OCEAN DRILLING PROGRAM

LEG 136 PRELIMINARY REPORT

OCEAN SEISMOGRAPHIC NETWORK PILOT HOLE -- HAWAIIAN ARCH

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May 1991

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Preliminary Report No. 136

First Printing 1991

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Canada/Australia Consortium for the Ocean Drilling Program
Deutsche Forschungsgemeinschaft (Federal Republic of Germany)
European Science Foundation Consortium for the Ocean Drilling Program
(Belgium, Denmark, Finland, Greece, Iceland, Italy, the Netherlands, Norway, Spain, Sweden, Switzerland, and Turkey)
Institut Français de Recherche pour l'Exploitation de la Mer (France)
National Science Foundation (United States)
Natural Environment Research Council (United Kingdom)
Ocean Research Institute of the University of Tokyo (Japan)

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SCIENTIFIC REPORT

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ABSTRACT

The primary objective of Ocean Drilling Program Leg 136 was to drill and case a reentry hole approximately 50-100 m into basement at a site approximately 225 km southwest of the Hawaiian Island of Oahu. The purpose of this hole is to provide a site for the future emplacement and testing of a broad-band ocean seismometer, which would be the first site of the Ocean Seismic Network (OSN). Coring of the hole provided valuable information on the geology of this region which had previously received little study. Also, testing of a prototype reentry cone borehole seal was performed in order to ready this instrument for deployment on Leg 139 (Sedimented Ridges) in July-September, 1991.

Two sites were drilled (842 and 843), both of which were planned to be the reentry hole for OSN-1. Three holes were drilled at Site 842, on the shoulder of a low northwest-southeast-trending abyssal ridge, but none reached the basement objective. Good recovery of the upper 15 m of Pliocene-Pleistocene ash-rich clays in Hole 842B provide a record of distinct ash layers that are probably related to volcanism from the islands of Maui and Oahu. Below this, red clays of Eocene-Miocene age contain some altered ash layers that point to an as yet unidentified volcanic source in this region of the Pacific. Below 35 mbsf, core recovery was extremely low, and consisted mainly of pieces of chert and silicified claystones. Small chalk fragments provide an age of Santonian at roughly 164 mbsf.

Site 843 drilled three holes near the top of the abyssal ridge, approximately 1 km northwest of Site 842. Hole 843A recovered late Albian to Cenomanian limestones immediately overlying basement basalts. Hole 843B, a cased-reentry hole, successfully drilled to 313.4 mbsf, with approximately 70 m of penetration into basement and 12.4 m of recovered basement basalts. This hole is now ready for emplacement of a broad-band ocean seismometer. The ODP Reentry Cone Seal was successfully emplaced in Hole 843B, detached from the drillstring, and retrieved.

BACKGROUND AND OBJECTIVES

The need for global distribution of seismograph stations in studies of earthquakes and Earth's structure was recognized as early as the beginning of this century. Major initiatives in deployment of broad-band digital networks are currently under way. These initiatives include, among others, the United States' Global Seismographic Network project sponsored by IRIS, GEOSCOPE in France, and MedNet in Italy. The Federation of Digital Seismographic Networks (FDSN) promotes common instrumentation standards and facilitates data exchange. All member countries of the Ocean Drilling Program are also members of FDSN.

With all this effort, however, distribution of land-based stations would be inadequate to study the Earth with uniform resolution. The potential contribution of ODP in establishing a network of permanent geophysical observatories on the deep-ocean floor was recognized in the COSOD II report (1987). The primary objective of ODP Leg 136 was to drill a hole for future experiments needed to develop the Ocean Seismographic Network (OSN). The long-term (5- to 10-year) goal is to establish a global network of 15 to 20 permanent seismic observatories in the deep ocean. Such a network would revolutionize studies of global Earth structure, upper mantle dynamics and lithosphere evolution, earthquake-source mechanisms, oceanic crustal structure, tsunami warning and monitoring, and deep-ocean-noise sources and propagation mechanisms. Proposed site OSN-1 (Hole 843B; Fig. 1), provides a location for pilot experiments including noise measurements, data recording from teleseismic events for comparison with existing nearby island stations, and testing new broad-band sensors and other long-term deployment instrumentation.

The second objective for drilling at Sites 842 and 843 (both proposed site OSN-1), was to characterize a poorly known part of the Pacific basin. The Hawaii area is important because it is the type locality for oceanic, intraplate hot spots, and it is centrally located well away from other tectonic and sedimentary influences. Previous drilling in this region (Deep Sea Drilling Project Site 67, ~150 km north-northwest of Oahu; Winterer et al., 1971) recovered only 3 cores over 60 m of section before drilling stopped due to the presence of porcellanites. Coring the sedimentary and basaltic sequences at the proposed OSN-1 site provided useful geologic information. The sediments and basalts at the site are analogs of the material through which the Hawaiian lavas first erupted. Analyses of the chemical and physical properties of this material provided a description of the contamination of Hawaiian magmas and has shed light on the role that these sediments play in the mechanical behavior of Hawaiian volcanoes. The frequency of explosive volcanism of Hawaiian volcanoes has been analyzed by evaluating the cored volcanic ash blown downwind from the islands of Hawaii and Maui. Age constraints on these deposits have been determined by paleomagnetic studies.

The third objective for Leg 136 was to test the prototype reentry-cone plug designed to seal boreholes for long-term temperature monitoring and fluid sampling. The reentry-cone seal (or "cork") consists of a mechanism that seals the throat of an ODP reentry cone and the 11-3/4-in. casing suspended below the reentry cone. The seal latches into the 11-3/4-in. casing hanger and thus prevents fluid flow into or out of the borehole. Housed in the seal is a removable data logger supporting a thermistor string with integral pressure transducers, suspended in the borehole. A hydraulic feed-through is incorporated into the thermistor string to allow for borehole-fluid sampling. The seal has been designed to allow the borehole-fluid samples to be retrieved and the data logger to be downloaded and/or removed, without the drill ship, utilizing a remote observation vehicle (ROV) or a manned submarine. The first deployment of the seal for scientific reasons will occur during Leg 139, Sedimented Ridges; July-September 1991.

SITE 842

The principal objective of operations at Site 842 (proposed site OSN-1), was the installation of a reentry cone on the seafloor and a hole cased to basement for use as a test site for the Ocean Seismic Network. Site 842 lies on the shoulder of a low northwest-southeast-trending abyssal ridge (Fig's. 2 and 3). Pre-drilling site-survey data indicated a total relief of approximately 75 m (4475-4400 m uncorrected depth).

Three holes were drilled at Site 842; the deepest, Hole 842C, attained a total depth (TD) of 242.5 mbsf. APC coring extended to 35.7 mbsf (Fig. 4), and drilling with intermittent XCB and wash cores extended from 35.7 to TD. The principal lithologies recovered were:

Lithologic Unit I (0-19.9 mbsf): Quaternary to Pliocene(?) silty clay, clayey silt, and clay. All the sediments of this unit contain variable amounts of volcanic ash and radiolarians. Ash layers are fresh at the top of the interval and are altered almost totally to clay and zeolite at the bottom.

Lithologic Unit II (19.9-35.7 mbsf): middle Miocene to upper Eocene clay and claystone with altered ash. Nodules of silica-cemented claystone are also present.

Lithologic Unit III (nominally 35.7-242.5 mbsf): This unit is a "catch-all" for the cherts and small samples of Santonian nannofossil ooze (approximately 164 mbsf) returned in several wash core barrels and during attempts to cut regular core. The cherts are varicolored and contain both opal-CT and, deeper in the section, quartz.

The volcanic ash in Core 136-842A-1H is dispersed throughout the section and is also present as discrete layers. The ash layers are not seen at equivalent levels in the cores collected from Hole 842B -- one of several puzzles in correlating the shallow sediments sampled at these adjacent holes. Well-developed ash zones in Core 136-842A-1H contain fresh glass as well as minerals that may have been deposited as a result of explosive Hawaiian eruptions. Distinct ash layers in lithologic Unit I were deposited between 1 and 3 Ma and are probably the result of explosive volcanism related to volcanic centers on the islands of Maui and Oahu. Ash zones are also seen within lithologic Unit II, but they are considerably altered. These older layers may record as yet unknown widespread central Pacific volcanic events.

Paleomagnetic data from Cores 136-842A-1H, 136-842B-1H, and 136-842B-2H were generally in good agreement. The Brunhes/Matuyama boundary was seen at approximately 1.8 mbsf, and the Jaramillo event at 4.5 mbsf. There appears to be 1 m or more of disturbed section at the top of Core 136-842B-2H. The base of Core 136-842B-2H is estimated to be 3.5 Ma on the basis of magnetic reversal stratigraphy. Cores 136-842B-3H and -4H suffer from coring-induced overprinting, which obscured the reversal record.

Physical-property-measurements of samples from the APC cores yield normal compaction and shear-strength trends with depth. Local maxima in compressional-wave velocity and bulk density are correlated with the presence of ash layers or increased concentrations of dispersed ash. Correlation between Holes 842A and 842B is relatively good. Of interest is the apparent expansion of the section at Hole 842B relative to Hole 842A, best seen in the velocity record. Compressional-wave-velocity profiles correlate well near the surface but become gradually offset up to about 0.5 m at 4 mbsf. Below this level, the offset remains constant.

Core 136-842A-1H contains a 20-cm-thick bed of clayey nannofossil ooze (8.75 to 8.95 mbsf) with radiolarians, silicoflagellates, diatoms, and sponge spicules intact. A preliminary age of 1.4 to 1.6 Ma agrees well with paleomagnetic stratigraphy. Section 136-842A-1H-6 contains as yet undated planktonic foraminifers. Cores 136-842B-3H and -4H contain middle Miocene and late Eocene-middle Miocene ichthyoliths, respectively, and Core 136-842B-10X (163.3 to 167.8 mbsf) yielded Santonian calcareous nannofossils.

The principal non-result of operations at Site 842 was the inability to drill and set a re-entry cone for later use as a test site of the Ocean Seismic Network. However, the recovery of 46 m of well-documented and dated sediments from a much undersampled area of the Pacific seafloor has yielded substantial scientific benefit as well as several questions:

1. Both magnetic and biostratigraphic data suggest that sedimentation rates are substantially higher than open-ocean North Pacific norms (a rough average of 3 m/m.y. for the past 4 m.y.). The surprise is in the lack of a marked increase in volcanic-ash sedimentation during the past 1 m.y. of sediment accumulation. The emergence of the Hawaiian Island chain, in particular Maui and Hawaii, should be reflected in an increase of airborne ash being deposited at Site 842.

2. Holes 842A and 842B were cored within 10 m of each other, and yet there is a remarkable lack of detailed correlation between the two cored intervals. In particular, ash layers in Core 136-842A-1H are not seen in Cores 136-842B-1H and -2H, and apparent offsets of physical-property trends are different than those of the paleomagnetic record.

3. The volume and shallow occurrence of cherts encountered was unexpected. Extremely poor recovery leaves the nature and, for the most part, the age of these cherts unknown.

SITE 843

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 (also proposed site OSN-1), is located on top of the northwest-southeast-trending abyssal hill identified during the site survey prior to spudding at Site 842. We had 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. Core 136-843A-3R was cut between 228.0 and 237.7 mbsf (Fig. 5). 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 at Hole 843B. Casing was set through the sediment column and cemented approximately 10 m into basement. After drilling out the cement inside the casing, 6.87 m of altered basalt was recovered from a sub-basement interval of 17.0-26.5 m, in Core 136-843B-1R. Drilling ahead deepened the hole an additional 19 m. A prototype Amoco PDC bit was installed and took Cores 136-843B-2R to -4R to a total basement depth of approximately 70 m. A mud-line core was retrieved after offsetting 10 m north (Hole 843C) once drilling and logging at Hole 843B had finished. Recovery 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 Seismic Network, there were several geological points of interest. Sediments recovered from Core 843C-1H appear to be missing much of the Holocene record, or at least they recorded very slow sedimentation during 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 lie over a fossil hydrothermal upwelling zone.

Hole 843B was reentered with the ODP borehole seal on 18 March, and the pipe was successfully unlatched 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.

REFERENCES

Second Conference on Scientific Ocean Drilling (COSOD II); European Science Foundation and JOIDES; Strasbourg, France, 6-8 July, 1987.

Winterer, E.L., et al., 1971. Initial Reports. DSDP, 7 (part 1): Washington (United States Government Printing Office), 841 pp.

TABLE CAPTIONS

Table 1. Coring Statistics, Leg 136

FIGURE CAPTIONS

Figure 1. Map of the Hawaiian region, showing location of Sites 842 and 843. Bathymetry in kilometers.

Figure 2. Leg 136 site survey track, showing location of Sites 842 and 843.

Figure 3. Detailed bathymetry in the immediate vicinity of Sites 842 and 843.

Figure 4. Summary diagram of Hole 842B, showing litho-, bio-, and magnostratigraphy, and physical properties of the top 40 m of core.

Figure 5. Schematic diagram of Holes 843A and 843B, showing lithology and recovery of basement rock. Depths of holes above basement are not to scale.

Ocean Drilling Program
Coring Statistics
Leg 136

Hole	Latitude	Longitude	Sea Floor Depth (mbrf)	Sea Floor Depth (mbsl)	Number of Cores	Interval Cored (m)	Recovered Core (m)	Percent Recovered	Interval Drilled (m)	Total Penetration (m)	Time (days)
842A	19°20.18'N	159°5.33'W	4441.0	4430.2	1	9.5	9.66	102.0	0.0	9.66	0.63
842B	19°20.18'N	159°5.33'W	4441.2	4430.4	10	72.3	35.65	49.3	148.9	221.2	1.49
842C	19°20.18'N	159°5.39'W	4441.2	4430.4	0	0.0	0.00	0.0	237.7	237.7	1.19
		Including Wash Core:			1	96.4	0.88	0.9	141.3		
843A	19°20.53'N	159°5.68'W	4422.5	4411.6	1	9.7	1.39	14.3	228.0	237.7	1.58
		Including Wash Core:			3	237.7	4.00	1.7	0.0		
843B	19°20.54'N	159°5.68'W	4418.0	4407.1	4	33.7	12.60	37.4	279.7	313.4	11.38
843C	19°20.70'N	159°5.72'W	4415.3	4404.4	1	4.2	4.22	100.0	0.0	4.22	0.07
	Site and Leg Totals:				17	129.4	63.52	49.1	894.3	1023.9	16.34
		Including Wash Core:			20	453.8	67.01	14.8	569.9	1023.9	

Table 1

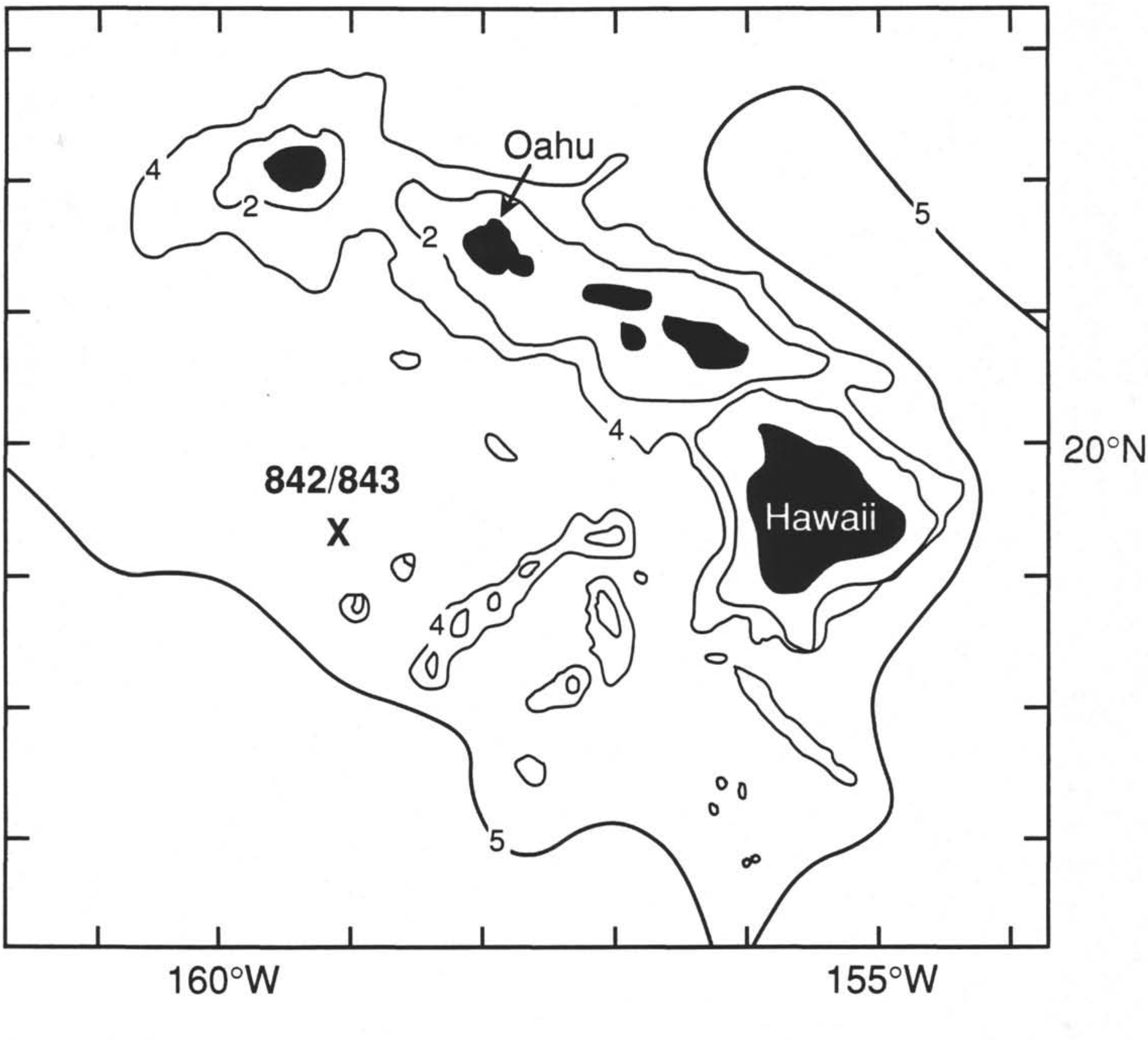


Figure 1

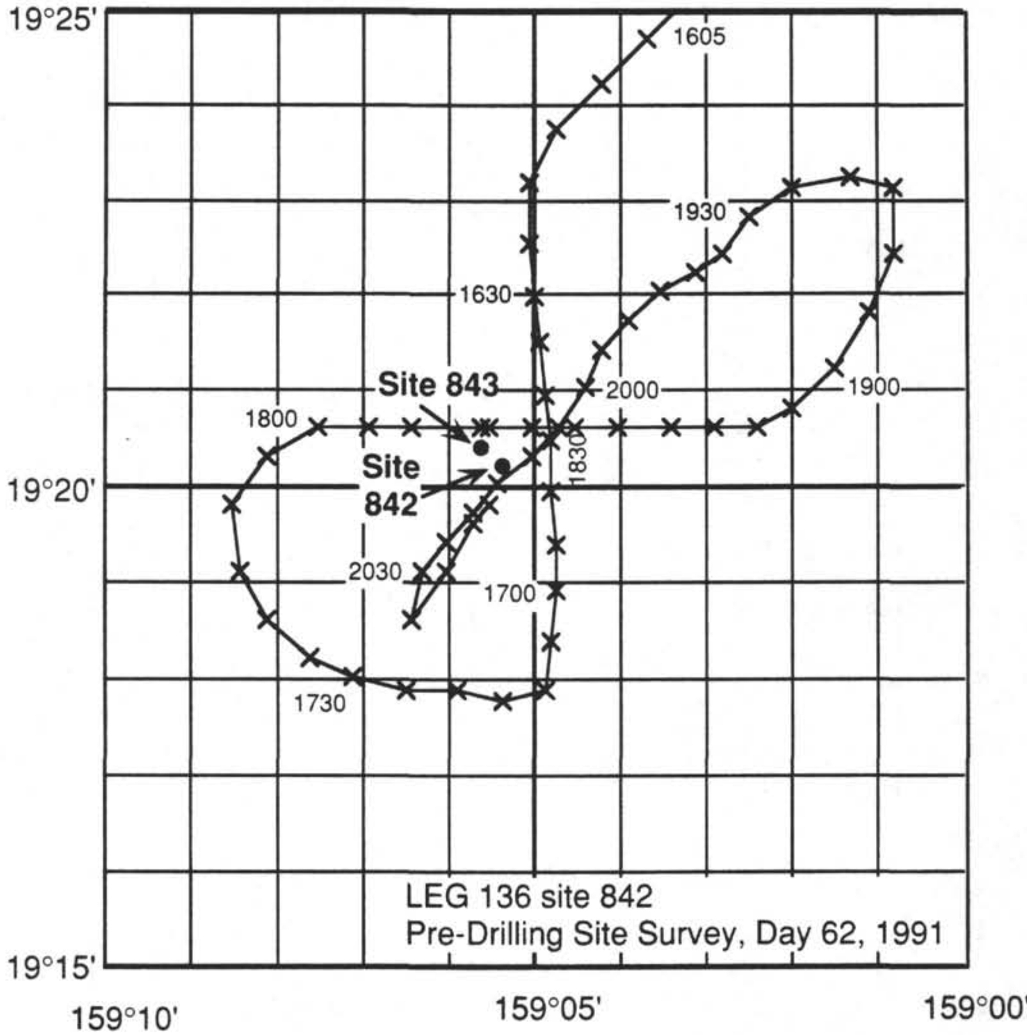

19°25'
19°20'
19°15'
159°10'
159°05'
159°00'
1605
1930
1630
Site 843
2000
1900
1800
1830
Site
842
2030
1700
1730
LEG 136 site 842
Pre-Drilling Site Survey, Day 62, 1991

Figure 2

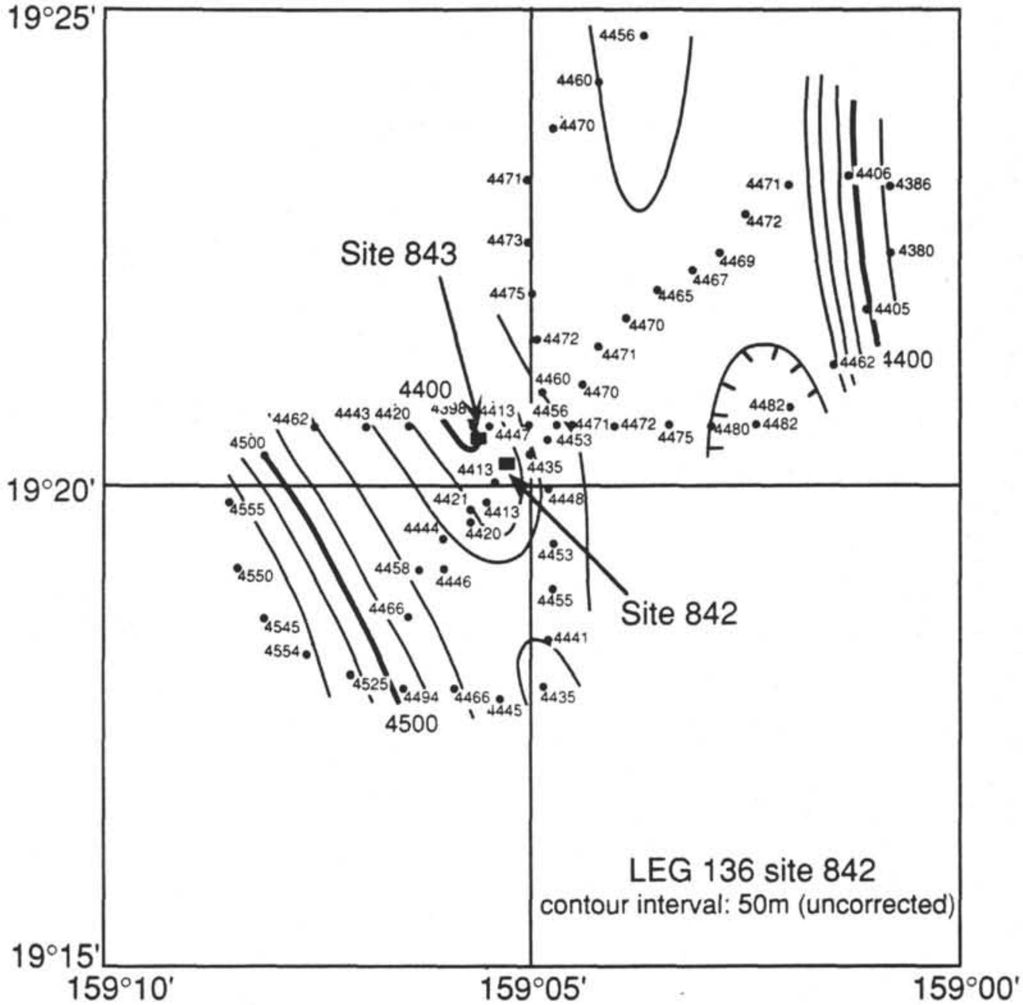

19°25'
19°20'
19°15'
159°10'
159°05'
159°00'
Site 843
Site 842
4400
4500
LEG 136 site 842
contour interval: 50m (uncorrected)

Figure 3

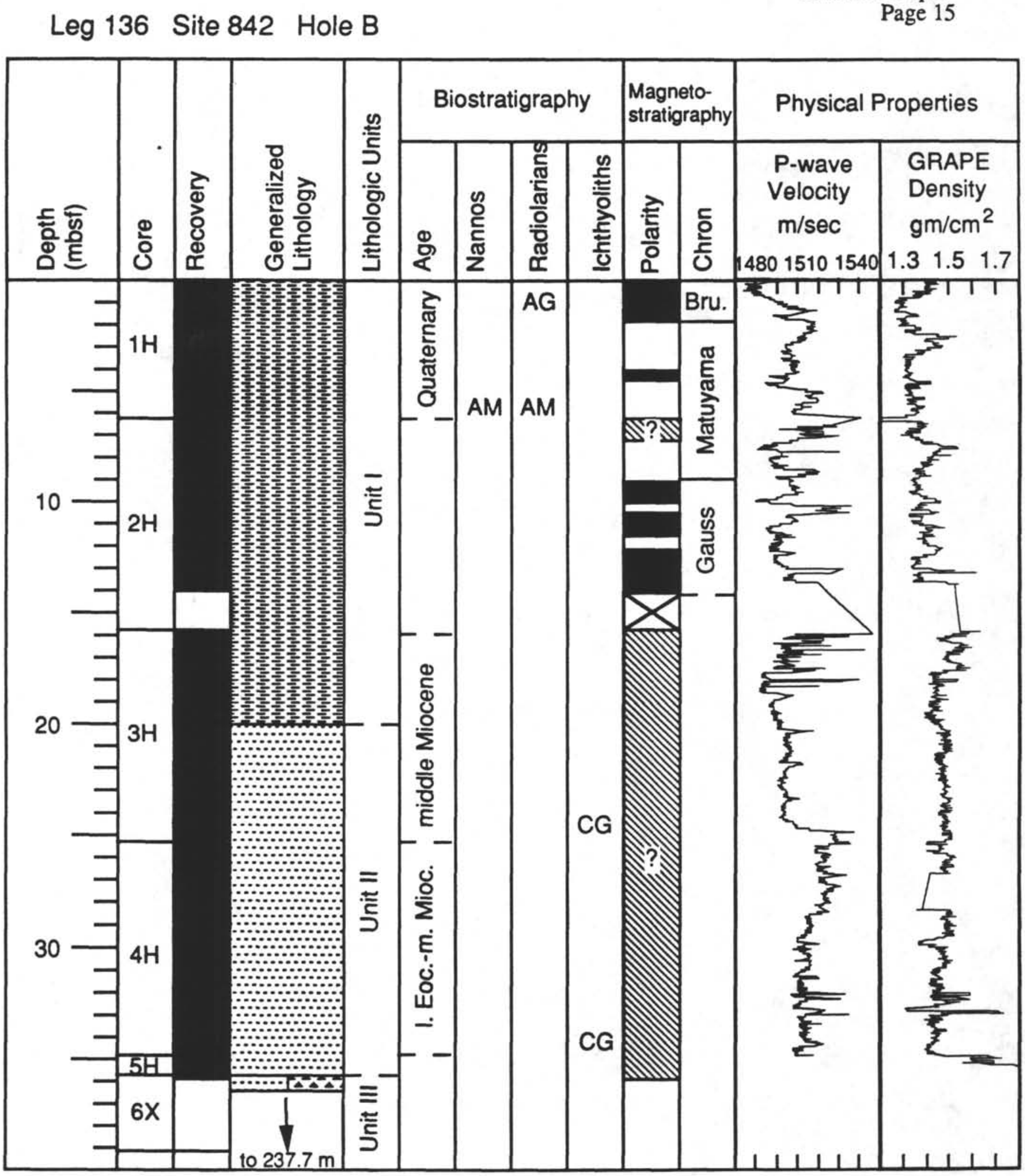

Leg 136 Site 842 Hole B
Depth (mbsf)
Core
Recovery
Generalized Lithology
Lithologic Units
Biostratigraphy
Age
Nannos
Radiolarians
Ichthyoliths
Magneto-stratigraphy
Polarity
Chron
Physical Properties
P-wave Velocity m/sec
1480 1510 1540
GRAPE Density gm/cm2
1.3 1.5 1.7
10
20
30
1H
2H
3H
4H
5H
6X
to 237.7 m
Unit I
Unit II
Unit III
Quaternary
middle Miocene
l. Eoc.-m. Mioc.
AM
AG
AM
CG
CG
?
?
Bru.
Matuyama
Gauss

Figure 4

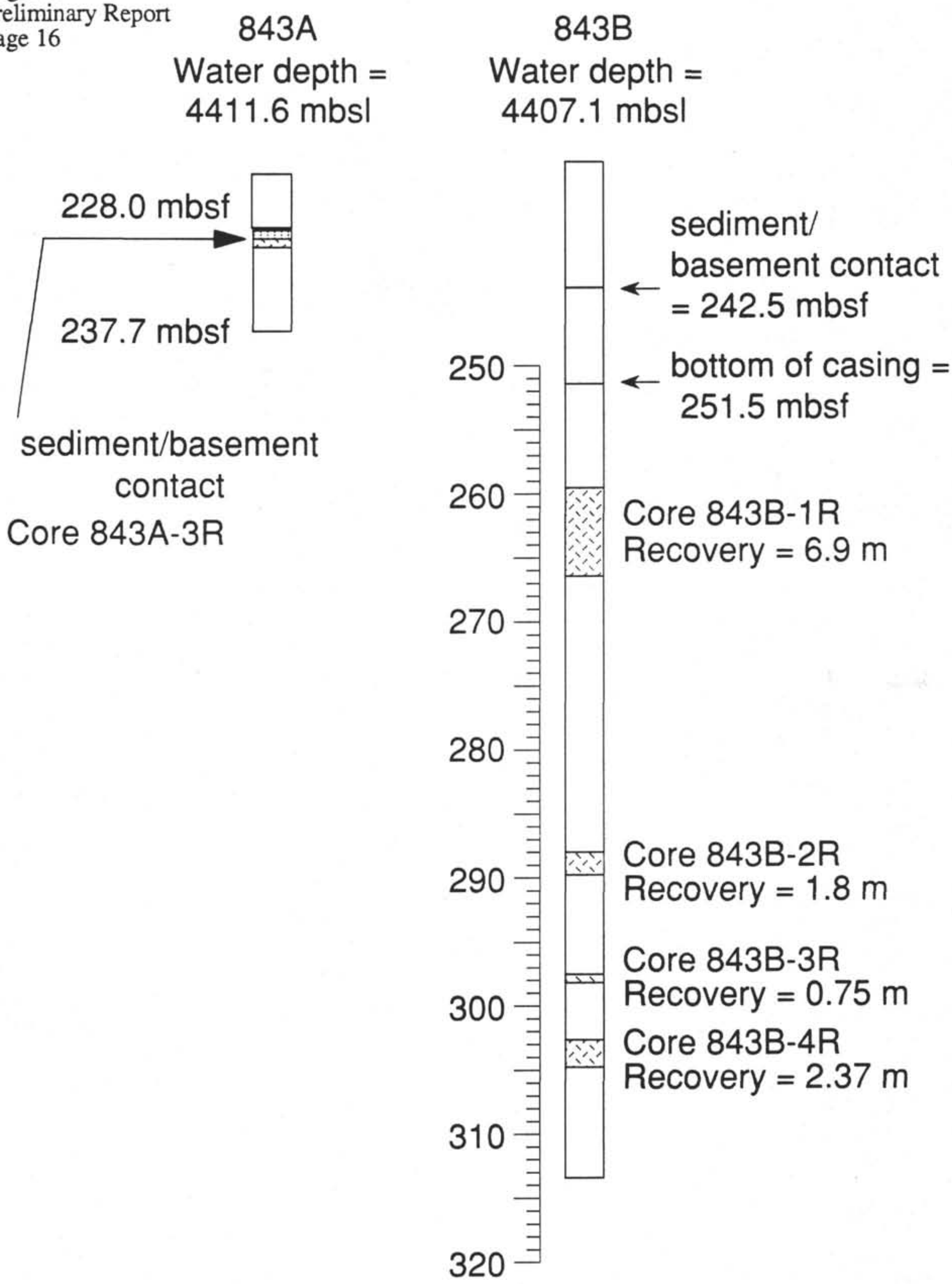

843A
Water depth =
4411.6 mbsl
228.0 mbsf
237.7 mbsf
sediment/basement
contact
Core 843A-3R
843B
Water depth =
4407.1 mbsl
sediment/
basement contact
= 242.5 mbsf
bottom of casing =
251.5 mbsf
250
260
270
280
290
300
310
320
Core 843B-1R
Recovery = 6.9 m
Core 843B-2R
Recovery = 1.8 m
Core 843B-3R
Recovery = 0.75 m
Core 843B-4R
Recovery = 2.37 m

Figure 5

OPERATIONS REPORT

The Operations and Engineering personnel aboard JOIDES Resolution for Leg 136 were:

ODP Operations Superintendent:	Barry Harding
ODP Development Engineer:	Tom Pettigrew
Schlumberger Engineer:	Scott Shannon
Observers:	Merrilee Gordon (Amoco)
	Roland Lawrence (DOSECC)
	Luc Floury (IFREMER)

HONOLULU PORT CALL

Leg 136 officially began at 0700 hr local time (LT; 1700 hr UTC) on 28 February, when the first line was passed to the dock in Honolulu harbor at Pier 1. The entrance into Honolulu marked the first time that JOIDES Resolution had been in a U.S. port since Norfolk, Virginia, in 1985. After customs and immigration officials finished with their formalities, the port-call activities got into high gear, since the port call was scheduled to be only 3 days, and there was a full agenda

SITE 842 (PROPOSED SITE OSN-1)

Hole 842A

A jet-in test was first performed to establish the 16-in. casing point, with a total penetration of 24 m. The drill string was pulled from the seafloor, and the first APC was shot from 4441.0 mbrf. Core 136-842A-1H recovered 9.66 m of red-brown silty clay with ash layers (Table 1). Since it was unclear that we had recovered the mud line, the drill string was pulled back 3 m, and the ship was offset 10 m to the east to begin Hole 842B.

Hole 842B

Core 136-842B-1H was shot at 0125 hr, 4 March, and recovered 6.3 m of sediments identical to those from 136-842A-1H. Therefore, the mud line was confidently determined to be at 4441.2 mbrf. Four additional APC cores were taken, with Cores 136-842B-1H through -5H coring 35.7 m and recovering 34.99 m. Core 136-842B-5H did not fully stroke, penetrating only 0.9 m and recovering 0.92 m of chert cobbles and cherty silicified mudstone, and requiring 20,000 lb of overpull. XCB coring commenced with Core 136-842B-6X, which penetrated 3.5 m and produced only 0.13 m of cherty rubble. Cores 136-842B-7X and -8X were drilled to full lengths of 9.5 and 9.4 m, respectively, and recovered a total of only 0.16 m of more chert rubble. The poor recovery prompted the decision to drill ahead with a center bit from the base of Core 136-842B-8X (58.1 meters below sea floor) for four drill pipe connections to a depth of 106.0 mbsf. The drilling of that interval averaged about 10 m/hr and used a 15-barrel (bbl) sweep of viscous drilling mud to help clean the hole. The recovered center bit showed extreme wear, and the wash barrel contained more chert rubble and fragments. Core 136-842B-9X, taken from 106.0 to 115.7 mbsf, had no recovery. The center bit was once again dropped, and drilling proceeded from 115.7 to 163.3 mbsf, with 60 bbl of drilling mud pumped to help clean the hole of the cherty fragments. The drilling of that interval averaged just over 38 m/hr. Core 136-842B-10X (163.3-167.8 mbsf) produced only 0.37 m of chert rubble. Drilling with a center bit resumed from 167.8 to 192.2 mbsf, and, when pulled, the center bit showed an extreme amount of wear. After replacing the center bit, drilling continued to a depth of 221.2 mbsf. When the center bit was pulled from that depth, it was found that the core barrel, about 20 cm above the center bit, had sheared off because of fatigue and high torque. An XCB core barrel was dropped to determine whether the piece of core barrel and center bit was in the bottom of the hole or if it had been pushed out of the way into the wall of the hole. After the XCB barrel landed, high torquing showed that the debris was still in the hole. Hole 842B had to be abandoned, and the drill pipe was tripped to the surface. Since the object of the exploratory hole at the first site was also to locate the depth of basement in order to set the 11-3/4-in. casing, it was decided to switch to a 9-7/8-in. rotary bit and an RCB coring assembly.

Hole 842C

During the trip to the seafloor with the drill pipe, the ship was offset 10 m to the east of Hole 842B. The plan before spudding Hole 842C was to drill the hole as quickly as possible and pull the core barrel every 50 m, or as necessary if abnormalities warranted. Hole 842C was spudded at 0530 hr, 6 March, and was drilled to 36 mbsf before the torque became high and the core barrel was pulled. After a new core barrel was in place, drilling proceeded from 36.2 to 141.3 mbsf. Beginning at 60 mbsf, hole torquing was experienced, and drilling-mud sweeps were begun. At the same time, the weather began to cause 2° to 3° rolls. The DP operator was requested to change the heading of the ship, after which the ship's motion subsided considerably, which also helped to reduce the hole torque. The core barrel was pulled after drilling to 141.3 mbsf, and a new core barrel was dropped. Drilling resumed from 141.3 to 237.7 mbsf. The wash core barrel from that interval recovered 0.88 m. With the drill pipe off bottom, after retrieving the wash barrel, a new barrel was dropped to cut the first rotary core. Upon attempting to pump the barrel down the drill pipe, the driller found that the flapper valve in the bit could not be opened and that the drill-pipe pressure was already reading 2800-3000 psi. To compound the problem, when the core barrel landed in the BHA it became stuck. The driller picked the string higher off bottom and the hole began to collapse because of the inability to circulate. After considering all of the above, it was decided to abandon Hole 842C, trip the drill pipe to the surface, and offset the ship approximately 1 km northwest to the top of a small elevated seafloor ridge to drill Site 843.

SITE 843 (ALSO PROPOSED SITE OSN-1)

Hole 843A

Since 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 Hole 843A.

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 un-jayed 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 3 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 x 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 rotating hours 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 hours 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, and 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.

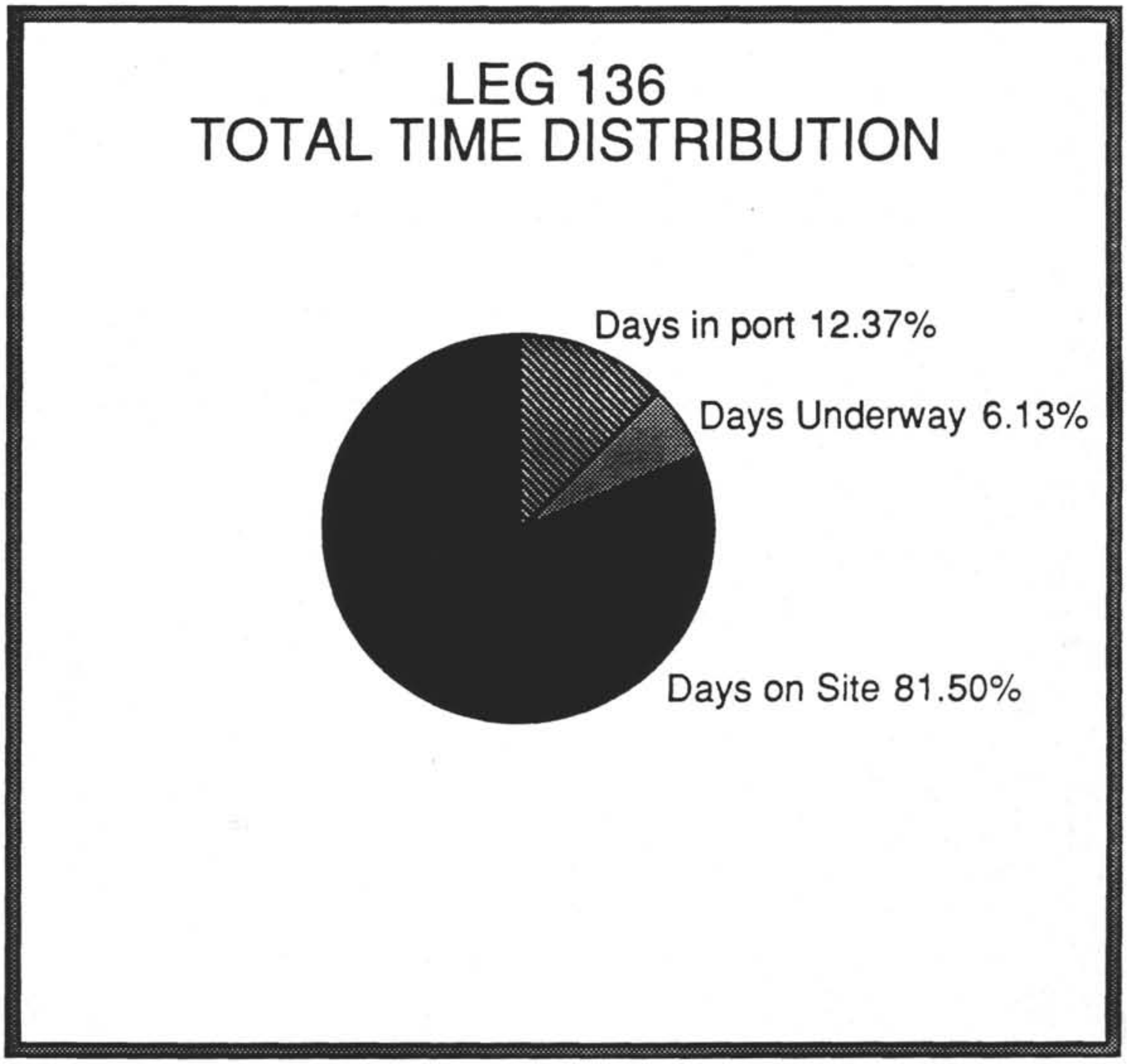
The ship was under way for Honolulu at 1830 hr, 19 March, and made the 137-nmi journey at an average speed of 9.96 kt. The pilot boarded JOIDES Resolution at 0730 hr, 20 March, and guided the vessel to Honolulu Harbor Pier 1. The line was thrown to the pier in Honolulu Harbor, at 0815 hr, 20 March, officially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

OCEAN DRILLING PROGRAM
OPERATIONS RESUME
LEG 136

Total Days (28 February - 20 March 1991)..20.05
Total Days in Port..2.48
Total Days Under Way...1.23
Total Days on Site...16.34

Trip Time..6.00
Coring Time...2.08
Drilling Time..2.79
Logging / Downhole Science Time...1.95
Reentry Time..0.70
Mechanical Repair Time (Contractor)...0.13
Casing and Cementing Time...2.15
Stuck Pipe / Hole Trouble... ----
Development Engineer Work...0.24
Other..0.30

Total Distance Traveled (nautical miles)...257
Average Speed (knots)..10.1
Number of Sites...2
Number of Holes...6
Number of Reentries...5
Total Interval Cored (m)..129.4
Total Core Recovery (m)..63.5
Percent Core Recovered...49.0
Total Interval Drilled (m)...634.8
Total Penetration (m)...764.2
Maximum Penetration (m)...313.4
Maximum Water Depth (m from drilling datum)..................................4441.2
Minimum Water Depth (m from drilling datum)...................................4415.3


LEG 136
TOTAL TIME DISTRIBUTION
Days in port 12.37%
Days Underway 6.13%
Days on Site 81.50%

TECHNICAL REPORT

The ODP Technical and Logistics personnel aboard JOIDES Resolution for Leg 136 of the Ocean Drilling Program were:

Laboratory Officer:	Burney Hamlin
Assistant Laboratory Officer:	Matt Mefferd
Yeoperson:	Michiko Hitchcox
Curatorial Representative:	Robert Kemp
Computer Systems Manager:	Edwin Garrett
Electronics Technician:	Bill Stevens
Electronics Technician:	Mark Watson
Electronics Technician:	Barry Weber
Photographer:	John Beck
Photographer:	Shan Pehlman
Chemistry Technician:	Valerie Clark
Chemistry Technician:	Mary Ann Cusimano
Chemistry Technician:	Chieh Peng
X-ray Technician:	Joan Perry
Marine Technician:	Wendy Autio
Marine Technician:	Mimi Bowman
Marine Technician:	Jenny Granger
Marine Technician:	"Gus" Gustafson
Marine Technician:	Alan King

PORT CALL

The JOIDES Resolution arrived Pier 1 in Honolulu Harbor at 0700 (LT) on 28 February. Shipments and freight movements were scheduled in the afternoon, and the activities progressed smoothly. Several hundred visitors were escorted around the ship and laboratories on 1 and 2 March by scientists from the University of Hawaii.

Several service calls for our lab equipment were arranged from the first day. Mr. Goree of 2G Enterprises arranged a liquid-helium delivery and attended the helium transfer as the cryogenic magnetometer was close to "dry." A new transfer line with a 90° bend was built and used with favorable results. An initial attempt to fill the unit was again stymied by ice (frozen atmospheric gases). Helium gas was allowed to flow through the machine to warm it and to dissipate or move the ice. A sudden increased helium-gas flow signaled success though the system, and it purged a while longer. Some liquid helium was later transferred to cool the unit before the bulk was added on the following day.

A DEC representative repaired the Borehole Research Group's video system on their VAX unit by changing a video board and the monitor. A representative from Hewlett-Packard diagnosed a faulty disk drive in the HP1000 and replaced it. The bad unit was returned to ODP.

Steven K. Cook from NOAA, in La Jolla, California, brought the SEAS equipment aboard. This is a computer/satellite link that can transmit weather and expendable bathythermographs (XBTs) data from each orbit. Initial protests to launching XBTs from the bridge wings resulted in setting up a second computer in the underway lab with a hand launcher outside. The primary system for sending the data is controlled by a Zenith laptop computer installed on the starboard side of the bridge. The mates were to go aft daily on site to drop and record an XBT; a floppy disk with the data was to be taken to the bridge two or three times per week for transmission with the daily weather data. The XBT activity is not yet routine. The optimum rate for XBTs is daily on site and four times a day under way.

Late in the port call the systems manager became aware of a system alarm on the regulated power system. The Cyborex UPS system had tripped, and regulated power was being supplied by the motor generator set. The Cyborex was engaged and the batteries charged, but the system again tripped out. The motor generator set was eventually manually engaged for the remainder of the leg. Inquiries were made to shore on the work and tests conducted on the transit to Honolulu.

ABS inspected the lab stack and was primarily interested in our chemical-storage areas and how the chemicals were separated. The inspection was satisfactory and uneventful.

Other activities included unloading the Leg 135 cores into a refrigerated container on the second day, and the purchase of requested items from local businesses and through GSA.

UNDERWAY OPERATIONS

Navigation tapes were started, and the JOIDES Resolution left the dock at 1830 hr, 2 March, for Site 842 (proposed site OSN-1). After the 12-hr run southeast of Oahu, a 4-hr seismic survey was conducted. Discrepancies were noted between our survey and the CONRAD lines used to define the site. After the beacon was dropped, a depth survey was made around the beacon to determine the seafloor slope and to ensure that the site was located on the shoulder of a slight ridge.

Leg 136 ended 17 days later with another 12-hr transit to Honolulu. Intentions were to deploy the seismic gear upon leaving Site 843 to gather data over the beacon, although this did not happen. The drilling site selected for the reentry cone and future seismic sensors (Site 843) was off the line of the initial site survey. Navigation tapes recorded the trip; bathymetric and magnetic data were collected for the first 4 hr only so backup tapes could be made.

SITE OPERATIONS

The primary objective of drilling into basement at this location was to allow the future installation of seafloor and downhole seismometers. Data comparisons will be made between these and shore based seismometers on the island of Oahu. Also, various data-storage systems and power packs will be tested. This is the prelude for a global seismic network of these subsea seismometers.

The first site (Site 842) proved difficult to drill, having encountered many chert stringers and generally poor hole conditions. A reentry cone was set at the second site (Site 843), on the top of the ridge, and the hole was cased to basement. Both sites were logged. Formation microscanner (FMS) data processing was deferred to the transit on the following leg. The first deployment of a reentry-cone seal was made. The camera system was unable to pass over the plug, which had pipe protruding from it, resulting in a more distant, dim view of the cone. This made the reentry less distinct than usual. The plug was successfully inserted and, after making a pipe round trip for the pulling tool, removed.

On 6 March, the first personnel exchange was conducted by helicopter, with two scientists leaving the ship and one coming aboard. An unscheduled helicopter flight was arranged on 8 March, for medical reasons, to allow an examination of a potential appendicitis patient. The helicopter did not arrive, and it was later reported that, after failing to locate the ship, it had crashed 15 mi offshore after running out of fuel on its return to Honolulu. The pilot and the agent's representative were rescued by a U.S. Coast Guard helicopter. The doomed craft had overturned, when one flotation device failed to deploy, and was lost along with an experimental Amoco Production Company drilling bit that it was carrying. The patient was picked up by a rescue U.S. Coast Guard helicopter the following day and was taken to a Honolulu hospital. A series of helicopter flights were conducted on 12 March to allow 3 persons to join the ship, and 6 to leave.

The weather was characterized by mostly gray days, with winds over 25 kt and a very noticeable cross swell. The roll created by the cross swell precluded the possibility of carrying out a vertical seismic experiment with large air/water guns. There was too much motion to use the extended crane boom needed to hold the gun array away from the ship. Those remaining aboard for Leg 137 were destined to enjoy the first outside barbecue and fair weather.

OPERATIONS SUPPORT

The Eastman Whipstock camera was used to analyze the orientation of three APC holes drilled at the first site. The oriented cores allowed scientists in the paleomagnetism lab to determine ocean-floor movement in the region.

An Electronics technician attempted to calibrate a flow meter associated with the TOTCO system. After figuring out how to wire a new transmitter card, we found that the calibration box was dead. It was recommended that a new flow meter and calibration box be purchased.

CURATION

With little core recovery and a correspondingly low number of samples, all aspects of core flow were done at the scientists' leisure. Soft- and hard-rock cores were processed routinely. An upgraded version of the sampling program was tried and referred to the systems manager and the shore for improvement.

CORE LAB

Operations were routine after physical-property equipment was calibrated, computer glitches fixed, and new pieces of equipment learned. As a consequence of the short port call and a short run to the first site, it was not possible to calibrate and verify the physical-property measurement systems before introducing the equipment to the new scientists.

CHEMISTRY LAB

A small amount of routine work was done on the siliceous red-clay samples recovered on this leg. This left ample time to develop procedures, write cookbooks, and conduct equipment maintenance and upgrades. Procedures for the analysis of biogenic opal were worked out and documented. Atomic absorbtion (AA) burner heads were replaced with versions that operate at lower temperatures. AA determinations for strontium using nitrous oxide gas were successfully made. Nitrate determinations for some samples were made with the spectrophotometer, as this time-consuming procedure has been requested for Leg 139. A different electrometric determination for chlorine was conducted, which compared favorably with standard titrations. It was faster and a bit more accurate, but it requires more valuable bench space. The gas chromatographs were prepared for use and detected only trace amounts from head-space samples. The new technician continued training and familiarization with the chemistry procedures and equipment.

X-RAY LAB

Scientists were interested in the mineral makeup of the recovered red clays, so 50 XRD scans were made. Problems with the auto sample changer required around-the-clock checks by two technicians to finish the scans before one of the interested scientists returned to Hawaii on one of the helicopter flights. Major-element measurements were achieved on 10 prepared samples with the XRF instrument. Trace-element analysis was not done, as the calibration was time-consuming and constrained by the present problem with the chill-water system. A request was made to analyze several more samples from our last core to be run during Leg 137.

The inability to operate both X-ray units at full power concurrently seems to be associated with two observations. The ship's chill-water-system temperature varies a few degrees, reflecting a cycling refrigerant compressor. The 42° to 45°C, measured at these compressors, is a bit warmer by the time the water gets to the X-ray lab (48° to 50°C) but is acceptable as recorded in past maintenance reports. Higher temperatures will cause the XRF to shut down, but the XRD water safety circuit is dependent upon pressure. Cooling-water flow rates were measured and adjusted through both X-ray units and were found to be fine. This indicates that the Haskris heat exchanger could be the cause of this problem, and this investigation is planned for the following leg when everything can be turned off. Restricted hoses and lines, worn pumps, flow regulators/valves, etc., will all be inspected. A temperature monitor will be installed during the transit to Hole 504B.

THIN-SECTION LAB

The five hard-rock cores were described with the help of 25 thin sections. These rocks consist mostly of basalt but also contain ash and tuff. The chemicals for an expanded carbonate staining procedure (Hutchinson) was assembled as the result of comments from a recent shipboard scientist.

COMPUTER SERVICES

WordPerfect and graphing classes were scheduled.` An initial AT clone was converted to a 386 level, and Windows software was installed. Additional memory was also installed, as well as cards to support color monitors. The remainder of the ship's ATs will be upgraded next leg. Several MAC hard disks failed and are being returned for repair. Slow turnaround with some APPLE repair items has raised concern. The continuing disappearance of MAC user manuals remains a problem. A new VCD program was installed and tested, along with a Grain Size program and a new version of the sampling program SAMUTL.

STOREKEEPER

Preparations were made for anticipated high recovery on Leg 138 by stocking D-tubes, core liners, waxed cartons, and other bulk consumables. Some of the D-tubes were stored in the port and starboard cement pods (80 starboard and 70 port). Curatorial bulk supplies, sponges, sample plugs, and caps filled the hold reefer stores. One K-box was set up in the casing hold and filled with sample plugs; the sponges were also moved to the casing hold to alleviate the congestion. HRS cannot be the prime storage area for these bulk stores.

PHOTO LAB

A new photo technician was trained in the use and maintenance of the photo lab's automatic processors. The units were completely cleaned, serviced, and calibrated to ensure quality performance.

ELECTRONICS SHOP

The electronics technicians worked on the installation of the SEAS system, TOTCO parameter sensors, X-ray-lab cooling and auto-changer problems, and the underway-lab survey equipment. Assistance was also given in most labs. The old DSDP water sampler was laid out and inspected. Lithium battery packs were wired for possible high-temperature deployment on Leg 137.

SPECIAL PROJECTS

The addition of security locks planned for Leg 137, was carried out this leg by direction from shore. Push-button combination locks were installed in the Downhole Measurements Lab door, separating LDGO's area from ODP's, and the ET shop. A heavy-duty hasp for a combination lock replaced the light-duty chain arrangement on the Underway Lab. SEDCO areas, including DP, electronic, and electric shops, were also upgraded.

SAFETY

METS members participated in the two weekly fire and boat drills. All the fire coats were aired, and the new firegloves added. The flashlights were checked, and new batteries added as necessary.

Pad eyes were welded waist high on the bulkheads adjacent to the hatches on the new bridge and main-deck level. Safety harnesses and lanyards are available in the core lab for those working at the open hatches.

LAB STATISTICS: LEG 136

GENERAL STATISTICS:

Sites	2
Holes	6
Interval cored (m)	129.4
Core recovered (m)	63.4
Number of sediment cores	16
Number of hard-rock cores	4
Number of samples	611

SAMPLES ANALYZED:

Inorganic carbon ($CaCO_3$)	0
Total carbon -- CNS	0
Water chemistry	10
Thin sections	25
XRD	50
XRF	10
MST runs	71
Cryomag runs	45
Phys-props velocity	68
Index properties	52
Thermal conductivity	24
Vane shear	62
2-min. GRAPE	32

UNDERWAY GEOPHYSICS:

Total miles traveled (approx.)	257
Bathymetry, magnetic (approx.)	167
Seismic (approx.)	43

DOWNHOLE TOOLS:

Core-orientation runs	3