OCEAN DRILLING PROGRAM

LEG 174B PRELIMINARY REPORT

CORK HOLE 395A

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ABSTRACT

The main objective of Leg 174B was to reenter Hole 395A to run a selected suite of downhole logs followed by installation of an instrumented borehole seal or CORK (Circulation Obviation Retrofit Kit). The purposes of the logs and CORK experiment were (1) to document the in-situ physical properties and hydrogeology at this young crustal reference site and (2) to test a hydrological model developed from observations obtained during three earlier reentries since the hole was drilled over 21 years ago in 1975-1976. Leg 174B operations at Hole 395A were very successful in achieving the following objectives: a temperature log and three advanced Schlumberger logs were run and the hole was smoothly CORKed. Sufficient time was left to collect advanced hydraulic piston cores through the full sedimentary section (predominantly nannofossil ooze) and an extended core barrel core in basaltic basement at Site 1074, 4 km northwest of Hole 395A.

Leg 174B represents the fourth time Hole 395A has been reentered since it was drilled on Deep Sea Drilling Project Leg 45 (1975-1976). Past observations from Hole 395A indicate a continuous downhole flow of ocean bottom water and generally support a model of lateral flow of seawater in the upper basement beneath the sediment pond in which the site is located. This model was generally confirmed by Leg 174B logs from Hole 395A and cores from Site 1074. Like all past temperature logs in Hole 395A, the Leg 174B data show virtually isothermal borehole temperatures from the seafloor down to 350 mbsf. This reconfirms prior indications of a strong flow of ocean bottom water down the hole, at a rate of 1000-2000 l/hr, exiting into the formation between casing and 450 mbsf. The Leg 174B Schlumberger logs and comparisons to past core descriptions and logs clearly show that Hole 395A consists of definable layers of pillow basalts, massive flows, and fluid aquifers that correlate to changes in the resistivity, velocity, and bulk density logs. Distinct changes in the high-resolution temperature gradient log and anomalies in the spontaneous (SP) log indicate that at least two major aquifers are active in the hole at approximately 310 and 420 mbsf. Zones of high resistivity and high sonic velocity distinguish massive lava flows, and both resistivity and velocity generally increase toward the bottom of the hole. High-resolution borehole images were obtained with the formation microscanner and two advanced tools new to the Ocean Drilling Program: the digital shear imager and azimuthal resistivity imager. The Leg 174B log data are particularly relevent to the hydrogeologic structure in Hole 395A and illustrate the physical state of the ocean crust in unprecedented detail. Overall, the Leg 174B logging program has solidified the position of Hole 395A as the most important reference hole for young oceanic crust formed at a

slow spreading rate. No CORK data will be available until the first submersible revisit to Hole 395A during the winter of 1998.

INTRODUCTION

The main objective of Leg 174B was to reenter Hole 395A (Fig. 1), to run a selected suite of downhole logs followed by installation of an instrumented borehole seal or CORK (Circulation Obviation Retrofit Kit; Davis et al., 1992). The purpose of the logs and CORK experiment were (1) to document the in situ physical properties and hydrogeology at this young crustal reference site and (2) to test a hydrological model developed from observations obtained during three earlier reentries since the hole was drilled over 21 years ago in 1975-1976. The observations from Hole 395A generally support a model of lateral flow of seawater in the upper basement beneath the sediment pond in which the site is located. The logs and CORK experiment will provide essential information about the formation pressure and permeability structure, which are keys to understanding the crustal hydrogeology at the site.

BACKGROUND

Only a handful of Deep Sea Drilling Project/Ocean Drilling Program (DSDP/ODP) holes penetrate more than 500 m into "normal" oceanic crust formed at mid-ocean ridges, and these are all, therefore, important reference holes. Among them, Holes 395A and 504B (Fig. 1) form the most important pair of reference sites for young, upper oceanic crust formed at slow and medium spreading rates, respectively. They are particularly important as reference sites for the hydrogeology of young oceanic crust, which has been studied with extensive downhole measurements and detailed heat-flow surveys at both sites (Fig. 2). Holes 395A and 504B are the best documented of several cases in which ocean bottom water is known to be flowing down open DSDP/ODP holes into permeable levels of upper basement. These examples suggest that young upper oceanic crust under a sediment cover is easily permeable enough to support active circulation of seawater, but we still barely understand the details of such off-axis hydrothermal circulation or its control by the pressure distribution and fine-scale permeability structure.

Site 395 is located in 7-Ma crust, in an isolated sediment pond with low heat flow (Hussong et al., 1979; Langseth et al., 1992) that might be considered somewhat typical of the structure and hydrogeological setting for thinly sedimented crust formed at slow spreading rates. Since it was drilled in 1975-1976 (Melson, Rabinowitz, et al., 1979), Hole 395A has been revisited three times for an extensive set of downhole measurements: during DSDP Leg 78B in 1981 (Hyndman, Salisbury, et al., 1984), during ODP Leg 109 in 1986 (Bryan, Juteau, et al., 1988), and during the French wireline reentry campaign DIANAUT in 1989 (Gable et al., 1992). The hole was originally drilled during Leg 45 to a depth of 664 m, or 571 m into basement, but bad hole conditions were encountered in the deepest 50 m (Melson, Rabinowitz, et al., 1979). When the hole was revisited five years later during Leg 78B, the deepest 55 m of the hole were blocked by fill (Hyndman, Salisbury, et al., 1984). However, very similar total hole depths were registered during Leg 109 and the DIANAUT program, indicating that hole conditions apparently stabilized shortly after Leg 45. Total open hole length is ~606 m with 513 m into basement.

On each of three prior reentries of Hole 395A, the first order of business was to log the hole with a temperature tool long after it had reequilibrated from any prior disturbance by DSDP/ODP operations and before it was disturbed by new logging. Each of the three temperature logs obtained from the previous cruises showed strongly depressed borehole temperatures, essentially isothermal to a depth of about 300 m into basement (Becker et al., 1984; Kopietz et al., 1990; Gable et al., 1992). Packer and flowmeter experiments conducted during prior reentries indicate that this section of basement is much more permeable than the underlying formation (Hickman et al., 1984; Becker, 1990; Morin et al., 1992). The near-isothermal temperatures in the upper part of the hole indicate a strong downhole flow of ocean bottom water into permeable upper basement, at rates of thousands of liters per hour, virtually unabated over the 21 yr the hole has been open. In that time, it is estimated that a total of over 200,000,000 liters of ocean bottom water has been drawn down the hole into the subseafloor hydrogeologic system at Site 395.

In comparison, temperatures measured during the multiple revisits to Hole 504B were initially strongly depressed to a depth of about 100 m into basement, but then rebounded nonmonotonically toward a conductive profile. This indicates that the rate of downhole flow in that hole had decayed since the hole was first drilled and that the downhole flow is directed into a more restricted section of uppermost basement than in Hole 395A (Becker et al., 1983a, 1983b, 1985, 1989; Gable et al., 1989; Guerin et al., 1996). This comparison suggests that Hole 504B penetrates a more passive hydrothermal regime, whereas Hole 395A provides a man-made shunt into a more active circulation system in basement. The various observations at Site 395 generally support a model proposed by Langseth et al. (1984, 1992; Fig. 3) for lateral circulation in the upper basement beneath the sediment pond where the hole is sited, but we have little resolution on any details of such circulation.

A number of holes drilled into young oceanic crust have proven to be drawing ocean bottom water down into permeable levels of basement (e.g., Erickson et al., 1975; Hyndman et al., 1976; Anderson and Zoback, 1982; Becker et al., 1983a, 1983b, 1984; Davis, Mottl, et al., 1992). Such downhole flow requires sufficient basement permeability and a differential pressure between the fluids in the borehole and the formation fluids. In general, we surmise that the necessary differential pressures may arise because of some combination of two independent effects:

(1) The differential pressure (which should not be termed an "underpressure") between the cold, dense seawater used as drilling fluid in the borehole and the warmer formation fluids; and
(2) True, dynamically maintained underpressures caused by active circulation in the basement that would occur even if the borehole were not present.

In cases of downhole flow in holes drilled into formations with high geothermal gradients, the driving force is probably dominated by the former effect (e.g., ODP Leg 139 sites in Middle Valley, Davis, Mottl, et al., 1992). For holes such as Hole 504B, both effects may be important. In holes drilled into young crust with low geothermal gradients, such as Hole 395A, the latter effect may be predominant.

OBJECTIVES AND METHODS

By leaving Hole 395A open for over 20 yr, with revisits for discrete data sampling roughly every 5 yr, we have learned only that the downhole flow has apparently continued at a significant rate. We have no resolution as to possible variations in downhole flow rates with time (as has been documented in Hole 504B), let alone the constancy or variability of the driving forces responsible for the downhole flow. Furthermore, we still do not understand exactly where the downhole flow is directed in the formation, other than the general statement that it is directed into the upper 300 m or so of basement.

The Leg 174B program was designed to address these important issues by providing essential information about the in situ physical properties, permeability structure, and formation pressure, which are keys to understanding the crustal hydrogeology at Site 395. With about five days to be spent at Hole 395A during Leg 174B, the operational program was scheduled to begin with about three days of logging, followed by about two days for installation of a CORK. These were planned in a sequence requiring two trips of the drill string, as follows:

1. Logs: After initial reentry with a logging bottom-hole assembly (BHA), a temperature log with the Davis-Villinger Temperature Probe (DVTP) was run, followed by three Schlumberger logs to delineate the fine-scale permeability structure of the open-hole section penetrated by Hole 395A. The three Schlumberger logs included two advanced sondes run for the first time in an ODP hole, the Azimuthal Resistivity Imager (ARI) and Dipole Shear Imager (DSI). If time allowed and formation conditions warranted, a flowmeter was also prepared for possible deployment.
2. CORK: Deployment of a fully configured CORK to seal the hole, instrumented with a 595-m-long, 10-thermistor cable, pressure sensor in the sealed section, and a reference pressure sensor at seafloor depth.

The CORK installation will provide a long-term (5 yr or longer) record of (1) the rebound of temperatures and pressures toward formation conditions after the emplacement of the seal, (2) possible temporal variations in temperatures because of lateral flow in discrete zones, and (3) pressure variations, which in a sealed hole would be the primary manifestation of changes in the forces that drive the natural circulation system. The first installment of data from the CORK experiment is scheduled to be collected during February 1998, utilizing the French submersible *Nautile*, with support from the National Science Foundation.

The primary purpose of the CORK experiment is not necessarily to assess the equilibrium pre-drilling thermal regime (which we can estimate from detailed heat-flow surveys as in Fig. 2), but instead to monitor how the hydrologic system varies with time as natural hydrogeological conditions are re-established. Full thermal re-equilibration could require many tens or hundreds of years if it occurs only by conductive processes, but could also occur in much less time if the Langseth et al. (1984, 1992) model of active lateral circulation is correct. We are interested primarily in exploring the causes of the hydrogeological state and any possible temporal variations, with the simplest goal to determine how these are associated with and controlled by formation pressure and/or permeability structure. It is impossible to model or predict all of the possible outcomes of the experiment, but considering two possible end-member results might be instructive.

1. If the model of active lateral circulation is basically incorrect and downhole flow is indeed simply an artifact of drilling, then sealing the hole should remove the driving force for the downhole flow, and temperatures and pressures will slowly and smoothly trend toward values consistent with conductive, hydrostatic processes.

2. If there is some element of truth to the model of active lateral circulation in basement, with this circulation providing the driving pressure differential for the downhole flow, then sealing the hole will not change the driving force, and lateral circulation should continue even though the seal has stopped the downhole flow. Pressures in the sealed hole should approach a nonhydrostatic value in an irregular fashion that reflects variability in the natural hydrogeologic processes. Similarly, temperatures will rebound toward values consistent with the circulation system, also in an irregular fashion that reflects natural hydrogeologic variability. In addition, differences in the behavior of the temperature sensors should reflect vertical variations in the lateral flow regime because of fine-scale permeability variations. We understand so little about crustal hydrogeology that simply defining the natural time and space scales of such variability will be a very important result.

RESULTS

Hole 395A

Leg 174B represents the fourth time Hole 395A has been reentered since it was drilled on Leg 45 (1975-1976). It was reentered for logging and downhole experiments during Legs 78B (1981) and 109 (1986) and using the French submersible *Nautile* during the DIANAUT reentry expedition

(1989). Past observations from Hole 395A indicate a continuous downhole flow of ocean bottom water and generally support a model of lateral flow of seawater in the upper basement beneath the sediment pond in which the site is located. The logs and CORK experiment deployed during Leg 174B will provide essential information about the formation pressure and permeability structure, which are keys to understanding the crustal hydrogeology at the site.

Initial shipboard interpretation of the DVTP and Schlumberger logs supports the following preliminary results: like all past temperature logs in Hole 395A, the DVTP (Fig. 4) and temperature logging tool (TLT) logs show virtually isothermal borehole temperatures from the seafloor down to 350 mbsf. From 350 to 450 mbsf, there is a slight increase in temperature; below 450 mbsf there is a much stronger increase in temperature. This reconfirms prior indications of a strong flow of ocean bottom water down the hole, at a rate of 1000-2000 l/hr, exiting into the formation between casing and 450 mbsf. Shipboard analyses of the Leg 174B Schlumberger logs (Figs. 5, 6) and comparisons to Leg 45 core description and logs from Legs 78B and 109 clearly show that Hole 395A consists of definable layers of pillow basalts, massive flows, and fluid aquifers that correlate to changes in the resistivity, velocity, and bulk density logs. Distinct changes in the high-resolution temperature gradient log and anomalies in the SP log indicate that at least two major aquifers are active in the hole at approximately 310 and 420 mbsf. Zones of high resistivity and high sonic velocity distinguish massive lava flows, and both resistivity and velocity generally increase toward the bottom of the hole. High-resolution borehole images, cement bond quality, formation strength, and elastic properties can be extracted from the Formation MicroScanner (FMS) and DSI logs. The ARI data (Fig. 7) produced images that show the character and orientation of individual pillow basalts and the heterogeneity of crustal structures at a vertical scale of approximately 1 m. From the comparison of FMS and ARI images, the extent of pillows and flows near the borehole may also be distinguished.

No CORK data will be available until the first submersible revisit to the site, tentatively scheduled for February of 1998, utilizing *Nautile*. The features of the log data described above are particularly relevent to the hydrogeologic structure in Hole 395A and illustrate the physical state of the ocean crust in unprecedented detail. Overall, the Leg 174B logging program has solidified the position of Hole 395A as the most important reference hole for young oceanic crust formed at a slow spreading rate.

Site 1074

Sixty-four meters of sediment and 0.58 m of basalt were recovered at the single hole drilled at Site 1074. A total of eight cores were recovered; Cores 1074-1H through 7H contain sediments, and Core 8X is basalt. Two lithologic units were defined: Unit I contains nannofossil ooze with varying amounts of foraminifers, clay, radiolarians and sand, and nannofossil clay, and overlies Unit II, a unit of aphyric basalt (Fig. 8). The sedimentary Unit I was divided into two subunits based on the magnetic susceptibility record, clay content, and the presence or absence of graded sand layers. Unit IA includes the upper 62 m of sediments; Unit IB, a red clay, occupies the lower 2 m. The clay content gradually increases, and the occurrence of sand (either foraminifer ooze or lithic fragments) decreases with depth in the hole. The magnetic susceptibility increases in intervals with increasing clay content, bioturbation, and sand layers. Foraminifer oozes are characterized by very low susceptibility values. The magnetic susceptibility increases sharply at the Subunit IA/IB contact and remains high in Subunit IB. Density and sonic velocity show normal gradients in the upper 10-20 m, below which high values correlate with sand layers.

The composition of interstitial waters at Site 1074 generally shows only minor variations as the result of diagenetic alteration. There is little evidence of microbial decomposition of organic matter, suggesting low organic matter content in the sediments. Potassium and H_4SiO_4 increase at the base of Subunit IA, indicating a source for these constituents in the clay-rich sediments (Subunit IB) at the base of the sedimentary section. There appears to be little diffusive exchange between sedimentary and basement pore fluids, perhaps as a result of the presumably low permeability basal clay. Downhole temperatures measured on Cores 3H through 6H are consistent with purely conductive heat transfer. Thus, there is no evidence for fluids vertically advecting through the sediment column at Site 1074. This observation supports the model proposed by Langseth et al. (1984, 1992) that fluid circulation is confined to the basement beneath the sediment pond and that heat transfer through the sediments is predominantly conductive.

CONCLUSIONS

The Leg 174B program was designed (1) to acquire logging data to provide essential information about the in situ physical properties, permeability structure, and formation pressure, which are keys to understanding the crustal hydrogeology at Site 395, and (2) to install a CORK with a 595-

m-long, 10-thermistor cable, a pressure sensor in the sealed section, and a reference pressure sensor at seafloor depth.

1. *Acquisition of logging data to provide essential information about the in-situ physical properties, permeability structure, and formation pressure.* Excellent quality logs were obtained with two temperature tools, the Schlumberger Formation MicroScanner, digital shear imager, azimuthal resistivity imager, density, and SP tools.

2. *Installation of a CORK with a 595-m-long, 10-thermistor cable, a pressure sensor in the sealed section, and a reference pressure sensor at seafloor depth.* The CORK was smoothly installed; first data will be recovered during a revisit tentatively scheduled for February of 1998, using the French submersible *Nautile*.

3. At contingency Site 1074, a 64-m-thick section of sediments was successfully cored. Downhole temperature measurements and pore-fluid chemistry indicate no significant pore-water advection through the sediments, supporting a model derived from observations at Hole 395A that significant lateral fluid flow occurs within basement beneath the sediment pond where both sites are located.

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FIGURE CAPTIONS

Figure 1. Location of Holes 395A, 418A, 504B, and 648B. Dashed lines show ages of crust in millions of years, deduced from magnetic anomalies (after Hyndman, Salisbury, et al., 1984).

Figure 2. Location of heat-flow measurements (filled circles), pop-up pore pressure instrument (PUPPI) deployments (open circles), piston cores (inverted triangles), and Hole 395A and Site 1074 in North Pond. Heat-flow values are given in mW/m^2 (from Langseth et al., 1992). A-A' marks the location of a seismic line shown in Langseth et al. (1992).

Figure 3. Schematic model of pore-water flow and isotherms (°C) beneath North Pond and surface heat flow, assuming laminar lateral flow rate of ~1 mm/yr (from Langseth et al., 1984).

Figure 4. DVTP temperatures vs. corrected depth in Hole 395A. Also shown are the positions of the thermistors (T1 through T10) deployed in the hole in the CORK experiment.

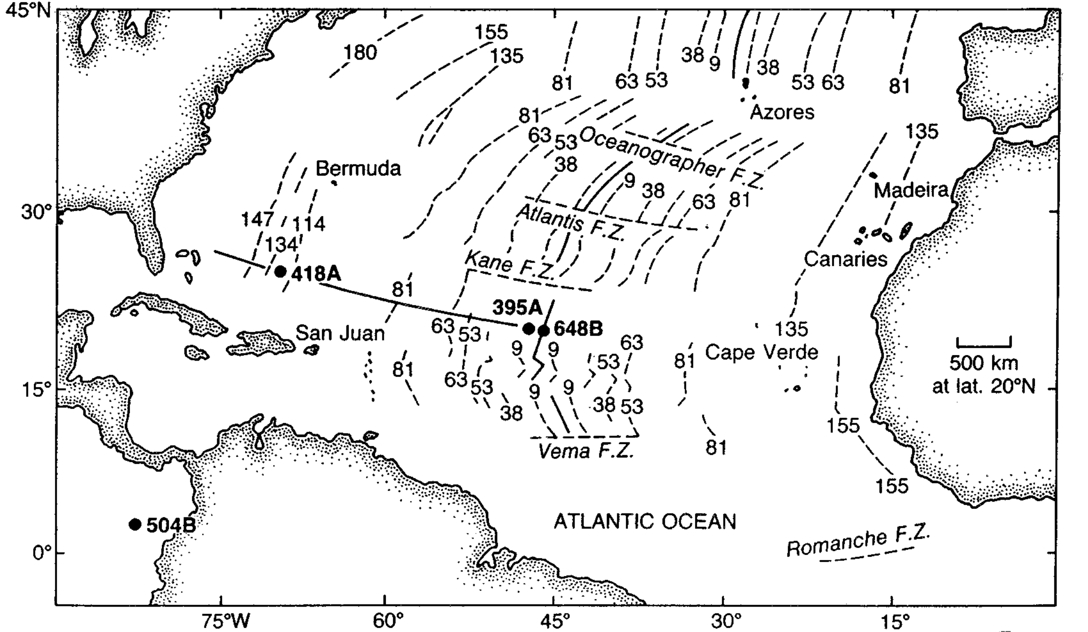
Figure 5. Composite log of hole parameters, electrical logs, and sonic logs recorded during Leg 174B in Hole 395A. Track 1: spontaneous potential (mV), temperature gradient (ºC/m), calipers C1 and C2 from the FMS tool (inches). Track 2: Pad 1 azimuth (P1AZ) of the FMS tool (º), hole azimuth (HAZI [º]), and hole deviation (DEVI [º]). Track 3: spherical focused log (SFLU in Ω-m) and induction log deep (ILD in Ω-m). Track 4: laterolog shallow (LLS) and deep (LLD) in Ω-m. Track 5: travel times for the shear (DTS) and compressional (DTC) waves (µs/ft).

Figure 6. Composite log of the nuclear logs and spectral gamma-ray logs recorded in Hole 395A during Leg 174B. Track 1: photoelectric factor (PEF; barns/e^-) and density (RHOB in g/cm^3). Track 2: neutron porosity (NPHI in %). Track 3: computed gamma ray (HCGR) and total spectral gamma ray (HSGR) both in gAPI. Track 4: contents of uranium (ppm), thorium (ppm), and potassium (%).

Figure 7. Comparison between ARI recordings, FMS images, the resistivity logs (LLSC and LLDC), the *P*-wave velocity (DT4P), and the shear wave velocity (DTS) between 462 and 472 mbsf. The 1-m-thick dark interval at 468 mbsf in the ARI image corresponds to a porous

zone, and the high-resistivity massive layer near 471 mbsf corresponds to distinct anomalies in the resistivity and sonic logs. The FMS images show considerably greater resolution of the relative conductivity changes over this interval and reflect formation characteristics that are not apparent at the broad scale of the other logs.

Figure 8. Generalized lithology of the sedimentary units recovered at Hole 1074A.


45°N
30°
15°
0°
75°W
60°
45°
30°
15°
180
155
135
81
63
53
38
9
147
114
134
Bermuda
Azores
Oceanographer F.Z.
Atlantis F.Z.
Kane F.Z.
Vema F.Z.
Romanche F.Z.
Madeira
Canaries
Cape Verde
San Juan
418A
395A
648B
504B
500 km
at lat. 20°N
ATLANTIC OCEAN

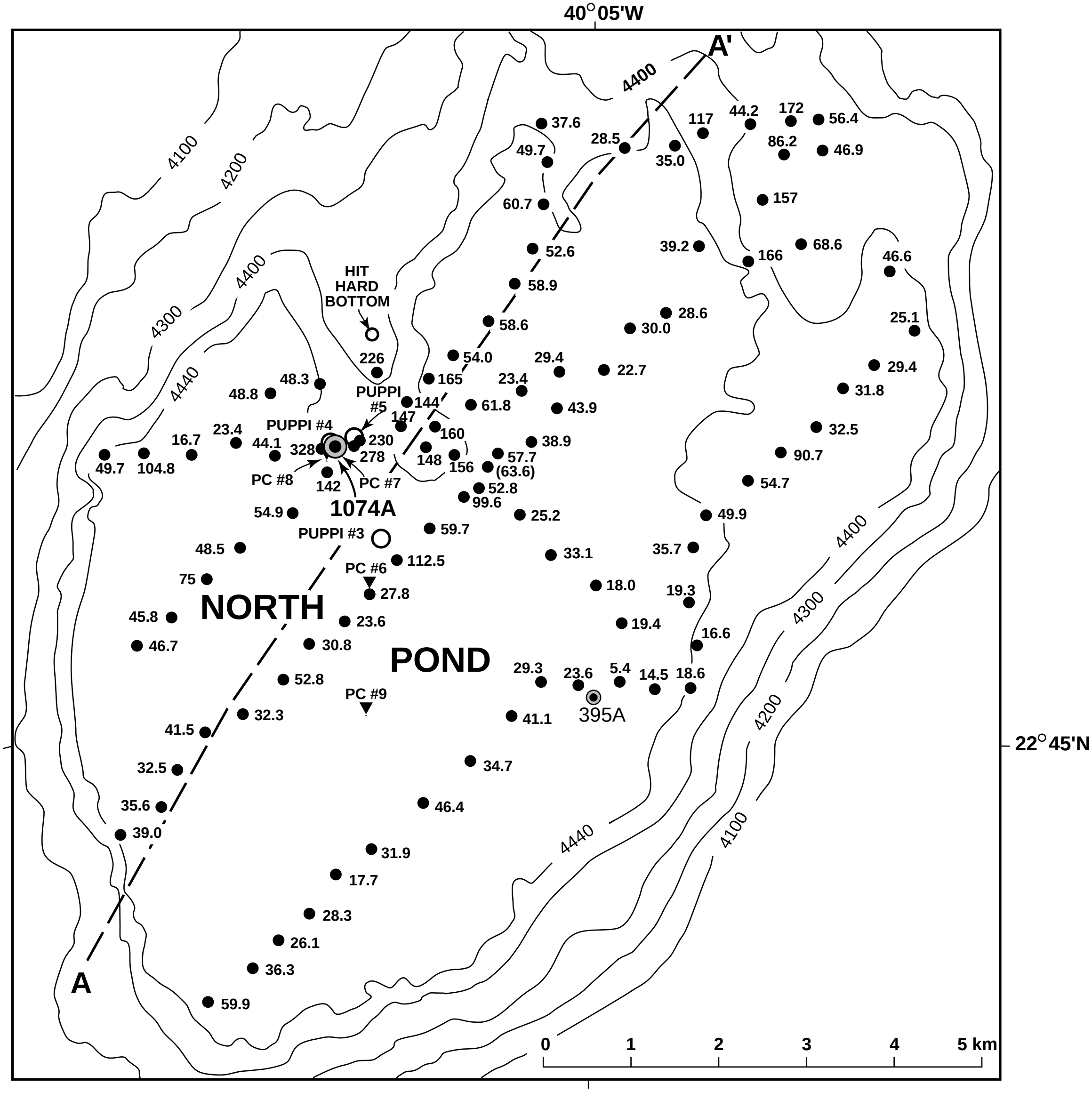

40° 05'W
22° 45'N
A
A'
4100
4200
4300
4400
4440
HIT HARD BOTTOM
PUPPI #4
PUPPI #5
PUPPI #3
PC #6
PC #7
PC #8
PC #9
1074A
395A
NORTH
POND
0 1 2 3 4 5 km

Figure 2

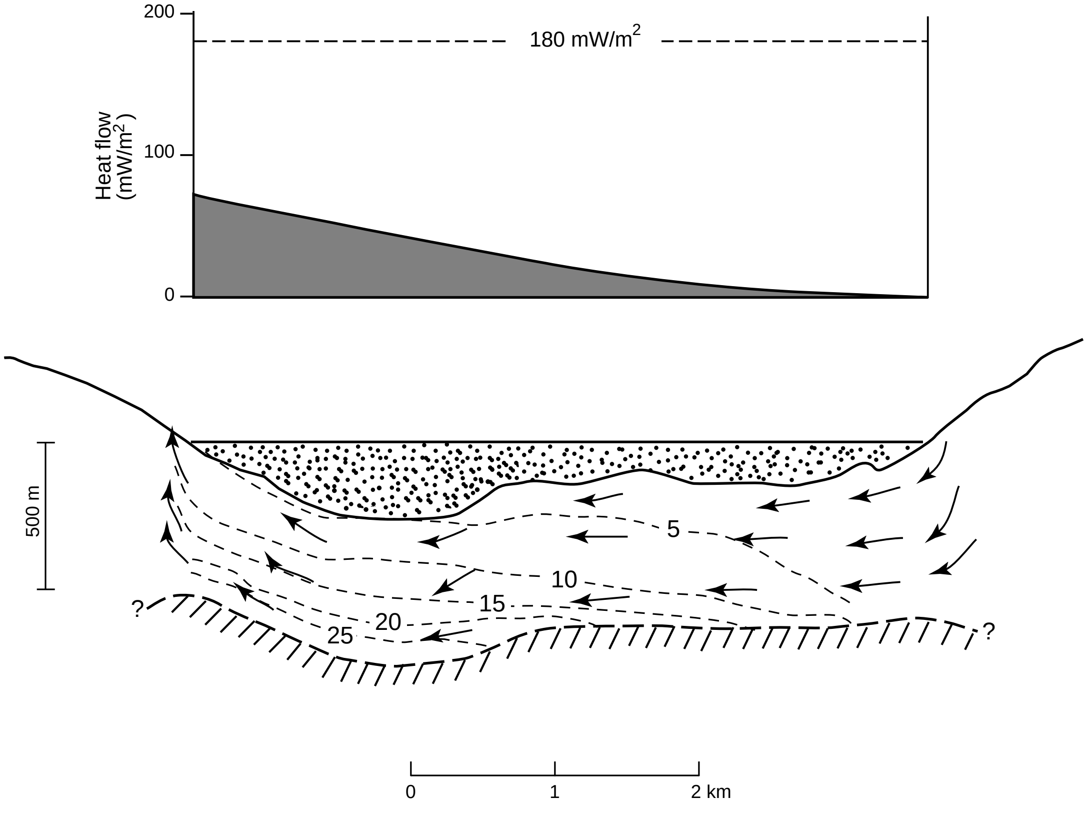


Figure 3

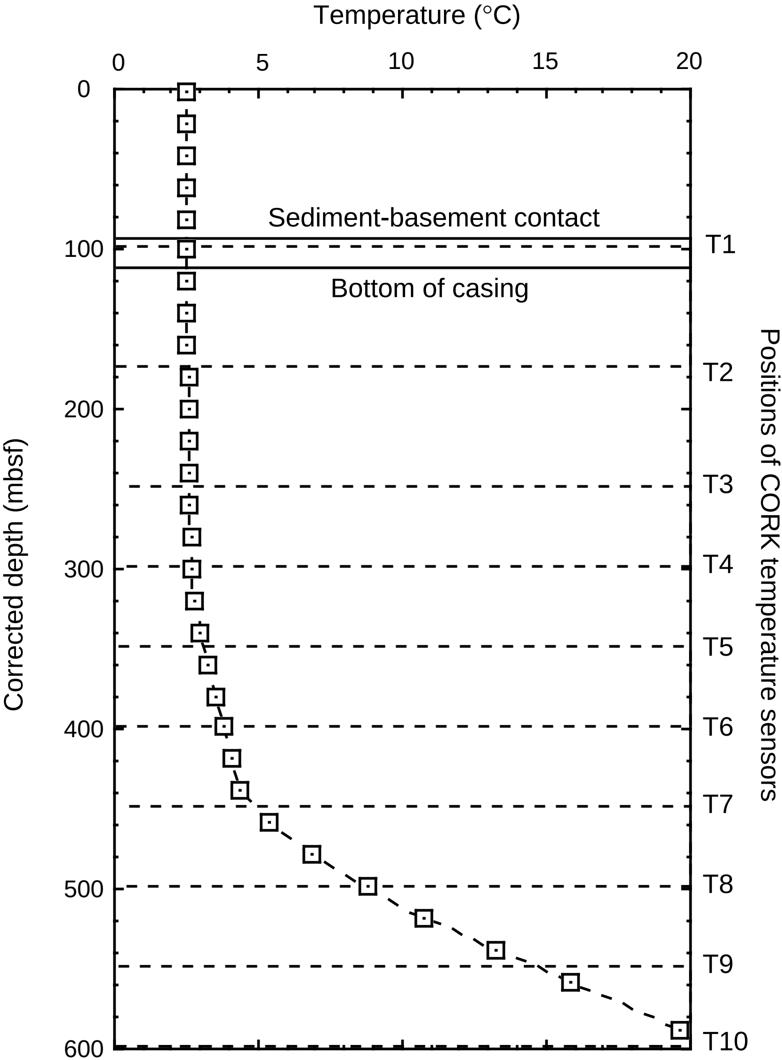

Temperature (°C)
0
5
10
15
20
0
100
200
300
400
500
600
Corrected depth (mbsf)
Sediment-basement contact
Bottom of casing
T1
T2
T3
T4
T5
T6
T7
T8
T9
T10
Positions of CORK temperature sensors

Figure 4

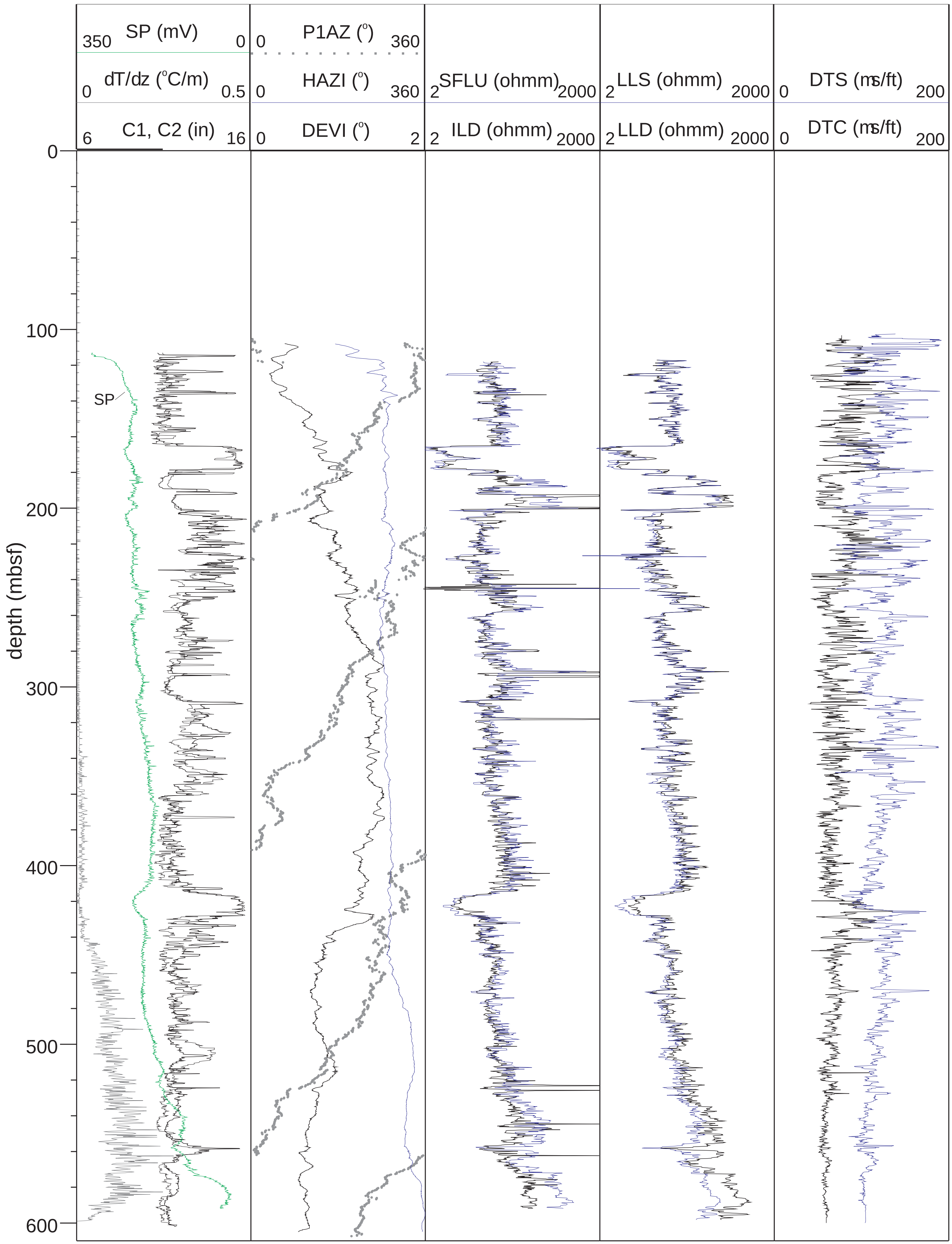
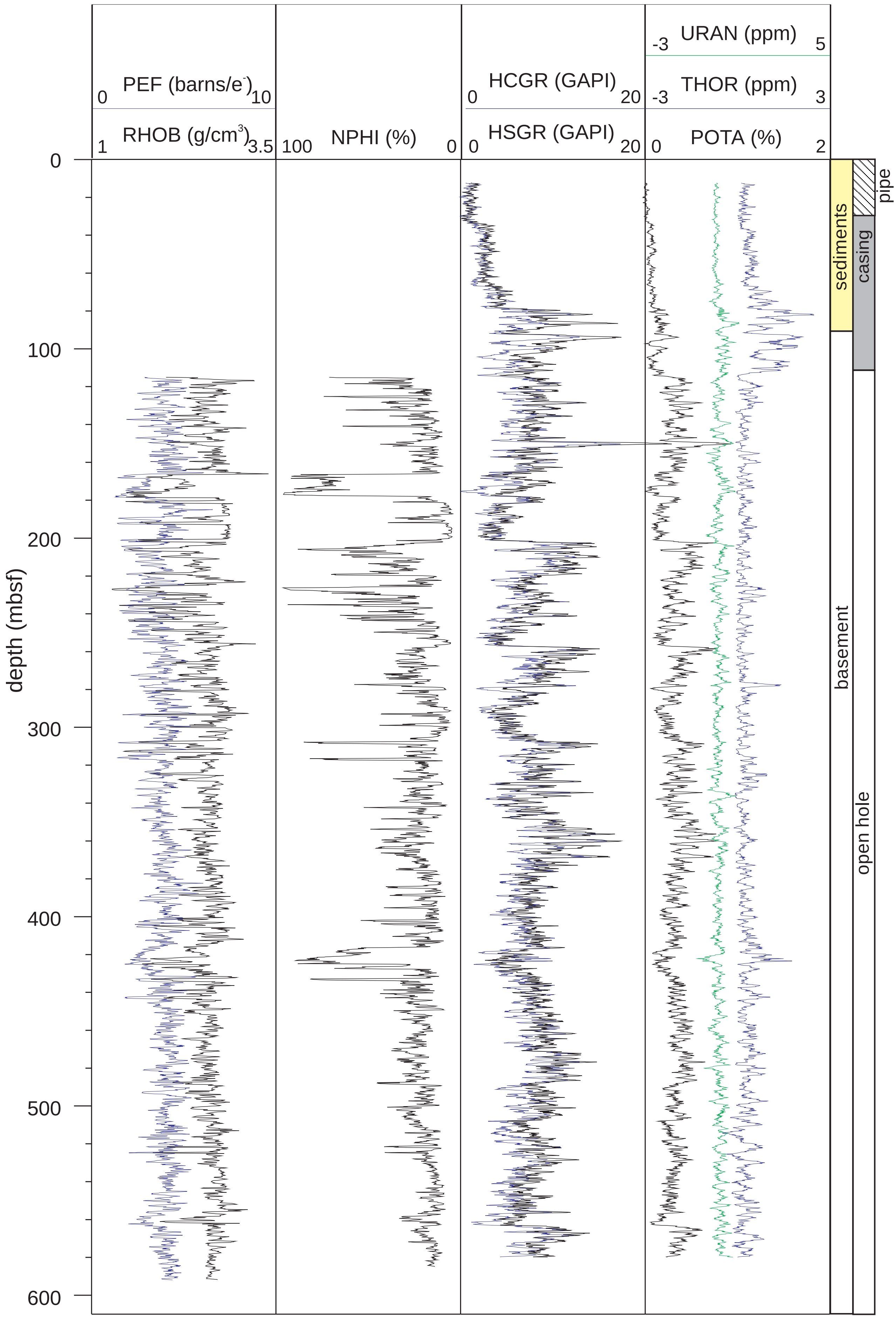
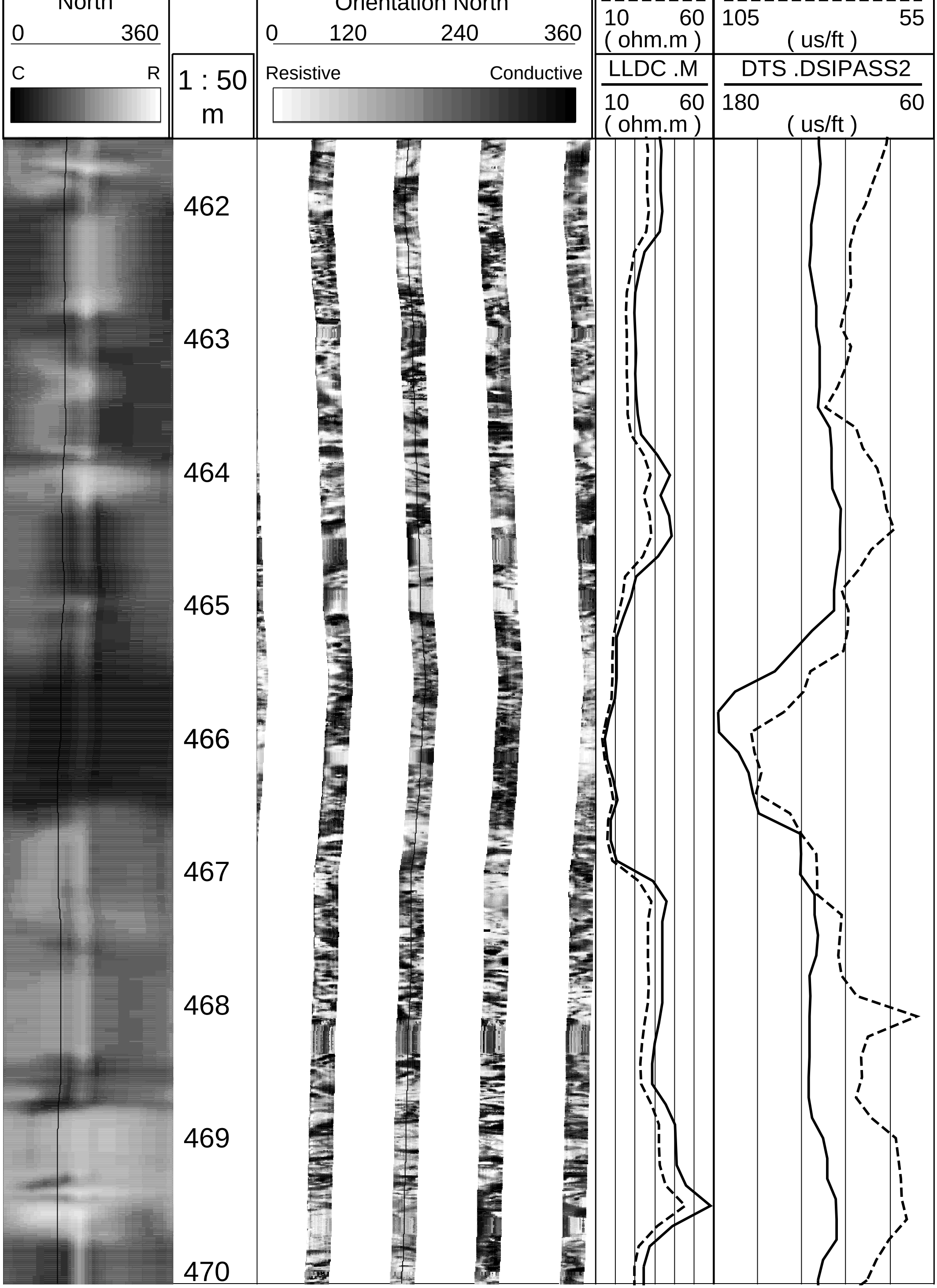


Figure 395-E-1



0 PEF (barns/e-) 10
1 RHOB (g/cm3) 3.5
100 NPHI (%) 0
0 HCGR (GAPI) 20
0 HSGR (GAPI) 20
-3 URAN (ppm) 5
-3 THOR (ppm) 3
0 POTA (%) 2
depth (mbsf)
0
100
200
300
400
500
600
sediments
basement
pipe
casing
open hole


North
0 360
C R
1 : 50
m
Orientation North
0 120 240 360
Resistive
Conductive
10 60
(ohm.m)
LLDC .M
10 60
(ohm.m)
105 55
(us/ft)
DTS .DSIPASS2
180 60
(us/ft)
462
463
464
465
466
467
468
469
470

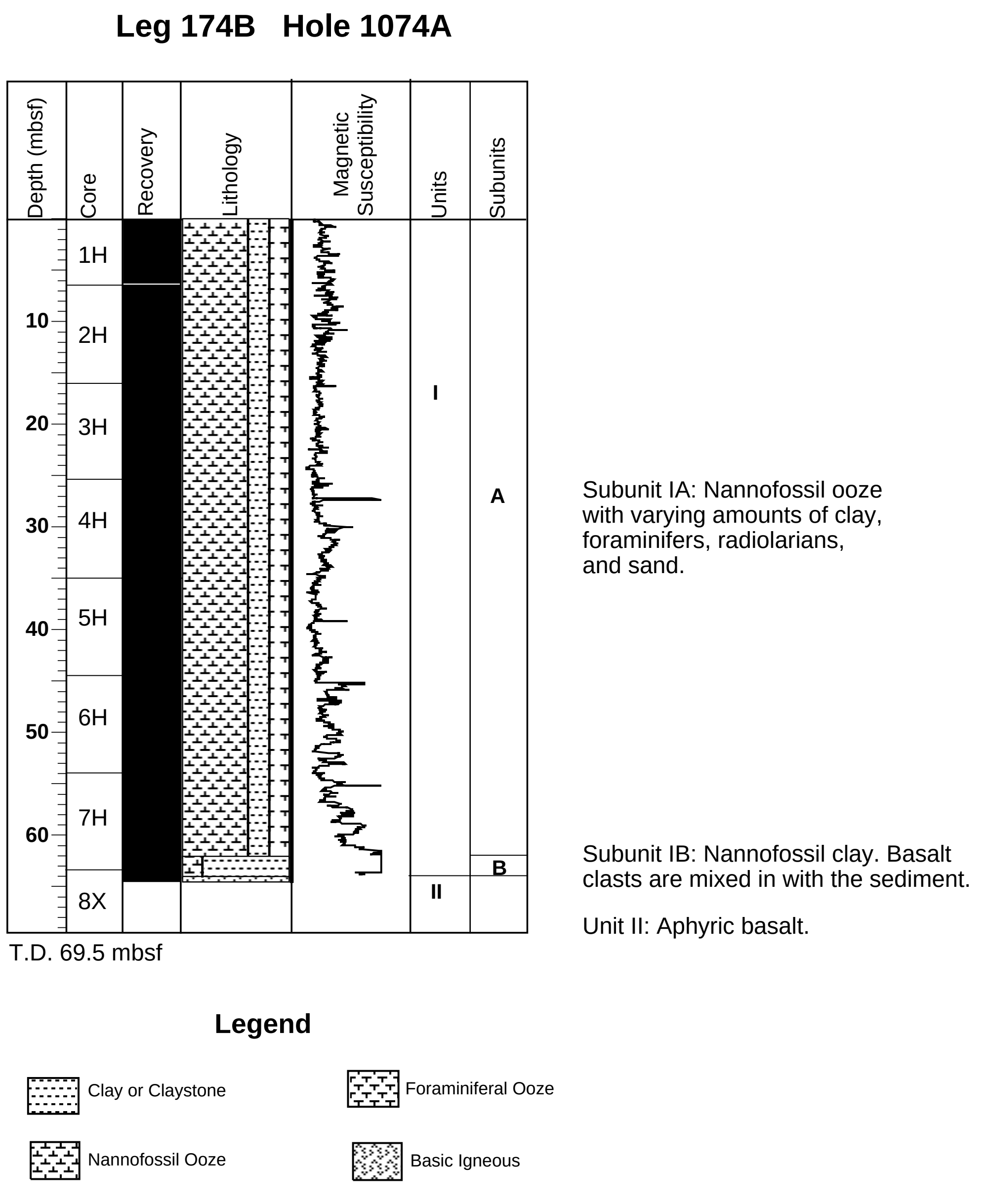

Leg 174B Hole 1074A
Depth (mbsf)
Core
Recovery
Lithology
Magnetic Susceptibility
Units
Subunits
1H
2H
3H
4H
5H
6H
7H
8X
10
20
30
40
50
60
I
II
A
B
Subunit IA: Nannofossil ooze with varying amounts of clay, foraminifers, radiolarians, and sand.
Subunit IB: Nannofossil clay. Basalt clasts are mixed in with the sediment.
Unit II: Aphyric basalt.
T.D. 69.5 mbsf
Legend
Clay or Claystone
Foraminiferal Ooze
Nannofossil Ooze
Basic Igneous

Figure 8

OPERATIONS SYNOPSIS

The drilling and engineering personnel aboard *JOIDES Resolution* for Leg 174B were:

Operations Manager:	Eugene Pollard
Engineer:	Charles Bollfrass
Schlumberger Engineer:	Jonathan Kreb

TRANSIT TO HOLE 395A

The ship departed at 1600 hr (EST) on 21 July, 1997 from New York City. The 1768 nmi (3274 km) sea voyage to Hole 395A was completed in 154.5 hr at an average speed of 11.4 kt. All subsequent times reported in this operations section are local time (UTC-2hr), unless otherwise noted.

HOLE 395A

The ship arrived on location at Hole 395A at 0700 hr on 28 July. Following deployment of a beacon, reentry/logging bottom-hole assembly (BHA), and reentry video system, the seafloor was tagged at 4494 mbrf or 4482.5 mbsl. The reentry cone was located and reentered in 3 hr, nearly 100 m northeast of the last reported coordinates. The bit was then positioned at 32 mbsf for logging. The DVTP was run first on the coring line, logging temperatures during 5-min station stops every 20 m down the hole. This was followed by three Schlumberger logging runs, including two advanced sondes never before deployed in ODP holes: the Azimuthal Resistivity Imager (ARI) and Dipole Sonic Imager (DSI). The first tool string included the ARI, spectral gamma ray (HNGS), and Lamont high-resolution TLT sondes; excellent data were acquired from 603 mbsf to the bottom of casing at 113 mbsf. The second tool string included the spectral gamma ray (NGT), DSI, and FMS. Three passes of this string in the open hole section were run using the DSI in conventional monopole, in-line and cross-dipole, and Stoneley wave recording modes, respectively. Good to excellent FMS and compressional and shear waveform data were collected during the first two passes, with the exception of two enlarged intervals near 120 and 420 mbsf. Data from the third pass are of lesser quality, partly because of an electronic fault that precluded further use of the wireline heave compensator. The third triple-combo tool string included the spectral gamma ray (HNGS), Advanced Porosity Sonde (APS), Lithodensity Sonde (LDS), and Digital Induction Tool (DITE). The entire hole was logged up to the seafloor without using the wireline heave compensator, and a repeat log was run from 136 to 106 mbsf. The data are of excellent quality, with the exception of the two hole enlargements near 120 and 420 mbsf, where the density and neutron porosity tools lost contact with the borehole wall. An SP log was also acquired over the open hole interval. Throughout the logging operations, good hole conditions were encountered down to 603 mbsf, and it was never necessary to run the bit beyond 32 mbsf and into open hole for cleanout operations.

After the logging operations, Hole 395A was successfully sealed with a CORK, instrumented with long-term data logger, pressure gauges above and below the seal, and a cable with 10 thermistors (at 98, 173, 248, 298, 348, 398, 448, 498, 548, and 598 mbsf). The data logger was positively latched into the CORK body, but the CORK body could not be mechanically latched into the casing. However, the CORK was seen on video to be in proper position, and the lack of a mechanical latch should not compromise the experiment; the seals are in proper position and the 21-yr history of downhole flow in Hole 395A suggests that there is virtually no possibility that the formation will develop positive pressures large enough to displace the CORK and breach the seals. The CORK running assembly arrived on deck at 0230 hr on 1 August, ending operations in Hole 395A.

HOLE 1074A

After successful deployment of the CORK, almost two days of operational time were still available. This extra time was applied to the contingency plan for Leg 174B, coring the sediments in North Pond. The ship was moved 2.4 nmi (4.44 km) northwest in dynamic positioning (DP) mode, and a beacon was deployed. An advanced hydraulic piston corer (APC) BHA was assembled, and a brief survey with the VIT frame camera was conducted to confirm the seafloor condition, which was flat and featureless. Based on recovery of the mudline core, the water depth is 4445.5 mbsl. Hole 1074A was spudded at 1315 hr, 1 August and APC Cores 1074A-1H through 7H were taken from 0 to 63.5 mbsf (103.6% recovery). Adara heat-flow measurements were made on Cores 3H through 6H, and the Tensor tool was run on Cores 3H through 7H. The inner core barrel used to cut Cores 2H, 4H, and 6H contained a 3-m-long nonmagnetic section. Core 7H was a partial stroke, encountering a hard layer (basalt clast) with increased torque at 8.5 m (62.5 mbsf); hence, the lower 1.53 m of Core 7H is probably highly disturbed (flow-in). The hole was drilled down to 63.5 mbsf, 1.5 m below the APC shoe penetration. We switched to the extended core barrel (XCB) coring system and Core 8X was cut from 63.5 to 69.5 mbsf. High torque stalled the rotary repeatedly, requiring increased pump rates, a mud sweep, and repeated reaming of the hole. Despite the hole problems, Core 8X was retrieved with 0.58 m of basalt (9.7% recovery).

During the connection after Core 8X, the beacon signal was lost for positioning. Shortly thereafter the internet connection to the global positioning system (GPS) Glonass and GPS systems in the underway lab were lost, and the positioning back-up reference was also lost. The drill pipe was pulled and the ship was held to a 45 m maximum excursion using dead reckoning until the bit cleared the seafloor at 0520 hr on 2 August, ending Hole 1074A.

TRANSIT TO LAS PALMAS

The 1726 nmi (3197 km) sea voyage to Las Palmas was completed in 166 hr at an average speed of 10.4 kt, which included 8.75 hr at 6 kt while conducting seismic streamer tests over the Madeira/Cape Verde abyssal plains. The first line was ashore at 1500 hr on 9 August, officially ending Leg 174B.

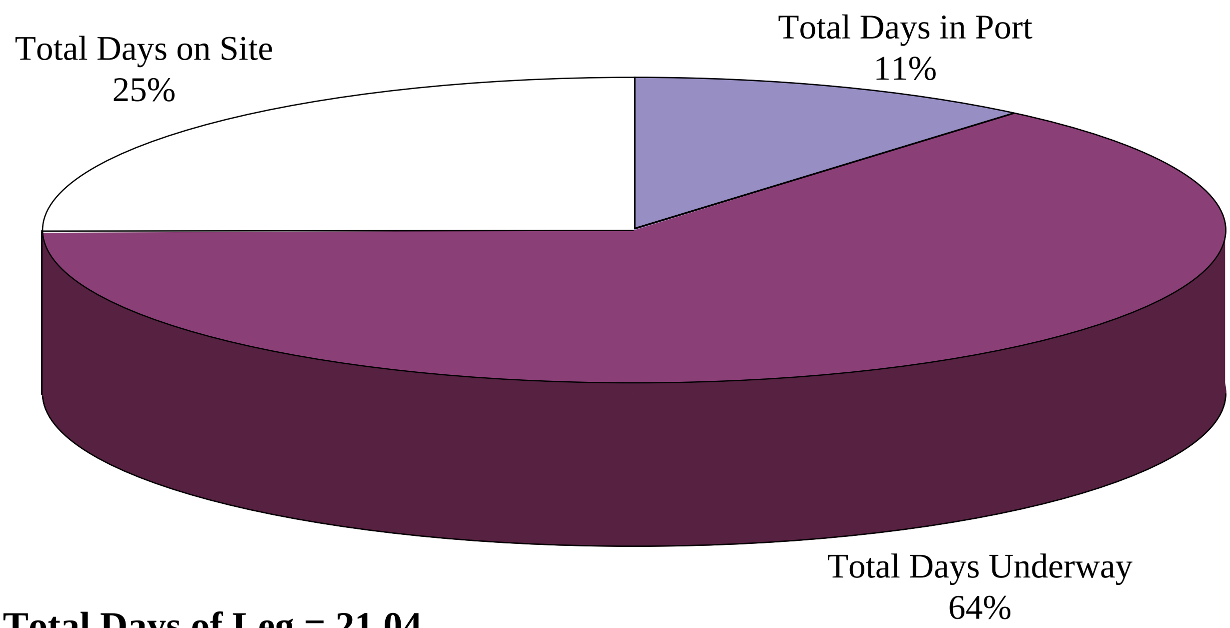
OCEAN DRILLING PROGRAM
OPERATIONS RESUME
LEG 174B

Total Days (19 JULY 1997 to 9 AUGUST 1997)	21.04
Total Days in Port	2.33
Total Days Underway	13.42
Total Days on Site	5.29

	days
Coring	0.65
Tripping Time	0.79
Logging/Downhole Science	1.66
Mechanical Repair Time (Contractor)	0.00
Stuck pipe/Hole Trouble	0.00
Reentry Time	0.00
W.O.W.	0.00
CORK	2.11
Other	0.08

Total Distance Traveled (nautical miles)	3496.0
Average Speed Transit (knots):	11.2
Number of Sites	2
Number of Holes	2
Number of Cores Attempted	8
Total Interval Cored (m)	69.5
Total Core Recovery (m)	71.76
% Core Recovery	103.3%
Total Interval Drilled (m)	0.0
Total Penetration	69.5
Maximum Penetration (m)	69.5
Minimum Penetration (m)	69.5
Maximum Water Depth (m from drilling datum)	4485
Minimum Water Depth (m from drilling datum)	4485

LEG 174B
TOTAL TIME DISTRIBUTION



Total Days of Leg = 21.04

OCEAN DRILLING PROGRAM
SITE SUMMARY
LEG 174B

HOLE	LATITUDE	LONGITUDE	WATER DEPTH (mbrf)	NUMBER OF CORES	INTERVAL CORED (meters)	CORE RECOVERED (meters)	PERCENT RECOVERED (percent)	DRILLED (meters)	TOTAL PENETRATION (meters)	TIME ON HOLE (hours)	TIME ON HOLE (days)
395A	22° 45.3519'N	46° 04.8609'W	4494.0	0	0.0	0.00	0.0%	0.0	0.0	91.5	3.81
HOLE 395A TOTALS:				**0**	**0.0**	**0.00**	**0.0%**	**0.0**	**0.0**	**91.5**	**3.81**
1074A	22° 46.8326'N	46° 06.7398'W	4457.0	8	69.5	66.34	95.5%	0.0	69.5	16.1	0.67
HOLE 1074A TOTALS:				**8**	**69.5**	**66.34**	**95.5%**	**0.0**	**69.5**	**16.1**	**0.67**
LEG 174B TOTALS:				**8**	**69.5**	**66.34**	**95.5%**	**0.0**	**69.5**	**107.6**	**4.48**

The ODP technical and logistics personnel aboard *JOIDES Resolution* for Leg 174B were:

Sandy Dillard	Marine Logistics Specialist (Storekeeper/Shipping)
Tim Fulton	Marine Lab Specialist (Photographer)
Edwin Garrett	Marine Lab Specialist (Paleomagnetics)
Dennis Graham	Marine Lab Specialist (Underway)
Gus Gustafson	Assistant Lab Officer/Marine Lab Specialist (Downhole Tools)
Burney Hamlin	Lab Officer
Michiko Hitchcox	Marine Lab Specialist (Yeoperson)
Dave Kotz	Marine Computer Specialist
Kevin MacKillop	Marine Lab Specialist (Physical Properties)
Bob Olivas	Marine Lab Specialist
Chieh Peng	Marine Lab Specialist (Chemistry)
Don Sims	Assistant Lab Officer/Marine Lab Specialist (X-ray)
Larry St. John	Marine Electronics Specialist
Chris Stephens	Marine Computer Specialist

GENERAL LEG INFORMATION

New York City Port Call

This port call was arranged as a Public Relations event, although there was considerable pressure to carry on much of the normal port-call routine. Because of limited facilities and potential cost, only high-priority items were moved, including cores to the ECR and leg samples and data. Logging-while-drilling tools and a SSI water gun were shipped to the owners. CORK components needed to instrument Site 395A and network system upgrade components were received.

Surplus equipment, DOT boxes, gas bottle racks, K-boxes, and pallets remained aboard. Hazardous items were deferred to Las Palmas and then Capetown port calls.

Tours for visitors were conducted over the three days, including VIPs, an open house for scientists, and tours for Schlumberger investor groups.

Service calls were arranged including ARL, to repair the second goniometer on the ARL X-ray fluorescence (XRF) unit, and SERCAL, to clean and align the research microscopes. Liquid helium was received to top off the cryogenic magnetometer in preparation for the upcoming remote southern latitudes and to verify how much helium the instrument is using. Bill Goree of 2G was employed for the fill and to recalibrate the support electronics. The device that measures the helium level was removed to be serviced.

Underway from New York City to Hole 395A

In port, Windows NT4 was installed on the navigation computers and a new version of WinFrog, our navigation software, was loaded. The ship departed New York City at 1600, 21 July. Underway watches begin at 1800, 22 July well out of New York's traffic. The quality of the 12-kHz depth transceiver record was poor and faded in deeper water. The instrument was eventually secured for troubleshooting. Depths for the remainder of the leg were read by hand from the 3.5-kHz record. Navigation, magnetic, and bathymetric data were collected. The Omnistar GPS receivers in GPS mode were used on the transit. The *JOIDES Resolution* arrived at Hole 395A located on the mid-Atlantic Ridge at 0700, 28 July to begin five days of reentry, temperature measurement, and a CORKing operation to seal the cone and prepare it for submersible tending. The reentry cone was located approximately 100 m from its reported location.

Underway from Site 1074 to Las Palmas, Canary Islands

Site 1074A was terminated a few hours early when the positioning beacon and the network carrying the site position display failed simultaneously. The ship maintained heading, drifting off site, while the drill pipe was pulled; we were underway for Las Palmas about 1415, 2 August. Watches started immediately, again recording bathymetry, magnetics, and navigation. Depths were read from the 3.5-kHz depth record. On the 7th of August, the multichannel and single channel hydrophone arrays were deployed for 8 hr of comparison testing.

LAB ACTIVITIES

Chemistry Lab

Shipboard analysis of interstitial waters extracted from 18 whole-round samples collected on Leg 174B included refractometric analysis for salinity; titrations for pmH, alkalinity, and chloride; ion chromatography for sulfate, potassium, sodium, calcium, and magnesium; and spectrophotometric analyses for silica, phosphate, and ammonium. Atomic absorption spectrophotometry was used to determine Sr concentrations in pore waters.

Routine equipment maintenance was preformed including reverting to the original NGA capillary columns used on the unit because of inconsistent results. Parts were ordered for the ignition section of the atomic absorption unit. Support was given to the JANUS group, who reviewed the chemistry lab database applications. Worn areas on the lab bench top surface were renewed, and cabinets were cleaned, painted, and relabeled. Sandy Dillard was introduced to some of the lab equipment and procedures.

Computer Services

Two network hubs were replaced with wideband fiber optics based units during the initial underway time. The physically larger size of the units slowed the replacement. This upgrade caused problems with Appletalk zones using the FastPath interface to the ethernet system. The network maintenance jobs were done "after hours" to minimize interference with the JANUS group users.

Several computer viruses were discovered and cleared, primarily from SEDCO machines. SEDCO replaced eight of the PCs on their network.

Core Lab

The catwalk heaters were wired and installed above the catwalk area in preparation for the upcoming high-latitude cruises. The electrical department then removed the heaters for storage until they are needed.

Curation

No curatorial representative sailed on Leg 174B. Eight cores were collected, tagging basement. Interstitial water samples were taken for the chemistry lab and physical properties and cryogenic magnetometer measurements were made. The interstitial water samples were squeezed and analyzed. Three X-ray diffraction (XRD) samples were taken. The samples and cores will remain on board for shipment to the BCR with the Leg 175 collection.

Electronics Support

Support in the labs was mostly routine, addressing problems with the pycnometer in the physical properties lab and the atomic absorption unit in the chemistry lab. A second EPC recorder was installed in the underway lab to replace the 12-kHz Raytheon machine. The 12-kHz transceiver and transducer were investigated as the system failed in deep water. Both copiers required maintenance and were cleaned.

An ongoing project to remove obsolete Totco and DCS sensors and wiring was outlined and initiated.

Magnetics Lab

The cryogenic magnetometer was filled and tuned during the New York port call. A series of experiments with wash cores and a hybrid core barrel with a stainless steel section were conducted to identify possible sources of magnetic overprints on sediment cores. Initial results concluded that the core barrel was not the major contributor to the overprint.

Microscope/Photography Labs

The microscope lab was used primarily by JANUS members who used the computer facilities.

Paleontology Lab

No core samples were processed. Electrical power distribution in the area was modified to dedicate a circuit to the dishwasher; the extension cords were removed.

Physical Properties

Physical properties measurements on the eight cores included multisensor track runs, thermal conductivity, index properties, and shear strength. The pycnometer process controller caused some trouble but is presently working. Information and suggested spare parts were requested. The Tech Help for the lab was brought up to date.

Safety

Four of the staff volunteered for the METS team and mustered for two fire drills. The library safety video VCR was moved to SEDCO's lounge for their ongoing Quality Through Teamwork indoctrination classes. Two Safety/training wood shop videos, missing for several legs, have not been returned.

Storekeeping

Whereas preparation for the port call was fairly hectic, administration of the plan went fairly well. Anticipated difficulty with the Unions proved to be unwarranted. As this was a cruise ship and passenger terminal, the layout was not optimal for normal dockside loading and unloading.

Underway/Fantail

Sets of positions were collected on site to compare the data quality of the two types of GPS receivers, the Omnistar GPS and Ashtech GPS/GLONASS. The second EPC flatbed recorder was installed, replacing the 12-kHz Raytheon flat bed recorder. The Pelagos annotation software was tested with both recorders; a few problems remain. A replacement power supply for the 12-kHz transceiver is expected in the coming shipment.

The hydraulics system associated with the hose handlers was disassembled to replace valves. Hoses and associated fittings were also replaced. Seals in two hose puller motors failed at different times; one was replaced. Planned space modifications and furniture installation for the underway lab was deferred as the furniture was not shipped to New York City as anticipated.

A test seismic line was conducted on 7 August to work with the yellow multichannel array. Various preamplifier and gain values were used to match the analog record of the multichannel array with the single channel analog record. Various lead weight combinations and lengths of cable played out were tried on the multichannel array to achieve comparable depths with the single channel array at the same speed. Initial conclusions are that the real time analog record from a six channel (six phones) combined does not compare with a 60 phone single-channel array.

X-ray Lab

Once the X-ray fluorescence unit stabilized, a long series of standards were made for major and minor element analysis in preparation for upcoming legs. Familiarization and training began for Bob Olivas in the X-ray lab, focusing on the XRD. There was exposure to other X-ray lab routines and the JANUS data application that is being developed. Three XRD analyses were made of samples taken from Hole 1074A.

MISCELLANEOUS

Special Projects

Journalist Alan Hall sent reports to shore that were ultimately destined for the *Scientific American* web page at www.sciam.com. A rough draft was placed on the ship's local web site to give us the flavor of the web page.

Paleomagnetist Mike Fuller carried out a series of experiments to study magnetic signatures potentially caused by the core barrels and/or moving the barrel through the drill pipe. A hybrid steel and stainless steel core barrel was employed for the test; a few coresat Hole 174A were taken with it.

JANUS database project members worked to complete some key tasks for the first development phase of the new computer database system and to set the stage for phase two. Phase two will primarily focus on incorporating digital photographic images of cores into the visual core description applications.

The library was thoroughly inventoried; some duplicates were removed to be returned to ODP. The Filemaker Pro book list was updated along with the printed catalog. The reprint files were spread into five file drawers to reduce crowding.

Problems

Heavy rain on the departure from New York generated a flood in the casing hold that was controlled by barrels, rags, and mops. The hatch gasket failed or was damaged moving the freight or cores. The hatch was eventually covered with a tarp until the rain abated and the seal could be reseated.

LABORATORY STATISTICS

General:

Sites:	2
Holes:	1
Total Penetration:	69.5
Meters Cored:	69.5
Meters Recovered:	66.78
Time on Site (days):	0.6
Number of Cores:	8
Number of Samples, Total	N/A
Number of Core Boxes:	11

Lab Analysis:

Magnetics Lab	
Half-section Measurements:	45
Discrete Measurements:	0
Tensor Tool Holes	1
Physical Properties	
Index Properties:	16
Velocity :	1
Resistivity:	0
Thermal Conductivity:	0 (WHOI) 29 (TK04)
MST:	57
Shear Strength:	1
Chemistry Lab	
Inorganic Carbonates ($CaCO_3$):	0
Water Chemistry (the suite includes pH, Alkalinity, Sulfate, Chlorinity Phosphate, Ammonia, Ca, Mg):	18
Head Space Gas Analysis:	0
Pyrolysis Evaluation, Rock-Eval:	0
X-ray Lab	
XRD:	3
XRF:	0
Thin Sections:	0

Underway Geophysics (est.)

Total Transit Nautical Miles:	2852
Bathymetry:	2852
Magnetics:	2852
Seismic:	48
XBT's Used:	0