OCEAN DRILLING PROGRAM

LEG 118 SCIENTIFIC PROSPECTUS

FRACTURE ZONE DRILLING ON THE SOUTHWEST INDIAN RIDGE

Paul T. Robinson
Co-Chief Scientist, Leg 118
Centre for Marine Geology
Dalhousie University
Halifax, Nova Scotia B3H 3J5
Canada

Richard P. Von Herzen
Co-Chief Scientist, Leg 118
Woods Hole Oceanographic Institution
Woods Hole, MA 02543

Andrew C. Adamson
Staff Scientist, Leg 118
Ocean Drilling Program
Texas A&M University Research Park
1000 Discovery Drive
College Station, TX 77840

Philip D. Rabinowitz
Director
ODP/TAMU

Audrey W. Meyer
Manager of Science Operations
ODP/TAMU

Louis E. Garrison
Deputy Director
ODP/TAMU

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Introduction

Leg 118 drilling plans include one or more holes in the Atlantis II Fracture Zone of the Southwest Indian Ridge. The primary goal will be to drill a deep (500 m +) hole in exposed upper mantle peridotite on a median ridge of the fracture zone with the aid of a hardrock guidebase. If a deep hole at this site is not achievable, other locations on the walls and floor of the fracture zone will be attempted. If a deep hole is achieved, a major program of geophysical logging and other downhole measurements will be carried out. Secondary objectives are to drill a series of shallow basement holes across the floor of the fracture zone and to sample basement in active and fossil nodal basins. The ship is scheduled to depart Mauritius 23 October 1987 and return to Mauritius 14 December 1987.

Scientific Objectives

Fracture zones are ubiquitous features of the oceanic lithosphere, yet little is known regarding their petrology, structure or tectonic evolution. Recent models for ridge dynamics (e.g., Schouten and Klitgord, 1982) suggest that fracture zones play a major role in segmentation of spreading ridges. They are considered to be relatively cold zones separating stationary spreading center cells beneath spreading ridge segments. Crustal magma chambers are believed to lie beneath the spreading cells, and new crust is formed by crystallization along the walls of the magma chambers and by vertical and lateral injection of magma along the spreading ridge. In this model, less magma will reach the far edges of the spreading cells (i.e., fracture zones) leading to thinner crustal sections. Such thinning of oceanic crust in the vicinity of fracture zones has been demonstrated by seismic studies along the ridge axes (e.g., Detrick and Purdy, 1980; Fox et al., 1980; Cormier et al., 1984). In some cases, the crustal thickness, particularly beneath nodal basins, may be less than 5% to 10% of normal sections.

Because of these relatively thin crustal sections and the great topographic relief of many fracture zones, mantle material is commonly exposed on their floors and walls. The abundance of mantle rocks in fracture zones appears to correlate closely with the spreading rate of the associated ridge. For example, peridotites compose over 65% of all material dredged from fracture zones of the very slow spreading Southwest Indian Ridge whereas they make up only 10-15% of dredge hauls from typical fracture zones of slow spreading ridges and are nearly absent from those of the fast-spreading East Pacific Rise (Dick, in preparation). Considering the difficulty of achieving deep penetration in normal ocean crust, fracture zone drilling provides one of the best possibilities for obtaining *in-situ* samples and stratigraphy of oceanic mantle.

Abyssal peridotites dredged from spreading ridges and fracture zones are generally regarded as residues of partial melting of mantle material from which mid-ocean ridge tholeiite magmas have been extracted. It is expected that drilling in fracture zones will allow sampling of petrologically related basaltic, gabbroic and ultramafic rocks. Study of such cores will lead to a better understanding of the processes of partial melting in the mantle, melt extraction and later modification in shallow magma chambers.

Other general objectives of fracture zone drilling are to:

1) Determine the lateral and vertical variability of rock types on the floor of the fracture zone.

2) Investigate the nature and distribution of deformation in a fracture zone and determine whether there is a single slip plane, multiple planes, or penetrative slip across the entire width of the feature.

3) Determine the thermal structure of transform-generated crust and assess the extent of alteration and seawater penetration.

4) Determine the nature and thickness of oceanic crust in the nodal basins where the ridge crests meet the transform fault.

5) Determine the physical properties, magnetism and seismic velocities of transform generated crust and particularly to document any anisotropy in these properties.

Geologic Background

The Atlantis II Fracture Zone is one of a series of major transform faults offsetting the very slow-spreading Southwest Indian Ridge (Figs. 1 and 2). This 210-km-long feature trends roughly north-south and crosses the ridge at approximately 57°E. Spreading on the Southwest Indian Ridge is very slow, on the order of 0.8 cm/yr (Fisher and Sclater, 1983).

Conrad cruise 27-09 (H. Dick, Chief Scientist) conducted a detailed survey of the fracture zone and adjacent ridge segments in October, 1986. Sea Beam echo sounding, seismic reflection profiling, magnetics, and gravity were run along closely spaced tracks (5 km) parallel to the fracture zone with nearly complete coverage over a 55-km-wide strip. The southern and northern rift valleys of the offset spreading ridge are well defined, with over 2200 m of relief and widths of 22 km and 38 km, respectively (Fig. 3). A line of small axial volcanos marks the southern ridge crest. Well defined nodal basins lying on the transform side of the present day neovolcanic zone mark the intersections of the transform and ridge axes.

The transform valley is about 30-40 km wide, measured between the slope breaks from normal ridge topography to the steep transform walls. The valley floor systematically deepens from about 5 km to 6 km and narrows from 14 km to 7.5 km between north and south. The spreading rate, as determined from the magnetic anomalies mapped to the east and west of the transform (Fig. 3), has been about 10 mm/yr over the last 20 m.y. The magnetic anomalies created since Anomaly 5 appear to extend into the transform valley close to the inferred present-day slip zone.

Relief on the transform valley is on the order of 5800 m, and the walls of the transform valley are remarkably steep (typically 30-40°), though locally they may be much more subdued - particularly along the western side of the valley. The deepest point is 6480 m in the southern nodal basin, and the shallowest is an uplifted bench on the eastern transverse ridge at 680 m.

A bathymetrically prominent "median tectonic ridge" bisects the northern half of the transform valley, and can be followed intermittently down the southern half as well (Fig. 3). In the north, this ridge shoals to 4200 m and has relief between 1000 m and 1500 m, whereas in the southern half the relief drops abruptly to only a few hundred meters. In this area, two deep (6.3 km) flat-floored, sedimented basins 2.5 km x 24 km and 4 km x 18 km are divided by a relatively low (120-250 m) median tectonic ridge. Seismic reflection profiles (Fig. 4) along the axes of these basins and across the median tectonic ridge show stratified sediments which are at least 120 m thick in the centers of the basin and which appear to onlap and possibly drape the intervening ridge. A piston core into each of these basins recovered 3 m of sand and pebbly gravel up to 2 cm in diameter. Each of the trigger cores contained pelagic ooze, and we believe that before the core was washed during recovery, the original sediment consisted of a mixture of pebbles, sand and pelagic ooze.

Dredging of the walls and floor of the fracture zone yielded chiefly ultramafic rock, and lesser amounts of gabbro, basalt and greenstone. In all, 2100 kg of rock were recovered from 35 dredge hauls. Peridotite is the dominant lithology in about one-third of these hauls. Four dredge hauls along the median tectonic ridge recovered serpentinized peridotite, gabbro, metamorphosed basalt and diabase, suggesting that this feature is the locus of extensive hydrothermal alteration and emplacement of serpentinized mantle peridotite. One dredge haul from the southern end of the median ridge recovered only peridotite. Virtually all of the basaltic rocks recovered are altered, and the alteration was usually oxidative with many of the rocks stained a bright red or white. In addition, some unusual breccias cemented by a black tarry-appearing hydrothermal oxide were recovered. These observations suggest that the conditions of hydrothermal alteration along the transform plate boundary may differ substantially from those occurring along ocean ridges.

The Conrad survey extended about 85 km into the fracture zone trace north of the transform. Curvilinear bathymetric trends along the east wall reflect the transition from seafloor material created at the ridge crest to that formed in the transform (Fig. 3). Two sedimented basins, 4.5 km to 5 km deep and 10 km to 20 km across, are found along this part of the fracture zone floor. In one of these, several heat flow measurements were made, and a piston core of pelagic ooze was recovered. Heat flow values obtained ranged from about 15 mW/m^2 to 115 mW/m^2, with most towards the lower end of the range.

Site Selection

The general scientific objectives of fracture zone drilling and selection of generic sites were outlined in proposals by Dick (JOIDES #89/13), Von Herzen (JOIDES #186F) and Dick et al. (JOIDES #89B, revised). The specific sites outlined below (Table 1) were chosen to address the most important problems, based on detailed site survey data.

SWIR I - Transform Median Ridge

The prime site (SWIR I) is located on the southern portion of the median ridge in the transform at about 32°32'S, 57°03'E (Table 1). The water depth at this site is about 4700 m. A survey along this portion of the ridge axis detected no sediment cover (Fig. 5), so a hardrock guidebase will be deployed if a suitable site can be located. A dredge haul in this area recovered mainly ultramafic rocks, suggesting that peridotite crops out at the surface.

The main goal at this site is to drill a deep hole in peridotite, presumed to represent upper mantle, in order to obtain samples for study of mantle mineralogy, petrology and alteration characteristics. Also of interest are the physical properties and deformational characteristics of the rocks.

The prime site will be surveyed with the television-sonar system to locate a flat, rubble free area. Several unsupported bare-rock spud-ins will be attempted with the 9 1/2 in. coring motors to determine the nature and drilling characteristics of the rock. If drillable peridotite is encountered, the guidebase will be set and a reentry hole drilled to whatever depth is feasible. If successful, the entire leg could be devoted to this one site (Table 2). Based on the experience of Leg 109 (Site 670) the drilling rate should be quite high in partly serpentinized peridotite. New drill bits have been devised by ODP to improve bit life and core recovery. If a deep hole is drilled successfully, it will be used to carry out an array of downhole measurements (Table 3).

<u>SWIR II - West Transform Wall</u>

Because the highest priority of Leg 118 is to drill a deep hole in mantle material, a backup site (SWIR II) has been identified in case no suitable site can be found on the median ridge. SWIR II is located on the west wall of the fracture zone at 32°51'S, 56°55'E in an area where abundant peridotite was dredged during the site survey and where the bathymetric contours suggest a relatively gently sloping wall. The area will be surveyed with the television-sonar system to locate a flat bench on which the hardrock guidebase can be deployed. As at SWIR I, the nature and drilling characteristics of the basement will be tested with the 9 1/2 in. coring motors prior to deploying the guidebase. The general objectives and operational scenario for this site are similar to those for SWIR I.

<u>SWIR III - Southern Transform Flat-Floored Basin (Central Basin)</u>

This "site" is a transect of 4 to 5 "pogo test holes" designed to sample basement across the sediment-filled basins in the southern half of the transform. Two possible locations have been identified, one at about 33°07'S, 57°07'E in the eastern basin, the other at 33°01'S, 57°03'E in the western basin (Fig. 3). The "pogo" drilling involves coring and washing the sedimentary section and coring the upper 20 or so meters of basement using the XCB/ 3-3/4 in. Navidrill. With this technique multiple holes can be drilled without tripping the pipe to the surface to change bits between each hole. The main goal of this drilling is to obtain samples of basement across the floor of the fracture zone to test for lateral variability in lithology, alteration and deformational fabric. A secondary objective is to sample the sediments on the floor of the fracture zone by spot coring. If one of the "pogo" holes samples easily drillable peridotite, the hole could be deepened by deploying a free-fall reentry cone. Alternatively, a standard reentry cone could be used to start a new hole in the same vicinity.

SWIR IV - Active Nodal Basin

This site is located in the northern nodal basin at approximately 31°57'S, 57°05'E. A profile across this basin indicated no sediment cover (Fig. 6), and two dredge hauls recovered basalt, gabbro, and greenstone. The main purpose of this site is to determine the lithology and structural characteristics of the rocks at the point were the spreading ridge and fracture zone meet. A deep reentry hole would be attempted here only if the hardrock guidebase had not been deployed at either SWIR I or SWIR II. Otherwise, unsupported bare-rock spud-in would be attempted using the 9 1/2 in. coring motors.

SWIR V - Fossil Nodal(?) Basin

This site is located in an isolated basin on the east side of the fracture zone north of the present northern nodal basin at about 31°34'S, 57°08'E on crust which has not passed through the transform. It is interpreted as a captured and uplifted fossil nodal basin with an age of about 10 m.y. The scientific rationale for drilling at this location is the same as for SWIR IV; the advantage is that SWIR V has a sediment cover in excess of 100 m (Figs. 7 and 8), making conventional drilling possible. However, SWIR V is given a lower priority because its tectonic environment is less certain.

Logging, Downhole Measurements, and Physical Properties

A primary objective of Leg 118 is deep penetration of rock believed representative of the mantle (peridotite) in the Atlantis II Fracture Zone. Assuming that such a hole is established by drilling on Leg 118, an important part of the leg scientific objectives is to characterize the nature of the rock penetrated as completely as possible, especially since such rocks are only rarely drilled. Logging, special downhole experiments, and laboratory physical properties measurements will be conducted particularly to characterize the physical state (*in-situ* temperature, porosity, permeability, acoustic, electrical, and magnetic properties, density, fabric, stratigraphy, stress, etc.) and the chemistry and mineralogy (including alteration). *In-situ* measurements will be compared with recovered sample measurements to the extent possible to optimize the characterization of the material penetrated (Table 3).

The standard (Schlumberger) logging tools will be used to obtain comparisons with the same measurements in crustal rocks drilled on other legs, and to give continuous data over the entire vertical section drilled. The standard tool combinations will be run: the seismic stratigraphy combo., geochemical combo., and lithoporosity combo. A dual laterolog tool will be used to give the deep (several meters) electrical resistivity around the hole, and a large-scale electrical resistivity experiment may be deployed to deduce the mean resistivities to even greater distances from the hole. The multi-(12) channel sonic tool will be deployed to provide the seismic wave (compressional, shear, Stoneley) structure of the material penetrated. Another seismic experiment of high scientific priority is a vertical seismic profile, in which a 3-component seismometer is clamped in the hole at various depths and a source (air/water gun) deployed at the ship, giving accurate total seismic traveltimes as well as data (possibly) on anisotropy.

Some special tools will be available to determine in-situ magnetic properties of rocks, including remanent magnetization direction and intensity, and magnetic susceptibility. It will be useful to compare these with similar measurements made in the shipboard laboratory on cores and samples which may provide information on the cooling history and/or metamorphism of these rocks. Rock alteration will be further quantified with a complex resistivity tool (low frequency AC current) which is sensitive to the clay and water content of rocks.

We will attempt to determine the equilibrium temperature profile in the rock penetrated by the borehole to calculate heat flow and the mode of heat transfer. This will be done by logging temperatures in the hole at least twice, separated in time as far as possible (e.g., preceding and after logging and other downhole measurements). Thermal conductivity will be measured on cores/samples in the laboratory and calculated in-situ from the porosity log. High resolution temperatures ($\leq$0.01 ^{o}C) will be obtained from either a sensor (platinum) multiplexed with the complex resistivity tool, or from independently recording instrumentation attached to the logging tools or built into the hydraulic piston corer.

Packers will be set in the hole to determine fluid permeability; either the section below the pipe can be packed off, or a straddle packer used to isolate vertical intervals of particular interest. A borehole televiewer will be run to determine configuration of any well bore breakouts, fabric, micro-fractures, and suitable locations for packer sets.

Some logs and experiments are not useful to run within the pipe or casing (lithoporosity, dual laterolog, multichannel sonic, borehole televiewer, magnetometer, complex resistivity, large-scale resistivity, packer). Therefore, to optimize logging, the amount of casing set should be minimized and the drill pipe kept as high in the hole as possible when these tools are being used.

As shown in Table 3, a complete suite of logs and downhole measurements in a moderately deep hole will require about 8.5 days; an added contingency time of 2 days would allow for possible tool failures or breakdown of associated equipment. Multiple holes with shallower penetration would require additional time because of the need to traverse the water column multiple times with each tool. In this case, compromises would have to be made in the tools deployed and/or the vertical intervals covered at each hole.

Physical properties of cores and samples will be determined in the shipboard laboratory with available instrumentation (density, water content, thermal conductivity, remanent magnetization, magnetic susceptibility, AC demagnetization, etc.), and attempts will be made to determine anisotropy in relevant parameters. Additional measurements in shore-based laboratories may be useful to characterize more completely the rock samples recovered and to enhance the interpretations of downhole logs and experiments (P & S wave acoustic velocities, thermal demagnetization, etc.).

Operational Plan

On departing from Mauritius, the vessel will head for the median ridge site (SWIR I), where a television-sonar survey and test spud-ins will be made to determine the optimal site for deployment of the hardrock guidebase. After deployment, the vessel will drill as deeply as possible at the site and carry out an extensive logging and downhole measurements program during the operational time of about 46 days before returning to Mauritius (Table 2).

If, on the other hand, problems are encountered with the primary objective, a series of fallback operations is available with lower priority sites (Fig. 9). These operations are designed to tackle the highest priority sites first and to utilize efficiently the available leg time. The operational pathways depend on the type of problem encountered and operational time remaining in the leg. The following operations description explains Figure 9 from top to bottom as operational decisions proceed during the leg.

If all proceeds satisfactorily with the primary objectives, the operations will follow the pathway through the upper left side of the diagram for the entire leg. Should drilling conditions be poor following deployment of the guidebase, then the option exists to move to the central basin (SWIR III). If, however, following the television-sonar survey and test spud-in at the median ridge, weather at the site is unsatisfactory or marginal for guidebase deployment, the ship would move to the central basin. Spud-in and washing/drilling with the normal rotary bottom-hole assembly is not as weather dependent, and would allow testing of basement rock type and drillability at several sites across the basins. These drilling tests would allow determination of lateral variability of rock types across the fracture zone, after which the vessel could return to the primary site if the weather had then improved. If not, a standard or free-fall reentry cone could be set at one of the basin sites if favorable drilling was indicated, or we could continue with other options following the diagram.

If the television-sonar survey or the test spud-ins do not define a suitable median ridge site, the vessel would traverse to the fracture zone west wall (SWIR II) where substantial peridotite was recovered in dredging. An operations scenario similar to that of the median ridge site would be followed here, and if a suitable site is found, the guidebase would be deployed and drilling/logging would continue for the remainder of the leg. On the other hand, the lack of a suitable site or poor drillability after deploying the guidebase would also cause default to the central basin transect (SWIR III).

If the gravel basin sites should prove undrillable or otherwise unsatisfactory, there are two possible default options. If the guidebase was still on board, the vessel would proceed to the nodal basin (SWIR IV) where the sediments are either very thin or absent. If the guidebase was not available because it had already been deployed at a previous site, drilling would be attempted in the fossil "nodal" basins in the northern fracture zone (SWIR V) where sufficient pelagic sediment exists for normal rotary spud-in. The latter would also be the preferred option if the nodal basin site proves unsatisfactory (Fig. 9). Depending on the remaining time available in the leg, the fossil "nodal" basin site could be either a single bit hole or a standard reentry hole.

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TABLE 1
LEG 118 OCEAN DRILLING PROGRAM
SOUTHWEST INDIAN RIDGE

Location of proposed sites

[a]Site Number	Latitude	Longitude	Water Depth (m)	[b]Penetr. (m)	Operations	Objectives
SWIR I	32° 32'S	57° 03'E	4600	500+	TV-sonar survey, unsupported spud-in, guidebase, rotary coring, logging	Deep hole into ultramafic rock
SWIR II	32° 51'S	56° 55'E	3800	500+	Same as SWIR I	Same as SWIR I
SWIR III	33° 01'S and/or 33° 07'S	57° 03'E and/or 57° 07'E	6200-6400	20, 500+	Rotary coring, set standard reentry cone, logging	Profile of pogo holes through sediment and into basement, with selection of one site for deep drilling
SWIR IV	31° 57'S	57° 05'E	5500	200+	Same as SWIR I	Same as SWIR I
SWIR V	31° 34'S or 31° 35'S	57° 08'E or 57° 04'E	4400	200+	Rotary coring, reentry, logging	Deep hole into basement

Notes:

[a] Alternative site names:

SWIR I	Transform median ridge
SWIR II	West transform wall
SWIR III	Southern transform flat-floored basin (Pogo sites)
SWIR IV	Active nodal basin, N.E. transform valley
SWIR V	Fossil (nodal?) basin

[b] Penetration into basement. SWIR III and SWIR V - meters of basement penetration after drilling through sediment.

TABLE 2
LEG 118 OCEAN DRILLING PROGRAM
SOUTHWEST INDIAN RIDGE

Primary Site Occupation Schedule

Site	Location	Travel Time (Days)	[a]Drilling Time (Days)		Date (Approximate)
	Depart: Mauritius				23 October 1987
	Underway	2.8			
SWIR 1	32° 32'S 57° 03'E		site survey	1.8	
			test hole(s)	4.4	
			HRGB deployment	2.7	
			[b]drilling	27.0	
			logging	10.5	11 December 1987
				46.4 days operations	
	Underway	2.8			
	Arrive: Mauritius				14 December 1987
		5.6 days transit			52 days leg total

Notes:

[a] All times are estimates.

[b] Drilling time includes approx. 6.6 days to set reentry cone and casing in hardrock guidebase (HRGB).

Transit times between primary and secondary sites are as follows:
SWIR I to SWIR III 2.5 hours
SWIR I to SWIR IV 2.9 hours
SWIR III to SWIR IV 5.5 hours

TABLE 3
LEG 118 OCEAN DRILLING PROGRAM
SOUTHWEST INDIAN RIDGE

Logging and Downhole Measurements

Experiment	[a]Time (hrs.)
1) Temperature w. magnetic susceptibility	9
2) Seismic strat./geochemical combo. logs	35
3) Lithoporosity log	10
4) Dual laterolog	10
5) 12-channel sonic	12
6) Borehole TV	16
7) Magnetometer	11
8) Complex resistivity	12
9) Large scale electrical resistivity	12
10) Vertical seismic profile	18
11) Drill string packer	[b]48
12) Temperature	9
Total	8.5 days
Breakdown + contingency	2.0 days

Notes:

[a] Assumes 700 m hole in 5 km water depth, and with sidewall entry sub installed; a 1 km water depth change will change total time by 0.5 day.

[b] Includes drill string trip time to install packer elements.

FIGURE CAPTIONS

Figure 1: Bathymetric map of the southern Indian Ocean. Contour intervals at 1000 m. Prime drill site (SWIR I) shown. Box shows location of Figure 2.

Figure 2: Atlantis II Fracture Zone within the plate tectonic configuration of the Southwest Indian Ocean. Magnetic anomalies after Patriat et al. (in preparation). Dashed line shows past plate boundaries. Box shows location of Figure 3.

Figure 3: Tectonic map of the Atlantis II Fracture Zone (after Dick et al., in preparation). Hachured linear zones are preliminary magnetic anomaly identifications. Short lines and circles are rock dredge locations: arrows highlight dredges consisting predominantly of serpentinized peridotite. Dotted areas denote basins. Proposed drilling sites are rectangles with Roman numerals, and lines with letters at each end are seismic profiles shown in other figures.

Figure 4: Seismic profile (air gun) B-B' (Fig. 3) across the sedimented central basins. Conrad cruise 27-09, 24 October, 1986.

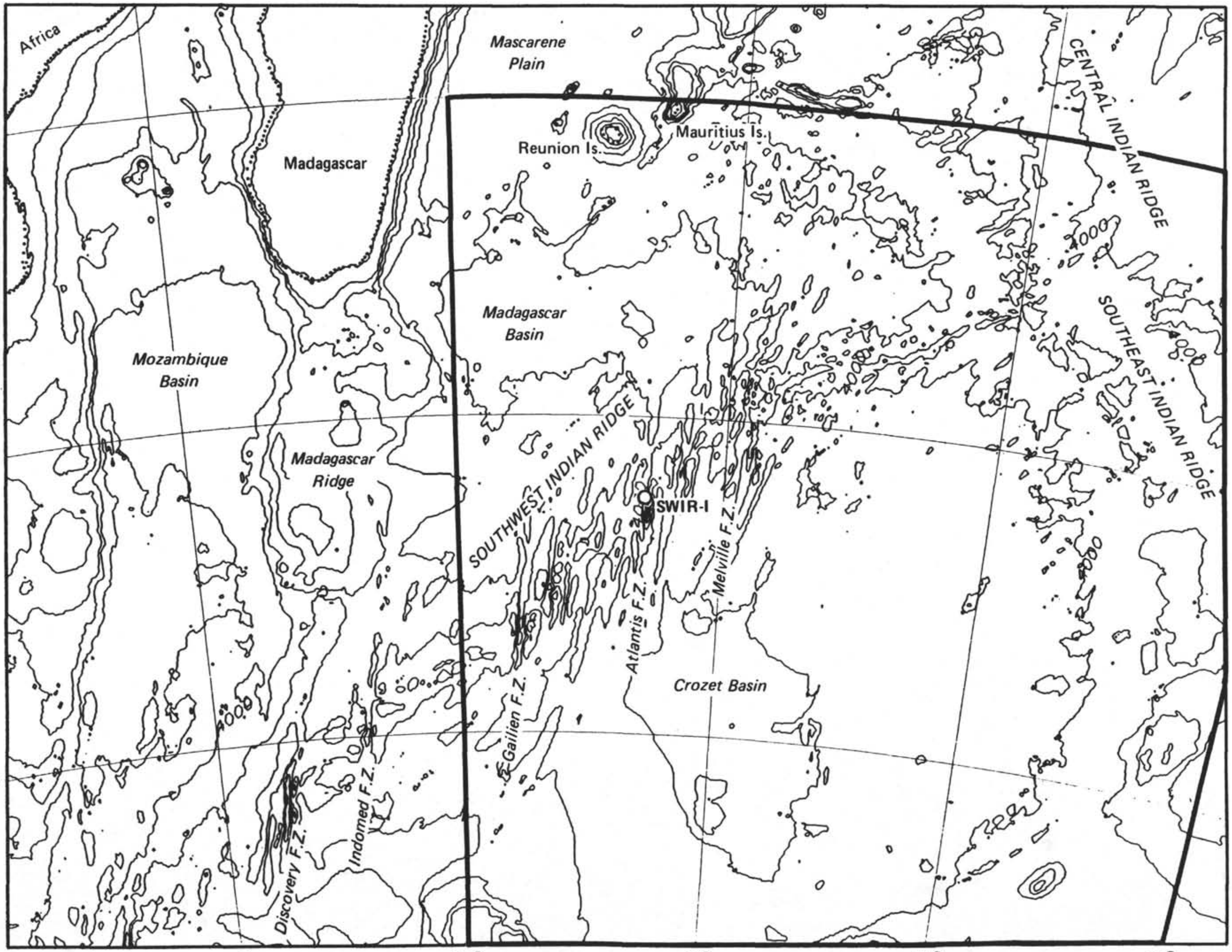
Figure 5: Seismic profile A-A' (Fig. 3) primarily along the eastern flank of the median ridge. Conrad cruise 27-09, 15-16 October, 1986.

Figure 6: Seismic profile C-C' (Fig. 3) across the northeastern nodal basin. Conrad cruise 27-09, 9 October, 1986.

Figure 7: Seismic profile E-E' (Fig. 3) across the eastern flanking walls and basins of the fracture zone north of the active transform. Conrad cruise 27-09, 7-8 October, 1986.

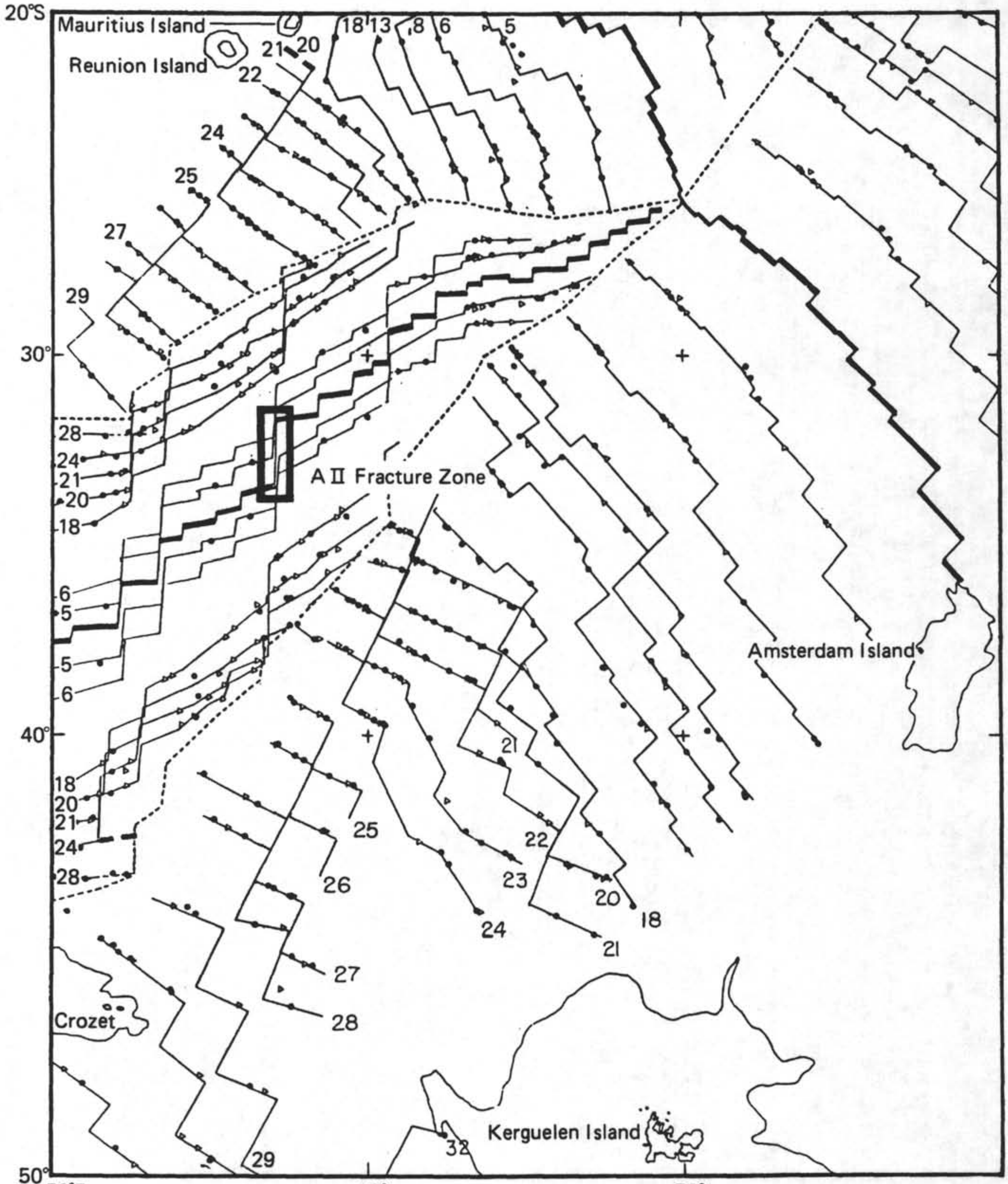
Figure 8: Seismic profile D-D' (Fig. 3) across basins in the fracture zone north of the active transform. HF#1 site marks the vicinity of several heat flow probe measurments. Conrad cruise 27-09, 19-20 October, 1986.

Figure 9: Schematic diagram of the operations with default options foreseen for Leg 118. Weather dependent alternatives are not shown: if weather is bad following the television-sonar survey and test spud-ins at the median ridge (SWIR I) or fracture zone west wall (SWIR II), the ship will move to the central basin (SWIR III); when weather improves sufficiently to deploy the hardrock guidebase the ship will return to SWIR I or SWIR II.



Africa
Mascarene Plain
Madagascar
Reunion Is.
Mauritius Is.
CENTRAL INDIAN RIDGE
20°S
Madagascar Basin
Mozambique Basin
SOUTHEAST INDIAN RIDGE
SOUTHWEST INDIAN RIDGE
30°
Madagascar Ridge
SWIR-I
Melville F.Z.
Atlantis F.Z.
Crozet Basin
Gallien F.Z.
40°
Indomed F.Z.
Discovery F.Z.
4000
40°E
50°
60°
70°
80°

Figure 1.


20°S
30°
40°
50°
50°E
60°
70°
Mauritius Island
Reunion Island
Crozet
Kerguelen Island
Amsterdam Island
A II Fracture Zone
18
13
8
6
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21
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32

Figure 2.

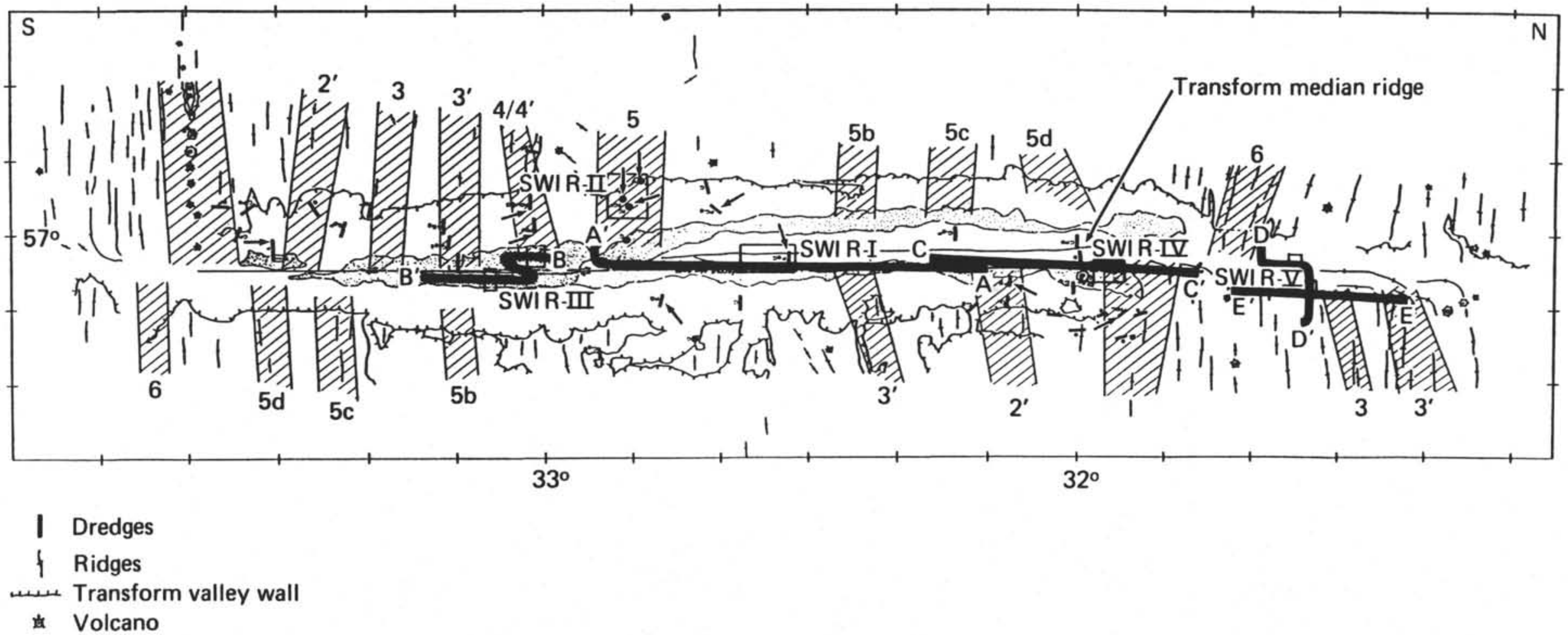

S
N
2′
3
3′
4/4′
5
5b
5c
5d
6
Transform median ridge
SWIR-II
A′
B′
B
SWIR-I
C
SWIR-IV
SWIR-III
A
C′
SWIR-V
D
D′
E′
E
57°
6
5d
5c
5b
3′
2′
3
3′
33°
32°
Dredges
Ridges
Transform valley wall
Volcano

Figure 3.

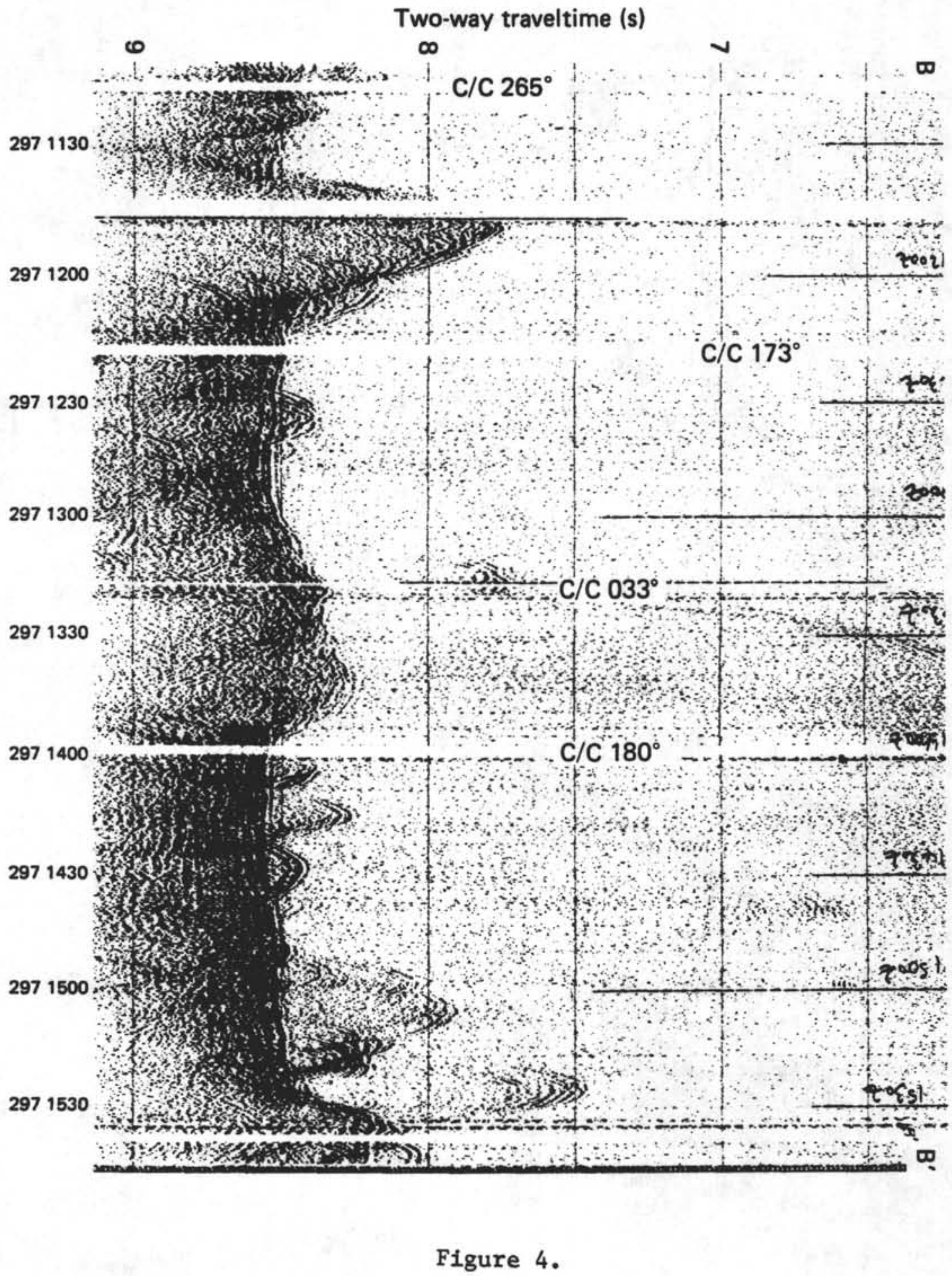

Two-way traveltime (s)
9
8
7
B
C/C 265°
297 1130
297 1200
C/C 173°
297 1230
297 1300
C/C 033°
297 1330
297 1400
C/C 180°
297 1430
297 1500
297 1530
B'

Figure 4.

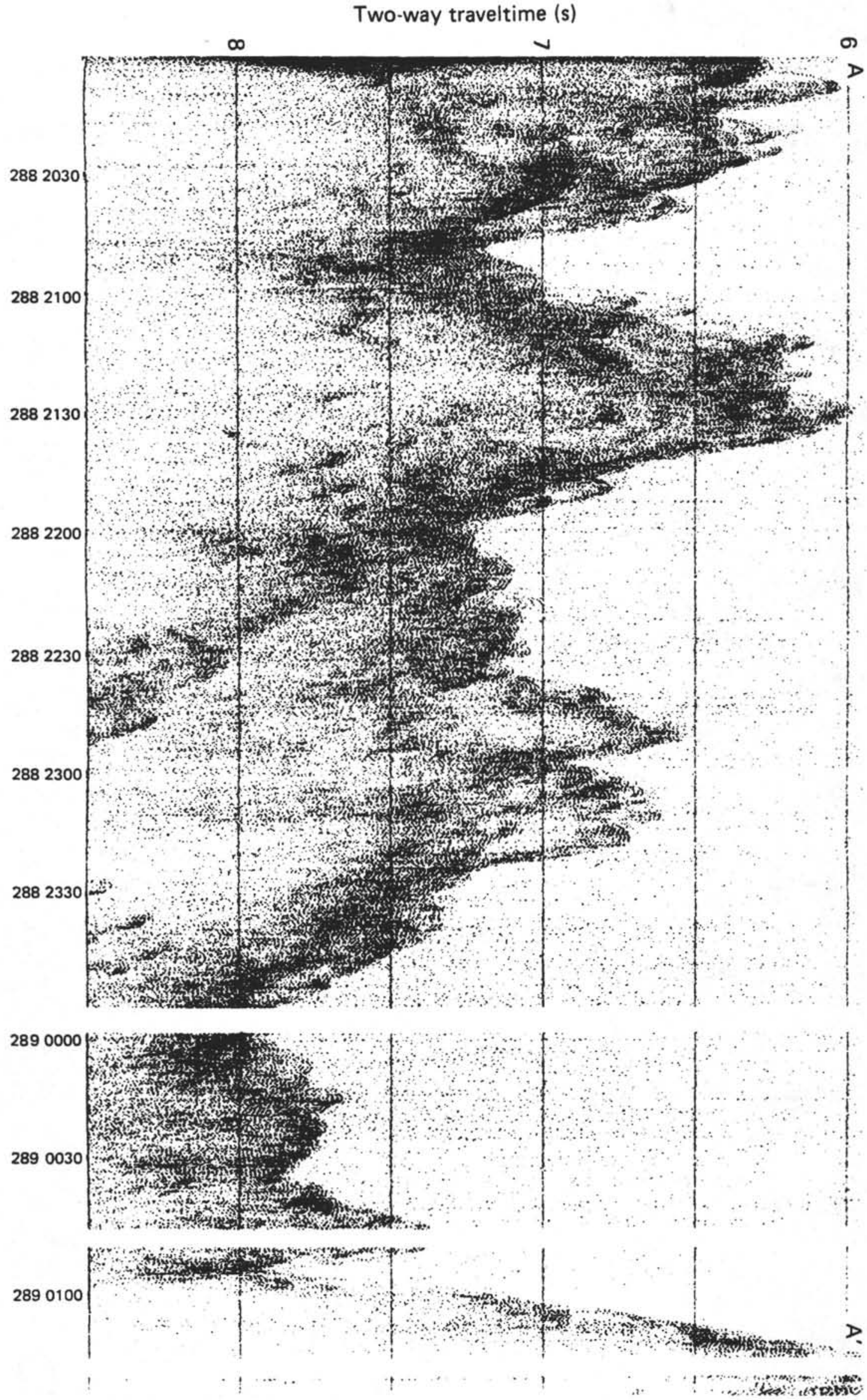

Two-way traveltime (s)
8
7
6
A
A'
288 2030
288 2100
288 2130
288 2200
288 2230
288 2300
288 2330
289 0000
289 0030
289 0100

Figure 5.

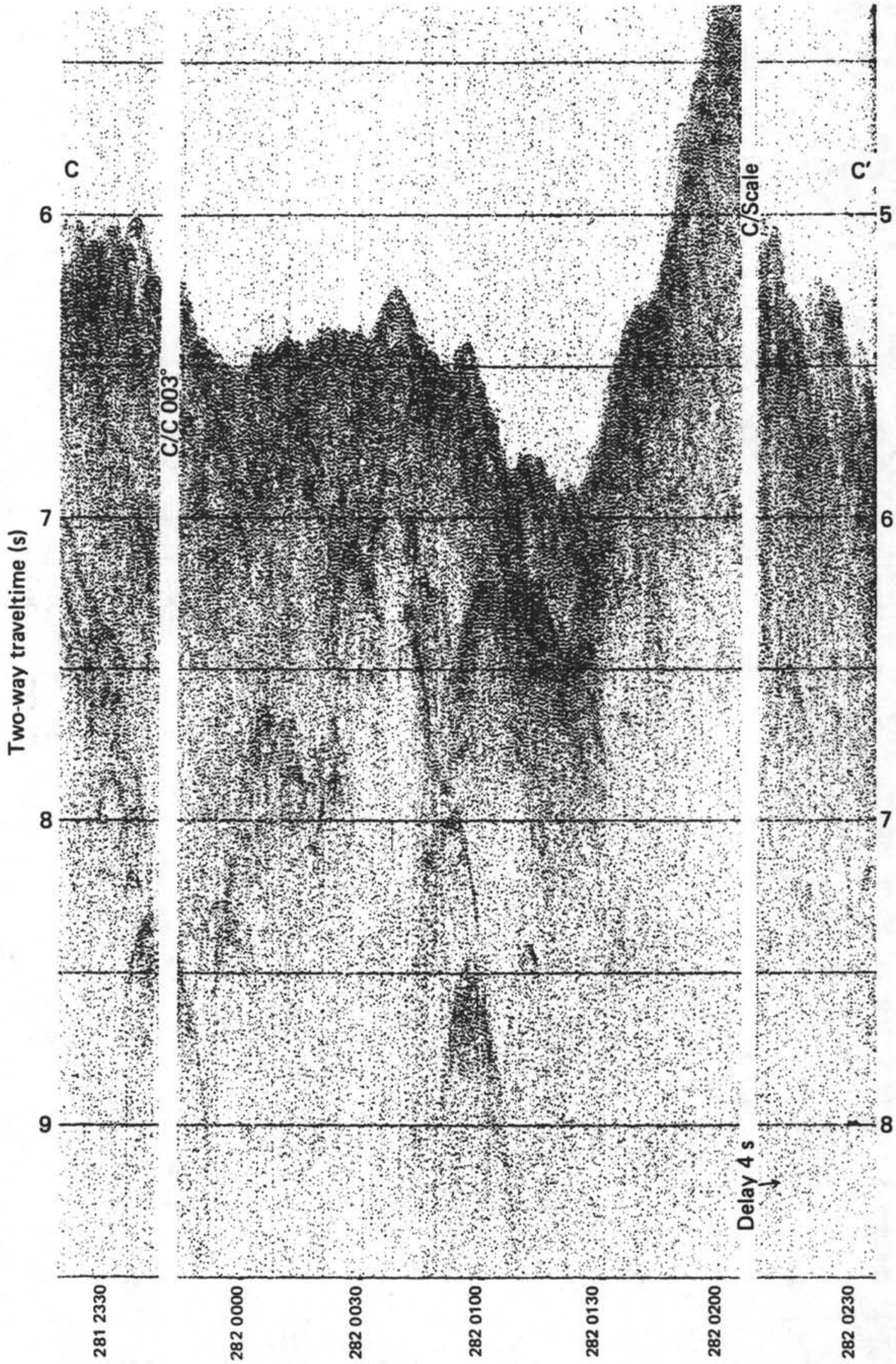
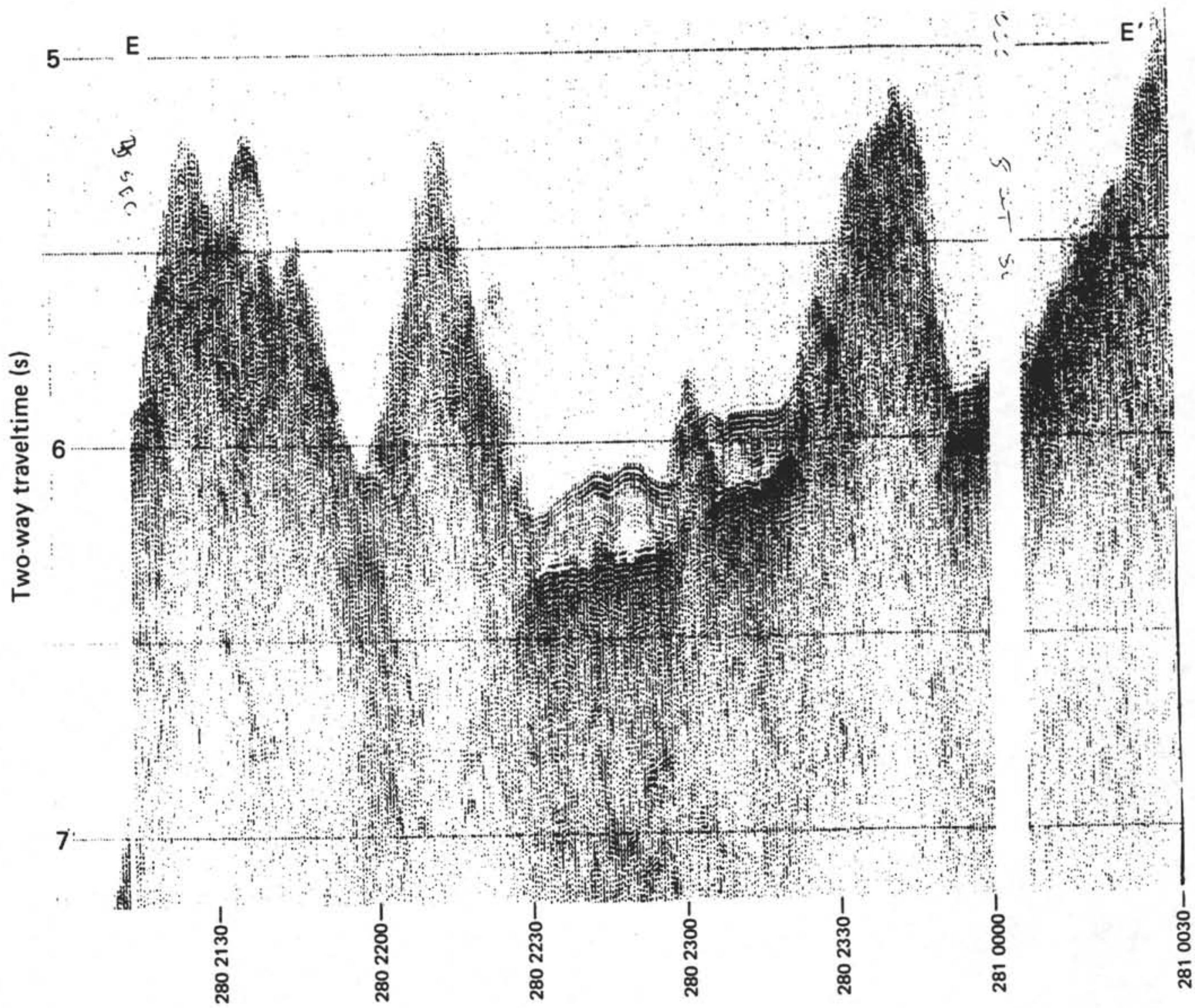

Two-way traveltime (s)
C
C'
C/C 003°
C/Scale
Delay 4 s
6
7
8
9
5
6
7
8
281 2330
282 0000
282 0030
282 0100
282 0130
282 0200
282 0230

Figure 6.



Two-way traveltime (s)
5
6
7
E
E'
280 2130
280 2200
280 2230
280 2300
280 2330
281 0000
281 0030

Figure 7.

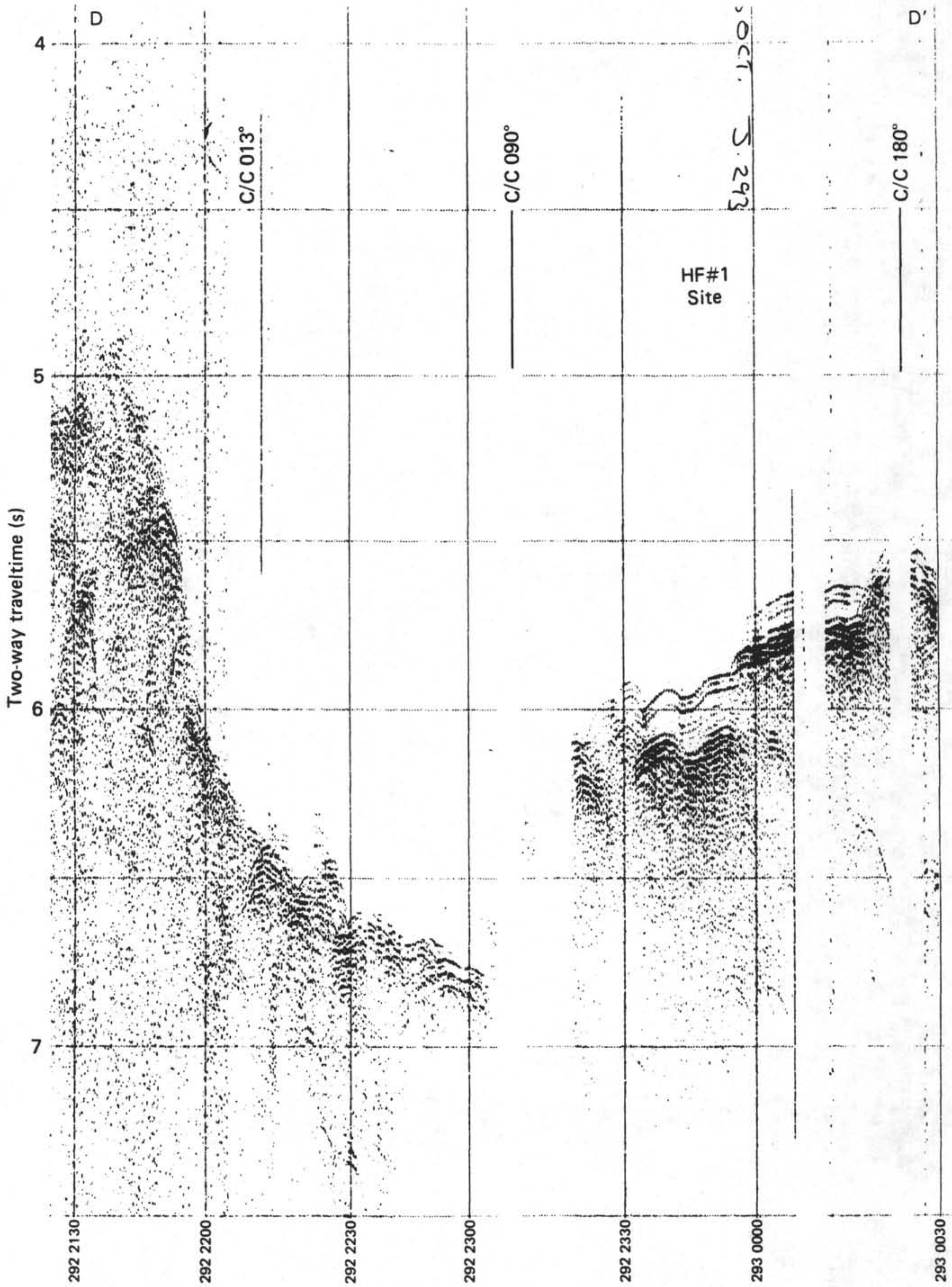

D
D'
Two-way traveltime (s)
4
5
6
7
C/C 013°
C/C 090°
C/C 180°
HF#1
Site
292 2130
292 2200
292 2230
292 2300
292 2330
293 0000
293 0030

Figure 8.

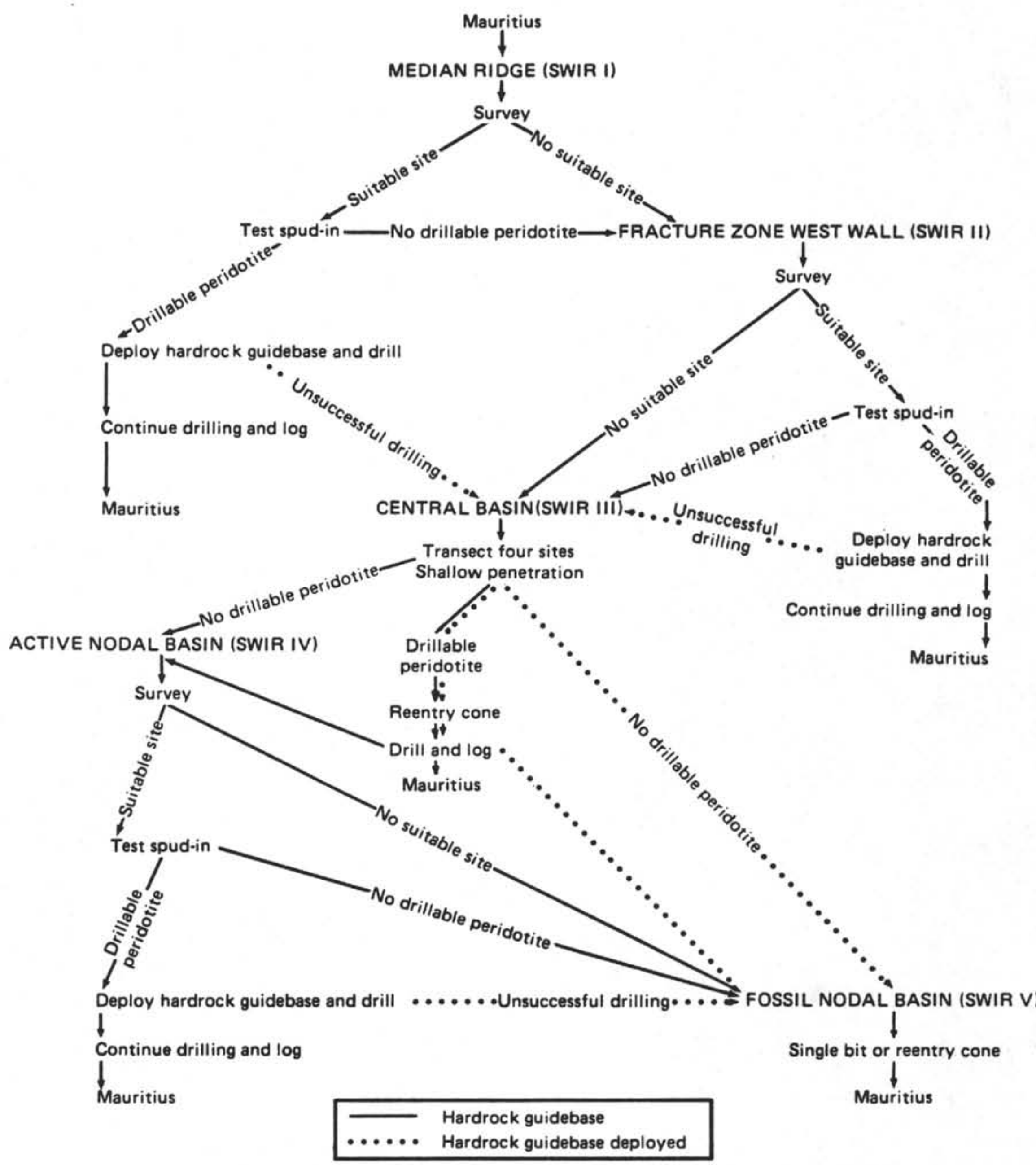

Mauritius
MEDIAN RIDGE (SWIR I)
Survey
Suitable site
No suitable site
Test spud-in
No drillable peridotite
FRACTURE ZONE WEST WALL (SWIR II)
Drillable peridotite
Deploy hardrock guidebase and drill
Continue drilling and log
Mauritius
Unsuccessful drilling
Survey
Suitable site
No suitable site
Test spud-in
No drillable peridotite
Drillable peridotite
CENTRAL BASIN (SWIR III)
Unsuccessful drilling
Deploy hardrock guidebase and drill
Continue drilling and log
Mauritius
Transect four sites
Shallow penetration
No drillable peridotite
ACTIVE NODAL BASIN (SWIR IV)
Drillable peridotite
Reentry cone
Drill and log
Mauritius
No drillable peridotite
Survey
Suitable site
No suitable site
Test spud-in
No drillable peridotite
Drillable peridotite
Deploy hardrock guidebase and drill
Unsuccessful drilling
FOSSIL NODAL BASIN (SWIR V)
Continue drilling and log
Mauritius
Single bit or reentry cone
Mauritius
Hardrock guidebase
Hardrock guidebase deployed

Figure 9.

SITE NUMBER: SWIR I (TRANSFORM MEDIAN RIDGE)

POSITION: $32^{o}32'S$ $57^{o}03'E$

SEDIMENT THICKNESS: 0

WATER DEPTH (UNCORR.): 4700 m

PRIORITY: 1

PROPOSED DRILLING PROGRAM:

Survey with television-sonar to locate suitable site for deployment of hardrock guidebase. Attempt several unsupported bare-rock spud-ins with the 9 1/2 in. coring motors to determine lithology and drilling characteristics of basement. Deploy hardrock guidebase and drill deep hole (500+ m) in basement.

SEISMIC RECORD: Conrad 27-09, 15-16 October, 1986 (Fig. 5)

HEAT FLOW: Yes

LOGGING: Yes

OBJECTIVES:

Determine the petrology, alteration state, and deformational fabric of mantle peridotite in a major fracture zone.

BASEMENT TYPE:

Partly serpentinized peridotite with perhaps minor amounts of gabbro and dunite.

SITE NUMBER: SWIR II (West transform wall)

POSITION: 32°51'S 56°55'E

SEDIMENT THICKNESS: 0

WATER DEPTH (UNCORR.): 3800 m

PRIORITY: 2

PROPOSED DRILLING PROGRAM:

Survey with television-sonar to locate suitable site for deployment of hardrock guidebase. Attempt several unsupported bare-rock spud-ins with the 9 1/2 in. coring motors to determine lithology and drilling characteristics of basement. Deploy hardrock guidebase and drill deep hole (500+ m) in basement.

SEISMIC RECORD: None

HEAT FLOW: Yes

LOGGING: Yes

OBJECTIVES:

Same as SWIR I. This is a backup site for SWIR I to be occupied only if a suitable location for the guidebase cannot be found on the median ridge.

BASEMENT TYPE:

Partly serpentinized peridotite.

SITE NUMBER: SWIR III (Southern transform flat-floored basin - pogo sites)

POSITION: $33^{\circ}01'S$ $57^{\circ}03'E$ or $33^{\circ}07'S$ $57^{\circ}07'E$

SEDIMENT THICKNESS: <120 m, poss. more

WATER DEPTH (UNCORR.): 6200-6400 m

PRIORITY: 3

PROPOSED DRILLING PROGRAM:

Use the XCB/3 3/4 in. Navidrill to drill and wash 4 - 5 holes through the sediment section to sample the upper 20 m of basement in a transect across the floor of a fracture zone. If basement drilling suitable at one or more sites, attempt deep (500+ m) penetration.

SEISMIC RECORD: Conrad 27-09, 24 October, 1986 (Fig. 4)

HEAT FLOW: Yes

LOGGING: Yes

OBJECTIVES:

To determine the nature and deformational characteristics of the basement rocks across the floor of a major fracture zone. Same as SWIR I for a deep hole.

BASEMENT TYPE:

Unknown, with probably partly serpentinized peridotite and variable proportions of dunite, gabbro and possibly basalt.

SEDIMENT TYPE:

Pebbles, sand and pelagic ooze.

SITE NUMBER: SWIR IV (Active nodal basin, N.E. transform valley)

POSITION: 31°57'S 57°05'E

SEDIMENT THICKNESS: 0

WATER DEPTH (UNCORR.): 5500 m

PRIORITY: 4

PROPOSED DRILLING PROGRAM:

Same as SWIR I (assumes hardrock guidebase has not previously been deployed)

SEISMIC RECORD: Conrad 27-09, 9 October, 1986 (Fig. 6)

HEAT FLOW: Yes

LOGGING: Yes

OBJECTIVES:

To determine the nature and deformational characteristics of the basement in an active nodal basin.

BASEMENT TYPE:

Probably partly serpentinized peridotite, possibly accompanied by gabbro and basalt.

SITE NUMBER: SWIR V (Fossil nodal basin)

POSITION: 31°34'S 57°08'E or
31°35'S 57°04'E

SEDIMENT THICKNESS: 100+ m

WATER DEPTH (UNCORR.): 4400 m

PRIORITY: 5

PROPOSED DRILLING PROGRAM:

Drill a single bit hole through the sediment cover and into basement. If time permits and drilling conditions are good, a reentry hole will be attempted using either a free fall or standard reentry cone.

SEISMIC RECORD:

Conrad 27-09, 7-8 October, 1986; 19-20 October, 1986 (Figs. 7 and 8)

HEAT FLOW: Yes

LOGGING: Yes

OBJECTIVES:

To determine the nature and deformational characteristics of the basement in a fossil nodal basin in the inactive fracture zone.

BASEMENT TYPE:

Partly serpentinized peridotite, possibly accompanied by gabbro and basalt.

SEDIMENT TYPE:

Pebbles, sand and calcareous pelagic ooze.

SHIPBOARD PARTICIPANTS

OCEAN DRILLING PROGRAM LEG 118

Co-Chief Scientist:	PAUL T. ROBINSON Centre for Marine Geology Dalhousie University Halifax, Nova Scotia B3H 3J5 Canada
Co-Chief Scientist:	RICHARD P. VON HERZEN Woods Hole Oceanographic Institution Woods Hole, MA 02543
Igneous Petrologist/ ODP Staff Scientist:	ANDREW C. ADAMSON Ocean Drilling Program Texas A&M University Research Park 1000 Discovery Drive College Station, TX 77840
Igneous Petrologist:	SHERMAN H. BLOOMER Department of Geology Duke University Box 6729, College Station Durham, NC 27708
Igneous Petrologist:	MATHILDE CANNAT Laboratoire de Petrologie Universite de Bretagne Occidentale 6 Avenue le Gorgeu 29287 Brest Cedex France
Igneous Petrologist:	HENRY J.B. DICK Woods Hole Oceanographic Institution Woods Hole, MA 02543
Igneous Petrologist:	REJEAN HEBERT Departement de Geologie Universite Laval Sainte-Foy, Quebec G1K 7P4 Canada
Igneous Petrologist:	PAMELA D. KEMPTON Dept. of Earth Sciences The Open University Milton Keynes MK7 6AA United Kingdom
Igneous Petrologist:	PETER S. MEYER Woods Hole Oceanographic Institution Woods Hole, MA 02543

Igneous Petrologist:	JAMES H. NATLAND Graduate Research Division Scripps Institution of Oceanography La Jolla, CA 92093
Igneous Petrologist:	KAZUHITO OZAWA Geological Institute Faculty of Science University of Tokyo Tokyo 113 Japan
Igneous Petrologist:	DEBRA S. STAKES Geology Department University of South Carolina Columbia, SC 29208
Geochemist:	ROLF F.K. EMMERMANN Institut fur Geowissenschaften und Lithosphärenforschung Senckenbergstr, 3 D-6300 Giessen Federal Republic of Germany
Geochemist:	JAN G.H. HERTOGEN Fysico-chemische Geologie University of Leuven Celestijnenlaan 200C B-3030 Leuven Belgium
Sedimentologist/ Logging Scientist:	STEPHEN A. SWIFT Woods Hole Oceanographic Institution Woods Hole, MA 02543
Paleontologist:	GUNILLA GARD Department of Geology University of Stockholm S-106 91 Stockholm Sweden
Physical Properties Specialist:	STEPHEN H. KIRBY U.S. Geological Survey Branch of Tectonophysics 345 Middlefield Road MS/977 Menlo Park, CA 94025
Physical Properties Specialist:	GERARDO J. ITURRINO Department of Earth and Atmospheric Sciences Geosciences Building Purdue University West Lafayette, IN 47907

Paleomagnetist:	EIICHI KIKAWA Earthquake Research Institute University of Tokyo Bunkyo-ku, Tokyo 113 Japan
Paleomagnetist:	JANET H. PARISO School of Oceanography University of Washington Seattle, WA 98195
Downhole Hydrogeophysicist:	KEIR BECKER Rosenstiel School of Marine and Atmospheric Science University of Miami 4600 Rickenbacker Causeway Miami, FL 33149-1098
VSP Scientist:	HARTLEY HOSKINS Ocean Industries Program Woods Hole Oceanographic Institution Woods Hole, MA 02543
Downhole Magnetic Specialist:	JAMES H. SCOTT 12372 West Louisiana Avenue Lakewood, CO 80228
Logging Scientist:	J. DIRK C. KASSENAAR Department of Earth Sciences University of Waterloo Waterloo, Ontario N2L 3G1 Canada
LDGO Logging Scientist:	DAVID GOLDBERG Borehole Research Group Lamont-Doherty Geological Observatory Palisades, NY 10964

OPERATIONS AND TECHNICAL STAFF

Cruise Operations Superintendent:	CHARLES HANSON Ocean Drilling Program Texas A&M University Research Park 1000 Discovery Drive College Station, TX 77840
Special Tools Engineer:	STEVE HOWARD Ocean Drilling Program Texas A&M University Research Park 1000 Discovery Drive College Station, TX 77840

Operations Specialist:	BARRY HARDING Ocean Drilling Program Texas A&M University Research Park 1000 Discovery Drive College Station, TX 77840
Laboratory Officer:	BURNEY HAMLIN Ocean Drilling Program Texas A&M University Research Park 1000 Discovery Drive College Station, TX 77840
Curatorial Representative:	DANIEL QUOIDBACH Ocean Drilling Program East Coast Repository Lamont-Doherty Geological Observatory Palisades, NY 10964
Schlumberger Logger:	LEE GEISER Schlumberger Houston 8460 Gulf Expressway Houston, TX 77023
Computer Systems Manager:	JOHN EASTLUND Ocean Drilling Program Texas A&M University Research Park 1000 Discovery Drive College Station, TX 77840
Electronics Technician:	MICHAEL REITMEYER Ocean Drilling Program Texas A&M University Research Park 1000 Discovery Drive College Station, TX 77840
Electronics Technician:	BARRY WEBER Ocean Drilling Program Texas A&M University Research Park 1000 Discovery Drive College Station, TX 77840
Yeoperson:	MICHIKO HITCHCOX Ocean Drilling Program Texas A&M University Research Park 1000 Discovery Drive College Station, TX 77840
Photographer:	CHRISTINE GALIDA Ocean Drilling Program Texas A&M University Research Park 1000 Discovery Drive College Station, TX 77840

Marine Technician: WENDY AUTIO
Ocean Drilling Program
Texas A&M University Research Park
1000 Discovery Drive
College Station, TX 77840

Marine Technician: MARY ANN CUSIMANO
Ocean Drilling Program
Texas A&M University Research Park
1000 Discovery Drive
College Station, TX 77840

Marine Technician: JENNY GLASSER
Ocean Drilling Program
Texas A&M University Research Park
1000 Discovery Drive
College Station, TX 77840

Marine Technician: TED "GUS" GUSTAFSON
Ocean Drilling Program
Texas A&M University Research Park
1000 Discovery Drive
College Station, TX 77840

Marine Technician: MATT MEFFERD
Ocean Drilling Program
Texas A&M University Research Park
1000 Discovery Drive
College Station, TX 77840

Marine Technician: JOE POWERS
Ocean Drilling Program
Texas A&M University Research Park
1000 Discovery Drive
College Station, TX 77840

Marine Technician: KEVIN ROGERS
Ocean Drilling Program
Texas A&M University Research Park
1000 Discovery Drive
College Station, TX 77840

Marine Technician: CHRISTIAN SEGADE
Ocean Drilling Program
Texas A&M University Research Park
1000 Discovery Drive
College Station, TX 77840

Weather Observer: VERNON ROCKWELL
Ocean Drilling Program
Texas A&M University Research Park
1000 Discovery Drive
College Station, TX 77840