	4.63	-41.1	-42.5	(THD)[a]		3.13	3.31
20-2, 49-51	1	165.50	5.29	-64.6	-38.7	(300)	82	6.76	1.75
21-1, 28-30	1	166.78	6.79	-77.1	-45.8	(300)	50	4.42	3.45
21-2, 84-86	1	168.77	7.36	-58.6	-34.5	(300)	57	3.80	4.35
21-3, 98-100	1	170.28	5.22	-79.5	-40.3	(300)	30	2.50	4.69
21-4, 138-140	1	172.01	6.39	-54.1	-38.4	(300)	123	4.00	3.59
Hole 433B									
4-1, 51-53	1	157.52	0.97	-36.4	-35.4	(300)	85	1.45	1.50
5-1, 71-73	1	167.31	3.23	-77.7	-37.5	(300)	64	1.40	5.18
5-2, 36-38	1	168.58	6.94	-54.4	-39.3	(300)	81	1.46	10.66
Hole 433C									
1-1, 61-63	1	163.50	9.12	-67.1	-35.4	(300)	68	4.51	4.53
1-2, 76-78	1	165.03	7.74	-58.0	-41.1	(300)	56	1.89	9.17
2-1, 22-24	1	168.19	5.10	-48.3	-41.3	(300)	79	1.87	6.11
4-1, 39-41	2	181.88	10.00	-84.1	-40.8	(300)	33	3.81	5.88
4-1, 86-88	2	182.32	7.01	-63.1	-30.0	(300)	37	4.08	3.85
5-1, 12-14	2	187.12	0.61	51.0	-33.0	(300)	55	2.61	0.52
10-1, 7-9	4	204.57	16.20	-43.1	-43.6	(200)	324	1.89	19.19
10-1, 37-39	4	204.87	26.30	-37.9	-38.2	(200)	279	2.93	20.09
10-1, 119-121	4	205.45	10.70	-43.8	-43.1	(200)	280	1.41	17.01
10-2, 21-23	4	205.81	12.70	-42.6	-41.9	(200)	305	1.57	18.06
10-2, 47-49	4	206.02	15.80	-43.1	-43.3	(200)	261	2.64	13.46
10-2, 85-87	4	206.31	14.10	-36.4	-38.2	(200)	240	2.15	14.64
10-2, 139-141	4	206.70	21.30	-40.8	-41.8	(200)	268	2.67	17.93
10-3, 16-18	4	206.93	19.60	-46.2	-47.2	(200)	252	2.85	15.40
10-3, 92-94	4	207.58	18.00	-40.5	-40.9	(THD)[a]		3.10	13.02
10-3, 135-137	4	207.96	31.50	-37.1	-38.0	(200)	300	2.95	24.00
10-3, 145-147	4	208.07	18.50	-38.7	-38.6	(THD)[a]		3.07	13.50
10-4, 9-11	4	208.17	23.20	-38.9	-40.4	(200)	237	2.66	19.59
10-4, 39-41	4	208.45	2.53	-50.0	-50.7	(150)	266	0.57	10.01
10-4, 56-58	4	208.62	14.00	-45.3	-46.5	(200)	276	1.97	15.97
10-4, 69-71	4	208.76	10.80	-46.0	-48.8	(THD)[a]		2.30	10.51
10-4, 112-114	4	209.10	8.83	-46.1	-47.5	(200)	315	1.51	13.10
10-5, 48-50	4	209.85	9.32	-40.2	-40.4	(200)	255	1.56	13.44
10-5, 73-75	5	210.07	20.30	-36.5	-37.6	(300)	288	3.18	14.33
10-5, 143-145	5	210.68	7.49	-45.8	-46.2	(300)	307	1.48	11.33
10-6, 38-40	5	211.09	4.83	-45.7	-43.7	(THD)[a]		1.24	8.75
10-6, 43-45	5	211.13	5.97	-48.1	-47.8	(300)	342	1.12	12.00
11-1, 5-7	5	214.05	5.03	-45.2	-44.8	(300)	314	1.07	10.49
11-1, 63-65	6	214.53	14.70	-43.5	-44.8	(200)	265	2.34	14.07
11-1, 127-129	6	214.99	7.22	-43.6	-43.5	(200)	320	1.61	10.06
11-1, 139-141	6	215.12	3.83	-44.1	-43.2	(THD)[a]		1.41	6.07
11-2, 50-52	6	215.55	8.08	-39.9	-40.4	(200)	350	1.45	12.50
11-3, 9-11	7	216.47	2.15	-47.4	-46.1	(400)	341	0.54	8.92
11-3, 84-86	7	217.19	1.91	-42.6	-42.4	(THD)[a]		0.68	6.31
11-3, 98-100	7	217.32	2.11	-43.7	-44.6	(400)	368	0.58	8.14
11-3, 112-114	7	217.47	1.87	-41.9	-42.9	(THD)[a]		0.67	6.28
11-3, 121-123	7	217.55	2.21	-44.9	-45.3	(400)	325	0.62	7.98
11-4, 58-60	8	218.18	3.31	-50.3	-50.0	(200)	531	0.62	11.99
11-4, 90-92	8	218.33	3.88	-53.1	-52.8	(200)	409	0.65	13.38
11-5, 36-38	8	218.92	5.43	-54.0	-73.6	(THD)[a]		2.82	4.33[c]
11-5, 40-42	8	218.95	5.04	-54.1	-54.2	(200)	277	1.85	6.13
12-1, 38-40	8	223.83	3.17	-53.1	-55.0	(200)	125	1.21	5.87
12-1, 102-104	9	224.33	4.37	-56.6	-56.6	(300)	250	1.19	8.25
12-1, 109-111	9	224.41	2.84	-60.0	-60.4	(THD)[a]		0.83	7.70

TABLE 17 – *Continued*

Sample (Interval in cm)	Flow Unit	Sub-bottom Depth (m)	J_{NRM} (× 10^{-5} emu/cm^3)	Inclination of NRM (°)	Stable Inclination (°)	AF (Oe)	MDF (Oe)	Suscept. χ (× 10^{-5})	Q_n (Oe)[b]
Hole 433C									
12-2, 49-51	9	225.19	2.78	–56.1	–55.8	(300)	217	0.79	7.91
12-2, 115-117	9	225.85	2.48	–55.3	–57.1	(300)	156	0.66	8.45
12-3, 5-7	9	226.21	1.67	–43.1	–42.2	(THD)[a]		1.12	3.34[c]
12-3, 48-50	9	226.63	4.22	–54.4	–56.3	(300)	110	1.22	7.74
12-3, 100-102	10	227.08	4.50	–20.8	–23.0	(300)	90	1.67	6.06
12-4, 22-24	10	227.62	3.99	–18.6	–25.4	(300)	160	0.82	10.90
13-1, 6-8	10	230.03	4.60	–40.6	–30.4	(300)	83	1.55	6.65
13-1, 125-127	10	231.18	2.30	–64.9	–62.1	(THD)[a]		1.31	3.95[d]
13-2, 53-55	10	231.93	3.75	–52.2	–35.0	(300)	44	1.00	8.43
13-2, 103-105	10	232.44	0.72	–79.4	–71.4	(THD)[a]		0.88	1.85[c]
14-1, 47-49	11A	233.47	2.21	–34.6	–31.7	(200)	372	1.58	3.12
14-2, 37-39	11A	234.84	2.66	–32.9	–32.6	(THD)[a]		0.96	6.24
14-2, 128-130	11A	235.73	1.17	–36.1	–35.8	(200)	569	0.57	4.60
14-3, 56-58	11B	236.47	4.13	–52.3	–51.5	(400)	367	1.62	5.71
14-4, 21-23	11B	237.56	2.47	–60.1	–47.7	(400)	61	1.52	3.64
15-1, 17-19	11B	242.65	2.68	–57.9	–54.2	(THD)[a]		1.41	4.26
15-1, 47-49	11B	242.94	4.92	–52.7	–53.3	(400)	253	1.14	9.68
15-1, 10-12	11B	242.57	2.40	–53.0	–53.4	(400)	118	1.31	4.12
15-2, 103-105	11B	244.40	4.00	–43.1	–51.7	(400)	313	2.82	3.19
15-3, 127-129	12	245.67	5.02	–16.7	–16.3	(300)	369	1.82	6.19
15-4, 21-23	12	246.00	3.58	–22.5	–18.5	(300)	303	3.73	2.15
15-4, 46-48	12	246.19	2.18	–25.6	–19.3	(300)	301	3.90	1.25
15-4, 48-50	12	246.22	1.63	–28.8	–32.9	(THD)[a]		5.90	0.62[d]
15-4, 84-86	12	246.50	1.26	–25.6	–28.0	(THD)[a]		4.79	0.59[c]
15-4, 99-101	12	246.61	2.17	–30.2	–23.2	(300)	267	3.55	1.37
15-4, 115-117	12	246.75	2.23	–25.8	–20.1	(300)	298	2.94	1.70
15-5, 14-16	12	247.13	2.58	–24.5	–19.6	(300)	436	2.45	2.36
15-5, 72-74	13	247.66	1.50	–21.2	–22.1	(THD)[a]		1.53	2.20
15-5, 79-81	13	247.72	1.78	–23.7	–20.8	(300)	446	1.93	2.06
15-6, 31-33	13	248.69	4.94	–37.0	–23.7	(300)	191	2.92	3.79
16-1, 11-13	13	252.10	7.80	–83.3	–23.5	(300)	46	3.90	4.48
16-1, 75-77	13	252.68	4.08	–59.4	–24.0	(300)	79	2.73	3.35
16-1, 80-82	13	252.74	3.24	–55.5	–46.6	(THD)[a]		3.16	2.30[c]
17-1, 17-19	13	255.65	8.93	–72.7	–21.7	(300)	61	2.11	9.51
19-1, 14-16	13	261.62	5.13	–59.8	–17.7	(300)	69	2.88	3.99
19-1, 87-89	14	262.26	1.47	–24.4	–24.9	(300)	825	0.42	7.92
19-1, 112-114	14	262.51	1.22	–24.6	–24.9	(300)	657	0.31	8.81
19-2, 9-11	14	262.95	0.95	–25.8	–24.6	(THD)[a]		0.43	4.92
19-2, 12-14	14	262.98	0.94	–22.2	–21.9	(300)	497	0.30	7.06
19-2, 23-25	14	263.07	1.04	–25.6	–24.8	(300)	474	0.28	8.36
19-2, 40-42	14	263.25	0.79	–29.9	–27.6	(THD)[a]		0.28	6.40
19-2, 56-58	14	263.40	0.59	–25.9	–25.7	(300)	598	0.22	5.94
19-2, 64-66	14	263.49	0.43	–25.3	–27.8	(THD)[a]		0.19	4.96
19-3, 15-17	15A	264.28	1.63	–39.2	–38.9	(300)	757	0.42	8.70
19-3, 74-76	15A	264.88	2.48	–35.9	–38.6	(THD)[a]		0.74	7.51
19-4, 17-19	15A	265.78	1.69	–52.4	–44.0	(300)	144	1.30	2.93
19-4, 68-70	15A	266.28	4.41	–45.9	–45.5	(300)	307	0.79	12.48
19-5, 25-27	15A	267.32	1.71	–53.6	–48.3	(300)	153	0.90	4.24
20-1, 24-26	15A	269.72	3.54	–49.1	–49.4	(300)	395	0.37	21.46
20-1, 81-83	15B	270.19	7.18	–55.6	–57.7	(200)	173	1.05	15.34
20-1, 103-105	15B	270.39	5.56	–61.3	–59.5	(THD)[a]		0.83	15.01
20-2, 20-22	15B	270.90	5.41	–58.3	–30.3	(THD)[a]		0.72	16.85[c]
20-2, 35-37	15B	271.03	4.42	–57.0	–57.1	(THD)[a]		0.83	12.00
20-2, 48-50	15B	271.13	6.01	–56.1	–59.7	(200)	157	0.75	17.92
20-2, 132-134	16	271.84	2.60	–58.6	–60.6	(300)	114	1.88	3.11
21-1, 73-75	16	279.55	1.85	–55.2	–58.2	(300)	208	0.93	4.46
21-1, 107-109	16	279.89	2.40	–60.1	–58.3	(300)	183	1.14	4.72
21-1, 128-130	16	280.06	6.77	–60.5	–57.6	(THD)[a]		4.57	3.32
21-2, 27-29	16	280.45	16.70	–56.6	–56.8	(300)	288	1.83	20.50
21-2, 104-106	17	280.92	6.70	–60.7	–60.8	(200)	312	2.16	6.96
21-3, 7-9	17	281.35	2.54	–63.5	–61.0	(THD)[a]		1.46	3.91
21-3, 32-34	17	281.53	3.69	–52.8	–61.5	(200)	246	2.19	3.78
21-4, 40-42	17	282.82	2.89	–68.0	–63.8	(200)	241	3.69	1.76
21-4, 64-66	17	283.01	4.28	–66.2	–66.5	(THD)[a]		3.78	2.54

TABLE 17 – *Continued*

Sample (Interval in cm)	Flow Unit	Sub-bottom Depth (m)	J_{NRM} ($\times 10^{-5}$ emu/cm^3)	Inclination of NRM (°)	Stable Inclination (°)	AF (Oe)	MDF (Oe)	Suscept. χ ($\times 10^{-5}$)	Q_n (Oe)[b]
Hole 433C									
21-4, 101-103	17	283.29	3.97	-52.1	-55.8	(THD)[a]		2.90	3.07
21-4, 120-122	17	283.41	1.65	-43.0	-58.6	(200)	89	3.15	1.17
21-5, 9-11	17	283.74	4.45	-59.6	-60.6	(200)	384	0.99	10.09
22-1, 94-96	18	289.18	4.37	-43.4	-43.6	(200)	278	2.97	3.30
22-1, 104-106	18	289.26	1.78	-32.6	-37.9	(THD)[a]		2.69	1.48[c]
22-2, 113-115	18	290.54	4.20	-41.8	-41.7	(200)	248	1.37	6.87
22-3, 64-66	18	291.35	2.83	-42.1	-41.5	(200)	93	1.56	4.06
22-3, 130-132	18	291.89	1.64	-50.1	-41.5	(200)	116	0.92	4.00
22-4, 23-25	18	292.24	1.91	-52.9	-42.1	(200)	89	0.97	4.41
22-5, 58-60	18	293.82	2.49	-48.7	-38.6	(200)	92	1.31	4.26
23-1, 86-88	19	298.77	10.30	-33.5	-33.7	(300)	263	1.60	14.42
23-1, 102-104	19	298.93	6.97	-37.0	-37.2	(300)	204	1.64	9.54
23-2, 55-57	19	299.70	2.73	-39.2	-38.7	(300)	415	0.97	6.29
23-3, 33-35	19	300.80	1.63	-43.6	-42.2	(300)	323	0.52	7.04
23-4, 99-101	19	302.75	1.99	-42.1	-45.1	(THD)[a]		1.17	3.81
23-7, 102-104	19	306.92	0.91	-38.3	-36.6	(300)	359	0.35	5.87
24-2, 17-19	19	308.75	4.53	-38.7	-38.5	(300)	364	1.10	9.20
24-3, 81-83	19	309.42	2.69	-41.0	-40.6	(300)	408	0.40	14.99
25-1, 131-133	20	317.43	0.48	-43.3	-42.4	(200)	617	0.27	3.97
25-2, 7-9	20	318.49	0.67	-41.7	-40.4	(THD)[a]		0.32	4.64
25-2, 10-12	20	318.51	0.84	-40.2	-40.4	(200)	684	0.34	5.49
25-2, 22-24	20	318.63	1.22	-40.4	-40.2	(200)	631	0.36	7.63
25-2, 27-29	20	318.69	1.12	-39.8	-39.7	(THD)[a]		0.38	6.62
25-2, 45-47	20	318.86	1.65	-40.6	-39.6	(200)	554	0.44	8.31
25-2, 54-56	20	318.96	1.50	-39.6	-38.2	(THD)[a]		0.48	7.00
25-2, 89-91	20	319.30	2.10	-41.0	-39.6	(200)	209	0.78	6.05
25-3, 18-20	21	320.04	3.25	-19.3	-19.8	(200)	236	2.27	3.21[d]
25-5, 77-79	21	323.31	4.37	-42.3	-40.1	(200)	273	1.26	7.76
25-5, 103-105	21	323.58	3.58	-40.7	-39.1	(THD)[a]		1.23	6.51
25-6, 56-58	21	324.55	4.70	-39.7	-39.8	(200)	297	1.23	8.57
26-1, 42-44	21	326.88	1.47	-37.6	-36.4	(200)	448	0.41	8.13
26-2, 29-31	21	328.18	2.01	-35.6	-34.8	(200)	357	0.58	7.73
26-3, 20-22	21	329.51	3.78	-41.3	-38.4	(200)	270	1.09	7.74
26-4, 138-140	22	331.96	0.74	-44.7	-43.3	(600)	690	0.27	6.03
26-5, 35-37	22	332.47	1.41	-42.6	-42.4	(600)	863	0.29	10.81
26-5, 82-84	22	332.94	3.59	-42.1	-41.9	(600)	554	0.39	20.46
26-5, 94-96	22	333.07	3.08	-44.7	-44.0	(THD)[a]		0.38	18.02
26-5, 123-125	22	333.35	2.78	-43.9	-43.3	(600)	428	0.74	8.41
26-6, 114-116	23	334.50	1.93	-40.7	-39.9	(300)	180	0.82	5.26
26-6, 129-131	23	334.66	1.79	-41.4	-42.6	(THD)[a]		0.77	5.25
26-7, 7-9	23	334.89	1.94	-40.4	-42.0	(300)	344	0.42	10.46
27-1, 17-19	24	336.14	0.80	-39.3	-41.5	(200)	405	0.21	8.46
27-1, 56-58	24	336.53	1.10	-42.3	-36.7	(200)	157	0.56	4.43
27-1, 69-71	24	336.66	1.04	-38.3	-35.7	(200)	123	0.38	6.09
27-1, 88-90	24	336.85	2.22	-41.7	-40.4	(200)	240	0.32	15.38
27-2, 131-133	24	338.55	1.68	-43.4	-34.9	(200)	133	0.28	13.55
27-3, 12-14	24	338.83	1.23	-37.0	-32.8	(200)	248	0.31	8.91
27-5, 18-20	24	341.47	2.38	-33.2	-31.9	(200)	277	1.01	5.26
27-5, 125-127	24	342.48	0.14	-43.8	-35.8	(200)	225	0.21	1.52
27-6, 13-15	24	342.82	0.68	-41.7	-35.5	(200)	91	0.48	3.17
27-6, 58-60	25	343.24	3.58	-28.0	-23.3	(300)	178	5.74	1.40[d]
28-1, 82-84	25	346.29	2.66	-84.9	-69.4	(300)	72	1.88	3.17
28-2, 34-36	25	347.20	2.18	-69.0	-70.7	(300)	85	2.75	1.78
28-3, 38-40	25	348.63	1.97	-71.6	-63.6	(300)	74	1.72	2.56
28-4, 26-28	25	349.87	1.63	-66.7	-69.5	(300)	227	1.60	2.28
28-4, 87-89	26A	350.37	2.46	-71.6	-69.5	(200)	516	0.56	9.86
28-4, 121-123	26A	350.66	1.47	-69.1	-69.3	(THD)[a]		0.61	5.40
28-5, 113-115	26A	351.88	1.55	-73.2	-68.3	(200)	130	1.29	2.68
29-1, 48-50	26A	355.43	1.37	-70.8	-67.8	(200)	132	0.99	3.10
29-1, 115-117	26A	356.05	2.93	-65.8	-69.4	(200)	236	0.88	7.42
29-2, 96-98	26B	357.00	2.25	-35.5	-22.8	(300)	261	1.56	3.24
29-2, 108-110	26B	357.06	6.21	-21.3	-17.7	(300)	298	2.70	5.16
29-2, 115-117	26B	357.14	2.56	-20.0	25.9	(THD)[a]		2.44	2.35[c]
29-2, 138-140	26B	357.29	13.70	-22.1	-21.2	(300)	371	2.39	12.91

TABLE 17 – *Continued*

Sample (Interval in cm)	Flow Unit	Sub-bottom Depth (m)	J_{NRM} ($\times 10^{-5}$ emu/cm^3)	Inclination of NRM (°)	Stable Inclination (°)	AF (Oe)	MDF (Oe)	Suscept. χ ($\times 10^{-5}$)	Q_n (Oe)[b]
Hole 433C									
29-3, 17-19	26B	357.50	4.41	-26.9	-22.2	(300)	358	2.02	4.90
30-2, 134-136	27	366.54	7.79	-74.3	-62.9	(200)	96	4.63	3.78
30-3, 57-59	27	367.15	5.29	-80.1	-64.3	(200)	85	3.95	3.01
31-1, 37-39	27	374.37	6.08	-77.2	-60.6	(200)	51	2.14	6.37
31-1, 79-81	27	374.79	3.72	-70.2	-59.9	(200)	65	2.17	3.85
31-1, 120-122	27	375.20	5.71	-63.6	-64.3	(200)	277	1.48	8.65
31-3, 88-90	28A	377.25	3.67	-64.4	-65.0	(200)	347	1.03	8.01
31-4, 49-51	28A	378.07	3.09	-53.0	-52.7	(200)	451	0.61	11.45
31-4, 73-75	28A	378.31	1.85	-54.3	-52.9	(200)	303	0.44	9.34
31-4, 83-85	28A	378.42	1.18	-55.7	-56.3	(THD)[a]		0.71	3.73
31-5, 29-31	28B	379.23	1.58	-46.2	-45.4	(300)	269	0.28	12.49
32-1, 30-32	28B	383.72	2.61	-43.3	-43.0	(300)	447	0.41	14.13
32-1, 38-40	28B	383.81	2.43	-44.6	-43.3	(THD)[a]		0.41	13.28
32-2, 43-45	28B	385.23	6.79	-43.1	-42.4	(300)	369	0.82	18.56
32-3, 100-102	28B	387.19	1.85	-41.8	-41.0	(200)	278	0.25	16.84
32-4, 138-140	29	388.52	5.45	-40.0	-39.9	(200)	275	0.61	20.10
32-5, 13-15	29	388.73	4.91	-39.7	-39.7	(200)	274	0.43	25.87
32-5, 72-74	29	389.32	4.11	-41.1	-40.5	(200)	325	0.36	25.40
32-5, 84-86	29	389.44	4.48	-40.0	-39.5	(200)	313	0.36	27.59
32-5, 115-117	29	389.75	4.27	-42.4	-42.6	(200)	316	0.45	21.33
33-1, 23-25	30	393.18	6.18	-43.0	-42.2	(200)	416	0.39	35.26
33-1, 34-36	30	393.29	5.27	-42.9	-42.4	(200)	380	0.39	30.50
33-1, 62-64	30	393.57	5.79	-44.5	-43.8	(200)	352	0.50	26.17
33-1, 87-89	30	393.82	3.02	-41.6	-41.8	(200)	278	0.49	13.76
33-2, 21-23	30	394.64	18.70	-40.9	-41.1	(200)	503	1.23	34.21
33-2, 72-74	31	395.10	11.10	-40.2	-40.3	(200)	366	1.56	16.01
33-2, 138-140	31	395.76	13.40	-41.0	-41.1	(200)	596	0.83	36.08
33-3, 12-14	31	395.98	4.85	-41.8	-41.5	(200)	545	0.46	23.51
33-3, 88-90	31	396.72	19.00	-40.3	-40.3	(200)	330	1.67	25.46
33-5, 10-12	32	398.70	27.40	-38.4	-38.9	(200)	294	2.04	30.03
33-5, 37-39	32	398.97	25.70	-38.7	-39.0	(200)	378	1.61	35.78
33-5, 63-65	32	399.23	10.60	-43.6	-44.2	(200)	337	1.21	19.65
34-1, 3-5	32	402.53	9.23	-38.2	-38.9	(200)	337	1.30	15.98
34-1, 56-58	32	403.06	16.60	-40.6	-40.3	(200)	352	1.29	28.79
34-1, 140-142	33	403.90	1.69	-42.5	-42.1	(200)	636	0.51	7.44
34-2, 59-61	33	404.57	2.82	-43.2	-43.0	(200)	566	0.29	22.19
34-2, 124-126	33	405.22	3.11	-41.7	-41.8	(200)	520	0.22	31.96
34-3, 8-10	33	405.53	4.70	-41.9	-42.0	(200)	432	0.28	37.78
34-3, 41-43	33	405.86	4.33	-42.6	-42.6	(200)	432	0.29	34.09
34-4, 14-16	34	407.05	5.69	-39.3	-39.8	(200)	333	1.07	11.89
34-4, 50-52	34	407.34	4.60	-40.4	-40.3	(200)	376	0.50	20.68
34-4, 95-97	34	407.79	2.73	-42.4	-42.2	(200)	358	0.38	16.35
34-5, 76-78	34	408.94	2.28	-42.8	-43.0	(200)	445	0.43	11.98
34-5, 113-115	34	409.29	1.93	-41.5	-41.8	(200)	456	0.40	10.73
34-7, 95-97	35	412.02	4.04	-51.9	-50.4	(200)	254	3.53	2.57
35-1, 112-114	35	413.13	3.29	-48.1	-55.2	(THD)[a]		1.78	4.14[c]
35-2, 21-23	35	413.67	5.20	-49.6	-49.8	(200)	375	1.48	7.85
35-4, 115-117	35	417.52	11.80	-49.1	-48.9	(200)	358	1.63	16.33
35-5, 97-99	35	418.80	5.96	-52.2	-50.4	(200)	360	1.04	12.80
35-6, 27-29	35	419.56	8.42	-52.0	-50.1	(200)	461	1.26	15.01
35-6, 48-50	35	419.78	7.86	-47.4	-48.0	(THD)[a]		1.53	11.52
35-6, 114-116	36	420.43	2.90	-47.3	-47.8	(500)	760	0.95	6.83
35-6, 121-123	36	420.12	2.57	-50.2	-49.4	(THD)[a]		0.81	7.11
35-6, 134-136	36	420.63	3.14	-50.9	-51.4	(500)	906	0.47	14.80
35-7, 116-118	36	421.74	1.65	-52.8	-53.0	(THD)[a]		0.42	8.72
36-1, 24-26	36	421.74	3.29	-52.0	-51.2	(500)	1269	0.28	26.36
36-1, 45-47	36	421.96	3.38	-51.6	-51.9	(THD)[a]		0.39	19.21
36-1, 50-52	36	422.00	4.81	-52.3	-51.7	(500)	990	0.44	24.79
36-1, 105-107	37	422.50	5.52	-51.3	-51.7	(THD)[a]		1.30	9.51
36-1, 114-116	37	422.58	5.28	-51.7	-51.0	(200)	380	1.16	10.20
36-1, 125-127	37	422.70	6.67	-50.9	-51.0	(200)	391	1.25	11.93
36-2, 27-29	37	423.19	9.92	-51.0	-51.3	(200)	335	1.52	14.63
36-2, 124-126	38	423.97	8.67	-51.3	-51.0	(300)	277	1.36	14.28
36-3, 22-24	38	424.42	7.59	-51.5	-51.1	(300)	284	1.31	13.03

TABLE 17 – *Continued*

Sample (Interval in cm)	Flow Unit	Sub-bottom Depth (m)	J_{NRM} ($\times 10^{-5}$ emu/cm^3)	Inclination of NRM (°)	Stable Inclination (°)	AF (Oe)	MDF (Oe)	Suscept. χ ($\times 10^{-5}$)	Q_n (Oe)[b]
Hole 433C									
36-3, 35-37	38	424.55	10.90	-51.7	-51.8	(300)	328	1.46	16.70
36-3, 60-62	38	424.81	5.56	-46.3	-45.5	(THD)[a]		1.91	6.53
36-3, 76-78	38	424.96	7.75	-50.0	-50.0	(300)	285	0.93	18.77
36-3, 101-103	38	425.21	6.67	-52.4	-51.9	(300)	298	0.79	18.88
36-4, 20-22	39	425.87	2.78	-52.6	-55.0	(300)	134	0.78	7.96
36-4, 56-58	39	426.24	2.50	-54.9	-57.9	(THD)[a]		0.84	6.63
36-4, 72-74	39	426.39	2.90	-58.2	-53.4	(300)	182	0.84	7.78
36-4, 84-86	39	426.51	4.78	-56.0	-54.7	(300)	193	0.84	12.84
36-4, 113-115	40	426.80	14.00	-53.4	-52.9	(400)	335	1.70	18.53
36-5, 12-14	40	427.26	24.10	-51.0	-50.6	(400)	338	2.38	22.71
36-5, 29-31	40	427.44	2.29	-53.1	-47.5	(THD)[a]		0.58	8.81
36-5, 79-81	41	427.85	4.02	-53.1	-53.6	(300)	268	0.76	11.92
36-5, 103-105	41	428.09	8.94	-54.9	-54.6	(300)	304	1.19	16.81
36-5, 126-128	41	428.32	6.08	-53.1	-53.6	(300)	311	0.86	15.89
37-3, 32-34	44	433.78	4.18	-51.1	-50.6	(200)	308	1.06	8.86
37-3, 74-76	44	434.21	3.68	-54.9	-54.3	(THD)[a]		1.43	5.77
37-3, 87-89	44	434.33	4.12	-52.3	-49.2	(200)	164	1.36	6.80
37-3, 139-141	44	434.83	2.84	-53.6	-47.5	(200)	149	1.19	5.35
37-4, 7-9	44	434.99	2.43	-51.0	-49.7	(200)	115	1.12	4.85
37-4, 52-54	44	435.44	2.02	-58.2	-50.3	(200)	140	1.40	3.25
38-1, 29-31	45	440.79	2.82	-48.5	-47.3	(200)	482	0.33	19.18
38-1, 57-59	45	441.08	2.22	-46.9	-45.7	(THD)[a]		0.36	13.76
38-1, 70-72	45	441.20	2.02	-49.1	-47.5	(200)	560	0.26	17.67
38-1, 121-123	45	441.70	2.08	-46.7	-46.7	(200)	519	0.28	16.80
38-2, 16-18	45	442.13	6.00	-49.3	-49.1	(200)	368	0.96	14.02
38-2, 41-43	45	442.38	4.61	-48.7	-47.7	(200)	257	0.96	10.81
38-2, 62-64	46	442.58	1.99	-53.0	-52.2	(200)	383	0.38	11.65[d]
38-3, 46-48	46	443.75	3.11	-7.6	-6.6	(200)	432	0.75	9.35
38-3, 46-48	46	443.74	1.82	-17.8	-15.0	(200)	282	0.78	5.24
38-3, 118-120	46	444.46	1.78	-16.0	-9.9	(200)	297	0.71	5.66
38-3, 139-141	46	444.66	3.07	-7.0	-5.5	(200)	349	0.77	8.97
38-4, 98-100	47	445.72	1.33	-12.4	-7.7	(300)	264	0.42	7.13
38-5, 63-65	47	446.83	1.22	-7.0	-2.2	(300)	246	0.40	6.85
38-5, 103-105	47	447.23	1.52	-24.9	-8.9	(300)	168	0.53	6.45
38-5, 119-121	47	447.40	0.97	-18.4	-24.3	(THD)[a]		0.57	3.85[c]
38-5, 139-141	47	447.59	1.46	-6.3	-2.3	(300)	278	0.53	6.13
38-6, 11-13	47	447.79	1.53	-8.6	-5.9	(300)	300	0.50	6.88
39-2, 58-60	48	451.59	2.93	-42.8	-43.3	(200)	330	0.74	8.94
39-3, 25-27	48	452.74	0.97	-48.1	-45.4	(200)	332	0.43	5.08
39-4, 91-93	48	454.89	1.61	-47.2	-45.0	(200)	331	0.43	8.44
39-5, 96-98	48	456.44	1.08	-42.8	-43.1	(THD)[a]		0.30	7.98
39-5, 102-104	48	456.49	1.26	-45.6	-42.0	(200)	527	0.31	9.26
39-6, 56-58	48	457.52	1.37	-43.0	-41.7	(200)	524	0.44	7.00
39-6, 78-80	48	457.75	1.30	-47.6	-48.1	(THD)[a]		0.54	5.38
40-1, 37-39	49	459.84	11.80	-42.9	-42.4	(200)	252	3.80	6.96
40-2, 24-26	49	461.19	9.44	-45.3	-44.5	(200)	332	1.30	16.31
40-2, 111-113	49	462.06	9.55	-46.8	-45.8	(200)	403	1.14	18.79
40-3, 8-10	49	462.50	6.79	-46.7	-45.9	(200)	408	1.08	14.05
40-3, 80-82	49	463.22	8.44	-46.6	-46.3	(200)	318	1.47	12.85
40-4, 94-96	51A	464.73	0.68	-48.7	-48.0	(400)	480	0.25	6.03
40-4, 111-113	51A	464.90	1.32	-33.4	-32.7	(400)	502	0.88	3.34[d]
40-5, 18-20	51A	465.44	3.78	-54.5	-53.5	(400)	459	1.31	6.48
40-5, 39-41	51A	465.65	1.18	-52.0	-50.6	(400)	475	1.18	2.24
40-6, 71-73	51B	467.31	5.12	-15.4	-12.8	(200)	297	0.98	11.76
40-6, 94-96	51B	467.54	4.68	-18.4	-12.5	(200)	307	0.95	11.09
41-1, 51-53	51B	469.52	4.22	-9.9	-13.7	(THD)[a]		1.22	7.73
41-4, 91-93	51B	474.18	4.13	-13.0	-11.1	(200)	303	1.00	9.27
41-4, 74-76	51B	473.96	5.81	-11.4	-10.0	(200)	286	1.31	9.94
41-6, 110-112	52	476.97	3.80	-14.4	-13.0	(200)	320	1.15	7.44
41-6, 138-140	52	477.25	4.22	-18.4	-15.7	(200)	322	0.82	11.57
42-1, 45-47	52	478.95	4.49	-16.0	-13.8	(200)	307	1.16	8.71
42-1, 68-70	52	479.19	3.26	-14.5	-15.9	(THD)[a]		1.18	6.22
42-1, 79-81	52	479.29	3.77	-14.1	-11.2	(200)	338	1.02	8.26
42-1, 106-108	52	479.56	4.12	-13.0	-11.7	(200)	338	0.96	9.58

TABLE 17 – *Continued*

Sample (Interval in cm)	Flow Unit	Sub-bottom Depth (m)	J_{NRM} ($\times 10^{-5}$ emu/cm^3)	Inclination of NRM (°)	Stable Inclination (°)	AF (Oe)	MDF (Oe)	Suscept. χ ($\times 10^{-5}$)	Q_n (Oe)[b]
Hole 433C									
42-2, 35-37	53	480.19	2.93	-13.6	-13.9	(200)	474	0.56	11.72[d]
42-2, 126-128	53	481.01	2.61	-22.4	-22.8	(200)	513	0.93	6.31
42-2, 136-138	53	481.12	2.11	-25.8	-28.8	(THD)[a]		1.09	4.32
42-3, 14-16	53	481.36	3.12	-28.4	-25.3	(200)	399	1.16	6.01
42-3, 25-27	53	481.47	2.73	-31.6	-26.1	(200)	350	1.15	5.32
42-4, 137-139	54	483.56	5.35	-33.1	-31.8	(200)	307	1.02	11.81
42-5, 37-39	54	484.03	4.12	-36.4	-34.1	(200)	307	0.91	10.15
42-5, 110-112	54	484.76	5.15	-36.1	-34.5	(200)	295	1.15	10.04
42-5, 134-136	54	485.01	4.63	-36.7	-34.8	(THD)[a]		1.15	8.99
43-1, 7-9	54	488.07	4.77	-37.1	-34.7	(200)	298	1.05	10.24
43-1, 33-35	54	488.34	3.64	-37.6	-36.0	(THD)[a]		1.11	7.36
43-1, 52-54	54	488.48	4.35	-33.8	-31.5	(200)	301	0.97	10.02
44-1, 23-25	56	497.73	2.51	-49.0	-43.6	(300)	265	1.42	3.95
44-1, 41-43	56	497.92	2.82	-49.8	-47.6	(THD)[a]		1.94	3.25
44-1, 46-48	56	497.96	3.99	-56.6	-43.1	(300)	172	1.71	5.24
44-1, 84-86	56	498.34	2.97	-38.7	-37.9	(300)	284	1.01	6.60
44-1, 107-109	56	498.57	1.82	-40.0	-40.0	(300)	173	1.12	3.63
44-3, 89-91	58	501.12	9.46	-45.2	-43.7	(200)	250	0.96	22.00
44-3, 131-133	58	501.48	3.55	-51.3	-48.9	(200)	244	0.97	8.25
44-4, 38-40	58	502.00	3.47	-50.9	-50.8	(200)	313	1.16	6.72
44-4, 81-83	58	502.43	8.99	-47.4	-47.6	(200)	335	1.03	19.51
44-4, 108-110	58	502.68	6.30	-45.3	-45.7	(THD)[a]		1.15	12.34
44-4, 126-128	58	502.83	5.95	-46.8	-46.2	(200)	307	1.09	12.25
45-1, 127-129	59	508.24	8.50	-48.2	-46.1	(300)	293	1.30	14.69
45-2, 31-33	59	508.76	3.62	-44.8	-43.8	(300)	216	1.06	7.64
45-2, 45-47	59	508.91	5.78	-46.8	-46.6	(THD)[a]		1.08	12.03
45-2, 59-61	59	509.04	7.09	-45.1	-45.1	(300)	357	0.94	16.87
45-2, 104-106	59	509.49	5.03	-47.2	-46.1	(300)	304	1.08	10.47
45-3, 22-24	59	510.15	4.38	-42.8	-42.4	(300)	375	0.65	15.19
45-4, 124-126	60	512.57	4.20	-49.7	-43.9	(300)	295	1.54	6.14
45-4, 6-8	60	511.39	4.61	-47.0	-42.5	(300)	257	1.55	6.67
45-5, 51-53	60	513.25	4.10	-54.5	-49.9	(THD)[a]		2.33	3.95
45-5, 84-86	60	513.57	6.21	-47.7	-41.4	(300)	231	1.49	9.37
45-6, 16-18	60	514.31	4.10	-69.7	-44.2	(300)	121	1.80	5.10
45-6, 43-45	60	514.59	2.37	-49.5	-56.5	(THD)[a]		1.71	3.10[c]
45-6, 73-75	60	514.88	2.03	-58.5	-42.7	(300)	155	1.84	2.48
45-7, 121-123	61	516.74	4.75	-45.2	-43.3	(200)	297	1.41	7.57
45-7, 144-146	61	516.97	4.55	-45.9	-44.0	(200)	332	1.21	8.41
46-1, 11-13	61	516.61	2.94	-43.2	-41.2	(200)	270	1.56	4.24
46-1, 48-50	61	516.98	1.75	-44.2	-44.1	(200)	261	1.39	2.81
46-1, 83-85	61	517.33	2.13	-44.1	-43.7	(200)	396	0.83	5.73
46-2, 120-122	62	519.17	8.59	-41.5	-40.3	(400)	393	1.51	12.80
46-3, 14-16	62	519.57	5.04	-41.2	-40.4	(400)	377	1.28	8.83
46-3, 54-56	62	519.95	3.49	-42.3	-44.8	(THD)[a]		1.27	6.17
46-3, 72-74	62	520.12	4.05	-43.9	-42.0	(400)	384	1.20	7.55
46-3, 120-122	62	520.60	2.52	-45.0	-41.3	(400)	351	1.14	4.98
46-4, 109-111	62	521.92	8.95	-34.7	-34.4	(400)	336	1.72	11.69
46-5, 142-144	63	523.54	3.85	-42.3	-40.9	(200)	373	1.57	5.50
47-1, 20-22	63	526.17	3.57	-41.2	-38.9	(200)	318	1.09	7.34
47-1, 26-28	63	526.24	3.13	-39.7	-40.2	(THD)[a]		1.17	6.01
47-1, 42-44	63	526.39	3.79	-45.1	-40.4	(200)	302	1.07	7.93
47-1, 60-62	63	526.57	4.00	-44.5	-40.7	(200)	311	1.13	7.97
47-1, 93-95	63	526.90	3.15	-41.0	-39.1	(200)	339	1.07	6.62
47-5, 25-27	64	531.94	10.40	-71.3	-79.1	(THD)[a]		1.22	19.04[c]
47-5, 80-82	64	532.39	2.89	-78.3	-77.0	(400)	177	1.02	6.32
48-1, 44-46	64	535.94	7.54	-65.1	-62.2	(400)	318	1.11	15.18
48-2, 15-17	64	537.13	30.30	-71.7	-71.2	(400)	351	2.60	26.12
48-2, 138-140	64	538.34	6.11	-68.5	-67.3	(400)	388	1.22	11.28
48-3, 30-32	64	538.76	5.72	-64.3	-62.6	(THD)[a]		1.03	12.47
48-3, 55-57	64	539.00	6.50	-69.6	-65.7	(400)	379	1.11	13.14
48-4, 12-14	65	540.03	7.98	-65.8	-65.6	(400)	480	0.71	25.35
48-4, 47-49	65	540.35	7.10	-67.3	-68.0	(400)	574	0.60	26.78
48-4, 61-63	65	540.49	3.85	-65.2	-65.1	(400)	513	0.45	19.31
48-4, 93-95	65	540.77	4.15	-66.3	-66.4	(400)	504	0.71	13.19

TABLE 17 – *Continued*

Sample (Interval in cm)	Flow Unit	Sub-bottom Depth (m)	J_{NRM} ($\times 10^{-5}$ emu/cm^3)	Inclination of NRM (°)	Stable Inclination (°)	AF (Oe)	MDF (Oe)	Suscept. χ ($\times 10^{-5}$)	Q_n (Oe)[b]
Hole 433C									
49-1, 6-8	65	545.06	6.25	–64.9	–65.4	(400)	373	1.05	13.39
49-1, 122-124	66	546.18	3.92	–65.6	–66.0	(400)	502	0.61	14.40
49-1, 142-144	66	546.38	3.06	–64.1	–64.8	(THD)[a]		0.59	11.71
49-2, 10-12	66	546.54	4.24	–67.0	–66.9	(400)	514	0.61	15.58
49-2, 31-33	66	546.75	4.96	–64.7	–64.6	(400)	545	0.59	18.96
49-2, 50-52	66	546.95	4.29	–64.8	–63.9	(THD)[a]		0.74	13.07
49-2, 58-60	66	547.02	4.41	–64.6	–65.1	(400)	401	0.67	14.76
49-2, 72-74	66	547.16	3.55	–67.7	–67.2	(400)	394	0.78	10.16
49-2, 111-113	66	547.56	9.62	–65.1	–64.3	(400)	367	1.35	15.86

[a]THD = Thermal demagnetization.
[b]Königsberger ratio Q_n calculated using geomagnetic intensities given in Kono (this volume).
[c]Not used in calculation of the flow mean inclination.
[d]Baked by the overlying lava flow. Not used in calculation of the flow mean inclination.

the time Suiko Seamount was formed were similar to those of the present magnetic field, such curves may represent an interval of several hundred to a few thousand years. Jumps in inclination trends also occur at many places. These may correspond to time gaps of any length, but certainly longer than several hundred years.

At least twelve such inclination jumps are apparent in Figure 31. From the rough estimates of time discussed above, we can conclude that the flow units collected in Hole 433C cover a time span of at least 10^4 years, probably considerably longer than that. On the other hand, all the flow units are reversely magnetized. According to the normal-reversed time scale of Heirtzler et al. (1968), the longest single polarity interval in the period 50 to 70 m.y. ago was about 2 m.y. long, and most of the others were less than 1 m.y. long. Since their time scale may neglect polarity intervals of short duration, the true length of a polarity interval may have been even shorter. It is therefore very unlikely that these flow units cover a time span of more than about 10^6 years. As discussed in the site summary chapter for Site 430 (this volume), a time interval of more than 10^4 years but less than 10^6 years is a very convenient one for sampling the paleosecular variation of the geomagnetic field; 10^4 to 10^6 years is regarded as sufficient to average out the secular variation, and in an interval less than 10^6 years we do not have to deal with the disturbing effects of plate motions, geomagnetic polarity reversals, and excursion.

To discuss the secular variation, we need to know how many of the inclination values can be regarded as independent data. In fact, as mentioned earlier, some flow units may have erupted in too short a time to be treated as independent samples. Proper treatment of this problem is a difficult matter, however. Instead, we show here that the statistical characteristics of inclination data from Suiko Seamount are essentially the same when analyzed at different sampling levels, implying that they represent the real properties of secular variation.

If we have two groups of n_1 and n_2 samples with mean $\bar{x}_1$ and $\bar{x}_2$ and standard deviation s_1 and s_2, and if the covariance

$$\text{C.V.} = 1.960\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}$$

is smaller than the difference $\bar{x}_1 - \bar{x}_2$, we can say that true means of the two groups μ_1 and μ_2 are different at the 95 per cent confidence level. This analysis was carried out on the flow mean inclination data in Table 18. When the statistical test showed a true difference in the means of adjacent flow units, a group boundary was drawn. Group means were calculated from inclinations of individual samples, and are listed in Table 19. In this table, N is the number of samples, I the mean inclination, s_1 the standard deviation, θ the magnetic latitude corresponding to I, and $\Delta\theta$ a measure of uncertainty in θ calculated by

$$\Delta\theta = 2(1 + 3\cos^2)\, I^{-1/2} dI$$

Figure 32 shows the distributions of inclination data at different levels. A striking similarity is apparent among the figures for different statistical levels. All have very similar modes, means, and median values (marked in arrows). This suggests that the sampling is adequate in our case and that the data represent true properties of inclination changes. Statistical data of inclination analyses are given in Table 20.

We conclude that the inclination changed with standard deviation of 14° about a mean of 42° during the time the Hole 433C lavas were erupted. The mean value is accurate to within ±4° at the 95 per cent confidence level. If this mean inclination is assumed to represent the axial dipole field of the earth, the estimated paleolatitude of Suiko Seamount is about 25°.

Another way to estimate the paleolatitude is to use magnetic latitude data of individual flow units or groups. Figure 33 shows distributions of such data, and corresponding statistics are given in Table 21. Again, there are no significant differences between these two levels. The mean and standard error shown in Table 21 suggest that the paleolatitude of Suiko Seamount was 26.3° ±2.8° if flow units are taken as data base, or

TABLE 18
Statistics of Paleomagnetic Data, Leg 55, Site 433 (mean value with standard deviation in parentheses)

Flow Unit/ Sub-unit	Number of Samples	Inclination (°)	Magnetic Latitude (°)	Intensity of NRM (10^{-5} emu/cm^3)	Median Demagnetizing Field (MDF) (Oe)	Susceptibility (10^{-5} emu/cm^3 Oe)	Q_n (Oe)	Remarks
1	15	-39.1 (3.5)	22.1	573 (198)	100 (75)	370 (206)	1.94 (1.19)	a
2	3	-36.3 (5.6)	20.2	585 (476)	25 (20)	347 (77)	1.52 (1.20)	
4	14	-43.2 (3.9)	25.1	1600 (760)	280 (25)	208 (71)	7.38 (1.60)	b
5	4	-44.1 (4.5)	25.9	964 (711)	315 (20)	170 (98)	5.44 (0.71)	
6	3	-43.3 (2.5)	25.2	989 (401)	315 (40)	179 (47)	5.44 (0.90)	
7	3	-45.2 (1.3)	26.7	214 (5)	345 (20)	57.6 (4.0)	3.72 (0.23)	
8	4	-52.9 (2.3)	33.5	382 (84)	335 (175)	107 (57)	4.17 (1.75)	
9	4	-56.0 (1.2)	36.5	344 (96)	185 (65)	88.1 (29.2)	3.61 (0.14)	
10	4	-28.3 (6.1)	15.1	418 (40)	95 (50)	125 (41)	3.57 (0.97)	c
11	8	-42.8 (13.7)	24.9	326 (140)	300 (160)	153 (63)	2.24 (0.97)	d
12	5	-20.2 (1.7)	10.4	261 (77)	320 (65)	328 (60)	0.788 (0.214)	
13	6	-21.9 (2.4)	11.4	540 (256)	190 (180)	272 (70)	2.02 (1.15)	
14	5	-24.4 (1.5)	12.8	105 (32)	610 (140)	30.3 (7.0)	3.40 (0.51)	
15	7	-49.2 (7.6)	30.1	371 (222)	300 (225)	79.0 (32.5)	5.29 (3.10)	e
16	4	-58.5 (1.6)	39.2	585 (716)	200 (70)	143 (48)	3.65 (3.67)	
17	5	-61.0 (2.3)	42.1	384 (187)	255 (110)	241 (103)	2.12 (1.67)	
18	6	-42.0 (1.8)	24.2	290 (117)	150 (90)	150 (74)	2.00 (0.55)	
19	7	-38.2 (2.8)	21.5	421 (330)	335 (75)	93.5 (54.0)	4.29 (1.67)	
20	5	-40.3 (1.2)	23.0	125 (64)	540 (185)	43.6 (19.9)	2.80 (0.77)	
21	6	-37.5 (2.3)	21.0	324 (128)	320 (70)	113 (65.3)	3.20 (0.88)	f
22	6	-42.0 (1.2)	24.2	205 (100)	510 (245)	48.7 (23.3)	4.57 (2.45)	
23	4	-39.2 (3.3)	22.2	128 (63)	230 (125)	36.6 (14.3)	3.83 (2.15)	
24	5	-34.2 (1.7)	18.8	121 (86)	215 (60)	45.6 (32.5)	2.89 (2.15)	
25	5	-68.3 (3.2)	51.5	239 (75)	125 (75)	272 (172)	0.998 (0.305)	g
26a	4	-68.1 (1.5)	51.2	206 (74)	245 (190)	92.5 (29.9)	2.57 (1.54)	
26b	4	-21.0 (2.3)	10.9	659 (494)	330 (40)	215 (49)	2.92 (1.93)	
27	5	-62.7 (1.9)	44.1	567 (146)	110 (95)	285 (133)	2.29 (1.05)	
28-1	3	-57.3 (6.8)	37.9	285 (93)	360 (80)	68.7 (29.9)	4.28 (0.77)	h
28-2	4	-43.0 (1.8)	25.0	318 (241)	350 (80)	43.7 (25.9)	7.15 (0.92)	h
29	5	-40.3 (1.3)	22.9	461 (54)	310 (30)	43.8 (9.9)	10.7 (1.4)	
30	5	-42.2 (0.7)	24.4	774 (619)	385 (80)	59.5 (35.3)	12.5 (3.9)	
31	4	-40.8 (0.9)	23.3	1200 (580)	460 (135)	112 (58)	11.3 (3.7)	
32	5	-40.6 (2.4)	23.2	1770 (827)	330 (40)	148 (34)	11.6 (3.6)	
33	5	-42.3 (0.5)	24.5	330 (120)	515 (85)	31.3 (11.2)	11.9 (5.4)	
34	5	-41.4 (1.3)	23.8	342 (161)	390 (55)	55.2 (29.3)	6.39 (1.9)	
35	5	-49.7 (0.7)	30.6	703 (306)	360 (75)	177 (99)	4.87 (2.52)	
36	4	-50.4 (2.0)	31.2	351 (86)	990 (225)	53.1 (28.8)	8.11 (4.08)	
37	3	-50.7 (1.0)	31.4	723 (236)	370 (25)	130 (19)	5.46 (1.00)	
38	5	-51.0 (0.9)	31.7	825 (159)	295 (15)	116 (29)	7.28 (1.17)	
39	3	-54.4 (0.9)	34.9	346 (111)	170 (30)	81.2 (3.0)	4.25 (1.28)	
40	2	-51.8 (1.6)	32.4	1900 (715)	340 (5)	203 (49)	9.18 (1.30)	
41	3	-53.9 (0.6)	34.5	630 (245)	295 (20)	92.8 (22.4)	6.63 (1.16)	
44	4	-49.3 (1.5)	30.2	310 (98)	175 (80)	121 (15)	2.60 (0.94)	
45	5	-47.2 (0.9)	28.4	348 (173)	435 (120)	55.1 (36.4)	7.00 (1.48)	
46	5	-8.9 (3.8)	4.5	233 (67)	350 (60)	67.1 (16.6)	3.64 (1.20)	i
47	5	-5.4 (3.1)	2.7	140 (14)	250 (50)	47.1 (6.3)	2.98 (0.18)	
48	5	-43.0 (1.6)	25.0	162 (76)	410 (105)	46.3 (15.8)	3.45 (0.76)	
49	5	-44.8 (2.0)	26.4	913 (181)	385 (115)	175 (114)	6.15 (1.98)	
51a1	4	-46.2 (9.3)	27.5	173 (138)	480 (15)	90.0 (46.7)	2.02 (0.92)	j
51b2	4	-11.6 (1.3)	5.9	490 (71)	300 (10)	105 (17)	4.69 (0.50)	j
52	5	-12.8 (1.8)	6.5	405 (30)	325 (10)	101 (14)	4.06 (0.70)	
53	3	-25.0 (2.0)	13.1	283 (22)	435 (70)	94.2 (27.8)	3.27 (1.32)	k
54	5	-32.9 (1.4)	18.0	471 (51)	300 (5)	101 (9)	4.66 (0.34)	
56	4	-41.2 (2.7)	23.6	280 (91)	220 (60)	130 (31)	2.17 (0.60)	
58	5	-47.5 (2.7)	28.6	623 (285)	290 (45)	104 (8)	6.13 (3.02)	

TABLE 18 – *Continued*

Flow Unit/ Sub-unit	Number of Samples	Inclination (°)	Magnetic Latitude (°)	Intensity of NRM (10^{-5} emu/cm^3)	Median Demagnetizing Field (MDF) (Oe)	Susceptibility (10^{-5} emu/cm^3 Oe)	Q_n (Oe)	Remarks
59	5	-44.7 (1.6)	26.3	568 (200)	310 (60)	99.7 (23.7)	5.78 (1.69)	
60	5	-42.9 (1.1)	25.0	420 (148)	210 (70)	163 (17)	2.65 (1.12)	
61	5	-43.1 (1.0)	25.1	320 (136)	310 (55)	127 (27)	2.56 (1.03)	
62	5	-41.0 (0.8)	23.5	578 (281)	350 (65)	136 (24)	4.09 (1.41)	ℓ
63	5	-40.3 (0.8)	22.9	364 (33)	330 (30)	118 (22)	3.15 (0.46)	
64	5	-69.0 (5.3)	52.4	1060 (1100)	360 (120)	140 (66)	6.41 (3.25)	
65	5	-66.1 (1.2)	48.5	582 (180)	490 (75)	69.5 (22.0)	8.73 (2.85)	
66	6	-65.7 (1.2)	47.9	506 (221)	455 (75)	76.2 (29.2)	6.67 (1.27)	

[a] Three samples from Hole 433B showed unstable behavior in AF demagnetization. They were excluded from inclination analysis.
[b] Probably contains more than one flow unit. Magnetic data are not very consistent.
[c] Probable flow boundary between Section 13-1, 8 cm and Section 13-2, 53 cm.
[d] Two probable flow boundaries are indicated by magnetic data: (1) between Section 14-2, 130 cm and Section 13-3, 55 cm; and (2) between Section 15-2, 105 cm and Section 15-3, 127 cm.
[e] Probable flow boundary within Section 20-1, in the interval 26-80 cm. Also a flow boundary is possible between Section 19-3, 17 cm and Section 19-4, 17 cm.
[f] Possible flow boundary between Section 25-3, 20 cm and Section 25-5, 77 cm. A sample from Section 25-3, interval 18-20 cm, was excluded from inclination analysis.
[g] Section 27-6, 58-60 cm was probably reheated by Unit 24, and so is excluded from inclination analysis.
[h] Flow boundary detected between Sections 31-4 and 31-5.
[i] Flow 46a excluded from inclination analysis.
[j] Flow boundary detected at approximately 130 cm in Section 40-5.
[k] Section 42-2, 35-37 cm was probably reheated by Unit 52, and so is excluded from inclination analysis.
[ℓ] Flow 62c excluded from inclination analysis.

25.1° ±3.4° if groups are taken as the data base, at the 95 per cent confidence level.

Conclusions

We draw several conclusions from this study.

1) The paleolatitude of Suiko Seamount is about 25°, with uncertainty of 4° at 95 per cent confidence level.

2) The 400-meters-thick basaltic cored top of Suiko Seamount apparently accumulated in a period greater than 10^4 years but less than 10^6 years. Some flow units seem to have erupted in quick succession, but a time gap is represented at other flow boundaries, suggesting that the volcanism was intermittent and episodic, just as is observed on volcanoes of the Island of Hawaii. The interval estimated above also suggests that a substantial part of a seamount may have been formed in a relatively short time, within a polarity interval, say, giving some support to paleomagnetism of seamount magnetic anomalies.

3) A good record of secular variation in inclination about 60 m.y. ago was obtained. It contains some portions where almost continuous change is recorded, 12 or more time gaps, and about 15 extreme (maximum and minimum) values. It seems sufficiently long to cover the entire range of secular variation. The standard deviation of inclination data is about 14°, and if we assume an isotropic variation, this corresponds to a standard deviation of about 20° in angle. This is somewhat larger than the value obtained from the present-day field at 25° latitude (about 15°).

4) The drilled basalts have magnetic properties similar to those of oceanic island basalts, and different from those of mid-ocean ridge basalts. Most rocks have NRM's stable to AF demagnetization, representing the direction of the ambient field when these rocks formed.

PHYSICAL PROPERTIES

Sonic velocity and density were measured with the Hamilton Frame and the GRAPE apparatus. For soft sediments, the sonic measurements were made through the plastic liner; for basalts, they were made on "splits" within a few hours after they were sawed, and on paleomagnetic "minicores" after paleomagnetic studies had been completed (one or two days, no thermal treatment). All the velocity measurements are listed in Tables 22 and 23. Continuous GRAPE measurements were made on the sediments and on all basalt pieces larger than about 10 cm, but because of time restrictions these data have not been reduced. The minicores were placed in a holder for "2-minute GRAPE" counts; these have been reduced, tabulated and plotted here.

There is no completely satisfactory way to assign sub-bottom depths to each sample. (The best would be to log the hole and match the samples to the log's signature.) We computed sub-bottom depth on the following assumptions: the top of the core is where coring began, and any void is at the bottom of the interval (i.e., we "push" the core "up"); each previous section of a core is exactly 150 cm long (even though there may be only 90 or 120 cm of rock in a section because of gaps and styrofoam spacers); the distance down in a section is the "centimeter" position of the sample (again we include the gaps and spacers). This method of assigning sub-bottom depths was derived before drilling in seamounts; when recovery is more than 90 per cent the interesting situation develops where samples from the bottom of

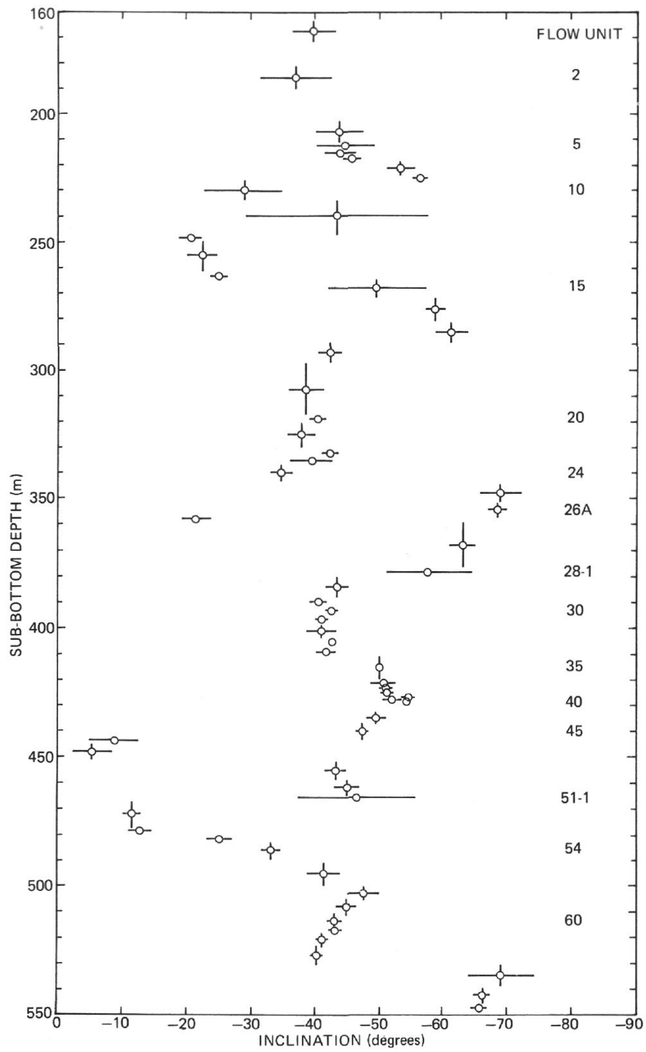


Figure 31. *Magnetic inclinations, Hole 433C.*

TABLE 19
Statistics of Grouped Magnetic Inclination Data, Site 433

Group	Flow Units/ Sub-units	N	I	SI	θ	$\Delta\theta$
1	1, 2	15	-38.5	3.9	21.7	2.8
2	4, 5, 6, 7	24	-43.6	3.5	25.4	2.7
3	8	4	-52.9	2.3	33.5	2.2
4	9	4	-56.0	1.2	36.5	1.3
5	10	4	-28.3	6.1	15.1	3.7
6	11	8	-42.8	13.7	24.9	10.4
7	12, 13	11	-21.2	2.2	11.0	1.2
8	14	5	-24.4	1.5	12.8	0.8
9	15	7	-49.2	7.6	30.1	6.7
10	16, 17	9	-59.9	2.4	40.8	2.8
11	18	6	-42.0	1.8	24.2	1.4
12	19, 20	12	-39.1	2.4	22.1	1.7
13	21	5	-37.5	2.3	21.0	1.6
14	22, 23	10	-40.9	2.6	23.4	1.9
15	24	5	-34.2	1.7	18.8	1.1
16	25, 26a	9	-63.2	1.5	44.7	1.9
17	26b	4	-21.0	2.3	10.9	1.3
18	27, 28a1	8	-60.7	4.8	41.7	5.6
19	28c2	4	-43.0	1.8	25.0	1.4
20	29	5	-40.3	1.3	22.9	1.0
21	30	5	-42.2	0.7	24.4	0.5
22	31, 32, 33, 34	19	-41.3	1.5	23.7	1.1
23	35, 36, 37, 38	17	-50.4	1.2	31.2	1.1
24	39	3	-54.4	0.9	34.9	0.8
25	40, 41	5	-53.1	1.5	33.6	1.4
26	44	5	-49.3	1.5	30.2	1.3
27	45	5	-47.3	0.8	28.4	0.7
28	46, 47	9	-7.0	3.7	3.5	1.8
29	48, 49, 51a1	14	-44.6	4.9	26.2	3.9
30	51b2, 52	9	-12.3	1.6	6.2	0.8
31	53	3	-25.0	2.0	13.1	1.2
32	54	5	-32.9	1.4	18.0	0.9
33	56	4	-41.2	2.7	23.6	2.0
34	58, 59	10	-46.1	2.5	27.5	2.1
35	60, 61	10	-43.0	1.0	25.0	0.8
36	62, 63	10	-40.0	2.1	22.7	1.5
37	64, 65, 66	16	-66.8	3.2	49.4	4.4

one core are deeper than those at the top of the next! Since the error is never more than about a meter, and since knowing the depths more accurately than this is not important to any of our studies, we adopted this simple, unambiguous method of calculating depth.

Four units in the sediments may be defined on the basis of velocities (densities will be processed later).

1) The top 1 meter in both Hole 433 and Hole 433A had a velocity of 1.60 km/s, higher than that below.

2) From 1 meter to 52 meters, the velocity was a very smooth 1.54 km/s, occasionally varying to 1.52 to 1.56 km/s.

3) Abruptly at 52 meters the signal disappeared. Whereas above the signal was very strong, the ultrasonic pulse could not propagate through the sample between 52 meters and about 62 meters.

4) Between 62 meters and 80+ meters, the velocity was about 2.00 km/s, perhaps decreasing slightly (to about 1.90 km/s) toward the bottom of this interval. Although the signal was weak (and in some parts of this interval the ultrasonic pulse could not propagate through the coarse, lumpy sediments), a velocity could be measured, and it was significantly higher than that of the unit above.

5) From 80 meters to 160 meters the core recovery was so incomplete that a meaningful velocity study could not be made.

In the basalts the physical properties vary widely. Velocity varies repeatedly from less than 3 km/s to more than 6 km/s in about a 5-meter or 10-meter interval. (The densities shown are for minicores only; presumably the less selective continuous GRAPE data will show equally sharp swings.) These variations correlate with the flow unit boundaries.

Because of the very high core recovery, we have here velocity and density data for a very continuous section. These data may be useful in two ways. First, they provide a good sample of what a well log of a large seamount would give, with large variations in velocity/density which correlate with flow boundaries. Thus, the feasibility of logging can be evaluated. Second, these properties correlate strongly with the flow boundaries as cored. If, however, petrologists and paleomagneticists cannot find among these data any information about units that is not better found by petrologic examination of the core itself, then the whole program of measuring

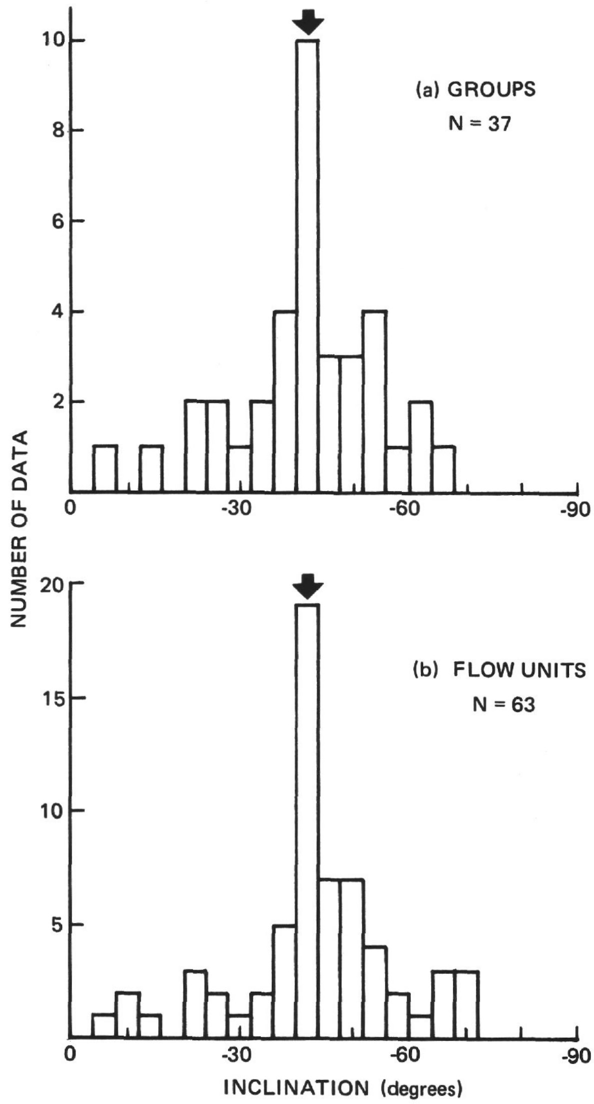


Figure 32. *Histograms of magnetic inclination (a) by groups and (b) by flow units, Site 433. The means are shown by the arrows.*

TABLE 20
Magnetic Inclination Statistics, Site 433

Sample	n	$\bar{x}$	Sx	$S\bar{x}$
Flow Units	63	42.8	14.1	1.8
Groups	37	41.5	13.4	2.2

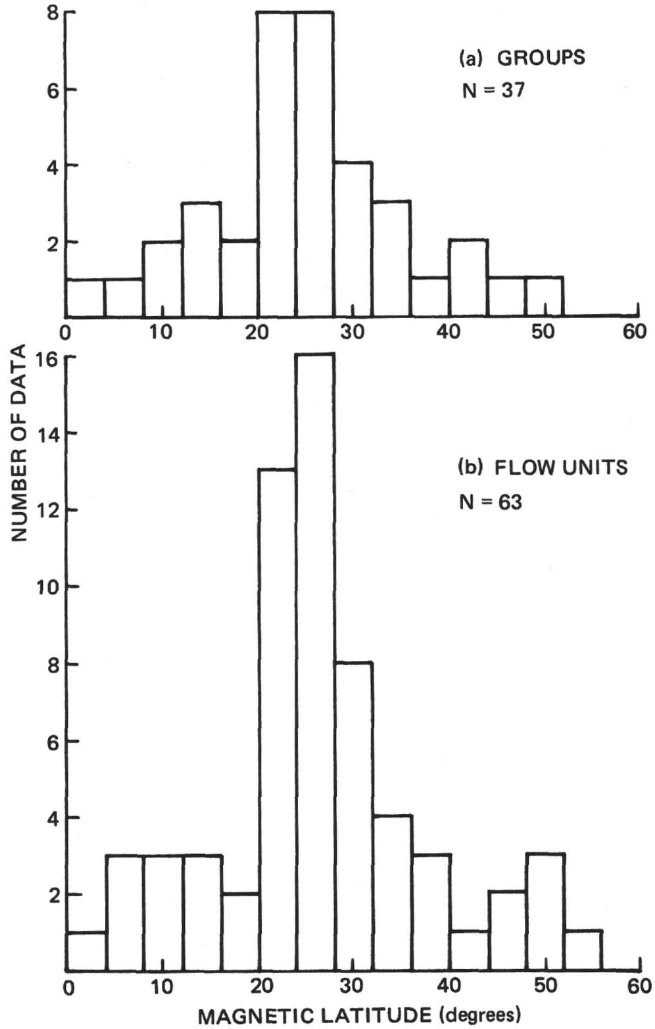


Figure 33. *Histograms of magnetic latitude (a) by groups and (b) by flow units, Site 433.*

TABLE 21
Paleolatitude Statistics, Site 433

Sample	n	$\bar{x}$	Sx	$S\bar{x}$
Flow Units	63	26.3	11.1	1.4
Groups	37	25.1	10.2	1.7

physical properties in basalts should be re-evaluated to allow for more effort in other areas.

CORRELATION OF SEISMIC PROFILES WITH DRILLED SEQUENCE

Suiko Seamount is the largest and most morphologically complex seamount drilled on the Emperor chain during Leg 55. The seismic reflection profiles across Suiko Seamount indicate that it has an extensive, flat-topped or slightly domed, northeast-southwest, elongated, central platform that probably is a drowned table reef, reef flat, or reef bank. These platform deposits appear to overlie unconformably an irregular acoustic basement of volcanic rock which may be locally exposed at the surface and which stands above the platform as rounded knobs or hills. Flanking this central platform on the north is a fairly extensive (approx. 300-sq.-mi.) ancestral lagoon filled with over 160 meters of well-stratified, unconsolidated sediments. This lagoon does not completely surround the central platform, as we first thought from interpretation of the *Lee* and *Kana Keoke* profiles, but appears to be restricted to the northern fringe of the seamount; another, smaller lagoon appears to be restricted to the southern fringe (Figure 2). The *Challenger* profiles show lagoonal features crossing

TABLE 22
Sonic Velocity for Site 433

Core-Section, Interval (cm)	Piece Number	Velocity (km/s)	Sub-bottom Depth (m)
Hole 433			
1-1, 9		1.65	0.09
1-1, 35		1.57	0.35
1-1, 70		1.57	0.70
1-1, 102		(1.61)[a]	1.02
1-1, 133		1.60	1.33
1-2, 15		(1.61)[a]	1.65
1-2, 76		1.52	2.26
1-2, 90		1.57	2.40
1-2, 137		1.53	2.87
1-3, 40		1.54	3.40
1-3, 95		1.54	3.95
1-3, 132		1.53	4.32
1-4, 25		1.53	4.75
Hole 433A			
1-1, 7		1.60	0.07
1-1, 36		(1.59)[a]	0.36
1-1, 38		1.61	0.38
1-1, 85		1.52	0.85
1-1, 96		1.52	0.96
1-1, 130		1.52	1.30
2-1, 13		1.58	5.13
2-1, 59		1.60	5.59
2-1, 96		1.61	5.96
2-1, 134		1.52	6.34
2-2, 8		1.52	6.58
2-2, 37		1.53	6.87
2-2, 61		1.53	7.11
3-1, 8		1.53	14.58
3-1, 73		1.51	15.23
3-1, 129		1.52	15.79
3-2, 27		1.52	16.27
3-2, 120		1.52	17.20
3-4, 43		1.53	19.43
3-4, 127		1.52	20.27
3-6, 27		1.54	22.27
4-1, 13		1.53	24.13
4-1, 75		1.53	24.75
4-1, 128		1.54	25.28
4-2, 12		1.55	25.62
4-2, 31		1.55	25.81
4-2, 74		1.56	26.24
4-2, 94		1.54	26.44
4-2, 121		1.55	26.77
4-2, 137		1.55	26.87
4-3, 11		1.54	27.11
4-3, 38		1.54	27.38
4-3, 63		1.53	27.63
4-3, 105		1.54	28.05
4-3, 136		1.54	28.36
4-4, 32		1.54	28.82
4-4, 86		1.54	29.36
4-4, 128		1.54	29.78
4-5, 33		1.54	30.33
4-5, 85		1.54	30.85
4-5, 141		1.54	31.41
4-6, 26		(1.54)[a]	31.76
4-6, 28		1.54	31.78
4-6, 42		1.54	31.92
4-6, 81		1.53	32.31

TABLE 22 – *Continued*

Core-Section, Interval (cm)	Piece Number	Velocity (km/s)	Sub-bottom Depth (m)
Hole 433A			
5-1, 34		1.52	33.84
5-1, 101		1.53	34.51
5-2, 18		1.53	35.18
5-2, 60		1.53	35.60
5-2, 94		1.54	35.94
5-2, 116		1.54	36.16
5-2, 133		1.54	36.33
5-2, 142		1.54	36.42
5-3, 13		1.53	36.63
5-3, 53		1.54	37.03
5-3, 123		1.53	37.73
5-4, 13		1.53	38.13
5-4, 54		1.54	38.54
5-4, 116		1.53	39.16
5-5, 40		1.52	39.90
5-6, 58		1.56	41.58
5-6, 87		1.58	41.87
6-1, 36		1.54	43.36
6-1, 63		1.53	43.63
6-1, 109		1.54	44.09
6-2, 61		1.54	45.11
6-2, 126		1.54	45.76
6-2, 136		1.53	45.86
6-3, 47		1.54	46.47
6-3, 111		1.53	47.11
6-4, 34		1.53	47.84
6-4, 76		1.55	48.26
6-4, 135		1.53	48.85
6-4, 141		1.54	48.91
6-5, 47		1.54	49.47
6-5, 127		1.53	50.27
6-6, 15		1.53	50.65
6-6, 50		1.53	51.00
6-6, 82		1.53	51.32
6-6, 102		1.55	51.52
6-6, 132		1.56	51.82
6-6, 143		1.54	51.93
6-7, 12		1.56	52.12
6-7, 27		(1.58)[a]	52.27
6-7, 33		(1.56)[a]	52.33
7 attenuated			
8-1, 85		(2.02)[a]	62.85
8-1, 136		(2.08)[a]	63.36
8-2, 52		(2.01)[a]	64.02
8-3, 69		(1.97)[a]	64.19
8-3, 130		(2.08)[a]	64.80
8-5, 63		(1.88)[a]	68.63
8-6, 88		(2.58)[a]	70.38
8-6, 106		1.91	70.56
8-6, 131		1.95	70.81
8-7, 21		1.86	71.21
8-7, 25		1.88	71.25
9 attenuated			
10-1, 112		(1.88)[a]	76.62
10-1, 122		(1.90)[a]	76.72
10-1, 144		2.21	76.94
10-2, 37		(1.89)[a]	77.37
10-2, 95		1.86	77.95
10-3, 40		atten.	78.90
10-3, 112		1.87	79.62

TABLE 22 – *Continued*

Core-Section, Interval (cm)	Piece Number	Velocity (km/s)	Sub-bottom Depth (m)
Hole 433A			
10-3, 121		(1.82)[a]	79.71
20-1, 3		4.73	163.53
20-1, 4		4.73[b]	163.54
20-1, 37		5.66[b]	163.87
20-1, 64		5.49	164.14
20-1, 114		5.12[b]	164.64
20-1, 115		(4.83)	164.65
20-1, 126		4.95	164.76
20-2, 11		5.23[b]	165.11
20-2, 21		4.83	165.21
20-2, 50		5.40[b]	165.50
20-2, 74		4.78	165.74
21-1, 6		5.52	166.56
21-1, 29		5.76[b]	166.79
21-1, 31		5.61	166.81
21-1, 83		5.63	167.33
21-2, 20		5.27	168.20
21-2, 80		5.40	168.80
21-2, 85		5.80[b]	168.85
21-2, 128		5.20	169.28
21-3, 14		5.56	169.64
21-3, 99		5.67[b]	170.49
21-4, 139		5.77[b]	172.39
Hole 433B			
4-1, 30	1c	4.75	157.30
4-1, 52	3c	4.86[b]	157.52
4-1, 62	2c	4.83	157.62
5-1, 72	6a	4.33[b]	166.72
5-1, 93	8	4.59	166.93
5-2, 37	2a	5.41[b]	167.87
5-2, 81	3c	5.99	168.31
5-2, 106	5	5.83	168.56
5-3, 90	9	6.06	169.90
Hole 433C			
1-1, 11	2	4.39	163.11
1-1, 22	4	5.57	163.22
1-1, 60	9	5.74	163.60
1-1, 62	9	5.75[b]	163.62
1-2, 73	3	5.14	165.23
2-1, 5	1	5.28	168.05
2-1, 23	3	5.27[b]	168.23
2-3, 30		(1.80)[a]	171.30
4-1, 29	2b	6.23	181.79
4-1, 40	2c	6.13[b]	181.90
4-1, 61	2d	6.08	182.11
4-1, 95?	3	6.00	182.45
4-1, 87	4	6.09[b]	182.37
5-1, 13	1	6.01[b]	187.13
10-1, 8	1a	4.29[b]	204.58
10-1, 15	1b	3.98	204.65
10-1, 38	1d	3.87[b]	204.88
10-1, 75	7b	2.50	205.25
10-1, 118	15	3.57	205.68
10-2, 22	3	3.85	206.22
10-2, 22	3	3.83[b]	206.22
10-2, 48	6b	3.46[b]	206.48
10-2, 88	11	3.36	206.88
10-2, 140	20	3.51	207.40
10-2, 140	20	3.58[b]	207.40

TABLE 22 – *Continued*

Core-Section, Interval (cm)	Piece Number	Velocity (km/s)	Sub-bottom Depth (m)
Hole 433C			
10-3, 18	2b	3.15	207.68
10-3, 35	5a	2.81[b]	207.85
10-3, 86	9c	2.76	208.36
10-3, 135	11	3.61	208.85
10-3, 136	11	3.47[b]	208.86
10-3, 146	11	3.62	208.96
10-4, 6	2	3.17	209.06
10-4, 10	2	3.39[b]	209.10
10-4, 40	3a	3.32[b]	209.40
10-4, 49	3b	3.47	209.49
10-4, 57	3c	4.40[b]	209.57
10-4, 113	8a	3.60[b]	210.13
10-4, 122	8b	3.62	210.22
10-5, 49	6a	4.03[b]	210.99
10-5, 58	6b	3.32	211.08
10-5, 98	9	4.17	211.48
10-5, 119	13a	3.16	211.69
10-5, 144	13c	3.65[b]	211.94
10-6, 12	1c	4.75	212.12
10-6, 44	3c	4.94[b]	212.44
10-6, 58	4	4.78	212.58
11-1, 7	1a	4.26	214.07
11-1, 60	4	3.51	214.60
11-1, 64	4	3.74[b]	214.64
11-1, 92	1g	4.52[b]	214.92
11-2, 51	5	3.50[b]	216.01
11-2, 125	9b	4.18[b]	216.75
11-3, 10	1b	5.25[b]	217.10
11-3, 123	2g	4.59[b]	218.23
11-4, 59	6	3.99[b]	219.09
11-5, 41	4	4.61[b]	220.41
12-1, 93	9a	3.09	224.43
12-1, 101	9b	2.99[b]	224.51
12-1, 134	11	3.93	224.84
12-2, 19	2b	3.41	225.19
12-2, 35	2e	3.96	225.35
12-2, 53	2h	3.90	225.53
12-2, 126	3a	4.28	226.26
12-3, 45	1d	4.37	226.95
12-3, 49	1d	4.34[b]	226.99
12-3, 84	3b	3.21	227.34
12-3, 101	4	4.69[b]	227.51
12-3, 125	7	4.88	227.75
12-4, 20	3	5.09	228.20
12-4, 23	3	5.26[b]	228.23
12-4, 75	9	5.09	228.75
12-4, 128	16a	5.14	229.28
13-1, 19	3a	5.34	230.19
13-1, 95	4b	4.93	230.95
13-1, 128	6c	5.29	231.28
13-2, 34	1e	5.75	231.84
13-2, 54	1h	5.40[b]	232.04
13-2, 89	1L	6.19	232.39
13-2, 130	3	5.29	232.80
13-3, 4	1a	5.08	233.04
14-1, 5	1a	3.08	233.05
14-1, 35	1g	4.00	233.35
14-1, 48	1h	3.97[b]	233.48
14-1, 106	1r	4.57	234.06
14-1, 133	4a	4.23	234.33

TABLE 22 – *Continued*

Core-Section, Interval (cm)	Piece Number	Velocity (km/s)	Sub-bottom Depth (m)
Hole 433C			
14-2, 16	1c	3.85	234.66
14-2, 69	2a	4.06	235.19
14-2, 129	3e	4.25[b]	235.79
14-3, 24	1d	3.79	236.24
14-3, 56	4a	4.11[b]	236.56
14-3, 128	11a	4.57	237.28
14-4, 18	1b	4.85	237.68
14-4, 22	1b	4.77[b]	237.72
14-4, 48	2b	4.74	237.98
15-1, 12	2a	4.10[b]	242.62
15-1, 48	2e	4.07	242.98
15-1, 48	2e	4.08[b]	242.98
15-1, 87	8	4.04	243.37
15-1, 129	12	4.49	243.79
15-2, 29	4	3.69	244.29
15-2, 95	16	3.71	244.95
15-2, 104	11	2.72[b]	245.04
15-3, 21	2	3.66	245.71
15-3, 79	8	4.56	246.29
15-3, 128	15	3.13[b]	246.78
15-3, 131	15	3.30	246.81
15-4, 11	1a	3.71	247.11
15-4, 22	2	3.74[b]	247.22
15-4, 23	2	3.83	247.23
15-4, 47	4	3.61[b]	247.47
15-4, 68	5	3.81	247.68
15-4, 100	8	3.85[b]	248.00
15-4, 116	9b	3.56[b]	248.16
15-4, 128	9d	4.11	248.28
15-5, 15	2	3.79[b]	248.65
15-5, 80	4a	4.39[b]	249.30
15-5, 90	4b	5.06	249.40
15-5, 116	5b	5.51	249.66
15-6, 10	1a	5.38	250.10
15-6, ?	1c	5.98[b]	?
16-1, 12	2	5.98[b]	252.12
16-1, 43	4b	5.93	252.43
16-1, 76	6b	6.09[b]	252.76
16-1, 105	8a	6.23	253.05
16-1, 131	9	5.86	254.31
17-1, 18	2	6.21[b]	255.68
17-1, 34	3a	5.88	255.84
17-1, 82	6	6.22	256.32
18-1, 5		6.07	258.55
19-1, 15	2a	6.03[b]	261.65
19-1, 21	2b	5.76	261.71
19-1, 46	4b	4.89	261.96
19-1, 113	8d	4.94[b]	262.63
19-2, 13	1b	5.26[b]	263.13
19-2, 50	2e	5.23	263.50
19-2, 113	8a	4.50	264.13
19-2, 148	14	3.78	264.48
19-3, 16	1c	4.16[b]	264.66
19-3, 47	1i	4.71	264.97
19-3, 91	1p	4.92	265.41
19-3, 136	1x	5.04	265.86
19-4, 36	2a	5.16	266.36
19-4, 69	2f	5.17[b]	266.69
19-4, 102	3a	5.19	267.02
19-4, 146	3f	5.01	267.46

TABLE 22 – *Continued*

Core-Section, Interval (cm)	Piece Number	Velocity (km/s)	Sub-bottom Depth (m)
Hole 433C			
19-5, 16	1b	5.12	267.66
19-5, 26	1c	4.95[b]	267.76
19-5, 68	1h	5.23	268.18
20-1, 18	2a	5.21	269.68
20-1, 25	2	5.23[b]	269.75
20-1, 80	8	4.58	270.30
20-1, 82	8	4.61[b]	270.32
20-1, 127	13	4.82	270.77
20-2, 37	4b	4.82	271.37
20-2, 49	5	4.70[b]	271.49
20-2, 79	9	3.76	271.79
20-2, 141		4.44	272.41
21-1, 44	3	4.98	279.44
21-1, 89	7b	4.70	279.89
21-1, 106	7d	5.21	280.06
21-1, 108		5.25[b]	280.08
21-1, 129	9b	4.59	280.29
21-2, 20	2a	4.55	280.70
21-2, 85	10	3.91	281.35
21-2, 105	12	4.92	281.55
21-2, 105		4.76[b]	281.55
21-2, 139	15a	4.60	281.89
21-3, 23	2	5.34	282.23
21-3, 60	6a	4.88	282.60
21-3, 120	8b	4.93	283.20
21-4, 46	6	4.91	283.96
21-4, 103	10	4.93	284.53
21-5, 36	4	5.09	285.36
22-1, 14	2a	5.12	288.64
22-1, 90	10	4.36	289.40
22-2, 24	3	4.36	290.24
22-2, 80	5d	4.13	290.80
22-2, 114	5h	4.78[b]	291.14
22-3, 38	4	4.90	291.88
22-3, 65	5c	4.81[b]	292.15
22-3, 120	8	4.64	292.70
22-3, 131	9	4.83[b]	292.81
22-4, 44	2b	4.77	293.44
22-4, 135	7	5.01	294.35
22-5, 91	7a	5.30	295.41
22-6, 13	1b	4.84	296.13
23-1, 19	2c	3.89	298.19
23-1, 46	4a	4.52	298.46
23-2, 33	3	2.77	299.83
23-2, 56	4d	3.32[b]	300.06
23-2, 73	5a	3.68	300.23
23-2, 140	9a	4.30	300.90
23-3, 34	1b	3.76[b]	301.34
23-3, 59	1e	4.94	301.59
23-3, 130	1j	4.97	302.30
23-4, 46	1c	3.09	302.96
23-4, 98	7a	3.66	303.48
23-5, 37	1e	4.55	304.37
23-5, 115	1n	4.30	305.15
23-6, 34	2a	3.63	305.84
23-6, 119	4k	4.27	306.69
23-7, 31	3	4.25	307.31
23-7, 103	5a	5.48[b]	308.03
23-7, 108	5a	5.31	308.08
24-1, 20	2	5.06[b]	307.70

TABLE 22 – *Continued*

Core-Section, Interval (cm)	Piece Number	Velocity (km/s)	Sub-bottom Depth (m)
Hole 433C			
24-1, 54	3b	3.21	308.04
24-1, 134	6g	3.99	308.84
24-2, 18	1a	3.25[b]	309.18
24-2, 28	1c	3.57	309.28
24-2, 96	8	4.03	309.96
24-3, 12	2	3.65	310.62
24-3, 82	9c	3.99[b]	311.32
24-3, 106	10b	4.19	311.56
24-4, 13	2a	4.22	312.13
24-4, 42	2c	3.12	312.42
24-4, 103	2e′	4.29	313.03
24-5, 56		atten.	314.06
24-7, 30	1b	3.28	315.30
24-7, 75	1f	5.08	315.75
24-7, 87	2	5.45	315.87
24-7, 113	3c	6.05	316.13
24-8, 23	1c	4.97	316.73
24-8, 96	3a	(3.54)[a]	317.46
25-1, 9	1b	3.97	317.09
25-1, 54	1i	3.58	317.54
25-1, 75	2a	3.61	317.75
25-1, 105	2g	4.22	318.05
25-1, 128	2m	4.86	318.28
25-1, 132	2o	4.84[b]	318.32
25-2, 11	1a	5.18[b]	318.61
25-2, 26	1b	5.03	318.76
25-2, 90	1m	3.88[b]	319.40
25-2, 134	1u	3.06	319.84
25-3, 19	1c	2.39[b]	320.19
25-3, 33	1e	2.81	320.33
25-3, 72	1k	3.12	320.72
25-4, 19	1c	4.20	321.69
25-4, 83	3b	4.42	322.33
25-4, 135	6a	5.00[b]	322.85
25-5, 33	1b	4.92	323.33
25-5, 120	1j	4.87	324.20
25-6, 24	1c	5.42	324.74
25-6, 100	1L	5.60	325.50
25-7, 14	1b	5.55	326.14
25-7, 78	1j	5.62	326.78
26-1, 36	2a	5.58	326.86
26-1, 115	2g	5.83	327.65
26-2, 30	2c	5.71[b]	328.30
26-2, 60	1g	5.75	328.60
26-3, 21	1b	5.65	329.71
26-3, 81	2c	5.42	330.31
26-4, 50	1i	4.42	331.50
26-4, 135	4j	4.60	332.35
26-4, 139	4j	4.32[b]	332.39
26-5, 60	1f	5.00	333.10
26-5, 124	1k	4.47[b]	333.74
26-6, 79	3f	4.22	334.79
26-6, 139	7b	4.74	335.39
26-7, 6	1a	4.22	335.56
26-7, 8	1a	3.88[b]	335.58
27-1, 52	2m	3.38	336.52
27-2, 66	2g	4.22	338.16
27-3, 97	4	3.50	339.97
27-4, 15	1c	3.55	340.65
27-4, 112	7g	3.67	341.62

TABLE 22 – *Continued*

Core-Section, Interval (cm)	Piece Number	Velocity (km/s)	Sub-bottom Depth (m)
Hole 433C			
27-5, 102	3c	3.50	343.02
27-5, 126	3c	3.21	343.26
27-6, 14	1e	3.36	343.64
27-6, 29	1e	3.60	343.79
27-6, 110	4b	3.18	344.60
27-6, 137	5	3.82	344.87
28-1, 42	2d	4.92	345.92
28-2, 70	4b	5.05	347.70
28-3, 102	5b	5.44	349.52
28-4, 23	2a	5.09	350.23
28-4, 66	5b	4.17	350.66
28-4, 58	6c	4.42[b]	350.58
28-4, 95	6d	4.46	350.95
28-5, 95	7d	5.83	352.45
29-1, 13	2a	5.25	355.13
29-1, 49	3c	5.13[b]	355.49
29-1, 90	3i	5.38	355.90
29-2, 97	14	5.09	357.47
29-2, 97	14	4.89[b]	357.47
29-2, 109	16	4.73[b]	357.59
29-2, 139	19	3.63	357.89
29-2, 139	19	3.38[b]	357.89
30-2, 20	2	4.42	366.20
30-2, 51	5	4.93	366.51
30-2, 135	12	5.95[b]	367.35
30-2, 146	13	5.94	367.46
30-3, 50	3a	6.15	368.00
31-1, 37	1f	6.27	374.37
31-1, 38	1e	6.35[b]	374.38
31-1, 72	1j	6.07	374.72
31-1, 80	1k	6.03[b]	374.80
31-2, 74	3d	4.72	376.24
31-3, 34	1f	4.50	377.34
31-3, 89	4a	3.87[b]	377.89
31-4, 10		4.52	378.60
31-4, 50	3a	3.40	379.00
31-4, 50	3a	2.88[b]	379.00
31-4, 74	3b	3.84[b]	379.24
31-5, 30	1b	atten.[b]	380.30
31-5, 46	2	atten.[b]	380.46
31-5, 97	5	4.13	380.97
32-1, 22	3a	3.24	383.72
32-2, 17	1i	atten.	385.17
32-2, 55	2b	3.13	385.55
32-2, 126	2g	3.79	386.26
32-2, 145	3b	2.87	386.45
32-3, 123	5a	2.43	387.73
32-4, 15	1d	3.33	388.15
32-4, 128	11b	4.37	389.28
32-4, 139	11b	4.34	389.39
32-5, 95	1e	4.81	390.45
33-1, 24		4.93[b]	393.24
33-1, 35		5.06[b]	393.35
33-1, 42	3c	5.22	393.42
33-1, 63		5.36[b]	393.63
33-1, 133	3j	3.64	394.33
33-2, 47	3d	4.01	394.97
33-2, 109	3j	5.16	395.59
33-3, 13		5.67[b]	396.13
33-3, 101	2e	4.94	397.01

TABLE 22 – *Continued*

Core-Section, Interval (cm)	Piece Number	Velocity (km/s)	Sub-bottom Depth (m)
Hole 433C			
33-4, 13	1c	3.83	397.63
33-4, 123	6b	4.14	398.73
33-5, 29	1b	4.55	399.29
33-5, 64		(3.6)[a,b]	399.64
33-5, 93	3b	4.44	399.93
34-1, 4		3.76[b]	402.54
34-1, 57		3.92[b]	403.07
34-1, 70		4.17	403.20
34-1, 75	1p	4.01	403.25
34-1, 127	1aa	4.31	403.77
34-2, 80	1n	5.05	404.80
34-2, 101	1p	5.31	405.01
34-2, 125		5.24[b]	405.25
34-3, 9		5.27[b]	405.59
34-3, 42		5.17[b]	405.92
34-3, 93	1g	4.96	406.43
34-3, 140	2e	3.81	406.90
34-4, 77	4b	4.74	407.77
34-4, 96		5.00	407.96
34-5, 77		3.53[b]	409.27
34-5, 88	4b	4.30	409.38
34-5, 114		4.13[b]	409.64
34-6, 31	1b	3.89	410.31
34-6, 133	1s	4.24	411.33
34-7, 83	3j	4.55	412.33
34-7, 131	3o	5.07	412.81
35-1, 47	1f	5.37	412.47
35-1, 121	1n	4.78	413.21
35-2, 5	1a	4.55	413.55
35-2, 126	1z	4.33	414.76
35-3, 45	1h	3.91	415.45
35-4, 51	1p	4.83	417.01
35-4, 111	1dd	4.97	417.61
35-4, 116	1dd	4.96[b]	417.66
35-5, 32	1d	5.89	418.32
35-5, 98	1L	5.76[b]	418.98
35-5, 132	1q	5.92	419.32
35-6, 53	1e	5.78	420.03
35-6, 113	1n	4.29	420.63
35-6, 115	1n	4.01[b]	420.65
35-6, 135	1q	4.43[b]	420.85
35-7, 5	1a	4.81	421.05
35-7, 83	4a	4.70	421.83
35-7, 118	5a	4.92	422.18
36-1, 29	od	4.27	421.79
36-1, 51	1e	4.79[b]	422.01
36-1, 115	3b	3.92[b]	422.65
36-1, 117	3b	4.06	422.67
36-1, 126	3c	4.12[b]	422.76
36-2, 28	1g	4.70	423.28
36-2, 28	1g	4.07[b]	423.28
36-2, 140	8g	4.50	424.40
36-3, 23	1d	4.15[b]	424.73
36-3, 36	1e	4.01[b]	424.86
36-3, 61	1h	4.52	425.11
36-3, 77	1i	4.04[b]	425.27
36-3, 102	1L	4.28[b]	425.52
36-3, 124	1n	4.85	425.74
36-4, 21	1c	4.10	426.21
36-4, 39	1e	4.76	426.39

TABLE 22 – *Continued*

Core-Section, Interval (cm)	Piece Number	Velocity (km/s)	Sub-bottom Depth (m)
Hole 433C			
36-4, 73	1i	4.54	426.73
36-4, 114	1n	3.76[b]	427.14
36-4, 130	1q	4.20	427.30
36-5, 99	4h	4.64	428.49
36-5, 104	4i	4.05[b]	428.54
36-5, 127	4k	4.28[b]	428.77
37-1, 37	5b	4.00	431.37
37-1, 116	12c	4.41	432.16
37-2, 44	5a	3.57	432.94
37-2, 143	11d	4.74	433.93
37-3, 12	1b	4.75	434.12
37-3, 13	1e	4.40[b]	434.33
37-3, 65	1i	4.90	434.65
37-3, 88	1k	5.12[b]	434.88
37-3, 124	1r	5.03	435.24
37-3, 140	2	4.25[b]	435.40
37-4, 28	1b	4.68	435.78
37-4, 53	1d	4.24[b]	436.03
37-4, 109	3b	3.81	436.59
37-5, 34	3a	4.52	437.34
38-1, 30	1d	5.61	440.80
38-1, 59	1f	5.90	441.09
38-1, 71	1g	5.88	441.21
38-1, 110	2c	4.48	441.60
38-2, 12	1b	5.04	442.12
38-2, 17	1b	5.29[b]	442.17
38-2, 62	2b	3.67	442.62
38-2, 63	2b	3.42[b]	442.63
38-2, 104	4a	3.49	443.04
38-3, 26	3	3.57	443.76
38-3, 47	5c	3.21[b]	443.97
38-3, 65	6d	3.26[b]	444.15
38-3, 140	7d	3.00[b]	444.90
38-4, 8	1a	3.97[b]	445.08
38-4, 12	1d	3.85	445.12
38-4, 58	2h	4.65	445.58
38-4, 99	2o	3.58[b]	445.99
38-4, 112	2q	4.24	446.12
38-5, 64	1k	4.66[b]	447.14
38-5, 88	1n	5.39	447.38
38-5, 104	1r	5.33[b]	447.54
38-5, 140	1u	4.94[b]	447.90
38-6, 9	1a	4.47	448.09
38-6, 12	1a	3.99[b]	448.12
39-1, 14	4	3.63	450.14
39-1, 68	24	4.61	450.68
39-2, 13	1b	2.93	451.63
39-2, 39	1h	3.60	451.89
39-2, 59	1j	3.60[b]	452.09
39-2, 135	1t	4.49	452.85
39-3, 26	1a	4.21[b]	453.26
39-3, 50	1b	4.78	453.50
39-3, 114	1i	5.05	454.14
39-4, 80	1g	5.40	455.30
39-4, 92	1h	5.57[b]	455.42
39-4, 129	1j	5.52	455.79
39-5, 50	1b	5.94	456.50
39-5, 113	1f	6.18	457.13
39-6, 39	1b	5.71	457.89
39-6, 57	1d	5.50[b]	458.07

TABLE 22 – *Continued*

Core-Section, Interval (cm)	Piece Number	Velocity (km/s)	Sub-bottom Depth (m)
Hole 433C			
39-6, 132	3	3.11	458.82
39-7, 27	1e	3.51	459.27
39-7, 84	1o	4.67	459.84
39-7, 131	5a	3.96	460.31
40-1, 14	2a	4.25	459.64
40-1, 10	1a	6.12	461.10
40-1, 25	1b	5.79[b]	461.25
40-1, 105	1g	5.78	462.05
40-1, 112	1g	5.84[b]	462.12
40-3, 9	1a	5.64[b]	462.59
40-3, 18	1b	6.14	462.68
40-3, 90	1j	4.39	463.40
40-4, 112	1v	3.49[b]	465.12
40-4, 144	1aa	3.77	465.44
40-5, 27	1e	4.56	465.77
40-5, 40	1g	3.26[b]	465.90
40-5, 138	5b	4.08	466.88
40-6, 72	2r	4.42[b]	467.72
40-6, 95	2t	4.32[b]	467.95
40-6, 104	2u	4.87	468.04
41-1, 26	1c	5.00	469.26
41-1, 114	1h	4.74	470.14
41-2, 63	1k	4.45	471.13
41-2, 129	3g	4.41	471.79
41-3, 78	4	3.93	472.78
41-4, 53	3g	4.90	474.03
41-4, 75	3k	4.59[b]	474.25
41-4, 106	5b	4.00	474.56
41-5, 85	5a	4.11	475.85
41-6, 65	1m	4.33	477.15
41-6, 111	3c	4.70[b]	477.61
41-6, 139	3f	4.83	477.89
41-6, 139	3f	4.41[b]	477.89
42-1, 46	1e	4.71[b]	478.96
42-1, 60	1f	4.98	479.10
42-1, 80	1h	4.71[b]	479.30
42-2, 22	2b	3.92	480.22
42-2, 36	3b	4.03[b]	480.36
42-2, 127	6d	4.79[b]	481.27
42-2, 135	6e	4.97	481.35
42-3, 26	1c	4.28	481.76
42-3, 127	10a	4.45	482.77
42-4, 49	3e	4.71	483.49
42-4, 138	8e	4.86[b]	484.38
42-4, 141	8e	5.09	484.41
42-5, 57	1g	4.94	485.07
42-5, 111	1L	4.56[b]	485.61
43-1, 8	1a	4.76[b]	488.08
43-1, 31	1g	4.95	488.31
43-1, 53	2a	4.81[b]	488.53
43-1, 126	4c	3.92	489.26
43-2, 63	4L	4.31	490.13
43-2, 111	5f	3.86	490.61
44-1, 35	1d	5.16	497.85
44-1, 85	1i	4.10[b]	498.35
44-1, 109	1L	4.54	498.59
44-2, 4	1a	4.40	499.04
44-2, 99	7c	4.01	499.99
44-3, 85	6f	4.29	501.35
44-3, 90	6f	3.95[b]	501.40

TABLE 22 – *Continued*

Core-Section, Interval (cm)	Piece Number	Velocity (km/s)	Sub-bottom Depth (m)
Hole 433C			
44-3, 142	10b	4.58	501.92
44-4, 39	2g	4.47[b]	502.39
44-4, 53	2h	5.11	502.53
44-4, 82	2k	4.00[b]	502.82
44-4, 127	5	4.14[b]	503.27
44-5, 11	1a	4.91	503.61
44-5, 76	1e	4.59	504.26
45-1, 10	1b	4.16	507.10
45-1, 128	2y	4.34[b]	508.28
45-2, 32	1c	4.69[b]	508.82
45-2, 47	1d	5.24	508.97
45-2, 60	1e	4.71[b]	509.10
45-2, 105	1i	4.24[b]	509.55
45-2, 125	1L	4.56	509.75
45-3, 70	3c	3.87	510.70
45-3, 142	4a	4.81	511.42
45-4, 39	3f	4.85	511.89
45-4, 111	4d	5.55	512.61
45-4, 125	1k	4.76	512.75
45-5, 31	1b	5.81	513.31
45-5, 109	3b	6.07	514.09
45-6, 17		4.75[b]	514.67
45-6, 46	1c	5.13	514.96
45-6, 74		4.99[b]	515.24
45-7, 51	3b	4.15	516.51
45-7, 122		4.58[b]	517.22
45-7, 133	5g	5.21	517.33
45-7, 145	5k	4.66[b]	517.45
46-1, 12		3.55[b]	516.62
46-1, 55	1j	3.45	517.05
46-1, 48-50	(48-58)	3.97[b]	516.98-517.08
46-1, 127	1x	3.80	517.77
46-2, 19	1d	3.91	518.19
46-2, 121		4.64[b]	519.21
46-2, 125	1aa	5.15	519.25
46-3, 15		4.71[b]	519.65
46-3, 31	1b	5.05	519.81
46-3, 108	2f	4.99	520.58
46-3, 121		4.65[b]	520.71
46-4, 23	1e	4.13	521.23
46-4, 27	2o	4.74	521.27
46-4, 110		3.70[b]	522.10
46-5, 55	4b	4.32	523.05
46-5, 97	6b	5.01	523.47
46-5, 130	6h	4.61	523.80
46-5, 143		4.39[b]	523.93
46-6, 30	1e	4.89	524.30
46-6, 93	4a	5.01	524.93
47-1, 21		4.44[b]	526.21
47-1, 26	2a	5.11	526.26
47-1, 61		4.06[b]	526.61
47-1, 94		3.98[b]	526.94
47-1, 127	2m	5.31[b]	527.27
47-2, 37	1f	4.18	527.87
47-2, 106	3e	4.55	528.56
47-2, 135	4b	4.55	528.85
47-3, 105	2m	3.83	530.05
47-4, 45	1h	3.64	530.95
47-4, 137	1x	4.32	531.87
47-5, 17	2	4.37	532.17

TABLE 22 – *Continued*

Core-Section, Interval (cm)	Piece Number	Velocity (km/s)	Sub-bottom Depth (m)
Hole 433C			
47-5, 81	6a	5.26[b]	532.81
47-5, 95	7	4.08	532.95
48-1, 25	1d	5.63	535.75
48-1, 45		5.40[b]	535.95
48-1, 130	2f	5.76	536.80
48-2, 122	2b	5.87	538.22
48-3, 7	1a	6.16	538.57
48-3, 56		5.63[b]	539.06
48-3, 135	3i	4.70	539.85
48-4, 54	4b	5.14	540.54
48-4, 62	4c	4.80[b]	540.62
48-4, 94	7a	3.97[b]	540.94
49-1, 69	5a	4.39	545.69
49-1, 123	7e	4.05[b]	546.23
49-1, 129	7f	4.68	546.29
49-2, 21	1c	4.78	546.71
49-2, 32	1d	4.51	546.82
49-2, 59	1i	4.74[b]	547.09
49-2, 65	1j	4.80	547.15
49-2, 112	4a	3.76[b]	547.62

[a]( ) - lesser quality.
[b]On minicore.

the central part of the seamount in a southwest direction (Figure 18). Locally, terrace deposits overlie a flat erosional acoustic basement surface along the outer edge of the seamount.

Site 433 is along the northeast margin of the lagoonal complex, and within what appears to be a graben that has formed along the southwest flank of the central ridge or platform (Figures 34 and 35). That ridge may originally have been constructed by a volcanic rift which probably trends northeast from the seamount crest. Faulting along the upper flanks of the ridge produced scarps upon which fringing reefs developed. To the southwest, the lagoon deepens, and about 16 nautical miles northwest of the graben, the lagoonal sediments thin and lap onto an acoustic basement ridge or cone of what is probably volcanic rock (Figures 2, 34, and 35).

The 3.5-kHz *Challenger* profiles taken across Site 433 show a relatively thick section of well-stratified sediments filling the graben (Figure 11). Many strong, continuous, rhythmically bedded, flat-lying to gently folded reflectors are shown (Figures 36 and 37). The records taken on station at Site 433 (Figure 12) show the sea floor as a wide (0.002 s), strong reflector beneath which an acoustically semitransparent zone (Zone A) with many weak, discontinuous reflectors occurs at a subsurface depth corresponding to 0 to 0.015 s. From 0.015 s to 0.019 s, a thin, acoustically transparent zone (Zone B) occurs; its top is distinctly marked by the shallowest, most continuous strong reflector (reflector 1). Between 0.019 and 0.024 s is a layer (Zone C) of weak, discontinuous reflectors lying upon a very strong, continuous reflector (reflector 2) that apparently marks a disconformable contact. To the south, near the base of the acoustic basement buttress that bounds the southern part of the graben, this reflector marks an angular, unconformable

TABLE 23
Density Data for Site 433

(2-minute GRAPE of minicores, σ = 0.100 cm^2/g)

Core-Section, Interval (cm)	Piece Number	ρ (g/cm^3)	Sub-bottom Depth (m)
Hole 433A			
20-1, 4		2.78	163.54
20-1, 37		2.92	163.87
20-1, 114		2.85	164.64
20-2, 11		2.91	165.11
20-2, 50		2.83	165.50
21-1, 29		2.59	166.79
21-2, 85		2.96	168.85
21-3, 99		2.94	170.49
21-4, 139		2.94	172.39
Hole 433B			
4-1, 52	3c	2.54	157.52
5-1, 72	6a	2.79	166.72
5-2, 37	2a	2.92	167.87
Hole 433C			
1-1, 62	9	2.92	163.62
2-1, 23	3	2.86	168.23
4-1, 40	2c	3.05	181.90
4-1, 87	4	2.96	182.37
5-1, 13	1	2.94	187.13
6-1, 5	1	2.92	
10-1, 38	1d	2.71	204.88
10-1, 120	15	2.58	205.70
10-2, 22	3	2.45	206.22
10-2, 48	6b	2.35	206.48
10-2, 140	20	1.89	207.40
10-3, 17	2b	2.38	207.67
10-3, 136	11	2.57	208.86
10-4, 10	2	2.16	209.10
10-4, 113	8a	2.51	210.13
10-5, 49	6a	2.51	210.99
10-5, 144	13c	2.36	211.94
10-6, 44	3c	2.71	212.44
11-1, 6	1a	2.64	214.06
11-1, 64	4	2.45	214.64
11-1, 92	1g	2.81	214.92
11-2, 51	5	2.13	216.01
11-3, 10	1b	2.87	217.10
11-3, 99		2.79	217.99
11-3, 122	2g	2.73	218.22
11-4, 59	6	2.41	219.09
11-4, 91	11	2.69	219.41
11-5, 41	4	2.22	220.41
12-1, 39	3d	2.60	223.89
12-1, 103	9b	2.30	224.53
12-3, 49	1d	2.71	226.99
12-3, 101	4	2.52	227.51
12-4, 23	3	2.82	228.23
13-1, 7	3a	2.86	230.07
14-1, 48	1h	2.08	233.48
14-2, 129	3e	2.46	235.79
15-1, 11	2a	2.60	242.61
15-1, 48	2e	2.37	242.98
15-2, 104	11	2.22	245.04
15-3, 128	15	2.34	246.78
15-4, 22	2	2.56	247.22

TABLE 23 – *Continued*

Core-Section, Interval (cm)	Piece Number	ρ (g/cm³)	Sub-bottom Depth (m)
Hole 433C			
15-4, 100	8	2.54	248.00
15-4, 116	9b	2.43	248.16
15-5, 15	2	2.49	248.65
15-5, 80	4a	2.68	249.30
16-1, 12	2	2.97	252.12
16-1, 76	6b	3.06	252.76
17-1, 18	2	3.06	255.68
19-1, 15	2a	3.02	261.65
19-1, 88	8a	2.50	262.33
19-2, 13	1b	2.77	263.13
19-2, 24	2a	2.68	263.24
19-3, 16	1c	2.46	264.66
19-4, 69	2f	2.91	266.69
19-5, 26	1c	2.87	267.76
20-1, 25	2	2.83	269.75
20-1, 83	8	2.73	270.33
20-2, 49	5	2.82	271.49
21-1, 108		2.86	280.08
21-2, 28		2.73	280.78
21-2, 105	12	2.78	281.55
21-3, 33		2.85	282.33
21-4, 121		2.83	284.71
21-5, 10		2.78	285.10
22-2, 114	5h	2.76	291.14
22-3, 65	5c	2.75	292.15
22-3, 131	9	2.80	292.80
22-4, 24	2a	2.77	293.24
22-5, 59	4	2.89	295.09
23-1, 87	4a	2.63	298.87
23-2, 56	4d	2.46	300.06
23-3, 34	1b	2.70	301.34
23-4, 30	1b	2.45	302.80
23-5, 6	1a	2.64	304.06
23-6, 109	4j	2.61	306.59
23-7, 103	5a	2.93	308.03
24-2, 18	1a	2.48	309.18
24-3, 82	9c	2.66	311.32
24-8, 13	1b	2.99	316.63
25-1, 132	2o	2.79	318.32
25-2, 11	1a	2.81	318.61
25-2, 46	1d	2.79	318.96
25-2, 90	1m	2.56	319.40
25-3, 19	1c	2.13	320.19
25-4, 135	6d	2.78	322.85
25-5, 78	1g	2.86	323.78
25-6, 57	1g	2.90	325.07
26-2, 30	2c	2.95	328.30
26-3, 21	1b	2.93	329.71
26-4, 139	4j	2.59	332.39
26-5, 36	1d	2.81	332.86
26-5, 124	1k	2.80	333.74
26-7, 8	1a	2.68	335.58
27-1, 18	2b	2.42	336.18
27-1, 70	2q	2.39	336.70
27-3, 13	1a	2.76	339.13
27-5, 19	1c	2.43	342.19
27-5, 126	3c	2.49	343.26
27-6, 14	1c	2.57	343.64
28-1, 83		2.88	346.33
28-2, 35		2.72	347.35

TABLE 23 – *Continued*

Core-Section, Interval (cm)	Piece Number	ρ (g/cm³)	Sub-bottom Depth (m)
Hole 433C			
28-3, 39		2.68	348.89
28-4, 27	2b	2.84	350.27
28-4, (57-90)		2.42	(350.58)
28-5, 114		2.90	351.14
29-1, 49	3c	2.71	355.49
29-1, 83		2.88	355.83
29-1, 116		2.73	356.16
29-2, 97	14	2.89	357.47
29-2, 109	16	2.79	357.59
29-2, 139	19	2.55	357.89
29-3, 18		2.76	358.18
30-2, 135		2.92	367.35
30-3, 58		2.96	368.08
31-1, 38	1e	3.04	374.38
31-1, 80	1k	3.00	374.80
31-1, 121		2.88	375.21
31-3, 89	4a	2.64	376.39
31-4, 50	3a	2.41	379.00
31-4, 74		2.68	379.24
31-5, 30	1b	2.66	380.30
32-1, 31		2.53	383.81
32-3, 101		2.49	387.51
32-4, 139		2.70	389.39
32-5, 14		2.72	389.64
32-5, 85		2.80	390.35
32-5, 116		2.79	390.66
33-1, 24		2.87	393.24
33-1, 35		2.96	393.35
33-1, 63		2.93	393.63
33-1, 88		2.53	393.88
33-1, 105		2.60	394.05
33-2, 22		2.81	394.77
33-2, 73		2.61	395.23
33-2, 139		2.86	395.89
33-3, 13		2.99	396.13
33-5, 11		2.66	399.11
33-5, 38		2.72	399.38
33-5, 64		2.48	399.64
34-1, 4		2.65	402.54
34-1, 57		2.41	403.07
34-1, 70		2.60	403.20
34-1, 141		2.51	403.91
34-2, 60		2.76	404.60
34-2, 125		2.76	405.25
34-3, 9		2.84	405.59
34-3, 42		2.82	405.92
34-4, 15		2.51	407.15
34-4, 96		2.79	407.96
34-5, 51		2.74	409.01
34-5, 77		2.59	409.27
34-5, 114		2.90	409.64
34-6, 13		2.49	410.13
35-1, 71		2.92	412.71
35-2, 22		2.64	413.72
35-4, 116	1dd	2.82	417.66
35-5, 98	1L	2.98	418.98
35-6, 115	1n	2.52	420.65
35-6, 135	1q	2.47	420.85
36-1, 25		2.61	421.75
36-1, 51	1e	2.85	422.01
36-1, 115	3b	2.34	422.65

TABLE 23 – *Continued*

Core-Section, Interval (cm)	Piece Number	ρ (g/cm³)	Sub-bottom Depth (m)
Hole 433C			
36-1, 126	3c	2.57	422.76
36-3, 23	1d	2.68	424.73
36-3, 36	1e	2.73	424.86
36-3, 77	1i	2.76	425.27
36-3, 102	1L	2.79	425.52
36-4, 21	1c	2.65	426.21
36-4, 73	1i	2.79	426.73
36-4, 85		2.78	426.85
36-4, 114	1n	2.39	427.14
36-5, 13		2.55	427.63
36-5, 80		2.59	428.30
36-5, 104	i	2.70	428.54
36-5, 127	4k	2.76	428.77
37-3, 33	1e	2.77	434.33
37-3, 88	1k	2.90	434.88
37-3, 140	7d	2.85	435.40
37-4, 8	1a	2.85	435.58
37-4, 53	1d	2.80	436.03
38-1, 30	1d	2.87	440.80
38-1, 71	1g	2.88	441.21
38-2, 17	1b	2.80	442.17
38-2, 42		2.59	442.42
38-2, 63	2b	2.36	442.63
38-3, 47	5c	2.16	443.97
38-3, 65	6d	2.08	444.15
38-3, 140	7d	2.37	444.90
38-4, 99	2o	2.87	445.99
38-5, 64	1k	2.72	447.14
38-5, 104	1r	2.86	447.54
38-5, 140	1u	2.82	447.90
38-6, 12	1a	2.66	448.12
39-2, 59	1j	2.54	452.09
39-3, 26	1a	2.75	453.26
39-4, 92	1h	2.87	455.42
39-6, 57	1d	2.87	458.07
40-2, 25	1b	2.95	461.25
40-2, 112	1g	3.01	462.12
40-3, 9	1a	2.92	462.59
40-3, 81		2.75	463.31
40-4, 95		1.82	464.95
40-4, 112	1v	2.45	465.12
40-5, 19	1c	2.44	465.69
40-5, (34-41)		2.28	465.90
40-6, 72	2r	2.65	467.72
40-6, 95	2t	2.78	467.95
41-4, 75	3k	2.76	474.25
41-6, 111		2.77	477.61
41-6, 139	3f	2.82	477.89
42-1, 46	1e	2.79	478.96
42-1, 107	1j	2.76	479.57
42-2, 36	3b	2.31	480.36
42-2, 127	6d	2.74	481.27
42-3, 26	1c	2.68	481.76
42-4, 138	8e	2.60	484.38
42-5, 111	1L	2.87	485.61
43-1, 8	1a	2.90	488.08
43-1, 53	2a	2.80	488.53
44-1, 24	1c	2.84	497.74
44-1, 47	1e	2.98	497.97
44-1, 85	1L	2.74	498.35

TABLE 23 – *Continued*

Core-Section, Interval (cm)	Piece Number	ρ (g/cm³)	Sub-bottom Depth (m)
Hole 433C			
44-3, 90	6f	2.52	501.40
44-3, 132	9g	2.69	501.82
44-4, 39	2g	2.79	502.39
44-4, 82	2k	2.76	502.82
44-4, 127	5	2.78	503.27
45-1, 23	1d	2.15	507.23
45-1, 84		2.56	507.84
45-2, 32	1c	2.62	508.82
45-2, 60	1e	2.86	509.10
45-2, 105	1i	2.75	509.55
45-3, 23	1d	2.15	510.23
45-4, 125	1k	2.89	512.75
45-5, 85	1h	2.90	513.85
45-6, 17		2.86	514.67
45-6, 74		2.82	515.24
45-7, 122		2.85	517.22
45-7, 145	5k	2.84	517.45
46-1, 12		2.29	516.62
46-1, (48-58)		2.62	(517.03)
46-2, 121		2.74	519.21
46-3, 15		2.81	519.65
46-3, 121		2.70	520.71
46-4, 110		2.32	522.10
46-5, 143		2.47	523.93
47-1, 21		2.87	526.21
47-1, 61		2.87	526.61
47-1, 94		2.77	526.94
47-5, 81	6a	2.93	532.81
48-1, 45		2.91	535.95
48-2, 139		3.01	538.39
48-3, 56		2.96	539.06
48-4, 13	1b	2.67	540.13
48-4, 48	4a	2.71	540.48
48-4, 62	4c	2.78	540.62
48-4, 94	7a	2.73	540.94
49-1, 7	1a	2.56	545.07
49-1, 123	7e	2.74	546.23
49-2, 11	1b	2.45	546.61
49-2, 32	1d	2.72	546.82
49-2, 59	1i	2.84	548.59
49-2, 73	1k	2.79	548.73
49-2, 112	4a	2.52	549.12

contact between overlying, gently southerly-dipping beds and underlying, synclinally folded strata.

A relatively thick, acoustically semitransparent zone (Zone D) containing many weak, discontinuous reflectors occurs between 0.024 and 0.037 s. The basal reflector (reflector 3) of this zone is the strongest and most continuous reflector in the 3.5-kHz profile at Site 433. Beneath reflector 3, from 0.037 to 0.041 s, another thin, acoustically transparent zone (Zone E) occurs; and beneath this, a zone (Zone F) of three strong, continuous reflectors, equally spaced, occurs between 0.041 and 0.045 s. An acoustically semitransparent zone (Zone G), 0.045 to 0.059 s, contains a few, weak, discontinuous reflectors. Finally, the base of the sedimentary pile observed in the 3.5-kHz profile consists of two to three

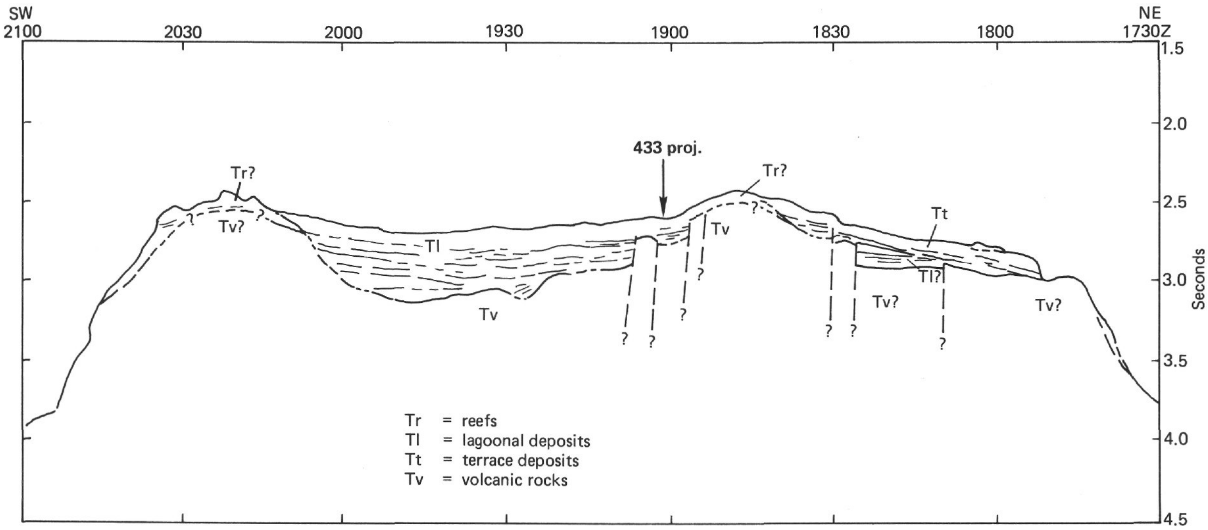


Figure 34. *Line drawing of* Kana Keoki *seismic reflection profile across Suiko Seamount, showing the lagoonal complex drilled at Site 433.*

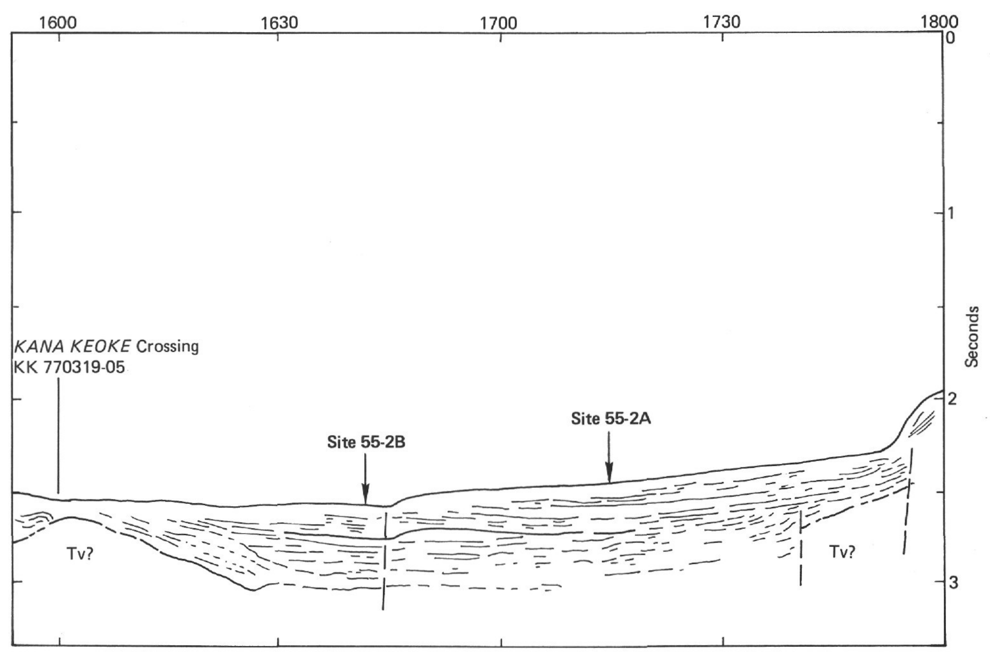


Figure 35. *Line drawing of the northern part of* S.P. Lee *seismic reflection profile across Suiko Seamount, showing the lagoonal complex drilled at Site 433.*

very strong, continuous reflectors (reflector 4) which range from 0.059 to 0.061 s and locally represent the surface of the acoustic basement for the 3.5-kHz system.

Using sonic velocities from cores of Hole 433A (see Physical Properties section), we correlated these reflectors with the lithology of the hole (Figure 38). The depths and thicknesses of the various acoustic zones identified in the 3.5-kHz and seismic reflection profiles are given in Tables 24 and 25. A relationship also exists between the defined acoustic zones and the drilling rate. Generally, the drilling rate decreases at every depth interval in which a strong, continuous reflector is identified in the seismic record. Therefore, the point of intersection of the drill bit with an acoustic zone can be determined by the decrease or increase of the drilling rate (see Table 26). The cores generally have homogeneous lithology and texture, however, with periodic layering of more consolidated material. Evidently, the density contrast that creates a seismic reflection boundary in the pelagic sediments results from better packing or from minor differences in diagenetic boundaries, rather than from a change in grain size.

The seismic reflection profiles obtained by the *Glomar Challenger* across Site 433 (Figures 9 and 10) show the drilled sedimentary basin to consist of three major acoustic units. The first (Unit 1) occurs between 0 and 0.08 s subsurface depth, and is masked in its upper part

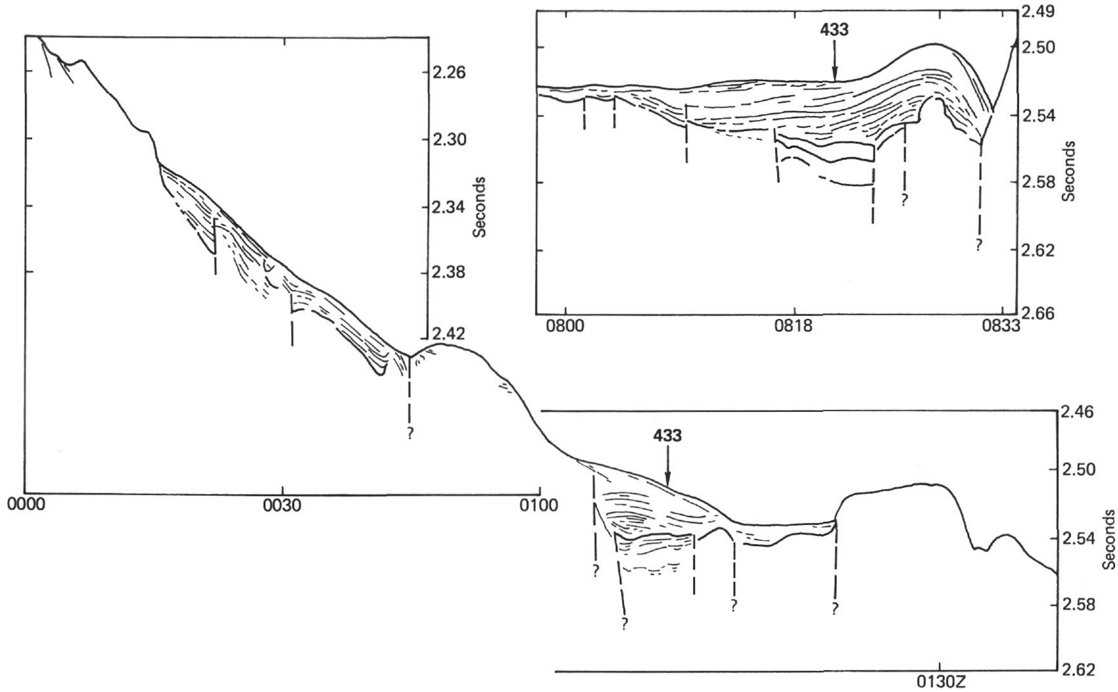


Figure 36. *Line drawings of* Glomar Challenger *3.5-kHz profiles across Site 433, showing the graben basin.*

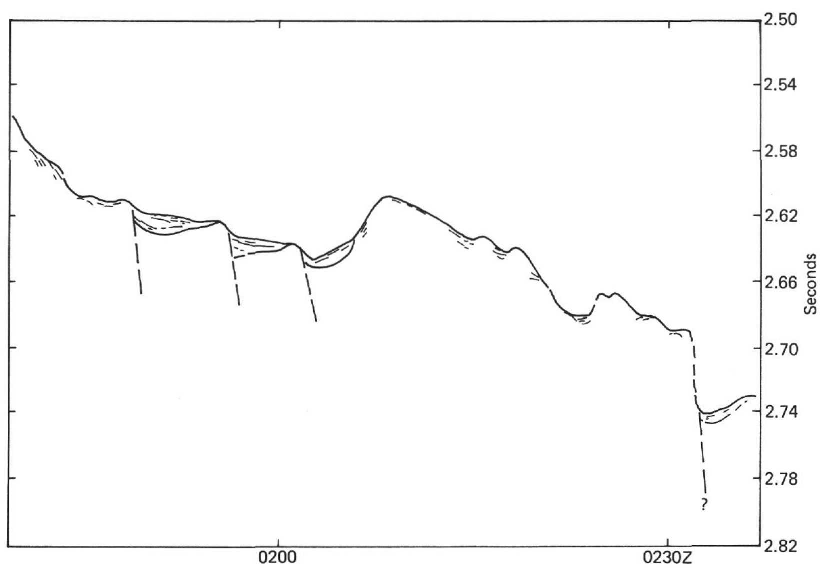


Figure 37. *Line drawing of* Glomar Challenger *3.5-kHz profile north of Site 433, showing faulting along the northern flank of the seamount.*

by nearly 0.05 s of bubble pulse. This part of the seismic record is clearly defined, however, in the *Challenger's* 3.5-kHz profile across the site (Figure 11). Beneath the bubble pulse, several strong, fairly continuous reflectors can be seen down to 0.08 s depth; they are flat-lying, except locally, where they are folded into a small, gentle syncline. Unit II consists of an acoustically semitransparent zone that extends from 0.08 to 0.18 s and contains few weak, discontinuous reflectors. Between 0.18 and 0.28 s, a zone (Unit III) of very strong, continuous reflectors exists. These reflectors are rhythmically bedded, equally spaced, and suggest acoustic ringing. The upper reflector of this unit is the strongest, and may represent the surface of a relatively dense bed overlying less dense material in which the seismic signal is trapped.

All these acoustic units appear to thin and lap onto an acoustic basement buttress to the north (Figure 39). The southern flank of this buttress is terminated by a normal fault, down-dropped to the south, which truncates the reflectors of acoustic Unit C. A high-angle

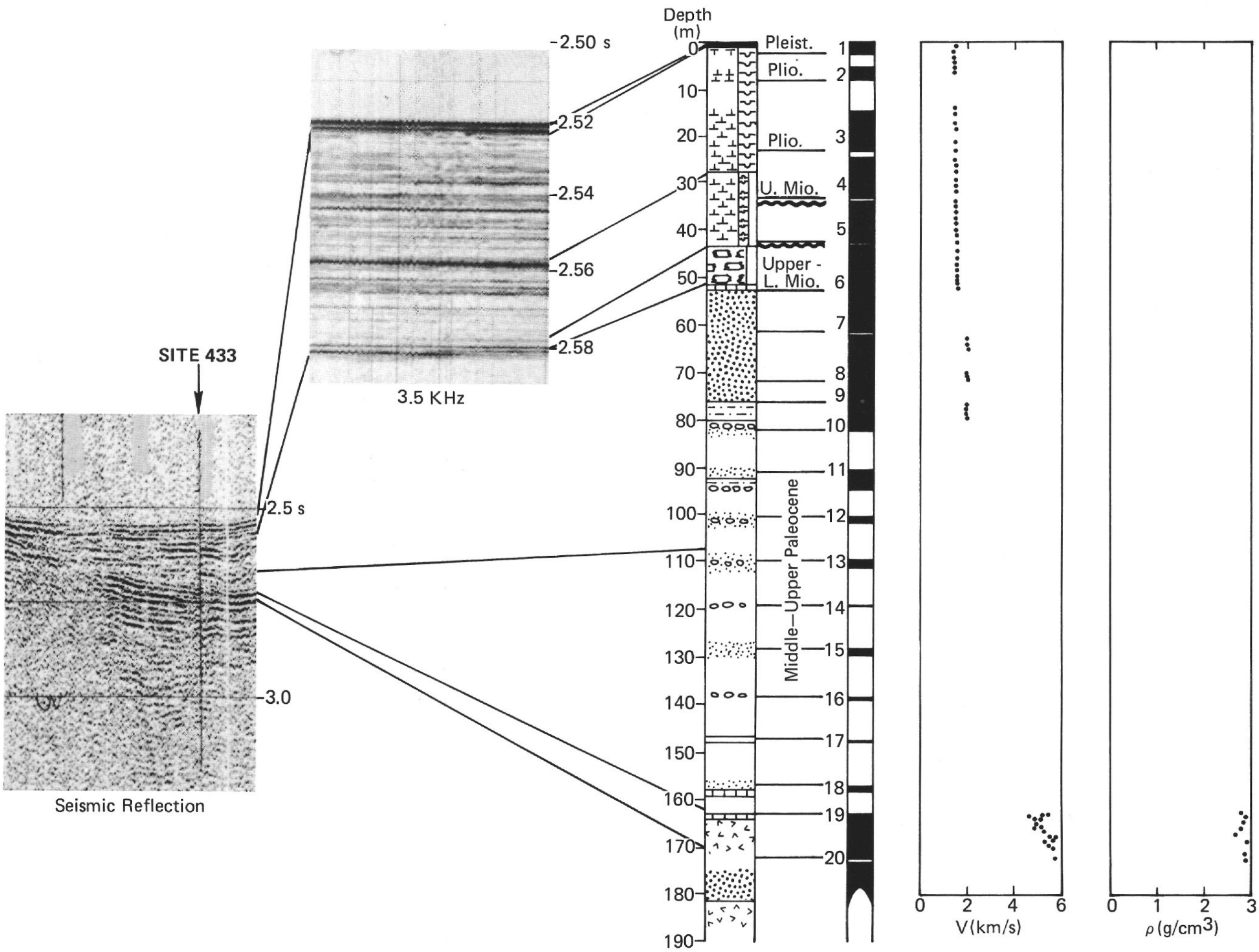


Figure 38. *Correlation of seismic reflection and 3.5-kHz profiles with physical properties and lithologic column, Site 433.*

reverse or thrust fault dipping to the north may have pushed the strata of acoustic Units C and B up toward the south and folded the beds of acoustic Unit A. Displacement appears to be small, however, and this fault probably has not significantly offset stratigraphy.

Figure 38 correlates the acoustic units with the lithostratigraphy established from the cores of Hole 433A. Acoustic Unit A is an unconsolidated Pliocene to Pleistocene foraminiferal-diatom-nannofossil ooze. Initial examination of the textural characteristics of the core did not indicate the presence of reflector 1, which was observed in the 3.5-kHz profile at a depth of 11.6 meters; but the drilling rate increased at a depth of about 10 meters. One would not expect to see all reflectors in the core, because drilling destroys consolidation of friable materials. Units B and C are Pliocene diatom-nannofossil ooze. No indication of reflector 2 was evident in the cores, and the drilling rate did not chang (Table 26).

Acoustic Unit D is a diatom-nannofossil ooze that rests on reflector 3. Reflector 3 is not clearly apparent in the core, but at the general depth of 28 meters (the reflector is placed at 28.9 m in the profile), lithology changes from a diatom-nannofossil ooze to a marly, siliceous nannofossil ooze. The paleontologists believe an upper Miocene/lower Pliocene unconformity may possibly occur at this depth, and the drillers reported a decrease in the drilling rate at a subsurface depth of 30 meters (Table 26). Upper Miocene marly siliceous nannofossil ooze evidently makes up acoustic Units E and F. Acoustic Unit G consists of a pelagic calcareous ooze that rests on chalk, siliceous ooze, and volcanic fine sand layers. The drilling rate slowed slightly between depths of 41 and 43 meters (Table 26), within Unit G, but in the 3.5-kHz profile only a few weak, discontinuous reflectors hint of any change in consolidation. At about 43 meters, a middle Miocene hiatus occurs (see Biostratigraphy chapter, this volume), and the core lithology changes from a marly siliceous nannofossil ooze to a calcareous ooze.

Reflector 4 appears at depths of 45.7 to 47.3 meters in the 3.5-kHz profile, and probably represents the surface of the lower Miocene chalk layer which occurs at a depth of about 49 meters in the core. The drilling rate

TABLE 24
Subsurface Depth Ranges for Acoustic Zones and Major Reflectors, Site 433

Acoustic Zone	Subsurface Depth Range (two-way travel time in seconds)	Subsurface Depth Range[a] (m)
A	0-0.015	0-11.6
B	0.015-0.019	11.6-14.7
C	0.019-0.024	14.7-18.6
D	0.024-0.037	18.6-28.7
E	0.037-0.041	28.7-31.8
F	0.041-0.045	31.8-34.9
G	0.045-0.059	34.9-45.7
Major Reflectors	Subsurface Depth (s)	Subsurface Depth (m)
1	0.015	11.6
2 (discontinuity)	0.024	18.6
3	0.037	28.7
4 (acoustic basement surface)	0.059-0.061	45.7-47.3

[a]Depth in meters calculated using an average velocity of 1.55 km/s, as determined from the sonic velocity measurements (see Physical Properties Chapter, this volume).

TABLE 25
Subsurface Depth Ranges for Acoustic Units, Site 433

Acoustic Unit	Subsurface Depth Range (two-way travel time in seconds)	Subsurface Depth Range[a] (m)
I	0-0.08	0-62.0
II	0.08-0.18	62.0-150.3
III	0.18-0.28	150.3-420.0
Major Reflector (in Unit II)	0.13	109.0

[a]Depth in meters calculated using an average velocity of 1.55 km/s for Unit I, 1.78 km/s for Unit II, and 5.7 km/s for Unit III; mean velocity used in calculating depths at the base of Unit II and the top of Unit III is 1.67 km/s. These velocities are based on sonic velocity measurements from cores within the acoustic units (see Physical Properties Chapter, this volume).

TABLE 26
Comparison of Major Reflector Depths Defined in *Challenger* Profiles with Depths of Changes in Drilling Rate

Depth to Major Reflector[a] (m)	Depth at Which Drilling Rate Decreased[b] (m)
11.6	9
18.6	
28.7	30
	41
	42
	43
45.7	46
47.3	49
	68

[a]See Table 24.
[b]Obtained from driller's geolograph. Depth at which rate of drilling decreased for a short duration.

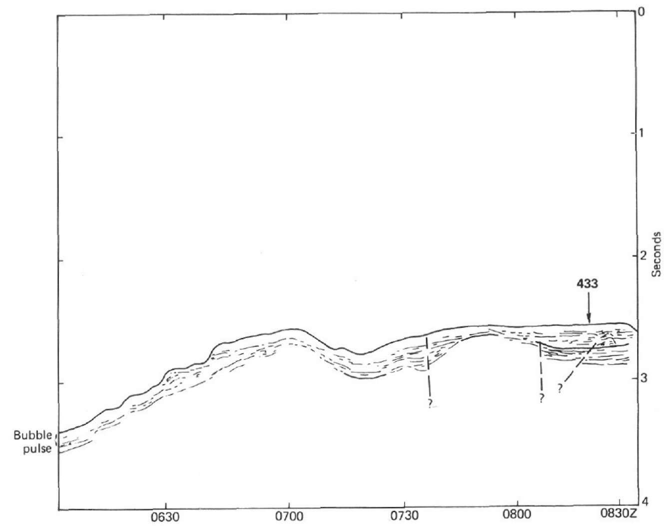


Figure 39. *Line drawing of* Glomar Challenger *seismic reflection profile across Site 433, showing the nature of lagoonal sediments drilled.*

decreased at 46 meters and again at 49 meters; this suggests that the bit encountered harder, more consolidated strata. The 3.5-kHz signal did not penetrate a siliceous ooze and volcanic sand layer beneath this surface, but the surface is shown on the profile as several strong reflectors, and on the seismic reflection profiles as the first strong, continuous reflector (and also the first folded reflector) beneath the bubble pulse (Figure 10).

All the above acoustic units defined in the 3.5-kHz profile make up the upper part of acoustic Unit I in the seismic reflection profiles. The lower part of Unit I is evidently composed of reef sand ranging from middle Paleocene to upper Paleocene. The base of acoustic Unit I is at 52 meters, where a large Oligocene to Eocene hiatus occurs (see Biostratigraphy section). But since the paleontologic age determinations of all cores involved core-catcher samples only, the depth to any age boundary may vary from 0 to 9.5 meters. Also, velocities used in depth calculations are probably lower than *in-situ* velocities because of the disturbance, mixing, and destruction of consolidation by drilling. Differences between acoustic and cored boundaries could thus differ by as much as 10 meters. We suggest that Unit I unconformably overlies the chalk and volcanic sand layers marking the boundary between the overlying pelagic sediments and the underlying shallow-water reef sands.

Acoustic Unit II consists of middle to upper Paleocene reef sands and calcareous sandy mud with algal concretions. It rests at 157 meters (150.3 m seismic depth) on a thin layer of well-lithified calcarenite. Only one strong, discontinuous reflector exists in Unit II — at a depth of 109 meters; it may represent a zone of high concentrations of algal concretions in the core.

Acoustic Unit III consists of interlayered basaltic lava flows and reef sands. At least two sand layers near the top of the unit appear to be interlayered with thin flows about 10 meters thick (see Operations section). Acoustic ringing and high attenuation of the seismic energy prevented us from distinguishing alteration zones and soil horizons that may be present between shallowly buried thin flows at deeper levels in the basaltic basement.

Discussion

On the basis of this correlation of the seismic reflection data with lithostratigraphy, we suggest a Tertiary tectonic and sedimentologic history for Suiko Seamount. Biostratigraphic data for Site 433 indicate that Suiko developed about 60 m.y. ago. Perhaps by early Paleocene time, several volcanic highs had been constructed and a well-developed northeast-trending rift lay near a structural basin developed by faulted, downdropped blocks. The island was beginning to sink, and the graben basin in which the Site 433 holes were drilled had been inundated by the sea. North of this basin a large lagoon was becoming increasingly isolated from the open ocean as fringing reefs and reef flats continued to widen. Fringing reefs grew along the nearby fault scarps of the rift and supplied coarse reef detritus to the graben basin. This debris was continually washed by waves in a shoreline environment, and was mixed with the volcanic detritus contemporaneously being eroded from the island.

Volcanism was probably still active during the early Paleocene, and several lava flows advanced across and buried beach deposits. Beach sands developed over the older flows, only to be covered later by further flows. The invasion of these flows across the shoreline of the lagoon probably ended during early Paleocene time, and the area experienced a long episode of shallow-water reef sedimentation.

Throughout the middle to late Paleocene, the reefs continued to grow, and kept pace with the subsidence that was by now well underway. The protective fringes of reefs essentially at sea level around the island produced a quiet-water environment for the lagoon and its marginal graben basin, where reef muds were deposited and algal mounds flourished. The island of Suiko submerged to become an atoll with the development of a table reef or reef flat on the central platform. The outer fringing reefs and lagoons, including the graben basin, were probably drowned at this time.

During the Eocene and Oligocene, sedimentation ceased, or all record of deposition was eroded. The reefed island could have emerged above sea level and been partially eroded, or it could have submerged deep enough to remove the seamount from clastic sediment sources and deep enough for currents to prevent accumulation of pelagic sediments. Continued subsidence removed the atoll from a reef environment. Deep-water pelagic sedimentation began in the early Miocene and is represented by a layer of volcanic fine sand mixed with siliceous ooze and chalk. Pelagic sedimentation of calcareous ooze continued through the early Miocene, but a middle Miocene hiatus exists at Site 433. In late Miocene time, pelagic sediments again began to rain upon the area of the lagoonal complex, and marly siliceous nannofossil oozes accumulated; these probably formed in a deeper water environment than did the calcareous oozes of the early Miocene. Accumulation of diatom-nannofossil ooze continued through Pliocene-Pleistocene time.

The folding and growth faulting evident in the *Challenger's* 3.5-kHz profile across Site 433 on Suiko Seamount indicate that tectonic activity within the graben basin continued at least through the late Pliocene. Most reef sediments have been down-dropped in the central part of the graben. The pelagic sediments are faulted only at their base, but their upper parts are folded in a manner that could only be caused by tectonic warping — not by sedimentary draping.

SUMMARY AND CONCLUSIONS

In the four holes drilled at Suiko Seamount we cored a continuous section from the surface to a depth of 550.5 meters. Sedimentary rocks were recovered between mudline and a sub-bottom depth of 163.0 meters. Below the contact of reef calcarenite with basalt, we penetrated 387.5 meters of basalt, and achieved the deepest penetration into basement to date in the Pacific basin.

Drilling of sediments on Suiko Seamount disclosed a lower Tertiary reef complex, as predicted by Green et al. (1978), although the reef developed in waters too cold for growth of reef corals. The sediments at Site 433 were divided into six lithologic units, in order of increasing age: (1) foraminiferal nannofossil ooze; (2) diatom-nannofossil ooze; (3) calcareous ooze; (4) tuffaceous sandy mud; (5) reef carbonate sand and mud; and (6) reef carbonate sand rich in volcanic material. Unit 6 occurs between the upper two basalt flows, indicating contemporaneous volcanic and reef activity. The reef detritus of Unit 5 grades from sand to a calcarenite at the base, which is in erosional contact with the basalt. A volcanic layer, Unit 4, separates the sediments laid down in warm shallow water from the overlying pelagic sediments, Units 1 through 3. The abrupt change from shallow- to deep-water sedimentation marked the end of reef growth and the progressive subsidence of the seamount.

During deposition of lithologic Units 1 through 3 (upper part), representing Pleistocene through late Miocene time, Suiko seems to have remained in approximately the same environment. The lower part of Unit 3 contains lower Miocene pelagic fossils; this finding suggests a sedimentological hiatus or period of erosion that encompassed at least the entire middle Miocene. Upper Miocene submarine deposits are diatomaceous ooze and contain more siliceous fossils than the lower Miocene. Subsidence was not significant in terms of the CCD (carbonate compensation depth), however, so that planktonic foraminifers were preserved in the sediments. Lower Miocene microfossils of pelagic origin occur at the base of sedimentological Unit 3 and in the upper part of Unit 4. The lower part of Unit 4 and the upper part of Unit 5, however, contain Paleocene fossils.

Within the middle part of Unit 4, a major sedimentological hiatus occurs, indicating erosion through a major part of the Oligocene and the Eocene. During Paleocene time, the seamount remained at about the same level beneath the sea; subsidence, if any, was minimal. Calcarenite and reef sands of the lower part of Unit 5 were continuously deposited in a depression on the flat top of the seamount during this time. The occurrence of well-sorted sands and overlying poorly sorted sands, however, indicates that minor vertical fluctuations may have taken place (in the area) during this period. The end of the main shield-building stage of Suiko Seamount occurred in middle Paleocene time; the top of the seamount submerged to a shallow water depth, allowing well-sorted coarse-grained sands at the base of lithologic Unit 5 to accumulate. These sands contain biota of warm- and shallow-water habitat, such as benthic foraminifers, coralline algae, bryozoans, and ostracodes which also occur in Unit 6, interlayered between basalt Flow Units 1 and 2. The oldest sediments above basalt contain nannofossils and foraminifers that suggest cessation of volcanism and submergence of the volcano by the middle Paleocene.

Hole 433C penetrated a total of 67 positively identified (numbered) lava flows between 165.5 and 550.5 meters sub-bottom. Of these, 21 contain one or more sub-units which may be either separate lava flows or flow lobes of single lava flows. This gives a total of at least 113 possible lava flows. In addition, there is apparently well-sorted carbonate and basalt beach sand below Flow Unit 1 in Core 433C-3, and a pumice lapilli tuff interval in Core 433C-21. The basalts were subdivided into an alkalic group (Flow Units 1 through 3) and a tholeiitic group (Flow Units 4 through 67). Shipboard XRF analyses were performed on 62 basalt samples. Flow Unit 1 is chemically a typical Hawaiian alkalic basalt. Its major-element contents are very close to those of average Hawaiian alkalic basalt (Macdonald and Katsura, 1964; Macdonald, 1968), and it is chemically distinct only in its low contents of Ba and Sr and high contents of P and Zr (Jackson et al., 1976). Flow Unit 2 is also a typical alkalic basalt, except, again, for its very low Ba and Sr contents. Flow Unit 3 was not sampled for analysis on shipboard, but it has a trachytic texture, and subsequent analyses show that it is alkalic as well. Flow Units 4 through 67 are all tholeiitic basalts. Flow Units/Sub-units 4a through 4h, 19a to 19d, 24, 28, and 29 are chemically and petrographically tholeiitic picrites (oceanites). The tholeiitic flows recovered from Suiko appear to represent the upper part of the tholeiitic, shield-building suite such as form the underpinnings of all subareally exposed volcanoes in the Hawaiian chain. The tholeiites at Suiko, like those of all southeastern Hawaiian volcanoes (Macdonald and Katsura, 1964, table 9), have their own chemical peculiarities, apparently including slightly lower than average TiO_2, P_2O_5, and Sr values, but all fall within the range reported for Hawaiian tholeiitic basalts.

More than 300 samples of basalt from Site 433 were studied for paleomagnetism on board ship. Most have very stable remanences, and their directions do represent the ambient magnetic field when these basalts erupted and cooled. The basalts are characterized by high median demagnetizing field, and moderate to high Q_n ratio. Examination under the reflection microscope shows that the ferromagnetic minerals in these rocks are fresh titanomagnetites with sharp crystal boundaries and with little trace of secondary alteration. Most titanomagnetite grains range from homogeneous and unoxidized to moderately oxidized (containing exsolution lamellae of ilmenite), but some show higher stages of oxidation (containing pseudobrookite and hematite) (Wilson and Haggarty, 1966). These results suggest that the basalts are similar in magnetic properties to those found on oceanic islands, and not similar to mid-oceanic ridge basalts.

With more than 60 successive lava flows, we have an adequate set of samples representing the geomagnetic field about 65 m.y. ago. In some sections, inclinations are almost identical among successive flows (e.g., Flow Units 4 to 7); at other places, inclination data define a smooth change with depth (e.g., Flow Units/Sub-units 51b to 63), or show jumps of 20° or more. They can be interpreted as representing secular variation of the geomagnetic field in which characteristic duration time varied from less than 100 years to 10^4 years or more. On the other hand, all the flows recovered are reversely magnetized. Magnetic data therefore suggest that these flows erupted in a period longer than 10^4 years but less than about 10^6 years, which is an ideal period for averaging out secular variation. We conclude that the inclination fluctuated about a mean of 42°, with a standard deviation of 14°, about 65 m.y. ago. The mean value is accurate to within $\pm 4°$ at the 95 per cent confidence level. Assuming this mean inclination to represent the axial dipole field of the earth, the estimated paleolatitude of Suiko Seamount is about 25°.

If the paleolatitude of formation of Suiko Seamount is taken as 25° $\pm 4°$ at the 95 per cent confidence level, then the melting anomaly that formed the volcano in earliest Paleocene time lay 2° to 10° north of the present latitude of the present melting anomaly at Kilauea (19°N). Other investigators (Molnar and Atwater, 1973) have, on other grounds, suggested small excursions of the hot spot in time. Still, when combined with data from Midway (Gromme and Vine, 1972), the Suiko data indicate that the Hawaiian-Emperor hot spot has remained fixed within five or ten degrees, and that reconstructions of the developmental history of the Pacific must take this into account.

REFERENCES

Benson, M. H., 1976. Petrology, mineralogy, and geochemistry of the East Molokai volcanic series, Hawaii, *Geol. Survey Prof. Paper 961*: Washington (U. S. Government Printing Office), p. 53.

Blatt, H., Middleton, G., and Murray, R., 1972. *Origin of Sedimentary Rocks*: New Jersey (Prentice-Hall, Inc.).

Buddington, A. F. and Lindsley, D. H., 1964. Iron-titanium oxides and synthetic equivalent, *J. Petrol.*, v. 5, p. 310-357.

Creager, J. S., Scholl, D. W., et al., 1973. *Initial Reports of the Deep Sea Drilling Project*, v. 19: Washington (U.S. Government Printing Office).

Dalrymple, G. B. and Clague, D. A., 1976. Age of the Hawaiian-Emperor bend, *Earth Planet. Sci. Lett.*, v. 31, p. 313-329.

Ginsburg, R. N., Murszalek, D. S., and Schneidermann, N., 1971. Ultra structure of carbonate cements in a Holocene algal reef of Bermuda, *J. Sediment. Petrol.*, v. 41, p. 472-482.

Greene, H. G., Dalrymple, G. B., and Clague, D. A., 1978. Evidence for the northward movement of the Emperor Seamounts chain, *Geology*, v. 6, p. 70-74.

Gromme, S. and Vine, F. J., 1972. Paleomagnetism of Midway Atoll lavas and northward movement of the Pacific plate, *Earth Planet. Sci. Lett.*, v. 17, p. 159-168.

Heirtzler, J. R., Dickson, G. O., Herron, E. J., Pitman, W. C., III, and Le Pichon, X., 1968. Marine magnetic anomalies, geomagnetic field reversals and motions of the ocean floor and continents, *J. Geophys. Res.*, v. 73, p. 2119-2136.

Hubbard, N. J., 1967. Some trace elements in Hawaiian lavas, Unpublished Ph.D. thesis, University of Hawaii.

Jackson, E. D., Bargar, K. E., Fabbi, B. P., and Heropoulous, C., 1976. Petrology of the basaltic rocks drilled on Leg 33 of the Deep Sea Drilling Project. *In* Schlanger, S. O., Jackson, E. D., et al., *Initial Reports of the Deep Sea Drilling Project*, v. 33: Washington (U.S. Government Printing Office), p. 571-630.

Johnson, H. P. and Atwater, T., 1977. Magnetic study of basalts from the Mid-Atlantic Ridge, lat. 37N, *Geol. Soc. Am. Bull.*, v. 88, p. 637-647.

Land, L. S. and Goreau, T. G., 1970. Submarine lithification of Jamaican reefs, *J. Sediment. Petrol.*, v. 40, p. 457-462.

Larson, R. L., Moberly, R., et al., 1975. *Initial Reports of the Deep Sea Drilling Project*, v. 32: Washington (U.S. Government Printing Office).

Macdonald, G. A., 1968. Composition and origin of Hawaiian lavas. *In* Coats, R. R., Hay, L., and Anderson, C. A. (Eds.), *Studies in Volcanology: Geol. Soc. Am. Mem. 116*, p. 477-522.

Macdonald, G. A. and Katsura, T., 1964. Chemical composition of Hawaiian lavas, *J. Petrol.*, v. 5, p. 82-133.

Molnar, P., and Atwater, T., 1973. Relative motion of hotspots in the mantle, *Nature*, v. 246, p. 288.

Ozima, M. and Larson, E. E., 1970. Low and high temperature oxidation of titanomagnetite in relation to irreversible changes in the magnetic properties of submarine basalts, *J. Geophy. Res.*, v. 75, p. 1003-1017.

Readman, P. W. and O'Reilley, W. O., 1972. Magnetic properties of oxidized (cation-deficient) titanomagnetite (Fe, Ti, $)_3O_4$, *J. Geomag. Geoelectr.*, v. 24, p. 69-90.

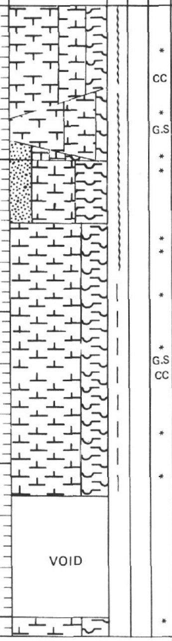
Schilling, J. G., 1966. Rare earth fractionation in Hawaiian volcanic rocks, Unpublished Ph.D. thesis, Massachusetts Institute of Technology.

Wilson, R. L. and Haggarty, S. E., 1966. Reversals of the earth's magnetic field, *Endeavour*, v. 25, p. 104-109.

SITE 433 HOLE CORE 1 CORED INTERVAL: 0.0-5.0 m

TIME-ROCK UNIT	BIOSTRAT ZONE	FORAMS	NANNOS	RADS	SILICOS	DIATOMS	SECTION	METERS
UPPER PLIOCENE	NN16-NN18	AG	AG	CG	CG		1	0.5
								1.0
							2	
							3	
							4	
							CC	

GRAPHIC LITHOLOGY / DRILLING DISTURBANCE / SEDIMENTARY STRUCTURES / LITHOLOGIC SAMPLE



LITHOLOGIC DESCRIPTION

0.0-1.30 m: SILTY FORAMINIFERAL-NANNOFOSSIL OOZE
0.0-1.10 m: olive (5Y 5/4)
1.10-1.35 m: gray (10YR 6/1)

S.S. (at 0.50 m):
25% foraminifera
25% calcareous nannofossils
25% carbonate unspecified
10% diatoms
5% fish remains
5% sponge spicules
5% quartz
TR feldspars and micronodules

S.S. (at 1.10 m):
30% foraminifera
30% calcareous nannofossils
25% carbonate unspecified
10% diatoms
5% quartz

1.30-2.15 m: SANDY DIATOM-NANNOFOSSIL OOZE
1.30-2.15 m: grayish brown (10YR 5/2) and olive gray (5Y 5/2)

S.S. (at 1.40 m):
20% foraminifera
20% carbonate unspecified
20% calcareous nannofossils
10% diatoms
10% quartz
5% sponge spicules
5% feldspar
10% clay

S.S. (at 1.60 m):
20% calcareous nannofossils
20% carbonate unspecified
30% diatoms
5% silicoflagellates
10% quartz
5% feldspar
10% clay
TR heavy minerals

2.15 - 4.85 m: DIATOM-NANNOFOSSIL OOZE
2.15-2.35 m: white (2.5Y 8/2)
2.35-2.60 m: light brownish gray (2.5Y 6/2)
2.60-4.85 m: white (2.5Y 8/2)

S.S. (at 2.25 m):
70% calcareous nannofossils
30% diatoms

S.S. (at 2.45, 2.85, 3.50, 4.25, 4.65 m and CC):
65% calcareous nannofossils
5% carbonate unspecified
25% diatoms (20% diatoms + 5% quartz at 2.45 m)
5% sponge spicules

CORE CATCHER: DIATOM-NANNOFOSSIL OOZE
White (2.5Y 8/2

$CaCO_3$ % at 1.01 m = 28% and at 3.91 m = 13%

SITE 433 HOLE A CORE 1 CORED INTERVAL: 0.0-5.0 m

TIME-ROCK UNIT: PLEISTOCENE; UPPER PLIOCENE NN16-NN18

BIOSTRAT ZONE: NN19; NP9

FOSSIL CHARACTER (FORAMS, NANNOS, RADS, SILICOS, DIATOMS): AB AG AG AG; AG AG AG AG

SECTION: 1, 2, CC — METERS: 0.5, 1.0 — GRAPHIC LITHOLOGY: VOID

LITHOLOGIC DESCRIPTION

0.0-0.45 m: SILTY FORAMINIFERAL–NANNOFOSSIL OOZE
Light brownish gray (2.5Y 6/2)

S.S. (at 0.10 m):
40% calcareous nannofossils
20% carbonate unspecified
10% foraminifera
10% diatoms
5% sponge spicules
10% quartz
5% feldspar

0.45-1.50 m: DIATOM–NANNOFOSSIL OOZE
Light gray (2.5Y 7/2)

S.S. (at 1.00 m):
65% calcareous nannofossils
5% carbonate unspecified
25% diatoms
5% sponge spicules

CORE CATCHER: DIATOM–NANNOFOSSIL OOZE
Light gray (2.5Y 7/2)

S.S. at Core Catcher:
Same as at 1.00 m

SITE 433 HOLE A CORE 2 CORED INTERVAL: 5.0-14.5 m

TIME-ROCK UNIT: UPPER PLIOCENE

FOSSIL CHARACTER (FORAMS, NANNOS, RADS, SILICOS, DIATOMS): AG AG CG CG

SECTION: 1, 2, CC — METERS: 0.5, 1.0 — GRAPHIC LITHOLOGY: VOID — LITHOLOGIC SAMPLE: G.S, CC

LITHOLOGIC DESCRIPTION

0.0-1.15 m: SANDY FORAMINIFERAL–NANNOFOSSIL OOZE
Olive (5Y 4/3)

S.S. (at 0.50 m):
50% calcareous nannofossils
25% foraminifera
10% carbonate unspecified
10% diatoms
5% sponge spicules
5% quartz

1.15-2.20 m: DIATOM–NANNOFOSSIL OOZE
White (2.5Y 8/2)

S.S. (at 1.30 m):
65% calcareous nannofossils
5% carbonate unspecified
25% diatoms
5% sponge spicules

$CaCO_3$ % at 0.56 m = 26% and at 1.36 m = 60%

SITE 433 HOLE A CORE 3 CORED INTERVAL: 14.5-24.0 m

TIME-ROCK UNIT: UPPER PLIOCENE

BIOSTRAT ZONE: NP9

FOSSIL CHARACTER (FORAMS, NANNOS, RADS, SILICOS, DIATOMS): AG AG AG AG

SECTION: 1, 2, 3, 4, 5, 6, 7, CC — METERS: 0.5, 1.0 — GRAPHIC LITHOLOGY: VOID — LITHOLOGIC SAMPLE: CC, G.S, CC, G.S, CC

LITHOLOGIC DESCRIPTION

0.0-7.85 m: DIATOM–NANNOFOSSIL OOZE
White (5Y 8/1)

S.S. (at 0.75 m):
75% calcareous nannofossils
5% carbonate unspecified
10% diatoms
5% sponge spicules
5% silicoflagellates

S.S. (at 2.25 m):
75% calcareous nannofossils
5% carbonate unspecified
15% diatoms
5% sponge spicules

S.S. (at 3.70 m):
70% calcareous nannofossils
5% carbonate unspecified
15% diatoms
10% sponge spicules
TR silicoflagellates

S.S. (at 5.25 m):
65% calcareous nannofossils
5% carbonate unspecified
20% diatoms
10% sponge spicules
Occurrence of forams and radiolarians

S.S. (at 7.10 m):
70% calcareous nannofossils
5% carbonate unspecified
15% diatoms
5% sponge spicules
TR silicoflagellates and radiolarians
<5% clay in foraminifera

CORE CATCHER: DIATOM–NANNOFOSSIL OOZE
White (5Y 8/1) to light gray (5Y 7/1)

S.S. (Core Catcher):
60% calcareous nannofossils
5% carbonate unspecified
15% diatoms
10% sponge spicules
5% silicoflagellates
TR radiolarians
<5% clay (foraminifera with clay: TR)

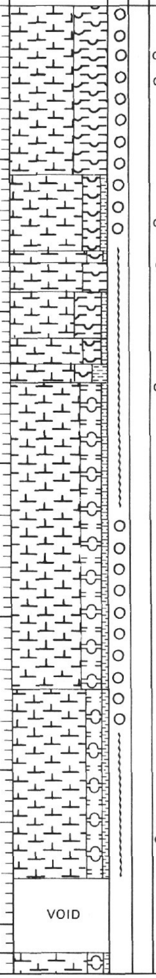
$CaCO_3$ % at 2.80 m = 82% and 4.93 m = 87%

SITE 433 HOLE A CORE 4 CORED INTERVAL: 24.0-33.5 m

TIME-ROCK UNIT: UPPER MIOCENE–LOWER PLIOCENE

FOSSIL CHARACTER: FORAMS CG; NANNOS AM; RADS AG; SILICOS CG

SECTIONS: 1, 2, 3, 4, 5, 6, 7, CC (METERS 0.5, 1.0)



LITHOLOGIC SAMPLE / COLOR: G.S, CC, 5Y 7/2, 5Y 7/1, 5Y 4/2, 5Y 6/2, G.S, 5Y 4/3, CC, 5Y 5/3-6/3, 5Y 4/3, 5Y 7/2, 5Y 7/1, 5Y 5/3-4/3, G.S, 5Y 7/2-6/2, 5Y 7/2, 5Y 5/2, 5Y 7/2, 5Y 6/2, CC, G.S, 5Y 7/1, 5Y 6/2

LITHOLOGIC DESCRIPTION

0.0-8.53 m: DIATOM–NANNOFOSSIL OOZE TO MARLY SILICEOUS–NANNOFOSSIL OOZE

0.0-1.65 m: DIATOM–NANNOFOSSIL OOZE, light gray green patches (glauconite) in silt fraction.

S.S. (at 0.65 m):
60% calcareous nannofossils; traces of foraminifera
25% diatoms
5% radiolarians, 5% sponge spicules
5% clays, traces of glauconite

1.65-2.50 m: MARLY DIATOM–NANNOFOSSIL OOZE olive gray and light olive gray glauconite

S.S. (at 1.72, 2.32, and 2.45 m):
50% calcareous nannofossils (↗70% at 2.45 m)
20% carbonate unspecified; traces of foraminifera
15% diatoms (↗20%)
5% radiolarians
TR sponge spicules and silicoflagellates
10% clays

2.50-2.80 m: DIATOM CALCAREOUS OOZE, pale olive-olive

S.S. (at 2.75 m):
50% carbonate unspecified
20% diatoms, 20% calcareous nannofossils
10% radiolarians
TR sponge spicules, clays and glauconite

2.80-3.70 m: MARLY DIATOM–NANNOFOSSIL OOZE, light gray-pale olive

S.S. (at 3.44 m):
60% calcareous nannofossils, traces of foraminifera
10% carbonate unspecified
25% diatoms, traces of radiolarians
5% sponge spicules
5% clays and glauconite

S.S. (at 3.60 m):
45% calcareous nannofossils, traces of foraminifera
15% carbonate unspecified
20% diatoms
10% radiolarians
TR sponge spicules and silicoflagellates
10% clays and glauconite

3.70-8.53 m: MARLY SILICEOUS–NANNOFOSSIL OOZE light gray, light olive gray, olive gray

S.S. (at 4.40 m):
60% calcareous nannofossils, traces of foraminifera
5% carbonate unspecified
20% diatoms
10% radiolarians
TR sponge spicules
5% clays

S.S. (at 6.75 m):
50% calcareous nannofossils
20% carbonate unspecified
15% diatoms
10% radiolarians
TR sponge spicules and silicoflagellates
5% clays

S.S. (at 8.50 m):
40% calcareous nannofossils
30% carbonate unspecified
20% diatoms
5% radiolarians
sponge spicules
5% clays

CORE CATCHER: MARLY SILICEOUS NANNO OOZE, light olive gray

$CaCO_3$ % at 2.10 m = 15% and at 3.62 m = 34%

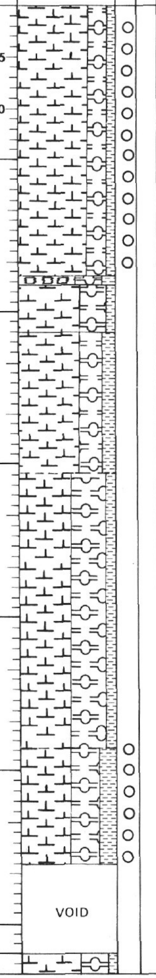
SITE 433 HOLE A CORE 5 CORED INTERVAL: 33.5-43.0 m

TIME-ROCK UNIT: UPPER MIOCENE

BIOSTRAT ZONE: NN11

FOSSIL CHARACTER: FORAMS RM; NANNOS AM; RADS AG; SILICOS CG

SECTIONS: 1, 2, 3, 4, 5, 6, 7, CC (METERS 0.5, 1.0)



LITHOLOGIC SAMPLE / COLOR: 5Y 7/1, 5Y 8/1, 5Y 7/1, G.S, 5Y 6/2, 5Y 8/1-7/1, 5Y 8/1-7/1, 5Y 8/1, G.S, 5Y 7/1, G.S, 5Y 8/1-7/1, 5Y 6/2, 5Y 7/1-7/2, 5Y 8/1

LITHOLOGIC DESCRIPTION

0.0-8.43 m: MARLY SILICEOUS–NANNOFOSSIL OOZE light gray, white

S.S. (at 0.70 m):
60% calcareous nannofossils
10% carbonate unspecified
15% diatoms
5% radiolarians
5% sponge spicules; traces of silicoflagellates
5% clays

S.S. (at 2.68 m):
35% carbonate unspecified
20% calcareous nannofossils
20% diatoms
10% radiolarians
5% sponge spicules; traces of silicoflagellates
10% clays

S.S. (at 2.85 m):
40% calcareous nannofossils; traces of foraminifera
20% carbonate unspecified
20% diatoms
10% radiolarians
5% sponge spicules; traces of silicoflagellates
5% clays

S.S. (at 3.20 m):
30% calcareous nannofossils; traces of foraminifera
30% carbonate unspecified
20% diatoms
10% radiolarians
sponge spicules and silicoflagellates
10% clays

S.S. (at 5.20 m):
35% calcareous nannofossils, traces of foraminifera
20% carbonate unspecified
20% diatoms
10% radiolarians
10% sponge spicules; traces of silicoflagellates
10% clays

S.S. (at 6.50 m):
35% calcareous nannofossils
20% carbonate unspecified
25% diatoms
10% radiolarians
TR sponge spicules and silicoflagellates
10% clays

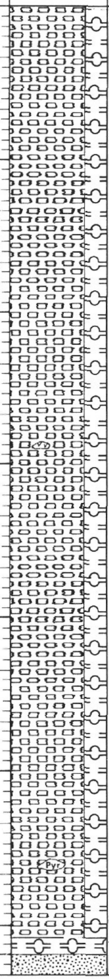
S.S. (at 8.40 m):
30% carbonate unspecified
25% calcareous nannofossils
20% diatoms
10% radiolarians
sponge spicules and silicoflagellates
15% clays

$CaCO_3$ % at 0.70 m = 59% and at 7.14 m = 60%

CORE CATCHER: MARLY SILICEOUS–NANNOFOSSIL OOZE, white

SITE 433 HOLE A CORE 6 CORED INTERVAL: 43.0-52.5 m

TIME-ROCK UNIT	BIOSTRAT ZONE	FORAMS	NANNOS	RADS	SILICOS	DIATOMS	SECTION	METERS	GRAPHIC LITHOLOGY	DRILLING DISTURBANCE	SEDIMENTARY STRUCTURES	LITHOLOGIC SAMPLE	LITHOLOGIC DESCRIPTION
UPPER MIOCENE							1	0.5, 1.0				G.S; 5Y 7/1	0.0-9.15 m: CALCAREOUS OOZE, light gray (5Y 7/1)
							2					*; G.S; 5Y 7/1	
							3					G.S	
							4					G.S *; 5Y 7/1	
							5					G.S; 5Y 7/1	
LOWER MIOCENE							6					G.S; *; G.S; 5Y 7/1; *; G.S; 7.5YR 8/1	
PALEOCENE		RM	CM	CM	RM		7			+20 cm		G.S; G.S; *; 5Y 5/1	
							CC						



0.0-9.15 m: CALCAREOUS OOZE, light gray (5Y 7/1)

S.S. (at 2.25 m):
50% carbonate unspecified
35% calcareous nannofossils
10% diatoms
5% silicoflagellates
TR radiolarians, clays

At 4.32-4.33 m: flat pebble of trachytic basalt (2.5 x 1.5 x 0.5 cm)

S.S. (at 5.25 m):
45% carbonate unspecified
30% calcareous nannofossils
10% diatoms
5% radiolarians, 5% sponge spicules
5% clays
TR silicoflagellates

S.S. (at 8.35 m):
50% carbonate unspecified
30% calcareous nannofossils
15% diatoms
5% sponge spicules, radiolarians, silicoflagellates
TR clays and volcanic glass

At 8.41-8.42 m: dense, well crystallized PYRITE concretion olive gray (5Y 4/2) – (3 x 4 x 1 cm)

8.43-9.00 m: CALCAREOUS CHALK white (7.5YR 8/1)

S.S. (at 8.85 m):
40% carbonate unspecified
45% calcareous nannofossils
10% diatoms, traces of sponge spicules
5% clays

SECTION 7 (9.00-9.50 m):
9.00-9.15 m: CALCAREOUS CHALK white (7.5YR 8/1)
9.15-9.50 m: MARLY SILICEOUS OOZE gray (5Y 5/1)

S.S. (at 9.25 m):
30% diatoms
30% radiolarians
15% sponge spicules
10% carbonate unspecified
10% volcanic glass
5% clays

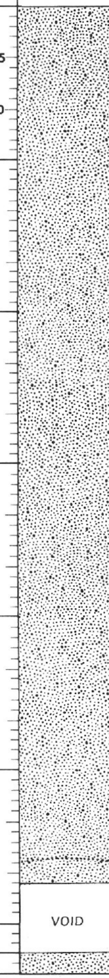
CORE CATCHER: SANDY VOLCANIC–CALCAREOUS MUD (Tuffaceous mud) dark gray (5Y 4/1), light gray (5Y 7/2) and white (2.5Y 8/1)

S.S. (white and light gray part):
65-60% calcareous nannofossils
10-15% carbonate unspecified + 5% foraminifera
10-15% diatoms + 5% radiolarians
sponge spicules and silicoflagellates, clay

S.S. (dark gray part):
20% calcareous nannofossils
10% discoasters
5% diatoms, 5% radiolarians, 5% sponge spicules
20% clays
10% volcanic glass, 10% quartz, 10% heavy minerals
5% feldspar

SITE 433 HOLE A CORE 7 CORED INTERVAL: 52.5-62.0 m

TIME-ROCK UNIT	BIOSTRAT ZONE	FORAMS	NANNOS	RADS	SILICOS	DIATOMS	SECTION	METERS	GRAPHIC LITHOLOGY	DRILLING DISTURBANCE	SEDIMENTARY STRUCTURES	LITHOLOGIC SAMPLE	LITHOLOGIC DESCRIPTION
PALEOCENE							1	0.5, 1.0		O		*; G.S	0.0-8.60 m: REEFAL CARBONATE SAND with CALCAREOUS ALGAL NODULES
							2			O			
							3			O			
							4			O			
							5			O		G.S	
							6			O		*; G.S	
							7		VOID				
		B	CM	CG	CG		CC						



0.0-8.60 m: REEFAL CARBONATE SAND with CALCAREOUS ALGAL NODULES
pale yellow (5Y 8/3) and white (5Y 8/2) reefal fragments, bryozoan, fish teeth, muddy concretions (olive gray 5Y 5/2), algal concretions. Compaction increases at the bottom of Core 6.

S.S. (at 0.50 m):
white fraction:
90% carbonate unspecified
10% calcareous nannofossils
TR heavy minerals
TR sponge spicules

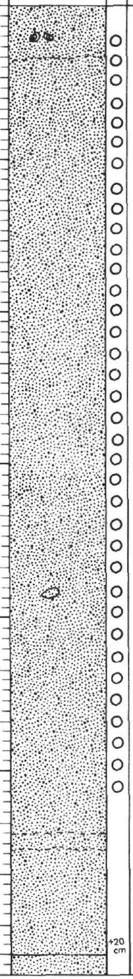
gray mud:
75% carbonate unspecified
10% calcareous nannofossils
5% glauconite, clays
5% quartz
5% feldspar and heavy minerals

S.S. (at 8.30 m):
100% carbonate clast

CORE CATCHER: REEFAL MUDDY SAND pale yellow (5Y 8/3)
in sandy fraction: angular carbonate clasts, bryozoan, fish teeth
coralline algal nodule (3 cm)
volcanic clasts

SITE 433 HOLE A CORE 8 CORED INTERVAL: 62.0-71.5 m

TIME-ROCK UNIT	BIOSTRAT ZONE	FORAMS	NANNOS	RADS	SILICOS	DIATOMS	SECTION	METERS	GRAPHIC LITHOLOGY	DRILLING DISTURBANCE	SEDIMENTARY STRUCTURES	LITHOLOGIC SAMPLE	LITHOLOGIC DESCRIPTION
?		B	B	B	B		1–7, CC	0.5, 1.0				G.S, •, G.S, •, G.S, •, G.S	



0.0-9.50 m: REEFAL CARBONATE SAND
"coralline-algal" sandy breccia, white (2.5Y 8/2), compaction increases at 8.10 m to 8.25 m, at 0.30 m concretion of coralline algal material

sandy fraction:
>177 μm coralline algal clasts, carbonate clasts, bryozoan; up to ϕ 5 cm
177-63 μm carbonate clasts

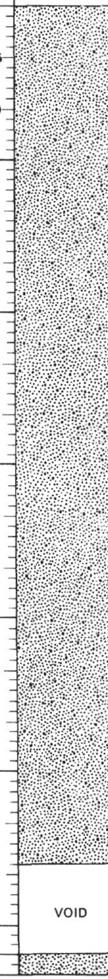
S.S. (at 1.44, 7.45, and 9.20 m):
100% carbonate unspecified; clasts
TR clays

CORE CATCHER: REEFAL CARBONATE SAND
white to yellow (2.5Y 8/6)

$CaCO_3$ % at 52-53 cm = 100%

SITE 433 HOLE A CORE 9 CORED INTERVAL: 71.5-75.5 m

TIME-ROCK UNIT	BIOSTRAT ZONE	FORAMS	NANNOS	RADS	SILICOS	DIATOMS	SECTION	METERS	GRAPHIC LITHOLOGY	DRILLING DISTURBANCE	SEDIMENTARY STRUCTURES	LITHOLOGIC SAMPLE	LITHOLOGIC DESCRIPTION
PALEOCENE		RM	CM	RM	B		1–7, CC	0.5, 1.0				•, G.S, •, G.S	



0.0-8.45 m: REEFAL CARBONATE SAND
white (2.5Y 8/2), with 2% volcanic clasts at the top, to 5% at ≃3 m and increases to 7-10% at the bottom. Mixed at the top with DIATOM–NANNOFOSSIL OOZE of Core 6.

S.S. (at 0.33) finest fraction:
45% calcareous nannofossils
30% carbonate unspecified, traces of foraminifera
20% diatoms
5% radiolarians, silicoflagellates
TR clays

S.S. (at 7.66 m):
100% carbonate unspecified: clasts
TR clays

SITE 433 HOLE A CORE 10 CORED INTERVAL: 75.5-81.0 m

TIME-ROCK UNIT	BIOSTRAT ZONE	FORAMS	NANNOS	RADS	SILICOS	DIATOMS	SECTION	METERS	GRAPHIC LITHOLOGY	DRILLING DISTURBANCE	SEDIMENTARY STRUCTURES	LITHOLOGIC SAMPLE	LITHOLOGIC DESCRIPTION
?		RM	FM	RM	B		1, 2, 3, 4, 5, 6, 7, CC	0.5, 1.0	+15 cm			•, CC, •, G.S, •	5Y 8/3; 5Y 8/3

0.00-9.40 m: REEFAL CARBONATE SAND and SANDY MUD, CALCAREOUS ALGAL CONCRETIONS AND MUDDY SAND LAYERS, pale yellow

0.0-1.05 m: Muddy calcareous reefal clastic sand compact, with patches of yellow (2.5Y 7/8) with coral-algal concretions
1.05-2.17 m: Calcareous sandy mud with sporadic inclusions of algal concretions
2.17-2.22 m: Layer of coralline algal concretions with carbonate clastic sand
2.22-2.46 m: Calcareous sandy mud
2.46-2.71 m: Layer of coralline algal concretions
2.71-3.87 m: Calcareous sandy mud
3.87-3.96 m: Muddy carbonate clastic sand with coralline concretions
3.96-4.30 m: Calcareous sandy mud
4.30-4.65 m: Muddy calcareous sand with coralline algal fragments and concretions
4.65-6.30 m: Calcareous sandy mud; at 5.48-5.56 m large algal concretion
6.30-6.50 m: Muddy calcareous sand with coralline algal fragments poorly sorted
6.50-7.15 m: Calcareous sandy mud; at 7.10 m, large algal concretion
7.15-7.50 m: *Muddy carbonate clastic sand*
7.50-8.10 m: Calcareous sandy mud
8.10-8.50 m: Muddy carbonate clastic sand with algal nodules, poorly sorted
8.50-8.84 m: Same as 7.50-8.10 m
8.84-9.00 m: Same as 8.10-8.50 m
9.00-9.13 m: Calcareous sandy mud
9.13-9.45 m: Muddy calcareous reefal clastic sand with algal concretions, bryozoan

CORE CATCHER: CALCAREOUS REEFAL SAND, pale yellow

S.S. (1.30, 5.20, and 9.05 m):
100% carbonate unspecified (clast) with clays

$CaCO_3$ % at 8.30 m = 92%

SITE 433 HOLE A CORE 11 CORED INTERVAL: 81.0-90.5 m

TIME-ROCK UNIT	BIOSTRAT ZONE	FORAMS	NANNOS	RADS	SILICOS	DIATOMS	SECTION	METERS	GRAPHIC LITHOLOGY	DRILLING DISTURBANCE	SEDIMENTARY STRUCTURES	LITHOLOGIC SAMPLE	LITHOLOGIC DESCRIPTION
UPPER PALEOCENE–LOWER EOCENE		B	FP	RP	B		CC						

CORE CATCHER ONLY:
REEFAL CARBONATE SAND
white (2.5Y 8/2)
poorly sorted calcareous reefal sand with 2-3 cm ø algal concretions

SITE 433 HOLE A CORE 12 CORED INTERVAL: 90.5-100.0 m

TIME-ROCK UNIT	BIOSTRAT ZONE	FORAMS	NANNOS	RADS	SILICOS	DIATOMS	SECTION	METERS	GRAPHIC LITHOLOGY	DRILLING DISTURBANCE	SEDIMENTARY STRUCTURES	LITHOLOGIC SAMPLE	LITHOLOGIC DESCRIPTION
UPPER PALEOCENE– LOWER EOCENE		B	RP	RP	B		1, 2, 3, CC	0.5, 1.0	VOID			CC G.S, TS, •	5Y 8/1; 7.5YR 7/1

0.00-3.45 m: REEFAL CARBONATE SAND, white (5Y 8/1)
well sorted calcareous reefal sand with:
≃5% volcanic clast and quartz
15% medium gray calcareous reefal detritus
80% white, yellow calcareous reefal detritus

3.00-3.05 m: algal concretion ø 5 cm
wavy laminae, cellular layers, white and gray calcareous layers

3.20-3.25 m: fine-grain muddy calcareous sand ; light gray

CORE CATCHER: well sorted CALCAREOUS SAND with algal concretions, and at bottom light gray calcareous muddy sand.

S.S. (at 3.23 m):
100% carbonate unspecified (clasts)

SITE 433 HOLE A CORE 13 CORED INTERVAL: 100.00-109.5 m

TIME-ROCK UNIT	BIOSTRAT ZONE	FORAMS	NANNOS	RADS	SILICOS	DIATOMS	SECTION	METERS	GRAPHIC LITHOLOGY	DRILLING DISTURBANCE	SEDIMENTARY STRUCTURES	LITHOLOGIC SAMPLE	LITHOLOGIC DESCRIPTION
UPPER PALEOCENE– LOWER EOCENE		RP	RP	B	B		1, CC	0.5, 1.0	VOID				

0.00-0.40 m: REEFAL CARBONATE SAND
light gray (2.5Y 7/1), poorly sorted, gradded bedding is a drilling artifact

CORE CATCHER: NODULES AND CONCRETIONS OF
gray (5Y 6/1) calcareous mud
white calcareous algal concretions
light gray (2.5Y 7/1) lithified calcareous sandy mud

S.S. IN CORE CATCHER finest part:
100% carbonate clast

SITE 433 HOLE A CORE 14 CORED INTERVAL: 109.5-119.0 m

TIME-ROCK UNIT	BIOSTRAT ZONE	FORAMS	NANNOS	RADS	SILICOS	DIATOMS	SECTION	METERS	GRAPHIC LITHOLOGY	DRILLING DISTURBANCE	SEDIMENTARY STRUCTURES	LITHOLOGIC SAMPLE	LITHOLOGIC DESCRIPTION
							1	0.5 1.0	VOID VOID			G.S CC	0.40-0.80 m: REEFAL CARBONATE SAND light gray (2.5Y N7/1) moderately, well sorted calcareous reefal sand composed of white and gray clast, plus algal concretions CORE CATCHER: CALCAREOUS ALGAL CONCRETION growth center, light gray interior, laminae layered around centers; while exterior highly recrystallized
		B		B	B		CC						

SITE 433 HOLE A CORE 15 CORED INTERVAL: 119.0-128.5 m

TIME-ROCK UNIT	BIOSTRAT ZONE	FORAMS	NANNOS	RADS	SILICOS	DIATOMS	SECTION	METERS	GRAPHIC LITHOLOGY	DRILLING DISTURBANCE	SEDIMENTARY STRUCTURES	LITHOLOGIC SAMPLE	LITHOLOGIC DESCRIPTION
		B					CC						CORE CATCHER ONLY: CALCAREOUS ALGAL CONCRETIONS, small nodules and fragments of algal concretions. Same as Core Catcher of Core 14

SITE 433 HOLE A CORE 16 CORED INTERVAL: 128.5-138.0 m

TIME-ROCK UNIT	BIOSTRAT ZONE	FORAMS	NANNOS	RADS	SILICOS	DIATOMS	SECTION	METERS	GRAPHIC LITHOLOGY	DRILLING DISTURBANCE	SEDIMENTARY STRUCTURES	LITHOLOGIC SAMPLE	LITHOLOGIC DESCRIPTION
UPPER PALEOCENE							1	0.5 1.0	VOID VOID			* G.S CC	0.20-0.85 m: REEFAL CARBONATE SAND gray (2.5Y N6/1) moderately sorted calcareous reefal sand composed of white and gray reefal detrital clasts, bryozoan , fine-grained up to 4 mm clasts CORE CATCHER: REEFAL CARBONATE SAND mix of white and light gray reefal detritus **S.S. (at 0.20 m) in finest fraction of sand:** 100% carbonate unspecified
		RP	RP	B	B		CC						

SITE 433 HOLE A CORE 17 CORED INTERVAL: 138.0-147.5 m

TIME-ROCK UNIT	BIOSTRAT ZONE	FORAMS	NANNOS	RADS	SILICOS	DIATOMS	SECTION	METERS	GRAPHIC LITHOLOGY	DRILLING DISTURBANCE	SEDIMENTARY STRUCTURES	LITHOLOGIC SAMPLE	LITHOLOGIC DESCRIPTION
UPPER PALEOCENE		B	RP	B	B		CC						CORE CATCHER ONLY: ALGAL CONCRETIONS 4 algal nodules (same as Core 14 Core Catcher). 1 bryozoan fragment recovered with recrystallized calcite

SITE 433 HOLE A CORE 18 CORED INTERVAL: 147.5-157.0 m

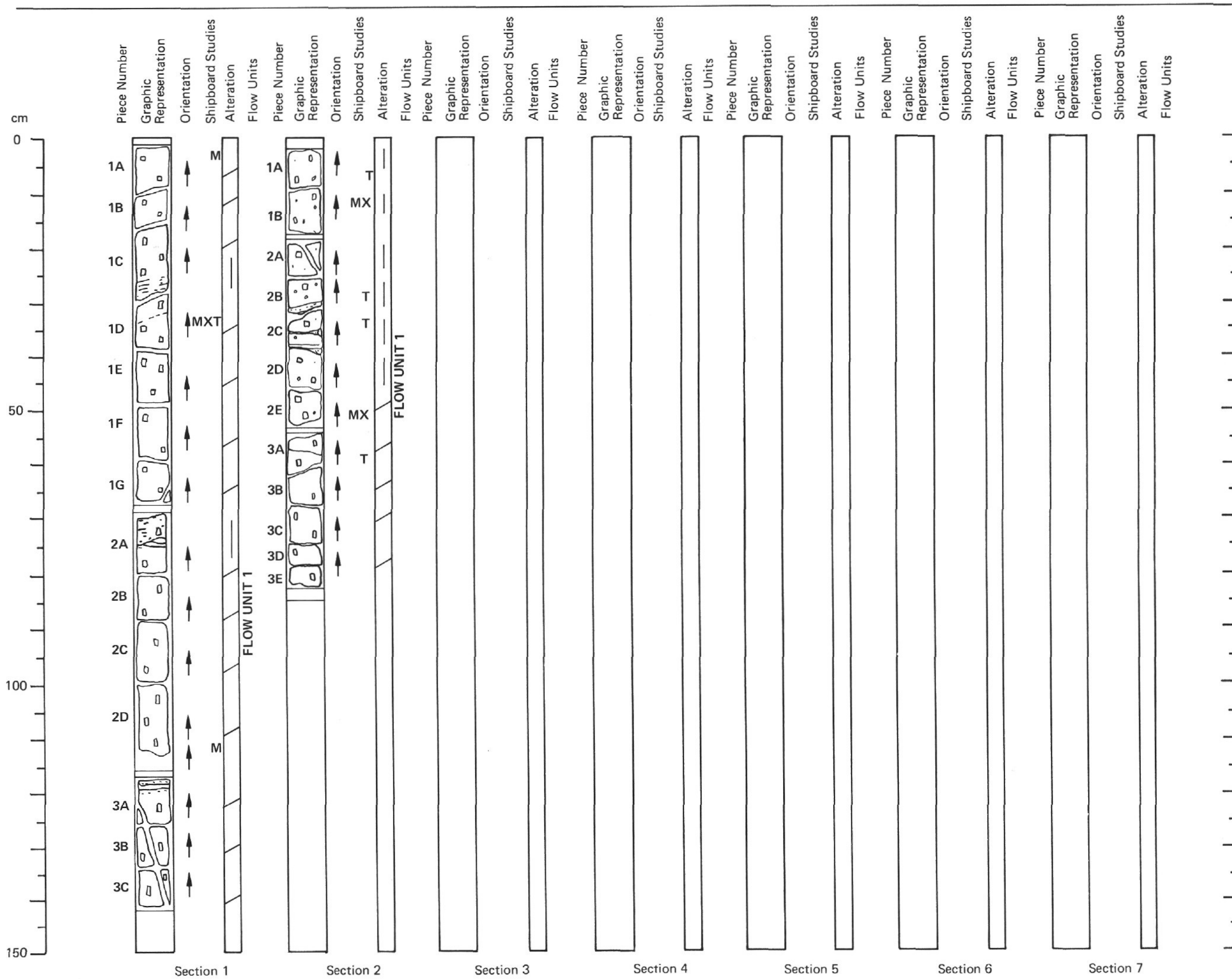
TIME-ROCK UNIT	BIOSTRAT ZONE	FORAMS	NANNOS	RADS	SILICOS	DIATOMS	SECTION	METERS	GRAPHIC LITHOLOGY	DRILLING DISTURBANCE	SEDIMENTARY STRUCTURES	LITHOLOGIC SAMPLE	LITHOLOGIC DESCRIPTION
UPPER PALEOCENE		B	RP	B	B		CC						CORE CATCHER ONLY: CALCARENITE (2.5Y N6/1) moderately lithified and cemented gray calcarenite, composed of gray and white reefal detritus, small white algal concretions (≃3.5 cm ø)

SITE 433 HOLE A CORE 19 CORED INTERVAL: 157.0-163.5 m

TIME-ROCK UNIT	BIOSTRAT ZONE	FORAMS	NANNOS	RADS	SILICOS	DIATOMS	SECTION	METERS	GRAPHIC LITHOLOGY	DRILLING DISTURBANCE	SEDIMENTARY STRUCTURES	LITHOLOGIC SAMPLE	LITHOLOGIC DESCRIPTION
UPPER PALEOCENE							1	0.5 1.0	VOID			G.S and CC	0.00-0.45 cm: REEFAL CARBONATE SAND well sorted calcareous reefal sand with gray and white fragments, reef detritus, bryozoans, 1-2% volcanics size 0.5 to 3 mm. CORE CATCHER: REEFAL CARBONATE SAND (same as above) AND LIMESTONE CALCARENITE composed of cemented algal nodules (2-3 mm ø) and reefal detritus, calcite cement (pebble ø: 6.5 x 5.5 x 4 cm)
		B	B	RP	B		CC					TS	

VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG 55 SITE 433 HOLE A CORE 20 DEPTH 163.5-166.5 m



FLOW UNIT NO. 1:

POSITION: Top - Core 20, Sect. 1, 0 cm; Bottom - Core 21, Sect. 5, 47 cm Also appears in Holes 433B and 433C.

CHEMISTRY: Alkalic basalt, 6 analyses in Table 1.

VISUAL DESCRIPTION

Mineralogy: Phenocrysts - ol., 3-5%, 0.5-3 mm, fresh in Core 21, Section 1; plag. 10-12%, up to 7 mm, px., 1-2 mm (Core 21, Section 3).

Groundmass: plag., ol., px., glass, op. - ol. fresh in many pieces

Lithology: Massive throughout, with only a few, scattered vesicles - flow top apparently eroded away; flow bottom not drilled

Alteration: Moderately altered throughout, some olivine still fresh

THIN SECTION DESCRIPTION

Phenocrysts: Ol. 1-10%, phenocrysts and microphenocrysts to 5 mm, euhedral to subhedral, mostly iddingsitized, some fresh (Core 21, Section 2 to Core 21, Section 4); plag. 2-10%, tabular to anhedral, to 7 mm; cpx. 0-10%, to 1.5 mm, anhedral to euhedral, fresh.

Groundmass: Ol. 1-10%, subhedral to anhedral 0.01-0.5 mm; plag. 40-50% to 1 mm, laths; cpx. 10-20%, to 0.2 mm; opaque 5-18%, anhedral, to 0.2 mm; glass, 0-7%, intersertial; apatite, <1% needles

Texture: Sub-trachytic, interstital to diabasic

Vesicles: 0-10% (mostly fine), up to 3 mm, clay filled and lined

Alteration: 3-25% clay after glass, ol., and plag.; Core 21, Section 2 to Core 21, Section 4 freshest

MAGNETIC DATA

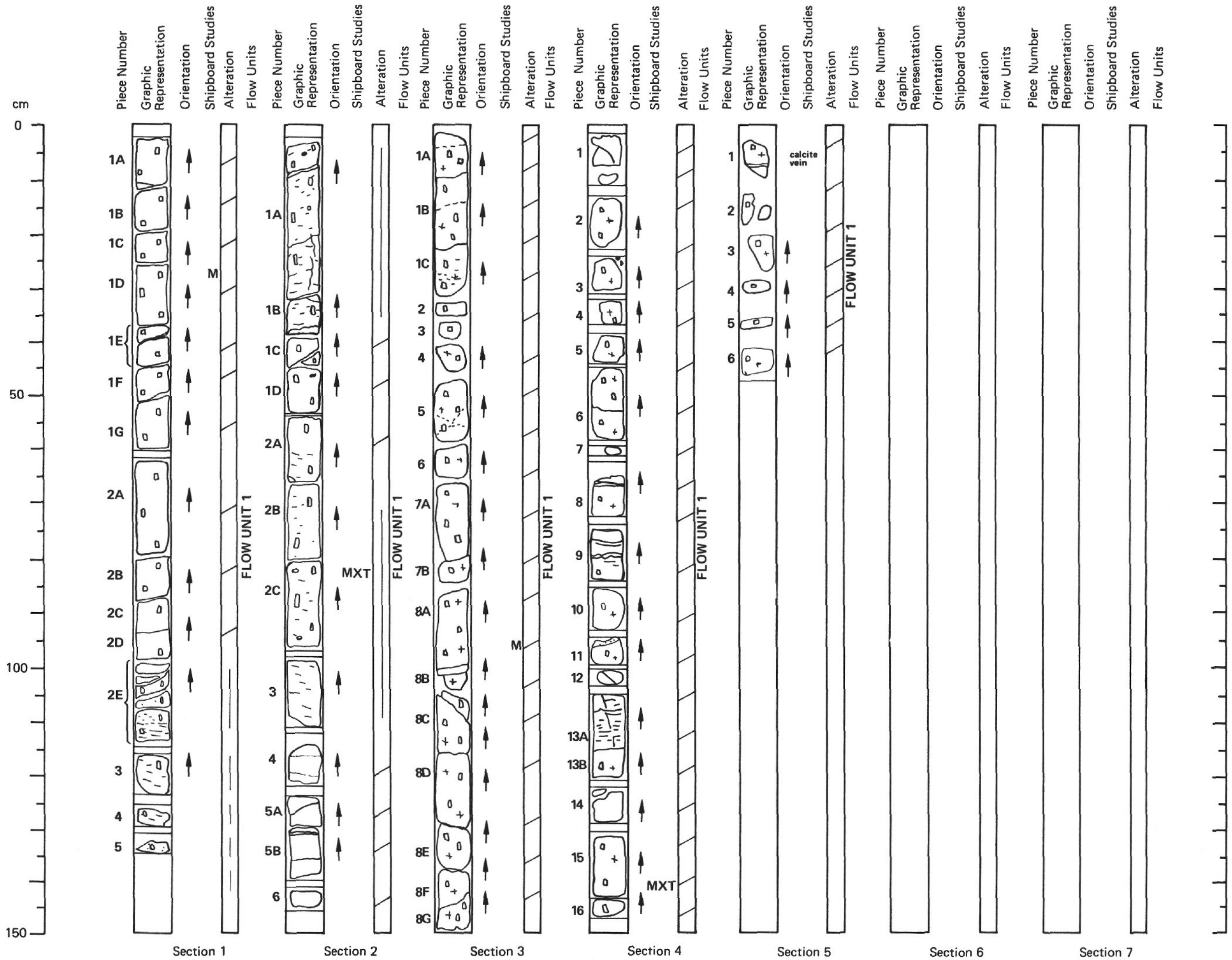
Average Inclination: –38.7°

Average Magnetic Intensity (10^{-5} Gauss): 590

VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG 55 SITE 433 HOLE A CORE 21 DEPTH 166.5-174.0 m

Same Flow Unit as in Core 20.



SITE 433 HOLE B CORE 1 CORED INTERVAL: 128.5-138.0 m

TIME-ROCK UNIT	BIOSTRAT ZONE	FORAMS	NANNOS	RADS	SILICOS	DIATOMS	SECTION	METERS	GRAPHIC LITHOLOGY	DRILLING DISTURBANCE	SEDIMENTARY STRUCTURES	LITHOLOGIC SAMPLE
							1	0.5, 1.0				G.S
							2		VOID; VOID, No Section 2			
							3		P	O		*
							4		P	O		G.S
							5		P	O		
							6		P	O		
							7			+20 cm		
PALEOCENE		B	RP		B	B	CC			CC		*

LITHOLOGIC DESCRIPTION

0.0-0.45 m: REEFAL CARBONATE SAND
light gray (2.5Y 7/0) gray (2.5Y 6/0) and white (2.5Y 8/0)
At bottom: 1 pebble of basalt
4 concretions of algal detritus
white (2.5Y 8/2) with yellow zones (2.5Y 8/6)

0.45-3.00 m: VOID, NO SECTION 2

3.00-9.25 m: REEFAL CARBONATE SAND
light gray (2.5Y 7/0), fine-grained, well sorted (may be drilling artifact) calcareous reefal sand composed of white and gray algal and bryozoan clasts
Macroscopically: Many bryozoan have pyrite and glauconite growing inside openings

9.25-9.50 m: Bottom of Section 7, REEFAL CALCARENITE
In 5 concretions of algal material white (2.5Y 8/2) and pale yellow (2.5Y 8/3)

CORE CATCHER: ALGAL CONCRETION ⌀ 3.5 cm, gray central core, white laminated layers surrounding core, recrystallized
CALCAREOUS SILTY MUD, gray (2.5Y N6)
CALCAREOUS REEFAL SAND, gray (2.5Y N5) with 15% volcanic clasts, radiolarian and green patches (glauconite?)

S.S. (at 3.10 m):
100% carbonate unspecified clasts

S.S. (at 0.7 m Core Catcher):
100% carbonate unspecified, with many rod-like crystals

SITE 433 HOLE B CORE 2 CORED INTERVAL: 138.0-147.5 m

TIME-ROCK UNIT	BIOSTRAT ZONE	FORAMS	NANNOS	RADS	SILICOS	DIATOMS	SECTION	METERS	GRAPHIC LITHOLOGY	DRILLING DISTURBANCE	SEDIMENTARY STRUCTURES	LITHOLOGIC SAMPLE
							1	0.5, 1.0	VOID			CC, CC
?		RP	B	B	B		CC					

LITHOLOGIC DESCRIPTION

0.00-1.20 m: REEFAL CARBONATE SAND
Poorly sorted silty calcareous sand, with gray and white clasts of coralline algal and bryozoan detritus (100% carbonate components).
Size grading by drilling effect.

CORE CATCHER: REEFAL CARBONATE SAND
Same as Section 1, with small algal concretions.

S.S. (at 0.10 m) silty gray fraction of the top of the core:
80% clasts of carbonate unspecified (algae)
20% clays and occurrence of small patches of pyrite

SITE 433 HOLE B CORE 3 CORED INTERVAL: 147.5-157.0 m

TIME-ROCK UNIT	BIOSTRAT ZONE	FORAMS	NANNOS	RADS	SILICOS	DIATOMS	SECTION	METERS	GRAPHIC LITHOLOGY	DRILLING DISTURBANCE	SEDIMENTARY STRUCTURES	LITHOLOGIC SAMPLE
PALEOCENE							1	0.5, 1.0	VOID			CC
		B	RP	B	B		CC					

LITHOLOGIC DESCRIPTION

0.00-0.60 m: REEFAL CARBONATE SAND
moderately well sorted, fine-grained calcareous reefal sand
light gray, and white clasts of bryozoans and coralline algal

CORE CATCHER: REEFAL CARBONATE SAND
Same as Section 1, with 2 pieces of moderately indurated calcarenite gray (7.5YR N5),
⌀ ≃ 1 x 2 cm

SITE 433 HOLE B CORE 4 CORED INTERVAL: 157.0-166.5 m

TIME-ROCK UNIT	BIOSTRAT ZONE	FORAMS	NANNOS	RADS	SILICOS	DIATOMS	SECTION	METERS	GRAPHIC LITHOLOGY	DRILLING DISTURBANCE	SEDIMENTARY STRUCTURES	LITHOLOGIC SAMPLE
?		B						0.5				

LITHOLOGIC DESCRIPTION

0.00-0.14 m: WHITE ALGAL CONCRETIONS
The pieces of cemented calcarenites composed of algal nodules, bryozoan, and reefal fragments.
Cement is calcite; calcite crystals grow in vesicles.

0.14-0.26 m: CALCARENITE–LIMESTONE
Lithified gray (5Y 6/1) limestone calcarenite with bedding, marked by change of grain size (coarse-grained above fine-grained) of reefal calcareous sand. Upper part contains algal concretions, red wathered basalt and 2 black rounded basalt pebbles. Cement is calcite, crystals are visible in vesicles.

0.26-0.35 m: LIMESTONE CALCARENITE
0.26-0.31 m: Lithified limestone calcarenite, grain size decreases with depth, particles change from gray, light gray (5Y 7/1) to pale yellow (2.5Y 8/4)

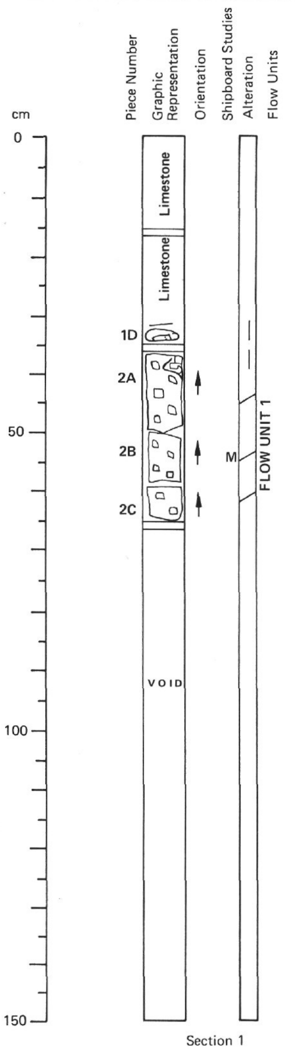
0.31-0.35 m: Dense lithified limestone possibly recrystallized contains contact between sediment and basalt sediment: pale yellow (2.5Y 8/4) marly calcareous clasts are rounded

0.35-0.49 m: SEDIMENT–BASALT CONTACT
Two generations of infill:
Filling of basaltic clast in calcite
Cemented calcareous sand of pale yellow variety

0.49-0.60 m: BASALT

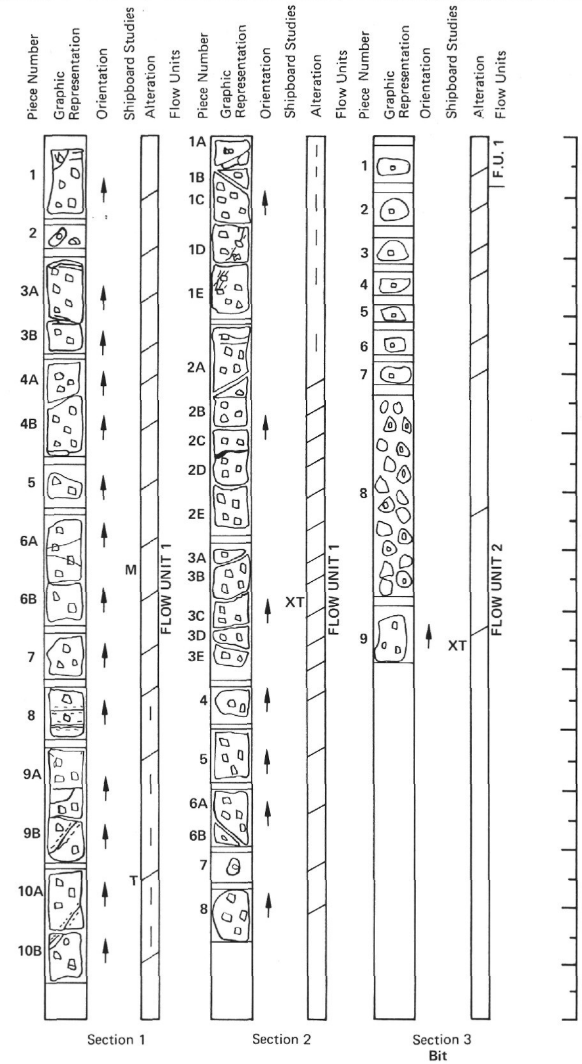
VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG 55 SITE 433 HOLE B CORE 4 DEPTH 157.0-166.5 m



Same Flow Unit as in all of Hole 433A.

LEG 55 SITE 433 HOLE B CORE 5 DEPTH 166.5-176.0 m



CORE 5 DEPTH 166.5-176.0 m

Sect. 1, 0 cm to Sect. 3, 8 cm is same Flow Unit as in all of Hole 433A.

FLOW UNIT NO. 2:
POSITION: Top - Core 5, Sect. 3, pieces 2, 7, 8, and 9.

VISUAL DESCRIPTION
Mineralogy: Phenocrysts: ol. 10-15%, to 5 mm, mostly fresh; plag., 10%, 2-15 mm, cpx. 5%
Groundmass: plag., px., ol., opaques
Lithology: Pieces recovered from bit when pipe pulled, rock massive (2-3% clay filled vesicles).
Alteration: Clay in groundmass; ol. mostly fresh

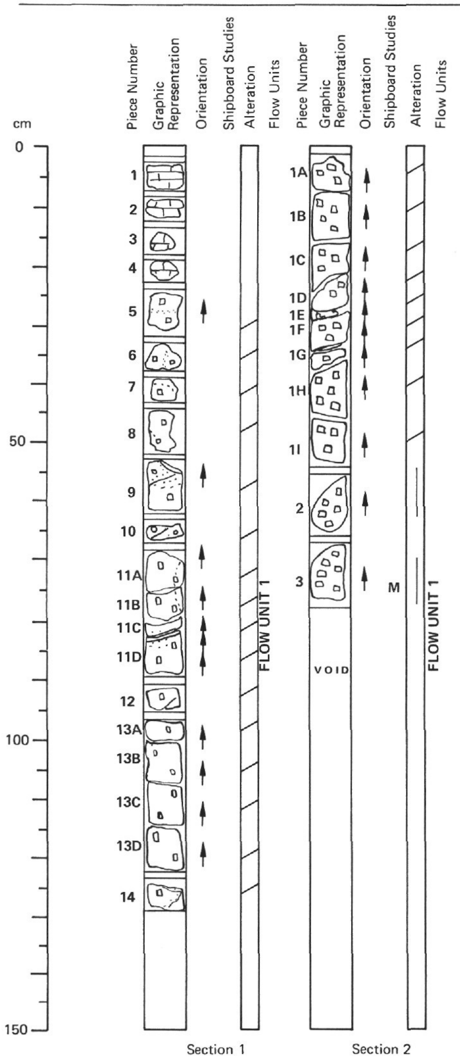
THIN SECTION DESCRIPTION
Phenocrysts: Ol. 10-12%, 0.5-4 mm, subhedral-euhedral, iddingsitized rims; plag. 5-7%, 0.5-3 mm, tabular, fresh; cpx., 5-7%, 0.4-1.5 mm, subhedral-euhedral, sector zoned
Groundmass: Ol. 5%, 0.1-0.2 mm, partly altered to iddingsite; plag., 40%, to 1 mm; cpx. 15%, to 0.2 mm; opaques 10%, 0.05 mm; glass 5%, altered; apatite, <1%, needles.
Texture: Microlitic
Vesicles: None in this section.
Alteration: Glass to clay (5%), partly iddingsitized ol.

SITE 433 HOLE C CORE 1 CORED INTERVAL: 163.0-168.0 m

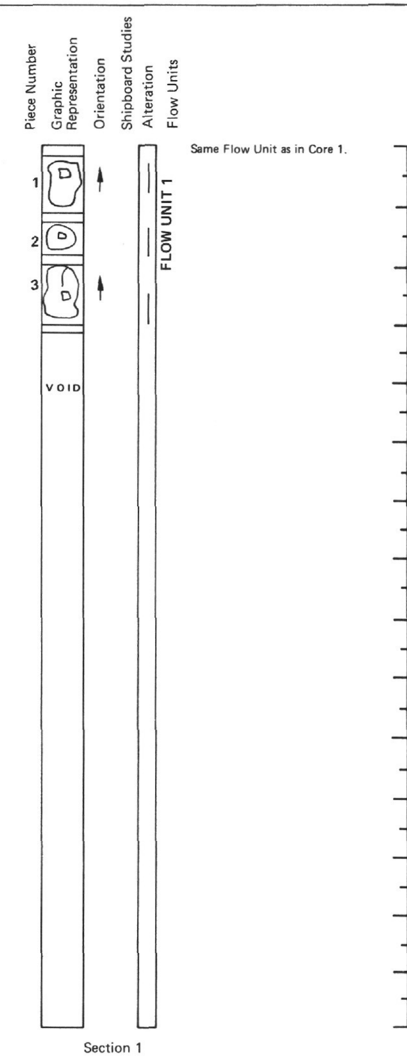
TIME-ROCK UNIT	BIOSTRAT ZONE	FOSSIL CHARACTER: FORAMS	NANNOS	RADS	SILICOS	DIATOMS	SECTION	METERS	GRAPHIC LITHOLOGY	DRILLING DISTURBANCE	SEDIMENTARY STRUCTURES	LITHOLOGIC SAMPLE	LITHOLOGIC DESCRIPTION
													0.0-0.25 m: CALCARENITE AND LIMESTONE 0.0-0.08 m: CALCARENITE, gray (7.5YR N6) Piece 4.5 x 3 x 6 cm composed of calcareous reefal material (shell, algal concretions, bryozoan, volcanic clasts) – cemented with calcite – euhedral calcite crystals growing open spaces 0.08-0.14 m: CALCARENITE, gray (7.5YR N6) Same as 0.0-0.08 m, and the sediment particles appear to be flat flying 0.14-0.19 m: LIMESTONE, dark gray (7.5YR N4) less porosity; more dense than above 2 rock, i.e., more cemented but with some material. 0.19-0.25 m: LIMESTONE–CALCARENITE, dark gray (7.5YR N4/1) to pale yellow (2.5Y 8/6) some components as above (reefal sand) very densely cemented Degree of cementing increases with depth

VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG **55** SITE **433** HOLE **C** CORE **1** DEPTH **163.0-168.0 m**



LEG **55** SITE **433** HOLE **C** CORE **2** DEPTH **168.0-177.5 m**



Same Flow Unit as in Core 1.

FLOW UNIT NO. 1:
(Flow Unit 1 of 433A and 433B)
POSITION: Top - Core 1, Sect. 1, 0 cm; Bottom - Core 2, Sect. 1, 30 cm

VISUAL DESCRIPTION

Mineralogy: Phenocrysts: ol. 5-8%, to 1 mm, some fresh; plag., 10%, up to 6 mm; px., 5-8%, to 1 mm
Groundmass: plag., px., ol., opaques, clay

Lithology: Mostly massive basalt (a few 1-3 mm vesicles) - flow top probably eroded

Alteration: Patches of clay in groundmass, ol. partially to iddingsite

MAGNETIC DATA

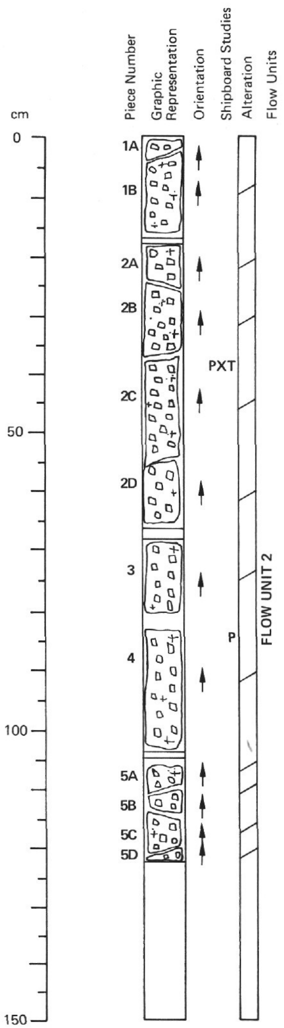
Average Inclination: −40.2°
Average Magnetic Intensity (10^{-5} Gauss): 726

SITE 433 HOLE C CORE 3 CORED INTERVAL: 177.5-181.5 m

TIME-ROCK UNIT	BIOSTRAT ZONE	FOSSIL CHARACTER: FORAMS	NANNOS	RADS	SILICOS	DIATOMS	SECTION	METERS	GRAPHIC LITHOLOGY	DRILLING DISTURBANCE	SEDIMENTARY STRUCTURES	LITHOLOGIC SAMPLE	LITHOLOGIC DESCRIPTION
							1	0.5 1.0					0.0-4.20 m: VOLCANIC RICH REEFAL CARBONATE SAND well sorted; ≃1 mm size clasts, moderately rounded 70% white and gray carbonate clasts c' coralline algae and bryozoan fragments 30% volcanic clasts and quartz CORE CATCHER: Same as above.
							2					G.S	
							3		VOID				
PALEOCENE		B	RB	B	B		CC						

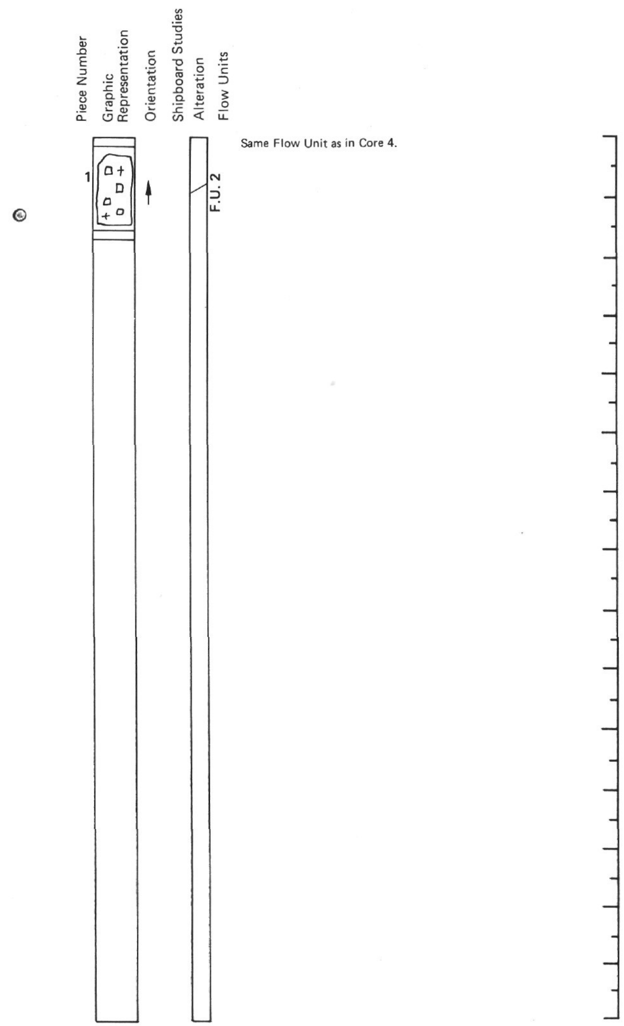
VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG 55 SITE 433 HOLE C CORE 4 DEPTH 181.5-187.0 m



Section 1

LEG 55 SITE 433 HOLE C CORE 5 DEPTH 187.0-190.0 m



Section 1

FLOW UNIT NO. 2:
POSITION: Top - Core 4, Sect. 1, 0 cm
CHEMISTRY: Alkalic basalt, 1 analysis in Table 1.

VISUAL DESCRIPTION
Mineralogy: Phenocrysts: ol., 5%, 1-10 mm, mostly fresh; plag., 7%, 1-10 mm; px., 1%, 2-10 mm
Groundmass: plag. px., opaque
Lithology: Flow top probably eroded, massive throughout (1%, 1-10 mm clay filled vesicles)
Alteration: Mostly fresh, some clay in vesicles and fractures

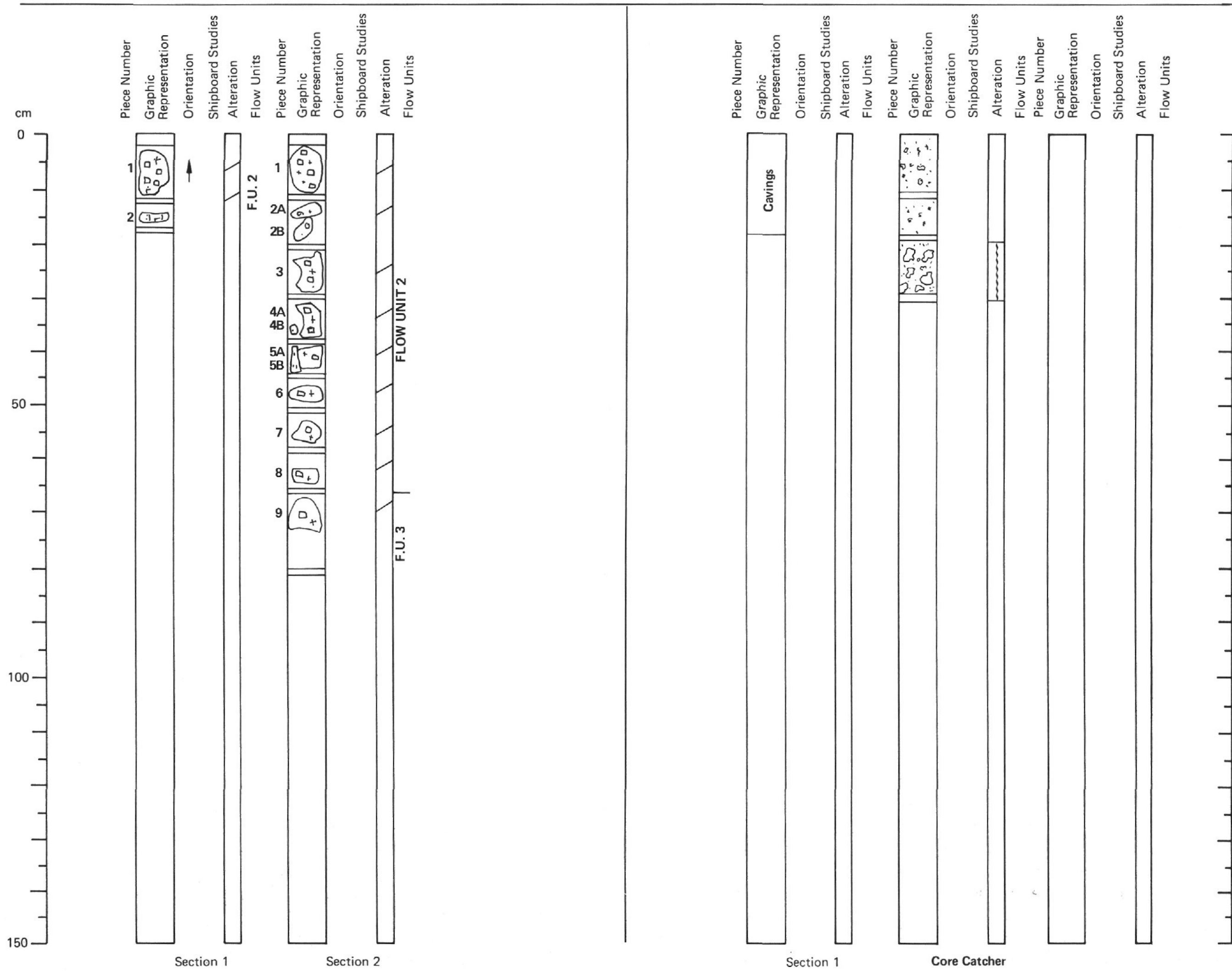
THIN SECTION DESCRIPTION
Phenocrysts: Ol., 5%, 1-3 mm, subhedral, partially altered; plag., 3%, 0.2-3 mm, subhedral; cpx., 2%, 0.2-3 mm, subhedral
Groundmass: Plag., 50%, to 0.2 mm, laths; cpx., 15%, to 0.2 mm, colorless; opaque, 7%, to 0.1 mm; apatite, 1%, needles
Texture: Interstitial
Vesicles: None in this section.
Alteration: 5% clay after groundmass ol.(?)

MAGNETIC DATA
Average Inclination: –36.3°
Average Magnetic Intensity (10^{-5} Gauss): 583

VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG 55 SITE 433 HOLE C CORE 6 DEPTH 190.0-196.5 m

LEG 55 SITE 433 HOLE C CORE 9 DEPTH 202.5-204.5 m



Sect. 1 and 2, 0-67 cm are Flow Unit 2 of Cores 4 and 5 (Note: Sect 2. was recovered from the bit when the pipe string was pulled.)

FLOW UNIT NO. 3:

POSITION: Top - Core 6, Sect. 2, 70 cm; Bottom - Core 6, Sect. 2, 75 cm (piece no. 9)

VISUAL DESCRIPTION

Mineralogy: Phenocrysts: plag., <1%, 1-5 mm, euhedral; px., <1%, 0.5-2 mm
Groundmass: plag. 60%, 0.1-0.5 mm, trachytic; ol.(?), 5%, altered; px., 20%; opaques

Lithology: One piece, massive, <1% vesicles, trachytic

Alteration: Groundmass to clay, ol.(?) to iddingsite

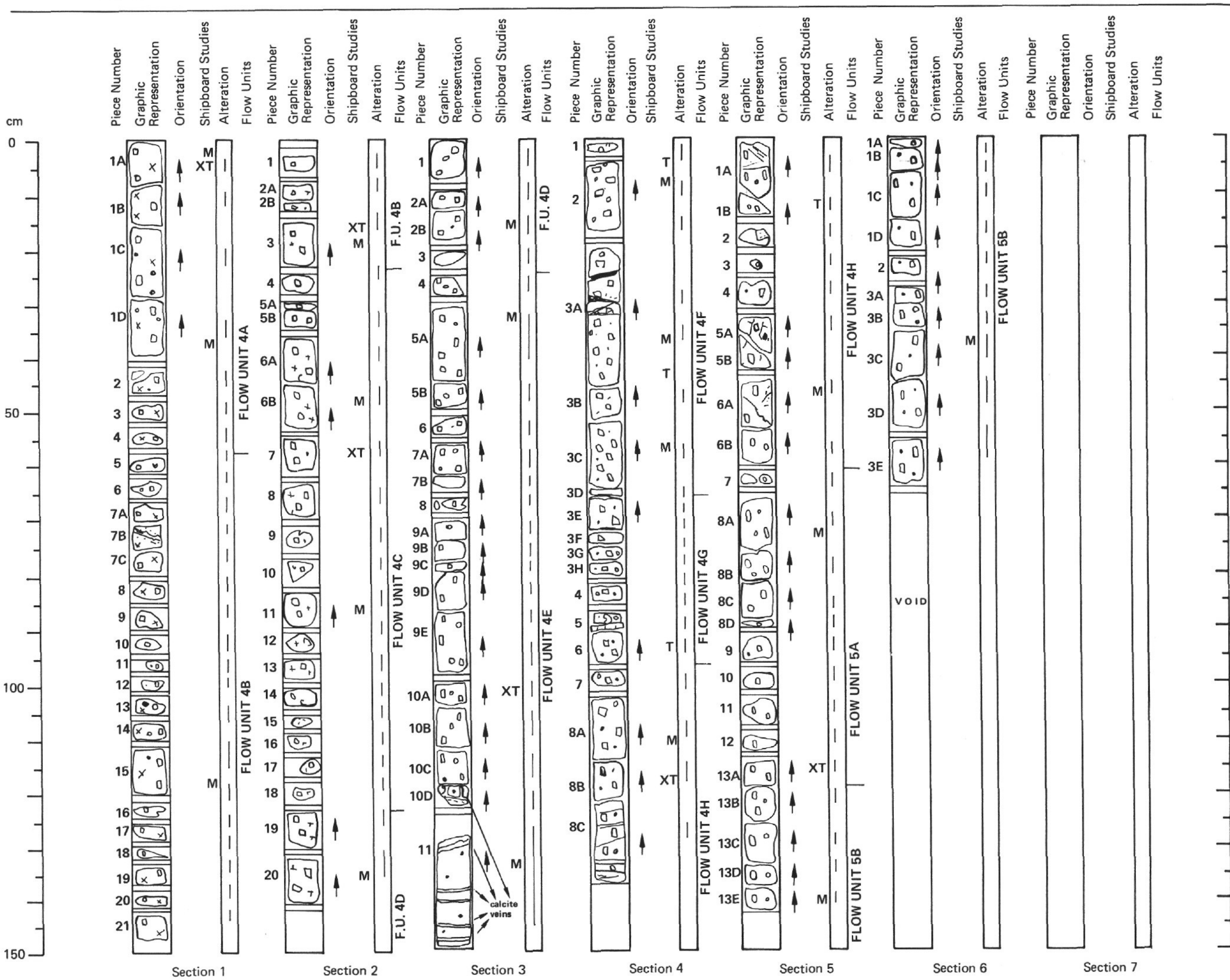
Note: No recovery for Cores 7 and 8.

CORE 9

Cavings - including glacial pebbles, reef debris, recent forams, and basalt fragments.

VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG **55** SITE **433** HOLE **C** CORE **10** DEPTH **204.5-214.0 m**



FLOW UNIT NO. 4:

POSITION: Top - Core 9, CC, 20 cm; Bottom - Core 10, Sect. 5, 62 cm
CHEMISTRY: Tholeiitic picrite, 4 analyses in Table 1.

VISUAL DESCRIPTION

Mineralogy: Phenocrysts: ol., 5-45% (mostly 15-20%), 1-8 mm, euhedral to anhedral, altered to iddingsite
Groundmass: plag., py., ol., opaques
Lithology: 8 subunits (see below) - vesicles vary from 0 to 40% and from 10 mm to 1 mm, some open, some filled by clay, calcite, or zeolites
Alteration: Moderately to extensively altered; groundmass contain rich clay

THIN SECTION DESCRIPTION

Phenocrysts: Ol. 3-50% (mostly 5-20%), 0.5-4 mm, euhedral to anhedral, completely altered. Plag. 0 to <1% (mostly 0), 1.5 mm, altered
Groundmass: Ol., 1-7%, 0.05 to 0.5 mm, altered; plag., 20-50%, 0.1-0.5 mm, partly altered, cpx., 10-20%
Texture: Vitrophyric, intergranular, sub-ophitic depending on position in the flow.
Vesicles: 10-45%, mostly 0.5 to 5 mm, filled by clay, calcite, and zeolites
Alteration: Groundmass (glass?) extensively altered to clay, ol., totally altered, many samples almost completely altered

MAGNETIC DATA

Average Inclination: −43.1°
Average Magnetic Intensity (10^{-5} Gauss): 1600

COMMENTS

8 sub-units based primarily on presence of intervals with many small vesicles (flow tops) which become fewer and larger downward and grade into a massive flow center. Tips of 4C and 4D are oxidized, 4H is much more olivine rich.

FLOW UNIT NO. 5:

POSITION: Top - Core 10, Sect. 5, 62 cm; Bottom - Core 11, Sect. 1, 26 cm
CHEMISTRY: Tholeiitic basalt, 1 analyses in Table 1

VISUAL DESCRIPTION

Mineralogy: Phenocrysts: ol. ≤1%, 4 mm, altered
Groundmass: plag., ol., px., op.
Lithology: Two sub-units based on changes in number and size of vesicles. Vesicles 5-20%, <1 mm to 8 mm, a few filled by calcite
Alteration: ol. to iddingsite; dark clay in groundmass, top oxidized red

THIN SECTION DESCRIPTION

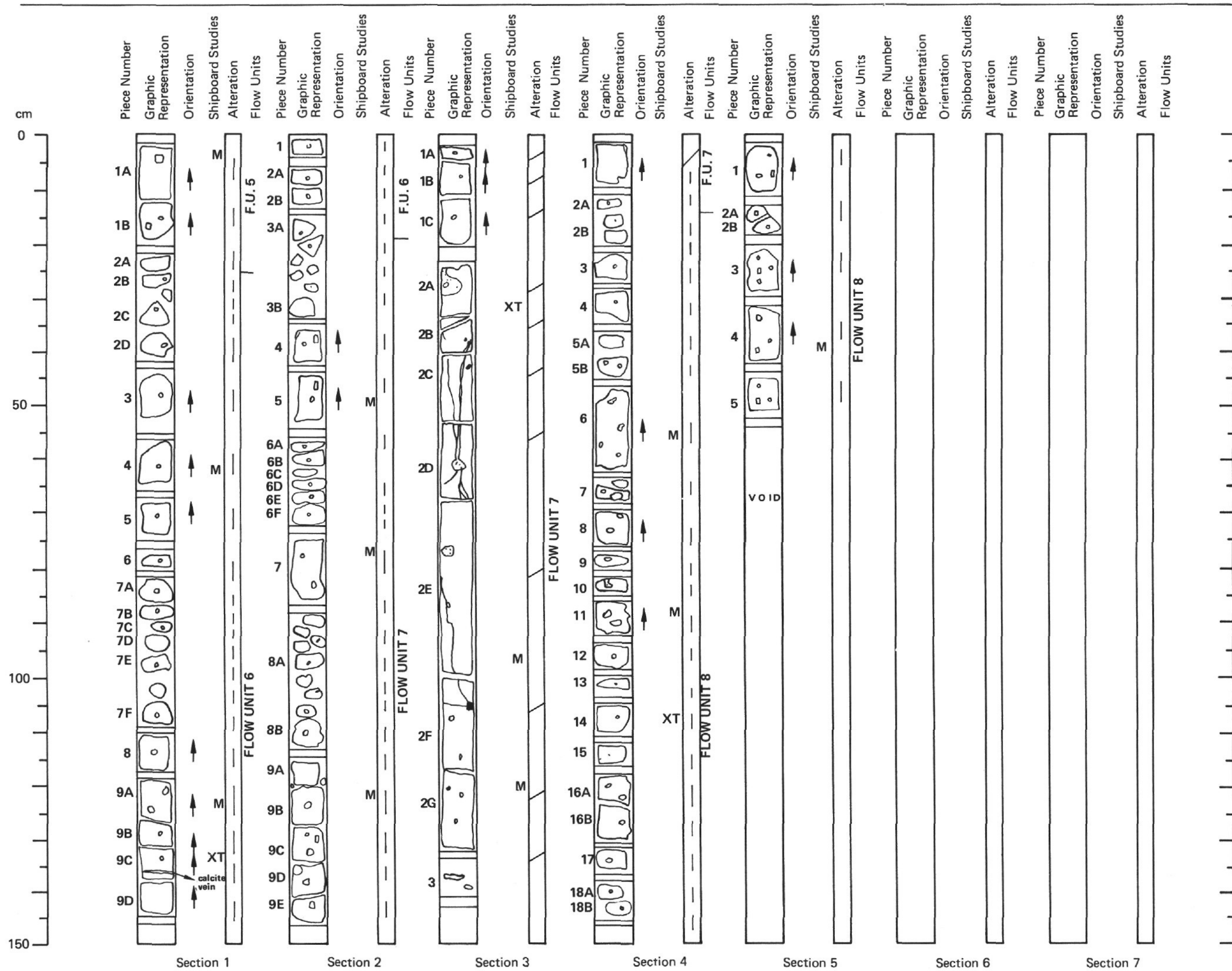
Phenocrysts: Ol., 1%, 0.2-0.7 mm, subhedral, altered
Groundmass: Ol., 7%, 0.02 to 0.1 mm, granular, altered; plag., 25%, <0.01 to 0.1 mm, laths; cpx., 10% 0.05 to 0.1 mm, granular; opaque, 15%
Texture: Intergranular
Vesicles: 20%, 0.5 to 1 mm, filled by calcite, clays, and zeolite
Alteration: 25% in groundmass, ol. to iddingsite

MAGNETIC DATA

Average Inclination: −37.6° (5A), −46.3° (5B)
Average Magnetic Intensity (10^{-5} Gauss): 2020 (5A), 611 (5B)

VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG **55** SITE **433** HOLE **C** CORE **11** DEPTH **214.0-223.5 m**



FLOW UNIT NO. 6:

POSITION: Top - Core 11, Sect. 1, 26 cm; Bottom - Core 11, Sect. 2, 19 cm

CHEMISTRY: Tholeiitic basalt, 1 analysis in Table 1.

VISUAL DESCRIPTION

Mineralogy: Phenocrysts: ol., < 1%, 1-2 mm, altered
Groundmass: plag., 0.1-0.2 mm; ol., px.,op.

Lithology: Vesicular flow top (25-40% vesicles, 1-20 mm) grading downward into a more massive center (5-10% vesicles)

Alteration: Groundmass altered to clay, ol. altered, vesicles lined by clay and partially filled by calcite

THIN SECTION DESCRIPTION

Phenocrysts: Ol., 2%, 1-2 mm, euhedral to subhedral, altered

Groundmass: Ol., 12-15%, 0.1-0.5 mm, subhedral, altered; plag., 45-50%, 0.3-50%, 0.3-1.0 mm laths; cpx., 15-20%, 0.1-1.0 mm; opaque, 10-12%; glass, 5%, altered

Texture: Ophitic to sub-ophitic

Vesicles 3-5%, 1-3 mm, zeolite filled

Alteration: Clay after glass, plag. and ol. phenocrysts, 7%

MAGNETIC DATA

Average Inclination: –44.7°

Average Magnetic Intensity (10^{-5} Gauss): 1083

FLOW UNIT NO. 7:

POSITION: Top - Core 11, Sect. 2, 19 cm; Bottom - Core 11, Sect. 4, 15 cm

CHEMISTRY: Tholeiitic basalt, 1 analysis in Table 1.

VISUAL DESCRIPTION

Mineralogy: Phenocrysts - ol., 1-2%, 1-2 mm
Groundmass: ol., plag., px., op.

Lithology: Vesicular flow top in Sect. 2 , grading downward into a more massive center and bottom.

Alteration: Most vesicles partially filled by green clay and calcite groundmass moderately to extensively altered to clay

THIN SECTION DESCRIPTION

Phenocrysts: Ol., 3%, 0.3-1.0 mm, anhedral, altered

Groundmass: Ol., 5%, 0.05 to 0.3 mm, anhedral, altered; plag., 40%, 0.02 to 0.1 mm, laths; cpx., 40%, <0.01-0.1 mm, granular, colorless; op., 3-5%, 0.01-0.1 mm, equant

Texture: Intergranular

Vesicles: 1 in this section, calcite filled

Alteration: 10-15% clay in groundmass (after glass?) and after ol.

MAGNETIC DATA

Average Inclination: –44.0°

Average Magnetic Intensity (10^{-5} Gauss): 361

FLOW UNIT NO. 8:

POSITION: Top - Core 11, Sect. 4, 14 cm; Bottom - Core 12, Sect. 1, 51 cm

CHEMISTRY: Tholeiitic basalt, 1 analysis in Table 1.

VISUAL DESCRIPTION

Mineralogy: Phenocrysts: ol., 2%, 1-4 mm, altered; plag.
Groundmass: plag., 0.2 mm, ol., px., op.

Lithology: Vesicular flow, top; moderately vesicular throughout

Alteration: Groundmass extensively altered to clay, ol. to iddingsite, vesicles clay lined and partially calcite filled

THIN SECTION DESCRIPTION

Phenocrysts: Ol., 10% (phenocrysts and microphenocrysts), 0.5-3 mm, euhedral; plag., 1%, 0.6-1.4 mm, euhedral

Groundmass: Ol., 5%, 0.2-0.5 mm, euhedral, altered; plag., 30%, 0.05-0.5 mm, laths; cpx., 20%, 0.04-0.3 mm, anhedral; op., 5%, 0.04-0.13 mm

Texture: Intergranular

Vesicles: 10%, 0.3 to >5 mm, calcite filled, clay lined

Alteration: 20% clay in groundmass after glass (?); ol. to iddingsite + clay

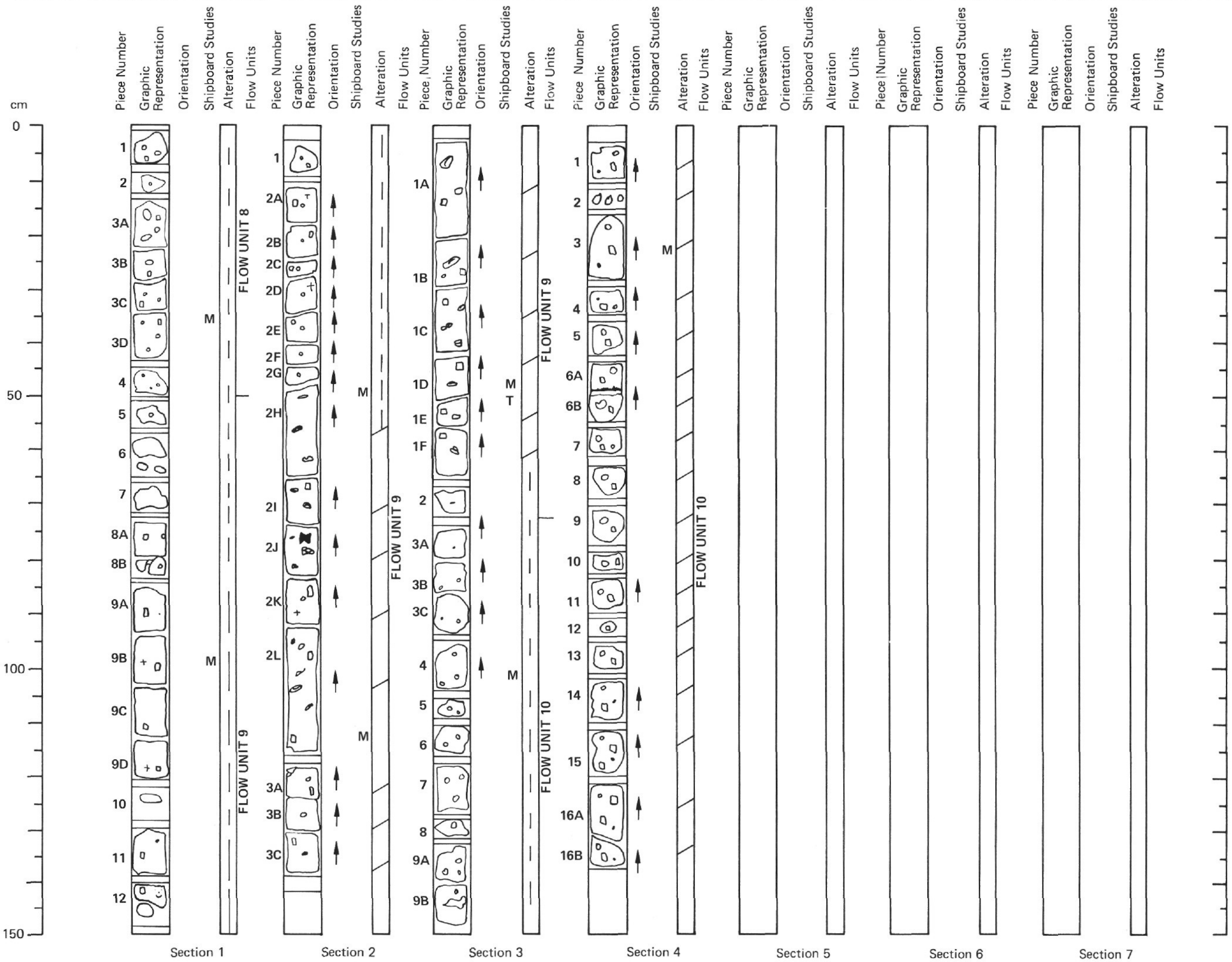
MAGNETIC DATA

Average Inclination: –52.9°

Average Magnetic Intensity (10^{-5} Gauss): 382

VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG **55** SITE **433** HOLE **C** CORE **12** DEPTH **223.5-230.0 m**



FLOW UNIT NO. 9:

POSITION: Top - Core 12, Sect. 1, 52 cm; Bottom - Core 12, Sect. 3, 71 cm

CHEMISTRY: Tholeiitic basalt, 1 analysis in Table 1.

VISUAL DESCRIPTION

Mineralogy: Phenocrysts: ol., 2%, 1-4 mm (fresh in Sect. 2); px., <1%, 0.5-2 mm, (fresh in Sect. 2)
Groundmass: plag., 0.2 mm; ol., px., op.

Lithology: Vesicular and oxidized flow top (25%, 0.5-2 mm vesicles) in Sect. 1, grades down into center and bottom with fewer and larger vesicles.

Alteration: Sect. 1, extensively altered (phenocrysts and groundmass) - Sect. 2 fresh phenocrysts and groundmass, ol. and px.

THIN SECTION DESCRIPTION

Phenocrysts: Ol., 2%, 0.5-2 mm, euhedral, altered; plag., 1%, 0.5-1 mm

Groundmass: Ol., 2%, <0.1 mm, granular; plag. 40%, 0.3-1.0 mm, microlites and laths; cpx., 15-20%, 0.2-0.5 mm, anhedral to subhedral, sector zoned; op., 10%; glass, 3%, altered

Texture: Microlitic

Alteration: 25-30% clay after glass and ol., calcite after ol., 1-2% zeolites in groundmass; ol. iddingsitized

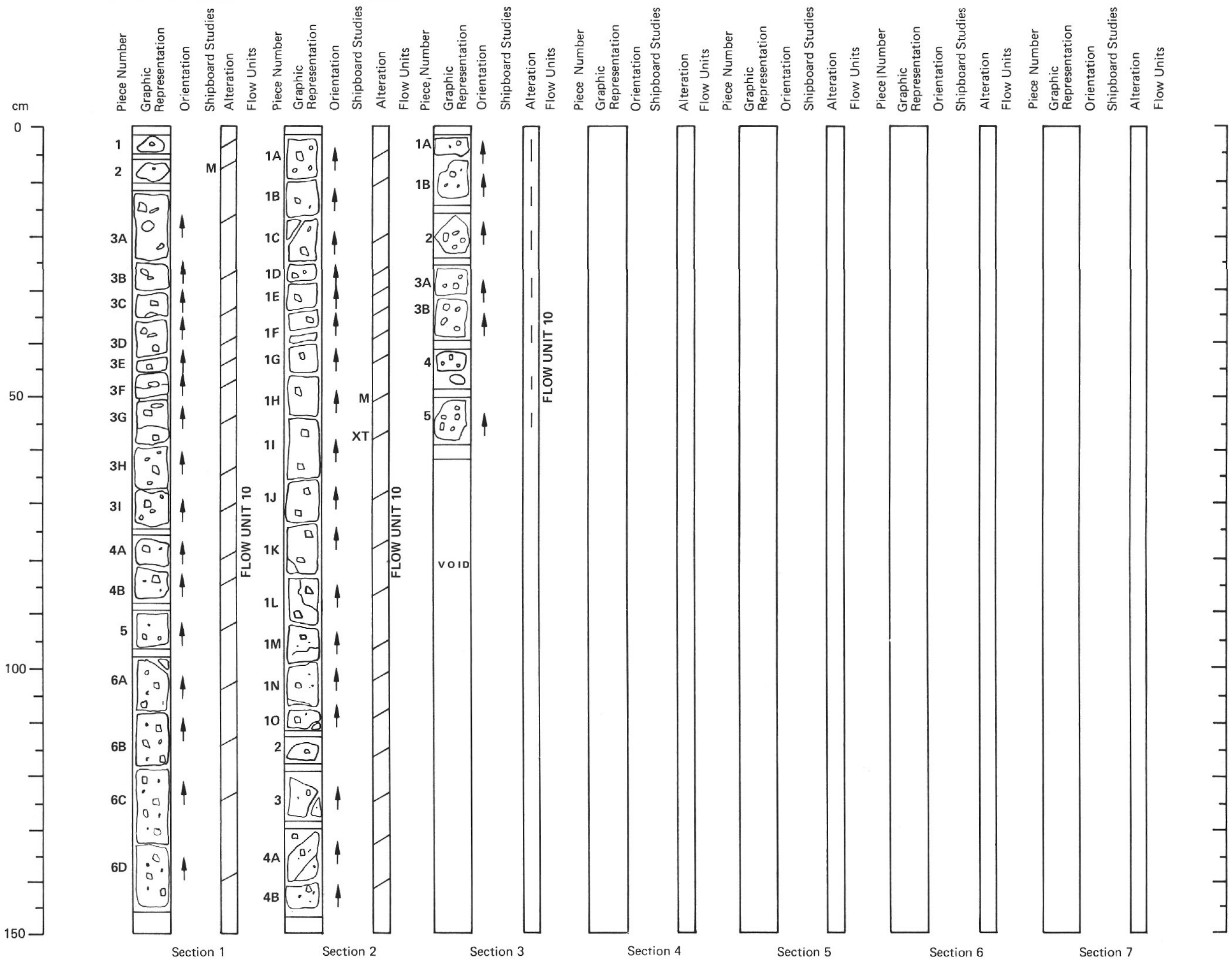
MAGNETIC DATA

Average Inclination: –56.0°

Average Magnetic Intensity (10^{-5} Gauss): 344

VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG **55** SITE **433** HOLE **C** CORE **13** DEPTH **230.0-233.0 m**



FLOW UNIT NO. 10:

POSITION: Top - Core 12, Sect. 3, 73 cm; Bottom - Core 13, Sect. 3, 60 cm

CHEMISTRY: Tholeiitic basalt, 1 analysis in Table 1.

VISUAL DESCRIPTION

Mineralogy: Phenocrysts: ol. 2%, 2-4 mm, fresh in Sect. 4 of Core 12, Core 13, Sect. 1 and Core 13, Sect. 2 (best) microphenos of plag. and px. in Core 13, Sect. 1
Groundmass: ol., plag., px. and op.

Lithology: Vesicular and oxidized flow top in Core 12, Sect. 3 and 4 (to 40% vesicles), more massive (5% vesicles) in Sect. 1 and 2 of Core 13. Vesicular bottom in Core 13, Sect. 2 and 3 (to 25% vesicles).

Alteration: Top oxidized; ol. mostly altered; Core 13, Sect. 2 (1G-1K freshest); bottom has more altered groundmass.

THIN SECTION DESCRIPTION

Phenocrysts: None in this section

Groundmass: Ol., 1-2%, 0.5-1 mm, altered; plag., 60% <0.1 to 2 mm laths; px., 30% 0.05-0.5 mm, anhedral, colorless; op., 3%, 0.02-0.2 mm, Mica 2%, 0.4 mm brown, anhedral; apatite; 1%, needles

Texture: Intergranular to sub-ophitic

Vesicles: None in this section

Alteration: 7% interstitial clays after ol. and glass(?)

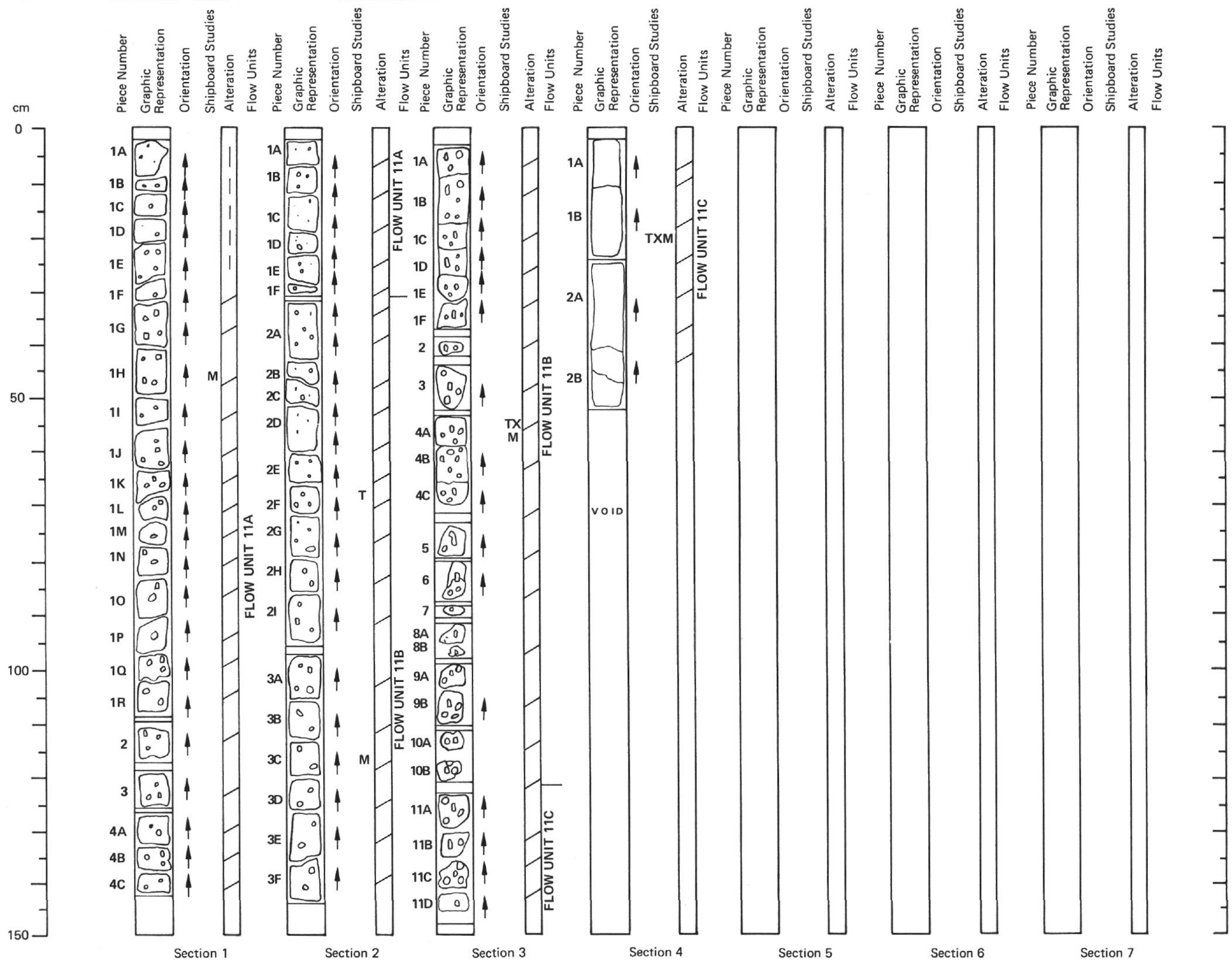
MAGNETIC DATA

Average Inclination: −28.3°

Average Magnetic Intensity (10^{-5} Gauss): 417

VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG **55** SITE **433** HOLE **C** CORE **14** DEPTH **233.0-242.5 m**



FLOW UNIT NO. 11:

POSITION:	Top - Core 14, Sect. 1, 0 cm; Bottom - Core 15, Sect. 3, 130 cm
CHEMISTRY:	Tholeiitic basalt, 3 analyses in Table 1.

VISUAL DESCRIPTION

Mineralogy:	Phenocrysts: ol., 2%, 1-2 mm, altered; aphyric below Core 14, Sect. 3; plag. and px. microphenos Groundmass: plag., ol., px., op.
Lithology:	4 subflow units based on occurrence of finely vesicular zones, and for 4D and oxidized breccia (AA) top; material in top of Core 14, Sect. 1 oxidized red - vesicles range from ≈0 to 30%
Alteration:	Ol. mostly altered (fresh in Core 14, Sect. 3 - Core 15, Sect. 2); oxidized zones; groundmass moderately altered to clay

THIN SECTION DESCRIPTION

Phenocrysts:	Ol. 0-1%, 0.5-1.2 mm, subhedral, altered; plag., 4-40%, 0.5-1.5 mm, tabular; cpx., 0-4%, 0.5-1.0 mm; cpx. and pl. glomerocrysts
Groundmass:	Ol. 0-7%, 0.03-0.5 mm, subhedral, fresh in Core 14, Sect. 4; plag. 30-50%, up to 1 mm long; cpx., 5-20%; op. 15-20%; glass, 5-30% altered
Texture:	Mostly diabasic; Core 15, Sect. 3 microlitic to sub-trachytic
Vesicles:	0-15%, 1-3 mm, clay lined
Alteration:	5-20% clay in vesicles and groundmass; ol. to iddingsite

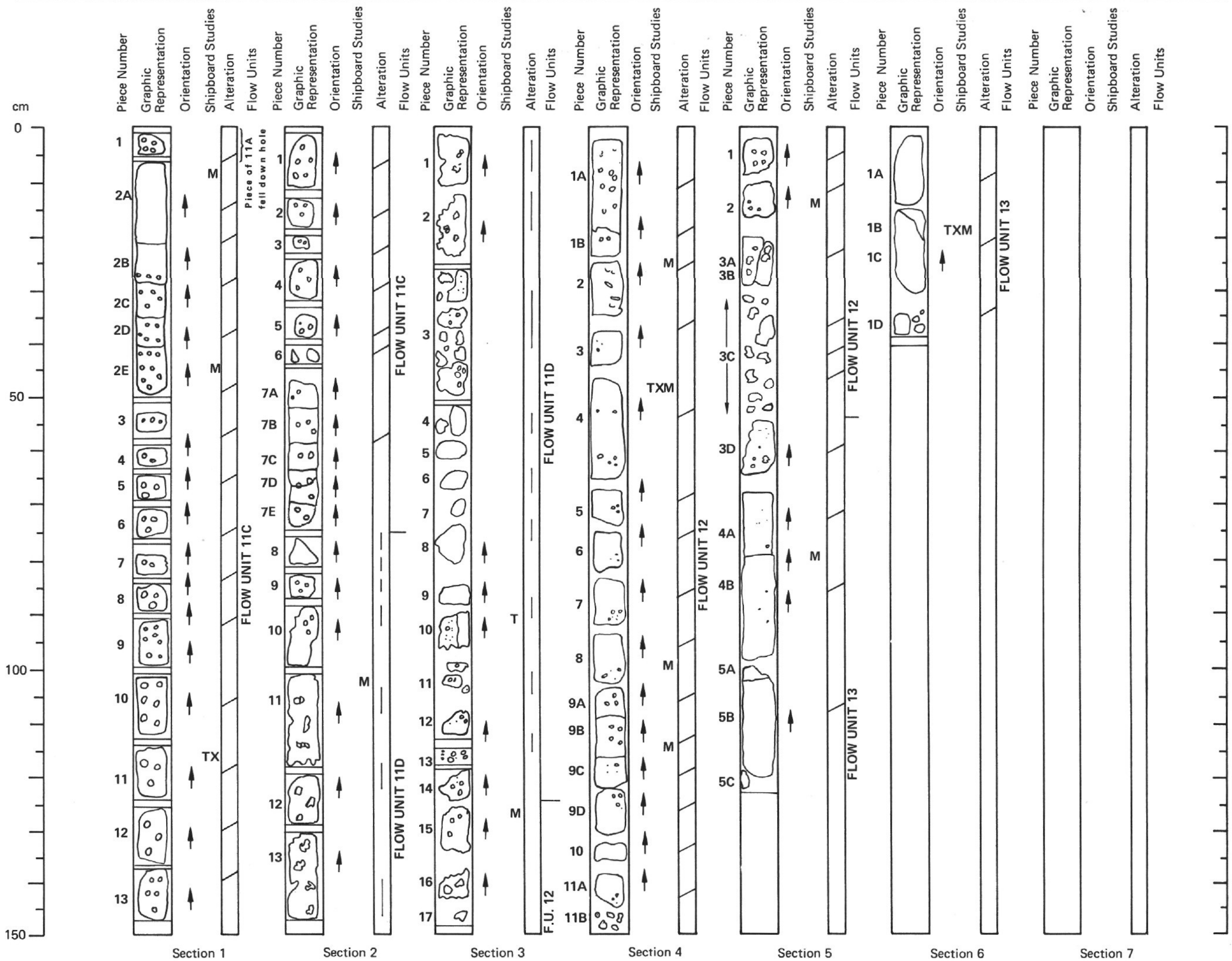
MAGNETIC DATA

Average Inclination: −42.8°

Average Magnetic Intensity (10^{-5} Gauss): 326

VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG **55** SITE **433** HOLE **C** CORE **15** DEPTH **242.5-252.0 m**



FLOW UNIT NO. 12:

POSITION: Top - Core 15, Sect. 3, 130 cm; Bottom - Core 15, Sect. 5, 55 cm

CHEMISTRY: Tholeiitic basalt, 1 analysis in Table 1.

VISUAL DESCRIPTION

Mineralogy: Phenocrysts: aphyric - some px. microphenos
Groundmass: plag., ol., px. op.

Lithology: Brecciated flow top in Core 15, Sect. 3 and 4, mostly massive, 2-3%, 0.5-1 mm vesicles (clay lined and filled), trachytic texture locally

Alteration: Dark clay alteration more abundant in Core 15, Sect. 5

THIN SECTION DESCRIPTION

Phenocrysts: cpx., 1%, 0.3-0.7 mm, euhedral, colorless

Groundmass: Ol., 2%, 0.2-0.3 mm, euhedral, altered; plag., 50%, 0.04-0.4 mm, laths; cpx., 25%, <0.01-0.1 mm, granular, colorless; op., 10%, 0.01-0.1 mm

Texture: Sub-trachytic

Vesicles: 5%, 1-3 mm, filled by green clay

Alteration: 15% clay in vesicles and groundmass

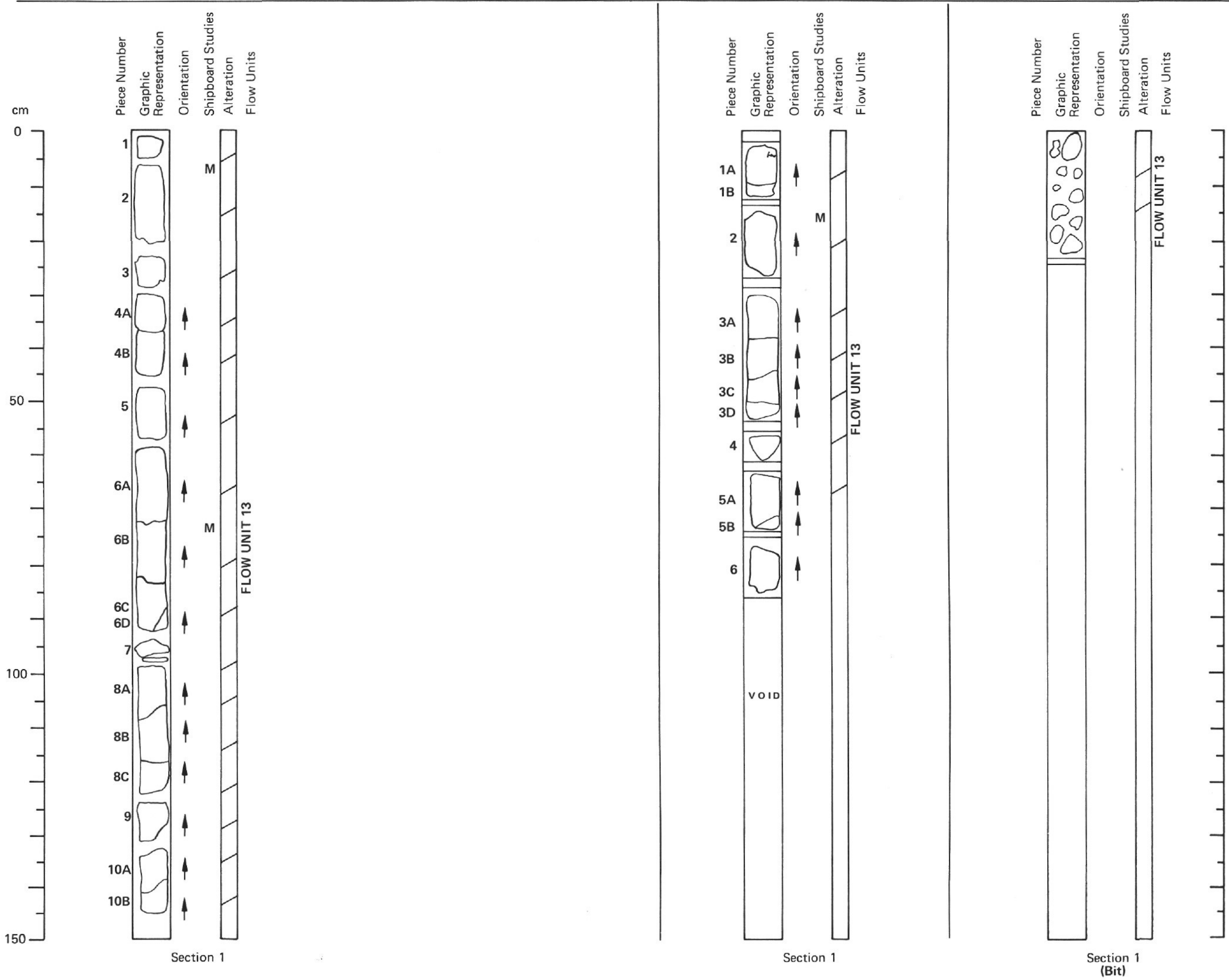
MAGNETIC DATA

Average Inclination: −20.2°

Average Magnetic Intensity (10^{-5} Gauss): 260

VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG **55** SITE **433** HOLE **C** CORE **16** DEPTH **252.0-255.5 m** CORE **17** DEPTH **255.5-258.5 m** CORE **18** DEPTH **258.5-261.5 m**



FLOW UNIT NO. 13:

POSITION: Top - Core 15, Sect. 5, 55 cm; Bottom - Core 19, Sect. 1, 55 cm

CHEMISTRY: Tholeiitic basalt, 1 analysis in Table 1.

VISUAL DESCRIPTION

Mineralogy: Phenocrysts: plag., 2-4%, microphenos, some ol. in lower part. Groundmass: plag., px., op., ol., in upper part

Lithology: Dense (2-4% vesicles) throughout, patches of vesicles, texture locally trachytic or variolitic

Alteration: Moderately altered throughout, clays fill vesicles

THIN SECTION DESCRIPTION

Phenocrysts: Plag., 3%, 0.2-2 mm; cpx., 1%, 0.1-0.5 mm; some plag.-cpx. glomerocrysts

Groundmass: Ol.(?), trace; plag., 45%, 0.05-0.2 mm, laths; cpx., 40%, 0.01-0.05, granular, colorless; op., 10%, 0.01-0.05 mm

Texture: Variolitic to sub-trachytic

Vesicles: None in this section

Alteration: 2-3% clays in groundmass

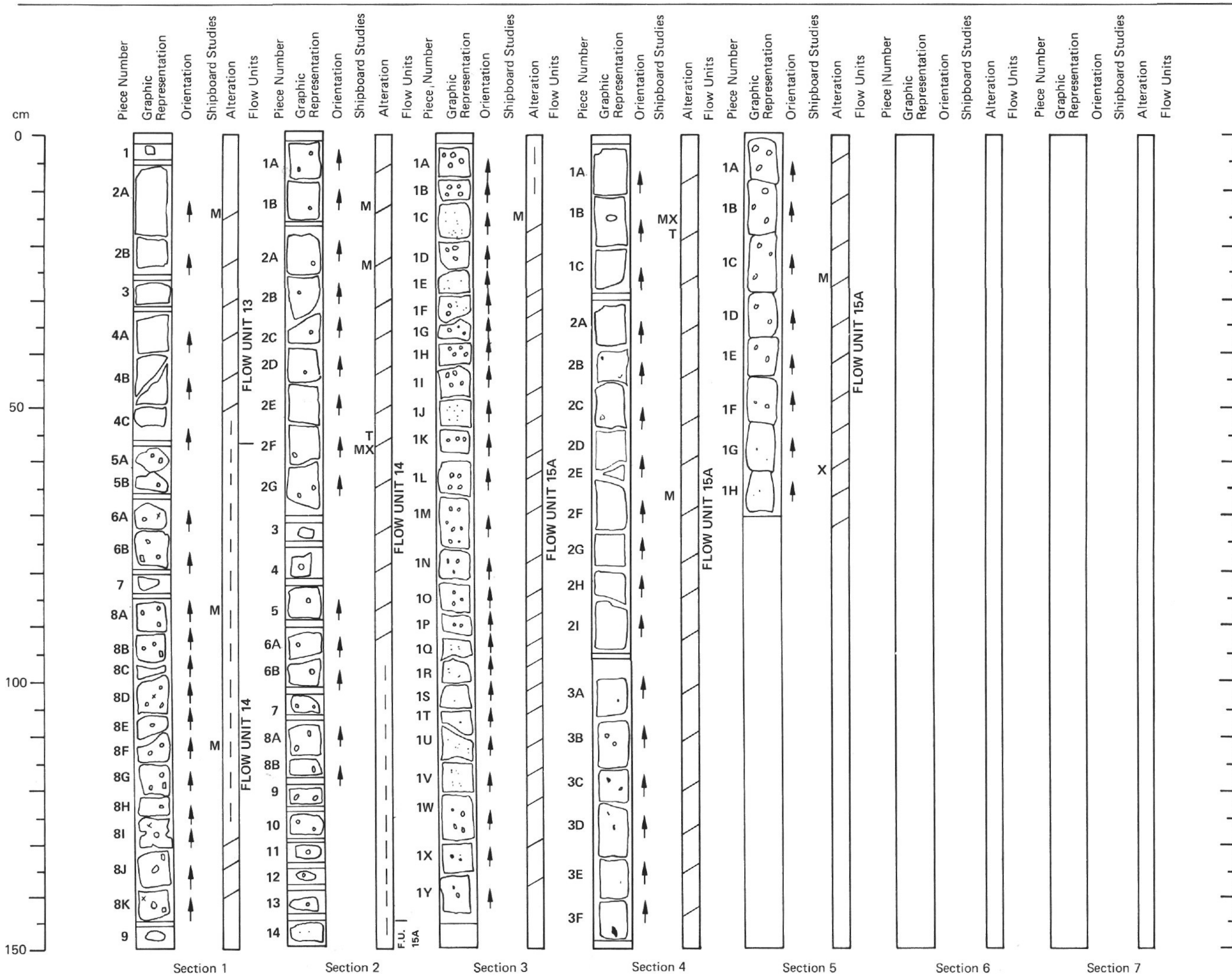
MAGNETIC DATA

Average Inclination: −21.9°

Average Magnetic Intensity (10^{-5} Gauss): 540

VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG **55** SITE **433** HOLE **C** CORE **19** DEPTH **261.5-269.5 m**



FLOW UNIT NO. 14:

POSITION: Top - Core 19, Sect. 1, 56 cm; Bottom - Core 19, Sect. 2, 144 cm

CHEMISTRY: Tholeiitic basalt

VISUAL DESCRIPTION

Mineralogy: Phenocrysts: ol. 1-2%, 0.5-2 mm, some fresh; plag. 2-3%, to 1.5 mm; px., 1%, 0.5-0.7 mm
Groundmass: plag., ol., px. op., glass (altered)

Lithology: Oxidized, vesicular flow top in Core 19, Sect. 1 (to 25% vesicles) grading downward to a more massive center (2-5% vesicles), and a more vesicular (to 25% vesicles) bottom. Bottom slightly oxidized.

Alteration: Ol. partially altered, groundmass moderately to extensively altered.

THIN SECTION DESCRIPTION

Phenocrysts: Ol., <1%, 0.5-1.5 mm, subhedral; plag., 3-5%, 0.5-2.0 mm, tabular; cpx., 1-2%, 0.5-1 mm, subhedral

Groundmass: Ol., 10%, 0.1-0.4 mm, subhedral; plag., 45%, 0.3-0.5 mm; cpx., 15-20%, 0.05-0.4 mm, interstitial; op., 10-15%; glass 5-7% (altered).

Texture: Interstitial

Vesicles: None in this section.

Alteration: 15% clay in groundmass; some even totally altered to clay.

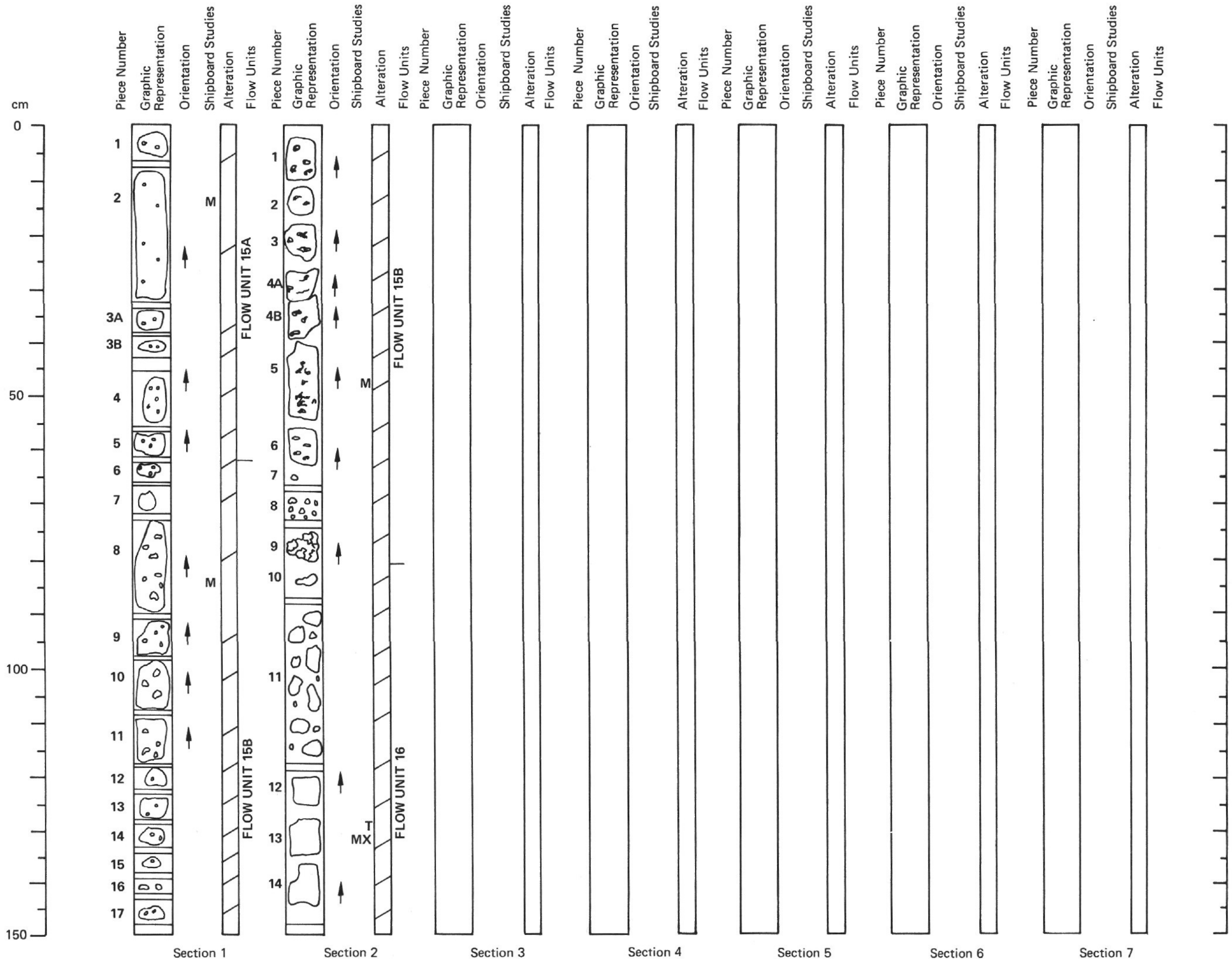
MAGNETIC DATA

Average Inclination: −24.4°

Average Magnetic Intensity (10^{-5} Gauss): 105

VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG **55** SITE **433** HOLE **C** CORE **20** DEPTH **269.5-279.0 m**



FLOW UNIT NO. 15:

POSITION: Top - Core 19, Sect. 2, 146 cm; Bottom - Core 20, Sect. 2, 83 cm

CHEMISTRY: Tholeiitic basalt, 1 analysis in Table 1.

VISUAL DESCRIPTION

Mineralogy: Phenocrysts: ol., 1-2%, to 1.5 mm; plag., 1-2%, to 1.2 mm; px., <1%, 0.5-0.7 mm
Groundmass: plag., ol., px., op., altered glass

Lithology: Oxidized and vesicular flow top in Core 19, Sect. 2 and 3 (to 25% vesicles), massive (to 0% vesicles) in Core 19, Sect. 4, 5 and 6; vesicular sub-flow unit top in Core 20, Sect. 1, continues vesicular to bottom; bottom rubbly.

Alteration: Some ol. fresh, groundmass moderately altered to clay, vesicles filled or lined by clay

THIN SECTION DESCRIPTION

Phenocrysts: Ol., 10%, 0.5-1.5 mm, euhedral to subhedral; plag., 1-2%, 0.5-1.5 mm; cpx., 0.5-1%, 0.5-0.7 mm, euhedral

Groundmass: Ol., 5%, 0.1-0.4 mm, subhedral; plag., 40%, 0.4-1.0 mm; cpx., 20%, 0.1-0.7 mm, op., 10%, glass, 12-15% (altered)

Texture: Sub-ophitic

Alteration: Ol. altered to iddingsite, 10% in groundmass, zeolites(?) in groundmass - some areas completely altered

MAGNETIC DATA

Average Inclination: –50.3°

Average Magnetic Intensity (10^{-5} Gauss): 371

FLOW UNIT NO. 16:

POSITION: Top - Core 20, Sect. 2, 84 cm; Bottom - Core 21, Sect. 2, 60 cm

CHEMISTRY: Tholeiitic basalt, 1 analysis in Table 1.

VISUAL DESCRIPTION

Mineralogy: Phenocrysts: essentially aphyric, rare microphenos of ol. and plag.
Groundmass: variolitic to trachytic, ol. (fresh), plag. px., opaques

Lithology: Flow top 5-10%, vesicles (clay filled) - Core 21, Sect. 2 more vesicular bottom, and slightly oxidized

Alteration: Fresh to moderately altered

THIN SECTION DESCRIPTION

Phenocrysts: Plag., 1%, to 1 mm, tabular

Groundmass: Ol., 10%, 0.1-0.5 mm, subhedral; plag. 45%, 0.3-0.8 mm; cpx., 15%, <0.1 mm, anhedral; op., 15%; glass, 15%, altered

Texture: Interstitial

Vesicles: 5%, clay filled

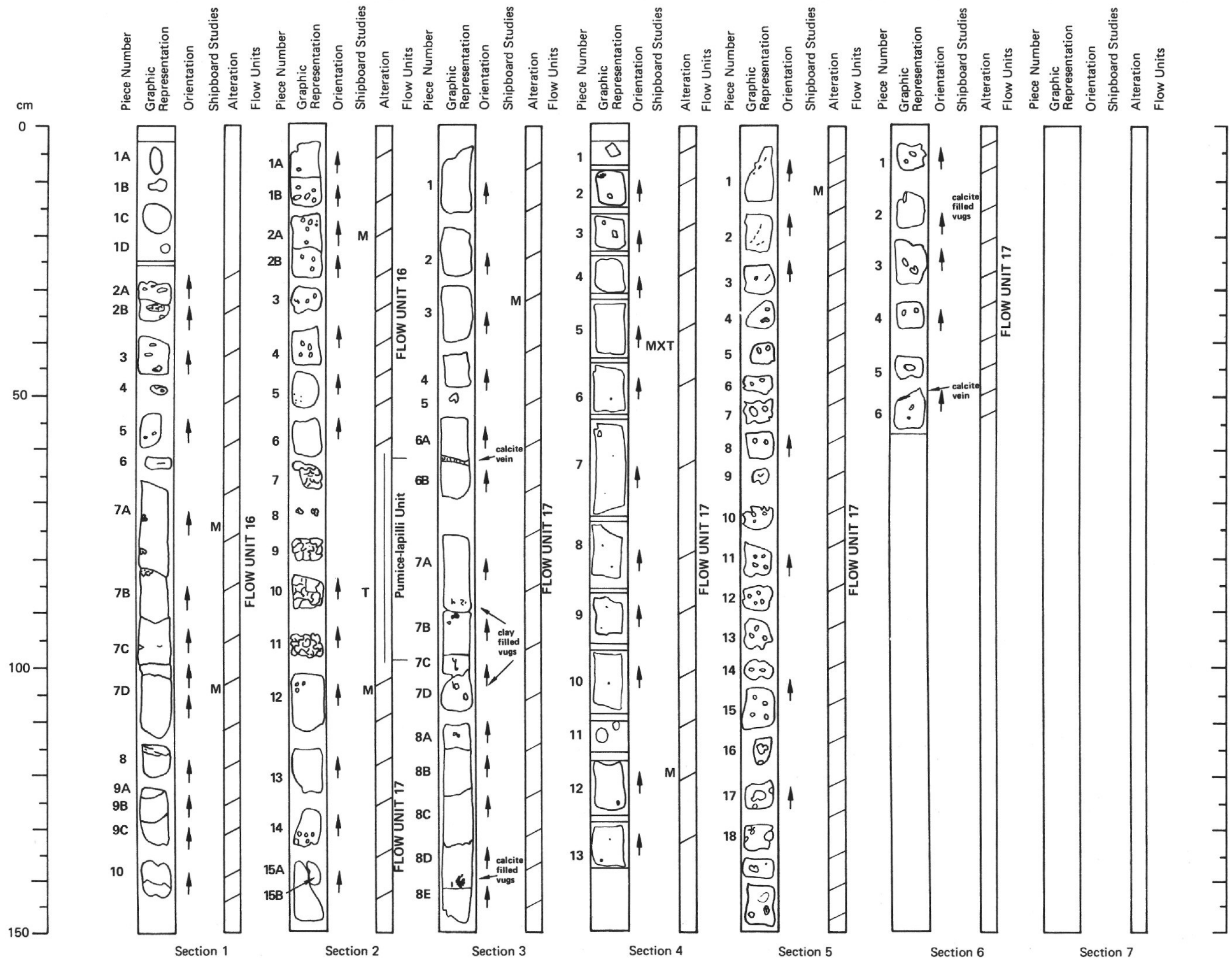
Alteration: Ol. altered, 15-20% clay in groundmass; some nearly totally altered areas.

MAGNETIC DATA

Averagine Inclination: –58.5°

Average Magnetic Intensity (10^{-5} Gauss): 585

LEG **55** SITE **433** HOLE **C** CORE **21** DEPTH **279.0-288.5 m**



Core 21, Sect. 2, 60-98 cm, is a layer of pumice lapilli oxidized red and brown cemented by calcite. The basalt is aphanitic and variolitic.

FLOW UNIT NO. 17:

POSITION: Top - Core 21, Sect. 2, 100 cm; Bottom - Core 22, Sect. 1, 63 cm

CHEMISTRY: Tholeiitic basalt, 1 analysis in Table 1.

VISUAL DESCRIPTION

Mineralogy: Phenocrysts: <1% plag.; <1% ol. and px. below Core 21, Sect. 5
Groundmass: ol., px. plag., op.

Lithology: Top 5-10% vesicles, clay filled; mostly massive (5-20% vesicles) to bottom

Alteration: 15 to 30% clay in groundmass

THIN SECTION DESCRIPTION

Phenocrysts: Ol., 1%, 0.4-0.6 mm, subhedral; plag., 2-3%, anhedral; cpx., <1%, 0.5-0.9 mm, subhedral

Groundmass: Ol., 5%, 0.1-0.3 mm; plag. 30%, 0.2-0.5 mm, microlites; cpx., 10%, 0.02-0.03 mm, glass, 30% altered

Texture: Microlitic

Vesicles: 5-7%, filled by dark clay

Alteration: 50% clay in groundmass and vesicles

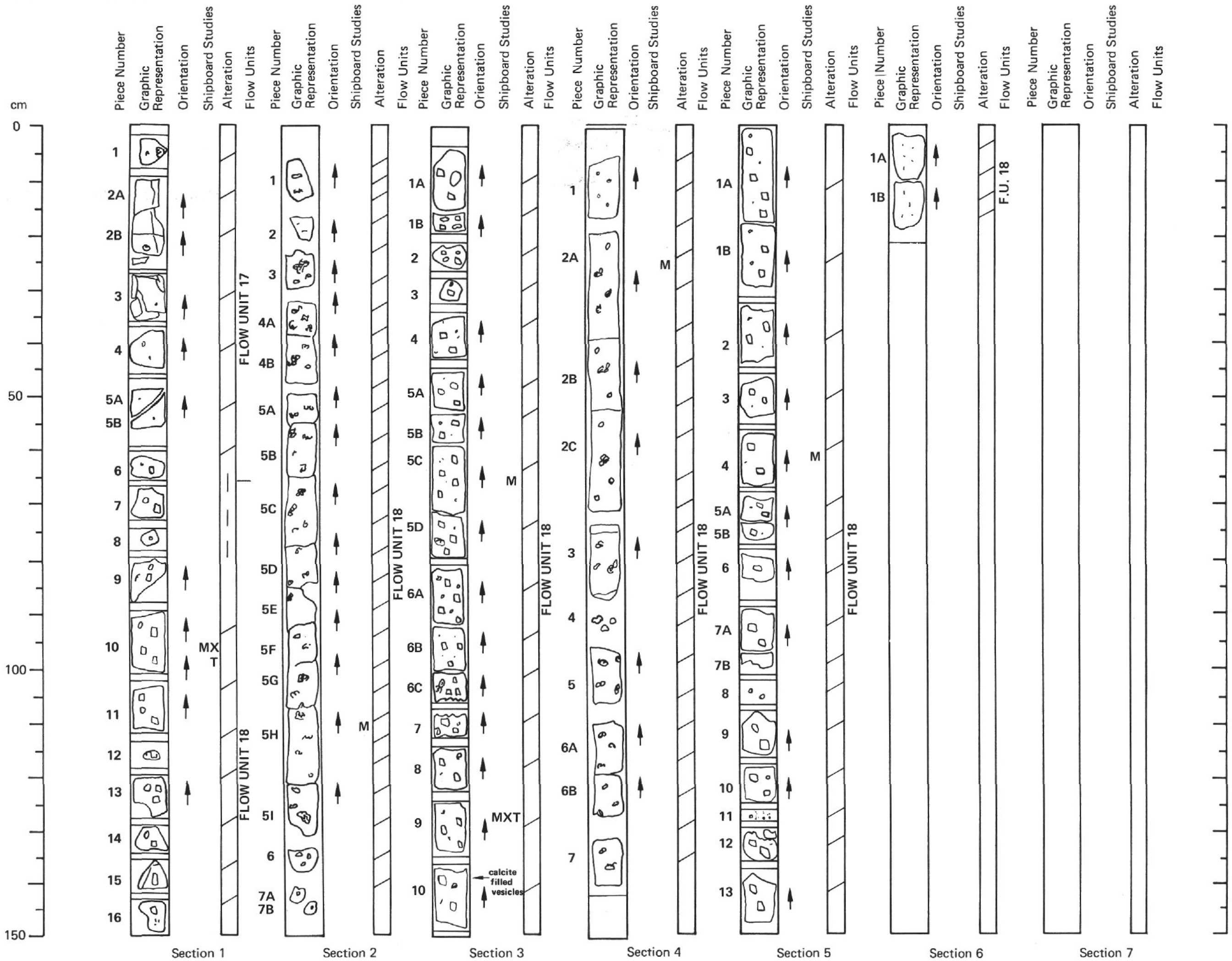
MAGNETIC DATA

Average Inclination: $-61°$

Average Magnetic Intensity (10^{-5} Gauss): 384

VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG 55 SITE 433 HOLE C CORE 22 DEPTH 288.5-298.0 m



FLOW UNIT NO. 18:

POSITION: Top - Core 22, Sect. 1, 65 cm; Bottom - Core 22, Sect. 6, 20 cm

CHEMISTRY: Tholeiitic basalt, 1 analysis in Table 1.

VISUAL DESCRIPTION

Mineralogy: Phenocrysts: plag. 7-10%, 1-2 mm; ol. (some fresh) and px. microphenos at top and ol. at bottom
Groundmass: plag., px. ol., op.

Lithology: Oxidized and brecciated flow top in Sect. 1 of Core 22, mostly 10-20% vesicles throughout.

Alteration: Ol. partially to clay and iddingsite, ≈5% dark clay in groundmass

THIN SECTION DESCRIPTION

Phenocrysts: Plag., 3%, 0.5-1.5 mm, subhedral to tabular; ol., 0.5-2.0 mm, subhedral, altered

Groundmass: Ol., 10%, 0.1-0.4 mm, subhedral; plag., 35-40%, 0.2-0.7 mm, laths and microlites; cpx., 15%, 0.04-0.2 mm, granular; op., 10%; glass 10-15%, altered

Texture: Microlitic

Vesicles: 5-20%, 0.1-2 mm, clay and zeolite filled

Alteration: Ol. to iddingsite and clay, 20-30% clay in groundmass

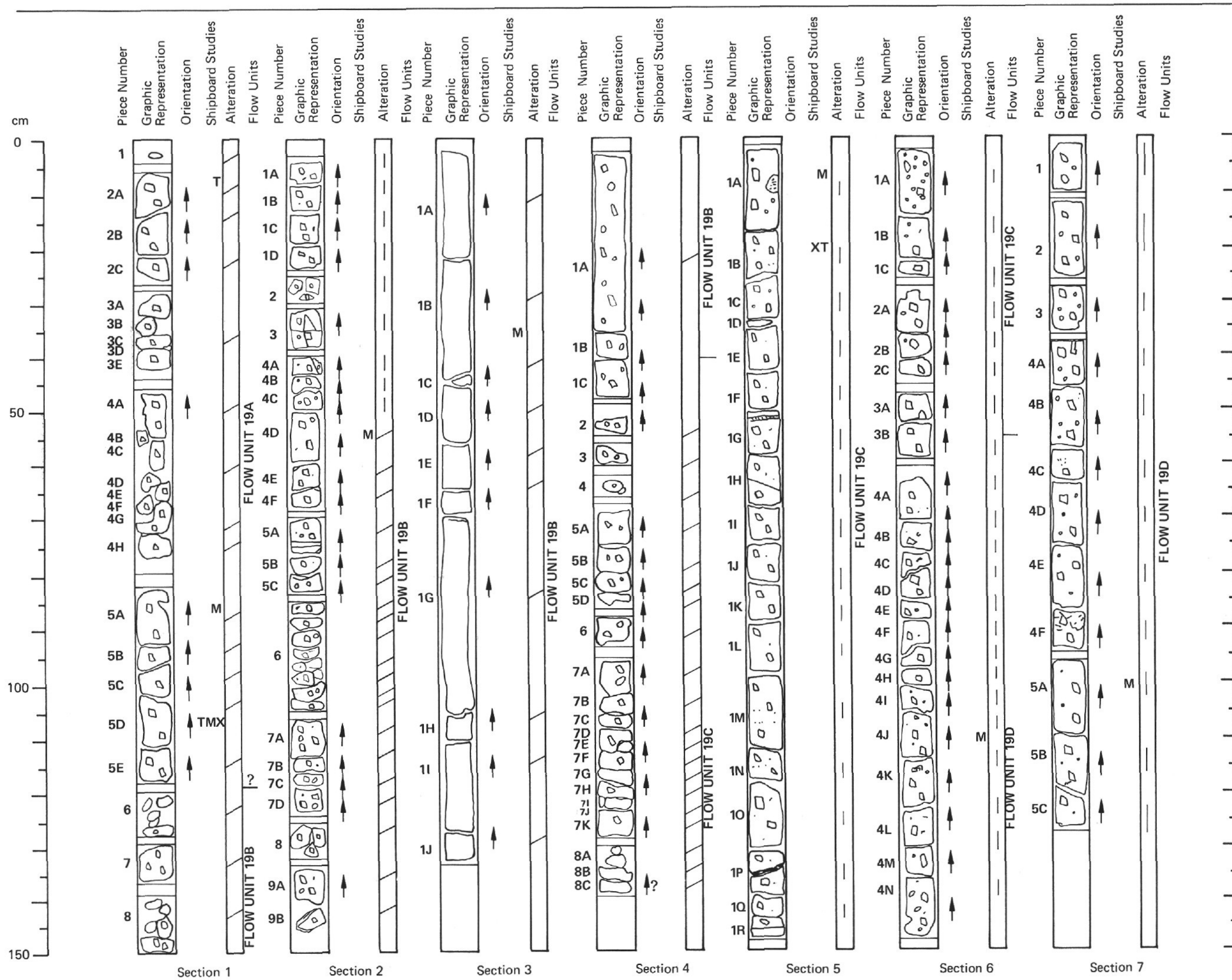
MAGNETIC DATA

Average Inclination: −42.0°

Average Magnetic Intensity (10^{-5} Gauss): 290

VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG **55** SITE **433** HOLE **C** CORE **23** DEPTH **298.0-307.5 m**



FLOW UNIT NO. 19:

POSITION:	Top - Core 23, Sect. 1, 0 cm; Bottom - Core 25, Sect. 1, 66 cm
CHEMISTRY:	Tholeiitic basalt to tholeiitic picrite, 4 analyses in Table 1.

VISUAL DESCRIPTION

Mineralogy:	Phenocrysts: ol., 7-15%, 1-2 mm, some fresh Groundmass: ol., plag., px., op., clay
Lithology:	4 sub-units based on changes in vesicularity, mineralogy, and oxidation; 5-30% vesicles, 1-30 mm, mostly clay and calcite filled
Alteration:	Groundmass moderately altered to clays; fresh ol. in Core 23, Sect. 3, Core 24, Section 7 and Core 24, Sect. 8.

THIN SECTION DESCRIPTION

Phenocrysts:	Ol. 5-35%, 0.5-5 mm, euhedral to subhedral, mostly altered (some fresh); cpx. (microphenos), 0.5-0.8 mm, 0 to ≪1%, anhedral, fresh
Groundmass:	Ol., 1-10%, 0.05 to 0.5 mm, subhedral, altered; plag. 15-35%, 0.05-1.0 mm; cpx. 5-25%, 0.02-0.5 mm, anhedral to sub-ophitic; op., 5-10%; glass (altered) 5-45%.
Texture:	Vitrophyric to sub-ophitic
Vesicles:	0-15%, to 3 mm, clay filled or lined
Alteration:	3 to 55% clay in groundmass, ol. mostly altered

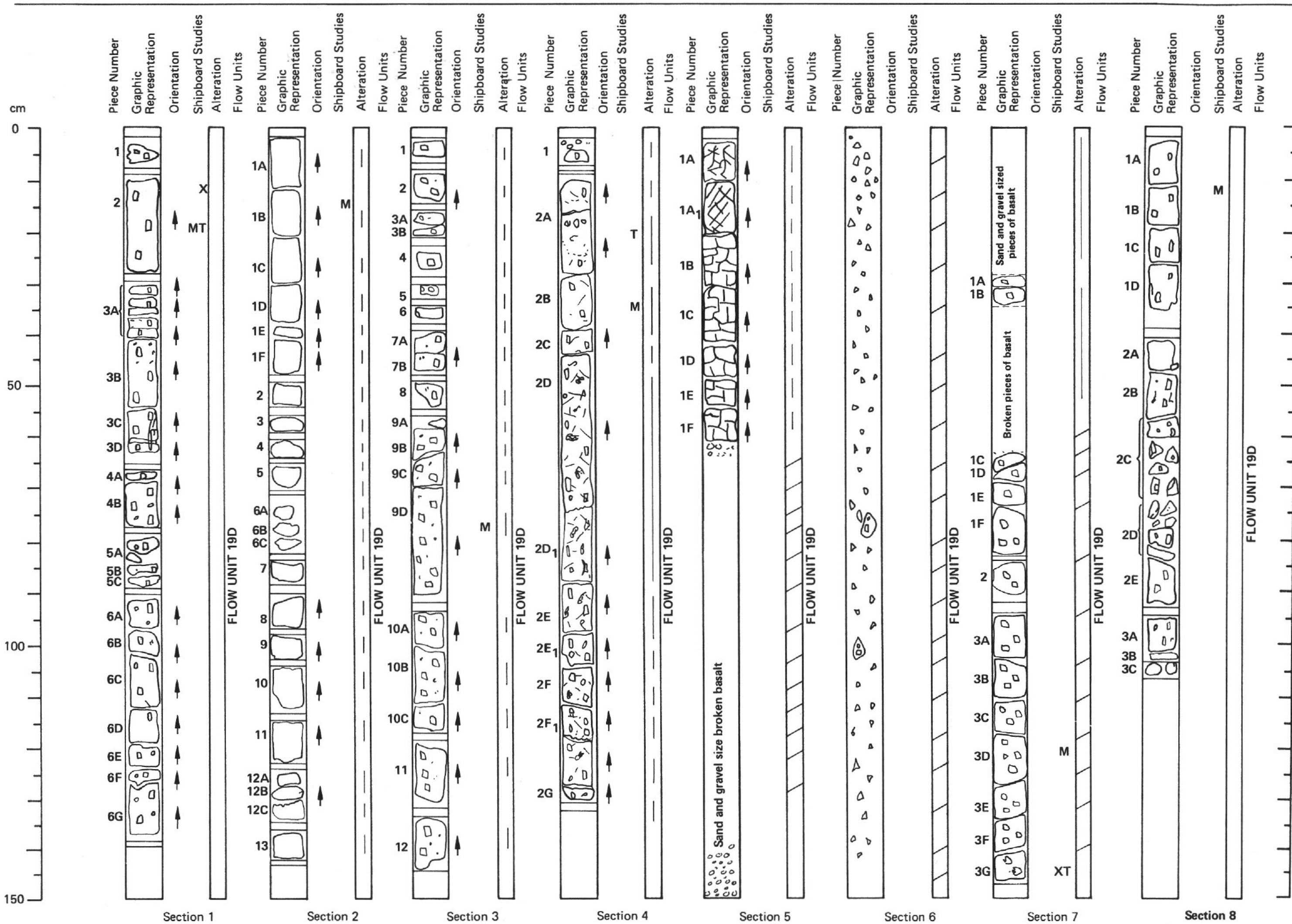
MAGNETIC DATA

Averagine Inclination: −38.2°

Average Magnetic Intensity (10^{-5} Gauss): 421

VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

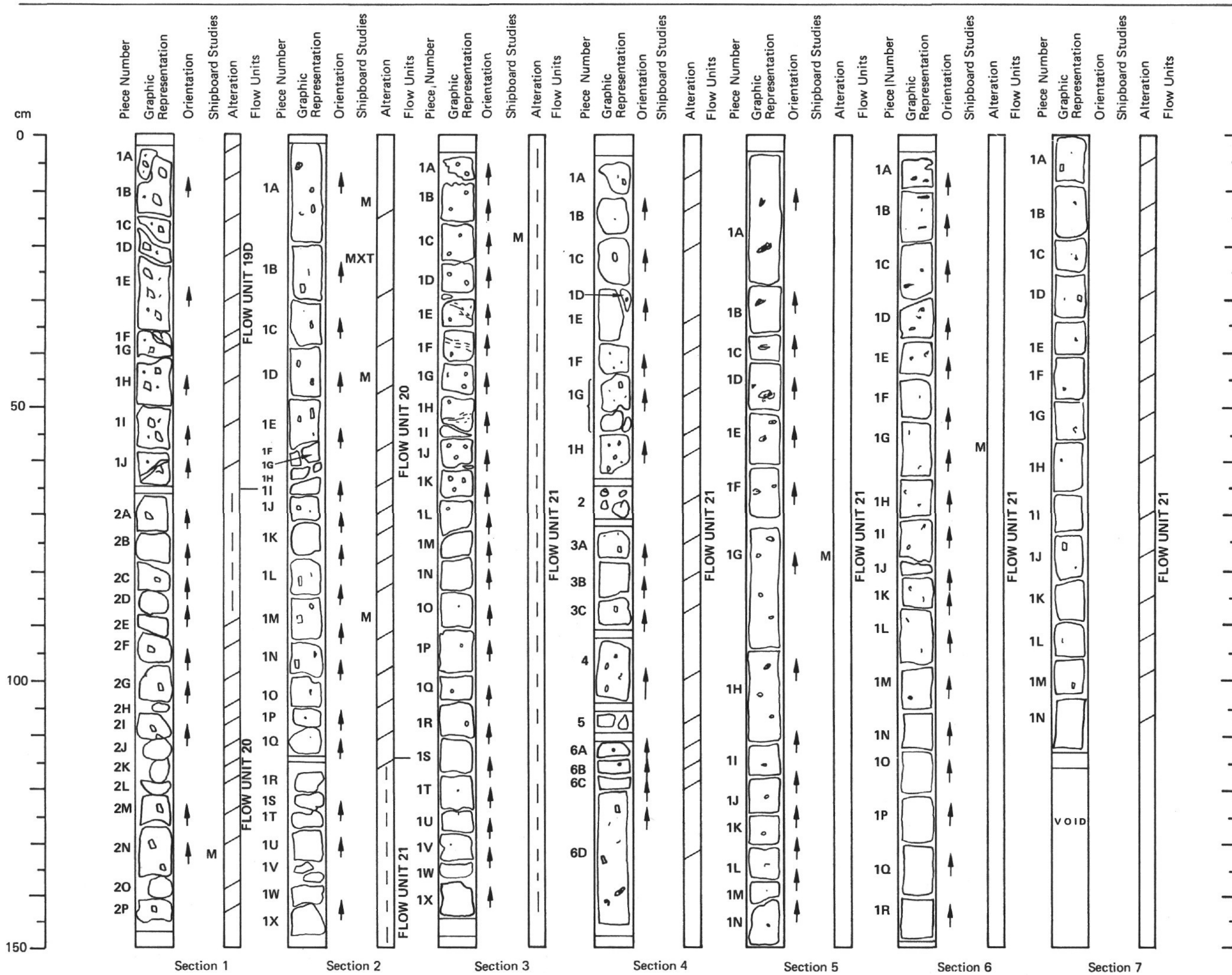
LEG **55** SITE **433** HOLE **C** CORE **24** DEPTH **307.5-317.0 m**



All Flow Unit 19, continued from Core 23.

All Flow Unit 19, continued from Core 23.

LEG **55** SITE **433** HOLE **C** CORE **25** DEPTH **317.0-326.5 m**



FLOW UNIT NO. 20:

POSITION:	Top - Core 25, Sect. 1, 68 cm; Bottom - Core 25, Sect. 2, 118 cm
CHEMISTRY:	Tholeiitic basalt, 1 analysis in Table 1.

VISUAL DESCRIPTION

Mineralogy:	Phenocrysts: ol., 1%, 0.5-1.5 mm, altered Groundmass: ol., plag., px., op.
Lithology:	Oxidized and vesicular flow top grades downward into a more massive (5-10% vesicles) and non-oxidized center and bottom
Alteration:	Ol. altered, vesicles filled and lined by clay

THIN SECTION DESCRIPTION

Phenocrysts:	Ol., 1-2%, 0.4-0.6 mm, subhedral, altered
Groundmass:	Ol., 10-15%, 0.1-0.4 mm, subhedral, altered; plag., 30%, 0.1-0.3 mm, cpx., 15%, 0.05 + 0.2 mm; op., 10%, glass (altered) 30%
Texture:	Interstitial to sub-ophitic
Vesicles:	None in this section
Alteration:	35% clay after glass and ol., ol. also to iddingsite

MAGNETIC DATA

Average Inclination: −40.3°

Average Magnetic Intensity (10^{-5} Gauss): 124

FLOW UNIT NO. 21:

POSITION:	Top - Core 25, Sect. 2, 119 cm; Bottom - Core 26, Sect. 3, 95 cm
CHEMISTRY:	Tholeiitic basalt, 1 analysis in Table 1.

VISUAL DESCRIPTION

Mineralogy:	Phenocrysts: ol., 0.5-1.5 mm, 3-5%, some fresh Groundmass: ol., plag., px., op.
Lithology:	Vesicles 0-15%, top more vesicular and slightly altered, zones of oxidation throughout
Alteration:	Moderately to extensively altered throughout, clay in groundmass ol. to iddingsite and clay

THIN SECTION DESCRIPTION

Phenocrysts:	Ol., 2%, 0.4-2.0 mm, subhedral, altered
Groundmass:	Ol., 5-10%, 0.1-0.4 mm, subhedral, altered; plag., 35%, 0.1-1 mm, microlites and laths; cpx. 15-25%, 0.05-0.2 mm; op., 10%; altered glass, 25-35%
Texture:	Interstitial to sub-ophitic
Vesicles:	None in this section
Alteration:	25-35% clay in groundmass; ol. to iddingsite and clay

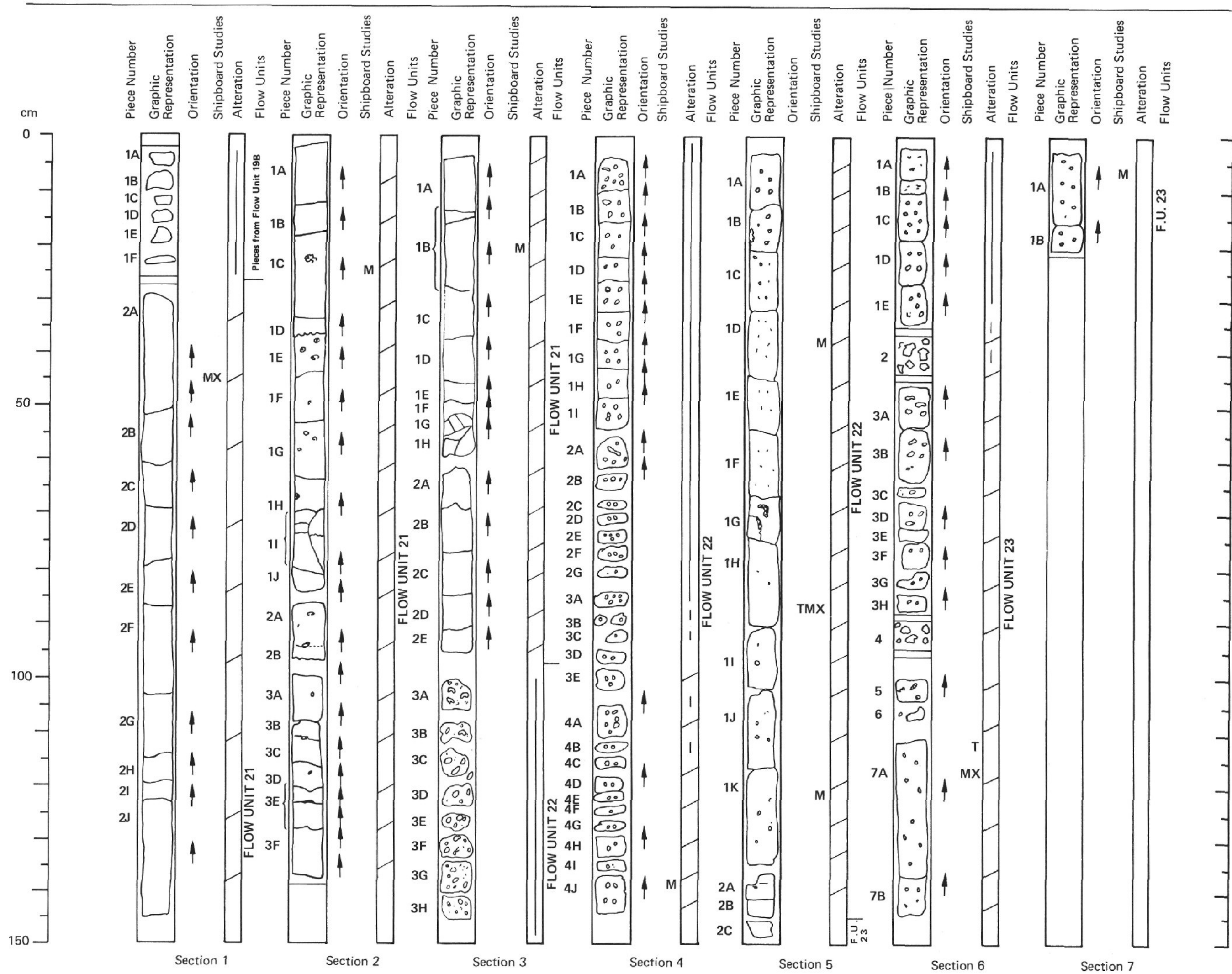
MAGNETIC DATA

Average Inclination: −37.5°

Average Magnetic Intensity (10^{-5} Gauss): 324

VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG **55** SITE **433** HOLE **C** CORE **26** DEPTH **326.5-336.0 m**



FLOW UNIT NO. 22:

POSITION: Top - Core 26, Sect. 3, 100 cm; Bottom - Core 26, Sect. 5, 145 cm

CHEMISTRY: Tholeiitic basalt, 1 analysis in Table 1.

VISUAL DESCRIPTION

Mineralogy: Phenocrysts: ol., 0.5-3 mm, 15%, some fresh
Groundmass: ol., plag., px. op.

Lithology: Oxidized and vesicular (20%) top in Sect. 3 and 4 of Core 26. Grades downward into a more massive and non-oxidized center and bottom.

Alteration: Clay in groundmass and filling vesicles; ol. to iddingsite; upper part extensively altered.

THIN SECTION DESCRIPTION

Phenocrysts: Ol., 10%, 0.5-2.5 mm, euhedral to subhedral, some fresh

Groundmass: Ol., 3-5%, 0.1-0.4 *mm, subhedral, altered; plag.*, 35%, 0.3-1.0 mm, laths; cpx., 30%; op. 5-7%, glass (altered) 15%

Texture: Sub-ophitic

Alteration: 15% clay after glass, ol. iddingsitized and altered to clay

MAGNETIC DATA

Average Inclination: –42.0°

Average Magnetic Intensity (10^{-5} Gauss): 205

FLOW UNIT NO. 23:

POSITION: Top - Core 26, Sect. 5, 145 cm; Bottom - Core 26, Sect. 7, 21 cm

CHEMISTRY: Tholeiitic basalt, 1 analysis in Table 1.

VISUAL DESCRIPTION

Mineralogy: Phenocrysts: ol. (microphenos), 0-25%, 0.5 mm, altered
Groundmass: ol. (some fresh) plag., px., op.

Lithology: Vesicles 10-25% throughout, ol. microphenos mostly at bottom

Alteration: Clay in groundmass and filling vesicles, calcite in vesicles

THIN SECTION DESCRIPTION

Phenocrysts: Ol., 5%, 0.5-0.9 mm, euhedral, altered

Groundmass: Ol., 15%, 0.1-0.5 mm, subhedral to euhedral; plag., 35%; cpx., 20%, 0.2-1 mm, ophitic; op., 5%, 0.05-0.15 mm

Texture: Ophitic, sub-trachytic

Alteration: 20% clay after glass in groundmass and 10% clays after ol., ol. iddingsitized

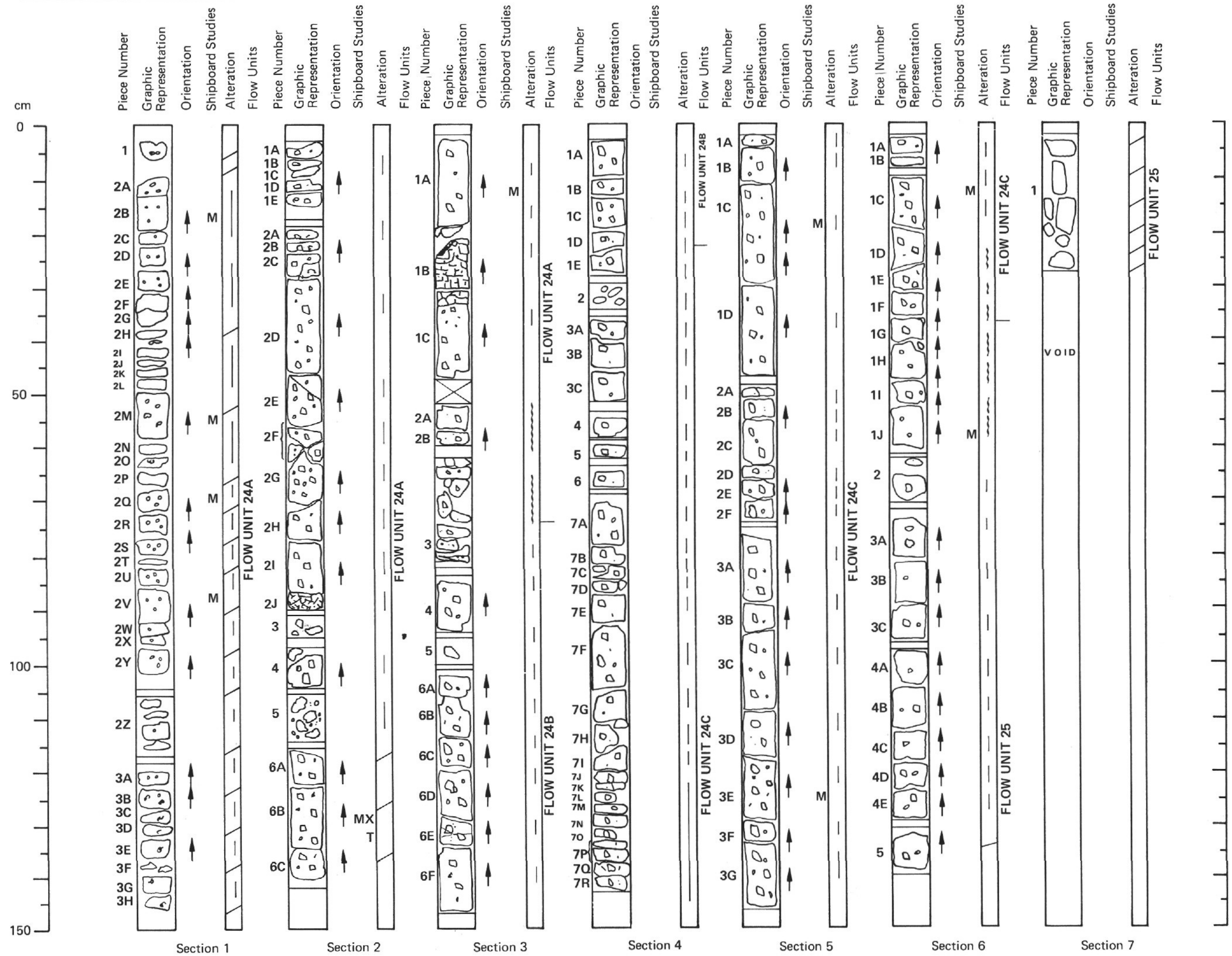
MAGNETIC DATA

Average Inclination: –39.2°

Average Magnetic Intensity (10^{-5} Gauss): 128

VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG **55** SITE **433** HOLE **C** CORE **27** DEPTH **336.0-345.5 m**



FLOW UNIT NO. 24:

POSITION:	Top - Core 27, Sect. 1, 10 cm; Bottom - Core 27, Sect. 6, 37 cm
CHEMISTRY:	Tholeiitic picrite, 1 analysis in Table 1.

VISUAL DESCRIPTION

Mineralogy:	Phenocrysts: ol., 15-20% in upper part, 5% in lower (some fresh) Groundmass: ol., plag., px., op., variolitic
Lithology:	5-30% vesicles throughout, 3 sub-units based on changes in color, vesicularity, and grain size
Alteration:	Moderately to extensively altered throughout.

THIN SECTION DESCRIPTION

Phenocrysts:	Ol., 30%, 0.2-5 mm, euhedral, partially altered
Groundmass:	Ol., 10%, 0.1-0.2 mm euhedral; plag. 25%, 0.1-1.0 mm, skeletal; cpx., 15%, 0.1-0.3 mm, skeletal; op., 10%, 0.03-0.1 mm, skeletal
Texture:	Variolitic to intergranular
Alteration:	10% clay after glass in groundmass; 30% clay after ol. and plag.

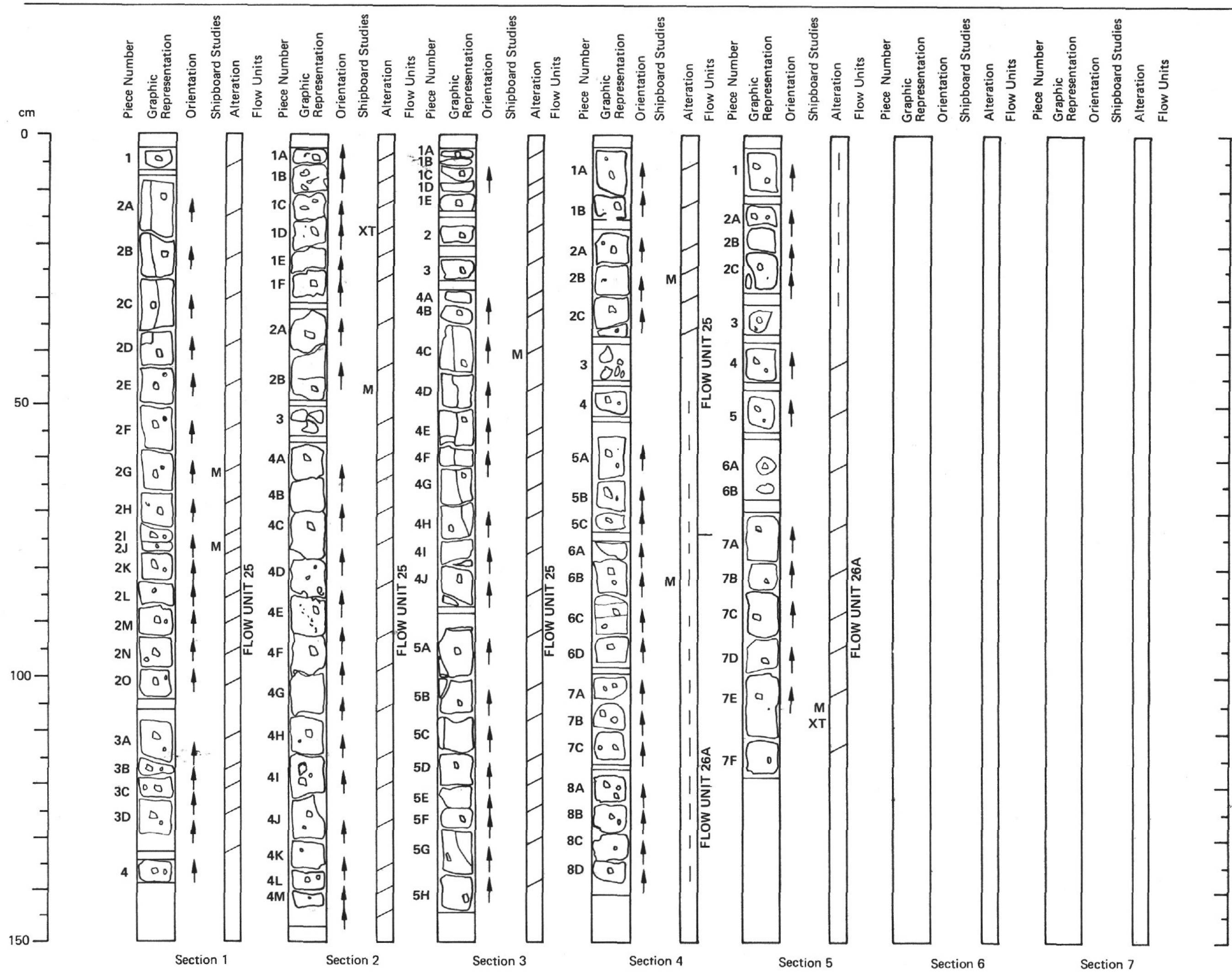
MAGNETIC DATA

Average Inclination: −34.2°

Average Magnetic Intensity (10^{-5} Gauss): 121

VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG 55 SITE 433 HOLE C CORE 28 DEPTH 345.5-355.0 m



FLOW UNIT NO. 25:

POSITION: Top - Core 22, Sect. 6, 39 cm; Bottom - Core 28, Sect. 4, 73 cm

CHEMISTRY: Tholeiitic basalt, 1 analysis in Table 1.

VISUAL DESCRIPTION

Mineralogy: Phenocrysts: ol., 1%, 1-3 mm, some fresh; plag., 10%, 0.5-7 mm, px., <1% microphenos
Groundmass: ol., plag., px., op.

Lithology: *Core 27, Sect. 6 contains a brecciated, oxidized, and* vesicular flow top. Vesicles increase in size and decrease in abundance downward (<5% in center). Bottom is oxidized.

Alteration: Clay in groundmass and filling vesicles; ol. partially altered.

THIN SECTION DESCRIPTION

Phenocrysts: Ol., 2%, 0.2-2.5 mm, euhedral; plag., 18%, 0.2-4 mm, euhedral, cpx., 5%, 0.15-2.0 mm, euhedral; some glomerocrysts of all through

Groundmass: Plag., 25%, 0.02-0.2 mm, laths; cpx., 20%, 0.04-0.1 mm, anhedral, op., 3%, 0.01-0.1 mm, subhedral

Texture: Interstitial

Vesicles: 2%, 0.4-0.8 mm, clay filled

Alteration: 25% clay in groundmass after glass and after ol. phenos.

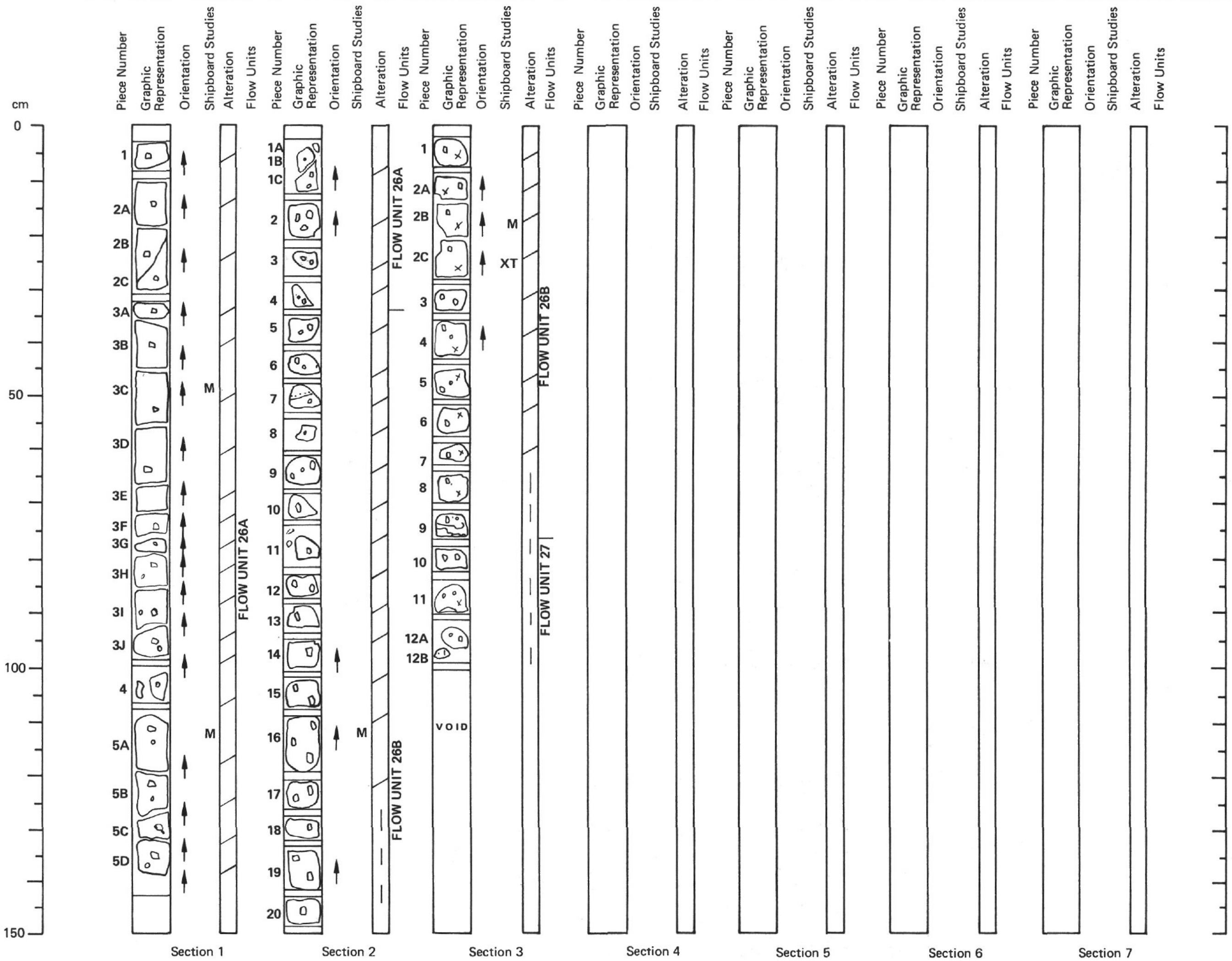
MAGNETIC DATA

Average Inclination: $-68.3°$

Average Magnetic Intensity (10^{-5} Gauss): 239

VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG **55** SITE **433** HOLE **C** CORE **29** DEPTH **355.0-364.5 m**



FLOW UNIT NO. 26:

POSITION: Top - Core 28, Sect. 4, 75 cm; Bottom - Core 29, Sect. 3, 73 cm

CHEMISTRY: Tholeiitic, 2 analyses in Table 1.

VISUAL DESCRIPTION

Mineralogy: Phenocrysts: ol., < 1%, 1-2 mm; plag. 2% in 26A, 5% in 26B; 1-3 mm; px., < 1%
Groundmass: ol., plag., px., op.

Lithology: Oxidized and vesicular top (30% vesicles) in Core 28, Sect. 4 and 5 and in Core 29, Sect. 2. Two sub-units based on changes in mineralogy, vesicles, and oxidation - should be two separate units.

Alteration: Clay in groundmass and filling vesicles - some ol. fresh throughout.

THIN SECTION DESCRIPTION

Phenocrysts: Ol., 2-5%, to 2.5 mm euhedral; plag., 5-7%, to 2 mm, euhedral; cpx., 5%, to 2 mm, euhedral

Groundmass: Plag., 30%, 0.03-0.5 mm, skeletal laths; cpx., 20%, 0.03-0.5 mm, granular; op., 5%, 0.04-0.4 mm, subhedral; ol.(?) altered, 0-15%

Texture: Interstitial, variolitic to sub-trachytic

Vesicles: 0-10%, 0.4-2 mm, clay filled

Alteration: Ol. altered to clay and iddingsite, 20% clay in groundmass

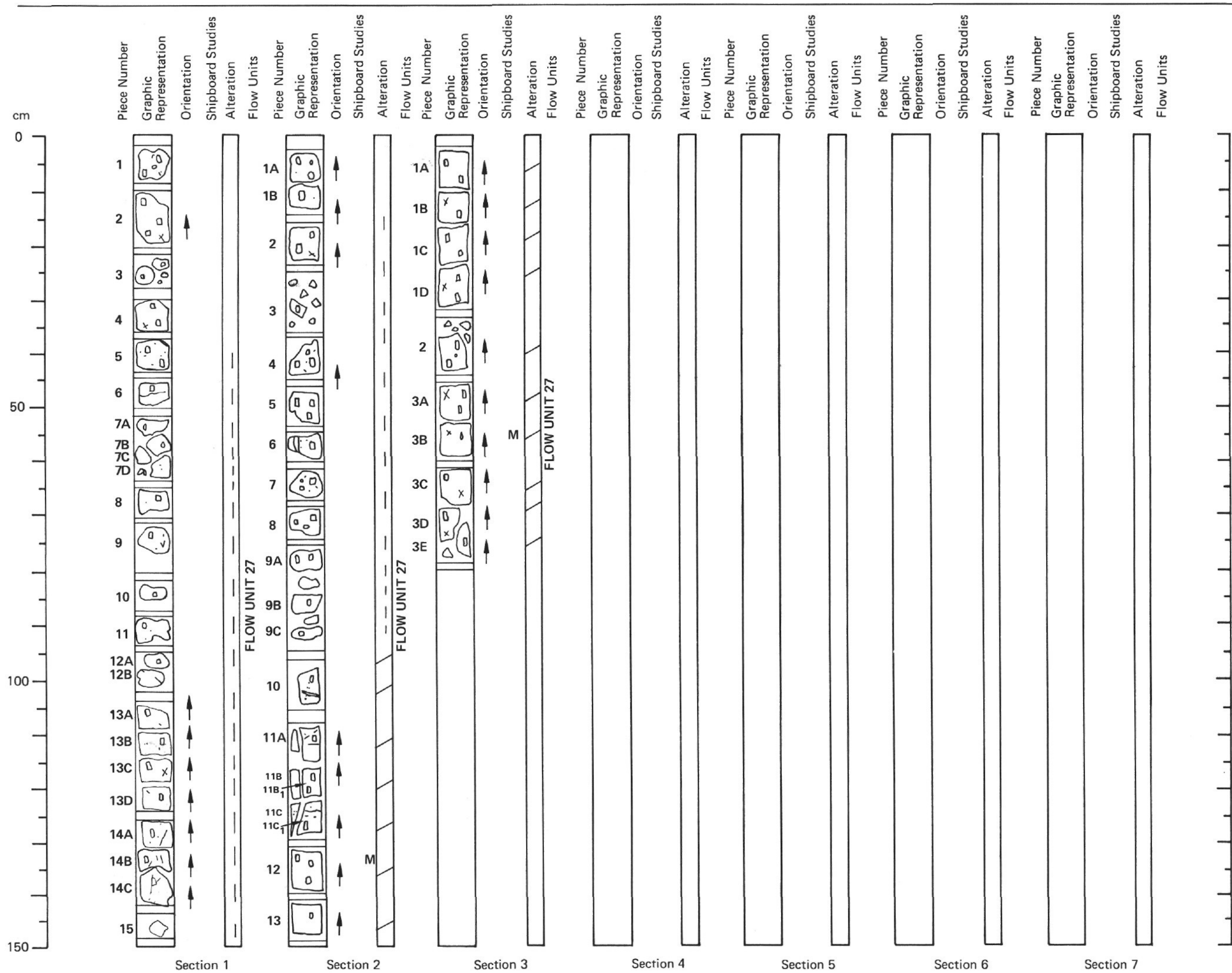
MAGNETIC DATA

Average Inclination: $-68.1°$ (26A), $-20°$ (26B)

Average Magnetic Intensity (10^{-5} Gauss): 206 (26A), 526 (26B)

VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG **55** SITE **433** HOLE **C** CORE **30** DEPTH **364.5-374.0 m**



FLOW UNIT NO. 27:

POSITION:	Top - Core 29, Sect. 3, 74 cm; Bottom - Core 31, Sect. 2, 59 cm
CHEMISTRY:	Tholeiitic basalt, 1 analysis in Table 1.

VISUAL DESCRIPTION

Mineralogy:	Phenocrysts: ol., 15%, fresh, 1-2 mm; plag. 4%, 1-2 mm, px., 1%, 1-2 mm Groundmass: ol., plag., px., op.
Lithology:	Oxidized and vesicular top in Core 29, Sect. 3 and Core 30, Sect. 1, massive and fresh center, and then oxidized bottom in Core 31, Sect. 2.
Alteration:	Clay in groundmass, ol. mostly to partially fresh throughout.

THIN SECTION DESCRIPTION

Phenocrysts:	Ol., 5%, 0.5-1.0 mm, anhedral, fresh with clay rims; plag., 2%, 0.5-1.5 mm
Groundmass:	Ol., 2%, 0.1-0.5 mm, granular; plag., 40%, 0.05-0.5 mm; cpx., 36%, 0.01-0.1 mm, granular; op., 10%, 0.01-0.1 mm; apatite, < 1%, needles
Texture:	Intergranular
Vesicles:	None in this section.
Alteration:	3-5% interstitial clay after glass, ol., and plag.

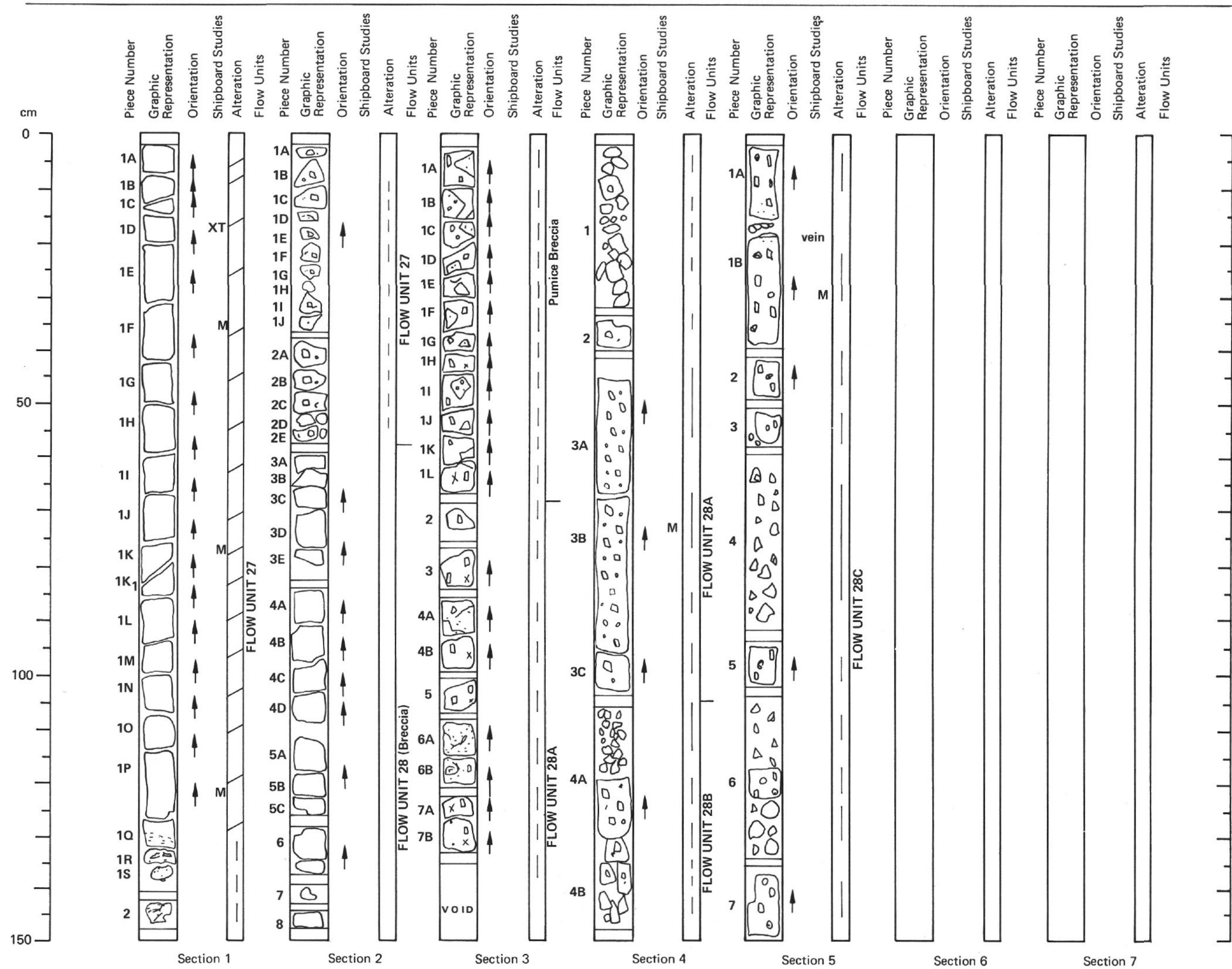
MAGNETIC DATA

Average Inclination: −62.7°

Average Magnetic Intensity (10^{-5} Gauss): 567

VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG **55** SITE **433** HOLE **C** CORE **31** DEPTH **374.0-383.5 m**



Core 31, Sect. 2, 61 cm to Core 31, Sect. 3, 68 cm is an oxidized and vesicular air fall breccia cemented by calcite not included in any Flow Unit.

FLOW UNIT NO. 28:

POSITION: Top - Core 31, Sect. 3, 70 cm; Bottom - Core 32, Sect. 3, 112 cm

CHEMISTRY: Tholeiitic picrite, 1 analysis in Table 1.

VISUAL DESCRIPTION

Mineralogy: Phenocrysts: ol., 25%, to 7 mm, altered
Groundmass: plag., ol., px. op.

Lithology: 15-25% vesicles throughout; flow top slightly oxidized, but also oxidized throughout - six sub-units based on changes in oxidization, vesicularity, and mineralogy

Alteration: Extensively altered throughout.

THIN SECTION DESCRIPTION

Phenocrysts: Ol., 25%, 1-7 mm, subhedral, partially altered to clay

Groundmass: Ol., 5%, 0.02-1 mm, granular; plag., 25%, 0.1-0.4 mm, cpx., 35%; glass 3%, altered.

Texture: Intergranular to sub-ophitic

Vesicles: None in this section.

Alteration: 10-15% clay after ol. and glass

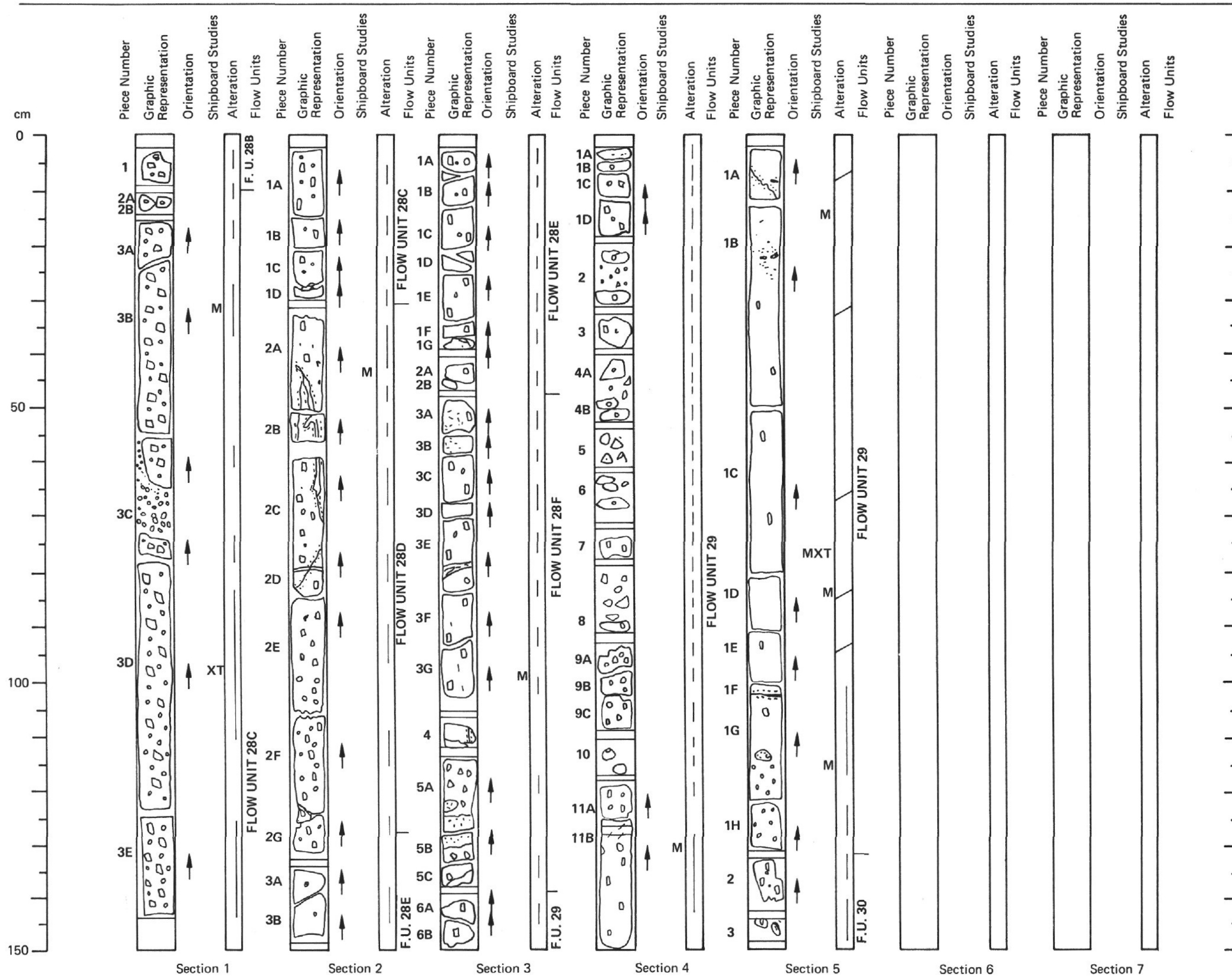
MAGNETIC DATA

Average Inclination: –43.0°

Average Magnetic Intensity (10^{-5} Gauss): 291

VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG **55** SITE **433** HOLE **C** CORE **32** DEPTH **383.5-393.0 m**



FLOW UNIT NO. 29:

POSITION:	Top - Core 32, Sect. 3, 140 cm; Bottom - Core 32, Sect. 5, 132 cm
CHEMISTRY:	Tholeiitic picrite, 1 analysis in Table 1.

VISUAL DESCRIPTION

Mineralogy:	Phenocrysts: ol., 2-15%, 1-2 mm, altered Groundmass: ol., plag., px., op., clay ≈ 35%.
Lithology:	0-15% vesicles throughout, breccia and sandstone above, top and bottom slightly oxidized.
Alteration:	Clay in groundmass and vesicles.

THIN SECTION DESCRIPTION

Phenocrysts:	Ol., 10%, 0.3-0.7 mm, anhedral, totally altered to clay
Groundmass:	Plag., 25%, 0.1-0.5 mm; cpx., 0.3-0.7 mm; op., 2%, 0.05-0.4 mm
Texture:	Ophitic
Vesicles:	None in this section.
Alteration:	30% clay after ol., glass, and plag.

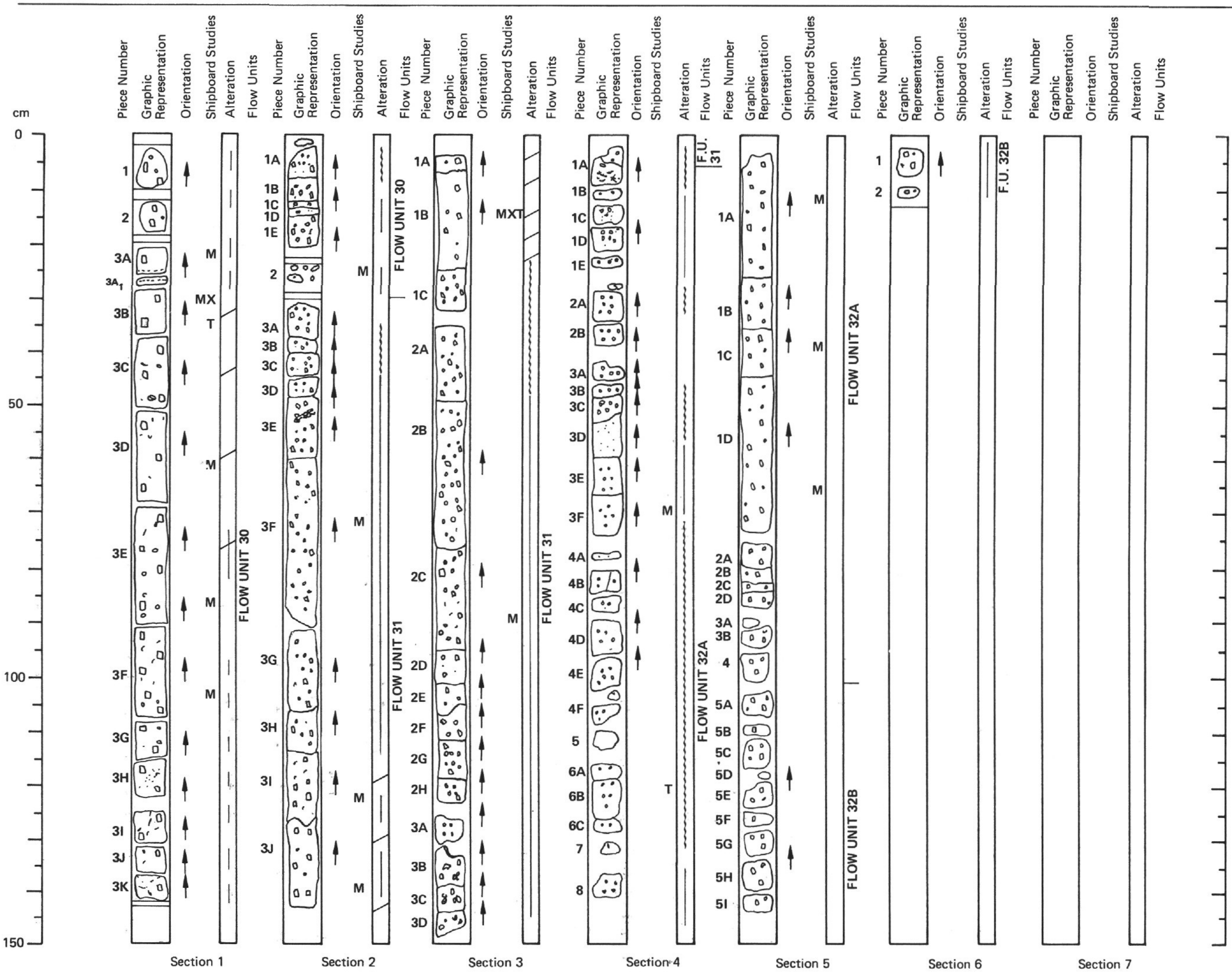
MAGNETIC DATA

Average Inclination: –40.3°

Average Magnetic Intensity (10^{-5} Gauss): 461

VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG **55** SITE **433** HOLE **C** CORE **33** DEPTH **393.0-402.5 m**



FLOW UNIT NO. 30:

POSITION: Top - Core 32, Sect. 5, 133 cm; Bottom - Core 33, Sect. 2, 28 cm

CHEMISTRY: Not analyzed.

VISUAL DESCRIPTION

Mineralogy: Phenocrysts: ol., 15%, 1-3 mm altered to clay and iddingsite, some fresh

Groundmass: ol., plag., px., op.

Lithology: Oxidized and moderately vesicular top; massive, non-oxidized center; oxidized base

Alteration: Clay in groundmass, some fresh ol.

THIN SECTION DESCRIPTION

Phenocrysts: Ol., 15%, 1-4 mm, 75% altered; plag., 2%, 2-4 mm

Groundmass: Ol., 2%, 0.03-1 mm; plag., 25%, 0.1-0.5 mm; cpx., 20%, 0.3-0.5 mm; op., 3%, 0.01-0.1 mm

Texture: Ophitic

Vesicles: None in this section.

Alteration: Clay 20% in groundmass, 1% interstitial carbonate.

MAGNETIC DATA

Average Inclination: −42.2°

Average Magnetic Intensity (10^{-5} Gauss): 774

FLOW UNIT NO. 31:

POSITION: Top - Core 33, Sect. 2, 30 cm; Bottom - Core 33, Sect. 4, 5 cm

CHEMISTRY: Not analyzed.

VISUAL DESCRIPTION

Mineralogy: Phenocrysts: ol., 5-20%, 0.5-5.0 mm, some fresh

Groundmass: ol., plag., px., op.

Lithology: Oxidized top, 5-20% vesicles throughout, center non-oxidized.

Alteration: Clay in groundmass and filling vesicles; some ol. fresh

THIN SECTION DESCRIPTION

Phenocrysts: Ol., 15%, 0.5-3.0 mm, subhedral, some fresh

Groundmass: Ol., 3%, 0.02-0.5 mm, granular; plag., 25%, 0.1-0.3 mm, laths; cpx., 25%, 0.1-0.2 mm; op., 0.01-0.1 mm

Texture: Ophitic

Alteration: 25% clay in groundmass

MAGNETIC DATA

Average Inclination: −40.8°

Average Magnetic Intensity (10^{-5} Gauss): 1200

FLOW UNIT NO. 32:

POSITION: Top - Core 33, Sect. 4, 5 cm; Bottom - Core 34, Sect. 1, 112 cm

CHEMISTRY: Not analyzed.

VISUAL DESCRIPTION

Mineralogy: Phenocrysts: ol.. 15-20% (25-30% in central parts of each sub-unit), average 2-3 mm, some fresh

Groundmass: ol., plag., px., op., altered glass

Lithology: Two sub-units (probably lobes of the same flow), moderately oxidized throughout, 15-30% vesicles throughout, center of each sub-unit coarser grained.

Alteration: Clay in groundmass, vesicles filled by clay and calcite.

THIN SECTION DESCRIPTION

Phenocrysts: Ol., 20%, 0.5-3 mm, euhedral, altered

Groundmass: Ol., 8%, 0.05-0.5 mm, anhedral to euhedral, altered; plag., 25%, 0.05-0.6 mm, skeletal laths; cpx., 7%, 0.05-0.3 mm; op., 5%; altered glass, 15%.

Texture: Intersertal

Vesicles: 15%, to 5 mm, mostly open

Alteration: 20% clay in groundmass and ol., and lining vesicles.

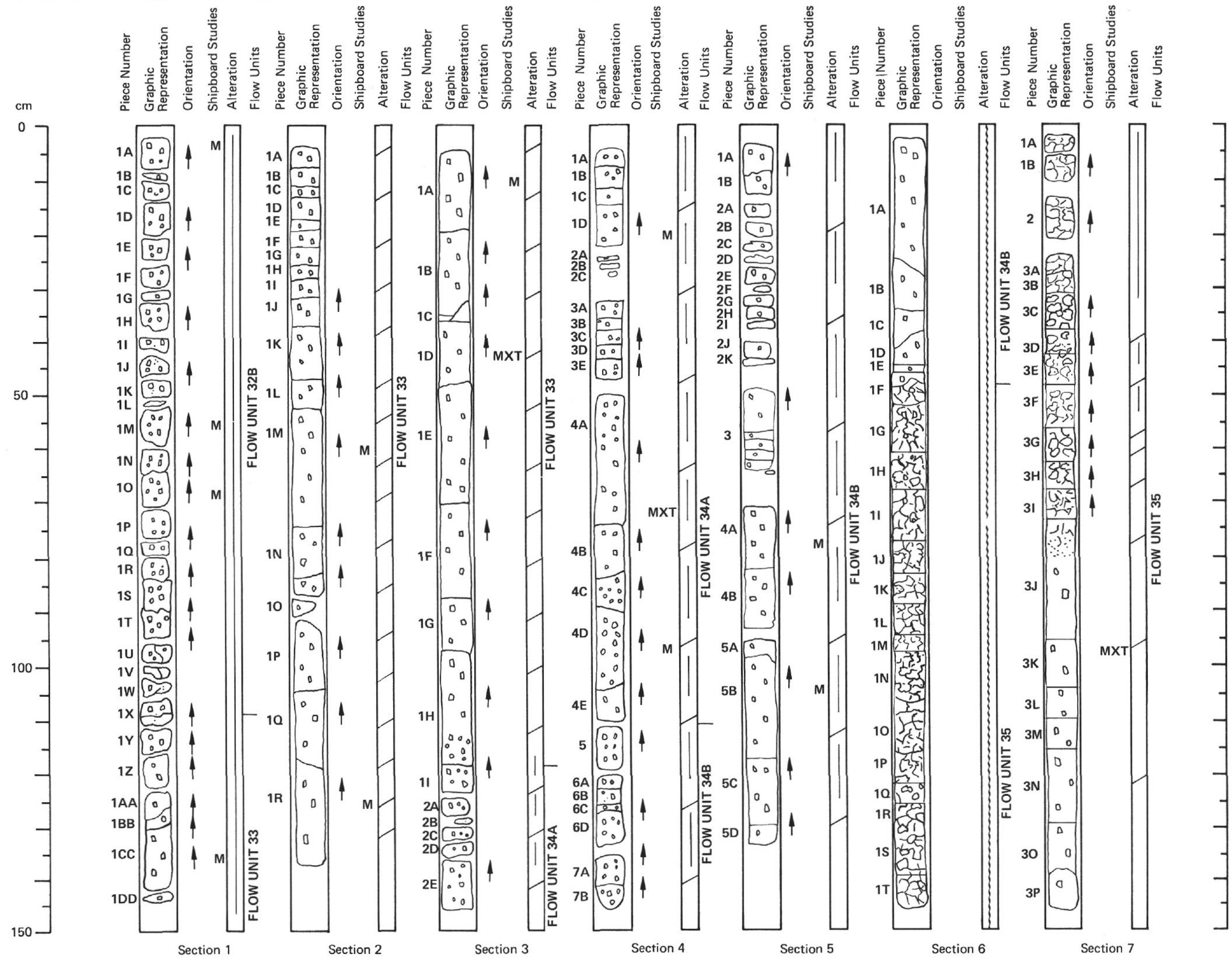
MAGNETIC DATA

Average Inclination: −40.6°

Average Magnetic Intensity (10^{-5} Gauss): 1770

VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG **55** SITE **433** HOLE **C** CORE **34** DEPTH **402.5-412.0 m**



FLOW UNIT NO. 33:

POSITION: Top - Core 34, Sect. 1, 112 cm; Bottom - Core 34, Sect. 3, 118 cm

CHEMISTRY: Not analyzed

VISUAL DESCRIPTION

Mineralogy: Phenocrysts: ol., 20%, 1-2 mm, average, some fresh
Groundmass: ol., plag., px., op., clay

Lithology: Oxidized and vesicular flow top (20% vesicles), massive and non-oxidized interior; vesicular (15%) base.

Alteration: Clay in groundmass; clay and calcite filling vesicles; ol. altered to clay and iddingsite.

THIN SECTION DESCRIPTION

Phenocrysts: Ol., 7%, 0.5-3 mm, subhedral, altered

Groundmass: Ol., 2%, 0.01-0.5 mm, granular, altered; plag., 38%, 0.1-0.5 mm, laths, some altered; cpx., 40%, 0.1-0.6 mm; op., 3%, 0.03-0.1 mm

Texture: Ophitic

Vesicles: None in this section.

Alteration: 10% clay in groundmass; ol. to iddingsite and clay; plag. going to clay.

MAGNETIC DATA

Average Inclination: −42.3°

Average Magnetic Intensity (10^{-5} Gauss): 330

FLOW UNIT NO. 34:

POSITION: Top - Core 34, Sect. 3, 118 cm; Bottom - Core 34, Sect. 6, 50 cm

CHEMISTRY: Not analyzed.

VISUAL DESCRIPTION

Mineralogy: Phenocrysts: ol., 10-15%, average 1-2 mm, some fresh
Groundmass: ol., plag., px., op., clays.

Lithology: Two sub-units based on textural changes; slightly oxidized throughout; vesicles 10-25% throughout.

Alteration: Clay in groundmass; clay and calcite fill vesicles; ol. altered to iddingsite and clay.

THIN SECTION DESCRIPTION

Phenocrysts: Ol., 10%, 0.5-2 mm, subhedral, some fresh cores

Groundmass: Ol., 3%, 0.05-0.5 mm, granular, altered; plag., 20%, 0.1-0.7 mm, laths; cpx., 28%, 0.05-1 mm; op., 5%, 0.02-0.1 mm

Texture: Ophitic

Vesicles: 5%, calcite filled

Alteration: Clay in groundmass; ol. altered to clay and iddingsite.

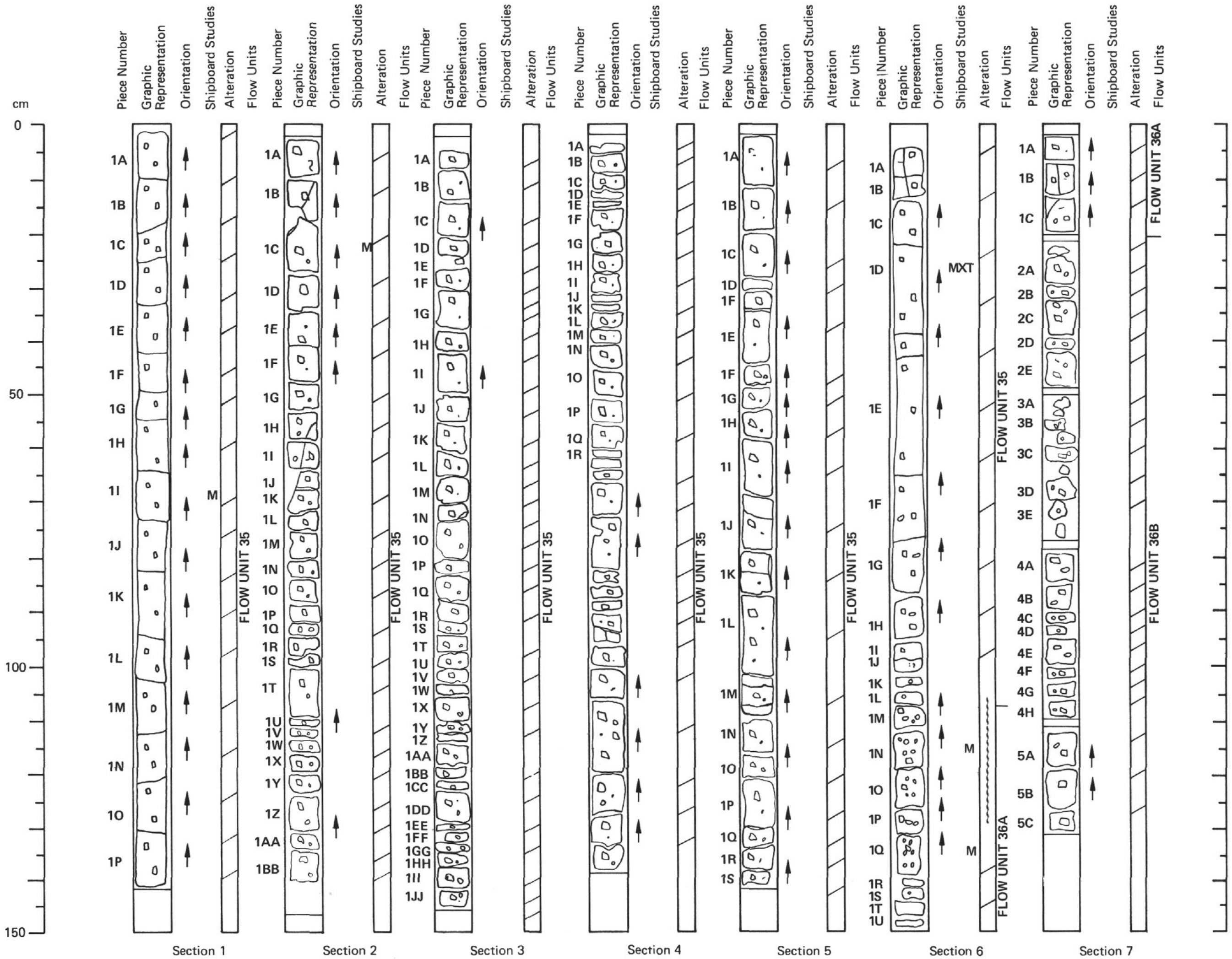
MAGNETIC DATA

Average Inclination: −41.4°

Average Magnetic Intensity (10^{-5} Gauss): 342

VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG **55** SITE **433** HOLE **C** CORE **35** DEPTH **412.0-421.5 m**



FLOW UNIT NO. 35:

POSITION: Top - Core 34, Sect. 6, 50 cm; Bottom - Core 35, Sect. 6, 107 cm

CHEMISTRY: Tholeiitic basalt, 2 analyses in Table 1.

VISUAL DESCRIPTION

Mineralogy: Phenocrysts: ol., 3-7% (more lower), 0.5-4 mm, mostly altered; px., <1%, 1 mm; plag., 3%
Groundmass: ol., plag., px., op., clay

Lithology: Oxidized and brecciated flow top (calcite cemented) in Core 34, Sect. 6 and Core 34, Sect. 7; grades into massive, non-oxidized, center in Core 34, Sect. 7, Core 35, Section 1, and Core 35, Sect. 2; below this it has 10-25% vesicles, but is non-oxidized.

Alteration: Clay in groundmass; clay and calcite fill vesicles; ol. to iddingsite and clay, some fresh.

THIN SECTION DESCRIPTION

Phenocrysts: Ol., 5%, 0.5-2 mm, anhedral to euhedral, mostly altered; plag., 2-3%, 0.5-1 mm; laths to anhedral

Groundmass: Ol., 2-3%, 0.05-0.5 mm, granular, altered; plag., 25-35%, 0.05-0.8 mm, laths; cpx., 45%, 0.01-0.1 mm, granular; op., 7-15%, 0.01-0.06 mm

Texture: Sub-trachytic, intergranular

Vesicles: *None in thin section.*

Alteration: 5% clay in groundmass, ol. to clay and iddingsite - a fresh rock.

MAGNETIC DATA

Average Inclination: −49.7°

Average Magnetic Intensity (10^{-5} Gauss): 703

FLOW UNIT NO. 36:

POSITION: *Top - Core 35, Sect. 6, 107 cm; Bottom - Core 36, Sect. 1, 85 cm*

CHEMISTRY: Not analyzed

VISUAL DESCRIPTION

Mineralogy: Phenocrysts: ol., 10-12%, 0.5-1.5 mm, altered; plag., 1%, 1-3 mm
Groundmass: ol., 10%, plag., 40%; px., 30%; op., 5%; variolitic to sub-diabasic

Lithology: Oxidized flow top, 20-40% vesicles throughout; two subunits based on oxidation and vesicularity.

Alteration: Clay in groundmass; clay and calcite vesicle filling; ol. to iddingsite and clay.

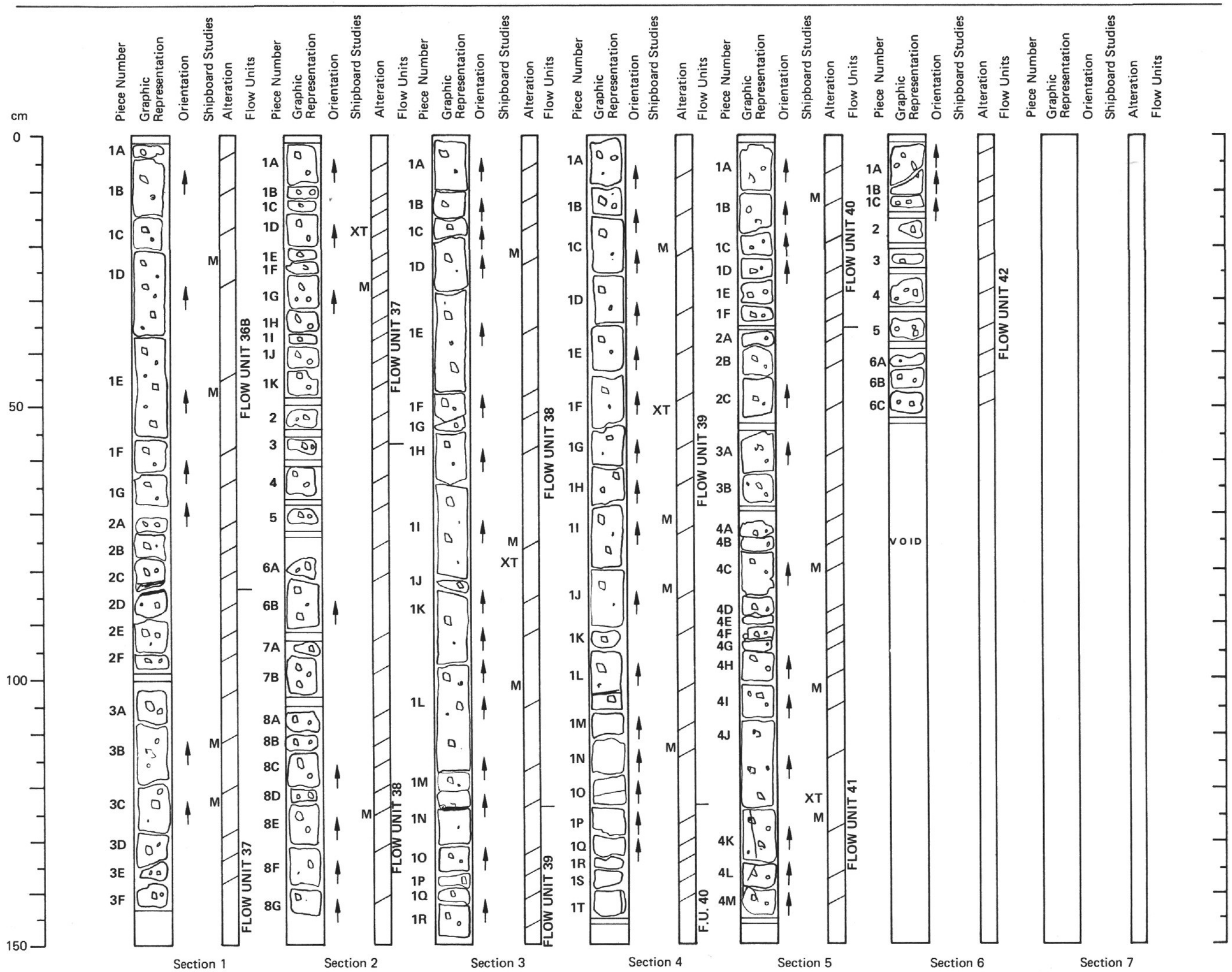
MAGNETIC DATA

Average Inclination: −50.4°

Average Magnetic Intensity (10^{-5} Gauss): 351

VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG **55** SITE **433** HOLE **C** CORE **36** DEPTH **421.5-431.0 m**



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS LEG **55** SITE **433** HOLE **C** CORE **36** DEPTH **421.5-431.0 m**

FLOW UNIT NO. 37:

POSITION: Top - Core 36, Sect. 1, 85 cm; Bottom - Core 36, Sect. 2, 60 cm

CHEMISTRY: Tholeiitic basalt, 1 analysis in Table 1.

VISUAL DESCRIPTION

Mineralogy: Phenocrysts: ol., 10%, 0.5-1.5 mm
Groundmass: ol., plag., px., op.

Lithology: Vitrophyric top and bottom, 10-25% vesicles throughout

Alteration: Moderately oxidized throughout; vesicles clay lined,ol. to clay and iddingsite.

THIN SECTION DESCRIPTION

Phenocrysts: Ol., 5%, 0.5-2.5 mm, anhedral, altered

Groundmass: Ol., 3%, 0.1-0.5 mm, granular; plag., 35%, 0.1-0.8 mm, laths; cpx., 30%, 0.1-0.3 mm; op., 7%, 0.05-0.2 mm, altered glass, 10%

Texture: Ophitic

Vesicles: 20%, clay lined

Alteration: 10% clay after glass and ol.; ol. to iddingsite and clay

MAGNETIC DATA

Average Inclination: −50.7°

Average Magnetic Intensity (10^{-5} Gauss): 723

FLOW UNIT NO. 38:

POSITION: Top - Core 36, Sect. 2, 60 cm; Bottom - Core 36, Sect. 3, 123 cm

CHEMISTRY: Tholeiitic basalt, 1 analysis in Table 1.

VISUAL DESCRIPTION

Mineralogy: Phenocrysts: ol., 15%, 0.5-1.0 mm, altered; plag., <1%, 1 mm
Groundmass: ol., plag., px., op.,; variolitic

Lithology: Vitrophyric top and bottom, top is vesicular (30%), lower part more massive.

Alteration: Clay in groundmass; clay and calcite fill and line vesicles; ol. to iddingsite and clay.

Phenocrysts: Ol., 15%, 0.5-3 mm, subhedral, 95% altered

Groundmass: Ol., 5%, 0.05-0.5 mm, granular; plag., 33%, 0.1-0.7 mm some altered; cpx., 25%, 0.1-0.4 mm; op. 5%, 0.05-0.2 mm; altered glass, 7%

Texture: Ophitic

Alteration: 5% calcite patches in groundmass; clay in groundmass; ol. to clay and iddingsite.

MAGNETIC DATA

Average Inclination: −51.0°

Average Magnetic Intensity (10^{-5} Gauss): 825

FLOW UNIT NO. 39:

POSITION: Top - Core 36, Sect. 3, 122 cm; Bottom - Core 36,Sect. 4, 124 cm

CHEMISTRY: Tholeiitic basalt, 1 analysis in Table 1.

VISUAL DESCRIPTION

Mineralogy: Phenocrysts: ol., 15-25%, 0.5-1.5 mm, altered
Groundmass: ol., plag., px., op.

Lithology: Vitrophyric top and bottom

Alteration: Clay in groundmass; ol. to iddingsite and clay; clay and calcite fill vesicles

THIN SECTION DESCRIPTION

Phenocrysts: Ol., 15%, 0.5-2 mm, anhedral, altered

Groundmass: Ol., 2%, 0.1-0.5 mm, granular, altered; plag., 33%, 0.1-0.5 mm, laths, partly altered; cpx., 20%, 0.05-0.2 mm; op., 5%, 0.02-0.1 mm, altered glass, 10%

Texture: Ophitic

Alteration: 15% clay in groundmass; ol. to clay and iddingsite.

MAGNETIC DATA

Average Inclination: −54.4°

Average Magnetic Intensity (10^{-5} Gauss): 346

FLOW UNIT NO. 40:

POSITION: Top - Core 36, Sect. 4, 124 cm; Bottom - Core 36, Sect. 5, 35 cm

CHEMISTRY: Not analyzed.

VISUAL DESCRIPTION

Mineralogy: Phenocrysts: ol., 15%, 0.5-1.5 mm, altered
Groundmass: ol., plag., px., op.; variolitic

Lithology: Vitrophyric top and bottom; 5-20% vesicles

Alteration: Clay in groundmass; clay and calcite lined and filled vesicles; ol. to iddingsite and clay.

MAGNETIC DATA

Average Inclination: −51.8°

Average Magnetic Intensity (10^{-5} Gauss): 1900

FLOW UNIT NO. 41:

POSITION: Top - Core 36, Sect. 5, 36 cm; Bottom - Core 36, Sect. 6, 14 cm

CHEMISTRY: Tholeiitic basalt, 1 analysis in Table 1.

VISUAL DESCRIPTION

Mineralogy: Phenocrysts: ol., 15%, 0.5-1.5 mm, altered
Groundmass: ol., plag., px., op., clay

Lithology: Fine-grained top and bottom; vesicles decrease in size and abundance downward.

Alteration: Clay in groundmass; vesicles lined and filled by clay and calcite; ol. to iddingsite and clay.

THIN SECTION DESCRIPTION

Phenocrysts: Ol., 7%, 0.5-2 mm, subhedral, altered

Groundmass: Ol., 3%, 0.05-0.5 mm, granular; plag., 35%, 0.1-0.5 mm, laths, partially altered; cpx., 35%, 0.1-0.3 mm; op., 0.01-0.1 mm; altered glass, 10%

Texture: Ophitic

Vesicles: 30%

Alteration: 40% clay in vesicles and groundmass; ol. to iddingsite and clay.

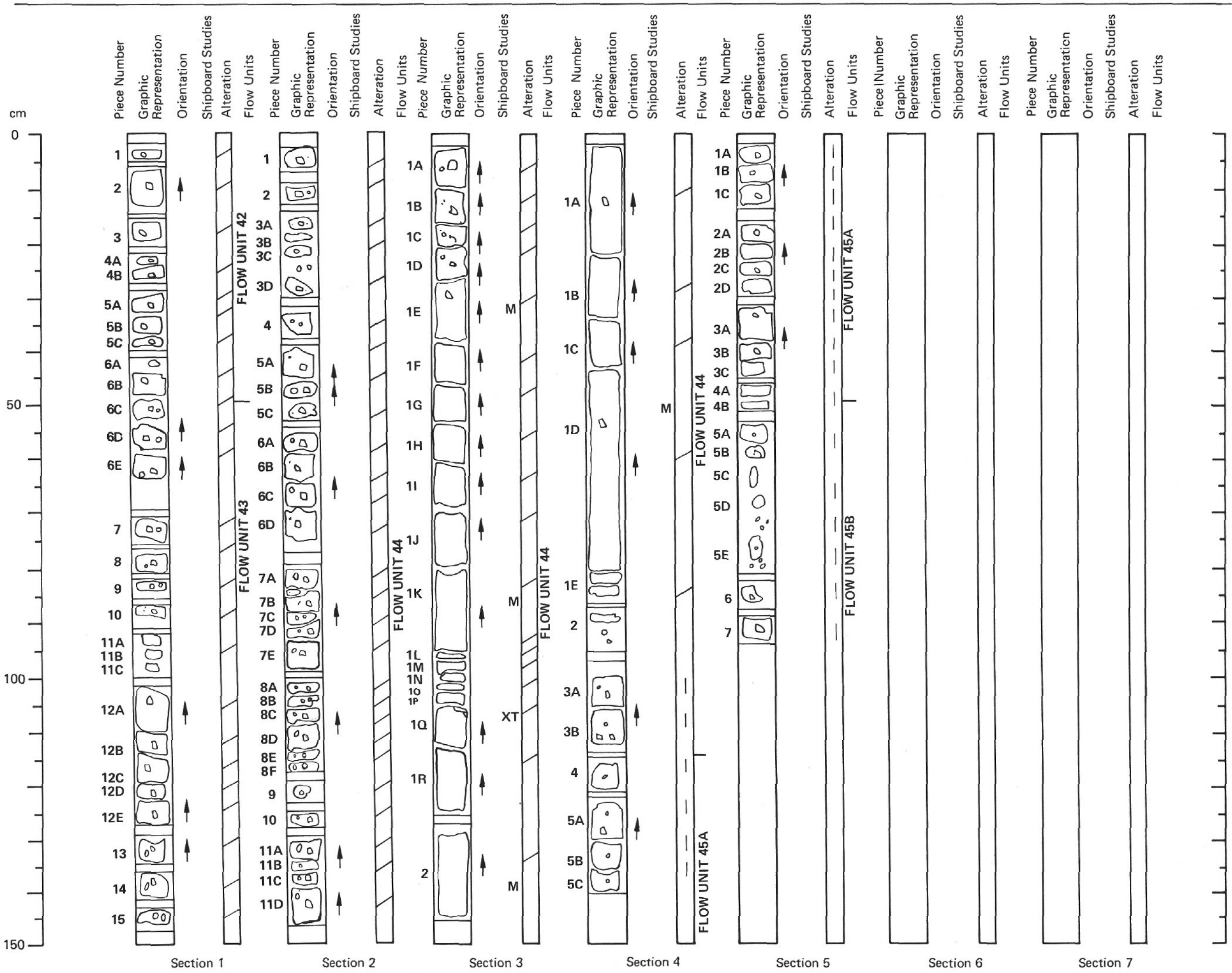
MAGNETIC DATA

Average Inclination: −53.9°

Average Magnetic Intensity (10^{-5} Gauss): 630

VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG **55** SITE **433** HOLE **C** CORE **37** DEPTH **431.0-440.5 m**



FLOW UNIT NO. 42:

POSITION:	Top - Core 36, Sect. 6, 15 cm; Bottom - Core 37, Sect. 1, 50 cm
CHEMISTRY:	Not analyzed.

VISUAL DESCRIPTION

Mineralogy:	Phenocrysts: ol., 15%, 0.5-3 mm, altered Groundmass: ol., plag., px., op., clay
Lithology:	*Fine-grained top, vitrophyric base, up to 30% vesicles, mildly oxidized*
Alteration:	Clay in groundmass and filling and lining vesicles, calcite filling vesicles.

FLOW UNIT NO. 43:

POSITION:	Top - Core 37, Sect. 1, 50 cm; Bottom - Core 37, Sect. 2, 20 cm
CHEMISTRY:	Not analyzed.

VISUAL DESCRIPTION

Mineralogy:	Phenocrysts: ol., 15%, 0.5-2 mm, altered Groundmass: ol., plag., px., op., clay
Lithology:	Vitrophyric top and bottom (all glass altered). Vesicular top, down center and base.
Alteration:	Clay in groundmass and filling vesicles; ol. to iddingsite and clay.

FLOW UNIT NO. 44:

POSITION:	Top - Core 37, Sect. 2, 20 cm; Bottom - Core 37, Sect. 4, 113 cm
CHEMISTRY:	Tholeiitic basalt, 1 analysis in Table 1.

VISUAL DESCRIPTION

Mineralogy:	Phenocrysts: olivine, 0-15%, 0.5-2 mm, altered Groundmass: ol., plag., px., op., clay
Lithology:	*Vitrophyric top and bottom; top vesicular (30% vesicles) center massive, base 40% vesicles*
Alteration:	Clay in groundmass and lining and filling vesicles; ol. to iddingsite and clay.

THIN SECTION DESCRIPTION

Phenocrysts:	Ol., 1%, 0.5-1 mm, subhedral, altered
Groundmass:	Ol., 7%, 0.1-0.5 mm, granular; plag. 40%, 0.05-0.7 mm, laths; cpx., 35%, 0.1-0.5 mm, granular; op. 7%, 0.02-0.2 mm
Texture:	Intergranular
Vesicles:	None
Alteration:	10% clay in groundmass; ol. to iddingsite and clay

MAGNETIC DATA

Average Inclination: −49.3°

Average Magnetic Intensity (10^{-5} Gauss): 310

FLOW UNIT NO. 45:

POSITION:	Top - Core 37, Sect. 4, 115 cm; Bottom - Core 38, Sect. 2, 34 cm
CHEMISTRY:	Tholeiitic basalt, 1 analysis in Table 1.

VISUAL DESCRIPTION

Mineralogy:	Phenocrysts: ol., 2-10%, 0.5-2 mm, mostly altered (fresh in Sect. 1 of Core 38) Groundmass: ol., plag., px., op., clay
Lithology:	Two subunits separated by vitrophyre; vitrophyric top, vesicles 10-30% throughout
Alteration:	Clay in groundmass; ol. mostly to clay and iddingsite, vesicles filled or lined by clay

THIN SECTION DESCRIPTION

Phenocrysts:	Ol., 5%, 0.5-3 mm, anhedral, mostly fresh
Groundmass:	Ol., 10%, 0.05-5 mm, granular, 50% fresh; plag., 30%, 0.01-0.2 mm, laths; cpx., 38%, 0.1-0.3 mm; op., 7%, 0.01-0.1 mm
Texture:	Ophitic
Vesicles:	None
Alteration:	10% clay in groundmass; ol. partially altered to clay

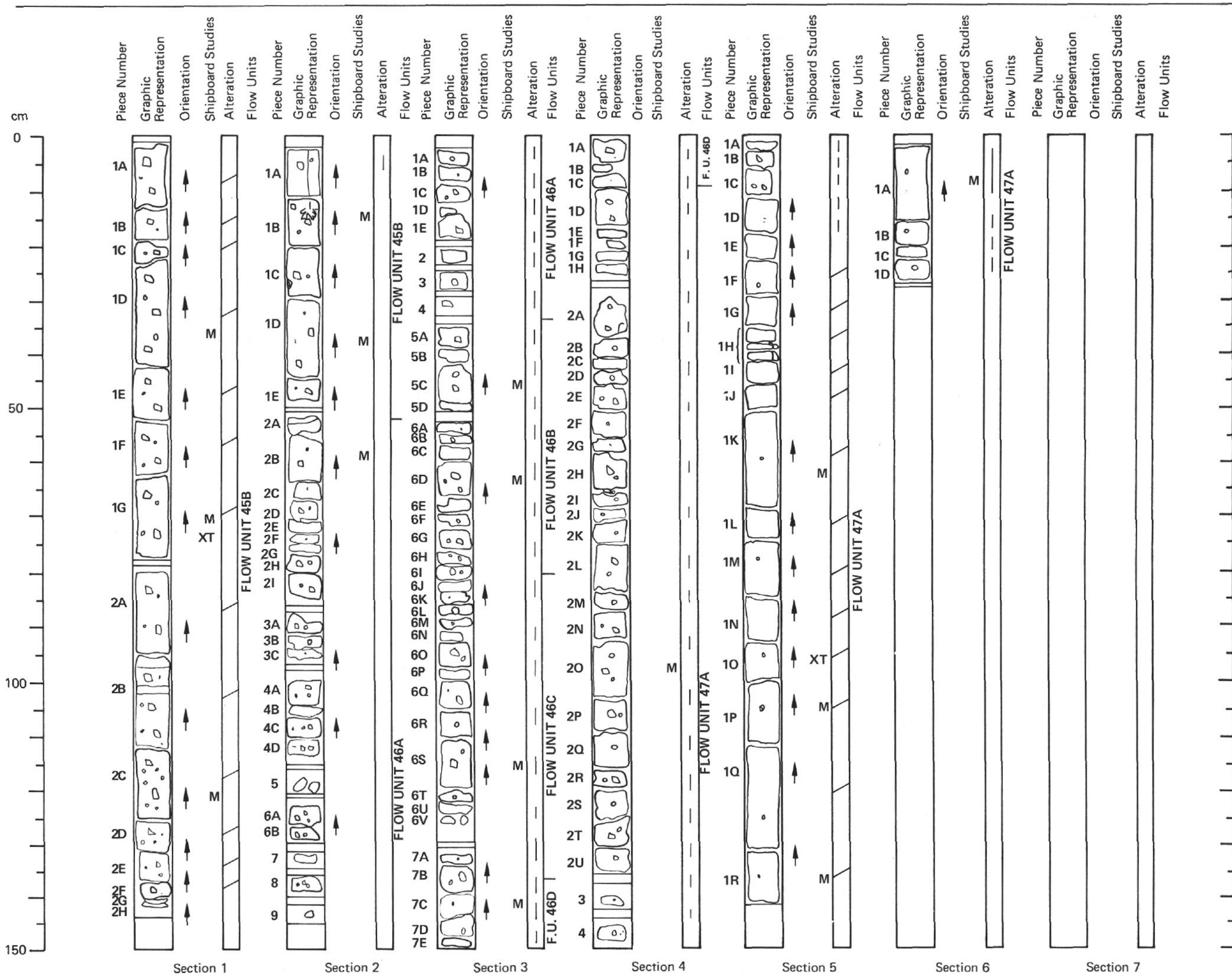
MAGNETIC DATA

Average Inclination: −47.2°

Average Magnetic Intensity (10^{-5} Gauss): 348

VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG 55 SITE 433 HOLE C CORE 38 DEPTH 440.5-450.0 m



FLOW UNIT NO. 46:

POSITION: Top - Core 38, Sect. 2, 54 cm; Bottom - Core 38, Sect. 4, 10 cm

CHEMISTRY: Not analyzed.

VISUAL DESCRIPTION

Mineralogy: Phenocrysts: ol., 1-5%, 0.5-1 mm, altered
Groundmass: ol., plag., px., op.

Lithology: Four subunits separated by vitrophyres (altered) 15-25% vesicles

Alteration: Ol. to iddingsite and clay; clay in groundmass; vesicles filled or lined by clay or calcite

MAGNETIC DATA

Average Inclination: −8.9°

Average Magnetic Intensity (10^{-5} Gauss): 233

FLOW UNIT NO. 47:

POSITION: Top - Core 38, Sect. 4, 10 cm; Bottom - Core 39, Sect. 1, 117 cm

CHEMISTRY: Tholeiitic basalt, 1 analysis in Table 1.

VISUAL DESCRIPTION

Mineralogy: Phenocrysts: ol., 0-1%, 0.5 mm, altered
Groundmass: ol., plag. px., op., clay; variolitic to granular

Lithology: Two subunits separated by oxidized and vesicular flow top (47B probably should have been a separate unit), 10-20% vesicles

Alteration: Clay in groundmass; vesicles lined or filled by clay or carbonate; ol. to iddingsite and clay

THIN SECTION DESCRIPTION

Phenocrysts: None

Groundmass: Plag., 35%, 0.1-0.5 mm, laths; cpx., 35%, 0.2-1 mm; op., 10%, 0.05-0.2 mm

Texture: Ophitic

Vesicles: None

Alteration: 20% clay in groundmass

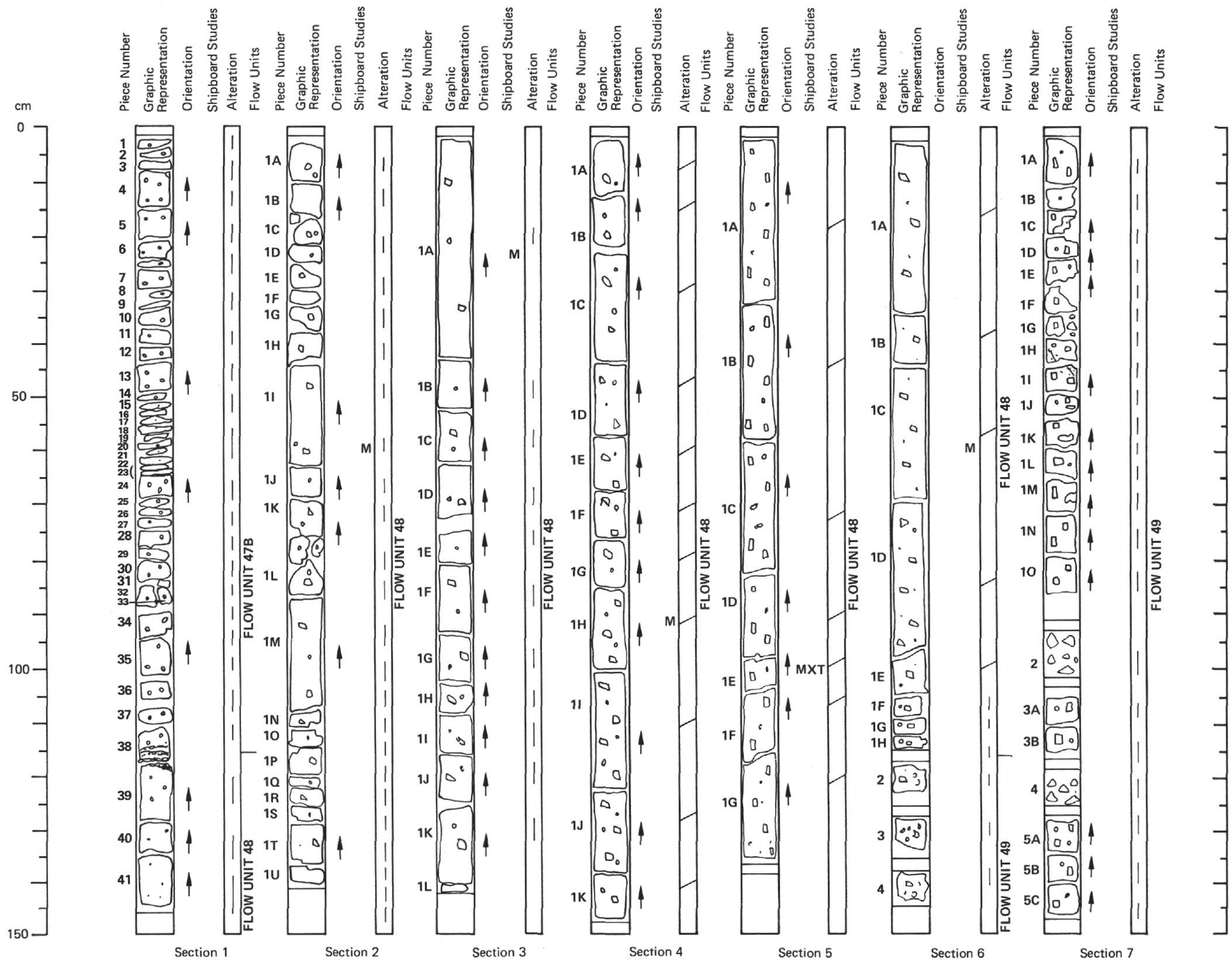
MAGNETIC DATA

Average Inclination: −5.4°

Average Magnetic Intensity (10^{-5} Gauss): 140

VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG **55** SITE **433** HOLE **C** CORE **39** DEPTH **450.0-459.5 m**



FLOW UNIT NO. 48:

POSITION:	Top - Core 39, Sect. 1, 117 cm; Bottom - Core 39, Sect. 6, 117 cm
CHEMISTRY:	Tholeiitic basalt, 1 analysis in Table 1.

VISUAL DESCRIPTION

Mineralogy:	Phenocrysts: ol., 5-10%, 0.5-1.5 mm, some fresh in Sect. 5 of Core 39 Groundmass: ol., plag., px., op., clay
Lithology:	Altered vitrophyric at top; top oxidized; 3-25% vesicles throughout
Alteration:	Ol. mostly altered to clay + iddingsite; clay in groundmass; vesicles filled or lined by clay

THIN SECTION DESCRIPTION

Phenocrysts:	Ol., 5%, 0.5-1 mm, subhedral, 50% altered
Groundmass:	Ol., 3%, 0.1-0.5 mm, granular; plag., 37%, 0.02-0.2 mm; cpx., 35%, 0.02-0.06 mm, granular; op., 5%, 0.02-0.2 mm
Texture:	Intergranular
Vesicles:	None
Alteration:	15% clay in groundmass; ol. to iddingsite + clay

MAGNETIC DATA

Average Inclination: –43.0°

Average Magnetic Intensity (10^{-5} Gauss): 162

FLOW UNIT NO. 49:

POSITION:	Top - Core 39, Sect. 6, 119 cm; Bottom - Core 40, Sect. 3, 96 cm
CHEMISTRY:	Tholeiitic basalt, 1 analysis in Table 1.

VISUAL DESCRIPTION

Mineralogy:	Phenocrysts: ol., 10%, 1-4 mm, mostly altered Groundmass: ol., plag., px., op.
Lithology:	Oxidized and vesicular flow top; glassy (altered) 6 cm; autobrecciated material in Core 39, Sect. 6 and 7; center and lower part of flow massive and non-oxidized
Alteration:	Ol. mostly to iddingsite + clay, some fresh in Core 40, Sect. 1

THIN SECTION DESCRIPTION

Phenocrysts:	Ol., 5%, 0.5-3 mm, subhedral, altered
Groundmass:	Ol., 1%, 0.05-0.5 mm, granular, altered; plag., 30%, 0.02-0.2 mm, laths; cpx., 35%, 0.01-0.05 mm, granular; op., 10%, 0.02-0.1 mm
Texture:	Intergranular
Vesicles:	None in thin section
Alteration:	15 to 20% clay in groundmass, ol. to iddingsite + clay

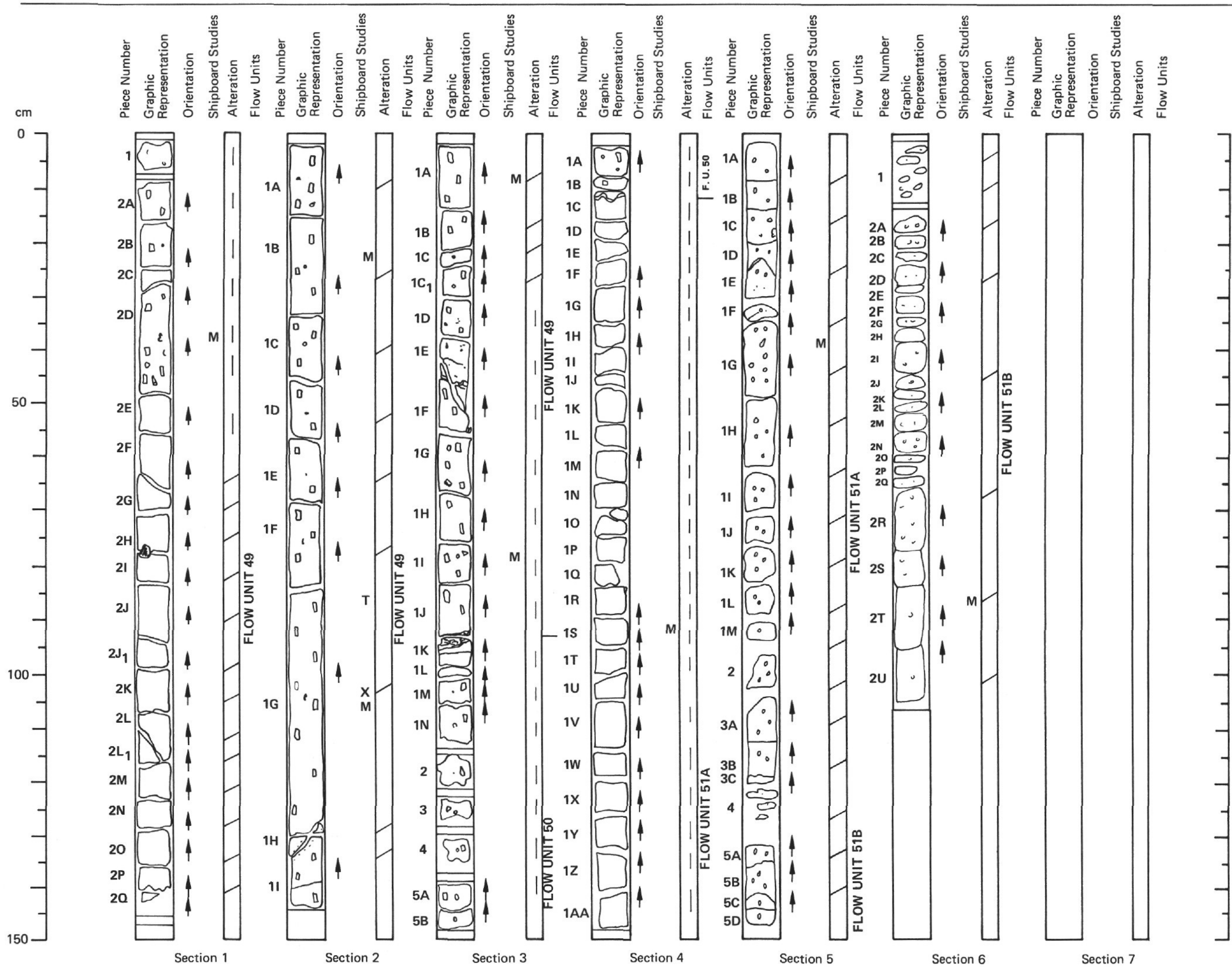
MAGNETIC DATA

Average Inclination: –44.8°

Average Magnetic Intensity (10^{-5} Gauss): 913

VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG **55** SITE **433** HOLE **C** CORE **40** DEPTH **459.5-469.0 m**



FLOW UNIT NO. 50:

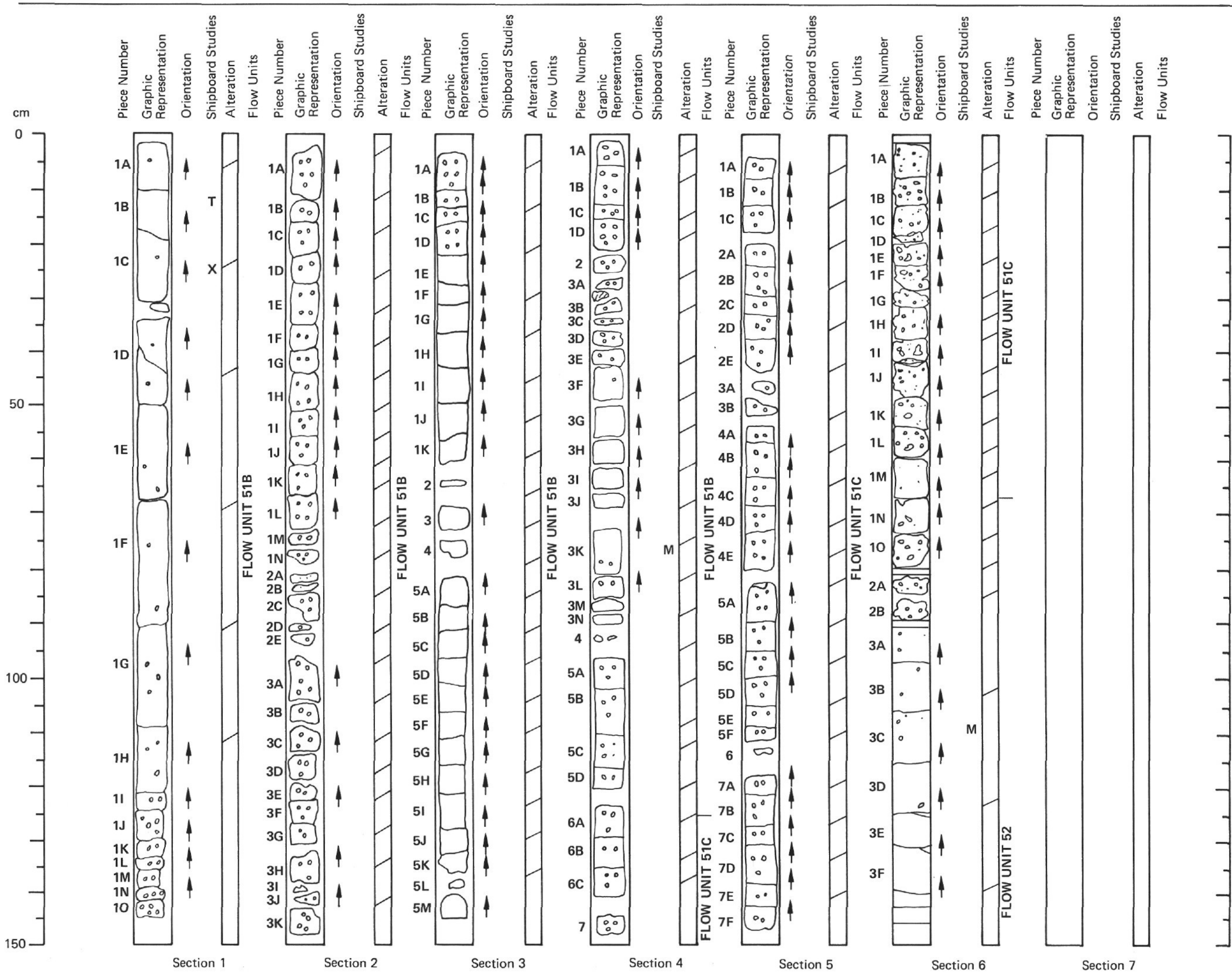
POSITION:	Top - Core 40, Sect. 3, 96 cm; Bottom - Core 40, Sect. 4, 10 cm
CHEMISTRY:	Not analyzed

VISUAL DESCRIPTION

Mineralogy:	Phenocrysts: ol., 5%, 1-4 mm, altered Groundmass: aphanitic, with ol. and microlites of plag.
Lithology:	Oxidized, 10-15% vesicles and vugs lined by clay and calcite
Alteration:	Extensively altered

VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG **55** SITE **433** HOLE **C** CORE **41** DEPTH **469.0-478.5 m**



FLOW UNIT NO. 51:

POSITION: Top - Core 40, Sect. 4, 10 cm; Bottom - Core 41, Sect. 6, 70 cm

CHEMISTRY: Tholeiitic basalt, 1 analysis in Table 1.

VISUAL DESCRIPTION

Mineralogy: Phenocrysts: ol., <1%, 0.5-1 mm, some fresh in center of flow
Groundmass: plag., ol., px., op

Lithology: Two sub-flow units with distinctly different magnetic inclinations, but little compelling lithologic evidence. Top of unit is oxidized. Bottom is slightly oxidized and glassy. Exact position of bottom not easily defined.

Alteration: Clay in groundmass

THIN SECTION DESCRIPTION

Phenocrysts: None

Groundmass: Ol., 1-2%, 0.2 mm, altered to iddingsite; plag., 40%, 0.2-0.7 mm, partially altered; cpx., 30%, 0.01-0.2 mm, op., 10%, 0.05-0.15 mm, altered glass, 10%

Texture: Intergranular to intersertal

Vesicles: ? (thin section plucked)

Alteration: 10% clay after glass; ol. to iddingsite

MAGNETIC DATA

Average Inclination: F. U. 51A, −46.2°; F. U. 51B, −11.6°

Average Magnetic Intensity (10^{-5} Gauss): F. U. 51A, 173; F. U. 51B, 490

FLOW UNIT NO. 52:

POSITION: Top - Core 41, Sect. 6, 70 cm; Bottom - Core 42, Sect. 2, 15 cm

CHEMISTRY: Tholeiitic basalt, 1 analysis in Table 1.

VISUAL DESCRIPTION

Mineralogy: Phenocrysts: ol., <1%, 0.3-0.5 mm, altered
Groundmass: ol., plag., px., op., clay

Lithology: Vesicular top; massive center, vesicular in lower part, glassy base

Alteration: ol. to clay + iddingsite, clay in groundmass

THIN SECTION DESCRIPTION

Phenocrysts: None

Groundmass: Ol., 1%, 0.2 mm, altered; plag., 37%, 0.1-0.8 mm, mostly fresh; cpx., 35%, 0.05-0.15 mm; op. 7%, 0.04-0.4 mm; altered glass, 10%

Texture: Intergranular to intersertal

Vesicles: ? (thin section plucked)

Alteration: 10% clay after glass, ol. to iddingsite + clay

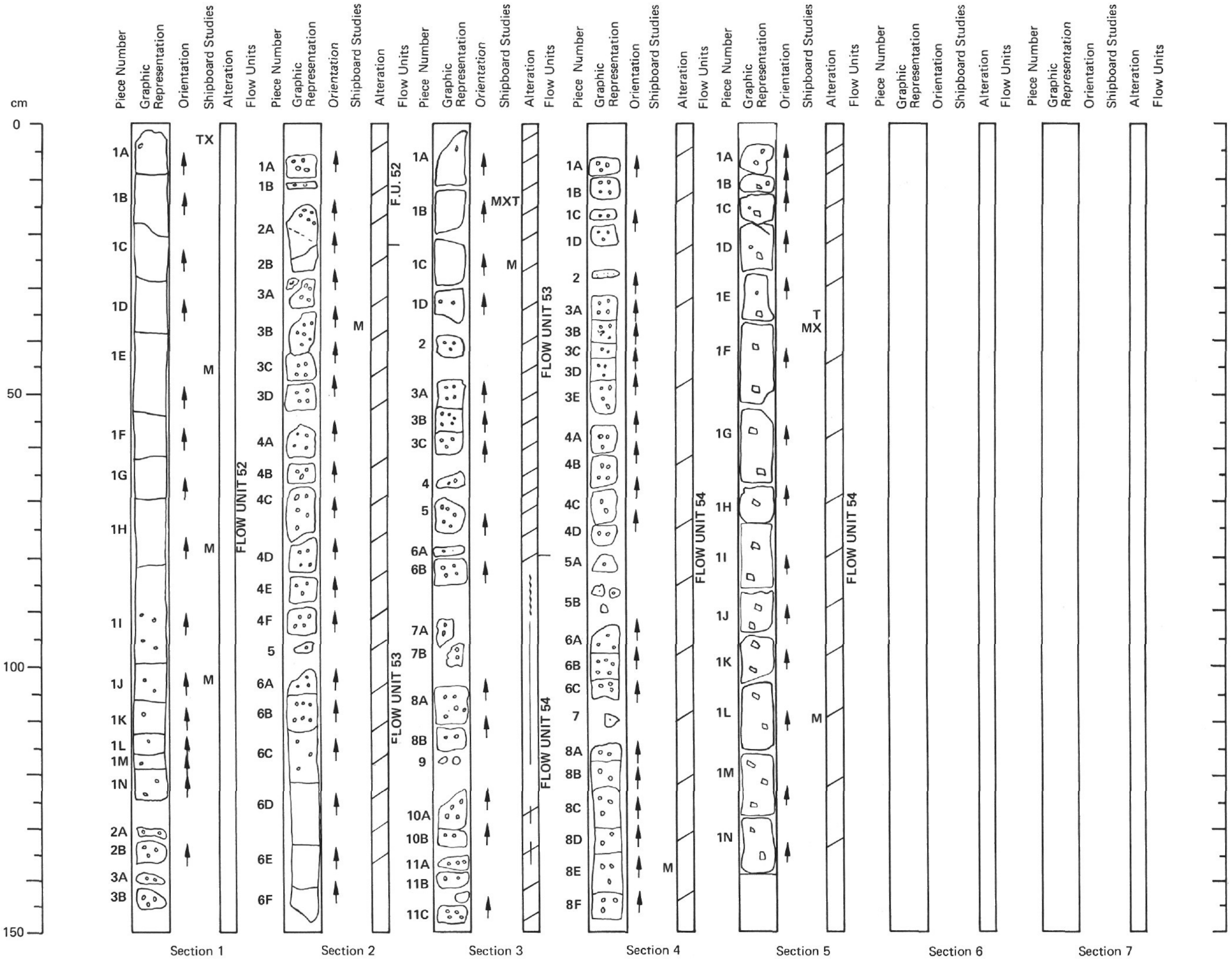
MAGNETIC DATA

Average Inclination: −12.8°

Average Magnetic Intensity (10^{-5} Gauss): 405

VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG **55** SITE **433** HOLE **C** CORE **42** DEPTH **478.5-488.0 m**



FLOW UNIT NO. 53:

POSITION: Top - Core 42, Sect. 2, 15 cm; Bottom - Core 42, Sect. 3, 80 cm

CHEMISTRY: Tholeiitic basalt, 1 analysis in Table 1.

VISUAL DESCRIPTION

Mineralogy: Phenocrysts: ol., 1-3%, 0.5-1 mm, plag., 2-3%, 0.5-1.5 mm, fresh
Groundmass: ol., plag., px., op., clay

Lithology: Oxidized and vesicular flow top, massive center (3%) vesicles, vesicular (15%) lower part; base glassy

Alteration: Clay in groundmass; ol. to clay + iddingsite

THIN SECTION DESCRIPTION

Phenocrysts: None

Groundmass: Ol., 2%, 0.05-1 mm, altered; plag., 46%, 0.1-1 mm, laths, mostly fresh; cpx., 35%, 0.1-0.2 mm; op., 7%, 0.03-0.15 mm; altered glass, 10%

Texture: Intergranular to intersertal

Vesicles: 20%, 0.5-1 mm, round, brown clay rims with green fillings

Alteration: 30% clay in vesicles and groundmass

MAGNETIC DATA

Average Inclination: −25.0°

Average Magnetic Intensity (10^{-5} Gauss): 283

FLOW UNIT NO. 54:

POSITION: Top - Core 42, Sect. 3, 81 cm; Bottom - Core 43, Sect. 1, 122 cm

CHEMISTRY: Tholeiitic basalt, 1 analysis in Table 1.

VISUAL DESCRIPTION

Mineralogy: Phenocrysts: ol., 1-5%, 0.5-1.5 mm, some fresh throughout, plag., 2-5%, 0.5-2 mm
Groundmass: ol., plag., px., op., clay

Lithology: Oxidized and vesicular (20%) flow top. Center fresher and more massive. Base oxidized and vesicular.

Alteration: Clay in groundmass, ol. to iddingsite + clay

THIN SECTION DESCRIPTION

Phenocrysts: Plag., 7%, 0.5-1.5 mm; cpx., 4%, 0.5-1.5 mm, anhedral

Groundmass: Ol., 1%, 0.1 mm, altered; plag., 39%, 0.1-0.5 mm; cpx., 35%, 0.05-0.5 mm, granular; op., 7%, 0.05-0.15 mm, altered glass, 7%

Texture: Intergranular to intersertal

Vesicles: 2%, 1 mm, round, brown clay rims and green clay fillings

Alteration: Clay in vesicles and groundmass; ol. to iddingsite + clay

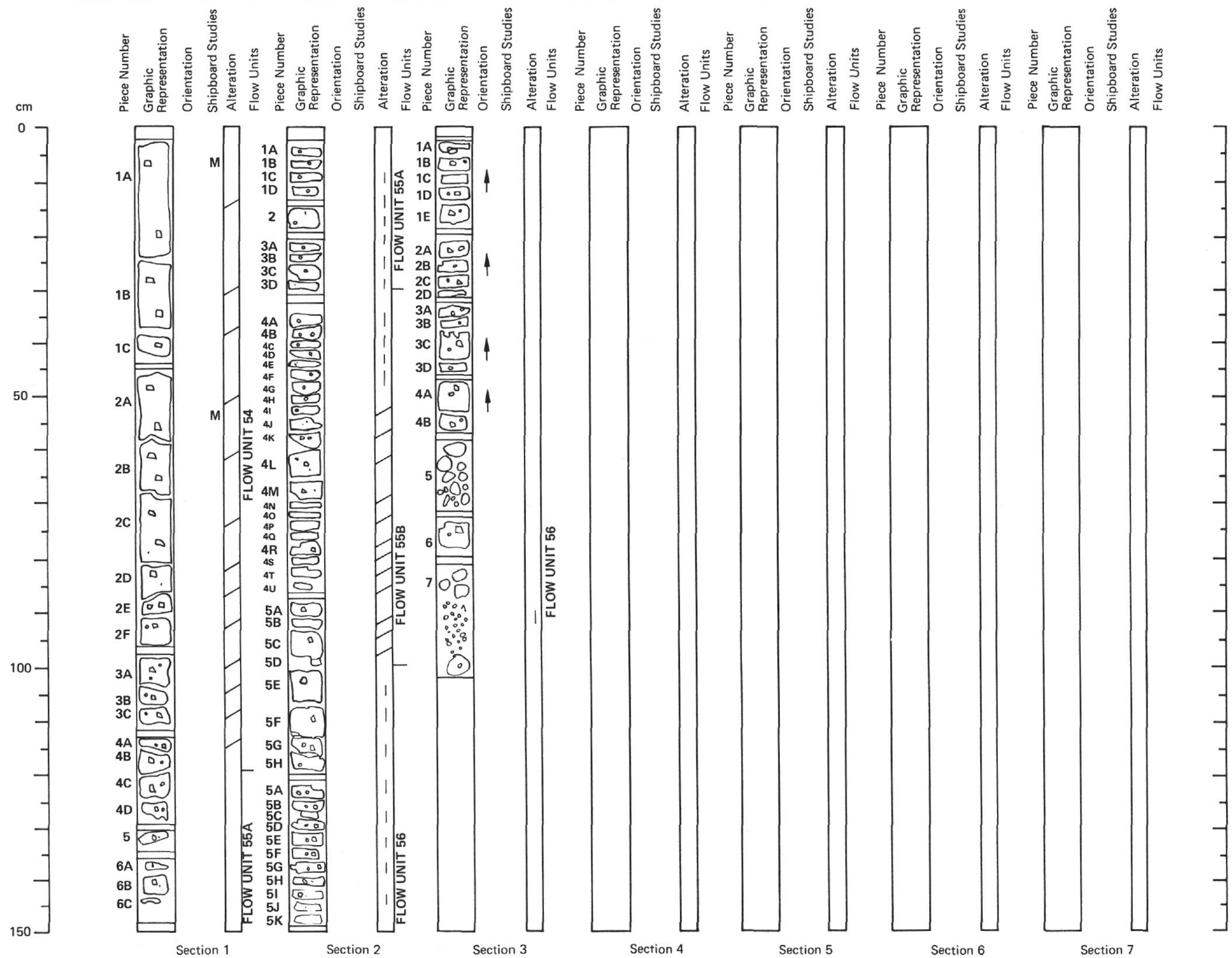
MAGNETIC DATA

Average Inclination: −32.9°

Average Magnetic Intensity (10^{-5} Gauss): 471

VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG **55** SITE **433** HOLE **C** CORE **43** DEPTH **488.0-497.5 m**



FLOW UNIT NO. 55:

POSITION: Top - Core 43, Sect. 1, 123 cm; Bottom - Core 43, Sect. 2, 100 cm

CHEMISTRY: Not analyzed

VISUAL DESCRIPTION

Mineralogy: Phenocrysts: ol., 5%, 0.5-1.0 mm
Groundmass: ol. 10%, plag. 40%, px. 30%, op. 5%, clay 15%

Lithology: Two sub-units separated by vitrophyre. Oxidized and vesicular throughout

Alteration: Clay in groundmass and filling vesicles; ol. to iddingsite + clay

FLOW UNIT NO. 56:

POSITION: Top - Core 43, Sect. 2, 150 cm; Bottom - Core 44, Sect. 2, 27 cm

CHEMISTRY: Not analyzed

VISUAL DESCRIPTION

Mineralogy: Phenocrysts: ol., 5-10%, 0.5-1.5 mm, altered, plag., 0-<1%, 1 mm
Groundmass: ol., 10%; plag. 40%, px., 30%, op. 5%, clay 15%

Lithology: Oxidized top, vesicular throughout; vesicles lined and filled by clay, glassy base

Alteration: Ol. to iddingsite and clay, clay in groundmass and vesicles

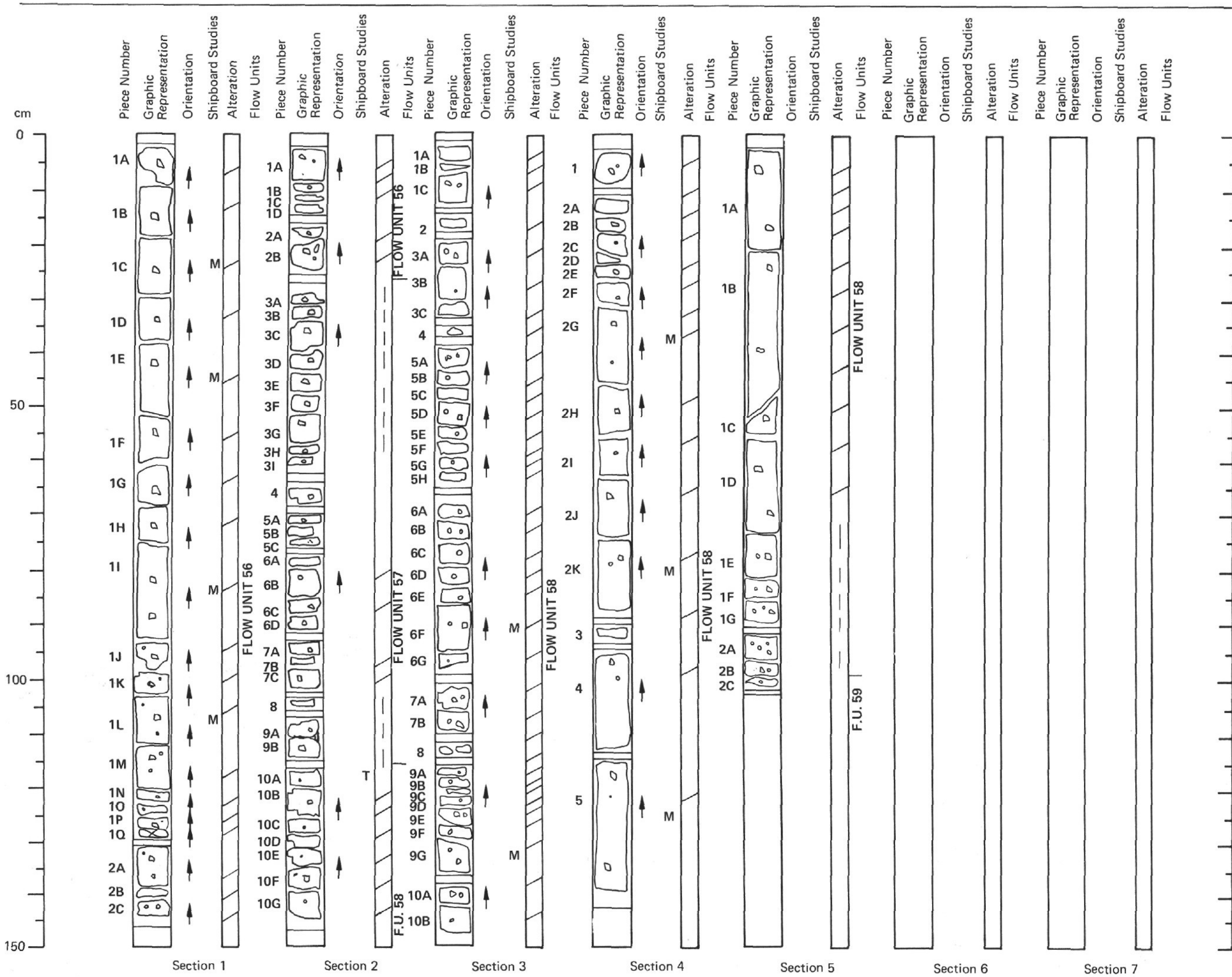
MAGNETIC DATA

Average Inclination: −41.2°

Average Magnetic Intensity (10^{-5} Gauss): 280

VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG 55 SITE 433 HOLE C CORE 44 DEPTH 497.5-507.0 m



FLOW UNIT NO. 57:

POSITION: Top - Core 44, Sect. 2, 28 cm; Bottom - Core 44, Sect. 2, 115 cm

CHEMISTRY: Not analyzed

VISUAL DESCRIPTION

Mineralogy: Phenocrysts: ol., 0.5-2 mm
Groundmass: variolitic, ol., 8%, plag., 40%; px., 20%; op. 5%; clay 25%

Lithology: Vesicles, 10-20%, top and bottom are oxidized

Alteration: Clay filling vesicles and in groundmass; ol. to clay + iddingsite

FLOW UNIT NO. 58:

POSITION: Top - Core 44, Sect. 2, 116 cm; Bottom - Core 44, Sect. 5, 100 cm

CHEMISTRY: Not analyzed

VISUAL DESCRIPTION

Mineralogy: Phenocrysts: ol., 2-3%, 0.5-1.0 mm, altered, plag. < 1%, 1 mm, only at base
Groundmass: ol., plag., px., op., clay (25%)

Lithology: 5-20% vesicles; top and bottom vesicular center more massive

Alteration: Groundmass extensively altered to clay, ol. to clay + iddingsite, vesicles filled by clay

THIN SECTION DESCRIPTION

Phenocrysts: Ol., 3%, 0.5-1.2 mm, altered; plag., 2%, 0.5-1.5 mm; cpx., 2%, 0.5-1.0 mm, augite

Groundmass: Ol., 6%, 0.1-0.5 mm, altered; plag., 20%, 0.1-0.5 mm; cpx., 7%, 0.1-0.5 mm; altered glass 40%

Texture: Intersertal

Vesicles: None

Alteration: 10% clay in vesicles and cracks; 45% clay after glass + ol.; 10% zeolite filling vesicles

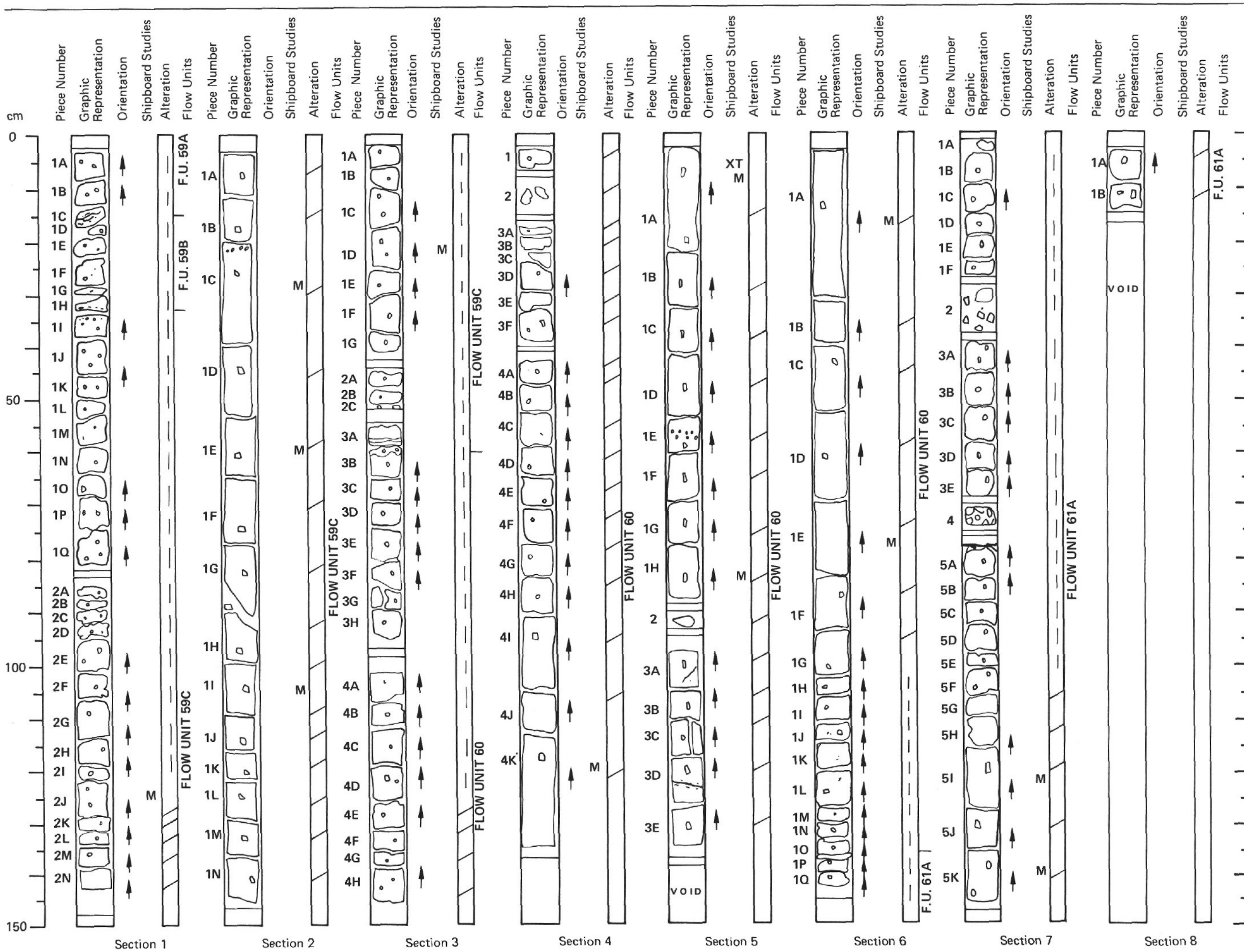
MAGNETIC DATA

Average Inclination: -47.5°

Average Magnetic Intensity (10^{-5} Gauss): 623

VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG **55** SITE **433** HOLE **C** CORE **45** DEPTH **507.0-516.5 m**



FLOW UNIT NO. 59:

POSITION: Top - Core 44, Sect. 5, 99 cm; Bottom - Core 45, Sect. 3, 59 cm

CHEMISTRY: Not analyzed

VISUAL DESCRIPTION

Mineralogy: Phenocrysts: ol., 1-5%, 0.5-1.5 mm, altered
Groundmass: ol., 0-5%, plag. 35%, px. 25%, op. 5%, clay 25%; variolitic

Lithology: Three sub-units. Top two probably are thin pahoehoe tongues. Top oxidized and vesicular, center massive, lower part vesicular

Alteration: Groundmass extensively altered to clay; clay in vesicles; ol. to iddingsite + clay

MAGNETIC DATA

Average Inclination: −44.7°
Average Magnetic Intensity (10^{-5} Gauss): 568

FLOW UNIT NO. 60:

POSITION: Top - Core 45, Sect. 3, 60 cm; Bottom - Core 45, Sect. 6, 137 cm

CHEMISTRY: Tholeiitic basalt, 1 analysis in Table 1.

VISUAL DESCRIPTION

Mineralogy: Phenocrysts: ol., 0-1%, 0.5-1.0 mm, some fresh, plag., 0-10%, 0.5-1.5 mm
Groundmass: ol., plag., px., op., clay

Lithology: Oxidized and vesicular top, massive and non-oxidized center, vesicular base

Alteration: Vesicles filled and lined by clay and calcite, ol. partially altered, groundmass extensively altered to clay

THIN SECTION DESCRIPTION

Phenocrysts: Ol., 2%, 0.5-0.7 mm, fresh; plag., 10%, 0.5-1.5 mm

Groundmass: Ol., 2%, 0.1-0.2 mm, altered; plag., 35%, 0.1-0.5 mm; cpx., 37%, 0.02-0.5 mm, op., 7%, 0.05-0.2 mm; altered glass, 7%

Texture: Intergranular

Vesicles: None in thin section

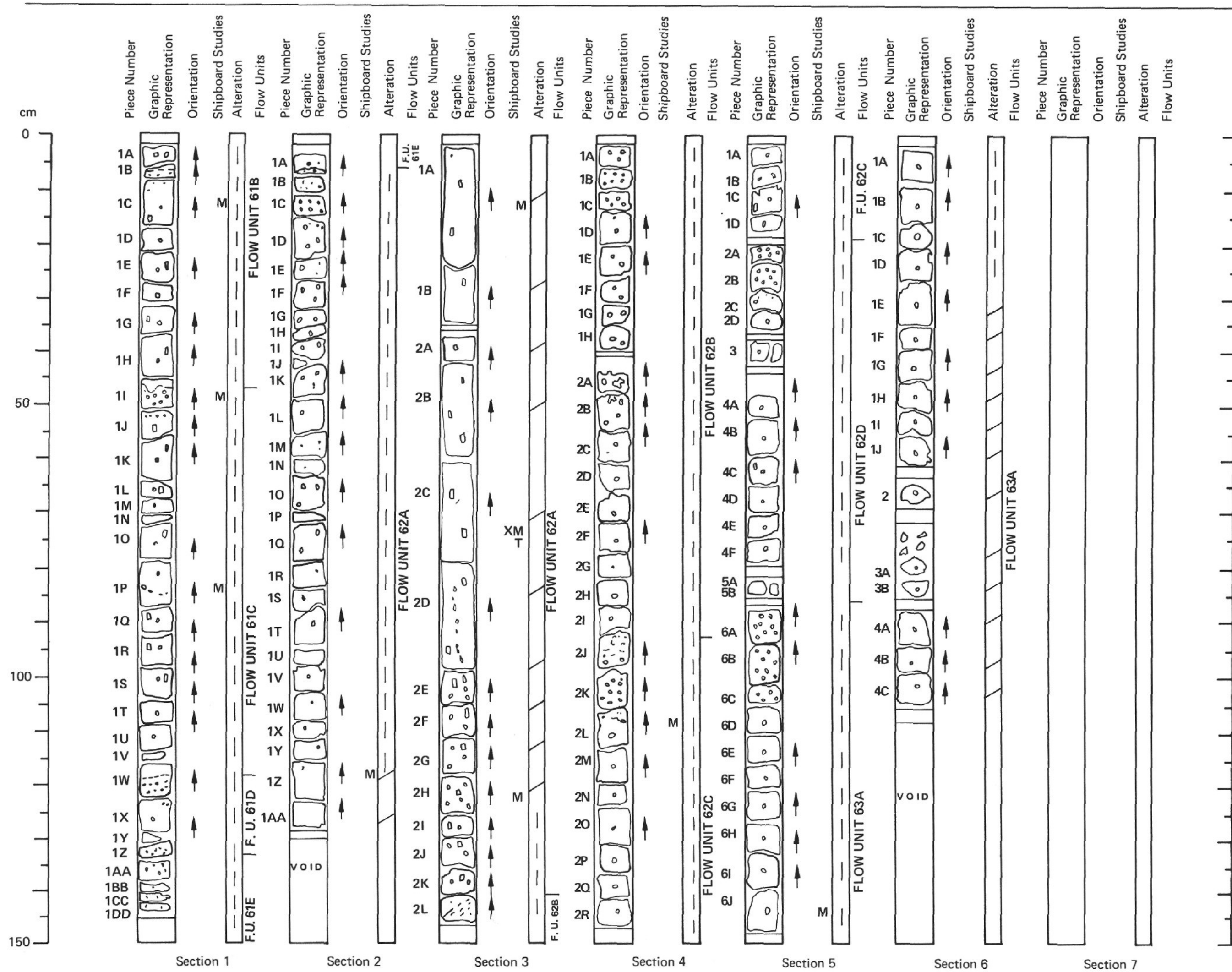
Alteration: 10% clay after glass + ol.

MAGNETIC DATA

Average Inclination: −42.9°
Average Magnetic Intensity (10^{-5} Gauss): 420

VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG 55 SITE 433 HOLE C CORE 46 DEPTH 516.5-526.0 m



FLOW UNIT NO. 61:

POSITION:	Top - Core 45, Sect. 6, 138 cm; Bottom - Core 46, Sect. 2, 5 cm
CHEMISTRY:	Not analyzed

VISUAL DESCRIPTION

Mineralogy:	Phenocrysts: ol., 2%, 0.5 to 2 mm; plag., 1%, 1-2 mm Groundmass: plag. 50%, ol.10%, px. + op. 30%; altered glass 10%
Lithology:	Five sub-units, each with an oxidized and vesicular top, less massive centers and bases
Alteration:	Some ol. fresh, vesicles filled and lined by clay + calcite; groundmass extensively altered to clay

MAGNETIC DATA

Average Inclination: –43.1°

Average Magnetic Intensity (10^{-5} Gauss): 320

FLOW UNIT NO. 62:

POSITION:	Top - Core 46, Sect. 2, 5 cm; Bottom - Core 46, Sect. 5, 85 cm
CHEMISTRY:	Tholeiitic basalt, 1 analysis in Table 1.

VISUAL DESCRIPTION

Mineralogy:	Phenocrysts: ol., 1-3%, 0.5-2 mm, some fresh, plag. 1-3%, 0.1-2.5 mm Groundmass: ol., plag., px., op., clay
Lithology:	Oxidized and vesicular flow top, four sub-units with oxidized tops and massive centers and bases, vesicles 5-25%
Alteration:	Groundmass extensively altered to clay, vesicles filled and lined by clay; ol. partially altered

THIN SECTION DESCRIPTION

Phenocrysts:	Ol., 1%, 0.5-1.5 mm, euhedral, altered; plag., 3%, 0.5-2 mm, euhedral; cpx. 2%, 0.5-1.6 mm, euhedral, section zoned
Groundmass:	Ol. 5%, 0.2-0.5 mm, altered; plag. 19%, 0.2-0.5 mm; cpx. 35%, 0.1-0.5 mm; op. 5%, 0.05-0.25 mm
Texture:	Interstitial
Vesicles:	20%, clay filled
Alteration:	30% clay after groundmass and in vesicles; ol. altered to iddingsite + clay

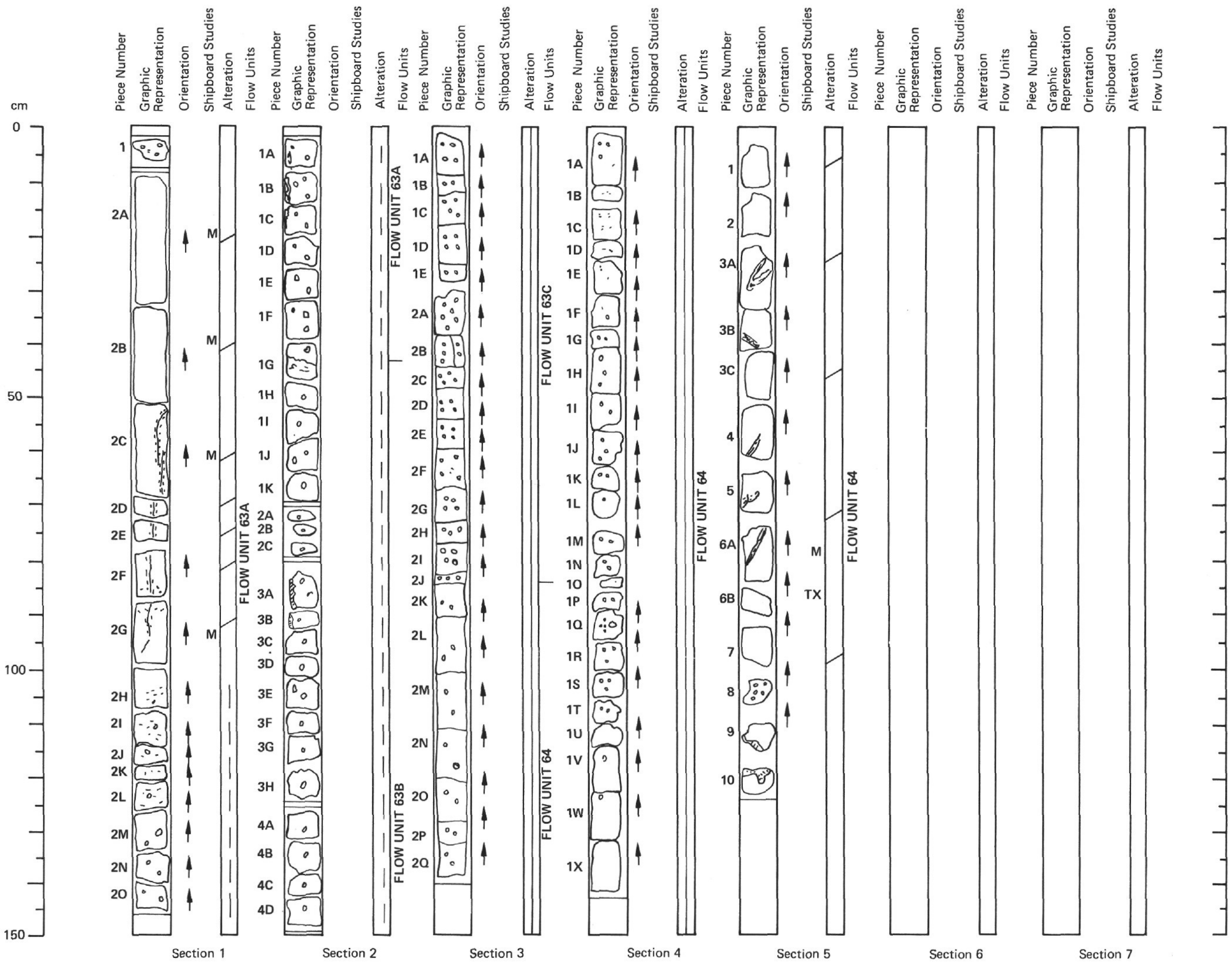
MAGNETIC DATA

Average Inclination: –41.0°

Average Magnetic Intensity (10^{-5} Gauss): 578

VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG **55** SITE **433** HOLE **C** CORE **47** DEPTH **526.0-535.5 m**



FLOW UNIT NO. 63:

POSITION: Top - Core 46, Sect. 5, 86 cm; Bottom - Core 47, Sect. 3, 86 cm

CHEMISTRY: Not analyzed

VISUAL DESCRIPTION

Mineralogy: Phenocrysts: ol., < 1%, 0.5-1 mm; plag. < 1%, 0.5-1.5 mm
Groundmass: plag. 50%, ol. 15%, px. + op. 25%, altered glass 10%

Lithology: Three sub-units each with an oxidized and vesicular top, vesicles 5 to 30%

Alteration: Vesicles filled and lined by clay and calcite; groundmass extensively altered throughout, ol. mostly altered

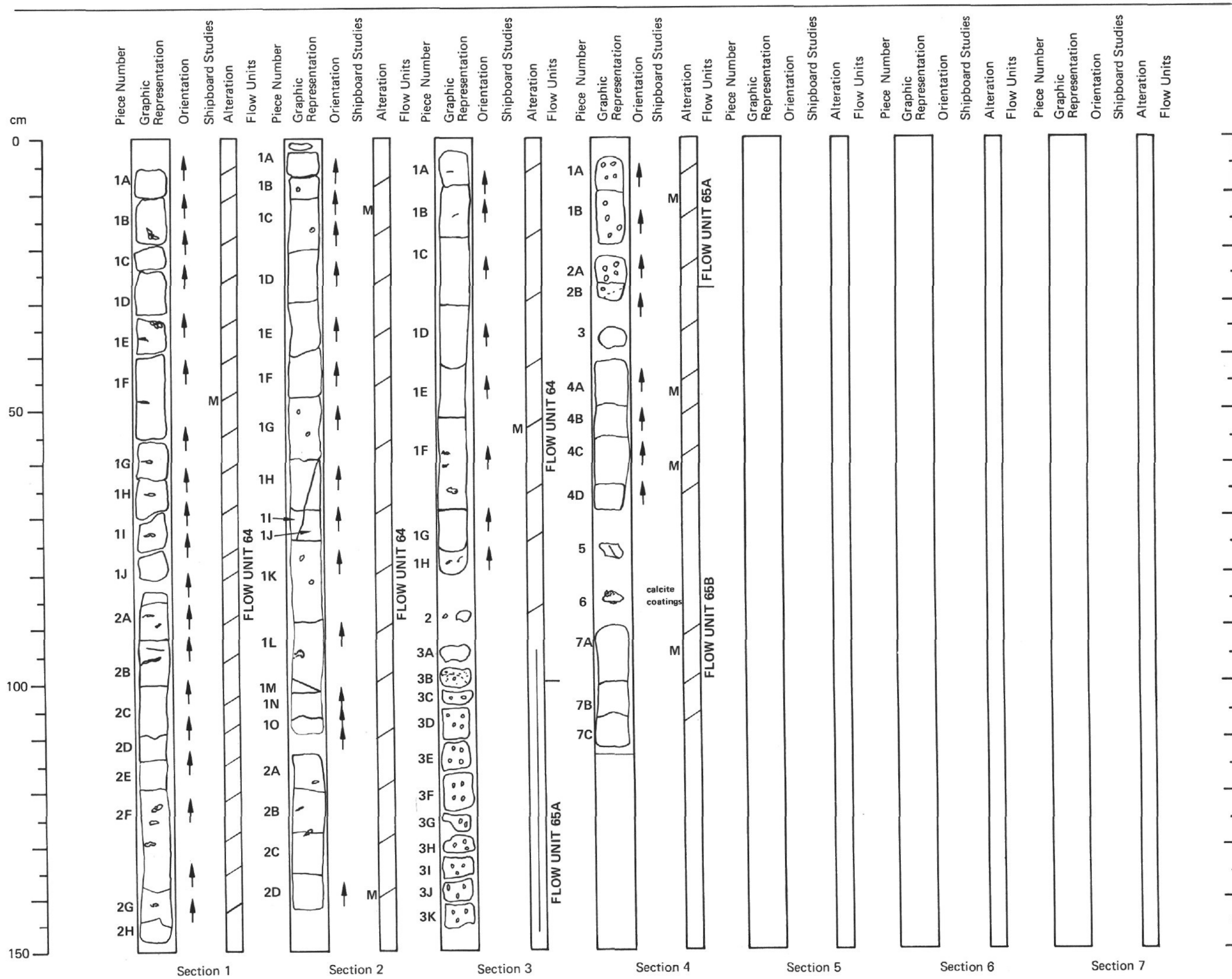
MAGNETIC DATA

Average Inclination: −40.3°

Average Magnetic Intensity (10^{-5} Gauss): 364

VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG **55** SITE **433** HOLE **C** CORE **48** DEPTH **535.5-545.0 m**



FLOW UNIT NO. 64:
POSITION: Top - Core 47, Sect. 3, 86 cm; Bottom - Core 48, Sect. 3, 97 cm
CHEMISTRY: Alkalic basalt(?), 1 analysis in Table 1.

VISUAL DESCRIPTION
Mineralogy: Phenocrysts: ol., 1-2%, 0.5-2 mm, some fresh, plag. 1%, 0.5-3 mm; px., <1%, 1 mm
Groundmass: plag., px., op., ol.
Lithology: Oxidized, vesicular and brecciated flow top; central part massive and very fresh
Alteration: Vesicles filled and lined by clay and calcite; groundmass altered to clay in places; some ol. altered

THIN SECTION DESCRIPTION
Phenocrysts: Ol., 2%, 0.7 mm, subhedral to anhedral, altered, plag., 2%, 0.2-0.5 mm, subhedral
Groundmass: Ol., 2%, 0.05-0.2 mm, altered; plag., 45%, 0.01-0.1; cpx. 25%, 0.01-0.02, colorless; op. 15%, 0.01-0.02 mm
Texture: Intergranular, sub-trachytic
Vesicles: 5%, 0.5-1 mm, lined by brown clay, filled by green clay
Alteration: *10% clay after glass; ol. to iddingsite*

MAGNETIC DATA
Average Inclination: $-69.0°$
Average Magnetic Intensity (10^{-5} Gauss): 1060

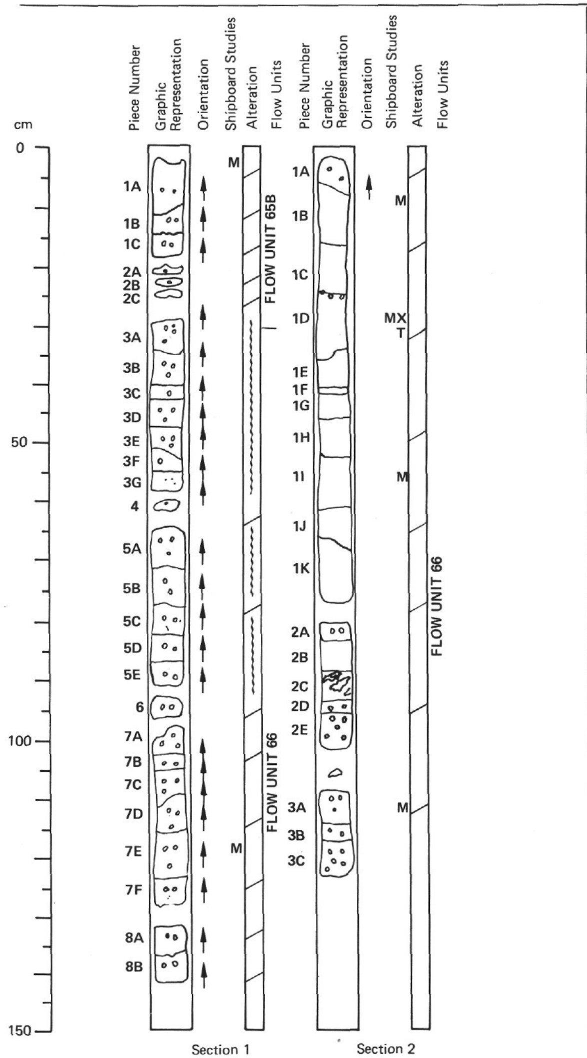
FLOW UNIT NO. 65:
POSITION: Top - Core 48, Sect. 3, 99 cm; Bottom - Core 49, Sect. 1, 31 cm
CHEMISTRY: Not analyzed

VISUAL DESCRIPTION
Mineralogy: Phenocrysts: ol., <1%, 0.5-1 mm, altered
Groundmass: ol., 15%; plag., 35%; px. + op., 40%; clay, 10%
Lithology: Two sub-units each with a vesicular and slightly oxidized top, and a moderately vesicular center and bottom. Also separated by a vitrophyre.
Alteration: Groundmass partially altered to clay; vesicles filled by clay + calcite; ol. altered

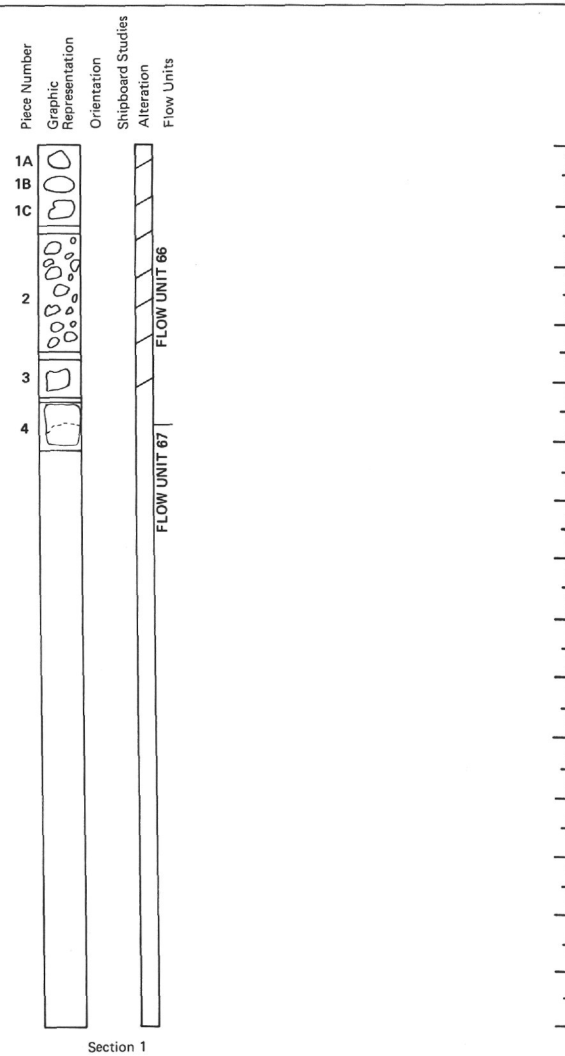
MAGNETIC DATA
Average Inclination: $-66.1°$
Average Magnetic Intensity (10^{-5} Gauss): 582

VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

SITE 433 HOLE C CORE 49 DEPTH 545.0-549.0 m



SITE 433 HOLE C CORE 50 DEPTH 549.0-550.5 m



FLOW UNIT NO. 66:

POSITION: Top - Core 49, Sect. 1, 33 cm; Bottom - Core 50, Sect. 1, 49 cm

CHEMISTRY: Tholeiitic basalt, 1 analysis in Table 1

VISUAL DESCRIPTION

Mineralogy: Aphyric
Groundmass: ol. 15%; plag. 35%; px. + op. 40%; clay 10%

Lithology: Oxidized top; 5-15% vesicles throughout

Alteration: Clay in groundmass; vesicles filled and lined by clay and calcite; some ol. fresh

THIN SECTION DESCRIPTION

Groundmass: Ol. 10%, 0.08-0.6 mm subhedral, altered; plag. 35%, 0.15-1.5 mm; cpx. 25%, 0.4-2.0 mm; op. 5%, 0.1-0.3 mm; altered glass 5%

Texture: Sub-ophitic

Vesicles: 5%, ≤1 mm; oval to irregular

Alteration: 15% clay in vesicles and after groundmass, ol. altered to iddingsite

MAGNETIC DATA

Average Inclination: –65.7°

Average Magnetic Intensity (10^{-5} Gauss): 506

FLOW UNIT NO. 67:

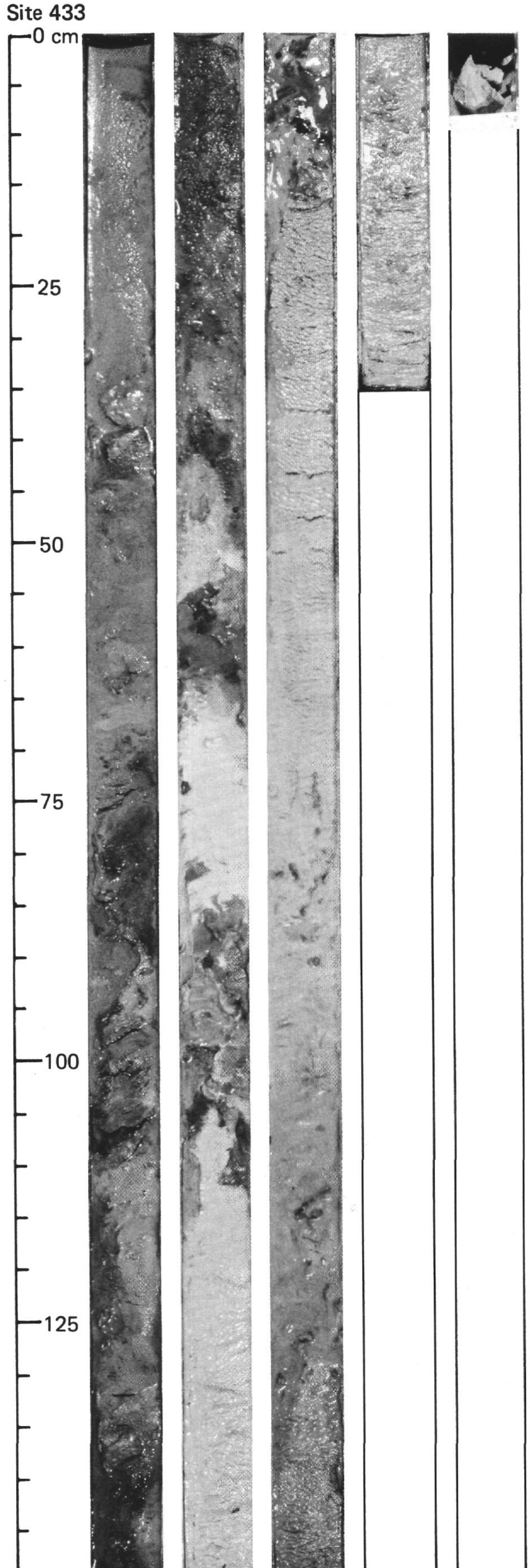
POSITION: Top - Core 50, Sect. 1, 47 cm; Bottom - Core 50, Sect. 1, 52 cm

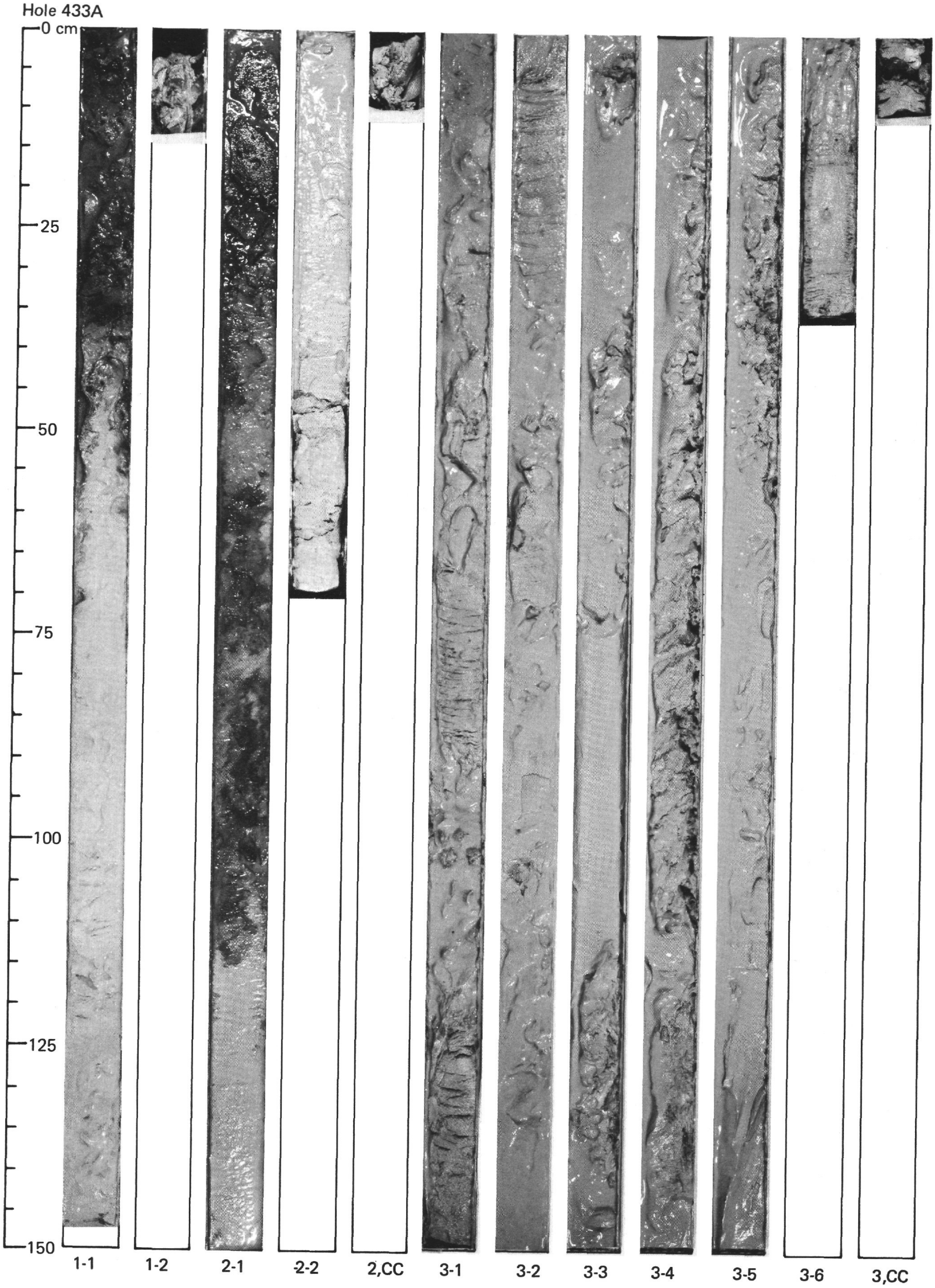
CHEMISTRY: Not analyzed

VISUAL DESCRIPTION

Mineralogy: Phenocrysts: ol., 0.5-1 mm
Groundmass: ol. + altered glass

Lithology: One piece of flow top recovered - oxidized and glassy


Site 433
0 cm
25
50
75
100
125
150
1-1
1-2
1-3
1-4
1,CC


Hole 433A
0 cm
25
50
75
100
125
150
1-1
1-2
2-1
2-2
2,CC
3-1
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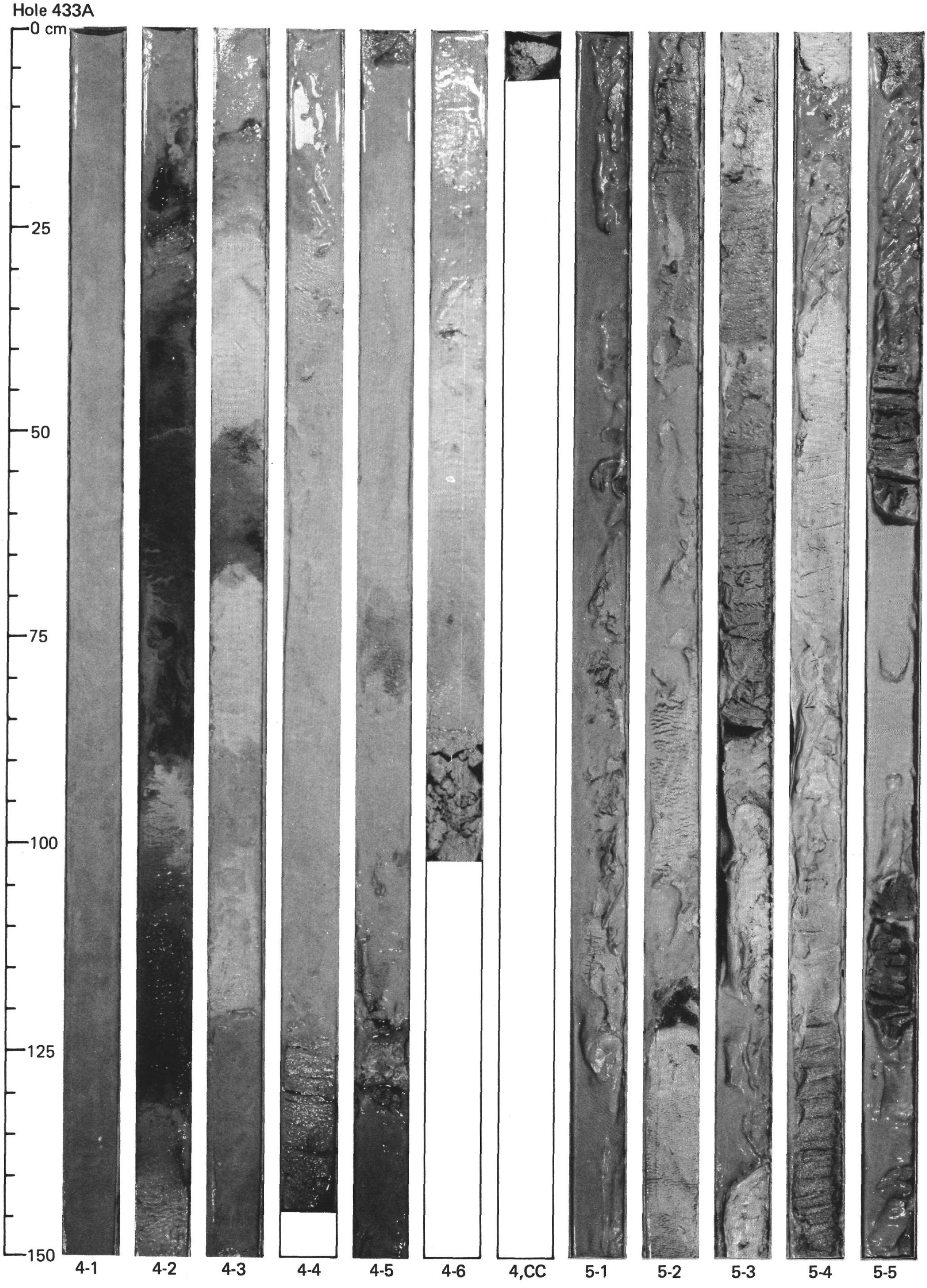
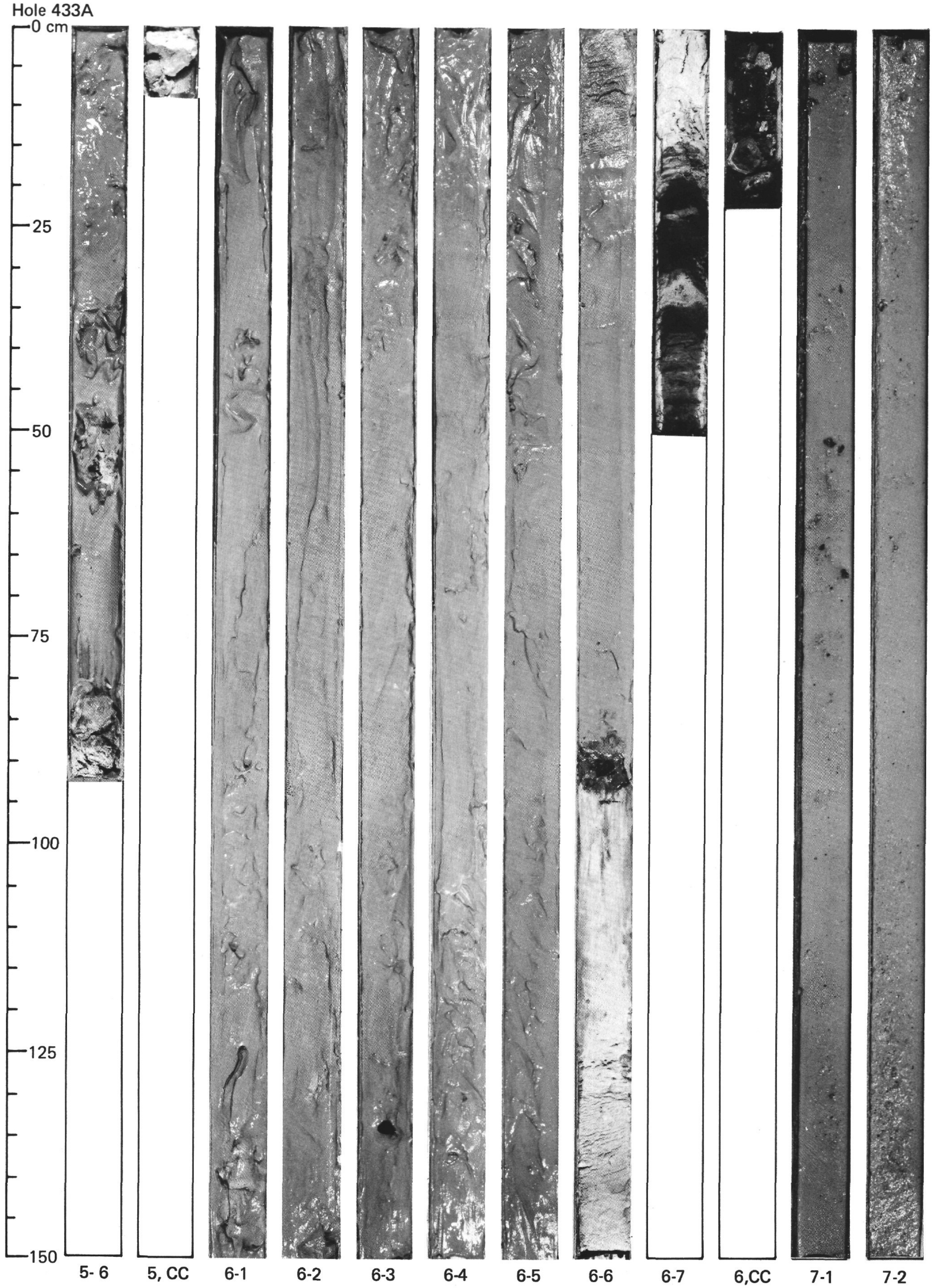
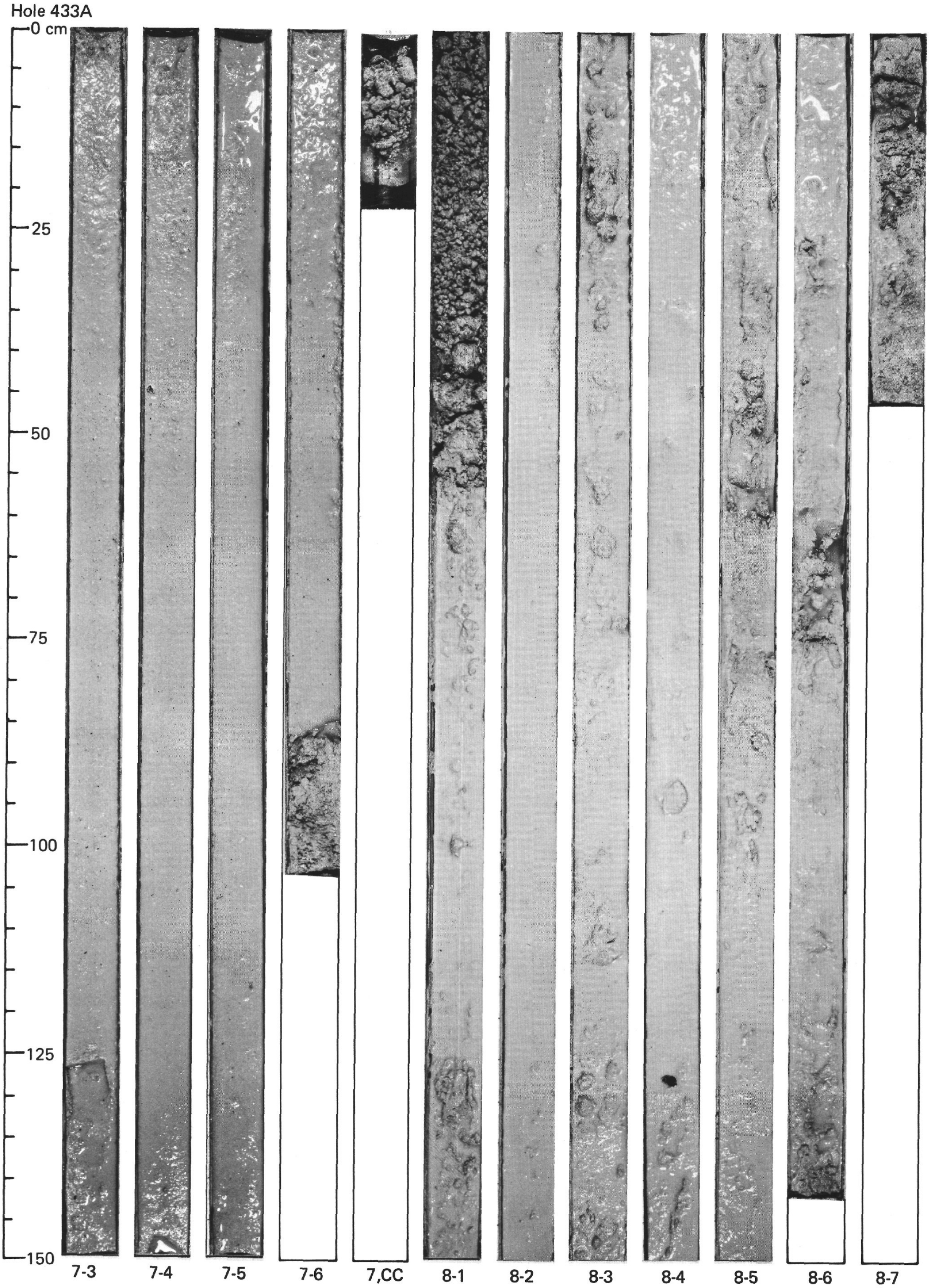
3-3
3-4
3-5
3-6
3,CC


Hole 433A
0 cm
25
50
75
100
125
150
4-1
4-2
4-3
4-4
4-5
4-6
4,CC
5-1
5-2
5-3
5-4
5-5



Hole 433A
0 cm
25
50
75
100
125
150
5- 6
5, CC
6-1
6-2
6-3
6-4
6-5
6-6
6-7
6,CC
7-1
7-2


Hole 433A
0 cm
25
50
75
100
125
150
7-3
7-4
7-5
7-6
7,CC
8-1
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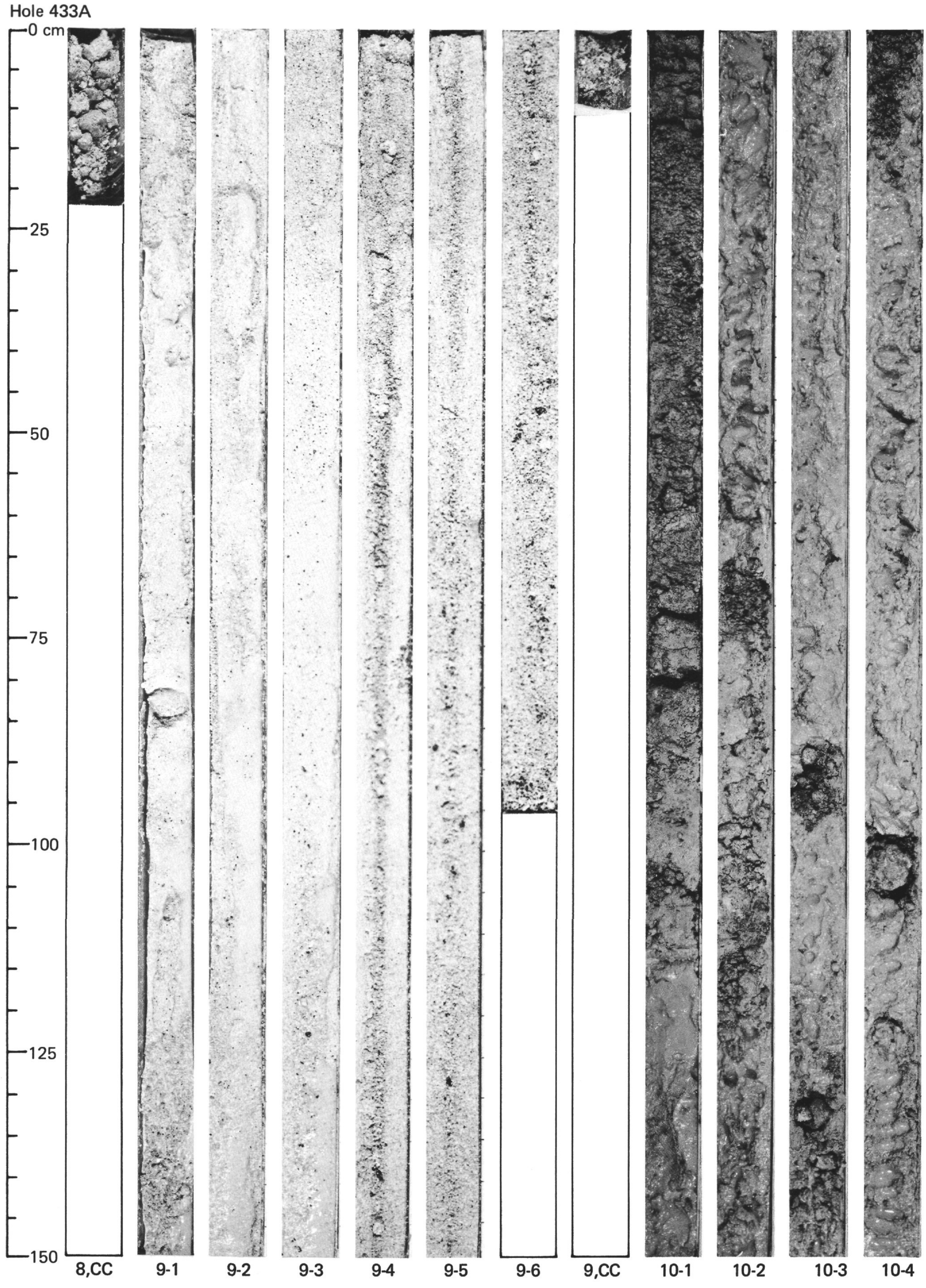
8-3
8-4
8-5
8-6
8-7


Hole 433A
0 cm
25
50
75
100
125
150
8,CC
9-1
9-2
9-3
9-4
9-5
9-6
9,CC
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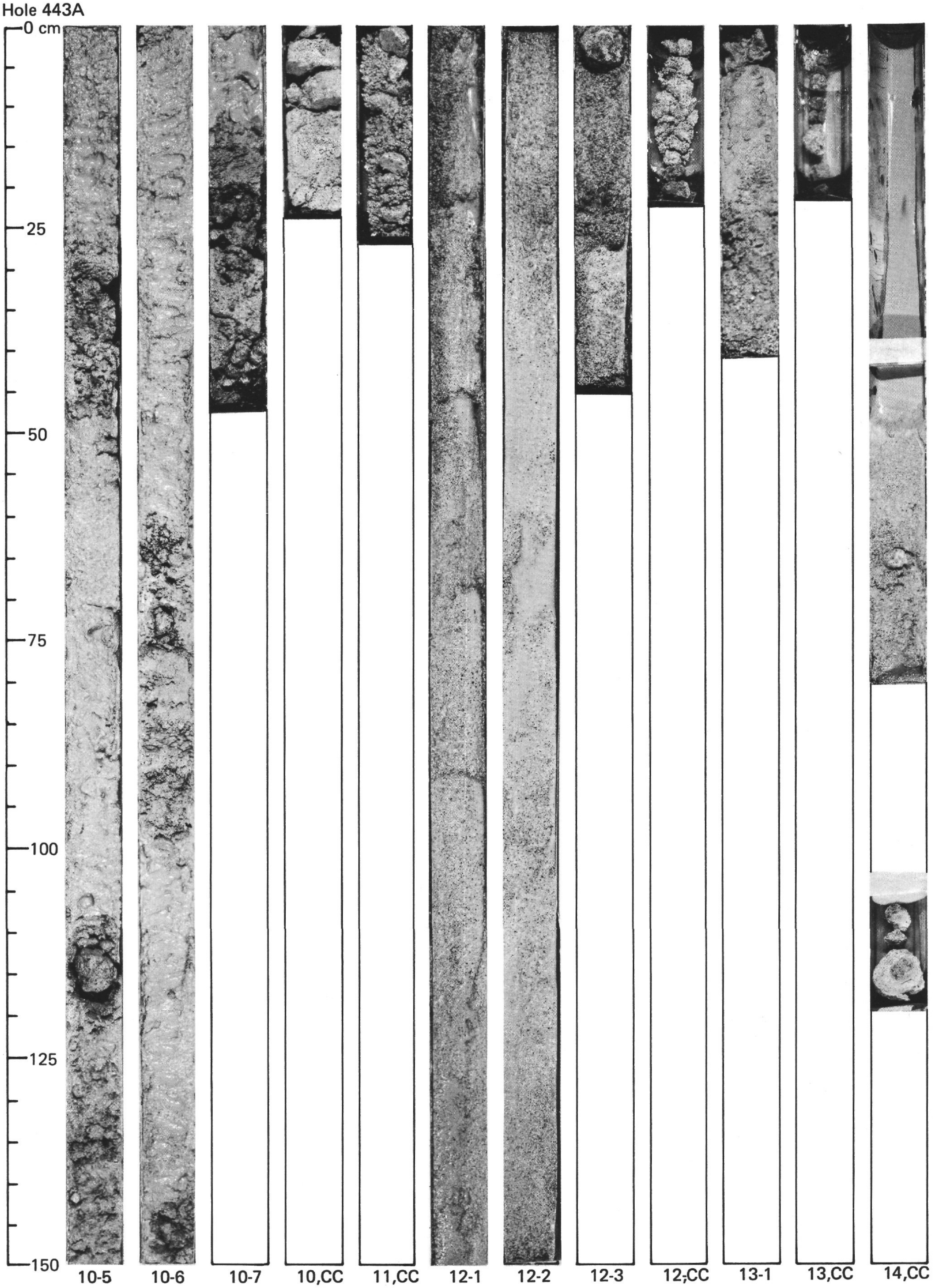
10-2
10-3
10-4


Hole 443A
0 cm
25
50
75
100
125
150
10-5
10-6
10-7
10,CC
11,CC
12-1
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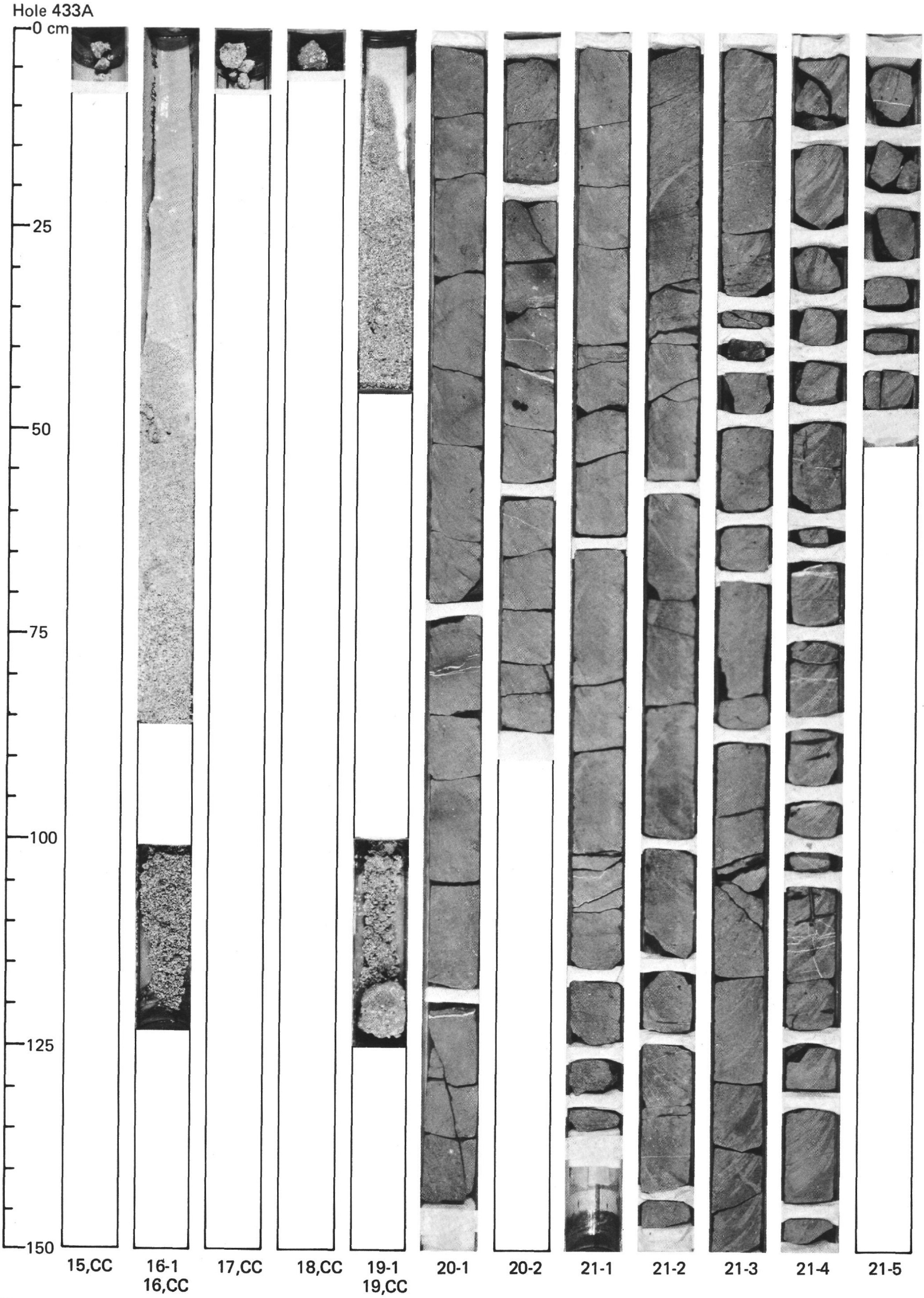
12,CC
13-1
13,CC
14,CC


Hole 433A
0 cm
25
50
75
100
125
150
15,CC
16-1
16,CC
17,CC
18,CC
19-1
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20-1
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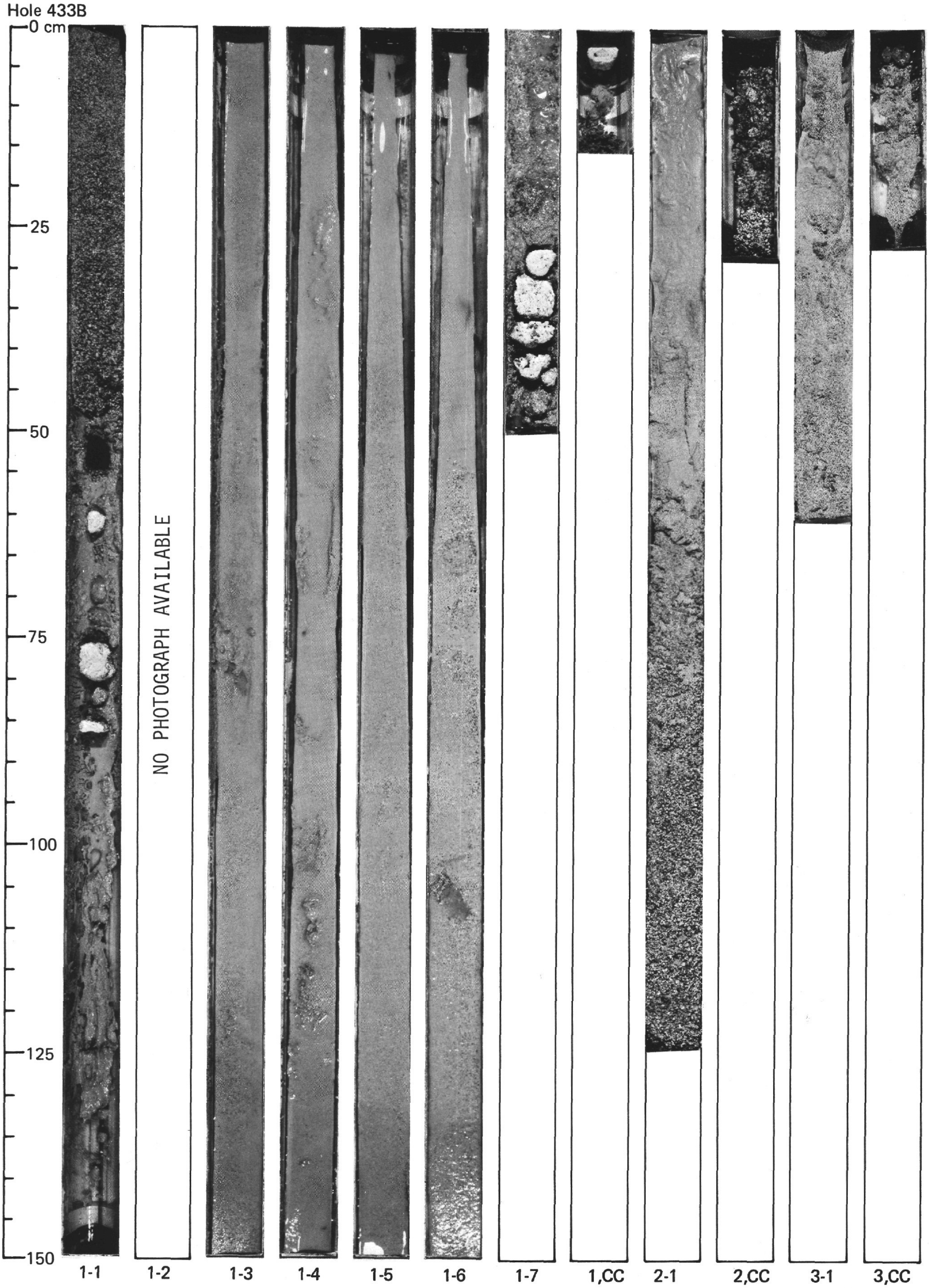
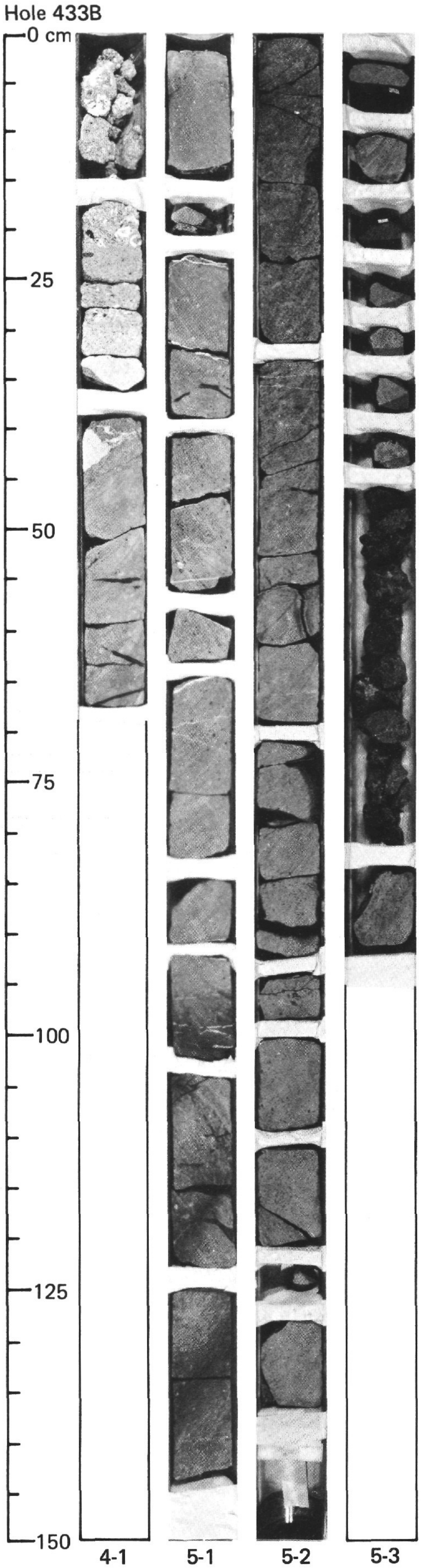
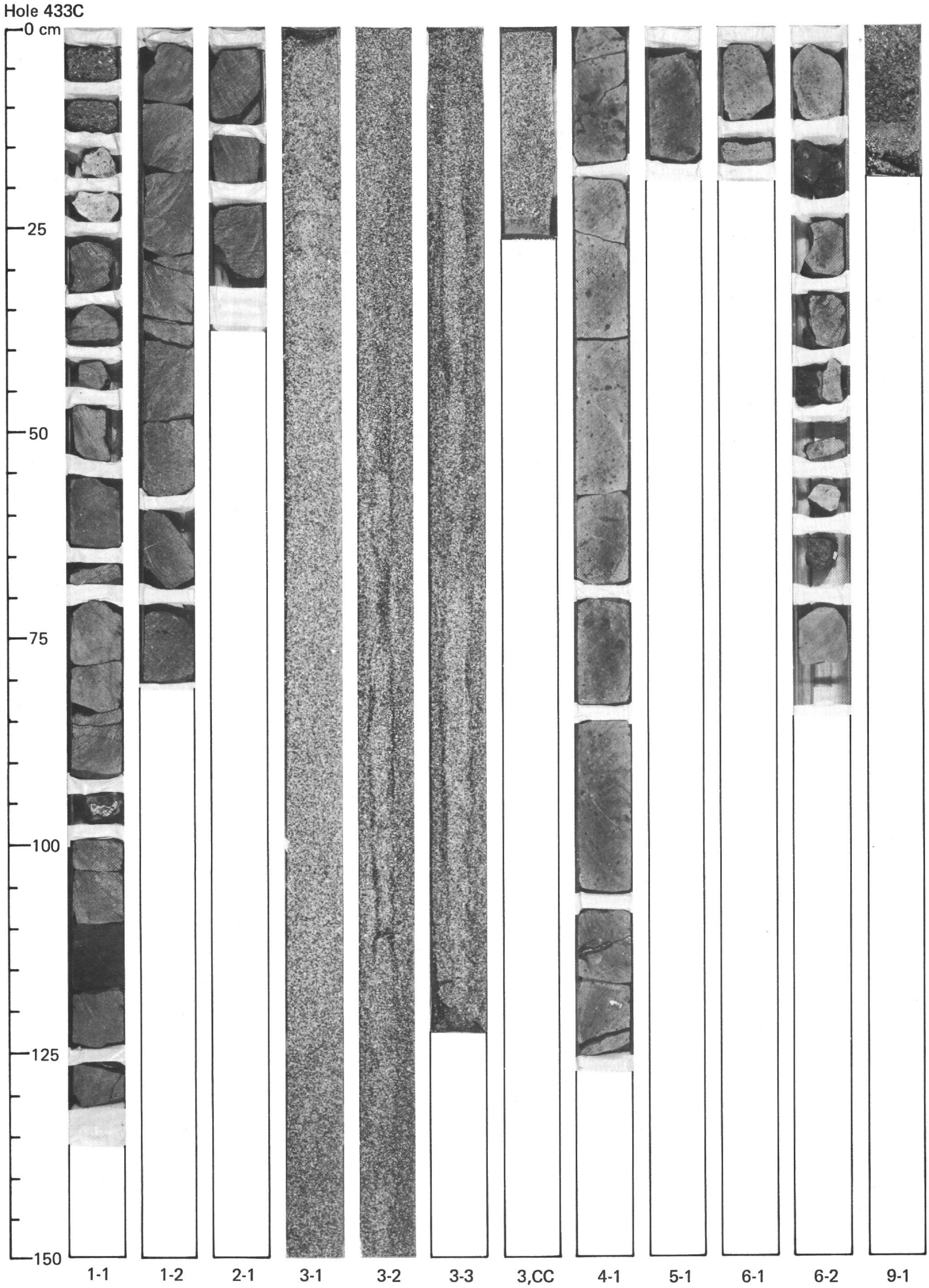
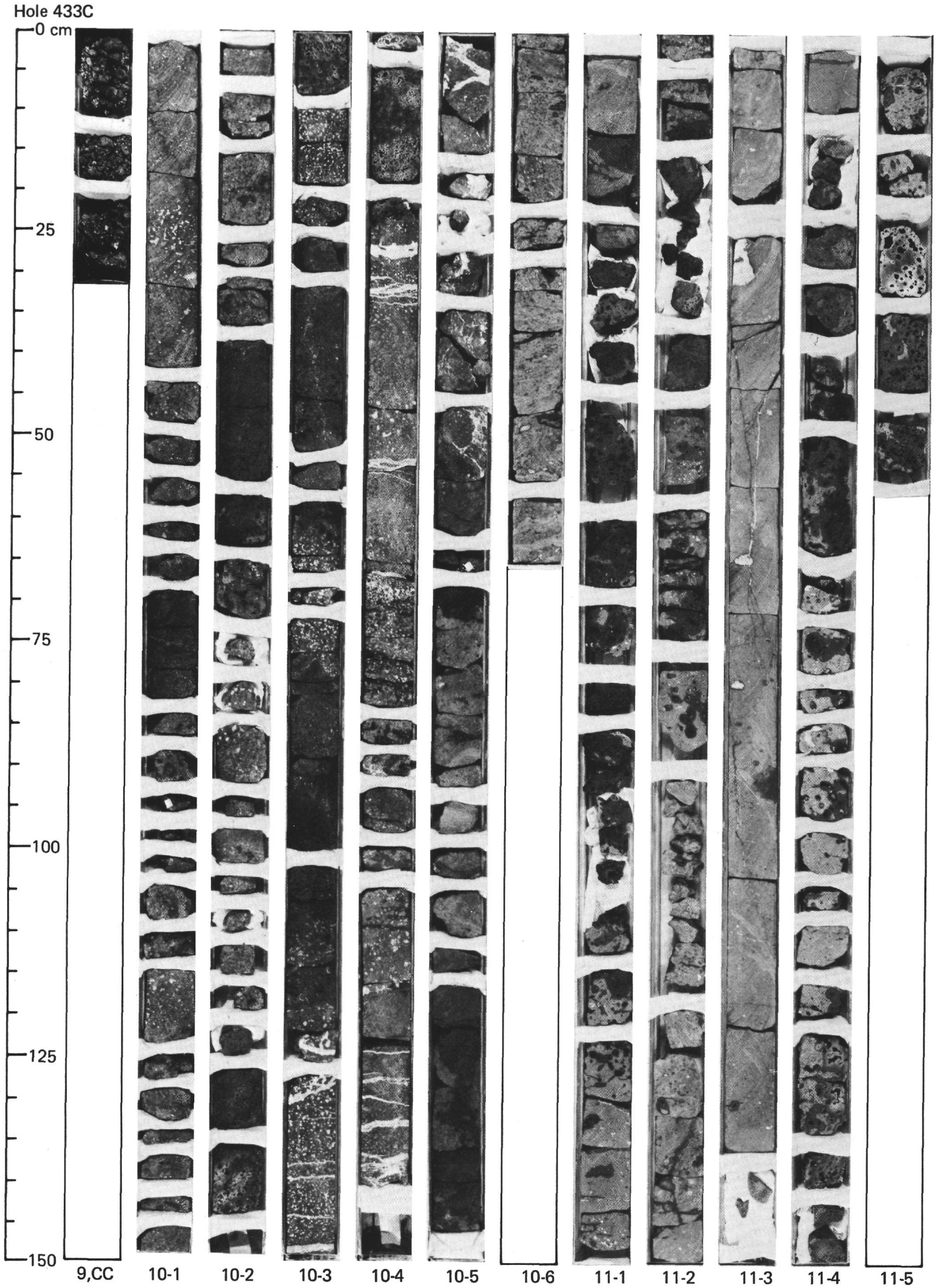
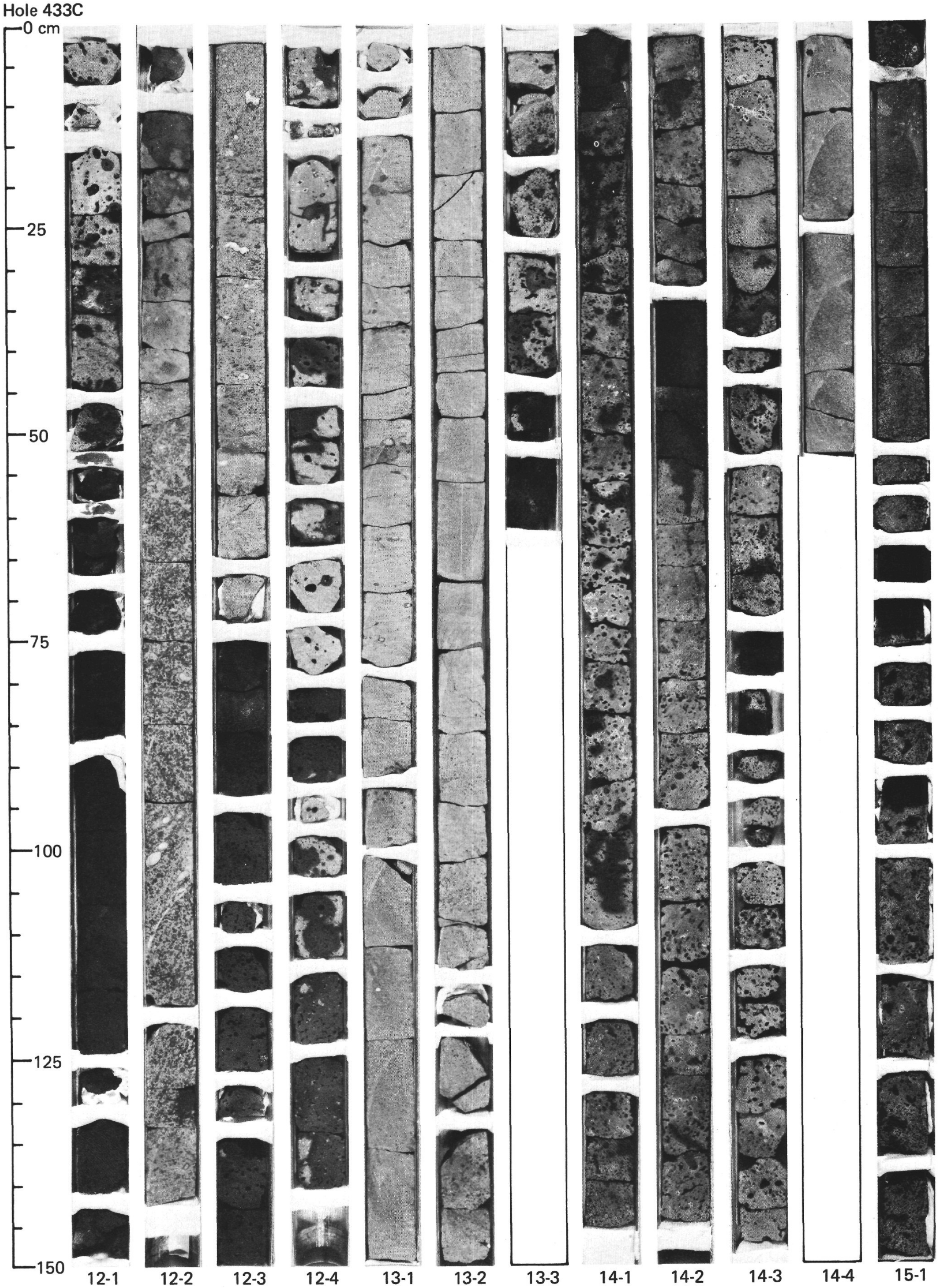
21-3
21-4
21-5

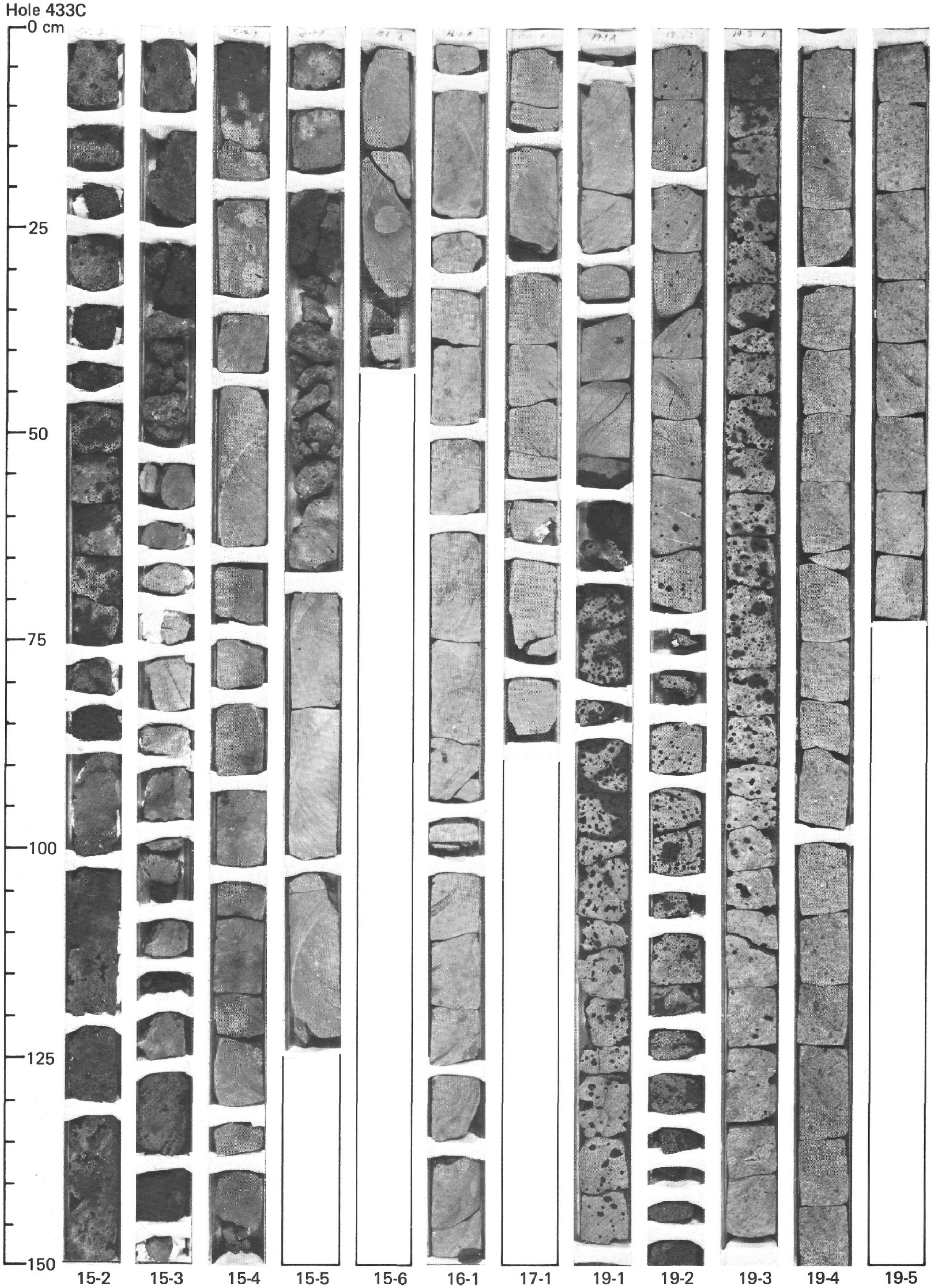

Hole 433B
0 cm
25
50
75
100
125
150
NO PHOTOGRAPH AVAILABLE
1-1
1-2
1-3
1-4
1-5
1-6
1-7
1,CC
2-1
2,CC
3-1
3,CC

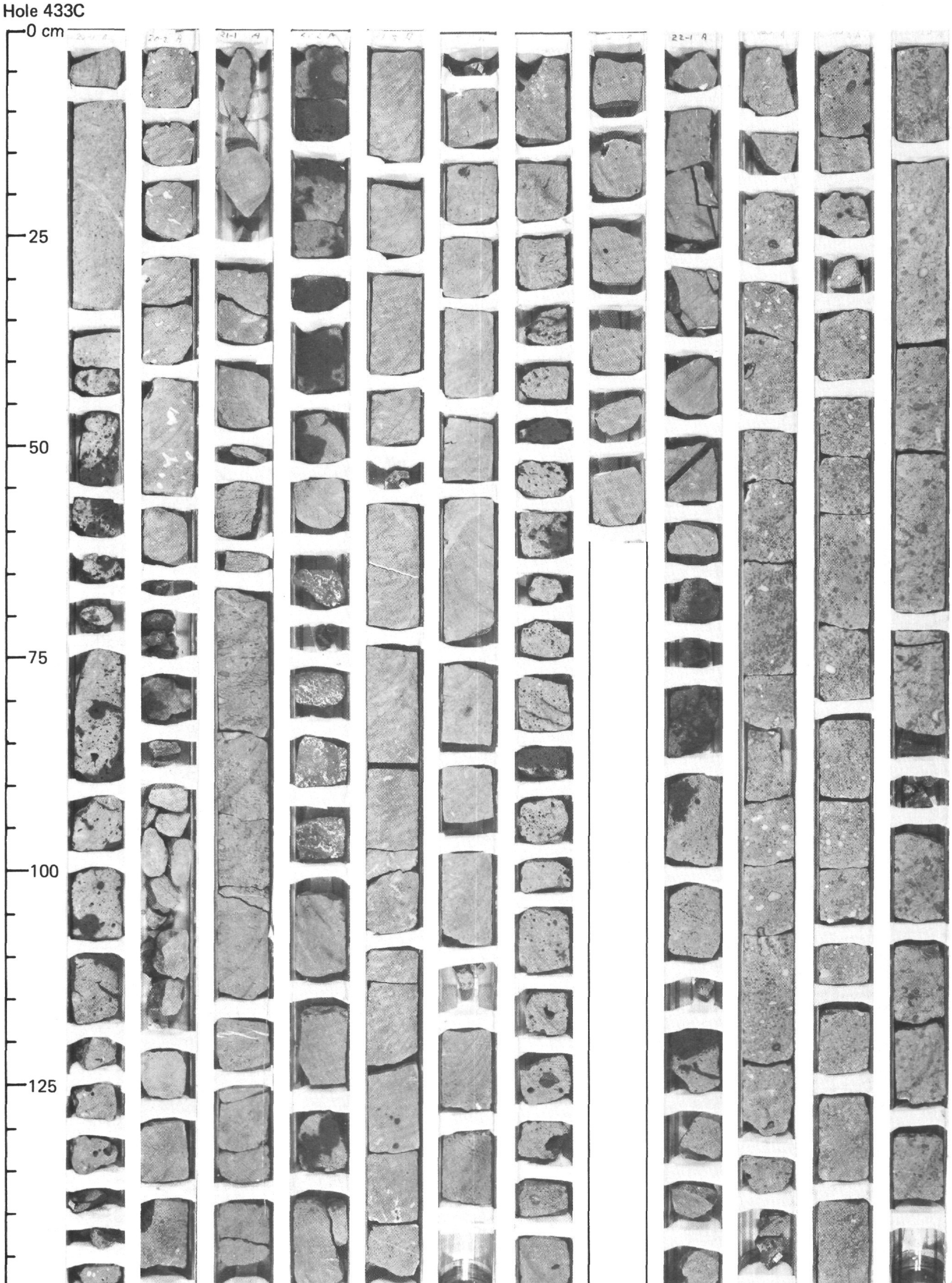

Hole 433B
0 cm
25
50
75
100
125
150
4-1
5-1
5-2
5-3


Hole 433C
0 cm
25
50
75
100
125
150
1-1
1-2
2-1
3-1
3-2
3-3
3,CC
4-1
5-1
6-1
6-2
9-1

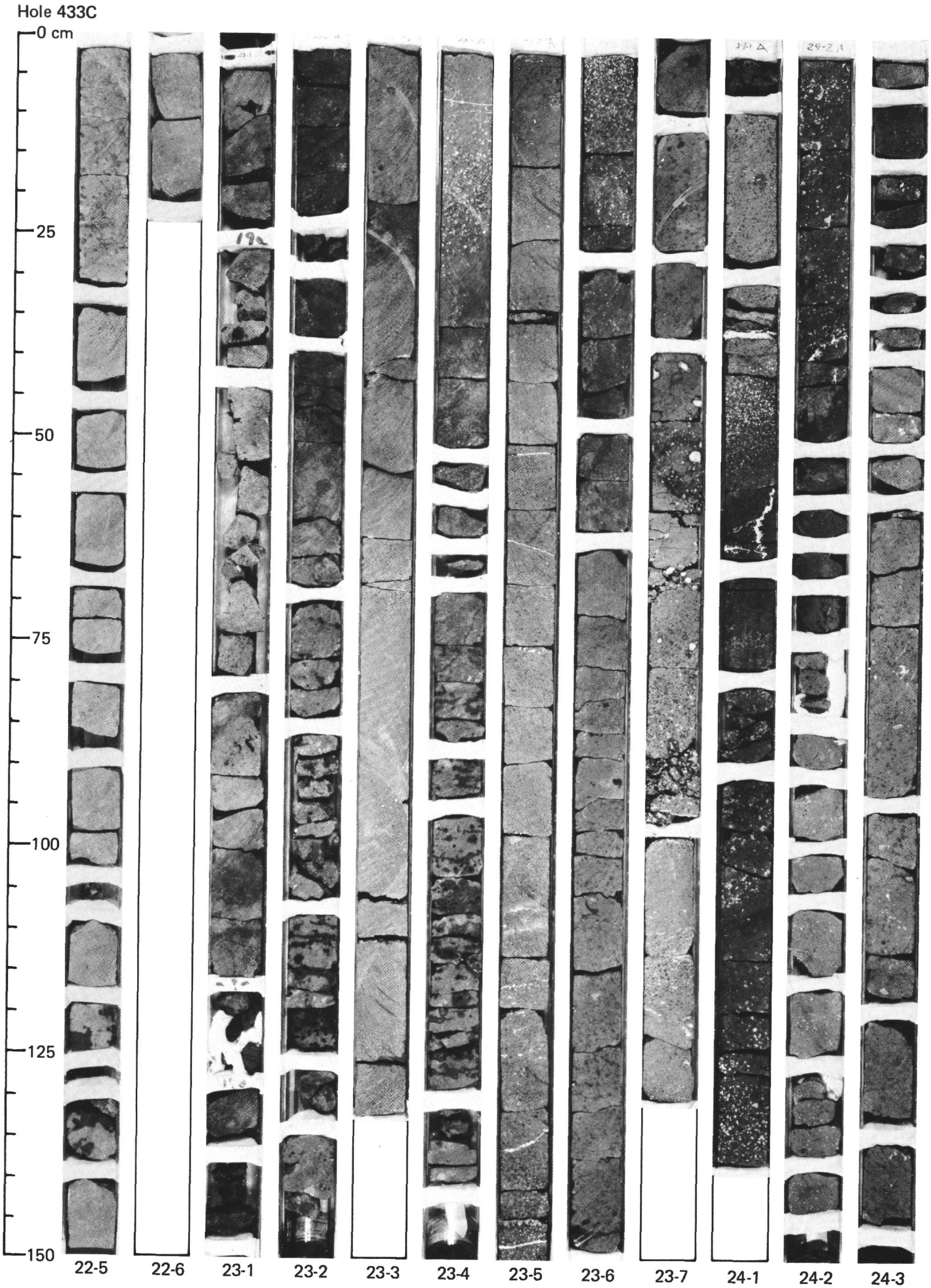

Hole 433C
0 cm
25
50
75
100
125
150
9,CC
10-1
10-2
10-3
10-4
10-5
10-6
11-1
11-2
11-3
11-4
11-5

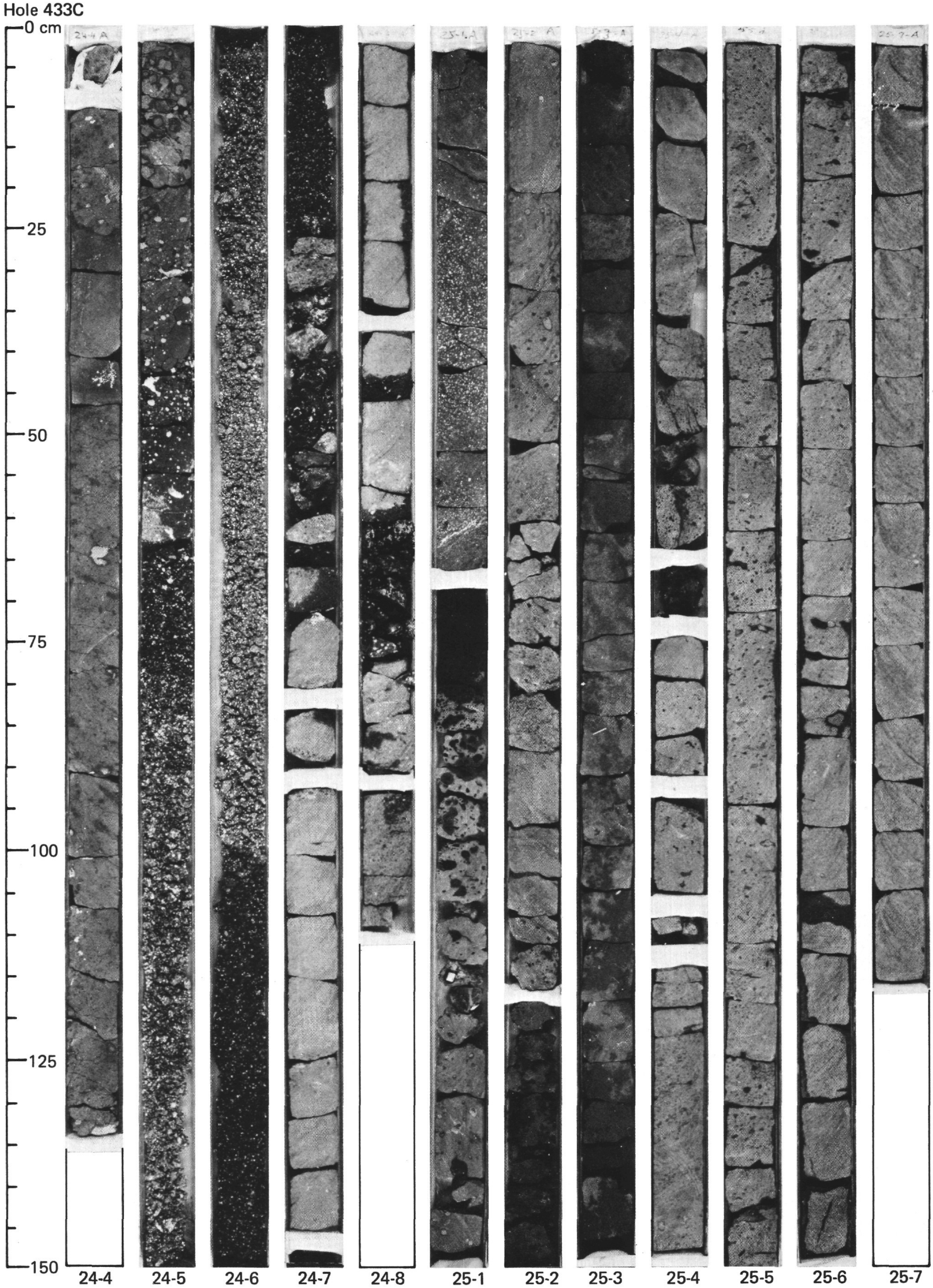

Hole 433C
0 cm
25
50
75
100
125
150
12-1
12-2
12-3
12-4
13-1
13-2
13-3
14-1
14-2
14-3
14-4
15-1

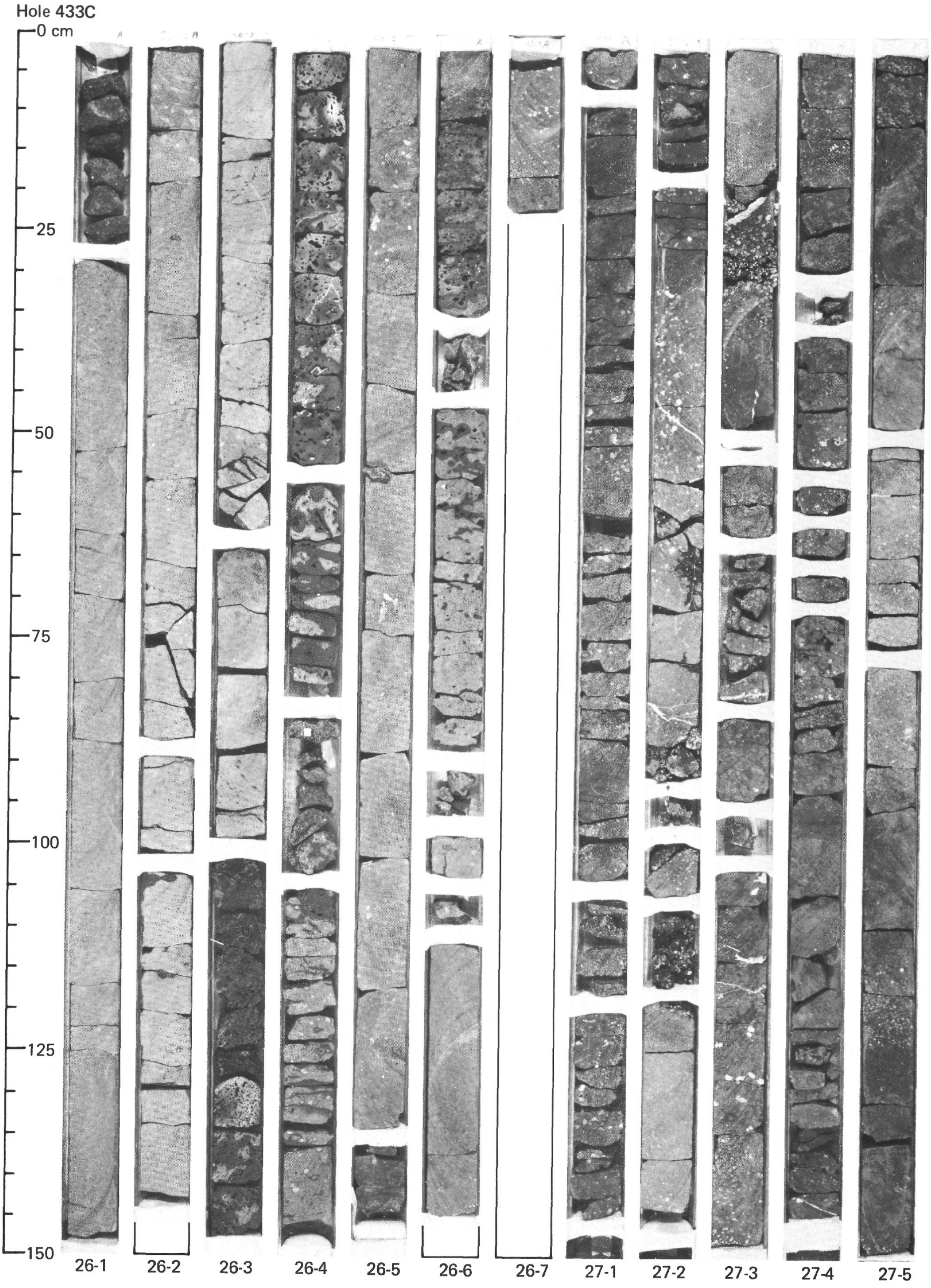

Hole 433C
0 cm
25
50
75
100
125
150
15-2
15-3
15-4
15-5
15-6
16-1
17-1
19-1
19-2
19-3
19-4
19-5



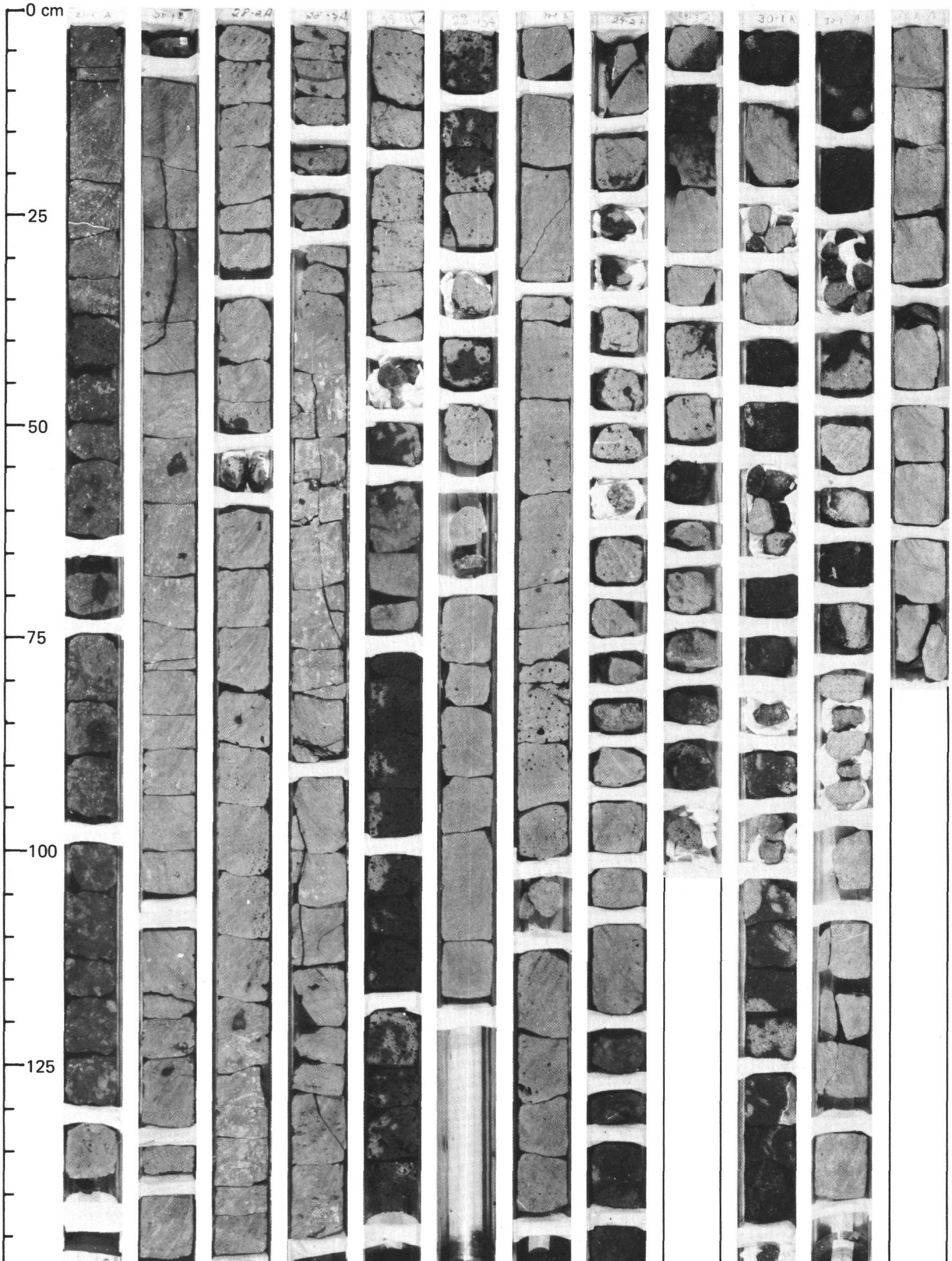
Hole 433C
0 cm
25
50
75
100
125
150
20-1
20-2
21-1
21-2
21-3
21-4
21-5
21-6
22-1
22-2
22-3
22-4

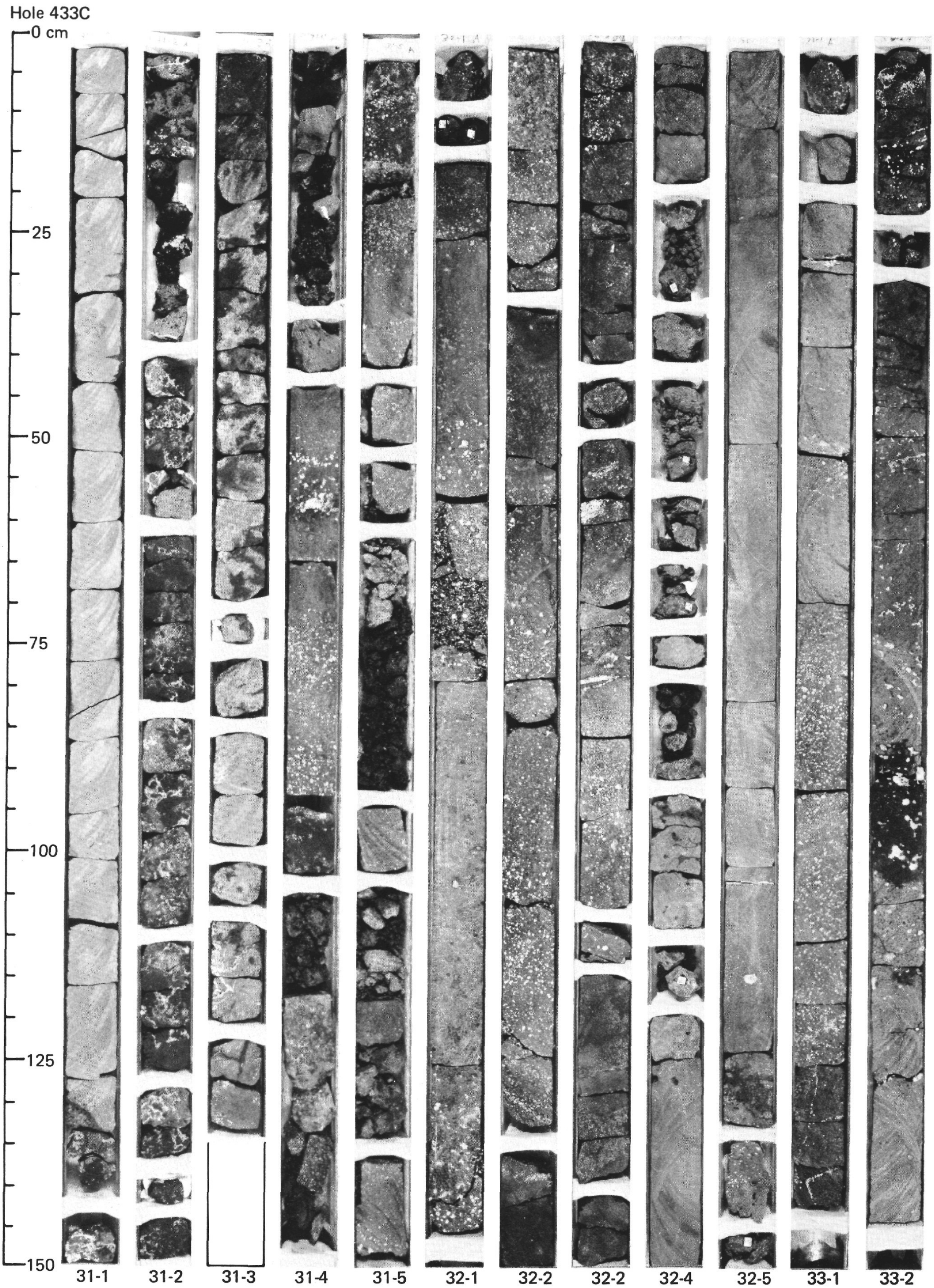

Hole 433C
0 cm
25
50
75
100
125
150
22-5
22-6
23-1
23-2
23-3
23-4
23-5
23-6
23-7
24-1
24-2
24-3

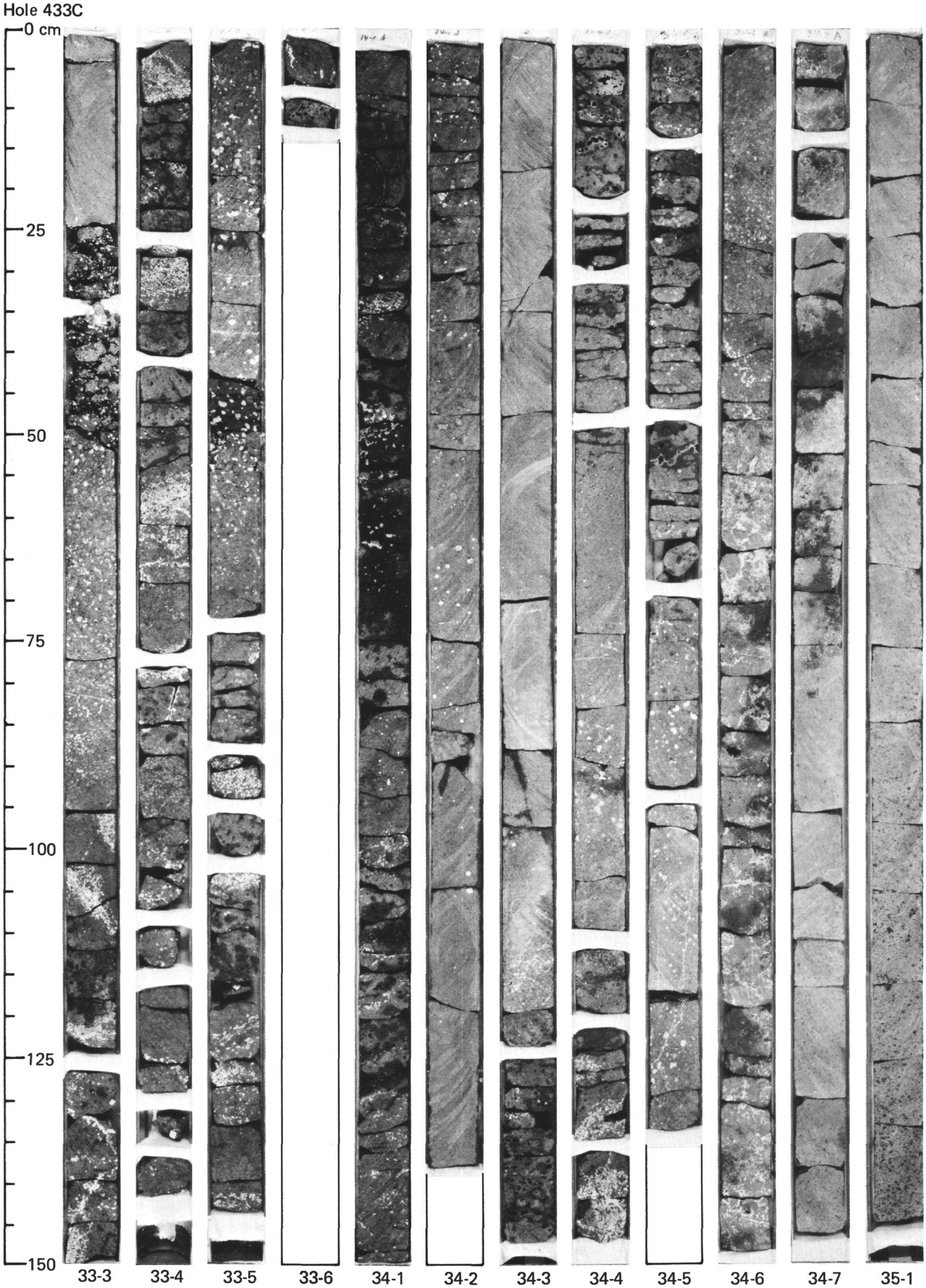

Hole 433C
0 cm
25
50
75
100
125
150
24-4
24-5
24-6
24-7
24-8
25-1
25-2
25-3
25-4
25-5
25-6
25-7

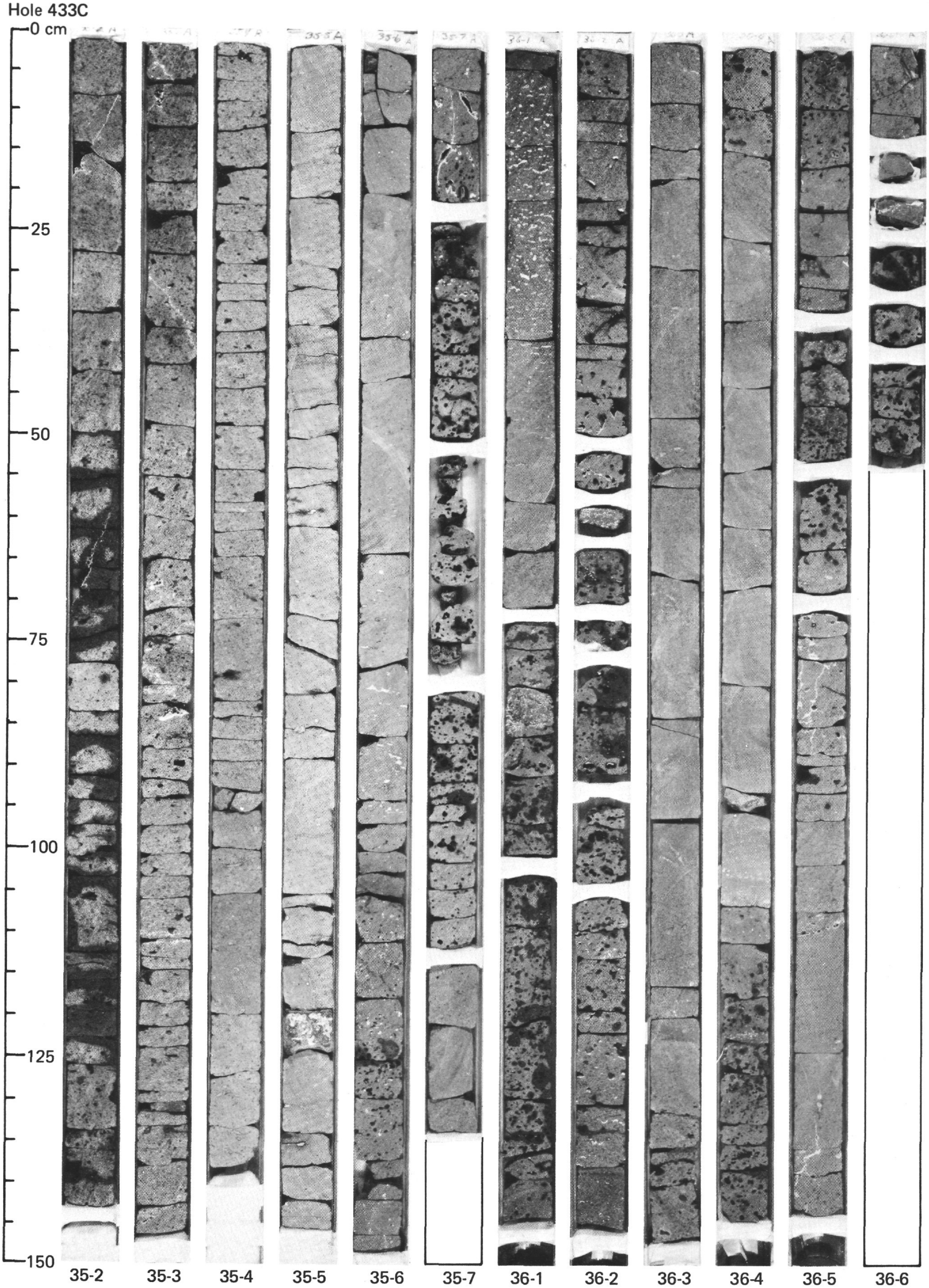

Hole 433C
0 cm
25
50
75
100
125
150
26-1
26-2
26-3
26-4
26-5
26-6
26-7
27-1
27-2
27-3
27-4
27-5

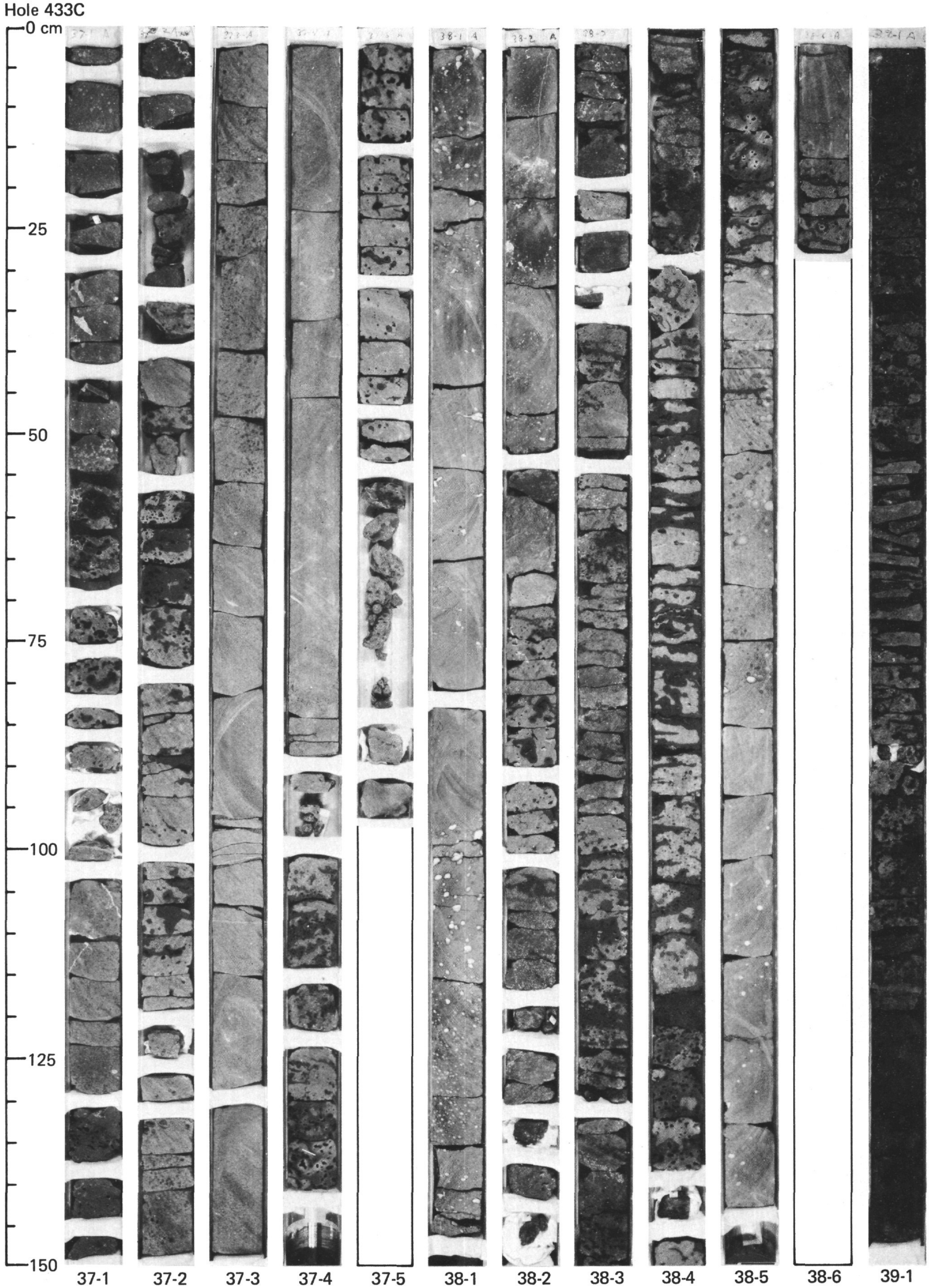
Hole 433C

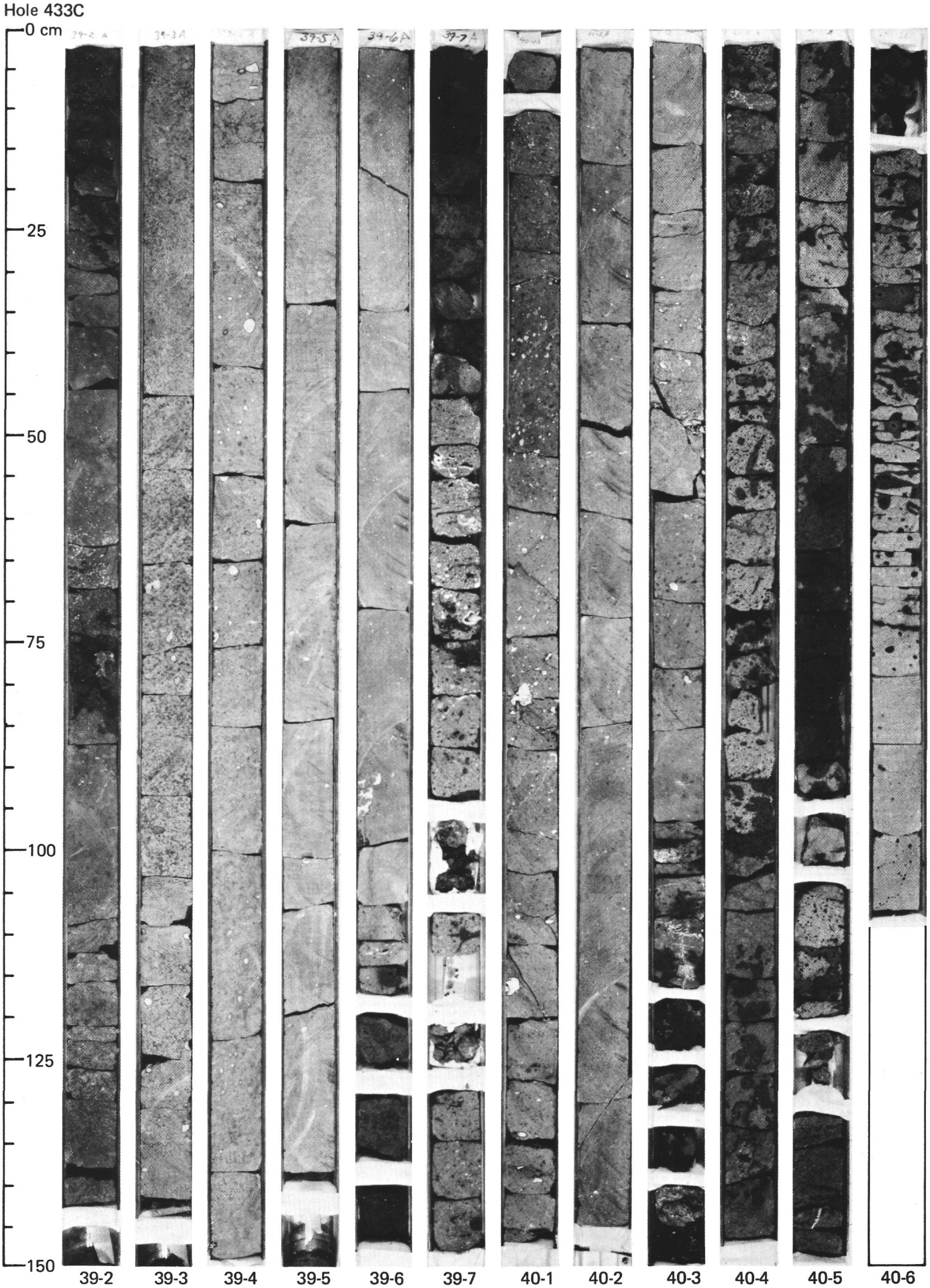

0 cm
25
50
75
100
125
150
27-6
28-1
28-2
28-3
28-4
28-5
29-1
29-2
29-3
30-1
30-2
30-3

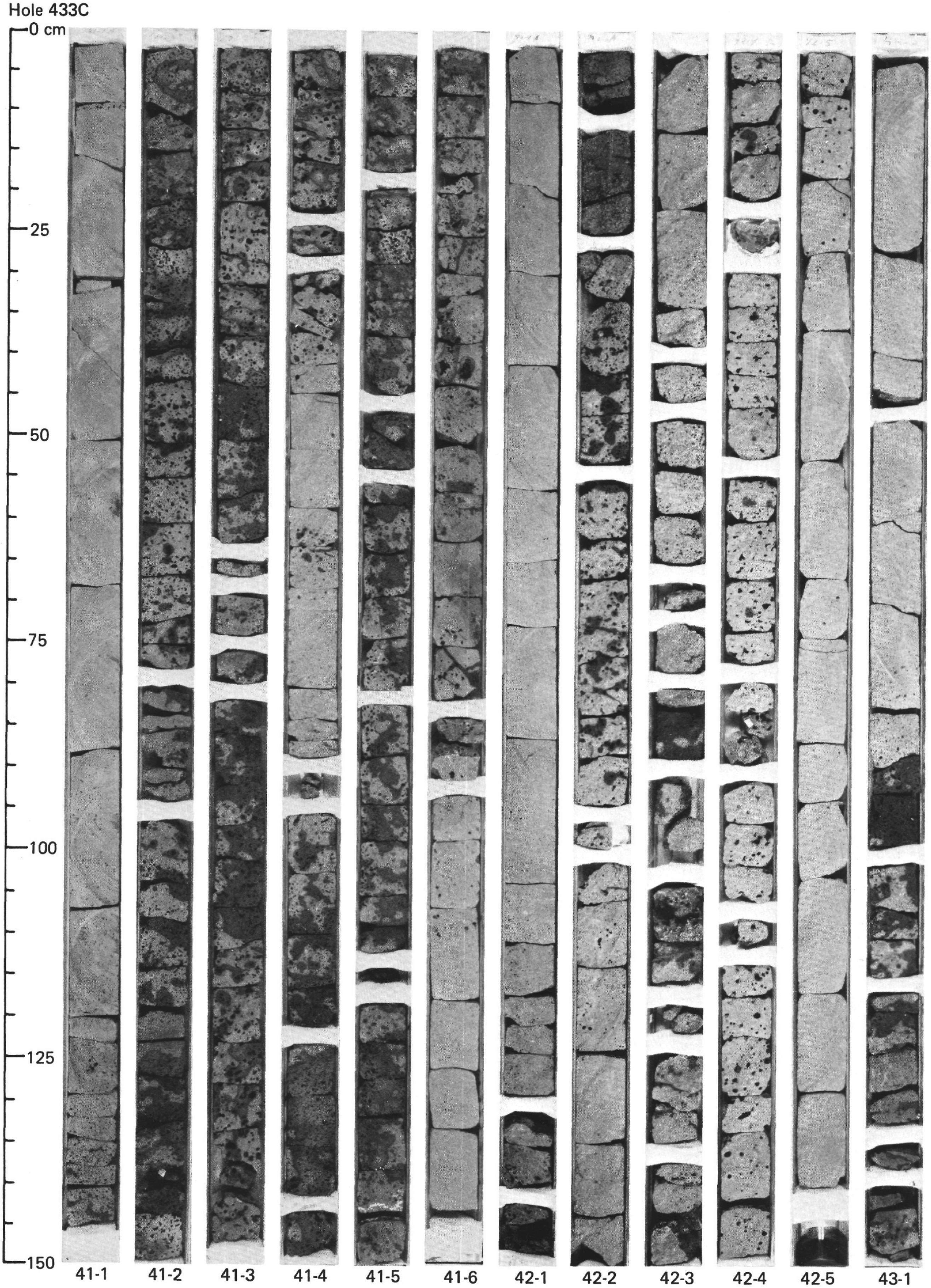

Hole 433C
0 cm
25
50
75
100
125
150
31-1
31-2
31-3
31-4
31-5
32-1
32-2
32-2
32-4
32-5
33-1
33-2

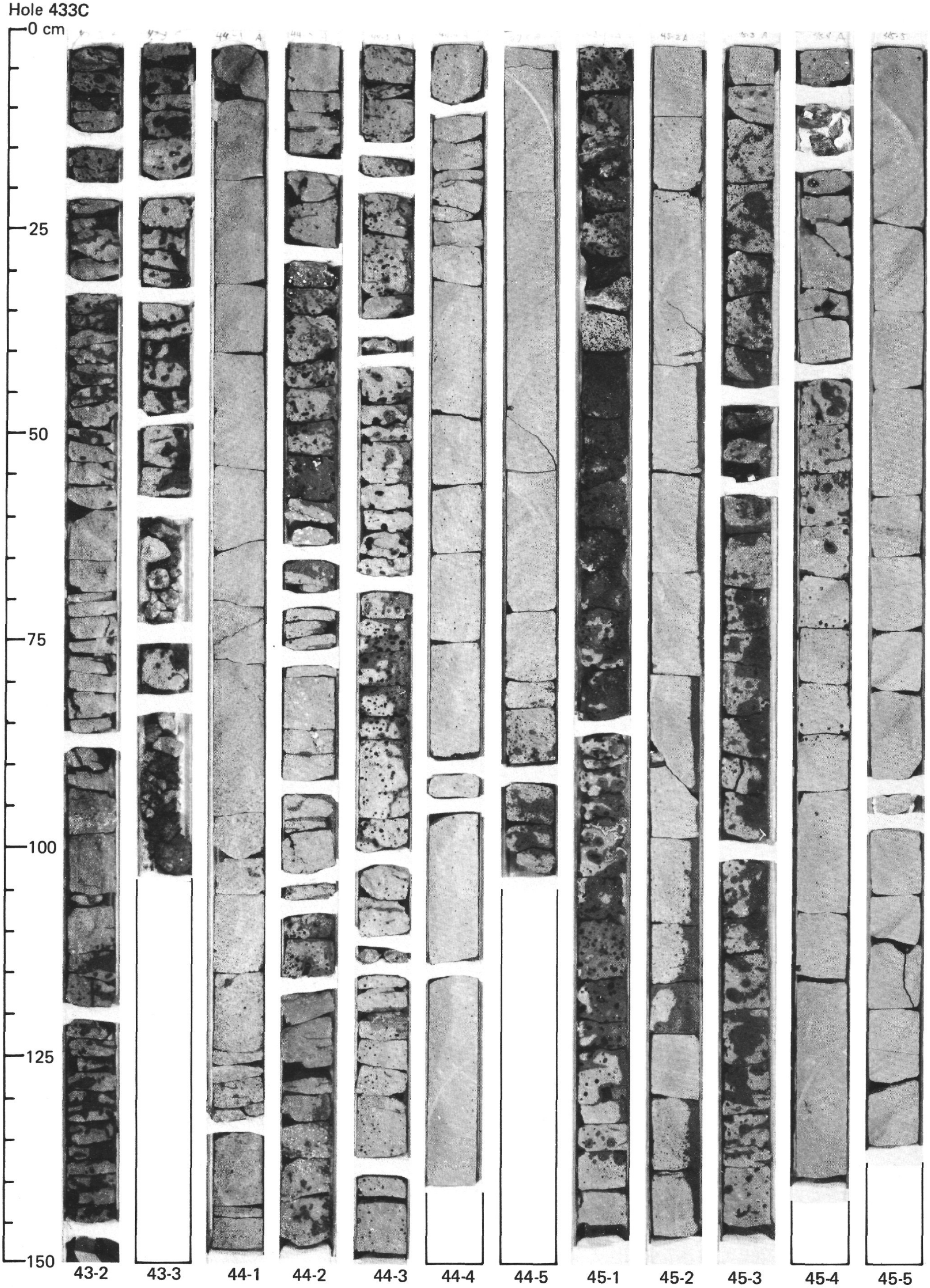

Hole 433C
0 cm
25
50
75
100
125
150
33-3
33-4
33-5
33-6
34-1
34-2
34-3
34-4
34-5
34-6
34-7
35-1

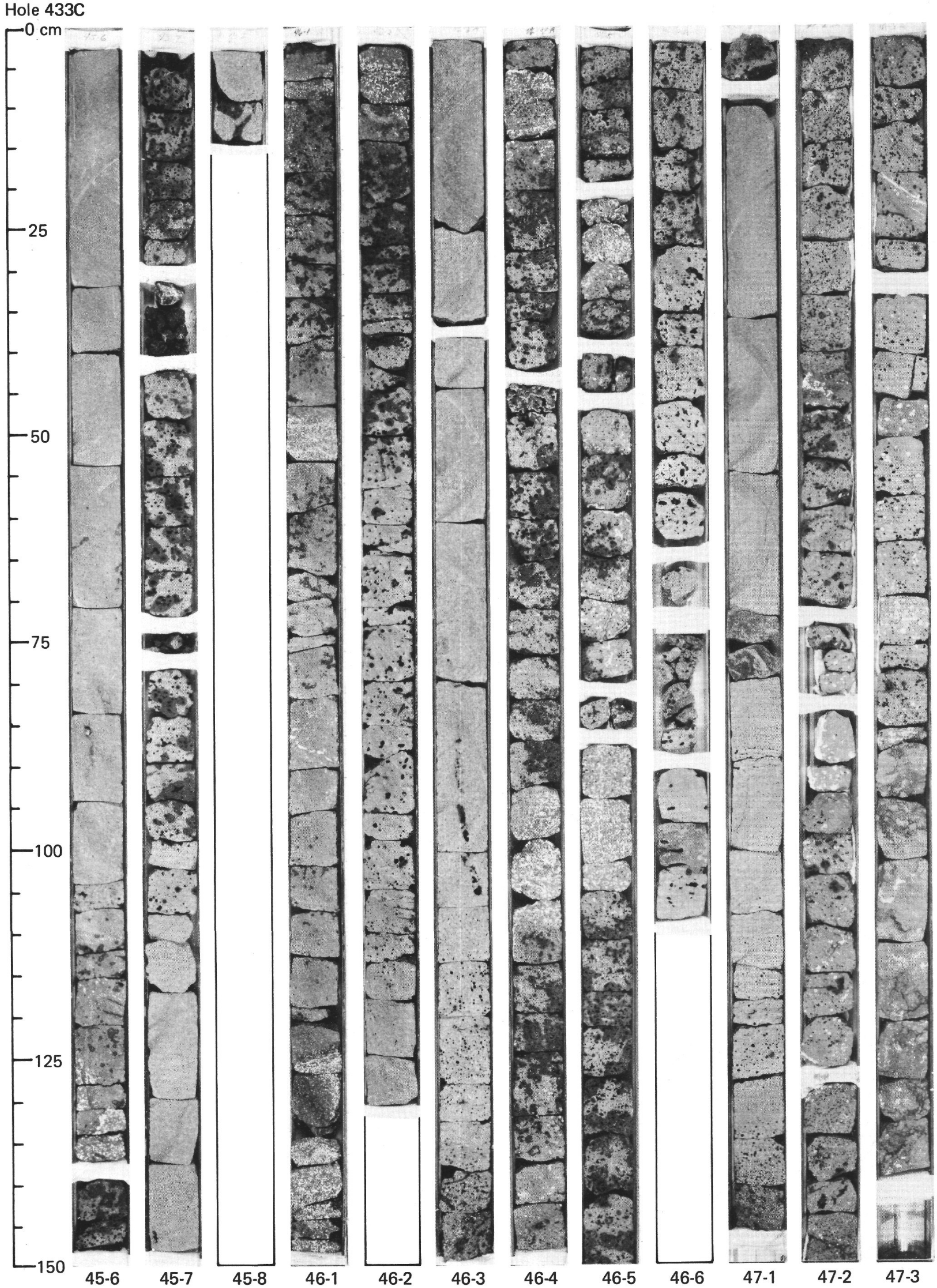

Hole 433C
0 cm
25
50
75
100
125
150
35-2
35-3
35-4
35-5
35-6
35-7
36-1
36-2
36-3
36-4
36-5
36-6

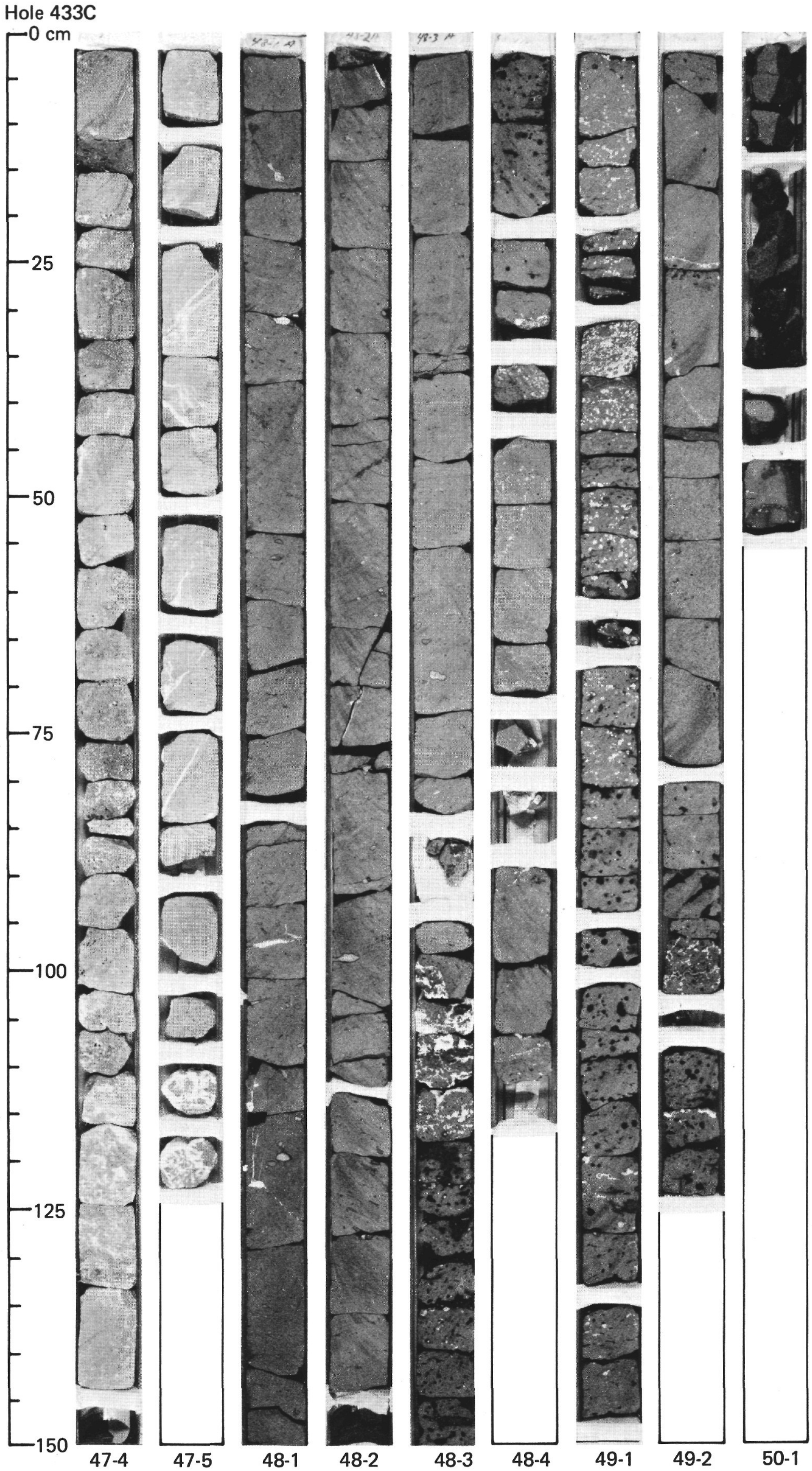

Hole 433C
0 cm
25
50
75
100
125
150
37-1
37-2
37-3
37-4
37-5
38-1
38-2
38-3
38-4
38-5
38-6
39-1


Hole 433C
0 cm
25
50
75
100
125
150
39-2
39-3
39-4
39-5
39-6
39-7
40-1
40-2
40-3
40-4
40-5
40-6


Hole 433C
0 cm
25
50
75
100
125
150
41-1
41-2
41-3
41-4
41-5
41-6
42-1
42-2
42-3
42-4
42-5
43-1


Hole 433C
0 cm
25
50
75
100
125
150
43-2
43-3
44-1
44-2
44-3
44-4
44-5
45-1
45-2
45-3
45-4
45-5


Hole 433C
0 cm
25
50
75
100
125
150
45-6
45-7
45-8
46-1
46-2
46-3
46-4
46-5
46-6
47-1
47-2
47-3


Hole 433C
0 cm
25
50
75
100
125
150
47-4
47-5
48-1
48-2
48-3
48-4
49-1
49-2
50-1