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5. SITE 843[1]

Shipboard Scientific Party[2]

HOLE 843A

Date occupied: 7 March 1991

Date departed: 8 March 1991

Time on hole: 1 day 7 hr 20 min

Position: 19°20.53′N, 159°5.68′W

Bottom felt (rig floor; m, drill-pipe measurement): 4422.5

Distance between rig floor and sea level (m): 10.9

Water depth (drill-pipe measurement from sea level, m): 4411.6

Total depth (rig floor; m): 4660.2

Penetration (m): 237.7

Number of cores (including cores with no recovery): 3

Total length of cored section (m): 237.7

Total core recovered (m): 4.0

Core recovery (%): 1.7

Oldest sediment cored:
Depth (mbsf): 228.0
Nature: nannofossil clay
Age: early-late Cretaceous

Hard Rock:
Depth sub-bottom (m): 228.8
Nature: basalt

Basement:
Depth sub-bottom (m): 228.8
Nature: basalt

HOLE 843B

Date occupied: 7 March 1991

Date departed: 19 March 1991

Time on hole: 11 days 2 hr

Position: 19°20.54′N, 159°5.68′W

Bottom felt (rig floor; m, drill-pipe measurement): 4418.0

Distance between rig floor and sea level (m): 10.9

Water depth (drill-pipe measurement from sea level, m): 4407.1

Total depth (rig floor; m): 4731.4

Penetration (m): 313.4

Number of cores (including cores with no recovery): 4

Total length of cored section (m): 33.7

Total core recovered (m): 12.6

Core recovery (%): 37.4

Hard Rock:
Depth sub-bottom (m): 242.5
Nature: basalt

Basement:
Depth sub-bottom (m): 242.5
Nature: basalt

Comments: Drill, case, cement to 251.5 mbsf.

HOLE 843C

Date occupied: 17 March 1991

Date departed: 17 March 1991

Time on hole: 1 hr 30 min

Position: 19°20.70′N, 159°5.72′W

Bottom felt (rig floor; m, drill-pipe measurement): 4415.3

Distance between rig floor and sea level (m): 10.9

Water depth (drill-pipe measurement from sea level, m): 4404.4

Total depth (rig floor; m): 4419.5

Penetration (m): 4.2

Number of cores (including cores with no recovery): 1

Total length of cored section (m): 4.20

Total core recovered (m): 4.22

Core recovery (%): 100.0

Oldest sediment cored:
Depth (mbsf): 4.22
Nature: clay
Age: Quaternary

Principal results: Poor hole conditions at Site 842 prompted an offset of the ship to a new drill site approximately 1 km northwest of the Site 842 location. Site 843 is located on top of the northwest-southeast-trending abyssal hill identified during the site survey prior to spudding in at Site 842. We hoped that conditions on top of the ridge might be somewhat better than on the shoulder, with perhaps a slightly thinner sediment sequence and less potential for encountering the chert rubble that had frustrated efforts to reach basement at the previous site. Hole 843A was washed to a depth of 228.0 mbsf. Two wash cores retrieved over the interval were filled with chert and chert rubble. The first true core, Core 136-843A-3R, was cut between 228.0 and 237.7 mbsf. The core returned approximately 80 cm of Albian-Cenomanian nannofossil calcareous clay and limestone overlying 0.6 m of basalt. The sediment-basalt contact appeared to be well preserved within the core.

A reentry cone was prepared and set in Hole 843B. Casing was lowered through the sediment column and cemented approximately 20 m into basement. After drilling out the cement inside the casing, 6.87 m of altered basalt were recovered from a sub-basement interval of 17.0–26.5 m. Drilling ahead deepened the hole an additional 19 m. A new Amoco PDC bit was installed and took Cores 136-843B-2R to -4R to a total basement depth of 70.9 m. A mudline core was retrieved after offsetting 10 m north (Hole 843C) once drilling and logging at Hole 843B was stopped. Recovery

[1]Dziewonski, A., Wilkens, R., Firth, J., et al., 1992. *Proc. ODP, Init. Repts.,* 136: College Station, TX (Ocean Drilling Program).
[2]Shipboard Scientific Party is as given in the list of participants preceding the contents.

of 4.22 m of ash-rich clays and several ash layers in the core revealed a Quaternary stratigraphy much like that of Site 842.

Beyond the establishment of Hole 843B as the first site of the Ocean Seismographic Network (OSN-1) there were several geological points of interest. Sediments recovered from Core 136-843C-1H appear to be missing much of the Holocene, or at least to record very slow sedimentation in the last 0.5–1 m.y., as was seen at Site 842. Recovery of the basement-sediment contact provides a good age constraint for crustal formation. Paleomagnetic data from the basalt core suggest origins from approximately 20° S latitude, consistent with an age of approximately 95 Ma and current reconstructions of Pacific plate motion. The basalt recovered from deeper in the section showed extensive evidence of hydrothermal alteration and mineral deposition. Site 843 may be located over a fossil hydrothermal upwelling zone.

Hole 843B was reentered with the ODP borehole seal on 18 March 1991, and the pipe was successfully detached from the seal. On 19 March, the drill string was successfully reconnected with the seal. This test shows promise for permanent deployment of several seals on upcoming Leg 139.

OPERATIONS

Site 843

Hole 843A

Table 1 summarizes the coring at Site 843.Because the drill string was being pulled with the flapper stuck shut, the trip was wet after each connection was broken. At 2866 mbrf, the drill pipe began to pull dry, so the driller rigged up the circulating head and began to pump. The sand line was sent down to see if the core barrel was still stuck or if it too had become freed. The core barrel was recovered, and the drill pipe was flushed clear with seawater. The move to Hole 843A was completed by 0530 hr, 7 March, and had covered 0.43 nmi, at a heading of 326° from Site 842. A new Benthos 211 dB, 16.0-kHz beacon was dropped at 0709 hr, and the drill pipe was lowered to 4380 mbrf. At 0815 hr, the rig had settled in on station, and the driller felt for bottom. The corrected PDR from the underway lab was 4425.0 mbsl, but the driller did not see the drill string take weight until 4442 mbrf. The hole was washed down to 4650.5 mbrf, taking two wash cores at 4544.3 and 4650.5 mbrf. A rotary core (136-843A-3R) was taken, which intersected the sediment/basement contact and reached a total depth of 4660.2 mbrf (237.7 mbsf). A decision was made to immediately log Hole 843A, then trip the drill string out, rig up, and run the reentry cone and casing for Hole 843B. A wiper trip up to 4487 mbrf was made, and 25 m of fill was found at the bottom of the hole. A mud sweep was circulated to try to clear the hole of as many drill cuttings as possible. The bit was dropped at the bottom of the hole, and the drill pipe was pulled up to 4487 mbrf for logging. After rigging up to log, 1 hr and 45 min was spent trouble-shooting the logging tools. The first of two logging runs was begun at 0645 hr, 8 March, and the tools reached TD at 227 mbsf. The logging tool string was the quad-combo, consisting of LSS-DITE-HLDT-NGT. After logging was completed, the drill pipe was tripped to the surface, and it cleared the seafloor at 1430 hr, 8 March, ending work at Hole 843A.

Table 1. Coring summary for Leg 136, Site 843.

Core no	Date Mar. 1991	Time	Depth (mbsf)	Meters cored	Meters recovered	Percent recovery
136-843A-						
1W	07	2230	0.0–121.8	121.8	2.17	(wash core)
2W	08	0500	121.8–228.0	106.2	0.44	(wash core)
3R	08	0800	228.0–237.7	9.7	1.39	14.3
			Coring Totals	9.7	1.39	14.3
			Washing Totals	228.0	2.61	
			Combined Totals	237.7	4.00	
136-843B-						
	Drilled		0.0–259.5			
1R	14	0015	259.5–269.0	9.5	6.87	72.3
	Drilled		269.0–288.0			
2R	15	1000	288.0–297.5	9.5	1.79	18.8
3R	15	1230	297.5–302.7	5.2	0.75	14.4
4R	15	1745	302.7–312.2	9.5	3.19	33.6
			Coring Totals	33.7	12.60	37.4
1H	18	0145	0.0–4.2	4.2	4.22	100.0
			Coring Totals	4.2	4.22	100.0

Hole 843B

The reentry cone for Hole 843B had been assembled and placed atop the moonpool doors at the end of Leg 135. The reentry cone had been fitted with the larger double-sided I-beam mud skirt for bearing area. The double "J" running-tool assembly was made up to the 16-in. casing hanger, and the 14-3/4-in. drilling assembly made up and stood back. The reentry cone was moved into the moonpool, and the sonar reflectors were installed while the rig-floor crew slipped and cut the drilling line. The entire reentry cone/casing assembly entered the water at 0745 hr, 9 March, and after the 8-hr trip to the seafloor was jetted in. Hole 843B is 4418 mbrf (DPM), at a latitude and longitude of 19°20.54'N, 159°5.68'W. The driller unjayed the drill string from the cone and began drilling ahead at 1730 hr, 9 March. The BHA was terminated with a 14-3/4-in. HTC tri-cone X-44 drill bit jetted with three each #16 nozzles. After the first 60 m of hole was made, the hole was cleaned with a 20-bbl viscous-mud sweep at every other connection. By 2315 hr, 9 March, approximately 208 m of penetration had been made, and the rate of penetration (ROP) had slowed considerably. The 11-3/4-in. casing design, and the potential for fill at the bottom of the hole, made us decide to drill 25 m into basement before running the casing. Having the 11-3/4-in. casing firmly anchored by cement in basement was also required to obtain good results from the seismometer that will be placed in the hole in the future. By 0845 hr, 10 March, the 14-3/4-in. hole had been drilled. A wiper trip, consisting of pulling two double connections, was made, and upon returning to bottom the driller found very little fill but felt a tight spot at 4642 mbrf. A second wiper trip to 4637 mbrf felt nothing at 4642 mbrf but required circulation to get back to bottom. A 30-bbl viscous-mud sweep was spotted on bottom, and the drill string was pulled from the hole to prepare to run the 11-3/4-in. casing. The TD of the 14-3/4-in. hole was 4677.5 mbrf (259.5 mbsf). At 2100 hr, 10 March, the bit was at the rig floor. The running of the casing on the drill pipe took 6 hr and was interrupted by deployment of the VIT television frame and a short period of rig downtime to install new brushes in the drawworks B motor.

Reentry of the drill string with casing was made in 15 min without any problems. Fill, in the amount of 15 m, was encountered on bottom, and the hole had to be circulated to land and latch the casing hanger. A total of 48 bbl of cement was pumped through the shoe, and 10.9 bbl was left inside the 11-3/4-in. casing. The top of the cement inside the casing was calculated to be at 4635 mbrf. The cementing stinger was pulled clear of the cone by 2330 hr, 11 March, and the drill pipe and VIT camera frame were tripped to the surface. An RCB BHA with a 9-7/8-in. C-4 bit jetted with 4 × 16 nozzles was rigged up, and a center bit was installed in the outer core barrel for the trip in the hole. Running the drill pipe commenced at 1100 hr, 12 March, and the reentry cone was first located at 1630 hr. The second reentry into Hole 843B required 2 1/4 hr because of heavy weather that the ship encountered at that time. The reentry was made at 1847 hr, 12 March, and the top of the cement was tagged at 4636 mbrf. Drilling cement required 8-1/4 hr before reaching the casing shoe, and then a 30-bbl viscous pill of mud was pumped to clean the hole of cement cuttings. After the center bit was pulled out, a core barrel was dropped, and coring began at 0730 hr, 13 March. The first hour of drilling encountered high torque and almost no penetration. Then the hole began to drill, and by 1300 hr, 13 March, a complete 9.5-m core had been drilled from 4677.5 mbrf (259.5 mbsf) to 4687 mbrf (269.0 mbsf), with 6.87 m of basalt recovered. Because of the lack of time left in the leg to accomplish all of the remaining objectives, a center bit was dropped to compare the rate of penetration (ROP) of drilling vs. the ROP of coring. Drilling ahead began at 1430 hr, 13 March, and continued until 2200 hr, 13 March, with an average ROP of 2.53 m/hr.

At 2200 hr the 9-7/8-in. C-4 roller-cone bit had 20.5 hr of rotation on it, and there was still 46 m of basalt to drill to reach the objective of 100 m of penetration into basement, so the bit was pulled to be changed. The ROP in drilling the basalt had increased from the coring rate of 2.0 to 2.53 m/hr, while drilling ahead with the center bit. When the roller-cone bit was retrieved, it showed excessive bit-wear, with numerous lost tungsten carbide buttons. The bit had probably drilled on the 2XJ dogs that were never found and most probably were in the hole. A new Amoco PDC bit was installed on the BHA, with a mechanical bit release in case the bit failed early and there was not enough time to trip the pipe for another bit. The trip into the hole began at 0730 hr, 14 March. The pipe trip reached 4400 mbrf at 1530 hr, 14 March, and reentry was made at 1600 hr. A 30-bbl viscous-mud sweep was spotted in the pipe and displaced with 80 bbl of seawater. Another 30-bbl viscous-mud sweep was pumped in an attempt to get at least some of the tungsten carbide buttons up off bottom before starting to drill with the PDC bit. Coring with the PDC bit began at 2045 hr, 14 March, at 288 mbsf, or 45.5 m into basement. The first core was cut in 1.67 hr, for an ROP of 5.69 m/hr, or double that of the roller-cone bit. Recovery was 1.79 m of basalt (18.8%), and no tungsten carbide buttons were found in the core barrel. A second core was cut with higher rpm. The ROP was 9.7–10.4 m/hr with the new rotation; 5.2 m was cored within 35 min. The ROP fell to zero quickly after coring the 5.2 m, and the pipe was lifted up by that amount. Upon running the pipe in the hole, the driller discovered that he had to ream the hole to get back to bottom. The second coring run averaged 8.92 m/hr but only recovered 14.4%. A third core was cut, during which the pump pressure increased to 2700–2800 psi, possibly indicating that one or more of the jets were plugged. The third core (136-843B-4R) recovered 2.37 m of basalt (20.3%) at an average ROP of 4.42 m/hr. Had time permitted, we would have done additional coring with the PDC bit, but at 0745 hr, 15 March, a center bit was dropped in the hope of finishing the remaining 21.8-m of basement within 3 hr. After 50 min, only 1.2 m of new hole had been made, and the PDC bit quit drilling. At 0930 hr, 30 bbl of high-viscosity mud was pumped and circulated out. It was decided to trip the drill string and rig up for logging. A wiper trip up to the 11-3/4-in. casing shoe was made without any drag, and once back on bottom the pumps were used to wash through 4 m of fill to bottom. The trip out of the hole began at 1130 hr, and the PDC bit was on the rig floor at 1900 hr, 15 March. The appearance of the bit suggested that it might have drilled on junk. Thirty hr were to be spent in logging, and just in case the logging went exceptionally well and finished ahead of schedule, a 9-7/8-in. APC/XCB bit and a short APC BHA were made up to log through. The logging BHA was run beginning at 2000 hr, 15 March. Hole 843B was reentered, and the bottom of the drill pipe was placed 30 m below the 16-in. casing shoe. The first log was the LSS-DITE-HLDT-NGT-TLT, and two passes of the open hole were made. Both passes reached a TD of 4731 mbrf. The second log was the FMS-GPIT-NGT-TLT and was started down the pipe at 1300 hr, 16 March. On the second run of the FMS, the tool would not pass through 4707 mbrf because of an obstruction. The Schlumberger tool was rigged down and the drill pipe was lowered to 4725 mbrf, where 6 m of fill on bottom was found. As a precautionary measure, to help get the light BHTV tool to the bottom of the drilled hole, the top drive was picked up and the pipe was circulated and rotated to bottom with little problem. The hole was circulated with seawater for 30 min to clean out as much of the cuttings or hole slough as possible with seawater. The BHTV log was run and was able to reach the same TD as the quad combo. The last log run was the GST-ACT-CNT-NGT string. That tool began logging uphole at 0845, 17 March, and lasted for 1 hr until the time alloted for logging had expired. The geochemical log also reached the TD of the hole, indicating that the wiper trip had cleared the fill from the bottom. Total elapsed time for logging was 33 hr.

Hole 843C

One final APC core was taken both to verify the water depth at Hole 843B and to allow the sedimentologists to look more closely at the ash layers in the upper several meters of sediments. Hole 843C consisted of one APC core offset 30 m to the north from Hole 843B. Core 136-843C-1H verified the water depth to be 4415.3 mbrf (DPM). The core recovered 4.2 m of clay. The core was on deck at 1530 hr, 17 March.

Hole 843B—Reentry Cone Seal Tests

The trip out of the hole was completed by 2300 hr, 17 March. The borehole seal and its BHA were rigged up and tripped down beginning at 0330 hr, 18 March. Reentry was complicated by both a bottom current and a crossing surface current, and the VIT camera was kept about 20 m above the seal assembly; the drill cuttings obscured the cone. The reentry took about 4-1/2 hr. The seals were energized inside the casing hanger, and the running tool was freed from the seal at 1500 hr, 18 March.

The drill string was tripped, and the seal retrieving tool, with a jet sub to steer the BHA into the bottom current, was rigged up. The BHA was run down to the top of the seal, and was latched onto it at 0730 hr, 19 March. The seal was detached from the reentry cone with 15,000-lb overpull, and the pipe was pulled up for the last time beginning at 0800 hr, 19 March. The seal reached the rig floor at 1600 hr, 19 March, ending Site 843.

The ship was under way for Honolulu at 1830 hr, 19 March, and made the 137-nmi journey at an average speed of 9.96 kt. The pilot boarded *JOIDES* Resolution at 0730 hr, 20 March, and guided the vessel to Honolulu Harbor Pier 1. The line was thrown to the pier in Honolulu Harbor, at 0815 hr, 20 March, officially ending Leg 136.

LITHOSTRATIGRAPHY

Sediments from Site 843 were recovered in one advanced hydraulic piston core (APC), two wash cores, and in one rotary drilled core. Because of the limited sampling of each depth interval, lithologic units are not defined for this site. The sediments of each core are described individually below.

Core 136-843A-1W

Dark yellowish brown clay and dark grayish brown zeolitic clay were the major lithologies recovered from the depth interval 0–121.8 mbsf in the first wash core. The clays are mottled and soupy from drilling disturbance. Nodules of dark yellowish brown ashy silty claystone and dark reddish brown chert are found over intervals 136-843A-1W-1, 30–68 cm, and 136-843A-1W-2, 50–62 cm.

Core 136-843A-2W

A drilling breccia of reddish brown and red chert was recovered from the depth interval 121.8–228.0 mbsf in Hole 843A. The chert is quartz in composition and many fragments have cavities filled with pinkish gray chalk. Several individual fragments of the chalk were also recovered.

Core 136-843A-3R

Core 136-843A-3R covered the depth interval 228.0–237.7 mbsf and sampled the sediment-basalt interface. Brown nannofossil limestone was recovered in the upper 64 cm of the core. The fragments of limestone have been highly fractured by drilling, but wavy laminations are visible. Smear-slide analysis indicates that >50% of the limestone is clay- and silt-sized rhombs of calcite. Several nodules of dark reddish brown chert are found within the section of limestone. Interval 136-843A-3R-1, 64–84 cm, is comprised of brown and reddish yellow nannofossil calcareous clay with parallel laminations. This calcareous clay unit lies directly on basalt that occupies the remainder of the core.

Core 136-843C-1H

Core 136-843C-1H covered the depth interval 0–4.2 mbsf. This core essentially consists of homogeneous bioturbated dark yellowish brown and dark grayish brown clay. This clay includes small amounts of siliceous biogenic debris and volcanic ash. Five or six volcanic ash layers occur in this core. However, all these ash layers are dismembered or dispersed by bioturbation, and within interval 843-1H-2, 90 cm, to 843-1H-3, 47 cm, ash layers are mottled with surrounding clay.

BIOSTRATIGRAPHY

Calcareous Nannofossils

Core 136-843A-3R contains limestone and calcareous clay with abundant, moderately preserved nannofossils. Sample 136-843A-3R-1, 81 cm, lies just above basaltic basement and contains *Eiffelithus turriseiffelii* and *Flabellites biforaminis.* The first occurrence of the former species marks the base of Zone CC9 of late Albian to early Cenomanian age. The latter species ranges no higher than Cenomanian, according to Perch-Nielsen (1985). In the absence of *Microrhabdulus decoratus*, the marker species for the late Cenomanian Zone CC10, this sample is assigned a late Albian to early Cenomanian age. Sample 136-843A-3R-1, 67 cm, also contains *E. turriseiffelii*, but does not contain *F. biforaminis* or *M. decoratus*, and is assigned a late Albian to early Cenomanian age. Both samples from Core 136-843A-3R also contain *Watzneuria barnesae, Parhabdolithus embergeri, Manivitella pemmatoidea, Rucinolithus* sp., and *Biscutum* sp.

Radiolarians

Poorly preserved radiolarians of indeterminate age were found in chert fragments from Core 136-843A-3R. Further study of these samples ashore may yield a definite age. Smear slides of Sample 136-843C-1H-CC were prepared and analyzed on board for fossil content. The sample contains an abundance of Quaternary radiolarians, including *Amphirhopalum ypsilon, Euchitonia elegans, Stylodictya validispina, Lamprocyrtis nigriniae, Theocorythium trachelium, Phormospyris stabilis, Spongocore puella, Dictyocoryne truncatum, Ommatartus tetrathalamus, Axoprunum angelinum, Spongaster tetras, Lithocampe* spp., *Arcosphaera spinosa, Cornutella* sp., *Peripyramis* sp., *Hexacontium laevigatum, Eucyrtidium hexagonatum, Dictyophimus hirundo, Lamprocyclas maritalis,* and *Lithopera bacca.*

Sample 136-843C-1H-CC is tentatively assigned to the lower Quaternary on the basis of the presence of lower Quaternary species *Axoprunum angelinum* and the absence of upper Quaternary markers, including both *Buccinosphaera invaginata* and *Collosphaera tuberosa*. It is conceivable that these markers are very rare, and have not been observed thus far. More detailed work will be done post-cruise to confirm the age of this sample.

PALEOMAGNETISM

The principal shipboard paleomagnetic measurements at Site 843 consisted of scans of pieces of the archive-half of the basaltic core from Hole 843B and the measurement of a mudline core from Hole 843C. Portions of four basaltic cores were examined (Core 136-843B-1R, 259.5–269.0 mbsf, Core 136-843B-2R, 288.0–297.5 mbsf, Core 136-843B-3R, 297.5–302.7, and Core 136-843B-4R, 302.7–312.2 mbsf), using the ODP cryogenic magnetometer. Measurements were made of total natural remanent magnetization (NRM) and of the remanence retained after alternating field (AF) demagnetization at 2, 4, 8, and in some cases 10 mT at 2-cm intervals on 24 pieces lifted from the archive-half samples of these cores. Essentially all specimens having a length greater than 15 cm were measured using a modified half-core method similar to that employed on the sediments of Hole 842B. Each half-core segment was placed in the magnetometer tray with blank spaces of at least 25 cm between segment ends. Several specimens had intensities that exceeded the magnetometer's capabilities at the NRM and lower demagnetization steps. By observing the offset of the magnetometer we determined that the maximum intensity was only 30% more than the instrument's range, thus one was assured that a reliable measurement could be made during the demagnetization procedure. Typical results from the demagnetization experiments showing the high stability of these basalts are illustrated in Figure 1.

The predominant feature of the observed remanence in the basaltic cores is an initial NRM, typically near 1000 mA/m, directed upward. This magnetization is shown in Figure 1, and the NRM plot of Core 136-843B-1R is presented in Figure 2. The NRM appears to have a small drilling-induced component that is readily removed at 2 mT. The strong drilling-induced overprint observed in the sediment cores in Holes 842A and 842B was not observed in the basaltic samples.

Progressive AF demagnetization to 10 or 12 mT removes a soft secondary component and stable end points seem to be reached by most samples by 8 to 10 mT. All samples yield inclination values lying in the –20° to –40° range. Although end effects are substantial in these short samples as can be seen by the sharply varying "tails" shown in Figures 2 and 3, the central portions of each sample generally shows consistent, i.e., +10°, inclinations, and the mean of these has been taken as the true direction for each specimen. The average of all these means is –29°, which corresponds to a paleolatitude of 15.5° south. This is in reasonable agreement with the model northward motion of the Pacific during the Cenozoic, derived from the Hawaiian hot-spot trace. Further refinement of this paleolatitude must await completion of the demagnetization studies of individual specimens ashore.

The mudline core from Hole 843C (Core 136-843C-1H) was measured both as a whole core, i.e., before splitting, and as an archive half core. Both measurements are in close agreement, and little evidence of a strong drilling-induced component is present. The Brunhes/Matuyama transition is clearly visible in the whole-core and half-core NRM records, although the observed inclinations are not equivalent due to the presence of a small uphole drilling-induced magnetization being present. The secondary component is removed by demagnetization to 5 mT and no significant additional directional change is noted at 10 mT. This demagnetization behavior is in marked contrast to the cores from nearby Site 842, where even AF demagneti-

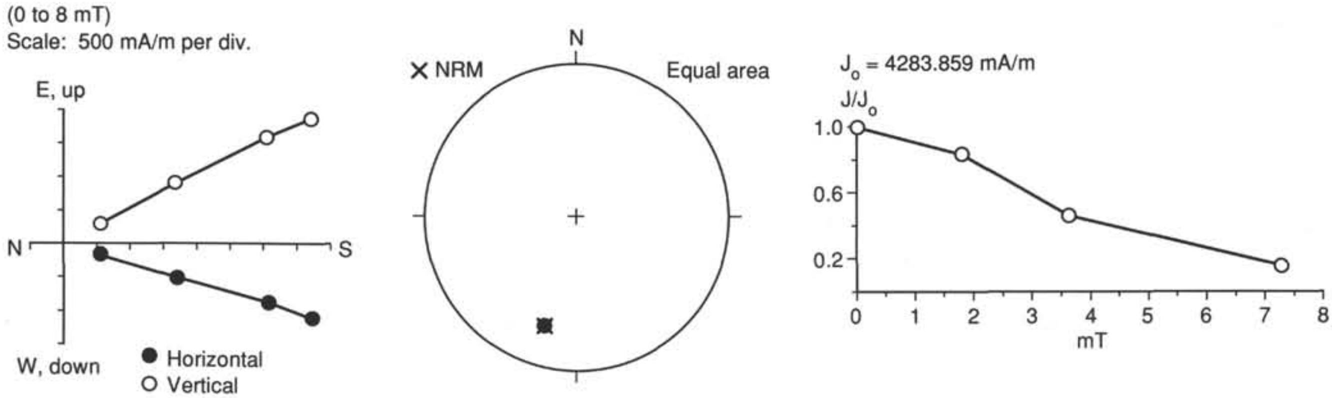

Figure 1. Orthogonal plot of AF demagnetization data from a basalt slab from Section 136-843B-1R-1, 10 cm (259.60 mbsf). Sample has a stable remanence isolated above 2 mT.

zation to 15 mT failed to completely remove the strong overprint. Because it is unlikely that the sediments have changed significantly in the 1000 m or so that separates the sites, one must conclude that the different bottom-hole assembly or core- barrel assembly was responsible for the marked reduction in the drilling- induced overprint.

The NRM and demagnetization records for Core 136-843C-1H are shown in Figures 4 and 5. The inclination in the upper portion of the Matuyama averages –36°, although several large "swings" to more than –45° are also present. These "swings" are much more pronounced on the NRM record and thus they may indicate that some degree of secondary component is present in these intervals. Nevertheless, the –36° is almost exactly what one should expect for a site of latitude 19.21°N (expected inclination is 35.07°). Above the Brunhes/Matuyama transition the inclination record is very uniform and averages about 40°. Between 0.5 and 2.0 mbsf it has a slight negative slope (approximately 8° per meter) suggestive of a compaction effect or perhaps just a relatively uniform variation of the field.

Core 136-843C-1H was logged for initial magnetic susceptibility as were the more continuous recovery portions of the basaltic cores from Hole 843. These records are shown in Figures 6 and 7. There is a very good correlation in the sedimentary susceptibility records between Holes 842A, 842B, and 843C.

Polarity Stratigraphy

Core 136-843C-1H displays a clear polarity reversal at 2.22 mbsf. Based upon the observations at Holes 842A and 842B this N/R (i.e., normal overlying reverse) polarity transition is considered to represent the Brunhes-Matuyama boundary. The upper transition of the Jaramillo was not observed although it would be expected to occur just below the cored interval based upon the observations at Site 842. The record from Hole 843C gives a sedimentation rate of 3.01 m/m.y., which is in close agreement with that from Site 842.

Susceptibility and Intensity

NRM intensity of the basalts is typically between 5000 and 10,000 mA/m, and is reduced by 10% to 60% in alternating fields of 10 mT. The sediments of Hole 843C have NRM's of 100 to 200 mA/m, a factor of two to four less than equivalent material from Holes 842A and 842B. This factor of two to four reduction in NRM intensity is probably best explained by the lack of heavy drilling-induced magnetism at Site 843. Thus the unusual magnetic properties noted for the deep-sea sediments at Site 842 probably were indeed the result of the imposition of IRM in a strong magnetic field (see discussion of Site 842). Upon demagnetization the sediments from Site 843 rarely lose more than 25% of their initial magnetization at AF demagnetization of 10 mT, and those of Site 842 rarely retained 25% of their initial magnetization after exposure to only 5 mT.

Initial susceptibility ranges from about 50 to 250 $\times 10^{-6}$ (SI) in the sediments from Hole 843A and from 200 to 2500 $\times 10^{-6}$ (SI) in the basalts from Hole 843B. As mentioned, there is good between-hole correlation of the susceptibility records between Sites 842 and 843, probably connected with ash content of the sediment.

Sampling for Shore-based Study

All cores at Site 843 were sampled for subsequent work. This sampling included standard cube samples at about 20-cm intervals in Core 136-843C-1H to verify and refine the polarity stratigraphy described above and more fully describe the magnetic properties and cubical or minicore samples from the basaltic cores of Hole 843B, to study the inclination record of the old Cretaceous crust from this part of the Pacific. A continuous sequence of 1-cm^3 cubes were taken across the Brunhes/Matuyama transition in Hole 843C extending about 25 cm above and below the transition, to study the details of the transition zones.

INORGANIC GEOCHEMISTRY

Introduction

The shipboard inorganic geochemistry procedures at Site 843 consisted of (1) chemical analyses of interstitial water (see Table 2), and (2) collection of samples for shore-based trace-element analysis. Details of the shipboard analytical procedures are given in the Explanatory Notes chapter. Samples were collected from a single piston core (Core 136-843C-1H) in unconsolidated pelagic red-clay sediments. Whole-round cores, 5 cm long, from each of the three recovered sections were squeezed; interstitial water recoveries were excellent (50–65 mL).

No significant concentration gradients were observed at Site 843 as would be expected from both the very slow deposition rate of pelagic clays, thereby allowing a large extent of diffusional equilibration and explaining why only one core reaching only 4.2 m downhole was obtained.

Salinity and Chloride

Salinity and Cl^- remain very near seawater values in the three samples with only a slight decrease observed for Cl^- (Table 2).

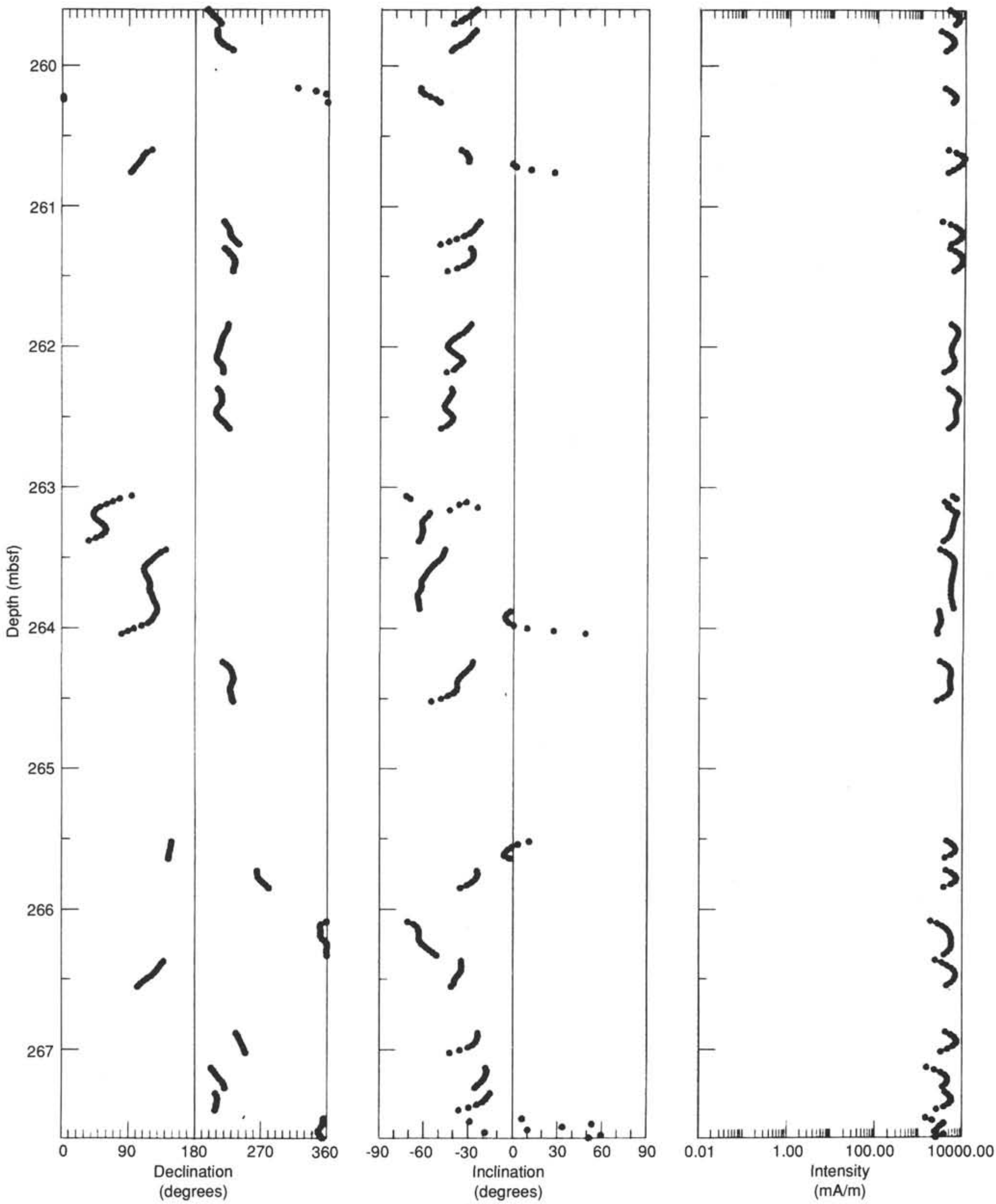

Figure 2. Plot of total NRM of basalt slabs from archive Core 136-843B-1R showing initial remanence and end effects of short basaltic samples.

Alkalinity and pH

Alkalinity exhibits a very small decrease of approximately 5% over the 4 m of core sampled. Interstitial water pH exhibits no significant trend and ranges from 7.6 to 7.7.

Sulfate

No evidence of the degradation of organic matter in the sediments is evident from the three interstitial water samples obtained at Site 843. All values are extremely close to that of open-ocean seawater.

Phosphate

As observed at Site 842, PO_4^{3-} concentrations at Site 843 decrease from just below the mudline from 2.4 μM at 1.5 mbsf to 1.5 μM at 3.9 mbsf. It is anticipated that PO_4^{3-} continues to decrease in the next few meters of sediment, although no additional data are available.

Ammonium and Nitrate

Concentrations of $NH4^+$ were below 25 μM in all three interstitial water samples and could not be quantified due to procedural problems. The spectrometric determination of such low concentrations is difficult in the presence of the slight NH_3 vapor present in the lab originating from the detergents used in cleaning of glassware just prior to the analytical run. Nitrate analyses were not performed because of the lengthy procedure required for this constituent; these will be carried out on shore.

Calcium and Magnesium

Dissolved Mg^{2+} at Site 843 ranges from just under 53 mM to just over 52.5 mM. It is likely, however, that this constituent is being actively depleted further downhole in a manner similar to that observed at Site 842. Dissolved Ca^{2+} exhibits a small corresponding increase downhole that supports the aforementioned conjectured reaction downhole.

Silica and Potassium

Dissolved silica concentrations are similar to those observed at the corresponding intervals of Site 842 (near 300 μM).

Conclusions

The limited sampling at Site 843 precludes any interpretation of diagenetic processes that may be taking place within these sediments.

PHYSICAL PROPERTIES

Physical properties measured at Site 843 included bulk density, compressional-wave velocity, and thermal conductivity. All of the data presented here are for Holes 843B and 843C; the short core from Hole 843A was not measured. Techniques and equipment employed are described in the Physical Properties section of the Explanatory Notes chapter.

Bulk Density

Bulk densities were determined by 2-min GRAPE determinations on 30 selected portions of the four cores collected at Hole 843B. Density values range from 2.63 to 2.80 g/cm^3, and have a mean value of 2.71 ± 0.05 g/cm^3 (Fig. 8). The data show no obvious change in density with depth. Much of the basalt contained veins, and density determinations on Samples 136-843B-1R-2, 128 cm, and 136-843B-4R-2, 106 cm, were made specifically across veins. The bulk densities

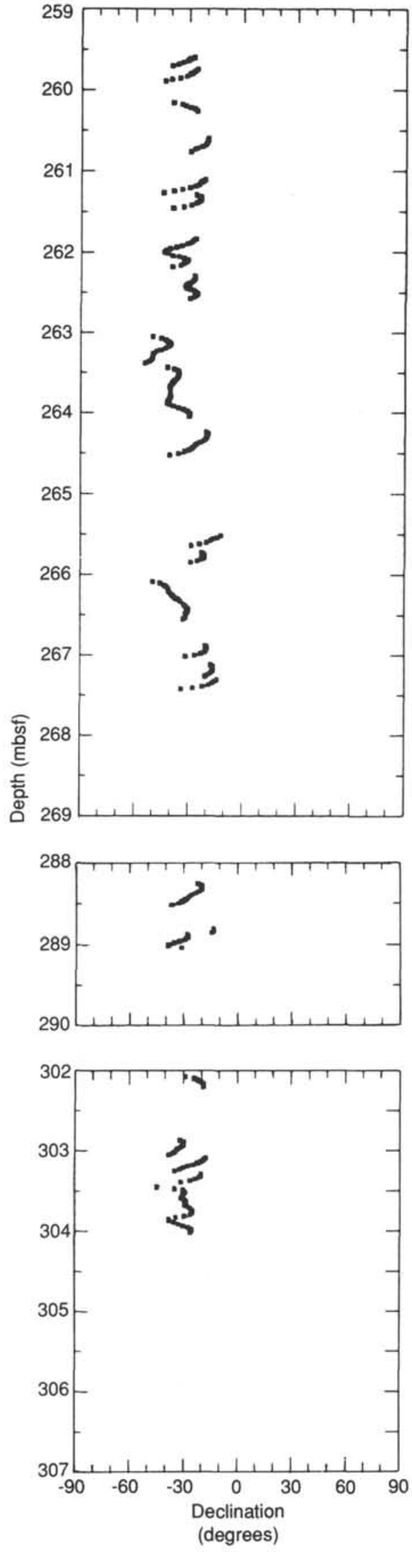

Figure 3. Plot of all inclinations measured after 8 to 10 mT alternating field demagnetization, from basalt slabs from Hole 843B. Note the very consistent inclination of about −30° and the decrease in scatter and shortening of "tails" seen in Figure 2.

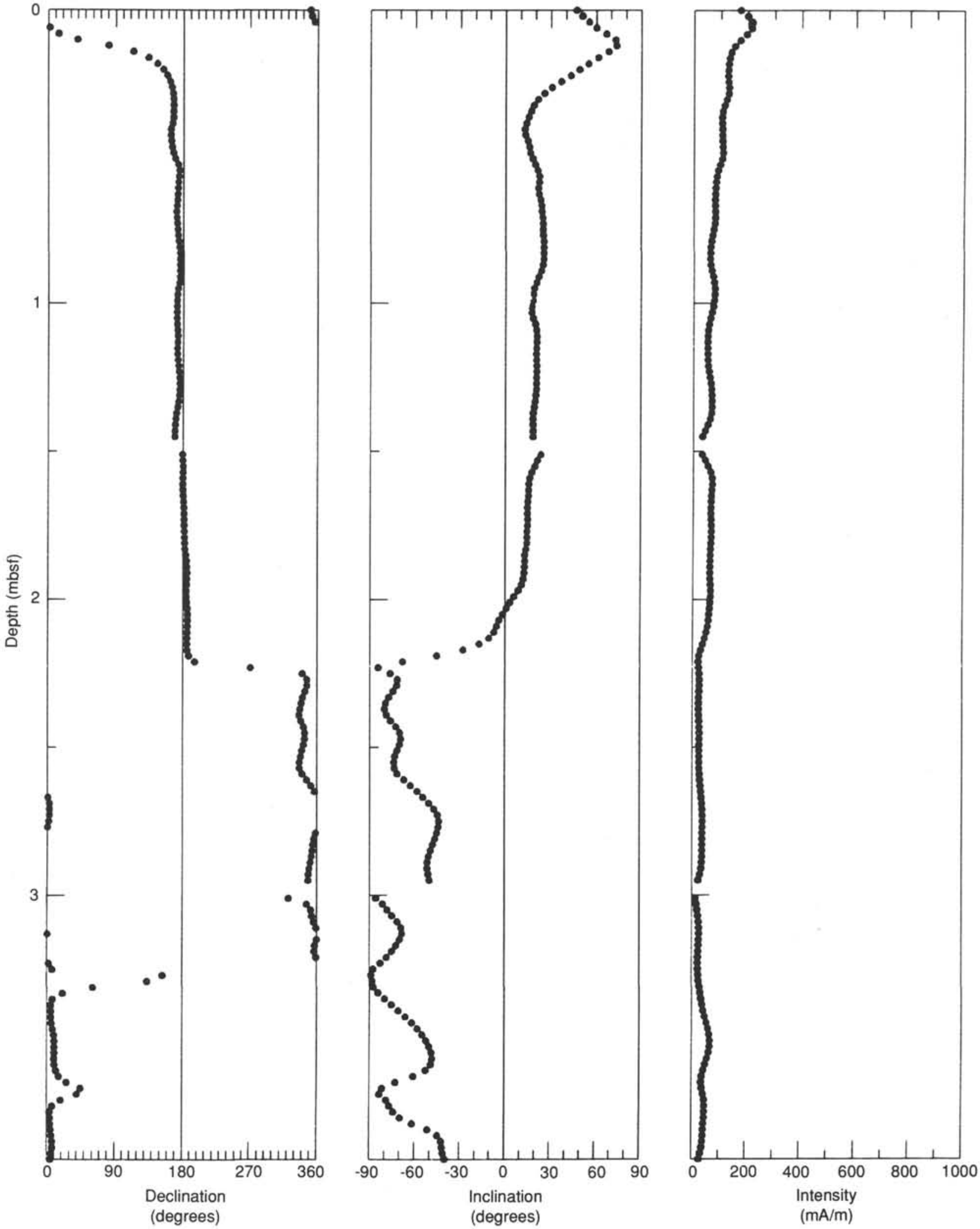

Figure 4. Plot of total NRM vs. depth in Core 136-843C-1H showing presence of Brunhes/Matuyama transition. Declination is arbitrary.

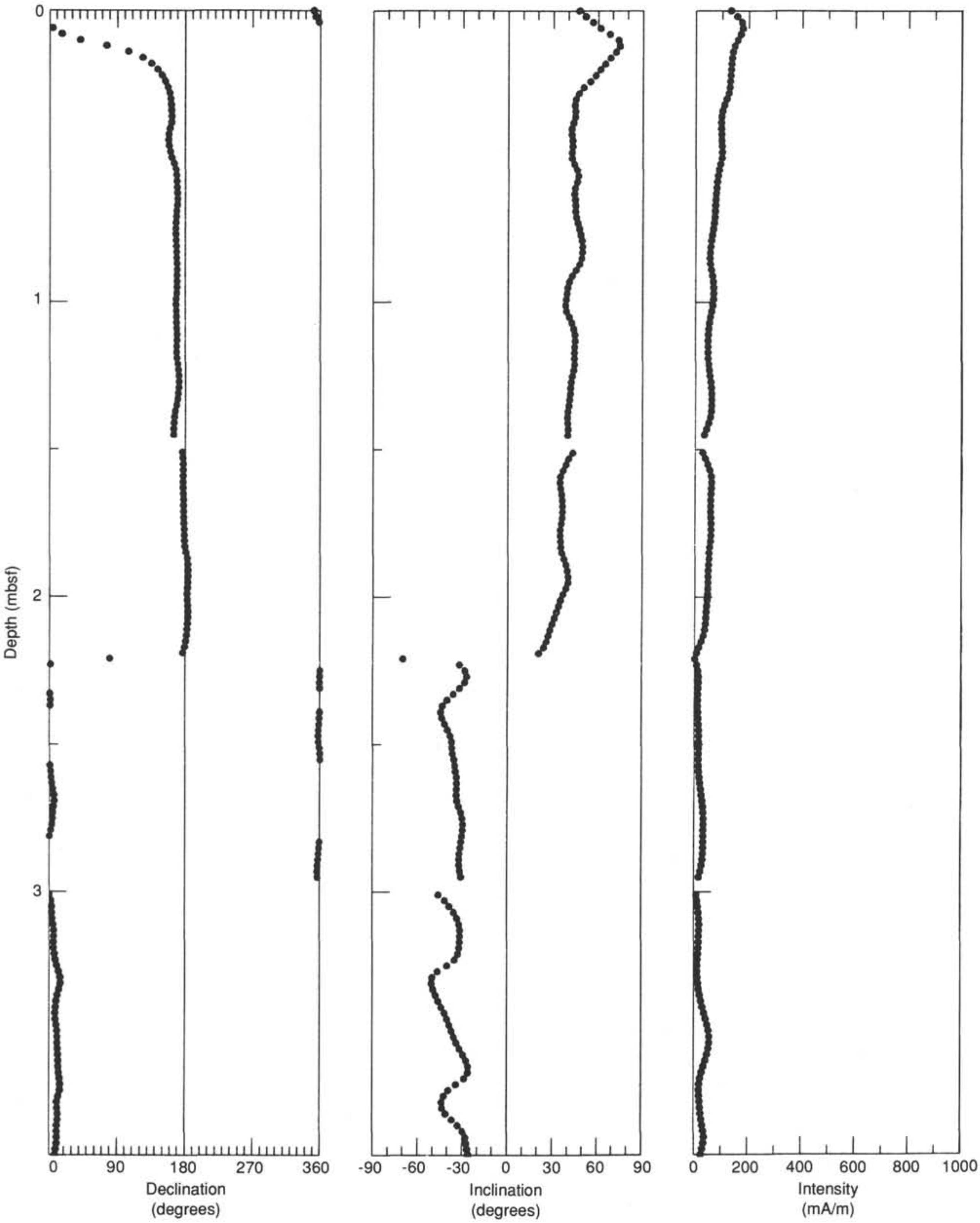

Figure 5. Plot of remanent magnetization (after AF demagnetization to 10 mT) vs. depth in Core 136-843C-1H. Declination is arbitrary.

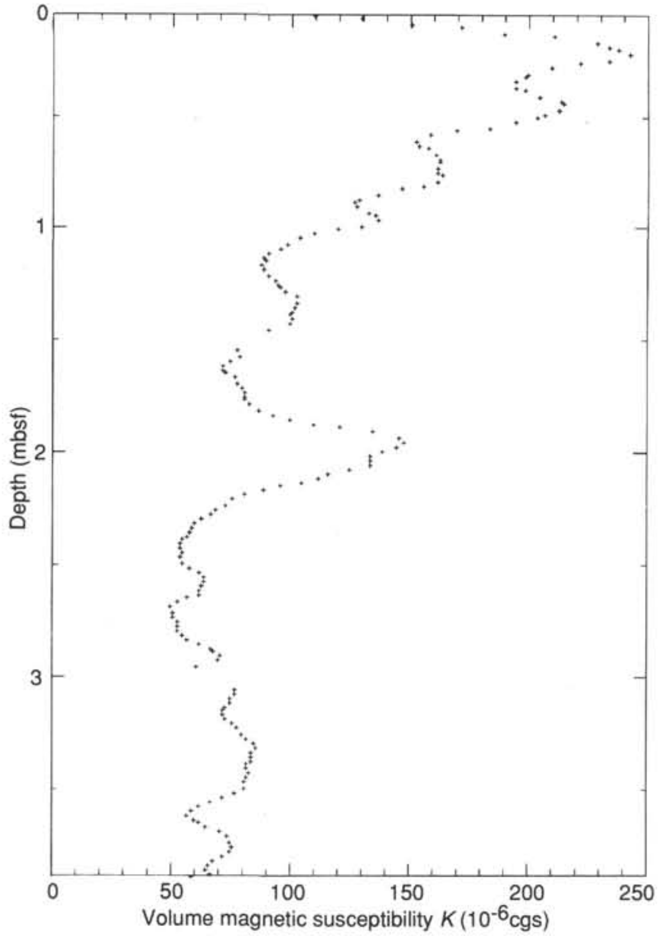

Figure 6. Plot of volume magnetic susceptibility vs. depth for Core 136-843C-1H. Note the significant increase in susceptibility in the portions of the core rich in volcanic ash.

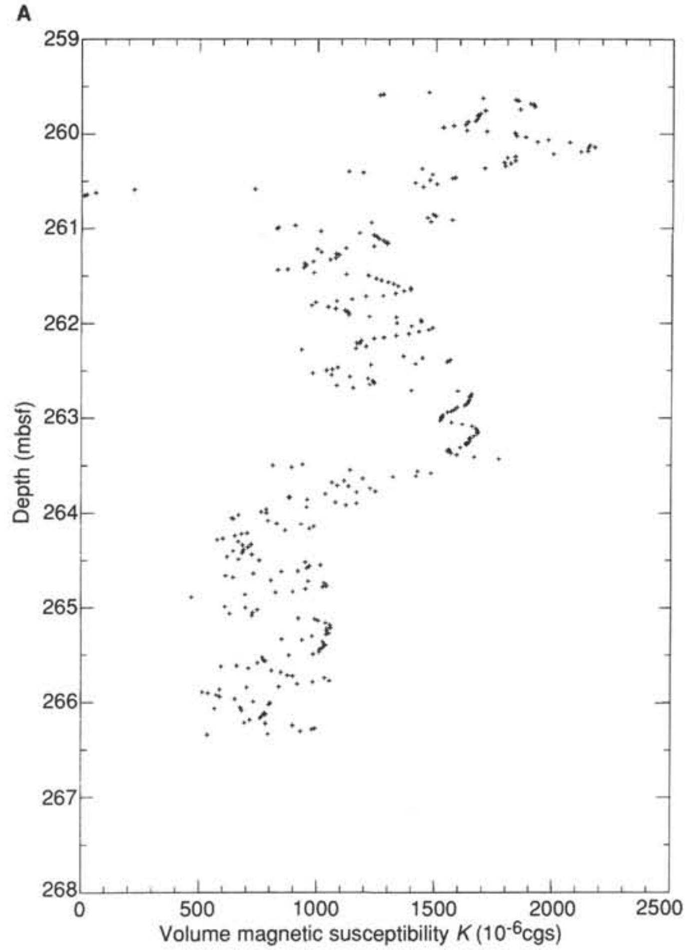

Figure 7. Plot of volume magnetic susceptibility vs. depth in Cores (**A**) 136-843B-1R, (**B**) -2R, and (**C**) -4R. Note that these data are uncorrected for volume variation in the core and that this correction may decrease the scatter by a factor of 2. The strong decrease in susceptibility probably correlates with the increasing degree of alteration with increasing depth observed in these cores.

of those samples were, respectively, 2.78 and 2.76 g/cm^3; higher than the mean density.

The densities measured in Hole 843B are slightly higher than near-surface densities (<200 mbsf; 2.35–2.7 g/cm^3) logged at Hole 418A in crust of comparable age (110 m.y.; Carlson and Herrick, 1990). Because shipboard determinations at Site 843 were made preferentially on coherent sections of core, the effects of unfilled fractures and voids, which certainly contribute to downhole density log data, are underestimated in our results.

Sediment bulk densities at Hole 843C (Fig. 9) are remarkably similar in magnitude and distribution to those observed at Hole 842A, even though the two sites are separated by about 1 km. High densities (1.4–1.5 g/cm^3) occur within the first meter below the seafloor and between 2.8 and 3.5 mbsf. Both density highs occur about 20 cm lower in the column in Hole 843C than in Hole 842A, suggesting that the sediment/water interface was not sampled at Hole 842A. The density highs correlate with increased abundance of volcanic ash within the section, although individual layers are not evident. The density data suggest that at least these near-surface ash horizons are laterally continuous and should be mappable acoustically.

Compressional-Wave Velocity

Compressional-wave (P-wave) velocities of basalts from Hole 843B and sediments from Hole 843C were measured with the Hamilton Frame velocimeter (Tables 3 and 4). The sediment velocities were

Table 2. Interstitial water composition, Hole 843C.

Core, section interval (cm)	Volume (mL)	pH	Alk. (mM)	Salin. (g/kg)	Cl^- (mM)	Mg^{2+} (mM)	Ca^{2+} (mM)	SO_4^{2-} (mM)	PO_4^{3-} (μM)	NH_4^+ (μM)	SiO_2 (μM)
136-843C-											
1H-1 (145–150)	65	7.62	2.376	35.0	556.8	53.0	10.5	28.9	2.41	<25	302
1H-2 (145–150)	55	7.63	2.266	35.0	554.4	52.6	10.8	28.9	1.71	<25	327
1H-3 (89–94)	70	7.69	2.215	35.5	554.8	52.8	10.8	28.9	1.51	<25	335

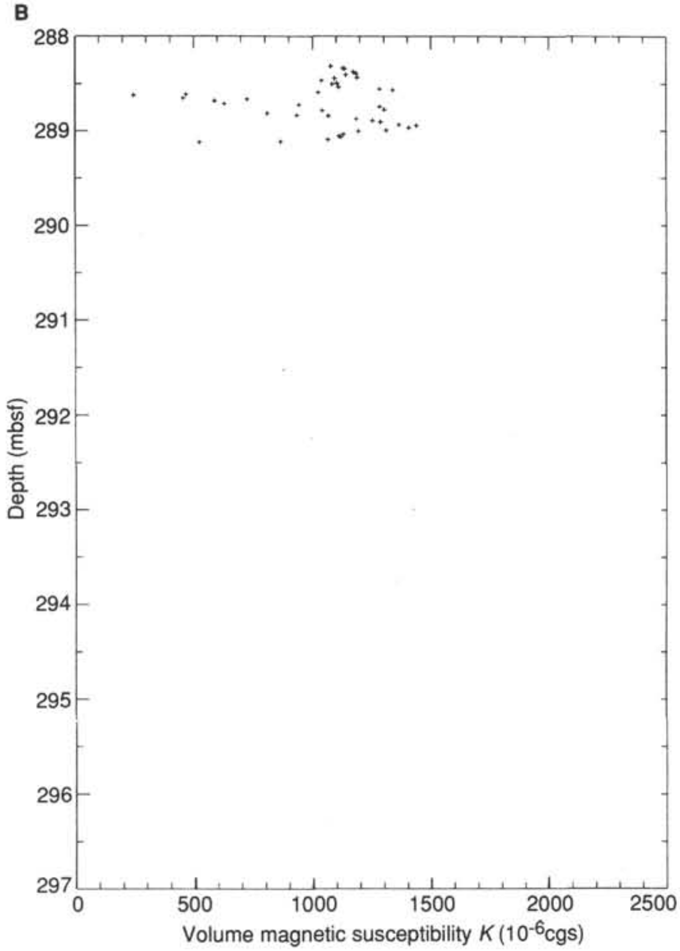

Figure 7 (continued).

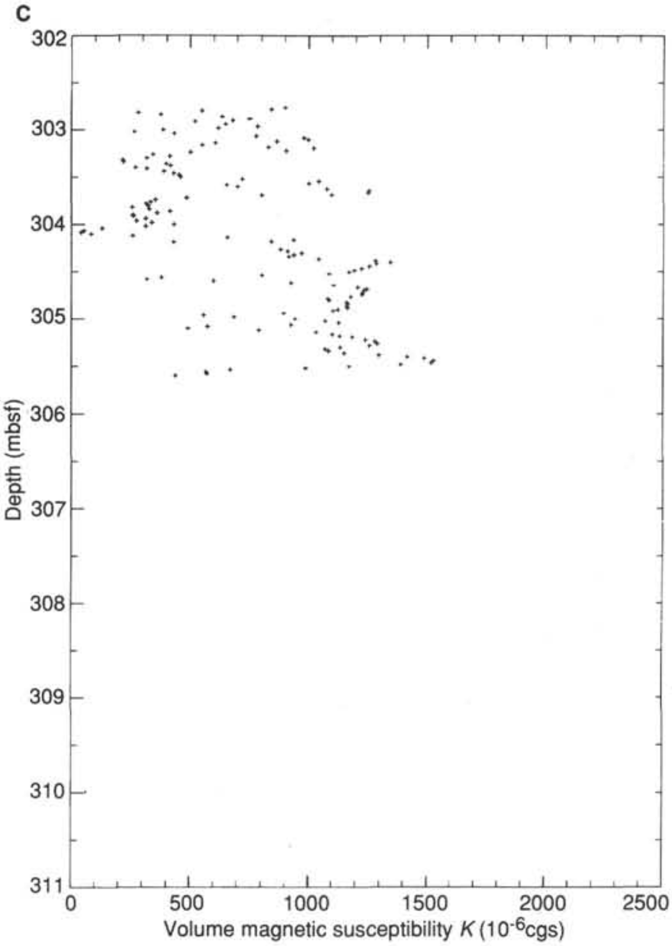

Figure 7 (continued).

also measured at an interval of 2 cm using the MST. The measurement methodology is described in the Explanatory Notes chapter.

For the basalt samples (typical dimensions were 1.5×1.5×1.5 cm), velocity was measured in three mutually orthogonal directions, i.e., the vertical and the two non-orientated horizontal azimuths (Fig. 10). Figures 10 and 11 show that over some depth intervals velocity varies as a function of propagation direction. This anisotropy is well constrained by the data. Although the accuracy of the velocimeter measurements may not be less than 2%–3%, the precision is about 1%. The anisotropy is associated with fractures and veins of altered (clay-rich?) material. The magnitude of the anisotropy evident in Figure 11 is probably an underestimate of the actual value because velocities were measured on samples that were less altered and less vein-rich relative to much of the cored material. This bias is due to the difficulty in cutting the more altered and fractured rocks and to the desire of the petrologists to preserve this material for alteration studies. The basalt velocities reported here are greater than the seismic velocity of the uppermost oceanic crust measured at this site. The latter value, which was determined from a high-quality expanding spread profile (ESP), is about 4.3–4.5 km/s (Brocher and ten Brink, 1987; Lindwall, 1991). This discrepancy is well known, and is due to the very different length scales (centimeters vs. hundreds of meters) over which the velocities are measured.

It can be seen from Figure 10 that relatively low velocities are found from 264 to 268 mbsf and from 288 to 289.5 mbsf. These low velocities appear to correlate with a relative increase in the number and size of calcite- and limonite-filled fractures. A similar decrease in velocity is seen in the downhole logs. In general, the downhole variations in density and velocity are well correlated (Fig. 12). The interval from 265–268 mbsf, where the two parameters are inversely correlated, is an exception to this general rule.

For Hole 843C, the sediment velocities measured with the MST and Hamilton Frame are shown in Figure 13. As for the sediment velocities from Site 842, the data measured with the Hamilton Frame are greater in magnitude by about 2%–3% (see Explanatory Notes chapter). The lack of correlation in the downhole variation of the two data sets is not understood.

Thermal Conductivity

Thermal conductivities of the basalts from Hole 843B were measured using the half-space method (Fig. 14; Table 5). Within the precision of the measuring technique (see Explanatory Notes chapter), conductivity does not change as a function of depth. The mean value of 1.8 W/m·°C is typical of the upper oceanic crust (Karato et al., 1983).

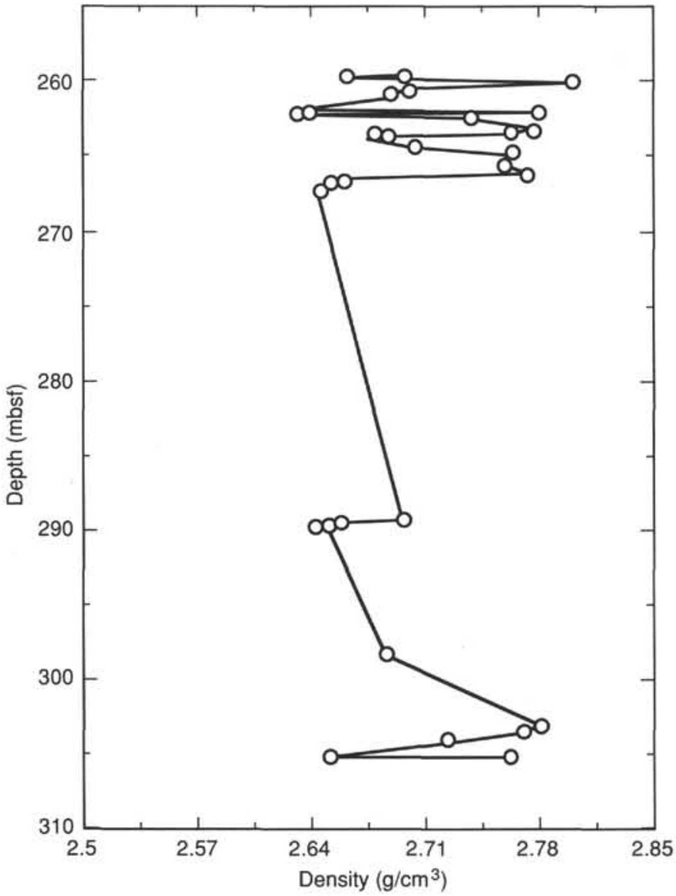

Figure 8. Bulk density (2-min GRAPE) determinations at Hole 843B.

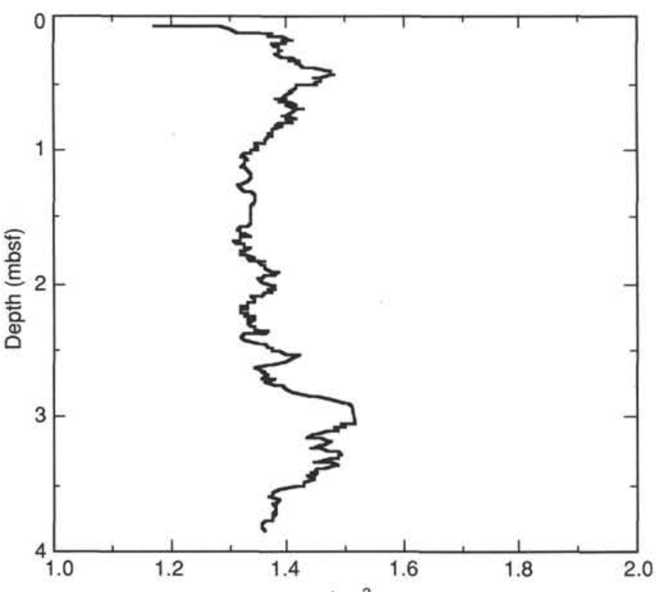

Figure 9. Bulk density distribution at Hole 843C. Values plotted are 5-point smoothed 2-s GRAPE determinations.

The conductivities of the sediments cored at Hole 843C (Fig. 15; Table 5) are similar in magnitude to the values measured at Hole 842B and are probably controlled by bulk porosity.

IGNEOUS PETROLOGY

Introduction

Two holes were drilled about 10 m apart at Site 843, which recovered basaltic basement rocks. Hole 843A penetrated about 3 m into basement recovering the basalt-sediment interface and about 0.65m of basalt. Hole 843B penetrated about 70 m into basement, but core was taken over only a 33.7-m interval. About 12.6 m of basalt was recovered from Hole 843B. The intervals that were drilled and cored for these two holes are shown in Figure 16. Shipboard studies of the basement rocks included whole-rock, major-element analyses (Table 6) and detailed petrography (Table 7). There was insufficient time for shipboard trace-element analyses.

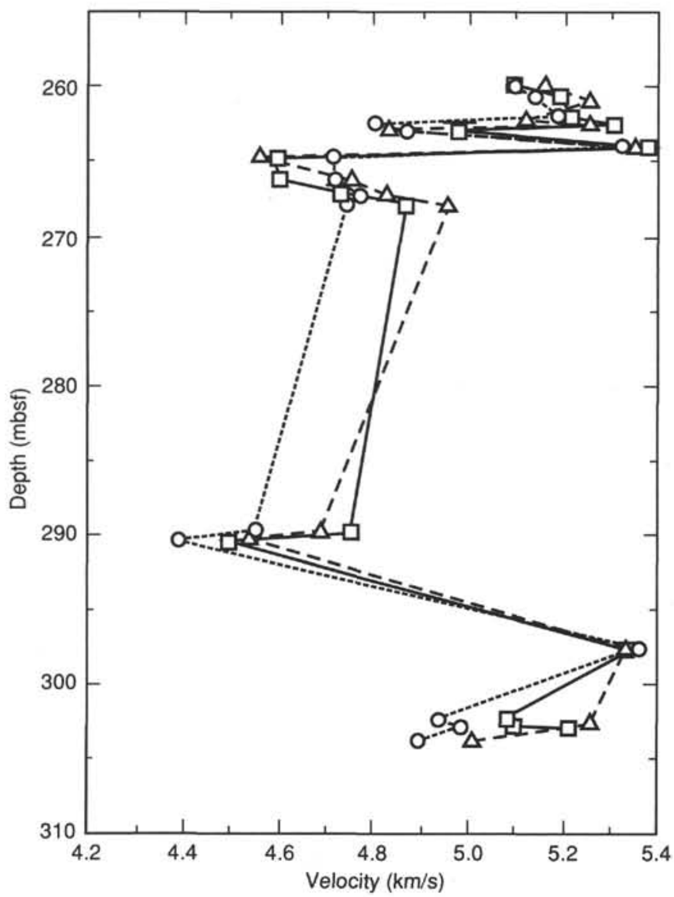

Figure 10. *P*-wave velocities of basalts from Hole 843B measured with the Hamilton Frame velocimeter. The datum points marked with the square-shaped symbol represent propagation in the vertical direction. The data points marked with the circular- and triangular-shaped symbols represent propagation in the non-oriented horizontal directions.

Table 3. *P*-wave velocities of basalts from Hole 843B measured with the Hamilton Frame velocimeter. Velocities were measured for the vertical (v) and two non-oriented orthogonal horizontal directions (h1 and h2). Maximum anisotropy for each interval was calculated using the vertical and horizontal velocities.

Core, section interval (cm)	Depth (mbsf)	Direction	Velocity (km/s)	Anisotropy (%)
136-843B-				
1R-1, 1–6	259.54	v	5.1007	1.0
1R-1, 1–6	259.54	h1	5.0962	
1R-1, 1–6	259.54	h2	5.1634	
1R-1, 92–101	260.47	v	5.1976	2.0
1R-1, 92–101	260.47	h1	5.1391	
1R-1, 92–101	260.47	h2	5.2604	
1R-2, 84–95	261.90	v	5.2102	2.0
1R-2, 84–95	261.90	h1	5.1854	
1R-2, 84–95	261.90	h2	5.1222	
1R-2, 138–148	262.43	v	5.3075	10.0
1R-2, 138–148	262.43	h1	4.8058	
1R-2, 138–148	262.43	h2	5.2573	
1R-3, 26–30	262.78	v	4.9815	3.0
1R-3, 26–30	262.78	h1	4.8542	
1R-3, 26–30	262.78	h2	4.8316	
1R-4, 1–6	264.04	v	5.3749	1.0
1R-4, 1–6	264.04	h1	5.3132	
1R-4, 1–6	264.04	h2	5.3501	
1R-4, 80–83	264.82	v	4.5982	3.0
1R-4, 80–83	264.82	h1	4.7066	
1R-4, 80–83	264.82	h2	4.5598	
1R-5, 98–102	266.50	v	4.5982	3.0
1R-5, 98–102	266.50	h1	4.7187	
1R-5, 98–102	266.50	h2	4.7584	
1R-6, 40–43	267.42	v	4.7289	2.0
1R-6, 40–43	267.42	h1	4.7578	
1R-6, 40–43	267.42	h2	4.8214	
1R-6, 110–113	268.12	v	4.8758	5.0
1R-6, 110–113	268.12	h1	4.7361	
1R-6, 110–113	268.12	h2	4.9619	
2R-2, 32–35	289.83	v	4.7562	5.0
2R-2, 32–35	289.83	h1	4.5429	
2R-2, 32–35	289.83	h2	4.6882	
2R-2, 88–91	290.40	v	4.4983	3.0
2R-2, 88–91	290.40	h1	4.3861	
2R-2, 88–91	290.40	h2	4.5356	
3R-1, 90–95	298.43	v	5.3341	0.0
3R-1, 90–95	298.43	h1	5.3439	
3R-1, 90–95	298.43	h2	5.3211	
4R-1, 83–85	303.54	v	5.0891	7.0
4R-1, 83–85	303.54	h1	4.9357	
4R-1, 83–85	303.54	h2	5.2595	
4R-1, 142–144	304.13	v	5.2108	4.0
4R-1, 142–144	304.13	h1	4.9893	
4R-2, 78–80	304.99	v	5.0982	4.0
4R-2, 78–80	304.99	h1	4.8834	
4R-2, 78–80	304.99	h2	5.0120	

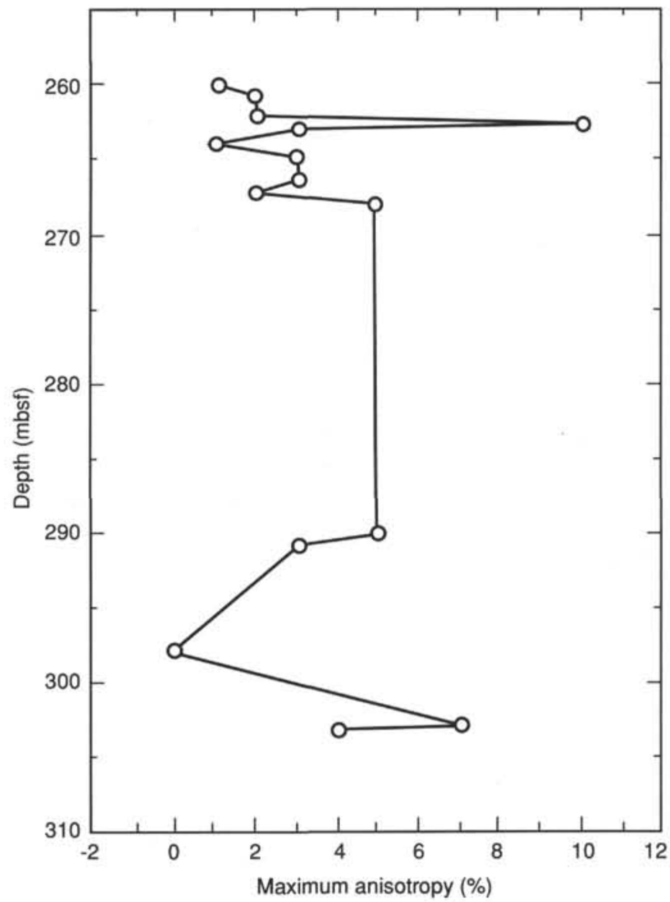

Figure 11. Maximum anisotropy as a function of depth for the basalts cored at Hole 843B.

Hole 843A

One core (136-843A-3R) in this hole penetrated about 3 m into basement, according to the drillers, recovering 63 cm of aphyric basalt. The contact between the basalt and the overlying carbonate nannofossil clay ooze was retrieved (see Fig. 17). It is a depositional contact. The sediments overlie a green, formerly glassy, pillow lava. Below the pillow exterior, the basalt is massive.

All six pieces of basalt that were recovered are petrographically similar. The basalt is essentially aphyric. It consists of rare, (<0.1 volume %), plagioclase phenocrysts in a formerly glassy or holocrystalline matrix. The matrix consists of plagioclase microlites, clusters of plagioclase with sector-zoned clinopyroxene, Fe oxides and altered olivine in cryptocrystalline material (see Table 7). The cores of the plagioclase phenocrysts are altered, but the rims appear to be unaltered. Groundmass plagioclase grains have compositions of 60% to 70% anorthite, as determined by the Michel-Levy technique.

The basalt has sparse, small (<1 mm), round, evenly distributed vesicles (1–3 volume %) filled with clay and calcite. Vesicles are more common at the top of the pillow (3 volume %), and decrease toward the more massive interior of the flow (<1 volume %).

The basalt has some fractures and veins lined with calcite, clay, and limonite. They are oriented either near horizontal or dip 35°–40°. They vary in width from hairline to 3 mm.

Alteration is extensive at the upper glassy contact and along fractures. In the massive interior of the basalt, alteration is slight. Olivine is altered to iddingsite in some places; in others, it is replaced by a blue-green clay. Plagioclase phenocryst cores are replaced by a fine-grained, white mineral (sericite?). The vesicles are filled with clay, limonite, and rarely, with calcite.

Three basalt samples from this core were analyzed for major elements using the shipboard XRF system (Table 6). The three samples are geochemically distinct. The uppermost sample has greater contents of incompatible elements (Ti, Na, K, and P) than the other samples. The two other samples are similar in TiO_2, Al_2O_3, CaO, and P_2O_5 contents, but are distinct in their Fe_2O_3 and K_2O contents. These minor differences may be related to alteration. This will be evaluated using trace elements in post-cruise studies.

Hole 843B

A second hole was drilled at Site 843 about 10 m from Hole 843A. Thus, Hole 843B is basically a continuation of Hole 843A. Coring in

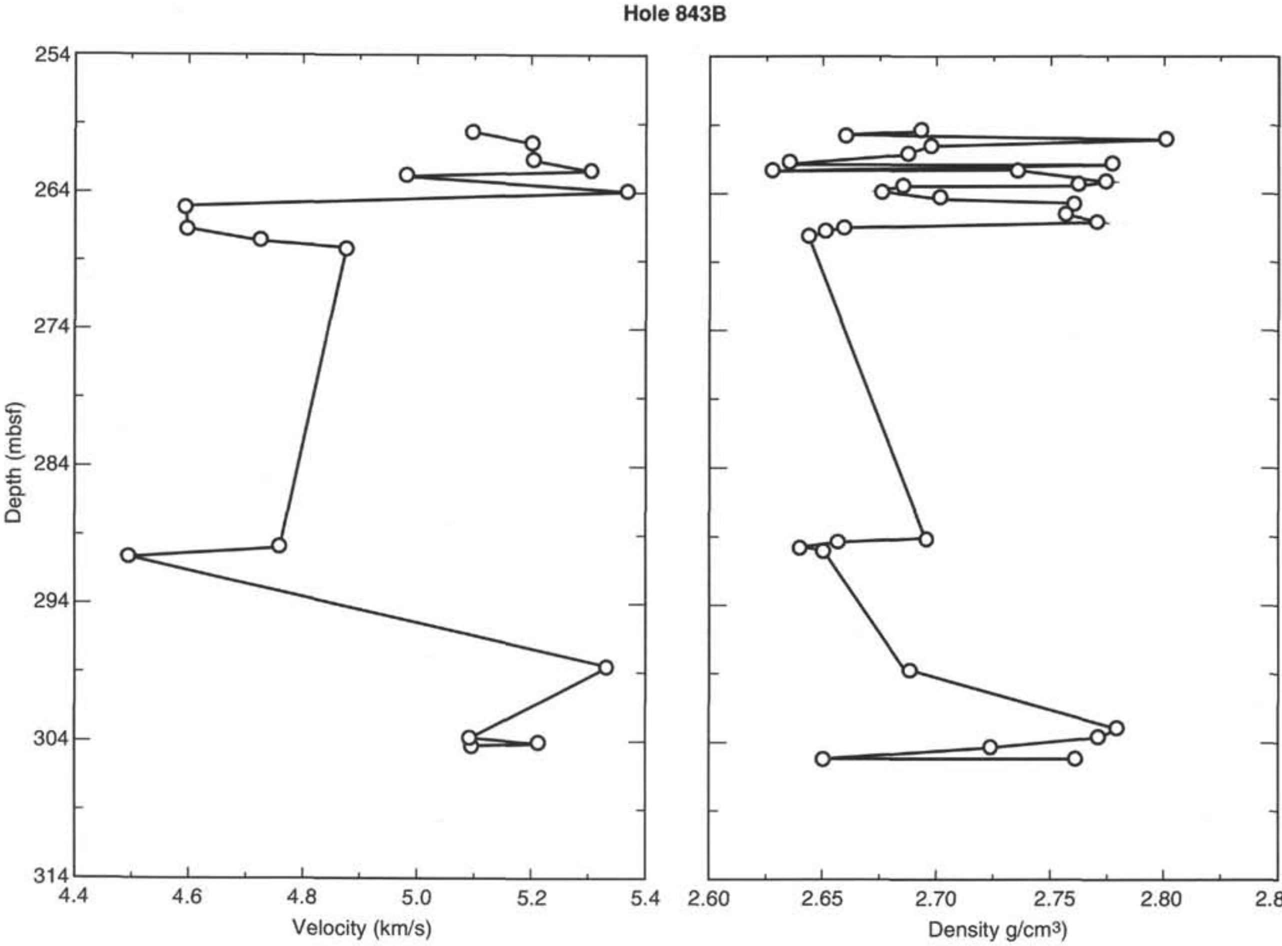

Figure 12. Variations in velocity and density (in the vertical direction) as a function of depth at hole 843B.

Hole 843B was begun about 17 m below the sediment/basalt interface and recovery was average to good (35%). Approximately 12.6 m of core was recovered over a 33.7-m interval. All but one of the lavas recovered (136-843B-2R-2, 18 cm) are nearly aphyric like the basalt cored in Hole 843A. They contain rare plagioclase phenocrysts (<0.1% volume) in a plagioclase and clinopyroxene-rich matrix. The anomalous sample contains 5%–10% volume phenocrysts of plagioclase with rare olivine and clinopyroxene phenocrysts. Dark-gray bands, 0.5 cm –2.0 cm thick, of glass cut the core at low angles (<20°).

Table 4. *P*-wave velocities of sediments from Hole 843C measured with the Hamilton Frame velocimeter.

Core, section interval (cm)	Depth (mbsf)	Velocity (m/s)
136-843C-		
1H-1, 34–36	0.35	1530.3
1H-1, 109–111	1.10	1525.2
1H-2, 4–6	1.55	1517.5
1H-2, 4–6	1.55	1513.7
1H-2, 34–36	1.85	1539.2
1H-2, 34–36	1.85	1542.0
1H-2, 36–38	1.87	1544.9
1H-2, 84–86	2.35	1558.2
1H-2, 84–86	2.35	1558.7
1H-1, 109–111	2.60	1553.7
1H-2, 109–111	2.60	1557.9
1H-3, 19–21	3.20	1549.9
1H-3, 69–71	3.70	1541.6
1H-3, 84–86	3.85	1541.3

The core from this hole can be subdivided into at least four units that appear similar as hand specimens. Unit 1 is distinguished from Unit 2 by its consistently holocrystalline texture. Unit 2 is glassy and fine-grained. Unit 3 is similar to Unit 2 except that it contains rare, small gabbroic xenoliths. Unit 4 is virtually identical to Unit 3 but it is separated from it by a distinct glassy margin.

The basalts have been fractured and locally brecciated (Fig. 18). The fractures range in width from hairline to 5 cm. They have been filled with calcite, clays, limonite, and in the upper part of the core, pyrite. Fluids from the fractures invaded the host basalt giving it a mottled appearance. The areas close to the fractures are darker gray (Fig. 19). The glass in the dark bands has been partially altered to clays and iron oxides.

The vesicularity of the basalts is very low (<1 vol. %) throughout most of the core, but locally it increases to 3% volume. They are small (<1 mm), round, generally evenly distributed, and are filled with clay; rarely, calcite fills the center of the vesicles. The low vesicularity of the lavas has probably impeded their alteration.

Thirteen of the freshest samples were selected for major-element analyses by XRF. The loss on ignition (LOI) values for these samples range from 0.40% to 2.96% weight (Table 6). The samples from Core 136-843B-1R are the freshest samples.

There are large variations in composition among these lithologically-similar lavas (see Table 6). For example, K_2O varies from 0.05 to 0.88 wt.% and Fe_2O_3 from 8.57 to 14.33. However, TiO_2 has only

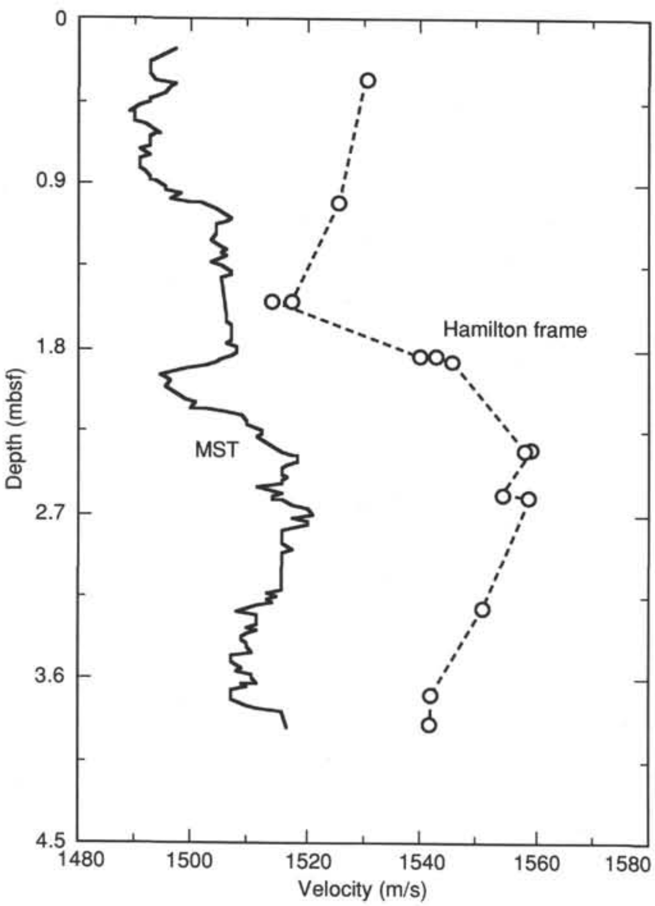

Figure 13. Velocity as a function of depth for the sedimentary section cored at Hole 843C.

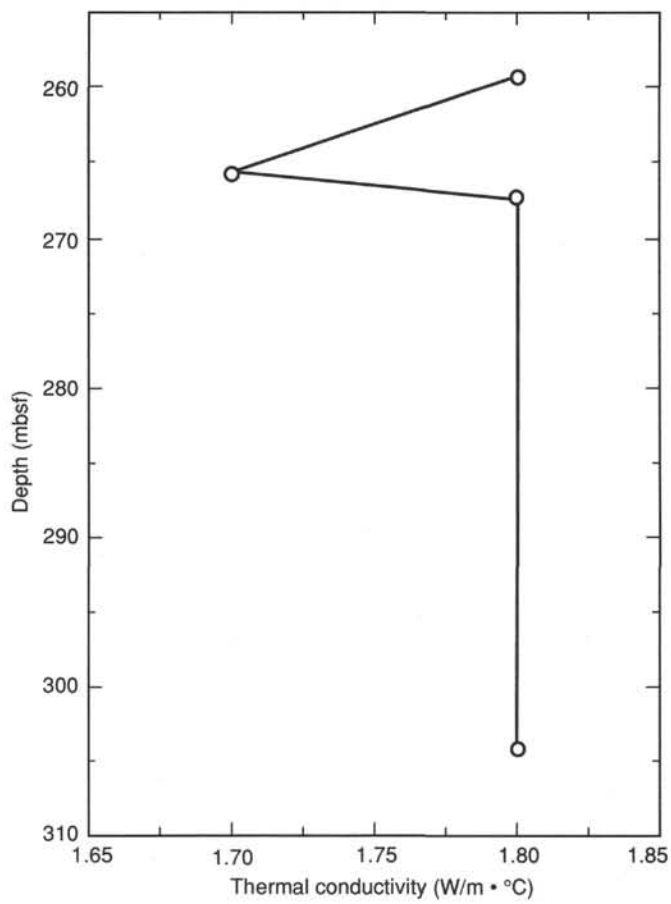

Figure 14. Thermal conductivity of the basalts cored at Hole 843B.

a small range (1.78 to 2.10 wt.%). There are at least five distinct compositions among the 13 samples analyzed. There is no systematic compositional variation with depth.

Alteration

Most of the core (Units 2, 3, and 4) is characterized by 3 mm- to 3 cm-wide, dark-gray to black alteration halos around fractures (Fig. 19). The dark color is presumably due to the presence of secondary clay minerals in the rock. The gray portions of the rocks, farther from the fractures, appear relatively unaltered in hand specimen. Section 136-843B-1R-4 exhibits somewhat different alteration effects, with brownish alteration zones, 1 to 3 cm wide, around clay + calcite veins. The brown color is attributed to the presence of secondary Fe-oxyhydroxides disseminated in the rock, and is typical of oxidation by reaction with circulating cold seawater. Some of the dark alteration halos in Sections 136-843B-1R-5 and -1R-6 exhibit narrow (1 mm–2 mm) red zones immediately adjacent to fractures, probably with a similar origin to the brown zones in the overlying section. Sections 136-843B-1R-3 and 1R-4 contain numerous, near-vertical fractures filled with dark (almost black) and brownish clay minerals and calcite. The abundant fractures probably provided pathways for circulation of the large amounts of seawater responsible for oxidation of the rocks. Fractures throughout the core are filled with various secondary minerals. Vein assemblages include: (1) dark clay (saponite?) ± calcite ± pyrite; (2) green to blue-green clay (celadonite?) ± calcite; and (3) green + brown clays. The latter may be a mixture of green clay and Fe-oxyhydroxides, but could be partly oxidized green clay. Core 136-843B-2R is extensively fractured and contains common celadonite(?) + calcium veins. Section 136-843B-2R-2 in particular is brecciated and cemented with calcite, which forms massive cement, with 3-mm rhombohedral crystals filling vugs (Fig. 18).

Overall, alteration effects in Hole 843B appear generally similar to those observed in other seafloor basalts altered at low temperatures and at variable water/rock ratios and oxidation states. The blue-green color of the celadonite(?) in Core 136-843B-2R is rather unusual for seafloor celadonites, which are typically more green in color. The

Table 5. Thermal conductivity of basalts (half-space method) from Hole 843B, and of sediments (full-space method) from Hole 843C.

Core, section interval (cm)	Depth (mbsf)	Thermal conductivity (W/m·°C)
136-843B-		
1R-1, 25–45	259.75	1.80
1R-5, 80–90	265.73	1.70
1R-6, 50–60	266.86	1.80
4R-1, 89–99	303.59	1.80
136-843C-		
1H-1, 75	0.75	0.85
1H-2, 75	2.25	0.76
1H-3, 50	3.5	0.79

abundant calcite is typical of some other old seafloor basalts (DSDP Sites 417 and 418 in the Atlantic; Donnelly et al., 1979), but the rhombohedral crystal morphology in Hole 843B is unusual (perhaps reflecting unique solution compositions?).

Discussion

The aphyric character of the Site 843 basalts simplifies our evaluation of their major-element compositions because there are essentially no phenocrysts present to modify the original magmatic composition of the lavas. However, low-temperature alteration may have somewhat modified the composition of the basalts. Potassium is the most likely of the major elements to be modified by alteration. A good correlation of K_2O and loss on ignition would indicate that it has been modified. No such correlation was found (Fig. 20).

Overall, the Site 843 basalts have systematic variations of CaO vs. MgO and K_2O vs MgO, but most of the other elements do not show systematic variations vs. MgO (Fig. 21). If two samples with consistently different compositions are excluded (Samples 136-843B-1R-3, 80–82 cm, and 137-843B-1R-4, 51–52 cm), then broad negative correlations are noted for TiO_2, Al_2O_3, FeO, Na_2O, and P_2O_5. The two anomalous lavas have relatively low loss on ignition values (0.66% and 0.76% wt.) and do not appear to be more altered, so they may have been derived from a different parental magma.

The apparent trend of increasing Al_2O_3 with decreasing MgO is surprising. Plagioclase is the only phenocryst in most of these lavas and most mid-ocean ridge basalts (MORB) have the opposite trend (e.g. Sinton et al., 1991). However, this trend is strongly influenced by two samples, one of which (Sample 136-843B-3R-1, 88–90 cm) has the highest Al_2O_3 content and is one of the most altered samples from the site. Thus, this trend may be the result of alteration. This will be checked with Sr analyses, because Sr is less susceptible to alteration than Al_2O_3 and is also concentrated in plagioclase.

The Site 843 basalts include a wide range of MORB compositions from normal to enriched varieties. This is well illustrated in a TiO_2 vs. K_2O plot (Fig. 22). Five of the lavas plot in the normal MORB field; a few plot just above the field and may be transitional MORB. The rest plot well above the field and may be enriched MORB.

Summary

Drilling of the basement at Site 843 provided the first samples of basaltic crust in the vicinity of the Hawaiian Islands. The only previous attempt to drill the crust near Hawaii was on DSDP Leg 7 at a Site about 150 km north of Oahu. It failed to reach basement because of rough seas and hard chert (Shipboard Scientific Party, Site 67, 1971). Thus, virtually nothing was known about the geochemistry of the oceanic crust on which the Hawaiian Islands were built prior to the drilling of Site 843. Furthermore, Cretaceous Pacific MORB is poorly

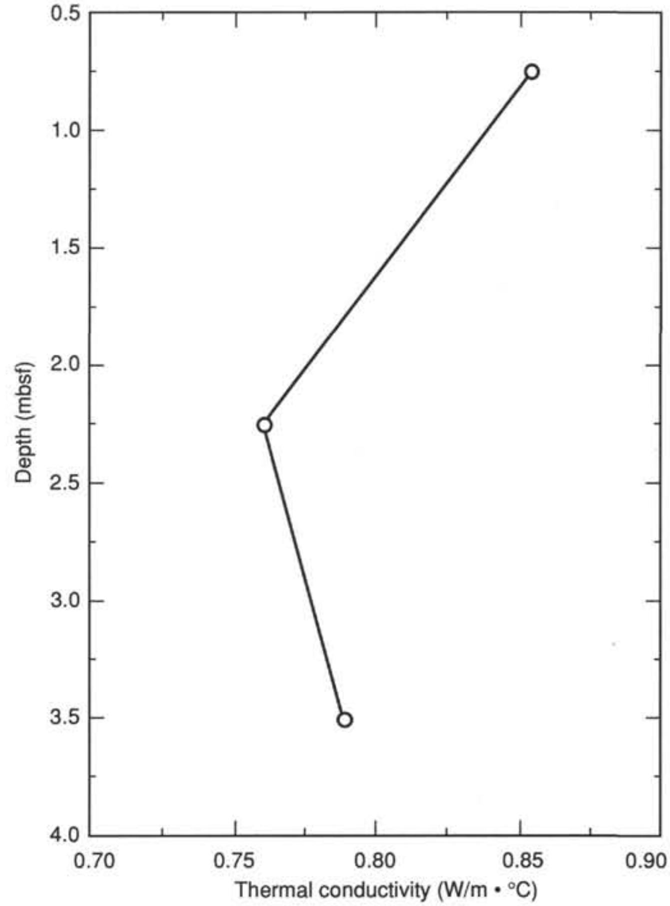

Figure 15. Thermal conductivity of the sediments cored at Hole 843C.

Table 6. Major-element analyses of volcanic rocks from Site 843, determined by XRF/LOI. Analysts: J. Perry and D. Sims.

Core, section, interval (cm)	SiO_2 (wt%)	TiO_2 (wt%)	Al_2O_3 (wt%)	Fe_2O3 (wt%)	MnO (wt%)	MgO (wt%)	CaO (wt%)	Na_2O (wt%)	K_2O (wt%)	P_2O_5 (wt%)	Total (wt%)	LOI (wt%)
136-843A-												
3R-1, 88–90	51.00	2.54	16.65	10.27	0.16	6.07	9.23	2.85	0.91	0.28	99.96	2.03
3R-2, 12–14	49.63	2.34	15.17	11.72	0.26	6.29	11.12	2.29	0.47	0.25	99.54	0.93
3R-2, 36–38	50.20	2.33	15.36	10.80	0.23	6.42	11.12	2.34	0.57	0.25	99.62	1.08
136-843B-												
1R-1, 58–60	50.50	1.91	14.57	11.53	0.18	7.27	11.55	2.36	0.05	0.18	100.10	0.40
1R-2, 122–124	51.81	2.01	15.61	8.57	0.18	7.24	11.93	2.49	0.14	0.18	100.16	0.57
1R-3, 80–82	249.54	1.78	13.66	14.33	0.23	6.19	10.93	2.10	0.72	0.16	99.64	0.66
1R-4, 51–53	50.27	1.83	13.94	13.95	0.20	5.62	10.30	2.22	0.88	0.17	99.38	0.76
1R-6, 86–88	51.29	2.00	15.23	9.68	0.18	6.85	11.42	2.57	0.33	0.19	99.74	0.46
1R-6, 105–107	50.93	2.03	15.35	9.65	0.20	7.25	11.25	2.60	0.16	0.18	99.60	0.63
1R-6, 132–134	51.12	2.00	15.38	9.96	0.18	6.75	11.35	2.55	0.36	0.22	99.87	0.67
2R-1, 107–109	50.94	2.03	15.89	9.61	0.20	6.49	10.79	2.61	0.25	0.21	98.90	2.01
2R-2, 75–77	51.24	2.05	15.60	10.84	0.20	5.72	10.32	2.67	0.44	0.40	99.47	2.96
4R-1, 88–90	50.83	2.00	15.20	10.25	0.22	6.44	11.41	2.32	0.15	0.19	99.00	2.43
4R-2, 26–28	51.56	2.10	15.19	9.30	0.21	6.52	11.57	2.29	0.24	0.18	99.17	1.40
4R-2, 80–81	50.25	2.02	15.07	10.34	0.21	6.31	11.20	2.42	0.27	0.19	98.25	1.83
4R-3, 28–30	50.74	2.05	15.30	9.81	0.21	6.71	11.18	2.43	0.28	0.19	98.89	1.91

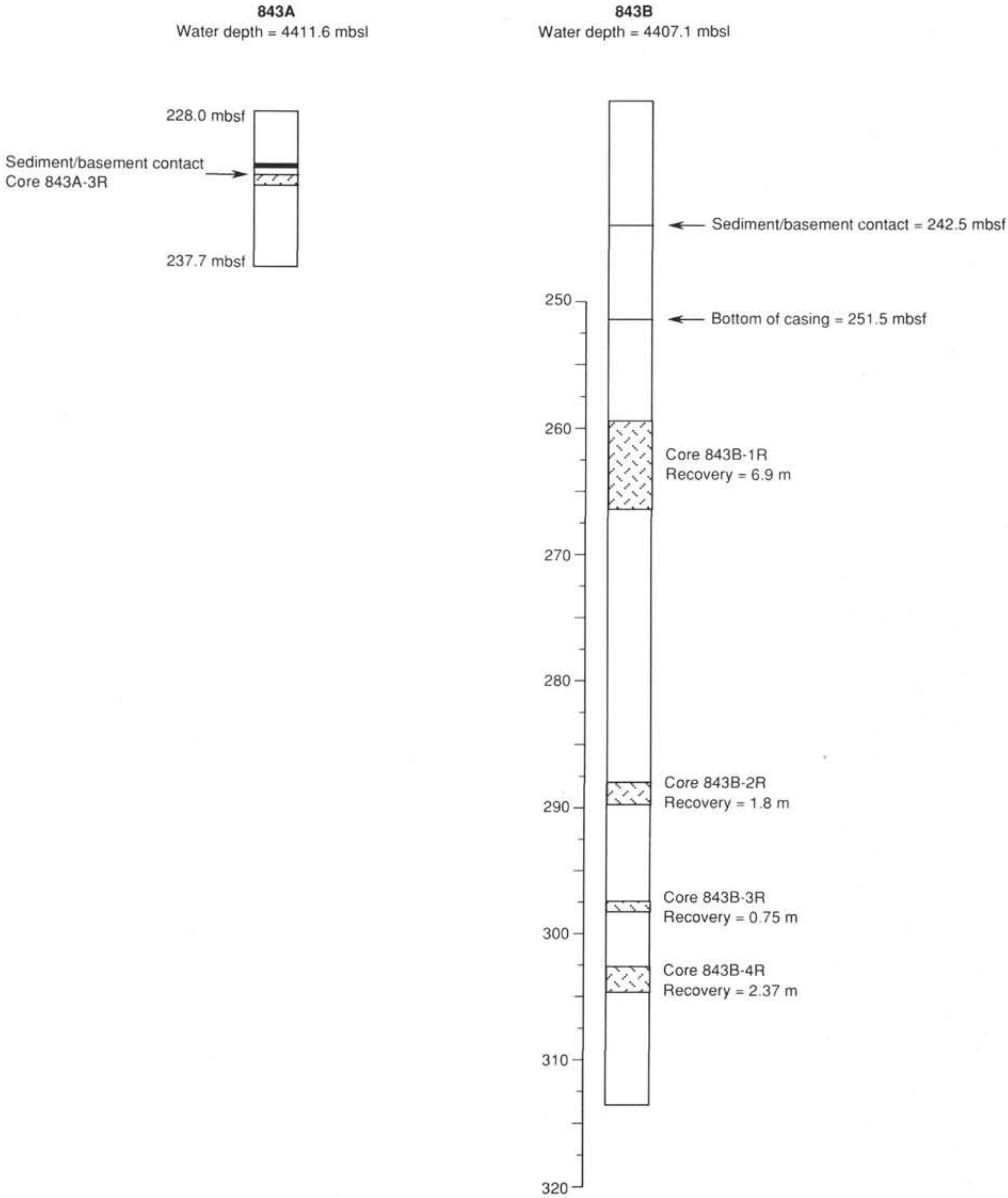

Figure 16. Schematic section of basaltic basement sections from Holes A and B from Site 843. The cross-hatched pattern indicates where basalt was recovered. The scale is in meters below the seafloor (mbsf).

Table 7. Modes of original (primary) minerals in basalts from Leg 136. Based on 500 points/sample. Analyst: G. Waggoner.

Hole	843A	843A	843A	843A	843B	843B	843B	843B	843B	843B	843B	843B	843B	843B
Core-section	3R-1	3R-1	3R-2	3R-2	1R-1	1R-1	1R-2	1R-2	1R-3	1R-3	1R-6	1R-6	2R-1	2R-2
Interval (cm)	83–85	93–94	5–6	26–28	7–8	72–74	23–25	35–37	27–28	83–95	93–95	102–104	106–108	16–19(A)
Piece number	1a	1b	1	3	1	5	3	5a	1	4	7	8	16	16
Phenocrysts														
Plagioclase	0.1	0.1	0.1	0.1	-	<<01	<<0.1	0.1	0.1	-	<<0.1	<<0.1	<<0.1	10
Clinopyroxene	-	-	-	-	-	-	-	-	0.1	-				
Olivine	-	-	-	-	-	-	-	-	-	-	-	-	-	0.1
Groundmass														
Plaogioclase	17	31	36	39	45	45	12	10	45	39	4	16	40	0
Clinopyroxene	9	17	22	26	15	28	9	7	30	21	4	9	20	0
Olivine	5	11	16	22	16	10	4	5	10	19	1	4	11	0
Fe-oxides	4	15	11	11	12	10	8	9	10	9	12	13	13	0
Glass*	65	26	15	2	9	7	67	61	5	12	79	59	16	90
Vesicularity	3	3	1	<<1	1	1	1	<<1	<<1	<<0.1	3	<<1	1	<<0.1

*Includes very fine-grained material.

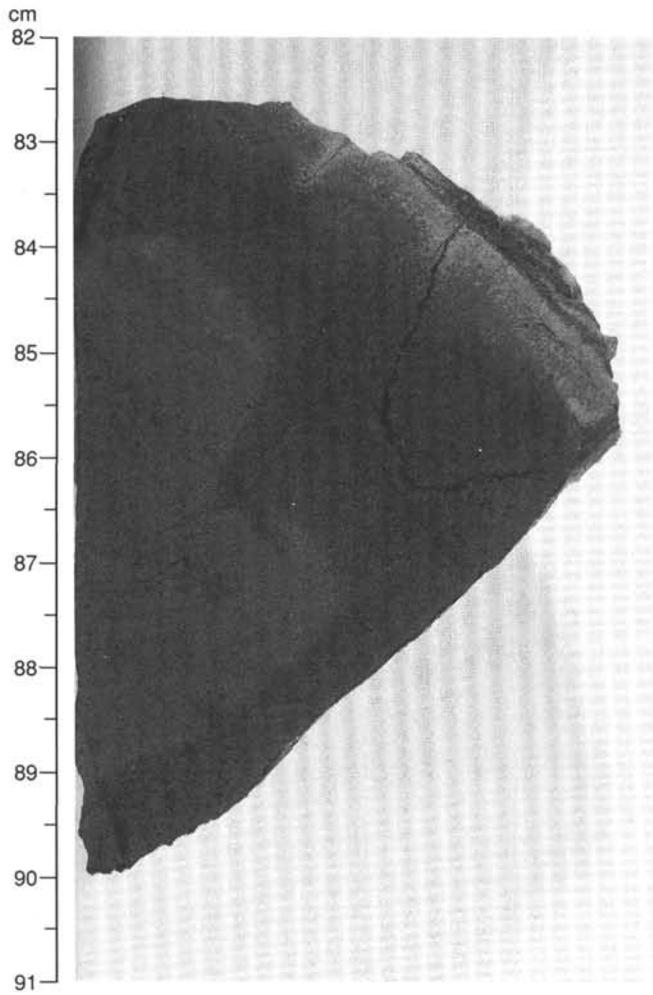

Figure 17. Photograph of the pillow margin from the uppermost flow of Hole 843A (interval 136-843A-3R-1, 82-91cm). The lava was in depositional contact with an overlying nannofossil clay ooze.

characterized, so these samples will fill in a large hole in our data base. They will allow us to test models that invoke the basaltic portion of the oceanic crust (or its source) as a contaminant in Hawaiian magmas (e.g., Chen and Frey, 1983).

Our shipboard results indicate that basalts at Site 843 are essentially aphyric and range from normal to enriched MORB. The lavas are weakly to moderately altered and are cut by fractures and veins that are filled with secondary minerals (mostly green clay, calcite, and iron oxides).

LOGGING

Operations: Hole 843A

Logging in Hole 843A commenced on 8 March 1991 with some technical difficulties, but without excessive delay. We collected a set of fair quality data with two passes of one tool string in about 9 hr. The Quad tool, which is made up of sonic (LSS), resistivity (DITE), density (HLDT), and natural gamma ray (NGT) sondes, was run. The acronyms used in this report are listed in Table 8. The 5-ft LDGO temperature tool (TLT) was not connected at its base, to accommodate the possibility of reaching the sediment/basement contact at the bottom of the hole with the resistivity sensor, lowermost in the string. Sediment filling the hole prior to and during logging, however, elimi-nated this possibility. Logging operations in Hole 843A are summa-rized in Tables 9 and 10. The tool string malfunctioned intermittently on deck in telemetering data to the recording unit; data from all of the sondes were affected. Surface electronics were swapped and the problem was apparently eliminated. The string was lowered downhole to TD (227.5 mbsf) and logs were recorded upward using the wireline heave motion compensator (WHC). The end of the drill pipe was raised and set at 49 mbsf. Fortunately, Pass 1 was successfully recorded to the mudline (0 mbsf), partially through pipe, before the telemetry problem resurfaced. Fair data from the natural gamma, resistivity, and density sondes, and somewhat noisy sonic data were recorded in the sedimentary sequence from 227.5 to 49 mbsf as a result of tool sticking in constricted hole intervals. The second pass reached TD at 218.0 mbsf; however, data were only recorded from about 135 to 49 mbsf due to intermittent telemetry. The logging speed for both up passes was held constant at 275 m/hr (900 ft/hr). After the second pass, cable tension of 8000 lb was unsuccessful in pulling the tool through the pipe, probably as a result of sediment accumulation on the tool, which kept the caliper arm partially open. Ultimately, the tool was worked free by pumping water over it and operating the hydraulic caliper arm.

Table 7 (continued)

843B	843B	843B	843B	843B
2R-2	4R-1	4R-2	4R-2	4R-3
16-19(B)	40-42	7-9	89-91	30-32
16	4	la	4a	5
<<01	-	<<0.1	<<0.1	<<0:1
-	<0.1	-	-	-
5	40	41	15	21
0	25	25	9	12
0	10	16	6	6
0	12	9	11	12
95	13	9	59	49
<<0.1	<0.1	1	1	<1

Operations: Hole 843B

Logging operations in Hole 843B began at 0500 local time on 16 March 1991 and succeeded in collecting excellent quality data in 31 hr including nine passes of four different logging tool strings. These strings included the quad-combination, the formation microscanner, the acoustic televiewer, and the geochemical combination. The logging operations in this hole are summarized in Tables 10 and 11. The wireline heave compensator (WHC) was used for all logging runs because approximately 3-m swells were present during operations. The driller's mudline was at 4418 mbrf, and during logging the bit with a lockable flapper valve was set inside the casing at 4472 mbrf. Casing (16 in. or 56.6 cm ID) was cemented 10 m below the sediment/basement interface and drilled through into basement with 9-3/4-in. roller-cone and PDC bits.

The Quad tool, consisting of LSS-DITE-HLDT-NGT-TLT sondes, was run first (see Table 8 for listing of acronyms). In sequential order, this tool combination measures (1) compressional-wave velocity surrounding the borehole; (2) deep and shallow formation resistivity, primarily sensitive to the porosity and the conductivity of the pore fluids; (3) the formation density and hole diameter; (4) the gamma-ray count of naturally emitted radiation of the formation; and (5) the borehole temperature. The string was run downhole to mudline and a down-log was recorded to TD (313.4 mbsf) with the TLT. The string successfully recorded Pass 1 from TD to 197.9 mbsf, through 50 m of casing at 275 m/hr (900 ft/hr), then lowered to TD for Pass 2 over the same interval. The sonic waveform automatic gain control was disabled for Pass 2, which achieved better traveltime data picking. The natural gamma, resistivity, and density data from this string are all excellent. The string was then lowered to the bottom of casing (251.3 mbsf) and the parameters to run the LSS sonde in an 8-ft bond log mode were set. Two passes in bond log mode were made through casing to 60.8 mbsf at 450 m/hr (1500 ft/hr); the data were recorded as a variable-density log (VDL) that is expected to show high-frequency ringing in intervals of poorly bonded casing. Usually, a shorter 3-ft offset is used for the bond log, and these data will require further processing to determine bonded and unbonded intervals.

The second string included the FMS-GPIT-NGT-TLT sondes and was run to mudline, temporarily halted, and a down-log was recorded to TD (313.4 mbsf) with the TLT. Good data were recorded in the first pass while logging upward at 300 m/hr (1000 ft/hr) to 249.7 mbsf. The caliper arms were closed to pass through a hole constriction at 282.6 m and further attempts to lower this tool below this depth were unsuccessful. Pass 2 was then recorded from 282.6 mbsf to the casing at 251.3

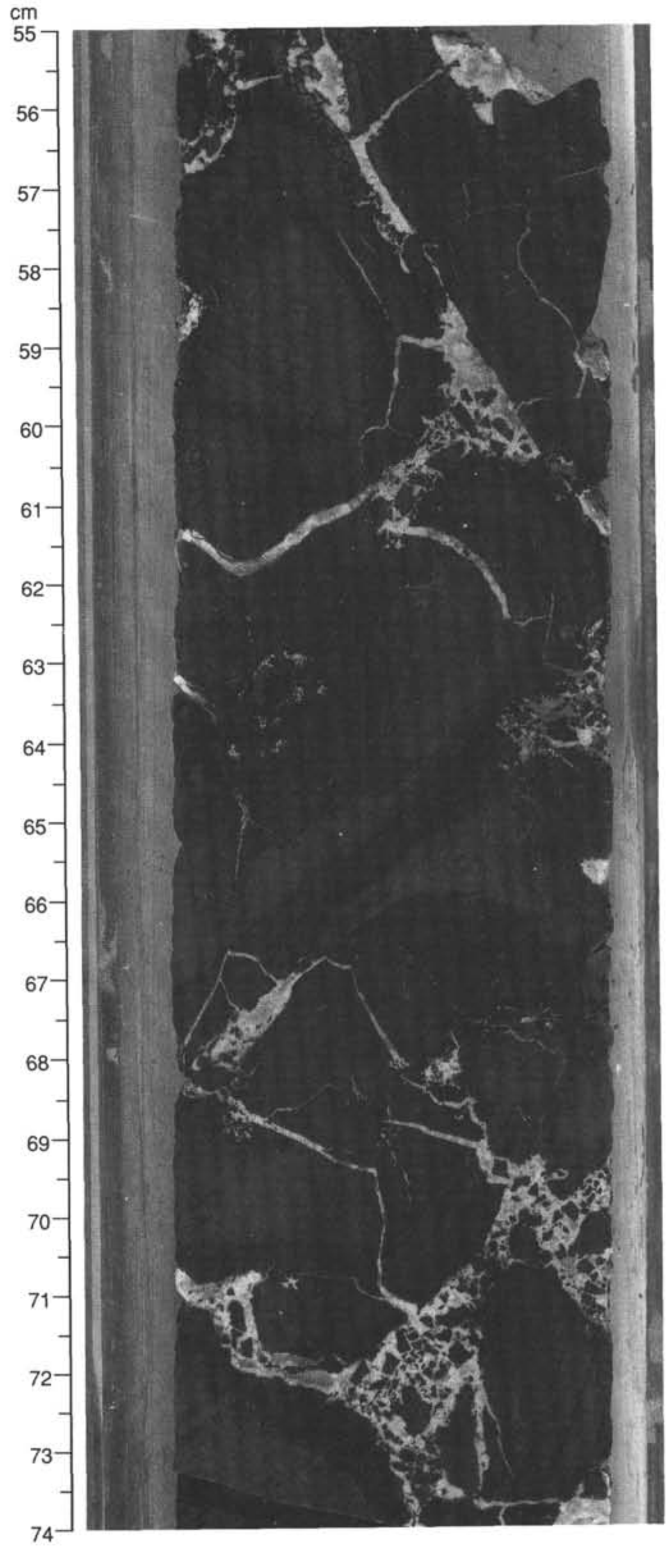

Figure 18. Photograph of a brecciated section of lava from Hole 843B (interval 136-843B-2R-2, 55–74 cm). The veins are filled with calcite, clay, and limonite.

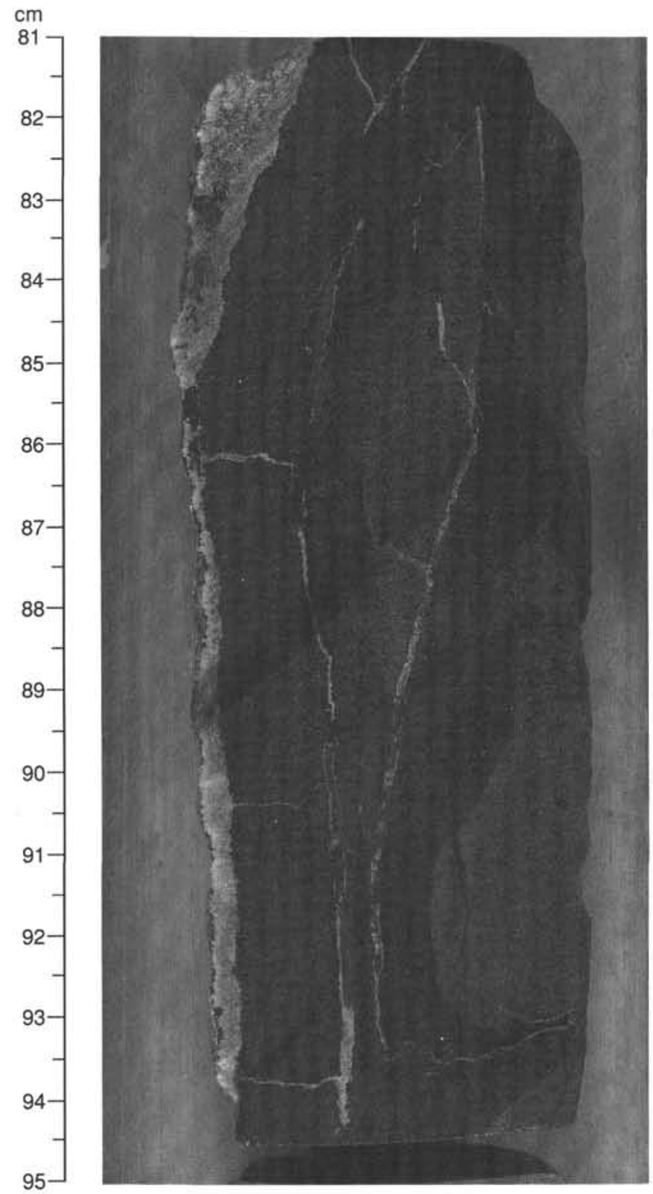

Figure 19. Photograph of a fractured and mottled massive basalt (interval 136-843B-1R-4, 81–95 cm). Note dark color along the veins and fractures.

mbsf, covering the remainder of the uncased extent of this hole. The FMS is a resistivity imaging tool consisting of four orthogonal caliper arms with 16 micro-electrodes on each, capable of measuring resistivity along 2-mm pathlengths. The tool can be used to image bedding and fractures downhole with post-log processing. In addition, the GPIT sonde measures the deviation and azimuth of the hole, and natural gamma-ray and temperature data were simultaneously recorded.

A wiper trip was made to clear the hole constriction encountered with the second string and cleaned approximately 6 m of sediment fill found at the bottom of the hole. After this operation, the analog BHTV was rigged up and calibrated in an orientation tank on the rig floor. The BHTV, which records the acoustic reflectivity of the borehole wall as a function of depth, is oriented in azimuth to magnetic north. The third string, including the TLT sonde, was pumped down the drill string at about 6000 m/hr to the mudline, temporarily halted, and a down-log was recorded to TD (310.2 mbsf) with the TLT. Two passes were successfully recorded with the BHTV acoustic transducer at different gain settings from

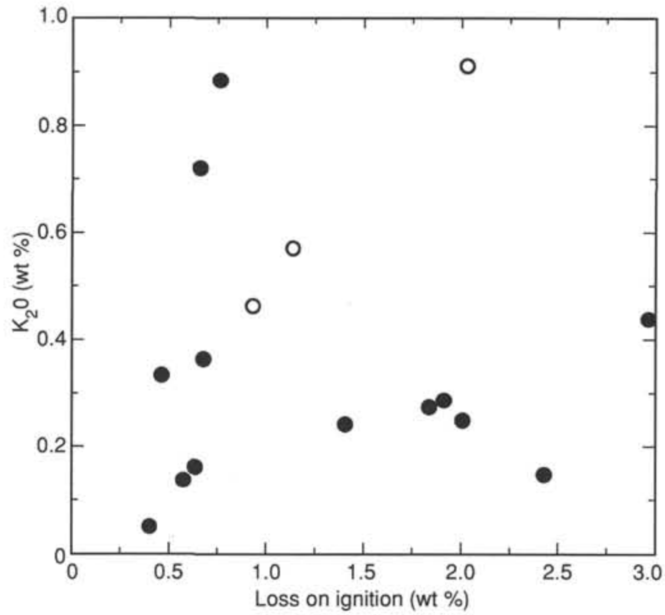

Figure 20. Loss on ignition vs. K_2O plot for lavas from Site 843. Open circles are from Hole 843A, and closed circles, from Hole 843B.

310.2 to 243.6 mbsf (casing) at 91.5 m/hr (300 ft/hr). See Explanatory Notes chapter for details about the operation of the BHTV. The analog data from both passes were recorded on video tape for later digital processing, and Polaroid images of the borehole wall were taken in real time for quality control and preliminary interpretation.

The fourth and final logging run in Hole 843B was the GST-ACT-CNT-NGT string. It is important to note that the TLT was attached to this string, unactuated, serving as a crossover between the bottom of the tool string and the go-devil required to open the lockable flapper valve in the bit. The GST combination was lowered to the mudline and successfully calibrated, then to TD (310.7 mbsf). One pass was made from 310.7 to 167.4 mbsf at 183 m/hr (600 ft/hr), through open hole and partially through the cased interval. Excellent data were recorded with high real-time quality indices and will be processed post-cruise for elemental and weight-percent oxide concentrations of the formation. After this run, the string was pulled out of the hole and we rigged down from logging.

Table 8. Acronyms used in logging.

ACT	Aluminum clay tool
API	American Petroleum Institute standard unit for gamma-ray activity based upon calibration in standard well in Houston.
BHC	Borehole compensated sonic tool
DIT	Phasor dual induction tool
FBRF	Feet below rig floor
FMS	Formation microscanner
GPIT	General purpose inclinometry tool
HLDT	Hydraulic lithodensity tool
LSS	Long-spaced sonic digital tool
MBRF	Meters below rig floor
MBSF	Meters below sea floor
NGT	Natural gamma tool
POOH	Pull out of hole
RIH	Run into hole
TD	Total depth (bottom of hole)
TLT	LDGO Temperature logging tool
GST	Geochemical spectral tool
WHC	Wireline heave motion compensator

Onboard Data Processing

Data were pre-processed to convert depth from feet below rig floor to meters below seafloor using the through-pipe gamma-ray log in Hole 843A and the driller's mudline depth in Hole 843B for the water depth. Note that the data from Hole 843A Pass 2 required an additional subtraction of 8 ft from the depth measurement to account for a stroke of the WHC after it was shut off re-entering the pipe. The raw traveltime logs from Hole 843A were noisy and were reprocessed to calculate compressional velocity using a threshold criterion (see Explanatory Notes chapter); Hole 843B traveltimes were not reprocessed in this manner. In both holes, these preliminary computed velocity logs should be used with caution, particularly in intervals where the caliper is large or varies rapidly (e.g., from about 160 to 176 mbsf in Hole 843A and 251 to 256 mbsf and 279 to 281 mbsf in Hole 843B) where the traveltimes were particularly noisy. Also, resistivity, density, and velocity data recorded in the pipe (although not in cemented casing) are unreliable and are discarded from the log figures.

Results: Hole 843A

The lithostratigraphy over a large interval in this hole is unknown because only wash cores were recovered in the upper 200 m. The known lithostratigraphy, however, can be roughly summarized as interlayered silty clay, claystone, and chert, and is likely to be consistent over the entire interval (see Lithostratigraphy section, Site 842 Chapter). Hence, the logging results may be particularly useful in delineating changes in lithostratigraphy in this hole. The logging results from both passes with the quad tool in Hole 843A are discussed below and shown in Figures 23 and 24, respectively.

The caliper logs record the diameter of the hole and are useful in evaluating whether information from other logs is valid. From the Pass 1 caliper log (Fig. 23, track 1) we see that the hole varied in diameter significantly from the maximum opening of the density tool caliper (48 cm or 19.3 in.) to a minimum of 5 in. The hole was in reasonably good condition below 135 mbsf, 2–3 in. over the 9-3/4-in. drill-bit size, but had widened considerably above this depth. The measurement of bulk density is most severely affected by borehole size variation and is only valid when the caliper arm is in contact with the wall of the borehole. Corrections for poor pad contact can be made; however, in depth intervals where the corrections are very large, the compensation is only approximate and the density log may be incorrect. The gamma-ray and resistivity logs are only slightly affected by borehole size.

In Figure 23, the Pass 1 resistivity (track 3) and velocity (track 5) logs show similar variations as a function of depth because both measurements are primarily controlled by the clay content and porosity of the formation. For example, sharp increases may delineate high-veloc-ity and high-resistivity chert layers, and decreases may delineate clay-rich beds. The Pass 1 bulk density log (Fig. 23, track 4) in Hole 843A shows changes that directly correlate to the velocity and resistivity, measuring high-density cherts and low-density clays. The Pass 1 gamma-ray log (Fig. 23, track 2) records the natural gamma-ray spectrum comprised of thorium, uranium, and potassium, which gives perhaps the most direct indication of clay content of the formation. The Pass 2 logs (Fig. 24) generally repeat the Pass 1 measurements; however, slight differences occur between the passes in gamma rays and density, and lower velocities were measured in the interval from the base of pipe (BOP) to 70 mbsf. These may be due to a change in borehole size and shape as the BOP moves with ship heave against the borehole wall. In general, high gamma-ray values correspond with low resistivity, low density, and low velocity in both passes, likely indicating clays, although the magnitude of these variations is not necessarily equal for each measurement due to the complexity of tool responses to clay.

Table 9. Hole 843A logging timetable for 8 March 1991.

Local time	Cumulative hours	Depth mbsf*	Remarks
4:00	0.0		Start logging rig up
4:45	0.8		Rig up Quad tool complete (NGT/DIT/HLDT/SDT/TLT)
5:15	1.2		Telemetry probs
6:15	2.3		Check indiv. tools—okay
6:35	2.6		RIH; 8 kft/hr
7:00	3.0		Change speed up to 10 kft/hr
8:25	4.4	0.0	"at TD 15,235' (227.5 mbsf) 37 degF"
8:50	4.8	227.5	Log up at 900 ft/hr; main log to casing (54 mbsf)
9:45	5.7	0.0	"log to SF (14,510'); down to TD for pass 2"
10:05	6.1	218.0	"at TD 15,225' (218 mbsf); log up w/ man. wf gain"
11:15	7.2	30.0	Pull 8 klb into pipe at 14670'; down out of pipe (2x)
11:45	7.7	50.0	Work caliper arm; pump over tool to free; POOH tool at rig floor
13:15	9.2		

*Based on through-pipe gamma-ray log.

Results: Hole 843B

The recovery of basalt core in this hole was 12.6 m over the drilled 70 m basement interval. As well as measuring physical properties, fracture distribution, and chemical compositions in the remaining uncored section, the logging results are expected to prove particularly useful in delineating the physical shape of this hole for its primary use in seismic instrumentation of the future. Therefore, the logging results concerning this primary objective are discussed in this preliminary report. Data from the first and second passes of the quad tool and the first down-log with the TLT sonde in Hole 843B are shown in Figures 25, 26, and 27, respectively.

The single-arm caliper log from the HLDT (Figs. 25 and 26, track 1) shows that the hole varied in diameter significantly from the 9-3/4" of the drill bit to a maximum opening of 18.5 in. at 280 mbsf. With the exception of narrow constrictions of the hole at 278 and 293 mbsf to approximately 7.5 in., the hole appeared to be 9.0 in. or greater in diameter throughout the drilled interval. Two significant enlargements in open hole intervals were apparent in this log from about 252 to 267 mbsf (16.2 in. max. diam.) and from 279 to 281 mbsf (18.5 in. max. diam.). Correspondingly, the density, resistivity, and sonic log data are less reliable in these intervals. This caliper log shows the most regular hole diameter in intervals from 268 to 278 mbsf and from 281 to 291 mbsf. The enlargement from 252 to 267 mbsf likely occurred in the

Table 10. Leg 136 well log data.

Log type	Hole 843A	Hole 843B
Resistivity	X	X
Bulk density	X	X
Neutron porosity		X
Gamma ray/ U-Th-K	X	X
Aluminum		X
Geochemistry		X
Sonic velocity	X	X
Sonic waveforms	X	X
Caliper	X	X
Formation microscanner		X
LDGO temperature		X
Borehole televiewer		X

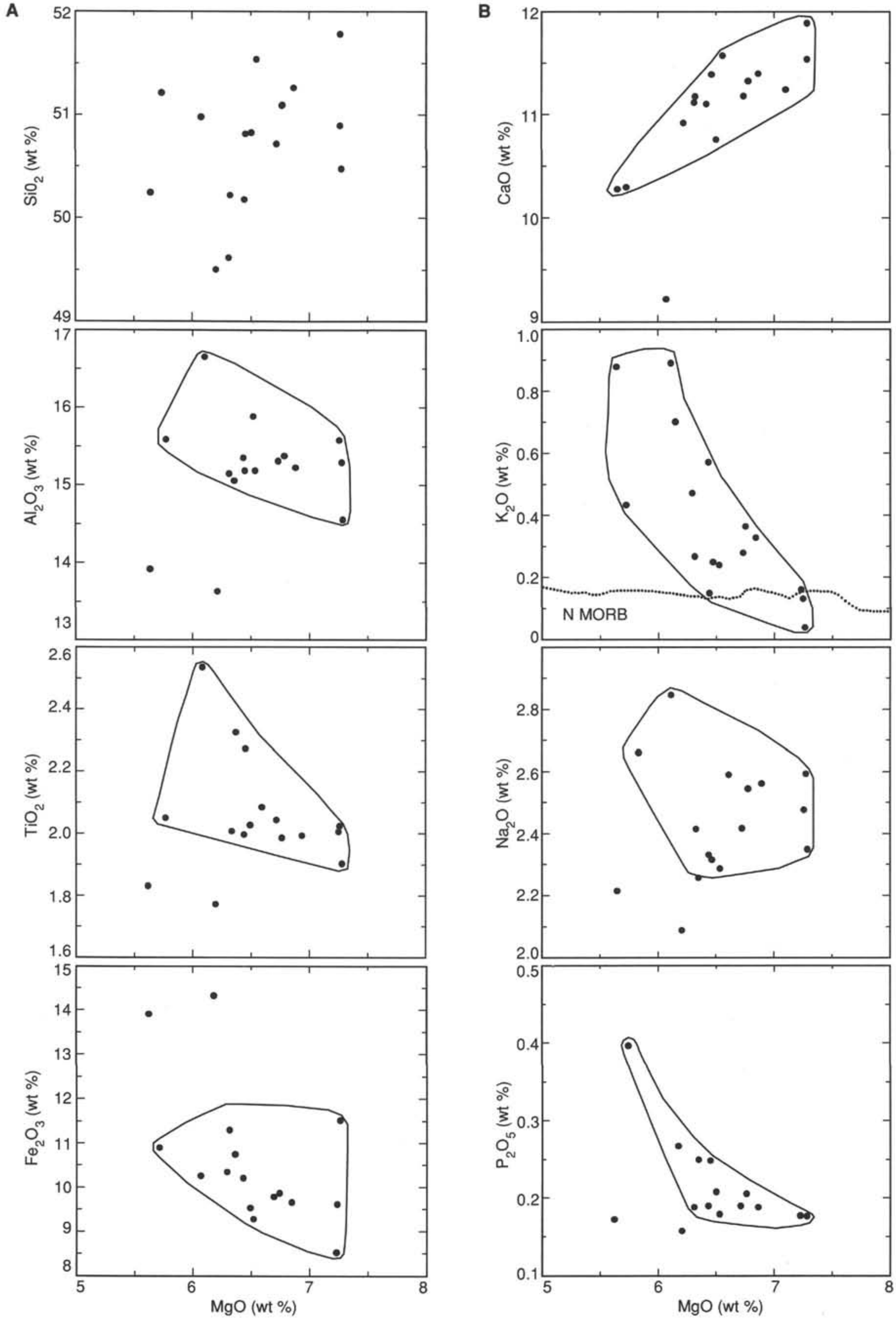

Figure 21. MgO variation diagrams for lavas from Site 843. Field drawn around most samples where a trend is present. Dotted line on K_2O diagram separates normal MORB (below) from transitional and enriched MORB (above). From Sinton et al. (1991).

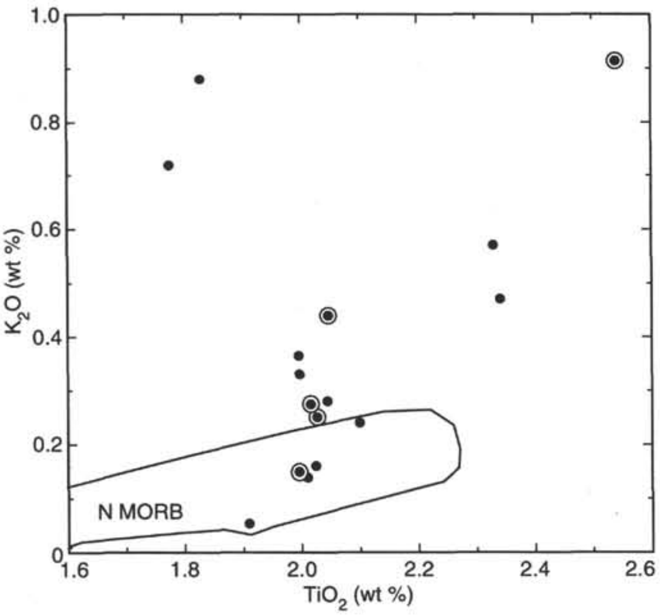

Figure 22. TiO_2 vs. K_2O plot for lavas from Site 843. The normal MORB field is from Natland and Melson (1980). Circled samples have the greatest loss on ignition values (1.2% wt.).

15-m interval below casing that was cement-filled after drilling with a large-diameter bit.

The preliminary BHTV log shows competent borehole wall in these same intervals and some detail of the enlargements, which appear as a series of horizontal features less than 30 cm wide. No high-angle features or breakouts were observed in the preliminary data. Significant heave may have affected the downhole tool motion significantly, and the data may show "stick-slip" or cyclical images after further digital processing.

In Figures 25 and 26, the resistivity (track 3) logs show a decreasing trend from about 50 ohm-m above 282 mbsf to about 5 ohm-m at 305 mbsf. Not considering variability on a fine scale, this trend may indicate an overall increase in conductive mineral abundance due to alteration as a function of depth. Unfortunately, the gamma-ray log (track 2) varies only slightly between 5 and 15 API units above 282 mbsf, which is the deepest measured point. The density log shows variation in bulk density between 2.7 and 2.85 g/cm^3 in competent open hole and large variations in cemented and cased intervals from 2.0 to 2.6 g/cm^3. A sharp decrease in density at about 242 mbsf is likely due to the contrast between cement-lined casing in basalt and sediment. In the casing, the density log probably measures a composite medium of cement, steel, and formation. The velocity log (track 5) was computed directly from the traveltime logs, not by traveltime reprocessing (see Explanatory Notes chapter). Average compressional-wave velocity varies in open hole from about 4.8 to 5.2 km/s and measures accurately the sound speed of the steel casing (5.5 km/s) above 250 mbsf. Large excursions of the velocity log in open hole, particularly in Pass 1, are associated with borehole washout or fracturing. Further processing is expected to improve the velocity results and to estimate the shear-wave velocity from sonic waveforms recorded in the open hole interval.

Significant post-processing of the other log data from the FMS and GST tool strings is required for FMS image displays and geochemical elemental analyses. This was not completed onboard during Leg 136. The GPIT log recorded with the FMS string, however, shows that the hole has less than 0.75° variation from vertical. Data from the first down-log with the TLT sonde is presented in Figure 27. The linear pressure data indicate a constant logging speed (12 cm/s) which was used to convert temperature-time record to depth. This depth calibration is approximate until a time-depth log can be incorporated from the quad string. The temperature data show a monotonic increase with depth in the casing from 1.5°C to 6.0°C; below casing a higher gradient

Table 11. Hole 843B logging timetable.

Local date	Local time	Cumulative hours	Depth (mbsf*)	Remarks
March 16, 1991	5:00	0.0		Rig up Quad tool (NGT/DIT/HLDT/SDT/TLT)
	6:05	1.1		RIH at 10 kft/hr
	8:00	3.0	0.0	Pause above mudline (14450'); log down TLT 1400'/hr
	8:52	3.9	313.4	At TD (15528.9'); log up 900'/hr to 15150'
	9:30	4.5	312.8	Down to TD (15527'); log up pass 2
	10:00	5.0	251.3	Down to casing shoe (15325'); set up bond log
	10:15	5.3	60.8	Log up at 1500'/hr to 14700
	10:45	5.8	258.9	Down to casing shoe (15350'); log up
	11:10	6.2	60.8	POOH
	13:45	8.8		Rig up FMS-NGTC-GPIT-TLT
	14:15	9.3		RIH at 10 kft/hr
	15:50	10.8	0.0	Pause at mudline (14475'); log down TLT 6000'/hr
	16:20	11.3	313.4	At TD (15528.9'); log up 1000'/hr to 15320'
	16:50	11.8	282.6	Down to bridge (15428'); log up pass 2
	17:10	12.2	251.3	POOH
	19:00	14.0		FMS-TLT on deck; start wiper trip & circulation
	22:00	17.0		Rig up BHTV-TLT; calibrate on rig floor
	23:00	18.0		RIH at ~6000'/hr pumping
March 17, 1991	0:00	19.0	0.0	Pause at mudline (14475') for 3 min; log down TLT
	1:30	20.5	310.2	At TD (15518.5'); log up pass 1 at 300'/hr to 15300'
	2:55	21.9	310.7	Down to TD (15520'); log up pass 2 at 300'/hr
	3:30	22.5	243.6	POOH
	5:30	24.5		Rig up GSTA-ACTA-CNTG-NGTC
	6:30	25.5		RIH at 10 kft/hr
	8:45	27.8	310.7	At TD (15520'); log up to 15050'
	9:45	28.8	167.4	POOH
	11:30	30.5		Tool on deck

*Based on driller's mudline.

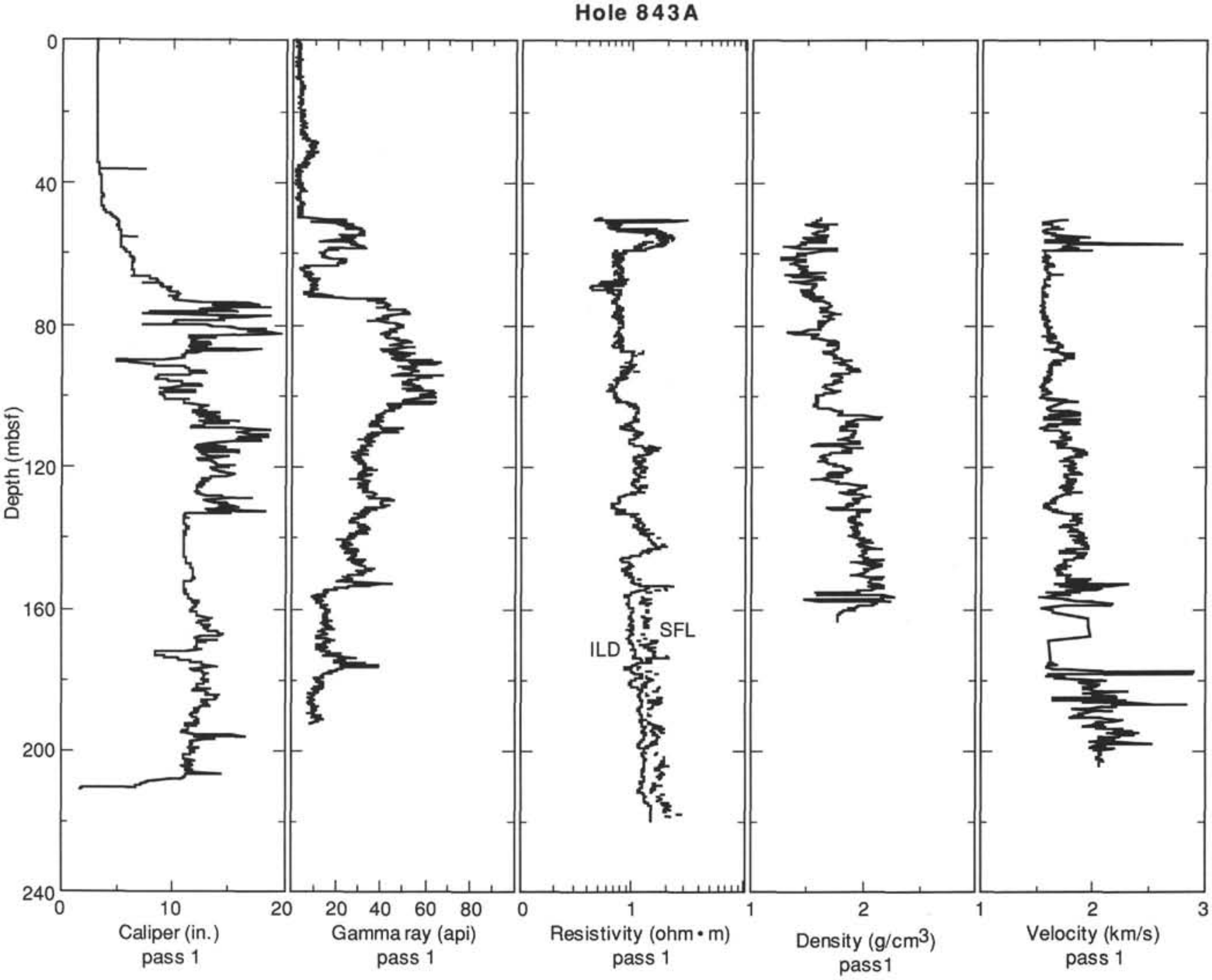

Figure 23. Pass 1 of the quad-combo tool string logs from 0 to 227.5 mbsf in Hole 843A: track 1—caliper; track 2—gamma ray; track 3–resistivity (spherically focused log, SFL, and deep induction log, ILD) on a logarithmic scale; track 4–density; track 5–velocity (V_p).

with some variation in open hole raises the temperature to a maximum of 9.3 °C at 313 mbsf. The open-hole variation may be due to fluid flow through fractures into the hole.

REFERENCES

Brocher, T. M., and ten Brink, U. S., 1987. Variations in oceanic Layer 2 velocities near Hawaii and their correlation to lithospheric flexure. *J. Geophys. Res.,* 92:2647–2661.

Carlson, R. L., and Herrick, C. N., 1990. Densities and porosities in the oceanic crust and their variations with depth and age. *J. Geophys. Res.,* 95:9153–9170.

Chen, C.-Y., and Frey, F. A., 1983. Origin of Hawaiian tholeiite and alkalic basalt. *Nature,* 302:785–789.

Donnelly, T., Francheteau, J., Bryan, W., Robinson, P., Flower, M., Salisbury, M., et al., 1979. *Init. Repts. DSDP,* 51, 52, 53 (Pt. 2): Washington (U.S. Govt. Printing Office).

Karato, S., Wilkens, R. H. and Langseth, M. G., 1983. Shipboard physical-properties measurements of basalts from the Costa Rica Rift, Deep Sea Drilling Project Legs 69 and 70. *In* Cann, J. R., Langseth, M. G., Honnorez, J., Von Herzen, R. P., White, S. M., et al., *Init. Repts. DSDP,* 69: Washington (U.S. Govt. Printing Office), 675–681.

Lindwall, D. A., 1991. Old Pacific crust near Hawaii: a seismic view. *J. Geophys. Res.,* 96:8191–8203.

Natland, J. H., and Melson, W. G., 1980. Compositions of basaltic glasses from the East Pacific Rise and Siqueiros fracture zone, near 9°N. *In* Rosendahl, B. R., Hekinian, R., et al., *Init. Repts. DSDP,* 54: Washington (U.S. Govt. Printing Office), 705–723.

Perch-Nielsen, K., 1985. Mesozoic calcareous nannofossils. *In* Bolli, H. M., Saunders, J. B., and Perch-Nielsen, K. (Eds.), *Plankton Stratigraphy:* Cambridge (Cambridge Univ. Press), 329–426.

Shipboard Scientific Party, 1971. Site 67. *In* Winterer, E. L., Riedel, W. R., et al., *Init. Repts. DSDP,* 7: Washington (U.S. Govt. Printing Office), 821–841.

Sinton, J. M., Smaglik, S. M., Mahoney, J. J., and Macdonald, K. C., 1991. Magmatic processes at superfast spreading mid-ocean ridges. *J. Geophys. Res.,* 96:6133–6155.

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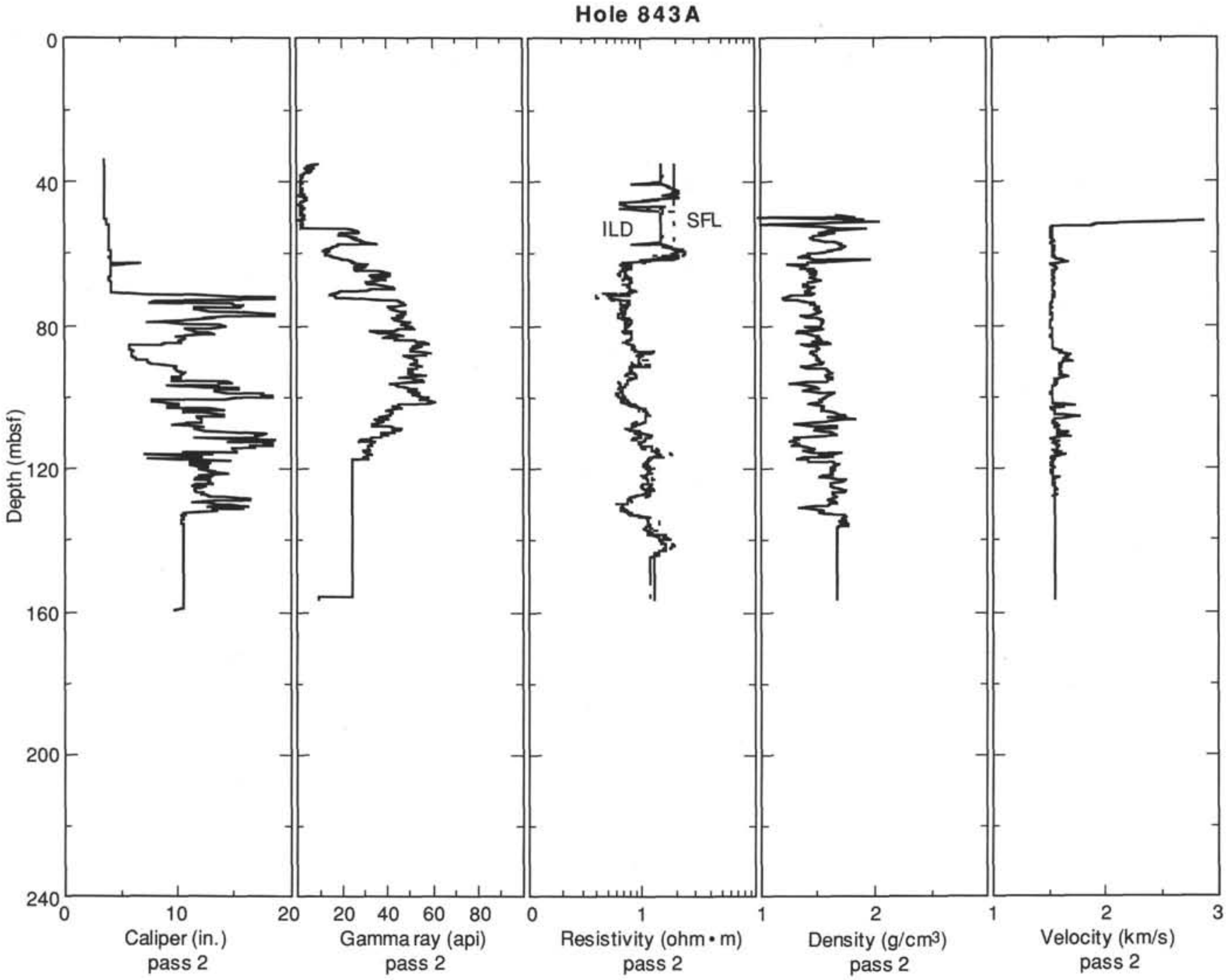


Figure 24. Pass 2 of the quad-combo tool string logs from 49 to 135 mbsf in Hole 843A: track 1–caliper; track 2–gamma ray; track 3–resistivity (spherically focused log, SFL, and deep induction log, ILD) on a logarithmic scale; track 4–density; track 5–velocity (*Vp*).

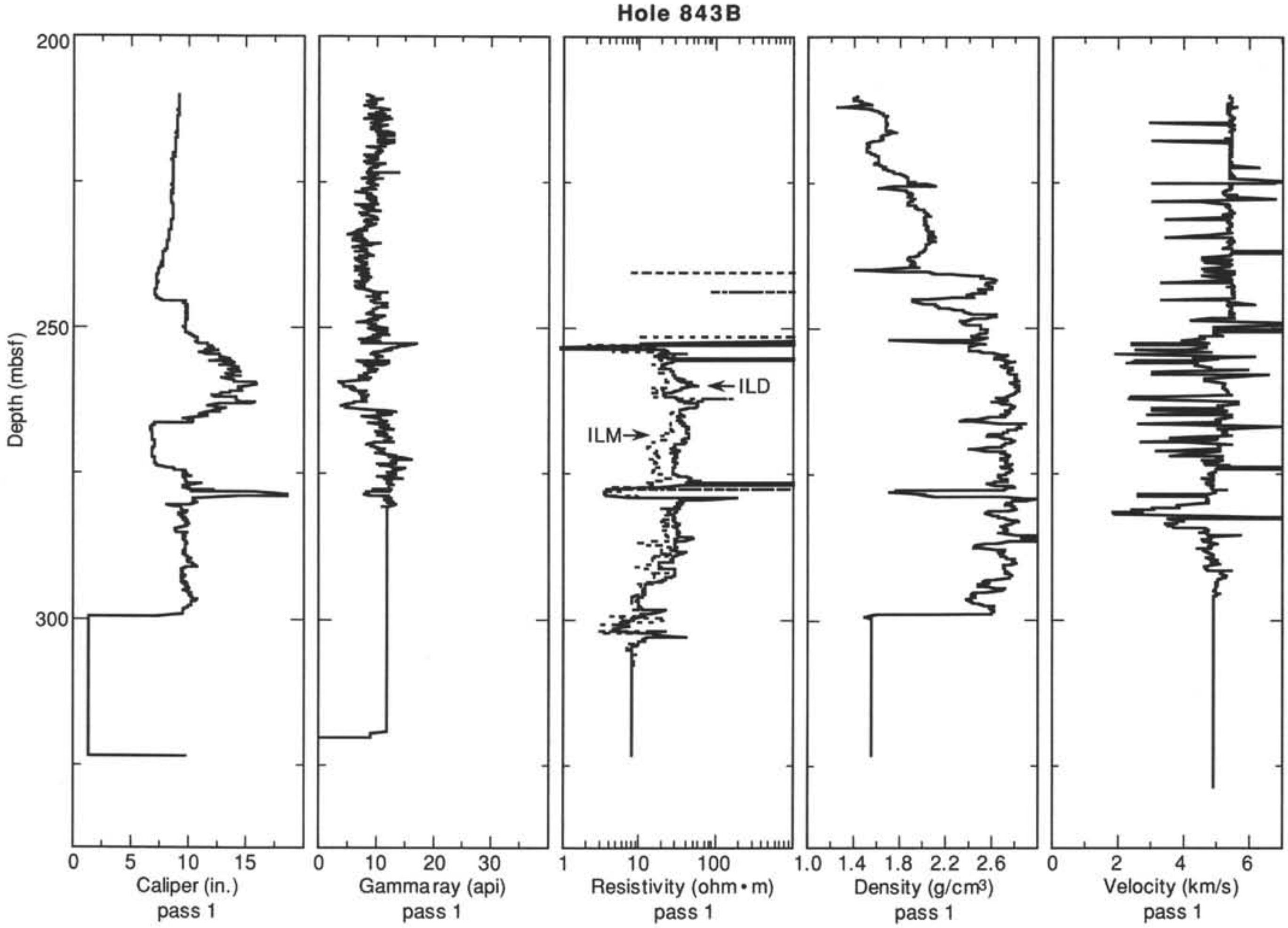


Figure 25. Pass 1 of the quad-combo tool string logs from 210 to 313 mbsf in Hole 843B: track 1–caliper; track 2–gamma ray; track 3–resistivity (medium induction log, ILM, and deep induction log, ILD) on a logarithmic scale; track 4–density; track 5–velocity (V_p).

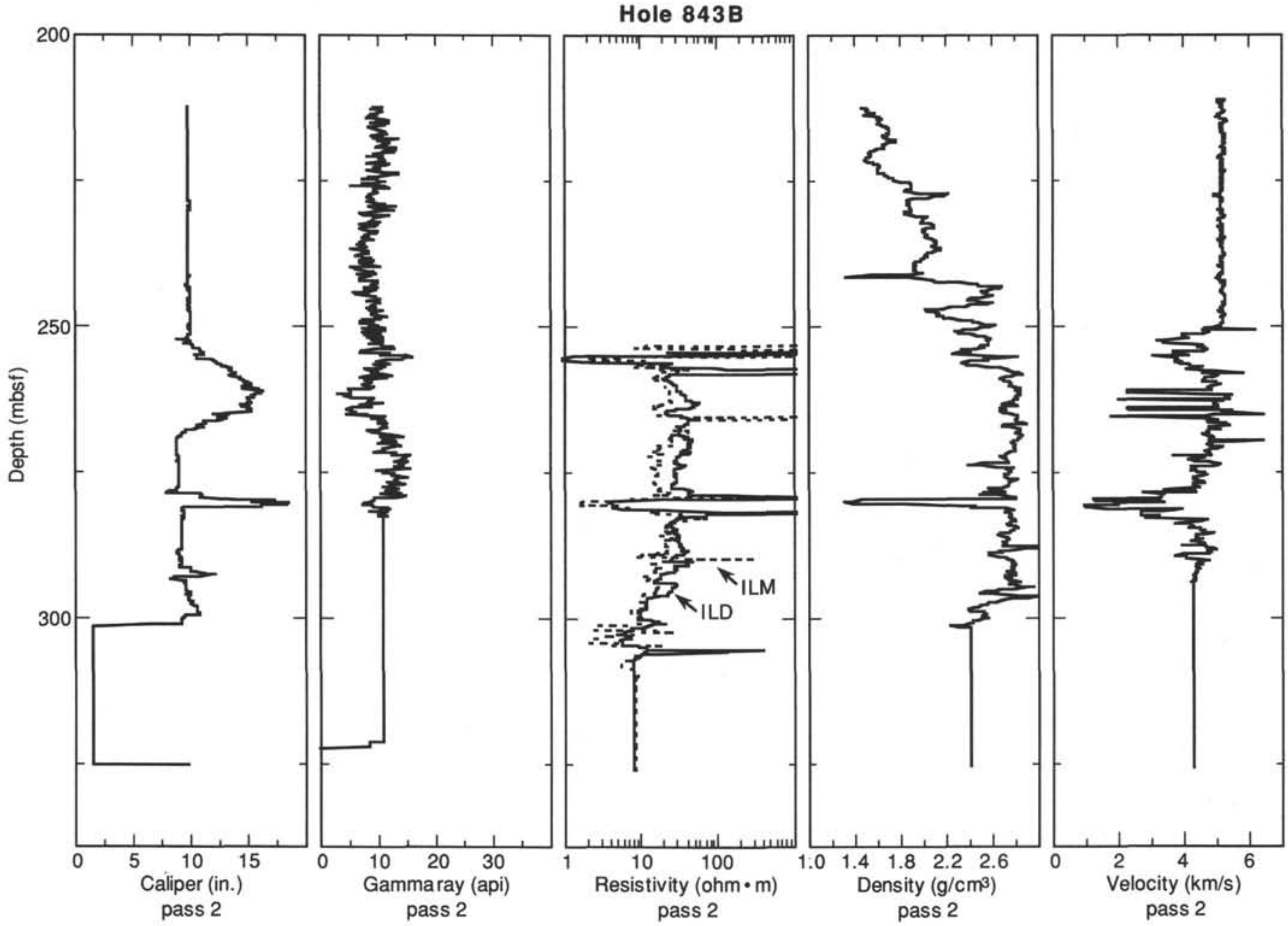


Figure 26. Pass 2 of the quad-combo tool string logs from 210 to 313 mbsf in Hole 843B: track 1–caliper; track 2–gamma ray; track 3–resistivity (medium induction log, ILM, and deep induction log, ILD) on a logarithmic scale; track 4–density; track 5–velocity (V_p).

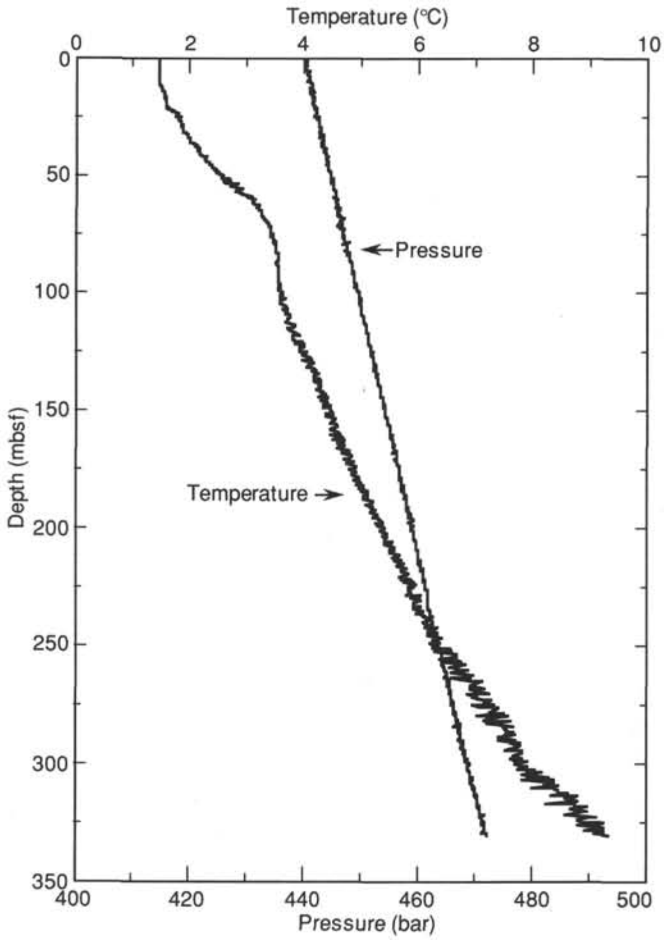
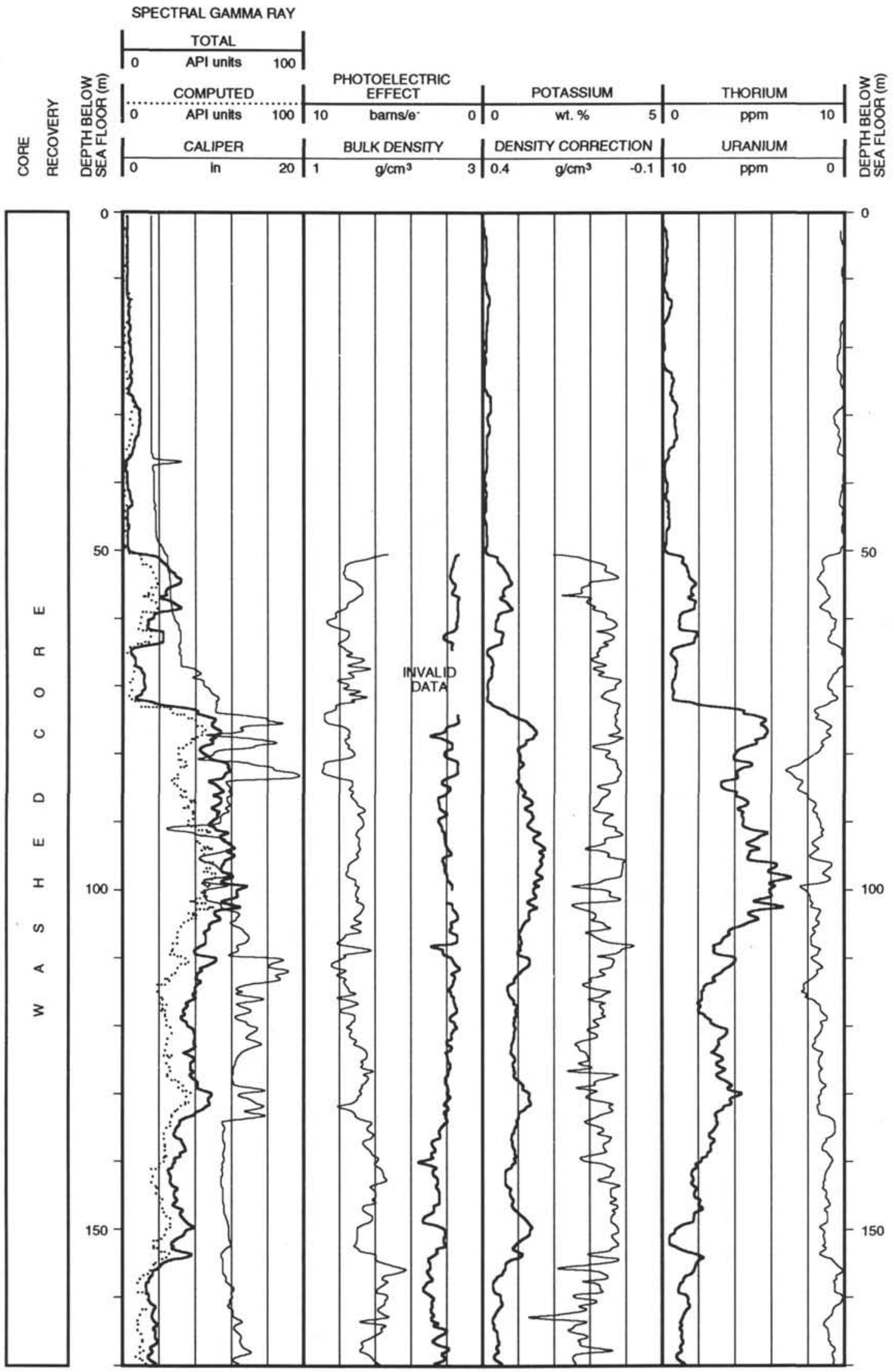
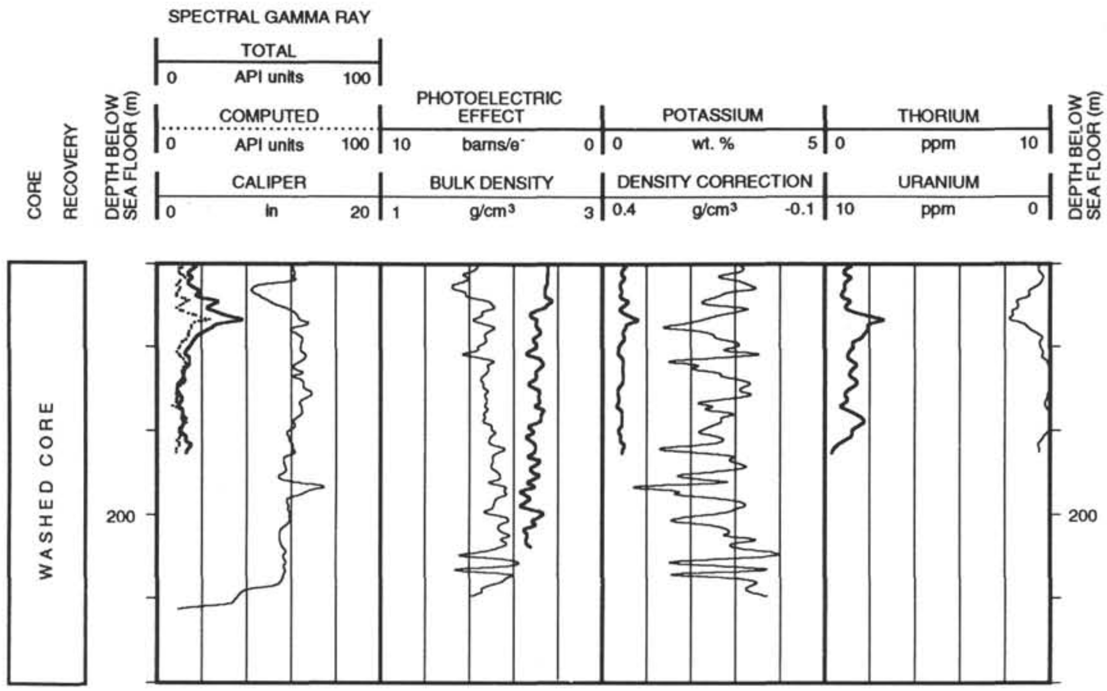


Figure 27. Pass 1 of the temperature tool logs from 0 to 313 mbsf in Hole 843B.

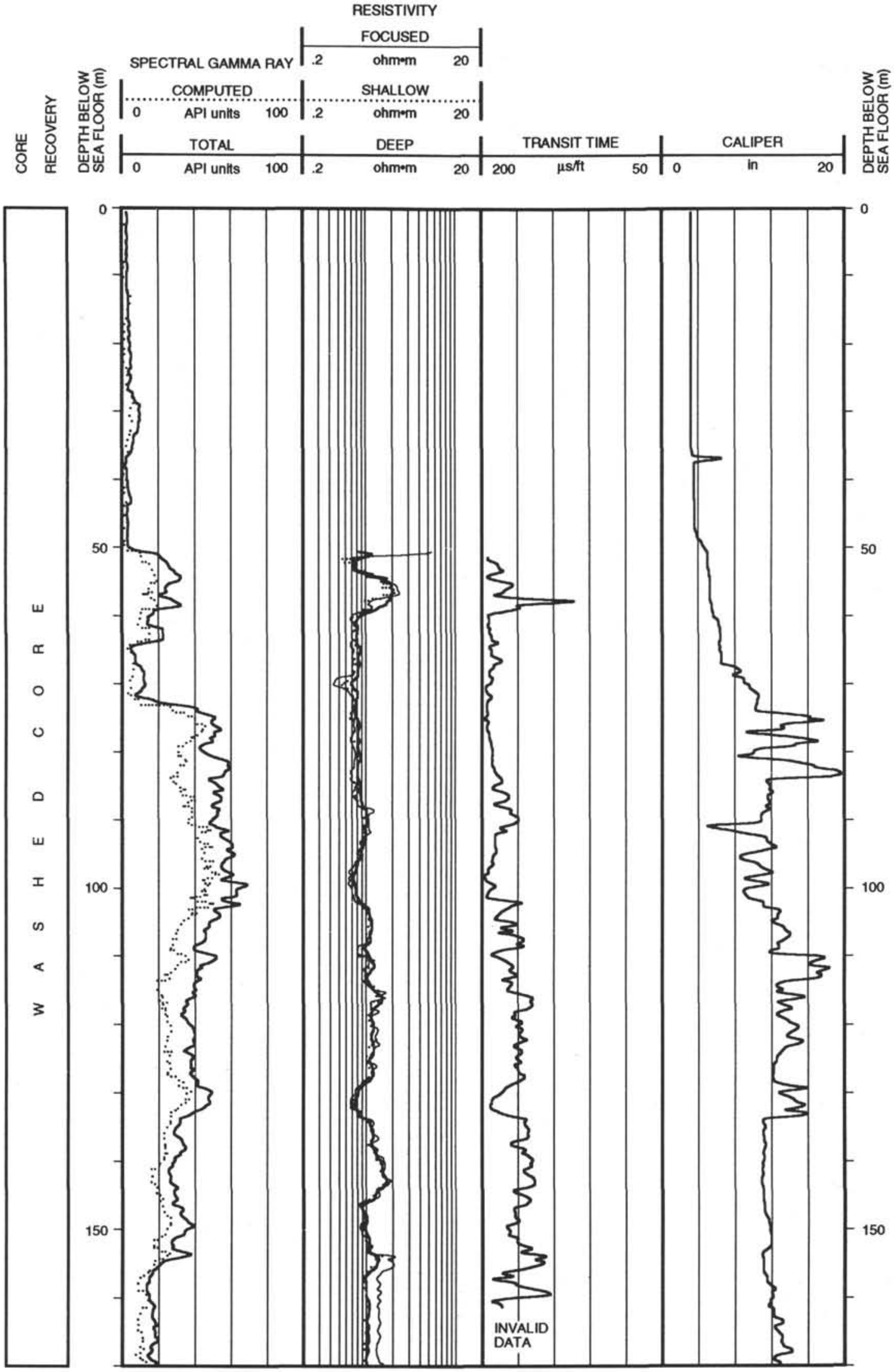
Hole 843A: Density-Natural Gamma Ray Log Summary



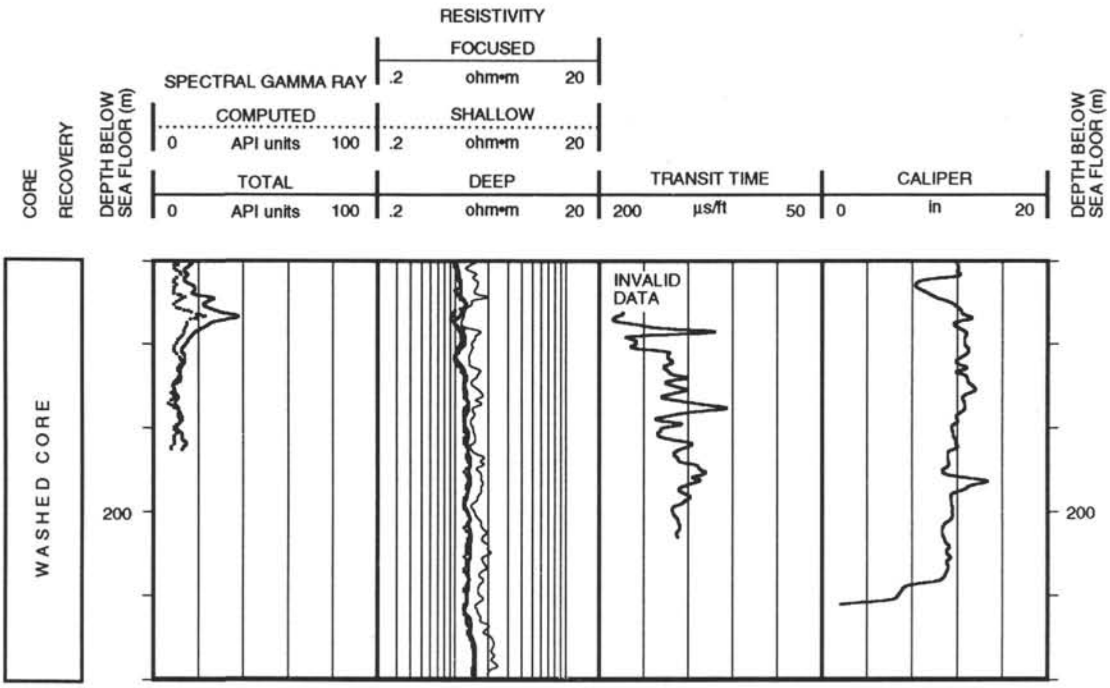
Hole 843A: Density-Natural Gamma Ray Log Summary (continued)



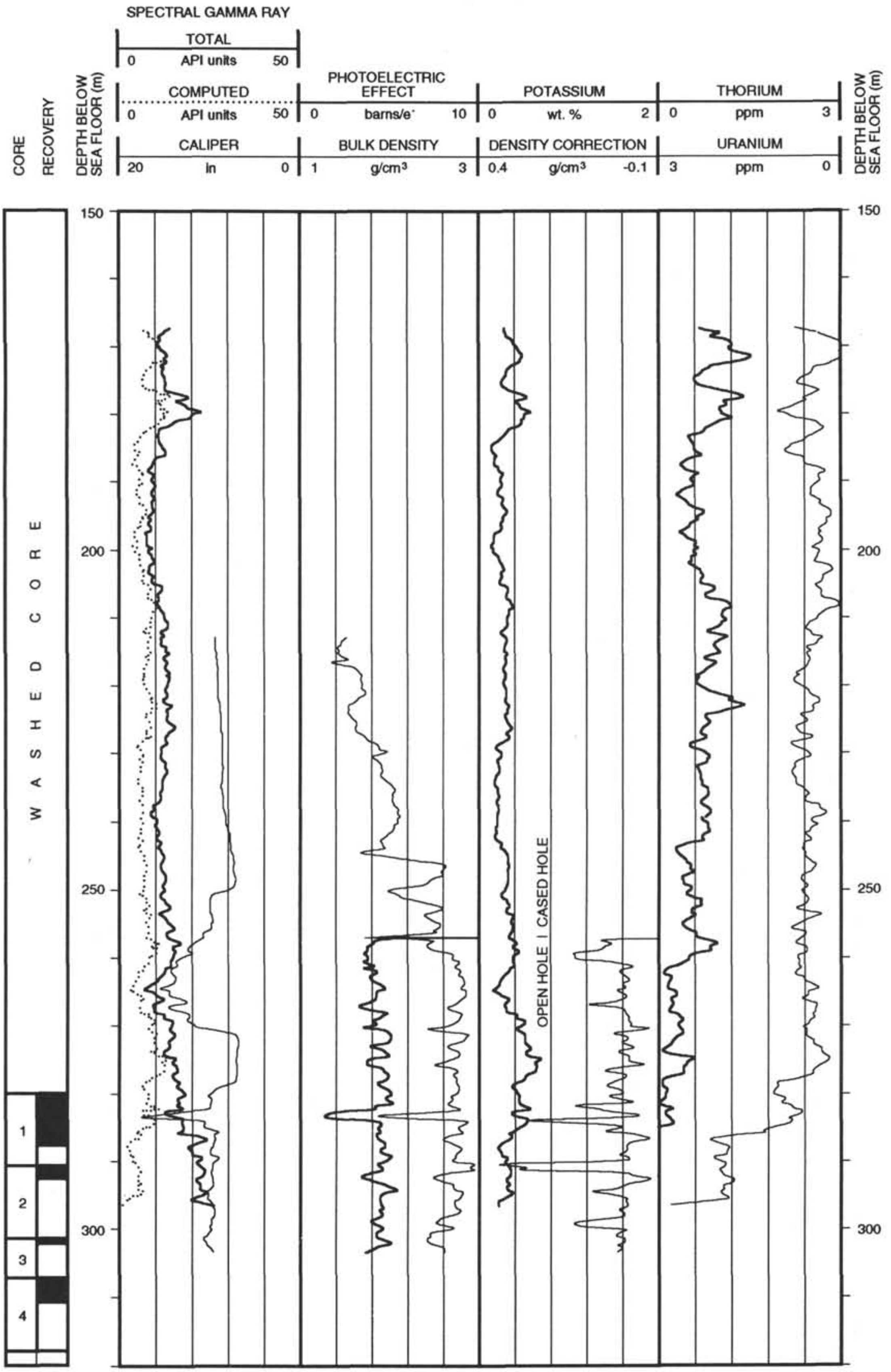
Hole 843A: Resistivity-Sonic-Natural Gamma Ray Log Summary



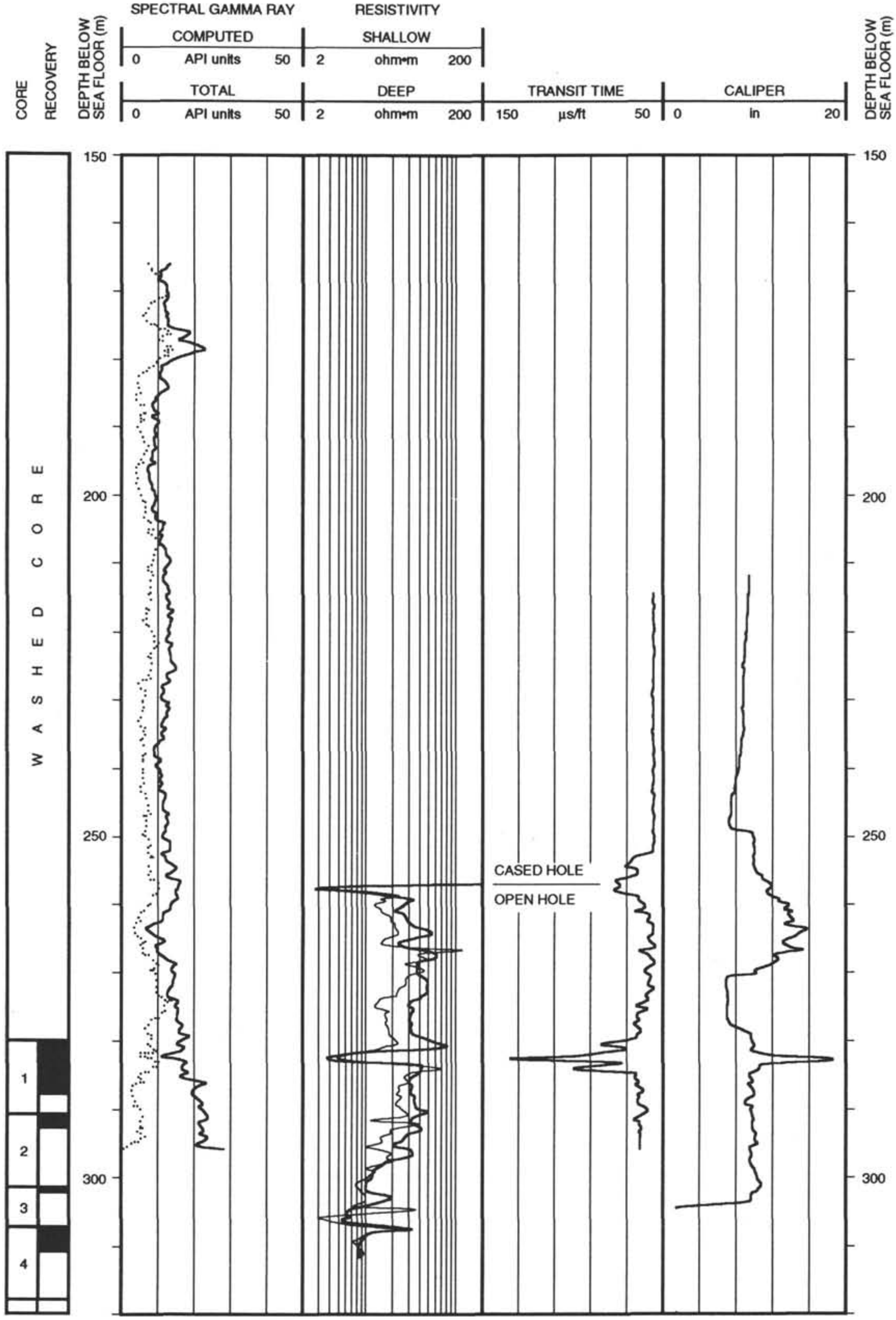
Hole 843A: Resistivity-Sonic-Natural Gamma Ray Log Summary (continued)



Hole 843B: Density-Natural Gamma Ray Log Summary



Hole 843B: Resistivity-Sonic-Natural Gamma Ray Log Summary



Hole 843B: Geochemical Log Summary