OCEAN DRILLING PROGRAM

LEG 102 PRELIMINARY REPORT

SITE 418A: DOWNHOLE MEASUREMENTS IN OLD OCEANIC CRUST

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SCIENTIFIC REPORT

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LEG 102 A

ODP/DSDP SITE 418

Date re-occupied: 21 March 1985 (2000 L)

Date departed: 8 April 1985 (1348 L)

Time on hole: 17 days, 17 hrs, 48 minutes

Position: 25 02.10'N, 68 03.44'W

Water depth (sea level; corrected m, echo-sounding): 5511

Water depth (rig floor; corrected m, echo-sounding): 5520.5

Bottom of open hole (rig floor; m, drill pipe): 6389

INTRODUCTION

During the 15 years of the Deep Sea Drilling Project, significant basement penetration (>500 m) was achieved at several sites in the ocean basins but comprehensive borehole geophysical measurements were successfully conducted at only two Sites, Holes 395A and 504B, both in young crust. These measurements have been of landmark importance. The results from 504B, for example, demonstrate that:

(1) Layers 2A, B and C correspond, respectively, to rubble, pillow basalts and sheeted dikes;

(2) Borehole measurements indicate that the permeability of the crust decreases by several orders of magnitude in the

upper 1 km of Layer 2 in response to a 10-fold decrease in porosity;

(3) The formation porosity in Layers 2A and B (the upper 600 m of the basement) averages 10%; below this, the porosity decreases to 1-2% (ie. grain boundary values) in the dikes, with the relatively narrow (about 100 m thick) dike/pillow basalt transition zone displaying intermediate values.

(4) Young crust is commonly underpressured by 1-10 bars. Temperature measurements conducted in Hole 504B at different times during drilling indicate that seawater was flowing down the hole at rates decreasing from 7000 to 150 liters per hour over a period of 3.5 years into permeable aquifers in the upper basement. Modelling studies suggest that underpressures measured in the crust are dynamically maintained by convection;

(5) Convection in the basement near Hole 504B is confined to the high permeability zone near the top of the extrusives; in the dikes, where fracture porosity approaches zero, temperature gradients imply conductive heat flow.

(6) The velocity structure of Layer 2 is controlled not by petrology but by variations in porosity with depth.

(7) The maximum horizontal compressive stress, sigma 1, is realigned sub-perpendicular to the ridge axis in relatively young crust.

Similarly, the measurements conducted in Hole 395A, while less extensive, confirm that the extrusives are underpressured and extremely porous and that the permeability is negligible below 500 m sub-basement.

Although it is tempting to extrapolate these results to the ocean crust as a whole, it must be remembered that they are based exclusively on young crustal sites. There is strong evidence that old crust is profoundly different (the absence of Layer 2A; the predominance of conductive heat flow), but no comparable set of borehole geophysical measurements has been made in old crust. (Hole 462A, though old, is not considered representative of old crust since the basement section drilled consists of Cretaceous sills).

Leg 102A was planned to re-enter one of the two deep basement holes (417D or 418A) drilled on Legs 51 -53 in 110 m.y. crust in the Western Atlantic (Figures 1 and 2). These sites, plus Sites 395 and 396 were drilled as part of a basement age transect during the early years of the International Program of Ocean Drilling (IPOD). The objective on Leg 102 was to acquire a comprehensive baseline suite of borehole geophysical data in old oceanic crust.

Leg 102B was to represent the Norfolk Azores Transit upon which no scientific objectives were to be met only training and testing of equipment including the new Cryogenic Magnetometer and a test of a drillpipe sonar tool was conducted on the Middle Atlantic Ridge.

OBJECTIVES

Specific scientific objectives addressed during Leg 102A included:

(1) Determination of in situ velocity structure at a site in old crust. Are Layers 2A, B and C present and do they correspond to the some lithologies as in Hole 504B?

(2) Determine the permeability of the old oceanic crust.

(3) Determine the porosity vs depth function of the site. These data, together with those from Hole 504B, would make it possible to determine whether or not the extrusive section become sealed by alteration products and to determine the porosity-permeability and porosity-velocity systematics for Layer 2.

(4) Determine the thickness of the magnetic layer in old crust.

(5) Determine whether or not convection and underpressures persist in old crust.

(6) Sample and determine the chemistry of water in equilibrium with old basement.

(7) Determine the direction and magnitude of in situ stress.

(8) Determine the temperature profile in old crust and from this, infer whether heat transfer in old oceanic basement is by convection or conduction.

(9) Determine the eruptive history of the Layer 2 extrusive pile from variations in magnetic susceptibility and NRM intensity, inclination and declination versus depth.

(10) Determine the magnitude, direction and origin of seismic

anisotropy in Layer 2.

(11) Determine whether or not subbasement seismic reflectors are present in the crust.

OPERATIONS

To these ends, the ship returned to Hole 418A, which was drilled through pillow basalts, massive basalts and into the top of the dike transition zone to a sub-basement depth of 544 m on DSDP Legs 52 and 53 (Figures 1, 3 and Table 1) but which was thought to have a logging tool lodged in the overlying sediments. After re-entering the hole we found that extensive bridges had developed in the uncased sediments during the interim, but that the tool was not lodged in the hole, so we eventually succeeded in re-opening it to total depth (6379.5 m below sea level, 868 m below sea floor, 544 m sub-basement) for further experiments and drilling. During Leg 102 we conducted 14 separate runs in the hole with 11 tools (Fig. 4, Table 2), including three which had never been run before in a marine environment (the USGS susceptibility tool, the German 3-axis magnetometer and the packer).

The hole was nearly to gauge (10") throughout (which is itself unusual), allowing virtually all of the tools to operate flawlessly. The only exceptions were the deep laterlog, which was improperly calibrated, the packer, which failed to seat, and the borehole televiewer, which caught on a ledge just outside the pipe. The only limitations experienced were those imposed by the presence of a bridge at 5988.5 m BSF, which required that the hole be logged in stages, and those imposed by time constraints, which prevented us from running several tools in the upper third of the basement and from logging the bottom 79 m after it was re-opened towards the end of the leg.

The specific experiments conducted at 418A included:

Conventional logging (LDGO/Schlumberger). Standard industry tools were run to determine the velocity, density, porosity, resistivity and natural gamma radioactivity structure of the section. The tools that were run included:

a) long-spaced sonic (first arrival, full wave form)
b) dual induction
c) spherically focussed resistivity
d) compensated gamma-gamma density
e) compensated neutron porosity
f) caliper
g) natural gamma-ray (spectral)
h) laterolog

Multichannel sonic logging (LDGO). A 12-channel sonic tool was run to determine the propagation characteristics of compressional, shear and Stonely waves in the section.

Oblique Seismic Experiment (WHOI). An oblique seismic experiment (OSE), using a 3-component borehole seismometer, airgun and explosive sources and the *R/V Fred Moore* as the shooting ship, was conducted in order to determine interval velocities, compressional and shear wave velocity gradients, seismic anisotropy, attenuation and the presence of sub-basement reflectors in the vicinity of the site. In addition, the Fred Moore conducted an extensive seismic reflection survey in the vicinity of the hole so that the OSE data may be corrected for topography.

Borehole televiewer (LDGO). A BHTV was run downhole in order to observe mesoscopic features such as pillows, fractures and dikes in the borehole wall and to determine the orientation of the in situ stress field from breakouts.

3-axis magnetometer (BGR). A 3-axis gyro-oriented borehole magnetometer was run in order to determine NRM intensity, inclination and declination versus depth in the hole. This tool also provided a borehole drift survey as a by product of probe orientation measurements needed for analysis of the magnetometer measurements.

Magnetic susceptibility (USGS). A magnetic susceptibility tool was run downhole to study susceptibility versus depth and alteration in the crust.

Temperature/heat flow (TAMU). The von Herzen HPC heat flow tool and the Barnes/Uyeda tool were deployed to measure the temperature gradient in the basement. The temperature data was also used to tell whether or not water is flowing down the hole.

Water Sampling (SIO). A sediment bridge near the sediment/ basement contact in Hole 418A was thought to have sealed off the basement from bottom water invasion since the hole was drilled during Leg 52 and 53 eight years prior to Leg 102. The Barnes sampler was used to collect water samples in equilibrium with the basement.

RESULTS

Since the hole was thought to have been isolated from the water column by cavings for the past eight years, a limited temperature measurement and water sampling program was conducted in the hole immediately after re-entry. The temperature measurements, conducted in the sediments between 52-81 m BSF and in the basement between 624-649 m BSF, indicate that heat transfer is conductive at the site. The water sample taken in the basement at 649 m is strongly enriched in Ca^{++} and depleted in Mg^{++} and K^{+}, suggesting exchange with basement water. There exists a remote possibility that these chemical changes are due to reaction with the basalts lining the borehole but this cannot be checked until oxygen isotope studies are completed in shore-based laboratories.

In general, the logs confirm and refine the lithologic units defined on Legs 52 and 53 on the basis of petrology (Fig. 5) and the log values of velocity, density, porosity and magnetic susceptibility often approach or match laboratory values previously obtained on core material. In particular, the massive basalts between 330-387 and 672-686 m BSF display compressional wave velocities of 5.5-6.0 km/s, shear wave velocities as high as 3.3 km/s, Vp and Vs semblance values greater than 0.5, densities of 2.9 g/cc, apparent porosities as low as 5% and resistivities exceeding 1000 ohm-m. On the other hand, the pillow basalts, which comprise 85% of the section logged, display compressional and shear wave velocities ranging, respectively, from 4.5-6.0 km/s and 2.6-3.3 km/s, lower values of semblance, densities of 2.6-2.8 g/cc, apparent porosities ranging from 15-30% and resistivities of 40-200 ohm-m. The pronounced difference in velocity and frequency content of multichannel waveforms in pillow and massive basalts is shown in Figure 6. While distinct from massive basalts, the pillow basalts in Hole 418A also behave quite differently from pillow basalts in young crust: the velocities and densities are much higher and the porosities are lower, suggesting the infilling and sealing of interpillow voids by alteration products. Since the compressional wave velocity throughout the section matches that of Layer 2B, but the natural gamma count in the top 190 m is high, we conclude that the upper part of the section was once much more porous and represents paleo-2A. Interestingly, the boundary between this unit and the rest of the section is also marked by a thick smectite-sealed breccia (Unit 6A), a sharp magnetic polarity reversal (Fig. 7) and a pronounced decrease in magnetic susceptibility from an average apparent value of about 1.5 m cgs units to about 0.5 m cgs units. Below 611 m, however, the susceptibility climbs sharply again to values exceeding 2.0 m cgs units (Fig. 5).

In addition to measurements of the borehole wall, a major two-ship seismic experiment was conducted on Leg 102 using the R/V H. Fred Moore as a shooting ship and a 3-component geophone clamped sequentially at 5 different depths in the basalt section of Hole 418A. Specifically, an oblique seismic experiment was conducted with shot points along radial lines and circles centered at the borehole (Fig. 8) in order to determine the velocity structure of the upper crust and to determine azimuthal variations in velocity and attenuation. A close-spaced seismic reflection survey was also made in this area to obtain basement topographic corrections; and a long-range sonobuoy survey was made around the site to look for deep layers. Preliminary results indicate that the old crust is anisotropic in its transmission of seismic waves, as indicated by both the velocity and amplitude of waveforms received in the borehole from shot points at different azimuthal positions (Fig. 9). This anisotropy may be related to in-situ stress or to structural features in the basement. The quality and dynamic range of the digitally recorded waveforms is vastly superior to those of previous surveys of this type. If deep reflectors exist in the crust or at the Moho, it should be possible to bring them into sharp focus by processing the high quality field data with beam-steering and stacking techniques.

FIGURE CAPTION

Figure 1: Location of Site 418 and Leg 102 alternate sites. Modified from Donnelly et al., 1979.

Figure 2: Bathymetric chart contoured at 100-meter intervals. Soundings corrected for velocity of sound in seawater after Matthews (1939). After Rabinowitz et al., 1979.

Figure 3: Stratigraphy of sediment and basement at Hole 418A. After Donnelly et al., 1979.

Figure 4: Leg 102 downhole logging locations, Hole 418A.

Figure 5: Leg 102 preliminary logging results, Hole 418A. All depth are relative to sea level.
Column 1: Magnetic susceptibility (cgs).
Column 2: Gamma ray (GAPI).
Column 3: Caliper (inches).
Column 4: Spherical focussed resistivity (ohm*m).
Column 5: Long-spaced sonic (first arrival, full wave form, us/ft).
Column 6: Vp waves velocity (km/s).
Column 7: Vs waves velocity (km/s).
Column 8: Density (g/cm^3).
Column 9: Neutron porosity (%).
Column 10: Thorium concentration (ppm).
Column 11: Photoelectric effect (relative scale)
Column 12: Uranium concentration (ppm).
Column 13: Potassium concentration (% of total counts)
Column 14: lateral resistivity (ohm*m)

Figure 6: Multichannel sonic waveforms from Hole 418A. A: massive basalt acoustic signature, B: pillow basalt acoustic signature.

Figure 7: 3-axis borehole magnetic results: Z-Log. All depths are relative to sea level. Lithologic column after Donnelly et al., 1979.

Figure 8: Oblique seismic experiment shot patterns conducted by the R/V Fred H. Moore.

Figure 9: Oblique Seismic Experiment, Vertical components - 2km circle.

TABLE CAPTION

Table 1: Basement Lithologic Unit, Hole 418A, from Results of Leg 52 and 53. After Donnelly et al., 1979.

Table 2: Leg 102 downhole operation summary, Hole 418A.

Unit	Top[a] (m)	Base[a] (m)	Thickness (m)	Type Cooling Unit	Phenocryst Assemblage	Intervals (Core-Section, cm)
1	324.0	329.6	5.6	Pillow basalt	Plag-(Oliv)	15-1, 20 to 16-1, 10
2A	329.6	331.7	2.1	Massive basalt	Plag-(Oliv)	16-1, 10 to 16-2, 105
2B	331.7	339.0	7.3	Massive basalt	Plag-(Oliv)	16-2, 105 to 17-4, 150
2C	339.0	363.1	24.1	Massive basalt	Plag-(Oliv)	18-1, 0 to 20-5, 81
2D	363.1	376.6	13.5	Massive basalt	Plag-(Oliv)-[Cpx]	20-5, 81 to 24-1, 57
3	376.6	383.3	6.7	Pillow basalt	Plag-(Oliv)-[Cpx]	24-1, 57 to 25-2, 60
4	383.3	387.1	3.8	Massive basalt	Plag-(Oliv)-[Cpx]	25-2, 60 to 26-2, 110
5	387.1	498.5	111.4	Pillow basalt and breccia	Plag-(Oliv)-[Cpx]	26-2, 110 to 40-3, 47
6A	498.5	510.5	12.0	Breccia	Plag-Oliv-(Sp)-[Cpx]	41-1, 0 to 42-2, 150
6B	510.5	611.0	100.5	Pillow basalt	Plag-Oliv-(Sp)-[Cpx]	42-3, 0 to 53-3, 150
7	611.0	629.2	18.2	Pillow basalt	Plag-Oliv-Cpx	54-1, 0 to 55-7, 70
8A	629.2	632.9	3.7	Pillow basalt	Plag-Oliv-Cpx	55-7, 70 to 56-3, 45
8B	632.9	636.3	3.4	Massive(?) basalt	Plag-Oliv-Cpx	56-3, 45 to 56-5, 125
8C	636.3	671.8	35.5	Pillow basalt	Plag-Oliv-Cpx	56-5, 125 to 60-4, 33
9	671.8	676.5	4.7	Massive, vesicular basalt	Plag	60-4, 33 to 60-6, 66
10	676.5	686.0	9.5	Massive basalt	Plag	61-1, 0 to 61 bit, 95
11	686.0	695.5	9.5	Pillow basalt	Plag-Cpx-Oliv	62-1, 0 to 63-5, 119
12	695.5	698.2	2.7	Massive(?) basalt	Plag-Cpx-Oliv	64-1, 0 to 64-2, 122
13	698.2	786.5	88.3	Pillow basalt and breccia	Plag-Cpx-Oliv	64-2, 122 to 75-4, 150
14A	786.5	793.6	7.1	Massive basalt	Plag-Cpx-Oliv	75-5, 0 to 77-1, 50
14B	793.6	821.5	27.9	Massive basalt	Plag-Cpx-Oliv	77-1, 50 to 79.7, 124
14C	821.5	859.8	38.3	Massive basalt	Plag-Cpx-Oliv	80-1, 0 to 86-1, 25
15A	–[b]	–	–	Basalt dikes	Plag-Oliv-Cpx	79-1, 75 to 79-1, 110 79-2, 78 to 79-2, 105 79-3, 105 to 79-4, 95
15B	–	–	–	Basalt dikes	Plag-Oliv	80-2, 117 to 80-3, 127 80-4, 2 to 80-4, 42 80-4, 107 to 80-5, 110
16	859.8	868.0	8.2	Pillow basalt and breccia	Plag-Oliv-Cpx-Sp	86-1, 25 to 86-6, 55

[a] Depths corrected for spacers.
[b] Undetermined.

Table 1: Basement Lithologic Unit, Hole 418A, from Results of Leg 52 and 53. After Donnelly et al., 1979.

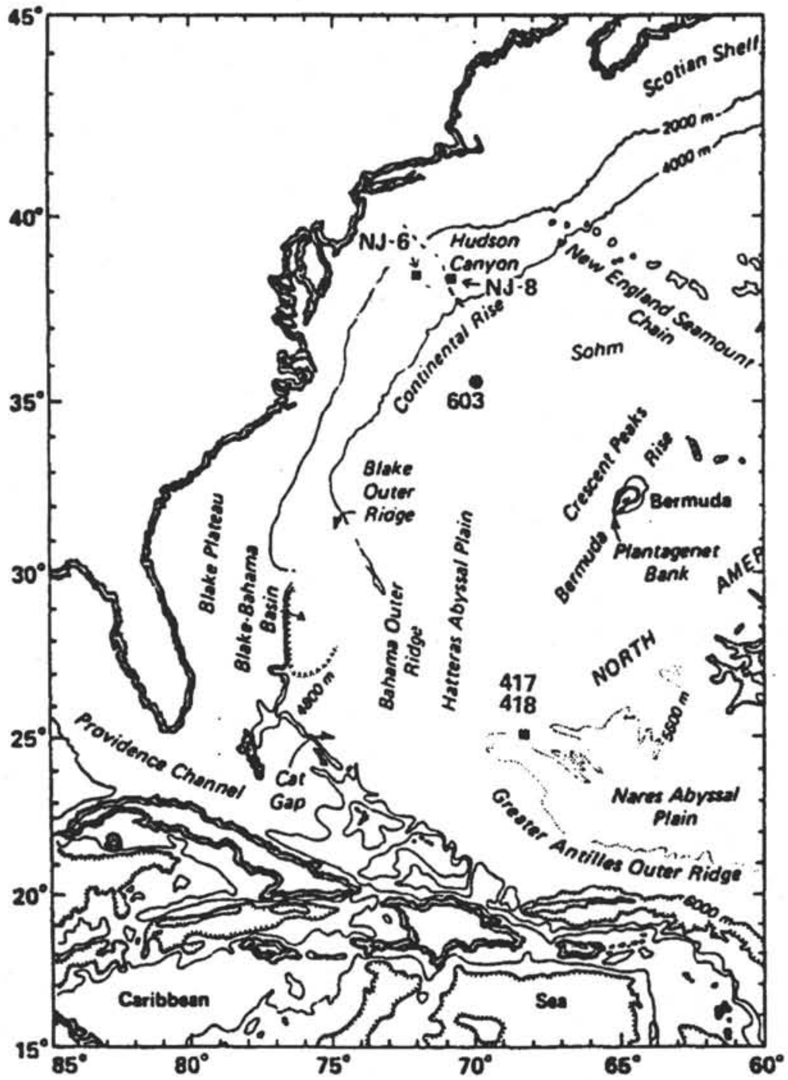


Figure 1: Location of Site 418 and Leg 102 alternate sites. Modified from Donnelly et al., 1979.

Run	Date	Time	Depth below rig floor (m)	Subbottom depth (m)	Logging direction	Tool/test	Data quality	Remarks
HPC temperature probe-Barnes/Uyeda temperature probe-water sampler								
1	3/24/85	2145-2400	5571-5600[a)]	52-81	Down	HPC temperature	Good	
						Uyeda temperature	Good	
	3/25/85	0000-0300				Barnes water sampler	Good	Sampled at 81 m
2	3/26/85	0330-0645	6143-6167[a)]	624-649	Down	HPC temperature	Good	
						Uyeda temperature	Good	
						Barnes water sampler	Good	Sampled at 649 m
USGS magnetic susceptibility tool								
1	3/26/85	1625-2400	5805-5847[b)]	295-337	Down	Susceptibility	Good	Tool temperature
	3/27/85	0000-0320				Conductivity	Poor	too low
2	3/27/85	0535-1200	5831-5990[b)]	321-480	Down, up	Susceptibility	Good	Tool temperature
						Conductivity	Poor	too low (down only)
Downhole logging								
1	3/27/85	1245-2130	5837-5990[b)]	327-480	Up	Vp	Good	
						Sonic waveform	Good	
						Ω ILM	Good	
						ILD	Good	
						SFL	Good	
						γ	Good	
						Caliper	Good	
2	3/28/85	0330-1115	5968-6298[b)]	458-788	Down, up	Vp	Good	
						Sonic waveform	Good	
						Ω ILM	Good	
						ILD	Good	
						SFL	Good	
						γ	Good	
						Caliper	Good	
3	3/28/85	1115-2100	5510-5972[b)]	0-462	Up	Spectral γ	Fair	Through pipe
			5972-6300	462-790	Down, up		Good	
			5510-5972	0-462	Up	γ-density	Poor	Through pipe
			5972-6300	462-790	Down, up		Good	
			5510-5972	0-462	Up	Neutron porosity	Poor	Through pipe
			5972-6300	462-790	Down, up		Good	
German 3-axis magnetometer								
1	3/28/85	2100-2400	5975-6300[b)]	465-790	Down, up	$H_{x,y,z}$	Good	
	3/29/85	2400-1500						
Downhole logging								
4	3/29/85	1500-2345	6000-6295[b)]	490-785	Up	Ω Laterlog LLS	Good	
						LLD	Fair	Out of calibration
LDGO multichannel sonic tool								
1	3/30/85	0100-0745	5875-6310[b)]	365-800	Down, up	Vp, Vs	Good	
USGS magnetic susceptibility tool								
3	3/30/85	0745-1600	5975-6310[b)]	465-800	Down, up	Susceptibility	Good	Tool temperature
						Conductivity	Poor	too low (down only)
WHOI borehole seismometer								
1	3/30/85	1815-2400	6065, 6165, 6265[b)]	555, 655, 755	Stationary	Vp, Vsv, Vsh, Anisotropy	Good	Shooting conducted by Fred Moore
	3/31/85	0000-2400						
	4/1/85	0000-2400						
	4/2/85	0000-2400						
	4/3/85	0000-2400	5853, 5876, 5916[b)]	343, 366, 406	Stationary	Evanescent waves	Good	Cable failed at 5853 m position
	4/4/85	0000-0430						
Packer								
	4/6/85	1625-2400	5867, 5985, 6037[b)]	347, 465, 517	Stationary	Pore pressure, permeability	--	Packer would not seat
	4/7/85	0000-0930						
L-DGO Borehole televiewer								
	4/7/85	1200-2300	5854-6200[b)]	344-690	Down	Borehole imagery	Fair	Slow sweep; tool caught on ledge
						Acoustic caliper	Fair	

a) Subtract 10 m to obtain depth below sealevel.
b) Equals depth below sealevel (rig floor height and cable stretch cancel each other, by coincidence)

Table 2: Leg 102 downhole operation summary, Hole 418A.

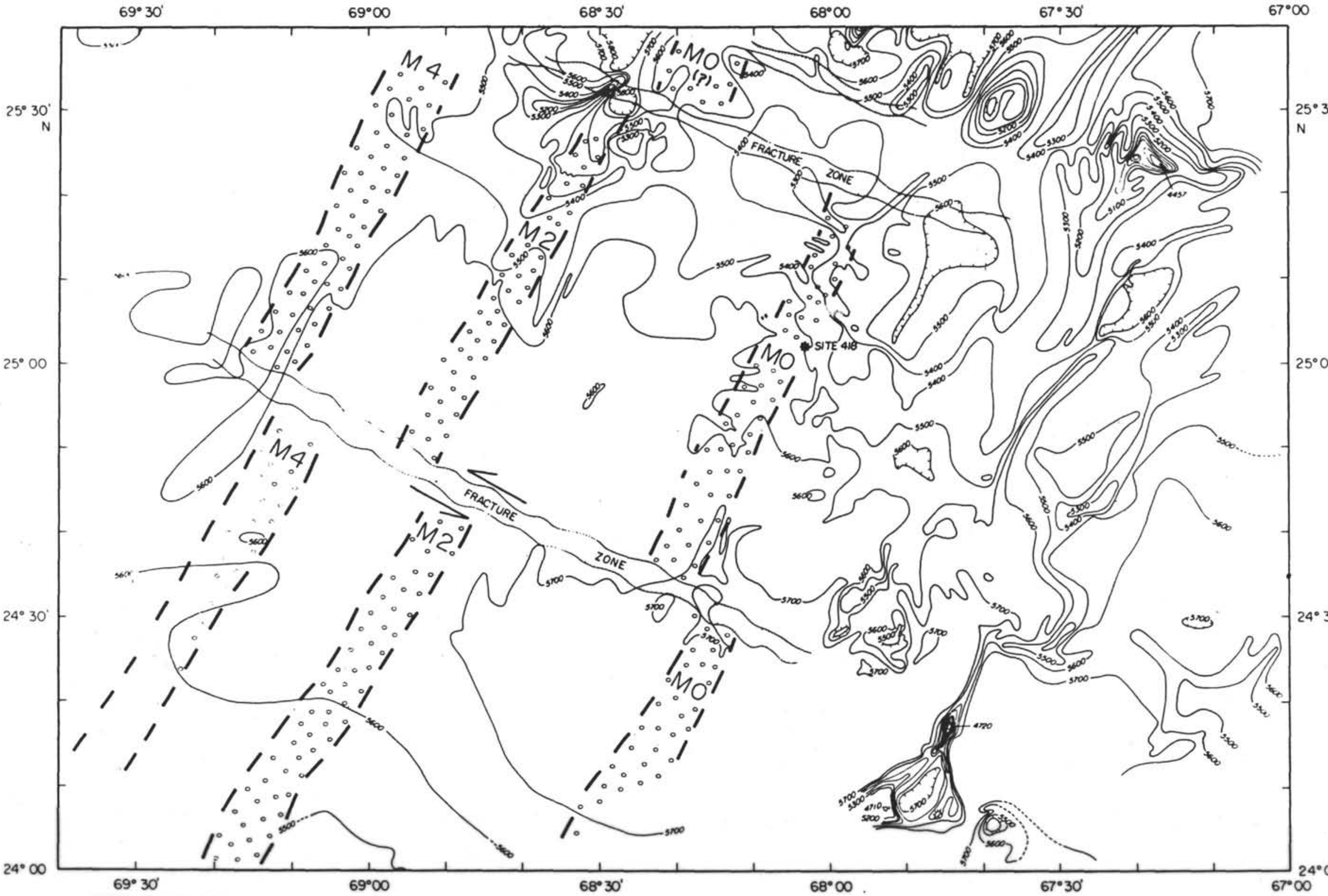


Figure 2: Bathymetric chart contoured at 100-meter intervals. Soundings corrected for velocity of sound in seawater after Matthews (1939). After Rabinowitz et al., 1979.

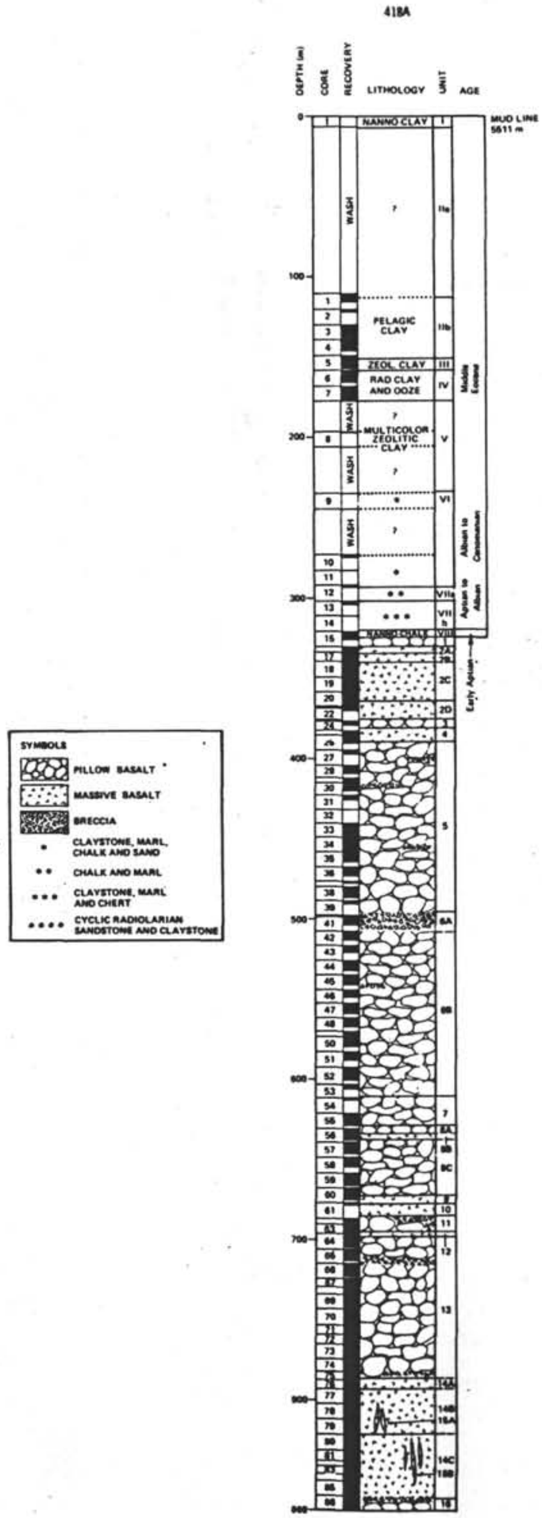


Figure 3: Stratigraphy of sediment and basement at Hole 418A. After Donnelly et al., 1979.

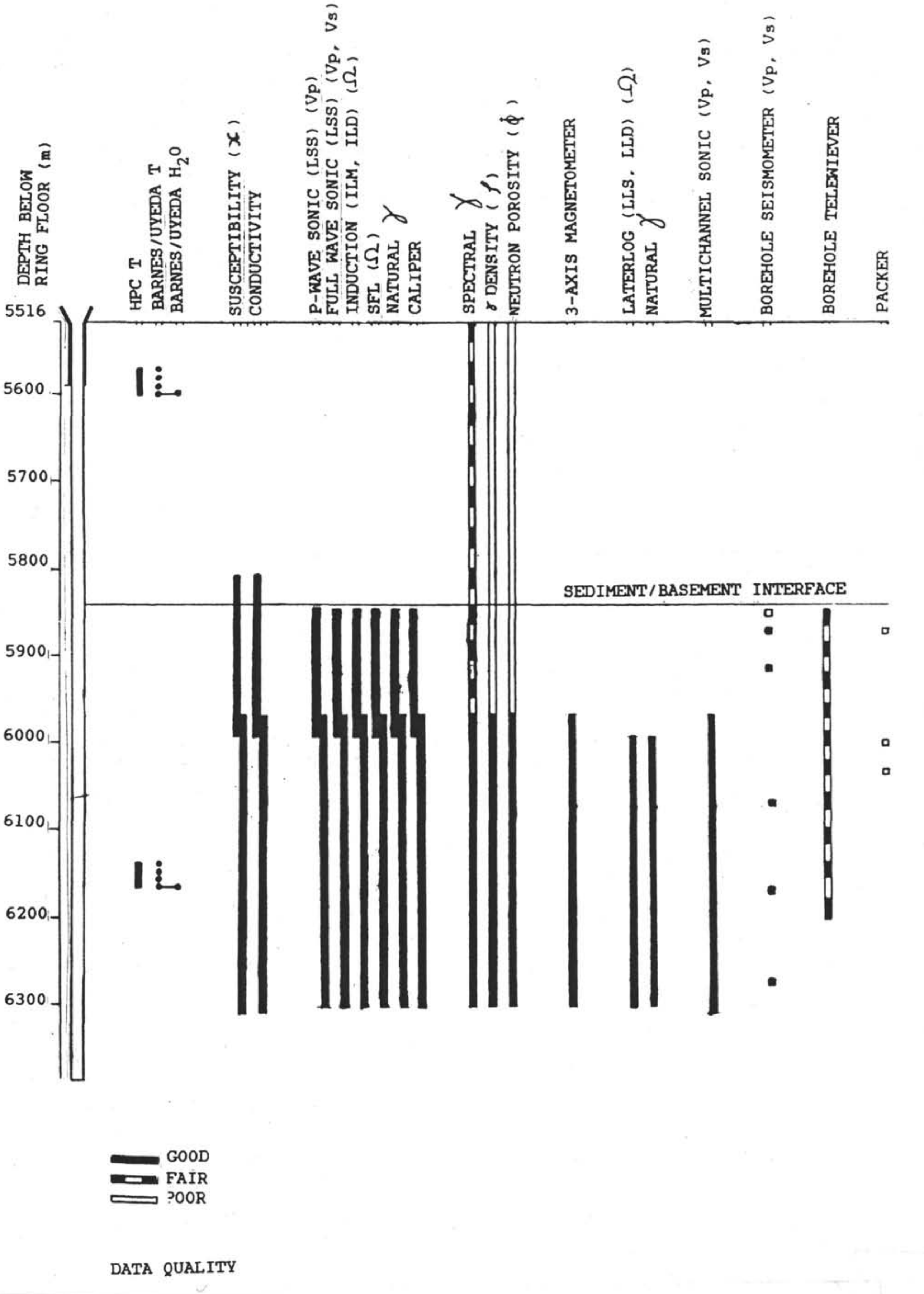
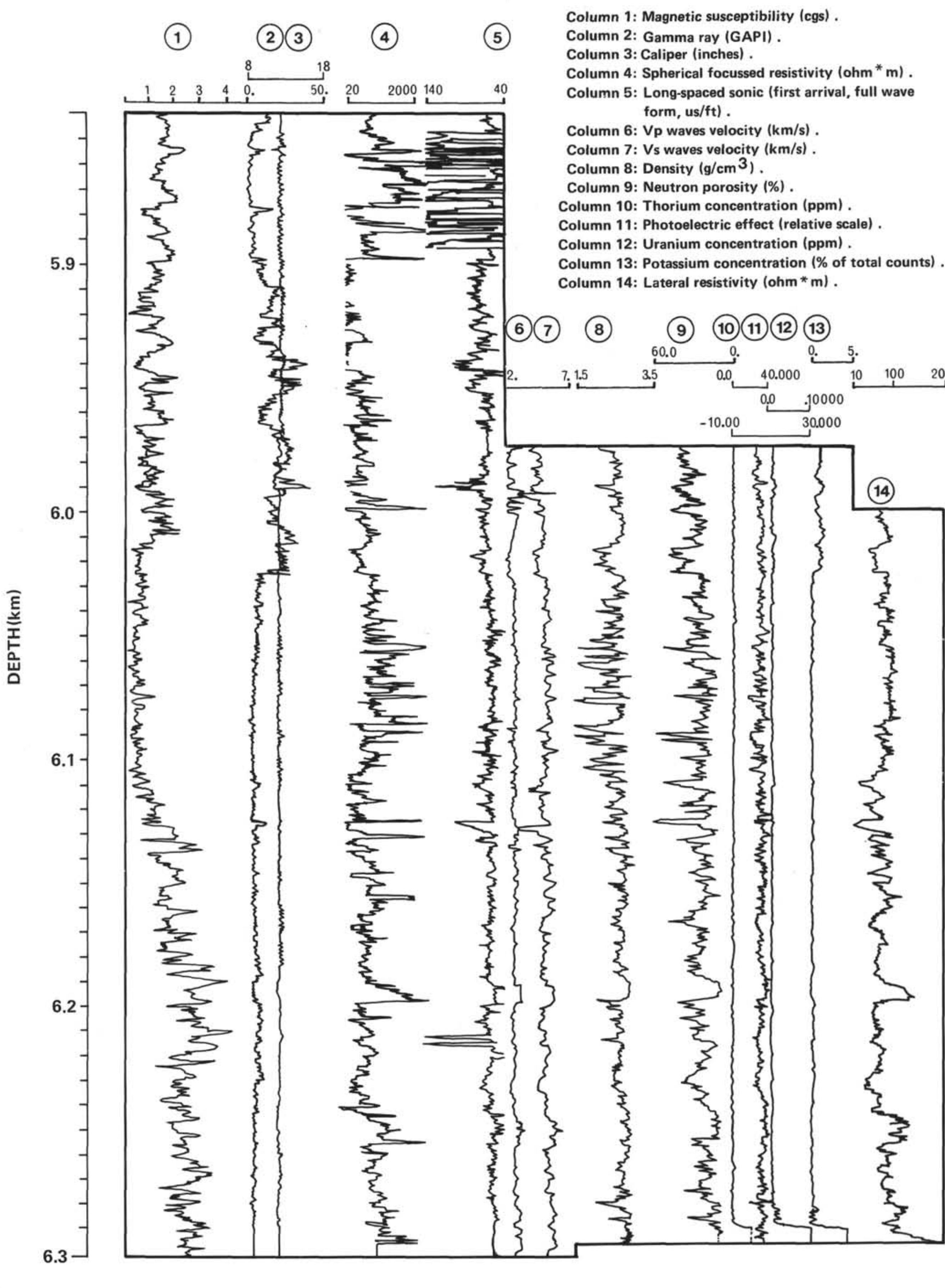


Figure 4: Leg 102 downhole logging locations, Hole 418A.

FIGURE 5: ALL DEPTHS ARE RELATIVE TO SEA LEVEL.



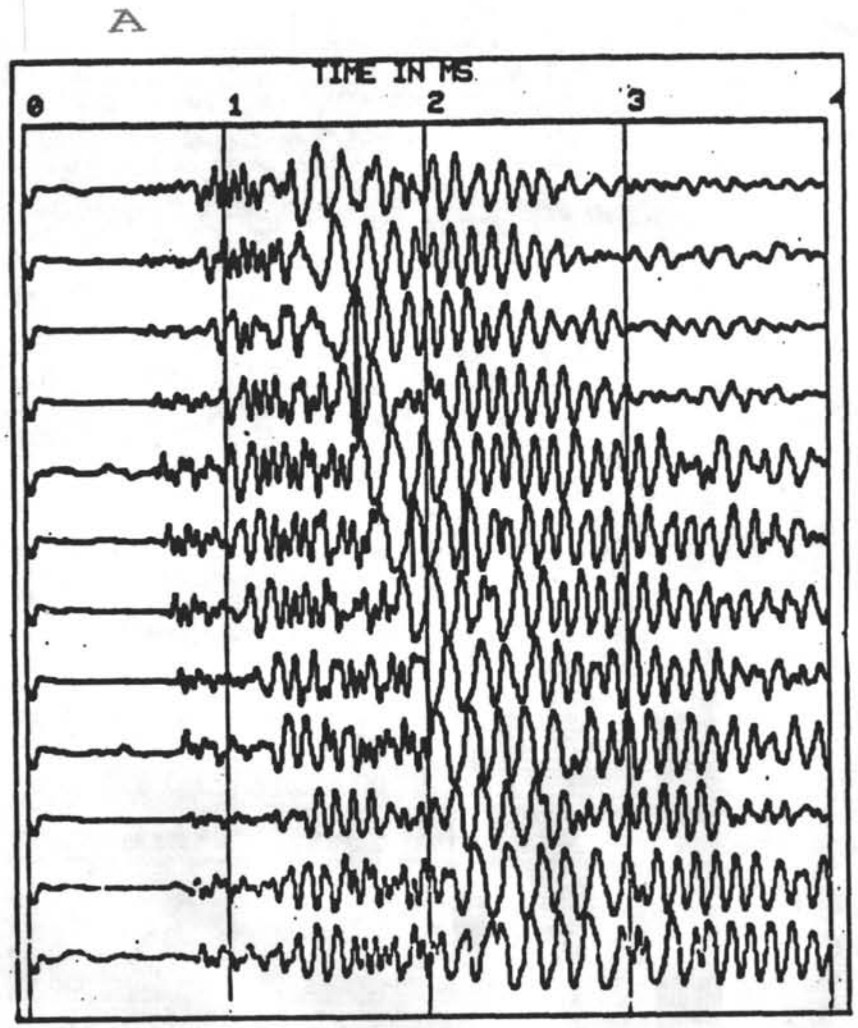


Figure 6: Multichannel sonic waveforms from Hole 418A. A: massive basalt acoustic signature, B: pillow basalt acoustic signature.

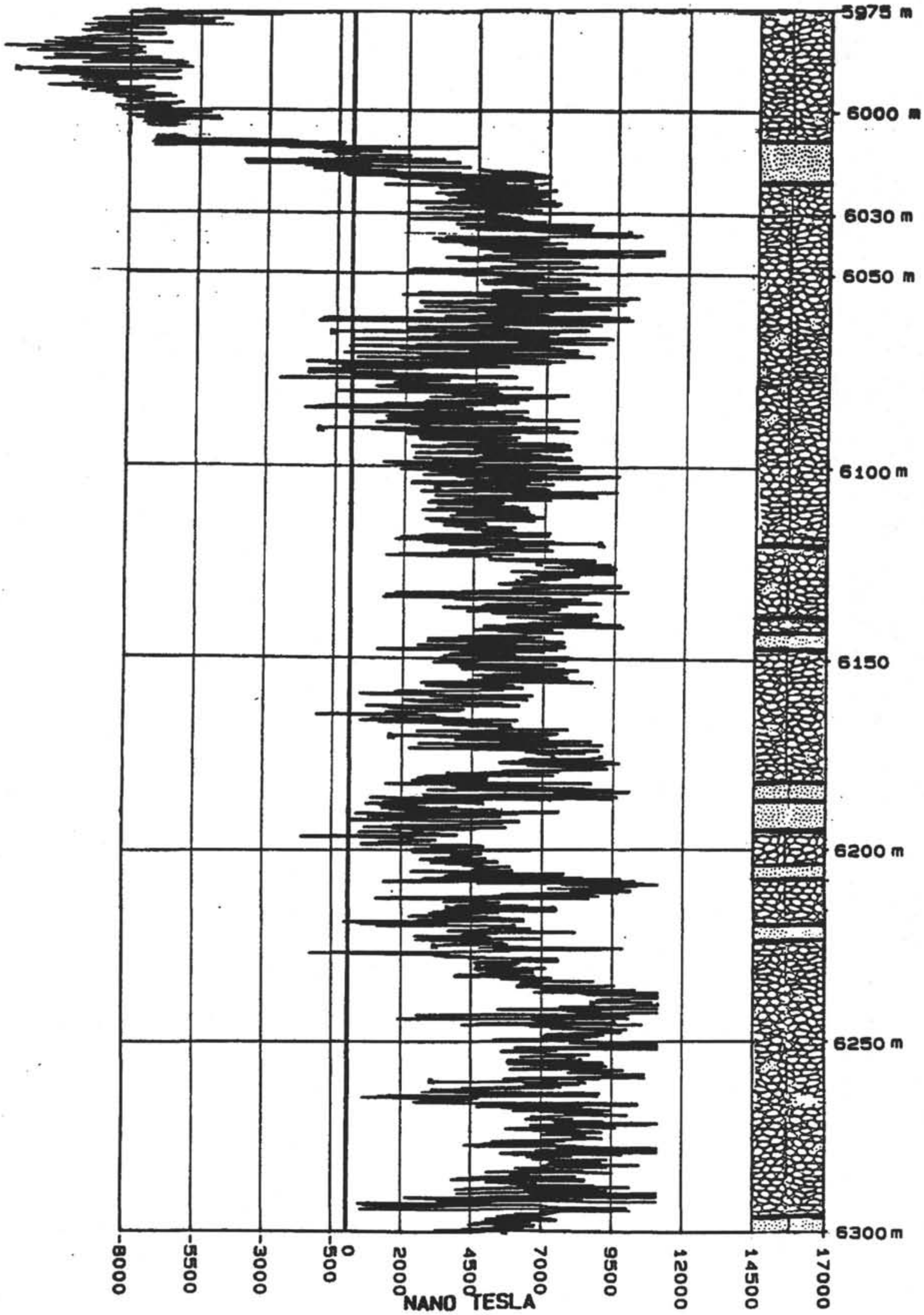


Figure 7: 3-axis borehole magnetic results: Z-Log. All depths are relative to sea level. Lithologic column after Donnelly et al., 1979.

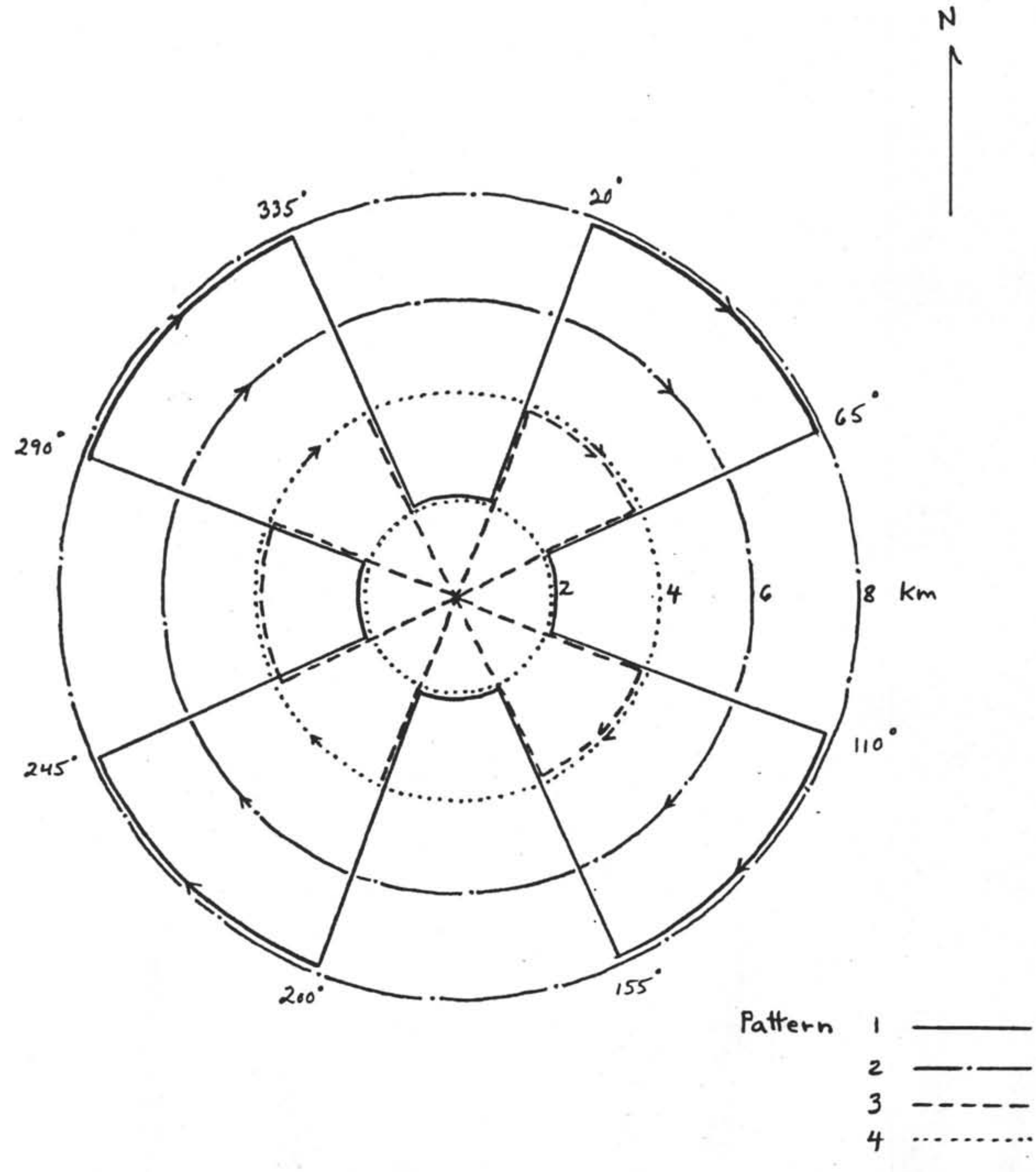


Figure 8: Oblique seismic experiment shot patterns conducted by the R/V Fred H. Moore.

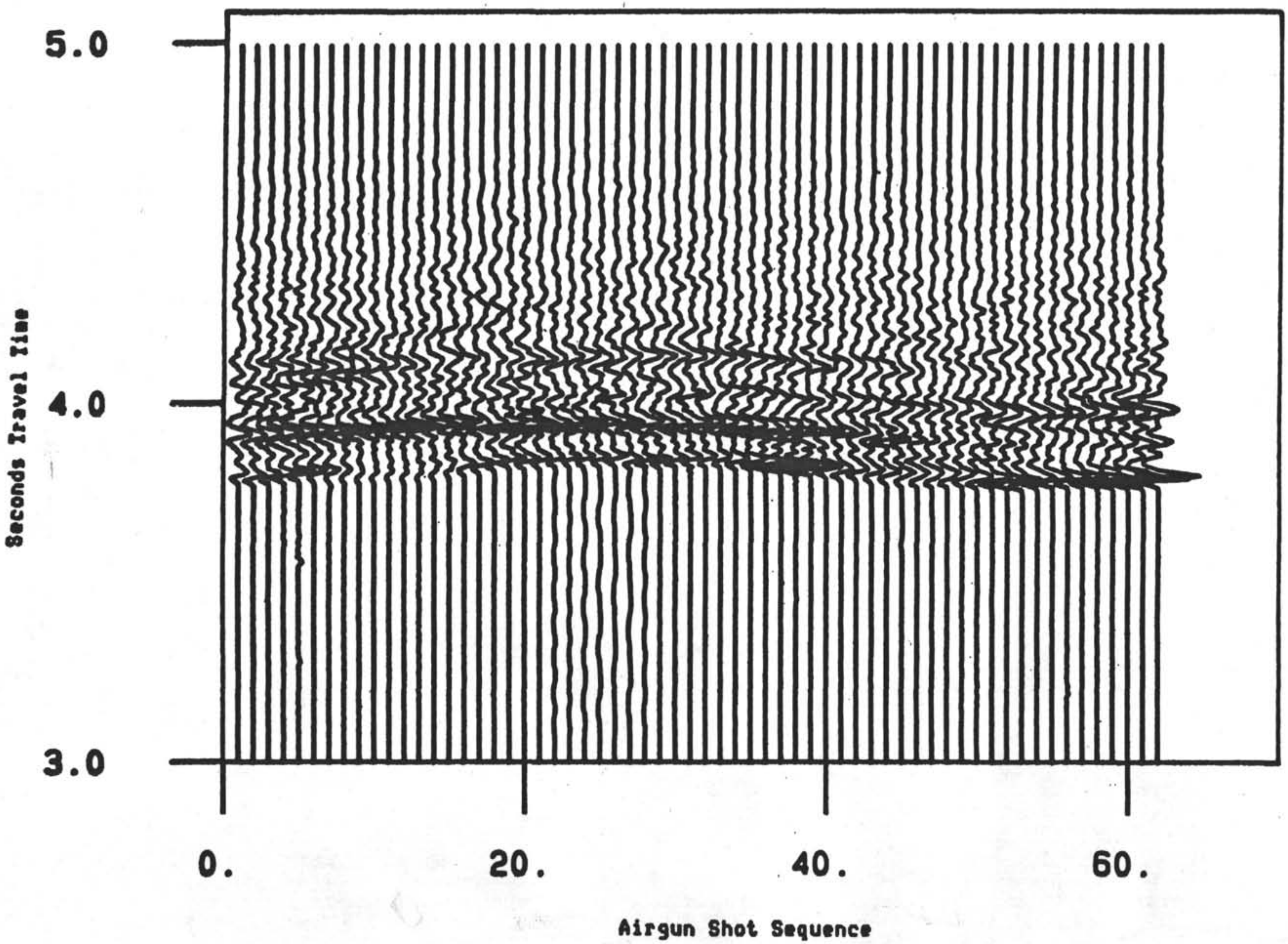


Figure 9: Oblique Seismic Experiment, Vertical components - 2km circle.

OPERATIONAL REPORT

The ODP Operations personnel aboard JOIDES RESOLUTION for Leg 102 of the Ocean Drilling Program were:

Cruise Operations Manager: Glen Foss

Special Tools Enineer: Patrick Thomson

Other Operations personnel aboard JOIDES RESOLUTION were:

Jeffrey Edwards, Fishing Tools Consultant (GOTCO International Inc., Houston, Texas)

Jeffrey Skelly, Schlumberger Logger (Schlumberber Offshore Service, Houston, Texas)

INTRODUCTION

The second voyage of the newly-reorganized Ocean Drilling Program was a relatively brief, but ambitious undertaking that mobilized the most complete array of downhole investigations in the history of borehole oceanography. The success of the multidisciplinary effort depended upon the reclamation of a drill site that had been abandoned eight years before under adverse circumstances.

The voyage commenced on March 14, 1985, in Miami, Florida and ended on April 25, 1985 at Ponta Delgada, Azores Islands. Leg 102 was composed of two parts: a scientific part (Part A) which ended at Norfolk, Virginia, where a port call was made for resupply and public relations purposes, and a transit part (Part B) between Norfolk and Ponta Delgada.

The downhole investigations of Leg 102 were carried out in DSDP Hole 418A, which had been drilled in 1977 about 700 miles east of the tip of the Florida Peninsula. Operational achievements of the leg included locating, re-entering and reopening the hole to a depth of over 800 meters below seafloor for the conduct of the various downhole experiments. Pipe was run at a second site, located on the Mid-Atlantic Ridge, for the purpose of evaluating underwater sonar and television systems and for inspection of the seafloor for possible future Mid-Atlantic Ridge drilling. No borehole was spudded at this location.

Total length of the voyage was 41.9 days, of which 19.3 days were spent on site, 13.7 days under way and 8.9 days in port. 1.4 days were consumed in fishing and remedial work, and mechanical downtime accounted for 0.5 days.

MIAMI PORT CALL

Leg 102 began at 0615 hours, March 14, 1985, with the first mooring line at Terminal Island Pier, Port of Miami. Major work items for the port call included: overhaul of number four main engine, repair of an oil leak in the motion compensator, loading and making up 336 joints of new 5-1/2" drill pipe, loading and installation of equipment for Leg 102 experiments, loading of general freight and supplies and offloading of Leg 101 cores and samples. In the laboratories, the X-ray fluoresence unit was installed and various air conditioning and ventilation modifications were either initiated or completed. Several tours were conducted, and a special luncheon was given aboard the ship for public relations purposes. The port call ended at 0815 hours, March 19, when JOIDES RESOLUTION departed on schedule for the operating site.

MIAMI TO SITE 418

The vessel averaged 12.4 knots on the transit from Miami despite moderate headwinds and seas. On March 20, one propulsion motor had to be taken off line due to an electrical problem. This had only a minimal effect on speed, as ten motors remained on line.

The site was approached on a direct course and full speed was maintained until a good SATNAV (satellite navigation) fix was received about twelve miles short of the site coordinates. Speed was reduced to four knots at about four miles, and the thrusters were lowered while the vessel proceeded on dead reckoning (DR) to the beacon drop point. An acoustic positioning beacon was launched at 1633 hours, March 21.

AT SITE 418

Since no geophysical profiling gear had been streamed, it was possible to bring the vessel to a dead stop as soon as the beacon was away. The beacon was being tracked by the ASK (automatic station keeping) system as it was falling and the hydrophones were being lowered. The beacon signal ceased abruptly about 20 minutes after launch and was never reacquired.

The vessel then hove to in the area to await the next good SATNAV fix. The PDR (precision depth recorder) and a bathymetric chart were used to maintain position in the proper water depth. The next fix (after about 2-1/2 hours) gave a location two miles northwest of the drill site. After another DR move, a second beacon was dropped at 2005 hours.

Before pipe could be run, it was necessary to determine with reasonable certainty that the beacon had landed within offsetting distance of the reentry cone. Further uncertainty was introduced by a marginally weak signal level from the new beacon. Any appreciable amount of noise from thrusters or main shafts caused loss of acoustics and missed updates in the ASK system. After a series of "insufficient data" fixes, an adequate SATNAV position was plotted to show the vessel 1200 meters to the east of the site. Another beacon was readied for launch as the offset was made, with the full expectation of losing the weak beacon signal during the move. The signal was found to be actually somewhat stronger with the horizontal offset, and the pipe trip was started at 0300 hours, March 22.

First Reentry - Wireline Instrumentation

The initial pipe trip was frustratingly slow due to a number of contributing factors. It was the crew's first real pipe trip; several joints of pipe, supposedly repaired in Miami, were still unsatisfactory and had to be laid down; the lower (5") drill string had to be measured; the new 5-1/2" pipe in the upper string had to be made up twice; a 4" diameter "rabbit" was passed through all components; minor repairs had to be made to the pipe elevators (twice), the new (5-1/2") piperacker system and a hose on the piperacker skate. After the 24-hour trip to 5505 meters, a rubber plug was pumped through the pipe to wipe out any accumulation of pipe dope, rust, zinc flakes, etc. in hopes of avoiding a sonar misrun.

The new Mesotech sonar tool was then rigged and run down the pipe. The wireline trip was slowed to detorque new wire and to test the sonar each 1000 meters. The sonar (after functioning perfectly at 5000 m) came to rest at 5473 m (the location of the bumper sub) by the logging depthometer. A depth error in the meter initially was assumed, and the sonar was powered up. It could not be made to calibrate, rotated only intermittently and showed an in-pipe signal. Several attempts were made to calibrate the instrument and to reseat it (or pass the restriction in the pipe). When this was unsuccessful, retrieval of the tool began -- only to have it become lodged in the 5-1/2" drill pipe at the top of the BHA (bottom-hole assembly). Efforts to "work" the sonar free with the logging winch resulted in failure of the cable head weak point, leaving the sonar in the pipe. The logging cable was then recovered, and the coring line was prepared for a fishing attempt with the overshot used to retrieve core barrels. The pulling neck on the sonar was engaged on the first attempt, and the tool came free with only slight drag. Inspection of the recovered sonar showed that: (a) the 15' inner core barrel attached to the top of the sonar was slightly bent, (b) the four bolts that held the four-inch diameter guide nose in place had sheared, allowing the nose to slide down on the shaft of the sonar and (c) the 3.5" aluminum transducer guard showed severe damage from contact with a sharp "up-looking" shoulder. It was inferred that the loose guide nose had caused the tool to become stuck while moving upward, but the reason(s) for the sheared bolts and the damaged guard were not understood, since the entire string had passed a four-inch rabbit.

Because of the apparent location of the obstruction, the nature of the transducer guard damage and some anomalous circulating pressure readings, it was suspected that a bumper sub washpipe had become detached. As this condition would seriously threaten downhole work even if a successful reentry were made, the time was taken to pump down a sealing go-devil to verify the pressure integrity of the drill string. The pipe held pressure when the go-devil landed, disproving the washpipe theory and necessitating another coring line trip -- but not a drill string round trip.

The backup sonar tool was an EDO-western unit that had been used by the Deep Sea Drilling Project. The sonar was fitted with a landing sub that had been modified to 3.87" diameter, run down the pipe and landed without incident at the restriction above the reentry/cleanout bit. When scanning was initiated, the reentry cone target was detected at a range of 82 meters and range to seafloor showed the water depth to be about 5516 meters from drilling datum. ASK offset maneuvers then were successful in closing the range to the cone, and the end of the pipe passed nearly over the rim of the cone on two or three occasions. Moves were being made to force the drill string to swing more actively when, after 130 minutes of scanning, the target was lost from the scope. It was then determined that the sonar had stopped rotating. When rotation could not be restored, the sonar was retrieved for replacement by a second EDO tool.

The third sonar tool was again landed with no problem. Initial scanning detected the target at 85 meters, which was somewhat surprising considering that heading and offsets were the same as for the earlier near pass. During the maneuvering to close the target, the function of the 45 transducer was lost, and it was necessary to finish the approach on the 8 transducer. The pipe showed little pendulum effect and was somewhat "dead" to the moves of the vessel. The heave compensator was used to remove most of the vertical motion, and the reentry stab was made from only about three meters above the cone at 1823 hours, March 24. Scanning time was a little under two hours.

The sonar was retrieved and one stand of pipe was added to the string to verify the reentry. Another stand was picked up in the derrick (as for reentry) and a combination water sampler/temperature probe was lowered to the bit on the coring line. The pipe was then lowered, in three steps without circulation or rotation, to 5600 m where the water sample and final temperature measurement were taken about seven meters below the conductor casing shoe. The rig pump had been shut down prior to the reentry and had not been restarted as a measure to insure fully equilibrated temperature data and an undisturbed water sample.

The probe was recovered packed with mud, and the lowermost temperature reading showed frictional heating effects from motion in sediment. The indication that the hole was filled with sediment or "soft fill" was born out by the drilling parameters as the cautious operation of cleaning out the well bore proceeded. No real resistance, but subdued weight indication and slight torque were felt to about 47 meters below the casing shoe, where an apparent bridge "took" a small amount of weight. This was consistent with records of re-entries in 1977 when resistance was encountered at this point. The hole then seemed mostly open to about 221m BSF (below seafloor), where the first real resistance was felt. For about five meters, weight, torque and pressure readings caused concern that the cleanout bit had been diverted, "sidetracking" the hole. The drill string freed up completely after this interval, however, and washing continued to about 250m BSF, where another "tight spot" of about one meter was encountered. After that, only occasional minor torque was noted through the sediment section.

This phase of the cleanout operation had proceeded slowly, because there was a strong possibility that a logging tool with several hundred meters of cable had been lost in the hole. Each joint of pipe had been pulled up and run back to depth after the initial penetration to ensure that the BHA was not fouled in the logging cable. When the hole had been opened past the sediment/basalt contact at 327m BSF, the hole was flushed with 50 barrels of bentonite mud and a "wiper trip" back into casing was made. No real overpull was felt pulling up, but again "tight spots" were noted in the interval from 218 to 260m BSF as the pipe was run back down. The resistance did not require deploying the top drive unit, however.

The basalt interval, as expected, seemed clear although some torque was noted in the upper part. The cautious "washing and fishing" continued to 626m BSF, with the last 19m of pipe lowered without circulation or rotation in preparation for a second temperature/water sampler run. Another stand of pipe was lowered during the measurement run.

On resumption of cleaning operation, the pipe was found to be stuck, probably as the result of cuttings and sediment settling around it during the probe run. It was worked free in about 15 minutes, and another 50-barrel mud flush was circulated to clean the hole.

The pipe was completely free in the hole as the washing proceeded toward total depth. Then, at 814m BSF, solid resistance to drill string weight was met. The weight resistance was not accompanied by an increase in either torque or pump pressure. As this was the indication to be expected from a ball of wire in the hole, it was considered highly possible that the "fish" was indeed in the hole and had fallen or been pushed to its present position with its top only 57 meters above total depth.

With nearly the entire basalt section now open to investigation, it was decided that at least the majority of the scientific objectives of the voyage should be accomplished before any fishing attempt, with its inherent risks of sticking the drill string or pulling wire back up the hole. A mud flush consisting of 50 barrels of bentonite and 50 barrels of weighted bentonite/barite mud was circulated out of the hole, and the bit was pulled back to 314m BSF in preparation for logging.

The planned order of logging runs was altered slightly to put the magnetic susceptibility log first. It was felt that this tool had the best chance of detecting wire that might be standing up in the hole to threaten subsequent operations.

The bit had been placed at 5830 m so that, when raised one stand in the derrick, it would expose about 42 m of open sediment hole above the basalt contact at 5843m. This was done so that an internal magnetic compass in the triaxial magnetometer tool (to be run later) could be used to correct the gyrocompass in that tool just prior to logging.

Unfortunately the light-weight magnetic susceptibility tool was stopped by a bridge or ledge only seven meters below the top of the basalt section and could not be worked past 5850 m. This was the disappointing termination of a wireline trip that had been extended about 2-1/4 hours by problems with the logging winch chain drive, a failed logging line weight indicator and a blown fuse in the surface instrumentation. It was then necessary to recover the logging tool to the rig floor and add a stand of pipe to put the bit below the obstruction. On the second attempt, the tool was lowered uneventfully to 5990 m, where it came to rest on a second bridge. When attempts to penetrate this obstruction failed, a log of good quality was recorded up to the pipe, which had been raised to 5830 m, and the logging tool was recovered.

The primary problem was thought to be the small susceptibility sonde, which weighed only about 150 lbs. in water even after the addition of a special "sinker" weight at the bottom. There was confidence that the next tool, the Schlumberger long-spaced sonic/dual induction/caliper/gamma ray, which weighed about 1000 lbs, could bull its way through and log the entire open-hole interval. This tool was also stopped dead at the same depth and could not be worked deeper. Again the section of hole from the bridge up to the pipe was logged and the sonde was retrieved. Pipe was then run to put the bit at 6004 m, where it would allow the logging tool to pass the obstruction (when lowered) and to log it (when raised). The same combination logging tool was then lowered all the way to 6300 m (a prudent distance above the fish) and the lower 2/3 of the basalt interval was logged and tied in with the previous run.

The logs and DSDP core data showed that the bridge had formed at a short, atypical interval of basalt breccia and clay and apparently was not a chance accumulation. It was felt that there was a strong possibility that the bridge would reestablish itself if the pipe were raised to open the entire basalt section and that the best use of the remaining operating time would be to collect the maximum amount of data in this very important 300+ m interval deep in the hole. The pipe was therefore left at this position for the full suite of logs.

The next run was made to 6300 m with the Schlumberger formation density/neutron porosity/spectral gamma ray sonde. The tool stopped on the way down in the BHA at the approximate depth of the bumper sub. On picking up and setting down harder, the tool came free. When the open hole had been logged, neutron and gamma ray curves were recorded all the way to the seafloor.

This was followed by the triaxial magnetometer furnished by German investigators. These data were logged downward at slow speed with stops each five meters. Total time for the 320-meter log was eighteen hours. Excellent results were obtained, and orientation data indicated that hole angle was less than two degrees from vertical through the entire interval.

Schlumberger then deployed the dual laterlog/gamma ray tool. A good log was recorded, but a communications breakdown between operating personnel as to the depth of the bit resulted in electrical damage to the sonde as it was pulled into pipe under full power. A delay of 1-1/2 hours occurred during retrieval when a hydraulic seal failed on the logging winch.

The multichannel sonic log of Lamont-Doherty was run next. The run, from the top of hole fill at 6310 m, was uneventful and fully successful.

Of all the logs deployed to this point, only the USGS magnetic susceptibility log had not recorded data from the lower open hole interval. This was now accomplished and the tie-in was made with the earlier run. When the susceptibility tool had been pulled into the pipe (in the raised position), the small tool was lowered in open hole to feel for the obstruction at 5990 m. Nothing registered on the weight indicator.

Although some of the scheduled downhole instrumentation deployments had not been made, time constraints forced cessation of logging at this point to ensure that there would be time for the oblique seismic and packer experiments, which had higher priority than the remaining logs. When the susceptibility tool had been recovered, the bit was pulled to 5859 m, in hopes that the Woods Hole clamping geophone could successfully negotiate the trouble spot at 5990 m and access the entire open basalt interval for the oblique seismic experiment.

This was the case and the geophone sonde traveled to its first (and deepest) clamping station at 6265 m without hesitation. The oblique seismic experiment, with R/V FRED H. MOORE providing shooting and airgun services in close coordination, began at 2100 hours, March 30.

The OSE (oblique seismic experiment) continued for four days, with excellent weather conditions (flat calm at times) contributing to the acquisition of data of excellent quality. Shooting patterns were run with the geophone clamped at depths of 6265, 6165, 6065, 5916 and 5876 m. Late on April 3, the geophone was raised to 5853 m, its shallowest intended position. Increasing swells during the night had occasioned the use of the drill string heave compensator to minimize the background noise of pipe against the wall of the hole. Shortly thereafter the investigators requested that the geophone be moved because of severe noise problems. On attempting to retract the clamping arm, it was noted that there were shorted and leaking conductors, apparently at the downhole end of the logging cable. This terminated OSE about twelve hours ahead of schedule, and the geophone was retrieved. On recovering, it was found that several meters of cable were severely kinked and twisted just above the cable head. This was cut off and found to be the source of the problem. In retrospect it is considered likely that, when the geophone was clamped only twelve meters below the end of pipe and three meters of slack were put into the cable, the cable formed a helix in the hole that reached the end of the pipe. The relative motion of the compensated pipe with respect to the cable then resulted in damage to the cable by the reentry/cleanout bit.

The pipe was then run back to 6303 m for an attempt to fish the logging cable and sonde from the hole. The top drive was deployed and soft hole fill was washed out to 6332 m, where firm contact had been made on the earlier cleanout/fishing attempt. Using maximum circulation to clean the hole and the top of the fish, a 50-barrel mud flush was pumped. On attempting to "tag" the fish, it was found that no weight was taken, but torsional resistance was met. Cautious washing then proceeded to clean the hole deeper. The torque indications disappeared below 6351 m, and only the indications of relatively soft hole fill were encountered as the bit was advanced to 6389 m, where hard bottom was felt. A flush of 50 barrels of gel mud followed by 50 barrels of weighted gel/barite mud was then circulated and displaced from the hole.

The pipe trip again was slow with delays for repositioning pipe in the racker when rubber drill pipe protectors interfered with racking. The crew's first "cut and slip" operation consumed two hours. At about 740 meters from the bit, a severely bent joint of drill pipe was encountered and had to be laid out. No explanation for the bent pipe could be given at the time, and a check of dynamic positioning records confirmed that no positioning excursion had been recorded while the pipe was in the hole. The torque encountered while cleaning the lower portion of the hole was thus explained, as the bent pipe was inside the casing at this time.

The bit arrived on deck at 0730 hours, April 5, after a trip of 20 hours.

Second re-entry: Packer Experiment

The TAM packer was then made up into the BHA and the drill string was started "the other way". Assembly of the BHA was slow because several components had to be interchanged or added. A new crossover sub with a faulty thread caused the pin thread of a drill collar to be damaged, and a new collar had to be brought from the storage rack. The drill pipe trip to reentry depth was much improved over the previous two, however.

It was again necessary to bypass the new Mesotech sonar in favor of a backup EDO unit--this time because of an electrical problem in the deck electronics module. The EDO tool was monitored periodically during the trip down the pipe and the 45 transducer function was lost during the latter part of the trip.

On landing the sonar at the bit, the system was powered up and the 8 transducer was confirmed to be functioning properly. No target was seen, however, although the ASK system remained set to the offset coordinates of the previous reentry stab. Only the heading had been changed. Several search moves were made, including an offset to a possible position indicated by SATNAV. When this was unsuccessful after three hours, a return to "square one" was agreed upon. The offsets and heading of the previous reentry were entered as part of a single move. Within a few minutes, a target, which was later determined to be the reentry cone, appeared on the screen at a range of about 107 meters (350 ft). The range stabilized at 25 m after the vessel had taken station. A check of the heading-related error was then made by turning the ship to the right while retaining the offset settings. The range had increased to 100 m and the target was beginning to fade when a 60 heading change had been entered. The heading was then again returned to original and maneuvering for reentry began. Great difficulty was then encountered in making small offset moves until a malfunctioning component of the ASK system was disabled. Then, after two straightforward moves, the reentry stab was made. Total scanning time was 9-1/4 hours.

When the sonar tool was recovered, the lower portion was found to be packed with clay. The vessel apparently had been far enough off station to drag the pipe across the seafloor in an area of shallower water.

The drill string was then run to position the packer at 5867 m, its first test point. Little resistance was felt in the sediment section of the hole, but a solid ledge was hit fairly hard approximately at the sediment/basalt contact. It was discovered only when the go-devil was dropped that the open reentry/cleanout bit had become plugged and that the pipe had not been filling. Circulation was started, the plug was blown out at about 800 psi, the pipe was filled and the go-devil was seated at the packer.

Further pumping raised the pipe pressure to 1000 psi and apparently inflated the packer. However, when weight was set down on the packer to shift the activation sleeve, it would hold only about 5000 lb and then appear to slide down the hole.

At this point operations were interrupted for about 45 minutes when the chain sprocket coupling failed on drawworks motor B. It was necessary to disconnect the chain drive and to proceed with only one drawworks motor.

Attempts to set the packer then continued at 6040 m and 5985 m and at pressures up to 3000 psi. Results were the same, although enough weight was supported on one attempt to shift the sleeve and dump pipe pressure to the annulus.

It was necessary to interrupt efforts to set the packer again because the clocks in the downhole pressure recorder (attached to the go-devil) had run down. Two attempts to engage and recover the go-devil with coring line and overshot were unsuccessful. The third attempt, using an inner core barrel and a short fingered core catcher, succeeded in recovering the go-devil. All was in good order and neither the pressure records nor the condition of the go-devil indicated a reason for the failure of the packer to seat.

Only a few hours of operating time remained in the voyage at this time, and chances of success with the packer appeared slim. Scientific priority therefore shifted to the acquisition of borehole televiewer data. After circulation to clear the hole, the bit was raised from 5985 m to 5854 m and the logging line was rigged. The televiewer sonde appeared to operating normally and logging data as it was lowered through the open hole interval to 6203 m, the bottom of the intended recording interval. Considerable drag had been noted as the light, centralized tool was lowered in open hole, but the indicated hanging weight had been repeatedly regained after each hesitation. Function of the televiewer was lost immediately upon the attempt to log upward, and it was felt that the rotating motor had burned out. There was no alternative but to pull out of the hole and go home, as there was no time for another run.

During the logging attempt, the rig crew had been working feverishly to replace the failed drawworks motor with the unit they had pulled from the rotary table module and to be prepared for the final pipe trip to meet the departure deadline. This work was nearing completion as the wireline trip proceeded at a slow pace while cable coating was applied. As the televiewer approached the surface, the final 300 m of logging cable was found to be severely damaged, indicating overrunning in the hole. Fortunately, no knots had formed in this case that could not be pulled into the pipe.

The tool and logging line were rigged down, and the televiewer was immediately bench-tested and found to be functioning perfectly.

The pipe trip then began--in low gear with one drawworks motor. Only five stands had been pulled when, after 45 minutes, the trip was stopped to connect the chain drive of the second motor. The trip then proceeded at an improved pace that showed the effects of increasing crew experience. When enough of the BHA had been recovered to bring the bit above the keel, the vessel began moving ahead to stream profiling gear (1348 hours, April 8).

A traverse across the site with the towed magnetometer had been requested by the magnetics investigators for magnetic background data. The RESOLUTION therefore steamed about six miles to the southeast before reversing course and returning to the borehole site. At 1600 hours the site was crossed and the vessel headed for Norfolk at full speed.

Although departure from Site 418 had been five hours later than scheduled, the vessel was able to average 12.1 knots on the 848-mile transit and to arrive at her assigned berth at Lambert's Point at 1142 hours, April 11, only 3-3/4 hours behind schedule.

NORFOLK PORT CALL

The last stateside port call that would be made for some time was a major effort in the areas of logistics and public relations. Scientific crew change and important repairs to major equipment were also accomplished.

Delivery of 468 joints of new five-inch drill pipe was made, with 120 joints of this pipe made up into stands on the piperacker. Total drill string on the ship is now over 14,000 meters. The fuel tanks were topped off with over 517,000 gallons of diesel fuel, the drill water tanks were filled and an extra supply of spare parts, foodstuffs and other consumables was onloaded. Two additional reentry cones were loaded to bring the on-board total to four, and 25 new drill collars were put in the racks on the main desk.

A new drawworks motor was installed to replace the unit that failed at Site 418. A representative of Stewart and Stevenson made extensive repairs to correct hydraulic leaks and other mechanical problems on the ODP logging winch. Machine work on several BHA components was done by a local shop, and a Mesotech representative was on hand to replace a failed power supply in the new sonar system.

The first major piece of laboratory equipment to be mobilized, the cryogenic magnetometer, was installed and made operational. Work continued on various air conditioning and utility problems in the laboratory structure. Downhole equipment of various investigators was offloaded, while a new external underwater television guide frame was put aboard for evaluation on the "B" portion of the leg.

Concurrent with the other port call activities was an extensive schedule of public relations activities and guided tours of the scientific spaces for distinguished guests representing the scientific community, industry and U.S. and foreign governments. A formal dinner for guests was held in the ship's mess room on April 14.

Although arrival in Norfolk had been delayed by a one-day operating extension at Site 418, good planning, hard work and good weather combined to sustain a rapid pace. At 0800 hrs, April 15, the last mooring line was brought aboard and departure was made one full day ahead of the original schedule.

NORFOLK TO SITE "ARCHIE"

On departing Chesapeake Bay, the vessel was met with strong headwinds and rough seas. However, with the passage of a frontal system, the wind shifted and began to help the cause. On April 16, the first full 24-hour steaming day, the vessel averaged a rather astonishing 15.5 knots with the aid of the Gulf Stream and following winds. Winds continued to be on or abaft the beam for most of the remainder of the transit, and an average speed of 13.8 knots was realized until 1200 hours on April 20th. At this time one main engine was taken off line as an experiment to evaluate the effect of such a measure on speed and fuel economy. With improving sea conditions, there was little effect on speed, and an average of over 13 knots was made good until 1845 hours, April 21st. Speed was then reduced to about four knots, the towed seismic gear was retrieved, and the final approach was made using the hull-mounted PDR to monitor bathymetry.

Agreement with the Seabeam bathymetric charts was excellent, confirming the accuracy of the vessel's navigation. At 2110 hours, the ship's engines were stopped, a positioning beacon was launched and the BHA/pipe trip began, all simultaneously.

SITE "ARCHIE"

The pipe was run to put the re-entry/cleanout bit just a few meters above the first PDR reading, which registered at a corrected depth of 2596m. The heave compensator was then utilized to "feel for bottom" as more pipe was added and the string was lowered carefully. It was suspected that the shallowest PDR readings were "side echoes", but it was not anticipated that bottom would not be tagged until two hours later at 2714.5 meters.

The operating area selected for the technical tests of Leg 102B is one of the most thoroughly surveyed areas of the ocean floor in the world. It lies within a portion of the Mid-Atlantic Ridge province that was studied by the renowned Project FAMOUS in 1973-74. The original target location had been a gently sloping area at the southern base of a submarine volcano known as "Mount Venus." The measured water depth and subsequent SATNAV fixes confirmed that this had been overshot and that the beacon had landed in a deep valley just to the southeast of the small mountain. The site was considered to be quite satisfactory to the investigating scientists, however, and the Mesotech scanning/imaging sonar was rigged and run down the pipe with the logging winch after pipe had been set back to put the bit about 15m off the seafloor.

When the sonar had been landed and scanning initiated, the operation was turned over to SEDCO personnel for calibration and adjustment of the ASK system vertical reference module. This was accomplished by rotating the vessel through a full 360 of heading while observing and recording the distance to certain "landmarks" on the sonar presentation of the seafloor. Positioning offsets were kept at zero-zero. The principal intended target was the positioning beacon itself, but the beacon was not seen until several heading changes had been made. It was subsequently determined that the beacon had landed near a steep canyon wall and that it was, at times, further from the sonar than the wall. As a result the beacon was lost in the returns from the strongly reflective wall. The beacon had been equipped with a 15-meter tether. When the target aspect had changed enough to bring the beacon into view, both the beacon and the reflector were clearly presented, and the two drill pipe weights were (debatably) discerned on the seafloor. It soon became apparent that the "eyeball" adjustments done to the system in Norfolk had been effective, as the circle described by the end of the drill string appeared to be no more than 20 meters in diameter. Using the beacon as a reference, adjustments were made that reduced this error by as much as 50%. The calibrations were completed after about 5-1/4 hours.

The systematic sonar reconnaissance of site "Archie" then began. Under the direction of shipboard scientists, the vessel was offset from the beacon in each of the cardinal directions, with observations taken from various heights above the seafloor. Nearby the entire procedure was videotaped. Dimensional restrictions of the rig's derrick limited vertical travel to about 30 meters. The steepness of the terrain, in turn, dictated that the investigation be carried out within about 100m of the beacon, beyond which the water became either too deep or too shallow.

Excellent weather conditions and the heave compensator minimized the effect of pipe motion, although it was a negative factor. The superior range and resolution of the sonar were readily apparent. Major linear features were presented extending off the screen at the maximum 100m range, while known highly reflective objects the size of the beacon and reflector were seen at 40 m. Prominent reflectors were complete with distinct "shadows" which should aid in interpretation. Efforts to resolve small features, such as boulders, ledges or crevices on the seabed from short range (down to 1-2m) were unsuccessful. The surface appeared cluttered, but it is not actually known what features exist in the area. The 90 beam "depth" of the sonar (from "straight down" to "straight out") was a major confusion factor, since there was no way to differentiate vertical range from horizontal. Transducers are easily interchangeable, however, and it may be possible to work with the manufacturer to develop special purpose transducers, for re-entry, bottom scanning, long range, etc.

The available terrain had been rather thoroughly scanned by 0600 hours, April 23rd, and there appeared to be insufficient time for a wireline round trip to adjust the length of the drill string. The tool had performed flawlessly for 20-1/2 hours of continuous scanning, and was found to be in excellent condition (albeit covered with pipe slope) upon retrieval.

A second operational objective of Leg 102B was the test deployment of a single-point suspended guide frame for underwater television. This system is under consideration for use in future bare-rock drilling. A deep water test of the assembly (which has been developed and used by Exxon Corporation) was desired to confirm that it could be deployed over the ODP drill string, with its rubber protectors, and that the single suspension cable would not wrap around and become fouled with the drill pipe.

As there were no electronics involved in this case, the frame was attached to the sandline. Snatchblocks were used to fairlead the line through the rig floor, around the rotary table and over the moonpool. Most of the deployment time involved handling the upper guide horn assembly, rigging the frame onto and off the drill pipe and opening/closing the moonpool doors and lower guide. The crucial part of the deployment was maneuvering the frame through the open lower guide horn. This was accomplished, in minimal seas, with only minor difficulty, but the light pipe frame could easily be damaged or crushed between the pipe and the edges of the guide horn halves if any amount of current or vessel roll were experienced.

The frame was run, with no difficulty of any kind, to the BHA and back in a little over two hours. No problems are foreseen with using the frame to external re-entries, other than that mentioned above.

The drill string was then recovered, the guide horn and clamp were reinstalled. While the vessel was being secured for sea, the hull-mounted acoustic command unit was tested. The commandable positioning beacon was successfully turned on and off twice. It was left off to preserve battery life for possible future investigations at site "Archie". At 1930 hours, April 23rd, the vessel departed for port.

"ARCHIE" TO PONTA DELGADA

A PDR profile at slow speed was made for ten miles due east before transit course and speed were set. The geophysical gear was streamed during this time. As only moderate speed was required to make the scheduled morning arrival, only three main engines were run on this leg of the voyage. Even so, an average speed of 11.1 knots was achieved. Leg 102 ended officially at 0915 hours April 25th, with the first line at Ponta Delgada, Sao Miguel, Azores, Portugal.

OCEAN DRILLING PROGRAM
SITE SUMMARY
LEG 102/102B

HOLE	LATITUDE	LONGITUDE	DEPTH METERS	TIME ON HOLE	TIME ON SITE
418A	25 02.2'N	68 03.4'W	5516	418.8	418.8
ARCHIE	36 49.2'N	33 15.8'W	2714.5	46.3	46.3

OCEAN DRILLING PROGRAM
BEACON SUMMARY
LEG 102/102B

SITE NO.	MAKE	FREQ. KHZ	SERIAL NUMBER	SITE TIME HOURS	WATER DEPTH	REMARKS
418A	Datasonics	15.5	162		5516	208db; failed abruptly 20 min. after drop
418A	Datasonics	14.5	189	425.7	5516	208db; weak signal before & after 4000' offset
418A	Datasonics	16.5	185	339.8	5516	214db; strong thruout
ARCHIE	Datasonics	14.5	172	46.3	2714.5	208db; strong; burned off on departure

TECHNICAL REPORT

The ODP Technical and Logistics personnel aboard JOIDES RESOLUTION for Leg 102 of the Ocean Drilling Program were:

Laboratory Officier:	Burney Hamlin	(Part A & B)
Senior Technician:	Bill Mills	(Part A & B)
System Manager:	Jhon Eastlund	(Part A & B)
Chemistry Technician:	Gail Peretsman	(Part A & B)
Chemistry Technician:	Katie Sigler	(Part A & B)
Electronic Technician:	Daniel Larson	(Part A & B)
Electronic Technician:	Michael Reitmeyer	(Part A & B)
Yeoperson:	Michiko Hitchox	(Part A & B)
Photographer:	Kevin de Mauret	(Part A & B)
Marine Technician:	Bettina Domeyer	(Part B)
Marine Technician:	Jenny Glasser	(Part A & B)
Marine Technician:	Harry "Skip" Hutton	(Part B)
Marine Technician:	Matthew Mefferd	(Part A & B)
Marine Technician:	Joseph Powers	(Part A & B)
Marine Technician:	Kevin Rogers	(Part A & B)
Marine Technician:	Christian Segade	(Part A & B)
Marine Technician:	Donald Sims	(Part A & B)
Marine Technician:	John Tauxe	(Part A & B)

Other Technical personnel aboard JOIDES RESOLUTION, for Leg 102 Part A were:

Leon Gove, Oblique Seismic Experiment Technician (Woods Hole Oceanographic Institution, Woods Hole, Massachusetts)

Ewald Meyer, Downhole Magnetometer Technician (Federal Institute for Geosciences and Natural Resources, Hannover, Federal Republic of Germany)

MIAMI PORT CALL

The installation of the X-ray Fluorescence system by Applied Research Laboratories of Switzerland was the primary technical effort in Miami. After months of co-ordinating the delivery, however, the expected equipment was lost with no trace for an apprehensive day before it mysteriously reappeared in a pile at the head of the dock. It was installed with few problems and has given good service. Service representatives from Xerox, DEC, and Perkin Elmer made service calls for repairs or calibration of some of our other equipment.

A representative from the TAMU Radiation Safety Office made a survey of all of the radiation devices aboard. All X-ray producing equipment safety mechanisms were tested and were found to be operating as designed. When the units were operating no radiation levels above background were noted. The GRAPE gamma source was also monitored.

Leg 101 cores were off loaded manually by the technicians for shipment to the East Coast Repository at Lamont. Freight too was off loaded and shipped. A forty foot container of freight from TAMU was unloaded and stored.

Mark Weiderspahn, from UT, delivered and ran new software for the MAASCOMP underway geophysics computer and conducted familiarization classes. An unexpected decision to cut off regulated power was reversed after the importance of bringing up the XRF and servicing the VAX system was related.

An extensive series of tours of the ship were conducted by Phil Rabinowitz, Christian Auroux, Anne Graham, Amanda Palmer and Karen Riedel with explanations by the technicians while they worked in their labs.

CRUISE ACTIVITIES (LEG 102A)

As the R/V Fred H. Moore with multi-channel capabilities was following the Joides Resolution no geophysical gear was towed in transit to Site 418.

The Barnes porewater sampler was prepared for service and successfully collected two water samples for Dr. Joris Gieskes from SIO. Temperature measurements were also taken at this time and were compared favorably with the Von Hertzen temperature measurements device in the cutting shoe.

The effort in the chemistry lab this leg was to focus on analytical techniques and instrumentation. Dr. Gieskes worked with the chemists during 102A to evaluate and refine the use of the labs auto- titrator and ion chromatographs. Exxon's Colorado oil shale was evaluated for possible use by ODP as CHN and

Rock-Eval standard. Some progress was made.

The oblique seismic experiment was conducted for 5 days with the technicians making 5 minute radar range and bearing logs of the Freed H. Moore shooting ship while she shot patterns around us. As the Moore had extra explosives remaining after the experiment another experiment was devised using sonobuoys and larger charges. Technician radar watches were again scheduled.

Re-entry of the hole was accomplished twice using EDO tools. The Mesotech tool was damaged on some unexplained obstruction in a drill collar on the first attempt and was replaced. One machined part was made for a second try but an electronics failure retired the system until parts could be delivered in Norfolk.

The fishing and logging emphasis on this leg allowed technicians to focus on several time consuming jobs and to learn new pieces of equipment.

In the corelab three of the high use butcherblock counter tops were modified by easing the 90 edges and coating the tops with resin to make them water proof. The data entry stations on the sample table were rotated 90 degrees to clear the aisles. In the cutting room the core cutter was remounted on a higher base and the capstan moved to the side to preserve clearance in the aisle. An overhead frame of Unistrut was installed to support electric water valves for the core cutter and the core hold down brace.

The thin section lab was utilized to augment the petrographic slide collection at the East and West Coast Repository. Several hundred billets were forewarded to the ship for processing as time permitted. Another technician was trained to use the facilities aboard.

SEM work was limited this leg to a few photographs for a scientist and test work.

The Claisse-Fluxer fusion device that makes glass disk samples for the XRF arrived in poor condition and considerable effort was expended making it work. A technique for casting successful samples was developed and put into practice. Standards were prepared and analytical procedures developed for the coming legs.

A small cabinet was added the paleo prep area to accommodate the centrifuge, add drawers, and open up a fume hood. A hole was cuting the wall behind the burn station to preview future storage potential for the area.

The remaining components for the lounge entertainment system arrived allowing the projection TV system to be installed. A mounting plate had to be fabricated and welded into the overhead to support the projector. A shelf was made for the Xerox area and some rearranging of cabinets was done to increase the work area.

Paper products stored on the mezzanine level of the casing hold were beginning to suffer water damage from the leaky hatch cover. These products were moved to the lower level of the casing hold and the gas bottles moved up to utilize the area. Permanent bottle racks are planned for this area.

Caging material and shelfing was installed in the core refrigerated area to accommodate heat sensitive products such as thermal paper, tapes, and some chemicals. On the upper tween deck landing a small area was enclosed to accommodate housekeeping supplies like mops and buckets.

A workbench was assembled from extra lab furniture components and a vice and bench grinder were mounted on it.

All technicians were encouraged to take the CT*OS word processing classes offered by the Computer Systems Manager and most developed a satisfactory level of skill.

UNDERWAY TO NORFOLK

Geophysical gear was deployed after getting underway for Norfolk. Objectives were to evaluate the systems ability to collect data in deep water and at transit speeds over 10 knots. In addition an emphasis was placed on developing consistent watch standing procedures for the technicians and the bridge officers.

As noted on leg 101 the 12 KHZ return is lost in ship noise at speed over 3-4 knots. We did have some luck with the 3.5 system although its signal too is often lost in the noise. Bathymetry on this leg was taken from the 3.5 records when available.

The magnetometer record was to noisy to be of value. As the deck electronics appear to be within specifications, the cable/sensor is suspect. A re-conditioned replacement is expected.

Regulated AC power is still rough and occasionally causes the MAASCOMP system to drop its program. Data tapes made with the system will be evaluated ashore.

At the request of management considerable time was devoted to preparing the lab complex for presentation to NSF officials and Congressmen in Norfolk. The labs were thoroughly cleaned, cabinets organized, and paint touched up where needed (The floors proved very difficult to clean as had been noted by the last crew. It was concluded in Norfolk that sealer was never put on the color coat and that the floors would eventually have to be resealed).

NORFOLK PORT CALL

The cryogenic whole core magnetometer by 2G Enterprises was delivered, installed, and made operational with few problems but much effort because of the port call time constraints. Equipment of this complexity is rarely made operational in three days.

Drill pipe was loaded for three days sometimes complicating crane service.

Tours, again conducted by Phil Rabinowitz, Lou Garrison, Karen Riedel and Christian Auroux, were conducted daily with technicians describing their equipment.

UNDER WAY TO THE AZORES (LEG 102B)

Efforts continued to develop watch procedures and to initiate the technicians into the nuances of producing good records. Directions were written for the bridge officers detailing what is needed from them to support our underway logs.

A complete physical inventory of all supplies was made on the transit. In addition the government funded equipment listings were updated and new equipment marked. This information will be included in the new inventory program when it is initiated. These figures will also be taken to ODP for a shoreside update.

LONG TERM JOB PROGRESS

Several jobs initiated on Leg 101 were completed on Leg 102 and some are still in progress this leg. These include water to the fantail, core extruder hydraulic fitting modification, fantail lighting, and the hinged hydraulic pump cover. Brackets for the core cutter capstan motor and rope pulley have been welded, as have the angle iron sill in the casing hold needed to complete the decking. Welding was begin on supports for the fold back knees that support a lower teen deck basket landing. The fabrication of platforms for the fantail await permission from SEDCO engineering.

Of the major problems listed in the 101 Technical Report only the fume hood exhaust fans noise has been eliminated. The remainder of the problems have been inspected, discussed, and solutions worked us on.

SAFETY

A "datatrieve" listing of hazardous chemicals was compiled by the yeoperson from manufacturers' data sheets. A paper copy of the file was given to the First Mate for the ships file. Completion of the file awaits attention on Leg 104.

the file was given to the First Mate for the ships file. Completion of the file awaits attention on Leg 104.

Hazardous spill neutralization instructions were compiled from instructions on the containers and the chemists' BAKER instruction booklet. An updated Safe Work Practices was edited and augmented to reflect ODP needs. The above mentioned spill instructions is included.