OCEAN DRILLING PROGRAM

LEG 118 PRELIMINARY REPORT

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

February 1988

This informal report was prepared from the shipboard files by the scientists who participated in the cruise. The report was assembled under time constraints and is not considered to be a formal publication which incorporates final works or conclusions of the participating scientists. The material contained herein is privileged proprietary information and cannot be used for publication or quotation.

Preliminary Report No. 18

First Printing 1988

Distribution

Copies of this publication may be obtained from the Director, Ocean Drilling Program, Texas A&M University Research Park, 1000 Discovery Drive, College Station, Texas 77840. In some cases, orders for copies may require a payment for postage and handling.

SCIENTIFIC REPORT

The scientific party aboard JOIDES Resolution for Leg 118 of the Ocean Drilling Program consisted of:

Paul T. Robinson, Co-Chief Scientist (Centre for Marine Geology, Dalhousie University, Halifax, Nova Scotia, B3H 3J5, Canada)
Richard P. Von Herzen, Co-Chief Scientist (Woods Hole Oceanographic Institution, Woods Hole, Massachusetts 02543)
Andrew C. Adamson, ODP Staff Scientist (Ocean Drilling Program, Texas A&M University, College Station, Texas 77840)
Keir Becker (Rosenstiel School of Marine and Atmospheric Science, University of Miami, Miami, Florida 33149-1098)
Sherman H. Bloomer (Department of Geology, Duke University, Durham, North Carolina 27708)
Mathilde Cannat (Laboratoire de Petrologie, Universite de Bretagne Occidentale, 29287 Brest Cedex, France)
Henry J.B. Dick (Woods Hole Oceanographic Institution, Woods Hole, Massachusetts 02543)
Rolf F.K. Emmermann (Institut fuer Geowissenschaften und Lithosphaerenforschung, D-6300 Giessen, Federal Republic of Germany)
Gunilla Gard (Department of Geology, University of Stockholm, Stockholm, Sweden)
David Goldberg (Lamont-Doherty Geological Observatory, Palisades, New York 10964)
Rejean Hebert (Departement de Geologie, Universite Laval, Quebec, G1K 7P4, Canada)
Jan G.H. Hertogen (Fysico-chemische Geologie, University of Leuven, B-3030 Leuven, Belgium)
Hartley Hoskins (Woods Hole Oceanographic Institution, Woods Hole, Massachusetts 02543)
Gerardo Iturrino (Department of Earth and Atmospheric Sciences, Purdue University, West Lafayette, Indiana 47907)
J. Dirk C. Kassenaar (Department of Earth Sciences, University of Waterloo, Waterloo, Ontario, N2L 3G1, Canada)
Pamela D. Kempton (Department of Earth Sciences, The Open University, Milton Keynes, MK7 6AA, United Kingdom)
Eiichi Kikawa (Earthquake Research Institute, University of Tokyo, Tokyo 113, Japan)
Stephen H. Kirby (U.S. Geological Survey, Branch of Tectonophysics, Menlo Park, California 94025)
Peter S. Meyer (Woods Hole Oceanographic Institution, Wood Hole, Massachusetts 02543)
James H. Natland (Scripps Institution of Oceanography, La Jolla, California 92093)
Kazuhito Ozawa (Geological Institute, University of Tokyo, Tokyo 113, Japan)
Janet H. Pariso (School of Oceanography, University of Washington, Seattle, Washington 98195)
James H. Scott (Lamont-Doherty Geological Observatory, Palisades, New York 10964)
Debra S. Stakes (Geology Department, University of South Carolina, Columbia, South Carolina 29208)
Stephen A. Swift (Woods Hole Oceanographic Institution, Woods Hole, Massachusetts 02543)

INTRODUCTION

Leg 118 of the Ocean Drilling Program began in Mauritius on 22 October and ended there on 14 December 1987. The aim of the leg was to drill one or more holes in the Atlantis II Fracture Zone of the Southwest Indian Ridge. The primary goal was 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 hard-rock guidebase and conduct a major program of geophysical logging and other downhole measurements. If a deep hole at this site was not achievable, other locations on the walls and floor of the fracture zone would be attempted. Secondary objectives were 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.

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 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 and lower crustal rocks are commonly exposed on their floors and walls. The abundance of plutonic 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 (H. 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 the lower crust and 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. SeaBeam 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, 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 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 the walls and floor of the fracture zone during the Conrad site survey yielded chiefly ultramafic rock, and lesser amounts of gabbro, basalt, and greenstone. In all, 2100 kg of rock was 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.

DRILLING RESULTS

Site 732

Site 732 (proposed Site SWIR I) is located on a median tectonic ridge that bisects the northern half of the north-south-trending Atlantis II Transform (Fig. 3). Dredge hauls from the wall of this ridge recovered mainly serpentinized peridotite, suggesting that the feature is a mantle diapir.

A 26-hour-long TV/sonar survey was carried out to locate areas for test spud-in and possible guidebase deployment. The survey revealed a relatively flat, sedimented surface on top of the ridge, with some areas of rock outcrop and boulders on steep, probably faulted, flank slopes.

Six test holes were drilled in two locations: Holes 732A through 732C at 32°32.81'S, 57°03.289'E, close to the break of slope, and Holes 732D through 732F at 32°32.85'S, 57°02.7'E, nearer to the ridge crest. The deepest penetration was 24 mbsf in Hole 732C. A total of 3.51 m of material was recovered which consists entirely of unconsolidated lithic gravel interlayered with indurated sandstone and poorly consolidated sand and muddy siliceous ooze. The siliceous ooze consists of about 60% siliceous microfossils, 35% clay, and 5% broken foraminifers. Most of the unconsolidated sand consists of volcanic detritus including rock fragments, plagioclase, and pyroxene; the remaining portion is composed of broken foraminifers and siliceous debris.

Pebbles and cobbles in the gravel range from less than 1 cm to 6 cm in maximum dimension and are subangular in shape. They consist of plagioclase phyric basalt, aphyric basalt, metabasalt, diabase, greenstone, pyroxene gabbro, metagabbro, ferrogabbro, serpentinite, serpentinized peridotite mylonite, amphibolite, and sedimentary rock. Basalt and diabase are the most common of the recovered clasts. The clasts of sedimentary rock are small fragments of well sorted, medium- to coarse-grained, reddish sandstone. One clast is graded in size from medium to fine sand. The sand grains are angular and consist of diverse lithic and mineral fragments.

Calcareous nannofossils from the recovered sediments indicate an age of mid-Pleistocene (calcareous nannofossil Zone NN20). A small amount of sediment from Hole 732F scraped from the drill bit contains nannofossils assigned to calcareous nannofossil Zone NN19 with an age somewhere between 1.88 Ma and 1.45 Ma. Rare specimens of reworked Miocene and Pliocene species are also present.

Drilling operations at Site 732 suggest that each hole penetrated a few (2-8) meters of soft material overlying a harder unit. Thus, the ridge appears to be capped by a poorly sorted gravel or conglomerate interlayered with sand and sandstone and overlain by a thin pelagic cover. Clasts from the gravels are similar in size and composition to those recovered from gravels on the floor of the transform during the site survey. These deposits were probably laid down by debris flows and turbidity currents originating on the steep walls of the transform. The appearance of these basinal sediments on top of the median ridge suggests recent uplift of that feature either by faulting or serpentinite intrusion.

Unstable hole conditions made it impossible to reach basement at this site. Consequently, the site was abandoned and the ship moved to Site 733 on the west wall of the transform.

Site 733

Site 733 (proposed Site SWIR II) is located on the west wall of the transform at about 33°05'S, 56°59'E (Fig. 3). Peridotite was dredged from this area during the site survey, and several small benches suitable for guidebase deployment are present. Gravels similar to those encountered at Site 732 were not expected at this site, and we hoped to find peridotite exposed on fault scarps on the transform wall.

A TV/sonar survey of the transform wall located two suitable drilling sites: a flat sedimented bench in about 4483 m of water and a small, sediment-filled trough about 700 m farther down the slope in about 5208 m of water.

Four holes were drilled in these two locations, the deepest of which penetrated 23.6 mbsf. Hole 733A at $33^{o}05.25'S$, $56^{o}58.65'E$, Hole 733B at $33^{o}05.30'S$, $56^{o}58.65'E$, and Hole 733C at $33^{o}05.30'S$, $56^{o}58.65'E$, are located on the upper bench and were test holes drilled a few meters apart. A total of 0.28 m of material was obtained for an average recovery of 1%. Hole 733D, at $33^{o}04.89'S$, $56^{o}59.31'E$, was drilled in the lower trough. It was washed to a depth of 15 m and then drilled to 23.6 mbsf.

The material recovered from Holes 733A, 733B, and 733C consists entirely of fragments of foliated metagabbro and amphibolite, none of which were actually cut by the bit. The size and shape of the fragments indicate that they represent talus deposits, not basement. Foliated metagabbro, amphibolite, and minor basalt were recovered in Hole 733D. Although a whole round core of foliated metagabbro was recovered, it probably came from a boulder in the talus pile rather than from basement.

The foliated metagabbros and amphibolites have been subjected to high-temperature plastic deformation and recrystallized under amphibolite facies conditions. Two types of metagabbro are present: a green variety composed chiefly of amphibole and plagioclase, and a brown variety that contains predominantly pyroxene and plagioclase. The protoliths for both varieties are believed to be an orthopyroxene-rich ferrogabbro. The amphibolite is strongly foliated and consists of amphibole, plagioclase, and epidote. In the metabasalt, actinolite replaces most of the mafic minerals and some of the groundmass plagioclase. Chlorite and epidote are absent, suggesting upper greenschist to lower amphibolite facies conditions of metamorphism.

The metagabbros have remanent magnetic intensities similar to those of fresh and altered gabbro from the Mid-Atlantic Ridge but initial susceptibility values that are much lower. The stable magnetic inclinations range from -21^{o} to -41^{o}, but these have little significance because the core was probably recovered from a boulder in the talus overlying basement at this site.

Measured grain densities of the metagabbros are 2.87 g/cm^3 and 2.96 g/cm^3, within the range of expected values. However, the compressional wave velocities (6.14-6.24 km/s) are somewhat higher than those for metagabbros from other fracture zones. The low values may be due to differing types or amounts of alteration or to varying proportions of microcracks.

Thermal conductivities range from 1.98 $W/m.^{o}C$ to 2.16 $W/m.^{o}C$ and vary systematically when measured parallel or normal to the foliation. The mean conductivity of 2.10 $W/m.^{o}C$ is typical for diabase and gabbros. The small observed anisotropy is believed to reflect preferred mineral orientations.

Because basement was not reached in these holes and drilling conditions were not promising, another site was selected for a test spud-in.

Site 734

Site 734 is located on the east wall of the Atlantis II Transform at about 32°07'S, 57°07'E (Fig. 3). Two dredge hauls in this vicinity, taken during the site survey, recovered mostly peridotite and dunite with minor basalt. Site 734 was selected for basement drilling because the topography indicated a steep, regular slope for this part of the transform wall without any indication of slumping or landsliding. We hoped to find a small, relatively flat bench on which the hard-rock guidebase could be deployed, allowing us to drill into the underlying peridotite.

A TV/sonar survey of the area located two areas of basement outcrop: one on the wall of a gully or small canyon at about 3750 m water depth; the other, about 700 m to the east and about 350 m shallower, probably on a small fault scarp.

Seven holes were drilled at this site, Holes 734A through 734E at the deeper site, and Holes 734F and 734G at the shallower site. Significant penetration was achieved only in Holes 734B and 734G (57 mbsf and 31.0 mbsf, respectively). A total of 7.8 m of sediment containing various clasts of igneous and metamorphic rock was recovered, chiefly from Holes 734B, 734D, and 734G.

Similar sequences of graded sand and gravel, each about 80 cm long, were recovered in Holes 734B and 734D. The grain size in these sequences decreases regularly upward from pebbles at the base to fine sand at the top. The upper few centimeters in each sequence consists of foraminiferal ooze and sand. Rock fragments in the gravels range up to 3.5 cm in length and are angular to subangular. They consist of serpentinite, amphibolite mylonite, metagabbro, and metabasalt. Fragments of aragonite and other alteration minerals such as prehnite, talc, and tremolite make up 10% to 15%.

A 6-m-long section of highly disturbed, soupy sand and gravel composed of ultramafic material was recovered in Hole 734G. Based on its soupy nature, lack of stratification, and poorly sorted texture this material is believed to represent drill cuttings or sediment that slumped into the hole from above.

The uppermost sediment in Holes 734B and 734D contains abundant and well preserved foraminifers and calcareous nannofossils; the nannofossils are dated as Holocene. The sediments recovered from Hole 734G are probably early Pleistocene in age, somewhere between 1.37 and 1.88 Ma.

Most of the recovered clasts in the sediment consist of highly metamorphosed and deformed peridotite and metagabbro; a few are composed of amphibolite mylonite, metabasalt, and carbonate-cemented breccia containing amphibolite and serpentinite clasts. The ultramafic rocks are foliated lherzolite and harzburgite composed of about 75% serpentine, 10% magnetite, and 10% to 15% relict primary olivine, orthopyroxene, and clinopyroxene. Two of the ultramafic samples are cut by calc-silicate veins composed chiefly of prehnite. In the metagabbros the original plagioclase and clinopyroxene have been largely replaced by clay minerals, albite, actinolite, and prehnite. Both the mylonite and breccia are almost devoid of primary minerals.

The TV/sonar survey carried out at this site revealed a steep slope (about 24°) heavily mantled with talus and sediment. Basement crops out only along steep cliffs on the walls of gullies and canyons or on fault scarps. None of the recovered core can be unequivocally interpreted as basement, but the abundance of ultramafic clasts and fragments suggests that such material is present beneath the rubble and talus.

Site 734 was abandoned after numerous unsuccessful attempts were made to sample basement. Considerable difficulty was encountered in starting a hole on such a steeply sloping cliff. For those holes at which spud-in was successful (Holes 734B and 734G), the drilling conditions were poor and the site was judged unsuitable for deployment of the hard-rock guidebase.

Site 735

Site 735 is located on a shallow platform in about 700 m of water on the east rim of the Atlantis II transform at about 32°43.40'S, 57°16.00'E (Fig. 3). This platform, about 5 km long in a north-south direction and 2 km wide, is one of a series of uplifted blocks that are connected by saddles to form a long, linear ridge parallel to the transform. The uplifted blocks are highly irregular in shape, defined by steep slopes commonly associated with major normal faulting in such terrains, and may represent simple horsts uplifted relative to both the rift valley floor at which the crust originated and the adjacent ocean crust to the east. Such topographic features are found in many fracture zones and are commonly underlain by upper mantle and lower crustal rocks (Bonatti, 1978; Engel and Fisher, 1975; van Andel et al., 1971).

The platform at Site 735 has a flat surface, suggesting that it is a wave-cut feature. Its position in the magnetic anomaly pattern on the east transform wall suggests a crustal age of about 12 Ma. A TV/sonar survey of the seafloor carried out prior to drilling revealed basement outcrops lightly mantled with sediment. Many of the outcrops have a well developed, steeply dipping foliation and are cut by a regular pattern of faults or joints.

An unsupported test spud-in, using the positive displacement coring motor, recovered 0.1 m of gabbro from Hole 735A (32°43.30'S, 57°16.30'E). The hard-rock guidebase was then deployed and drilling commenced in Hole 735B (32°43.42'S, 57°15.97'E). Although this was only the second time that a guidebase had been used, deployment proceeded smoothly and required only 2 days. Once the guidebase was cemented in place on the seafloor, the coring motor was used to start a hole and to drill to a depth of 60 m. When the hole was deep enough to provide lateral support for the standard rotary coring system we used it to drill to 500 mbsf. A newly developed Navi-Drill coring system was then tested in the hole and cut another 0.7 m. The entire 500.7-m-deep hole was drilled in 17 days, resulting in an average rate of penetration of 30 m/day.

A total of 434.81 m of olivine gabbro, olivine-bearing gabbro, two-pyroxene gabbro, Fe-Ti-oxide gabbro, troctolite, and microgabbro with rare basalt and trondjhemite was recovered from Hole 735B for an average recovery of 87%. These rocks have undergone varying degrees of plastic and brittle deformation, and many have well developed foliations. Six major lithostratigraphic units are recognized in the sequence, based primarily on igneous mineralogy, mineral compositions, and degree and style of deformation.

Unit 1 is a 39.5-m-thick sequence of foliated metagabbro with porphyroclastic to mylonitic textures. Rock types include poorly foliated metagabbro, porphyroclastic metagabbro, mylonite, gneissic metagabbro, and augen gneissic metagabbro. Igneous textures have been completely destroyed, and the rocks now consist chiefly of neoblasts of plagioclase, clinopyroxene, and amphibole. Relict porphyroclasts of plagioclase, orthopyroxene, clinopyroxene, Fe-Ti oxides, and rare olivine suggest that the protolith was a two-pyroxene gabbronorite or olivine gabbronorite. A few Fe-Ti-oxide-rich layers are probably secondary because the oxides fill fractures and pore spaces in the gabbros.

Unit 2 consists of 140.5 m of olivine and olivine-bearing gabbro. The upper contact is drawn at the first appearance of clearly igneous textures, and the lower boundary is a rapid transition to gabbro with more orthopyroxene and more sodic plagioclase. Most of the rocks are mesocumulates commonly with primary layering defined by size variations. Alternating bands of olivine-rich and olivine-poor gabbro reflect rare modal layering. These gabbros consist of plagioclase (40-70%), clinopyroxene (30-50%), olivine (0-25%), and orthopyroxene (0-3%) along with traces of Fe-Ti oxides, primary brown amphibole, and sulfides. Chemically, they are fairly primitive rocks with MgO contents between 9 wt% and 12 wt% and Mg numbers between 0.78 and 0.85. Interlayered Fe-Ti-oxide-bearing gabbros commonly have igneous textures in which the oxide minerals are intimately intergrown with pyroxenes. A few pyroxene-rich layers containing inverted pigeonite were probably formed from significantly more evolved liquids than those from which the olivine gabbros crystallized. Some mylonitic and porphyroclastic intervals are present, particularly in the upper part of the unit.

Unit 3 is a 44-m-thick sequence of olivine gabbro with intervals of Fe-Ti-oxide gabbro. These gabbros are macroscopically similar to those of Unit 2 but have significantly more evolved compositions. The upper contact is gradational and is defined by the appearance of sodic plagioclase (An_{40-45}), low-calcium pyroxene, and iron-rich olivine. It coincides with a change in chemical composition from olivine gabbro with 12-13 wt% MgO to one with 8-9 wt% MgO. A reappearance of more magnesian olivine gabbro at 211 mbsf coincides with a geochemical break between the upper and lower parts of Unit 3. A well-developed igneous lamination is steeply dipping in the upper part of the unit but flattens with depth. Mylonitic and foliated zones are common and the lower contact of Unit 3 is marked by a 60-cm-thick zone of mylonite.

Unit 4 is made up of 48 m of Fe-Ti-oxide-rich gabbro. The upper contact is gradational into Unit 3, and the lower boundary is marked by a 3-m-thick layer of mylonite. This gabbro has more abundant opaque minerals (10% or more) and less olivine than those of Unit 3. It consists chiefly of plagioclase, clinopyroxene, and Fe-Ti oxide with minor amounts of olivine, calcium-poor pyroxene, reddish-brown hornblende, apatite, and sulfides. Like those of Unit 3, these rocks have relatively sodic plagioclase and some iron-rich olivine. The Fe-Ti-oxide gabbros have granular textures commonly with cumulus plagioclase and clinopyroxene. Olivine is typically intergranular, and the Fe-Ti oxides, mostly ilmenite and magnetite, form intergranular to poikilitic masses enclosing plagioclase and clinopyroxene. These rocks have iron oxide contents up to 30 wt% and titanium oxide contents up to 9 wt%. The Mg numbers of these rocks are the lowest of all samples analyzed from Hole 735B and range from 0.32 to 0.51. On land, these rocks would be investigated as a possible ore deposit. A felsic intrusion breccia with trondjhemite veins occurs at two levels in the unit.

Unit 5 consists of 102.5 m of relatively uniform olivine gabbro characterized by a scarcity of Fe-Ti oxides and low calcium pyroxene. Most of the gabbros are mesocumulates, and some exhibit primary grain size layering. They are mineralogically and chemically similar to those of Unit 2. Small changes in mineral proportions are shown by the presence of a thin troctolite layer and several plagioclase-rich zones. Zones of brecciation are common, and these contain felsic veins with epidote and albite.

Unit 6 is a 126-m-thick interval of olivine-rich gabbro with numerous layers of troctolite. The gabbros are similar to those of Unit 5 but have consistently higher modal percentages of olivine. Grain size layering is common, and there are some lenses and layers of microgabbro. The troctolites and troctolitic gabbros are interlayered with the olivine gabbros. Most are fine-grained rocks with granular textures, and they are interpreted as small intrusive layers. They consist on average of 43% olivine, 53% plagioclase, 3% clinopyroxene, and 1% spinel with trace amounts of sulfides. These are the most mafic rocks encountered in Hole 735B, with up to 25 wt% MgO and Mg numbers that range from 0.83 to 0.87. The fine-grained, granular textures indicate a non-cumulate origin, and these compositions are probably close to the original liquids. A few coarse-grained Fe-Ti-oxide gabbros are also present, and there is an intrusion of orthopyroxene+oxide+apatite gabbro near the upper contact. Unit 6 also has numerous intervals of metagabbro characterized by mylonitic to porphyroclastic textures.

None of the contacts between units is clearly magmatic. The contacts between units 1 and 2 and between units 4 and 5 are clearly tectonic.

Veins and fractures generally dip 40° to 90° with a strong peak at 60° to 65°. The mean dip of both veins and foliation decreases downward in the hole, suggesting that deformation took place along listric normal faults that flatten downward.

The rocks from Hole 735B have been subjected to varying degrees of metamorphism and alteration. An early stage of dynamothermal metamorphism produced highly foliated porphyroclastic, gneissic, and mylonitic textures. These highly deformed rocks are most abundant in lithostratigraphic unit 1 but occur intermittently elsewhere in the section. This high temperature event was followed by brecciation and static alteration associated with brittle deformation. The static alteration was controlled by permeability and is manifested by numerous veins, from 0.5 mm to 2 cm wide, filled largely with hornblende and sodic plagioclase. Clinozoisite, epidote, and minor prehnite occur in the lower parts of the core. A few silicic veins containing diopside, hornblende, sphene, clinozoisite, and albite are also present. In undeformed gabbros, static alteration resulted in development of coronas of hornblende, tremolite, talc, clinozoisite, magnetite, chlorite, sphene, epidote, and phlogopite(?) around the primary igneous minerals. A late stage of oxidative alteration is reflected in carbonate-hematite-smectite pseudomorphs of olivine and orthopyroxene. These occur sporadically in the upper 256 m of the core and are particularly abundant at 33-39 mbsf. Oxidative alteration is also observed in brecciated zones at 180 mbsf, 275 mbsf, and 330 mbsf.

Paleomagnetic intensities are variable, generally in the range of other oceanic gabbros but up to >2.5 emu/cm^3 in some of the Fe-Ti-oxide gabbros. Magnetic susceptibilities average about 100 x 10^{-6} cgs, and are significantly lower than values from gabbros of the Kane Fracture Zone (Fox and Opdyke, 1973). Again, the highest values are in the Fe-Ti-oxide gabbros. Natural remanent inclinations are all steep and about equally divided between normal and reverse. Stable inclinations are reversed and average $65^o \pm 15^o$. The theoretical inclination for the site is -52^o, so the observed inclinations are somewhat steeper than expected. Logging in the hole shows that it has an average tilt from vertical of about 5^o in a north and east direction, so the inclinations are even more anomalous with respect to the present mean field.

Other results of logging and downhole measurements (Table 2) reveal interesting structural and physical properties of the rock penetrated at this site. Compressional wave seismic velocities in the gabbros are in the range of 6.5 km/s to 7.0 km/s, both on rock samples and in situ, confirming expectations from the low porosities measured (less than a few percent) that velocities would be relatively high in the bulk rock and that fracture porosity is not significant throughout the section. Physical properties measurements show seismic anisotropy up to 10% particularly in some of the foliated rock, and successful borehole multichannel (MCS) and in situ vertical seismic profiling experiments may reveal more details of the bulk seismic properties. The MCS experiment indicated that in situ seismic velocity increases somewhat (5-10%) with depth over the hole. Grain (matrix) densities obtained from logs average about 2.9 g/cm^3 over the hole, and the caliper log showed a relatively uniform diameter ($\pm$1 in. or less), generally changing only gradually with depth.

One of the more interesting logs at this site is the laterolog, showing variations of electrical resistivity of 4 orders of magnitude downhole (~4 to 40k ohm-m). The highest values are to be expected from silicate rock with low porosity, but the lower values are not generally correlated with higher porosity. The most prominent low resistivity zone occurs throughout unit 4, and is likely the effect of the high mineral conductivity of the Fe-Ti oxides. Smaller scale variations (a few m) in the units below may reflect the same conductivity mechanisms.

The borehole TV showed that most of the hole wall is relatively smooth, with scattered linear and sinusoidal features probably indicating small fractures cutting the borehole. Nearly vertical broader bands of light/dark reflectivity may indicate non-circularity of the borehole cross-section, although further processing and analysis may be needed to distinguish the similar effects of a de-centralized tool.

Four magnetometer sondes were run in the hole (Table 2): the Schlumberger 3-component tool used primarily for hole inclination and orientation, a USGS 3-component magnetometer, a USGS susceptibility tool, and a University of Washington/LDGO combined 3-component magnetometer and susceptibility tool. The magnetometers showed large and similar variations in the fields measured in the hole, especially in the Fe-Ti-oxide-rich zone where the fields are up to 50% greater and more variable. Although the susceptibility is also more variable in this zone, most of the variability is probably due to the remanent component, much of it unstable, as deduced from samples examined in the paleomagnetics laboratory aboard ship.

A borehole packer experiment indicated low fluid permeability below about 272 mbsf, with higher values (by several orders of magnitude) above this level. Because of the low porosity, the higher permeability is unlikely to be related to bulk properties of the rock, but probably reflects fracture permeability at least in a few zones. The temperature log shows a very low or even negative gradient in the hole, further suggesting the effects of seawater advection even with low porosity.

More comprehensive studies of the rock samples recovered and the data obtained should better define the origin, tectonics, and physical state of this unique section of material believed to represent the lower oceanic crust.

REFERENCES

Bonatti, E., 1978. Vertical tectonism in oceanic fracture zones. Earth Planet. Sci. Lett., 37:369-379.

Cormier, M.-H., Detrick, R. S., and Purdy, G. M., 1984. Anomalously thin crust in oceanic fracture zones: New seismic constraints from the Kane Fracture Zone. J. Geophys. Res., 89:10249-10266.

Detrick, R. S., and Purdy, G. M., 1980. Crustal structure of the Kane Fracture Zone from seismic refraction studies. J. Geophys. Res., 85:3759-3777.

Engel, C. G., and Fisher, R. L., 1975. Granitic to ultramafic rock complexes of the Indian Ocean ridge system, western Indian Ocean. Geol. Soc. Am. Bull., 86:1553-1578.

Fisher, R. L., and Sclater, J. G., 1983. Tectonic evolution of the southwest Indian Ocean since the Mid-Cretaceous: plate motions and stability of the pole of Antarctica/Africa for at least 80 Myr. Geophys. J. Roy. Astron. Soc., 73:553-576.

Fox, P. J., Detrick, R. S., and Purdy, G. M., 1980. Evidence for crustal thinning near fracture zones: Implications for ophiolites. In Panayiotou, A. (Ed.), Proceeding of the International Ophiolite Symposium: Cyprus Geological Survey Dept., 161-168.

Fox, P. J., and Opdyke, N. D., 1973. Geology of the oceanic crust: magnetic properties of oceanic rocks. J. Geophys. Res., 78:5139-5154.

Schouten, M., and Klitgord, K. D., 1982. The memory of the accreting plate boundary and the continuity of fracture zones. Earth Planet. Sci. Letts., 59:255-266.

van Andel, T. H., von Herzen, R. P., and Phillips, J. D., 1971. The Vema fracture zone and the tectonics of transverse shear zones in oceanic crustal plates. Mar. Geophys. Res., 1:261-283.

FIGURE CAPTIONS

Figure 1: Bathymetric map of the southern Indian Ocean showing the location of sites drilled during Leg 118. Contour intervals at 1000 m.

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

Figure 3: Bathymetric map at 500-m contour interval of the Atlantis II Fracture Zone, Southwest Indian Ridge, showing drill sites. Survey from Conrad cruise 27-09, 1986, H. Dick, Chief Scientist, with D. Gallo and R. Tyce.

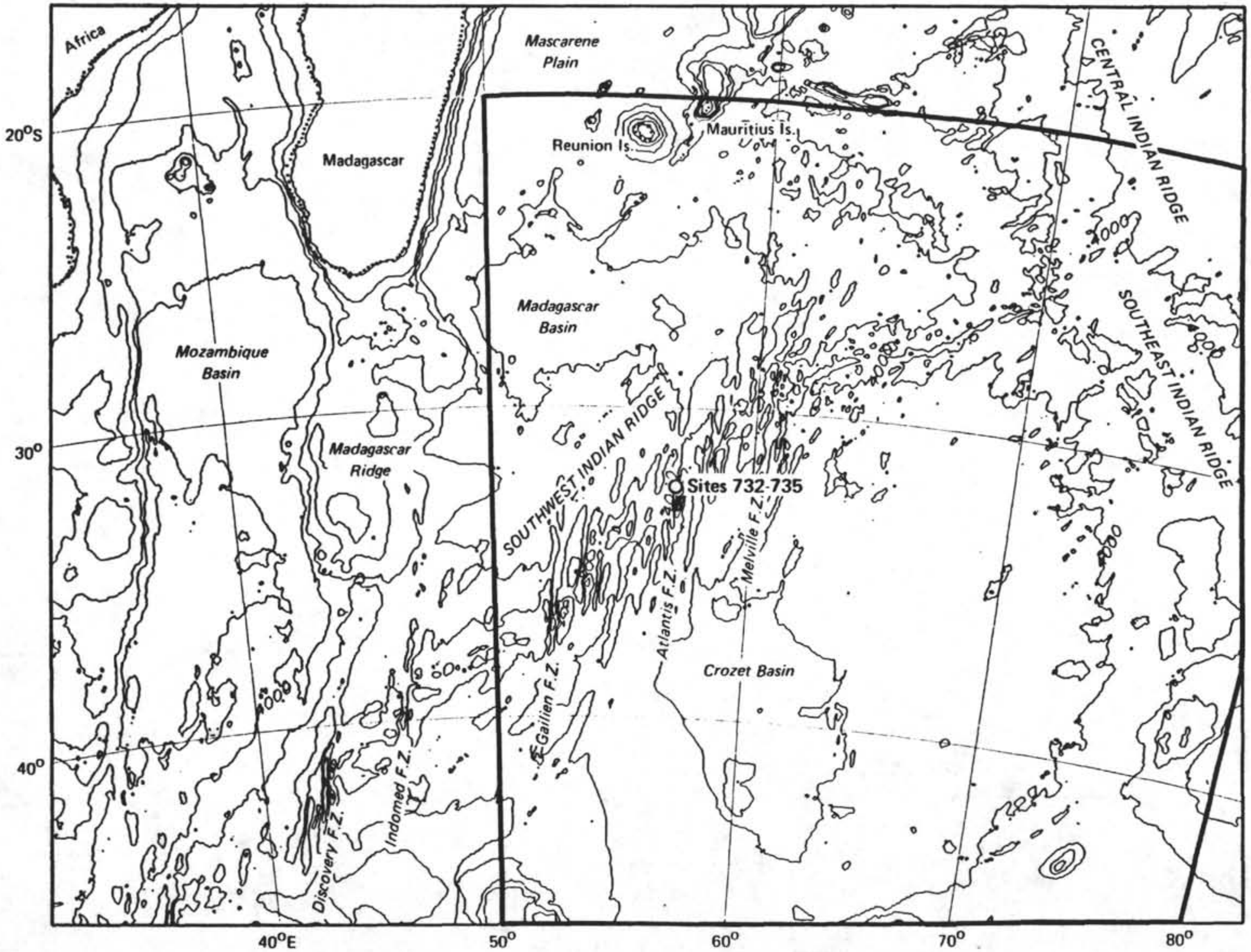
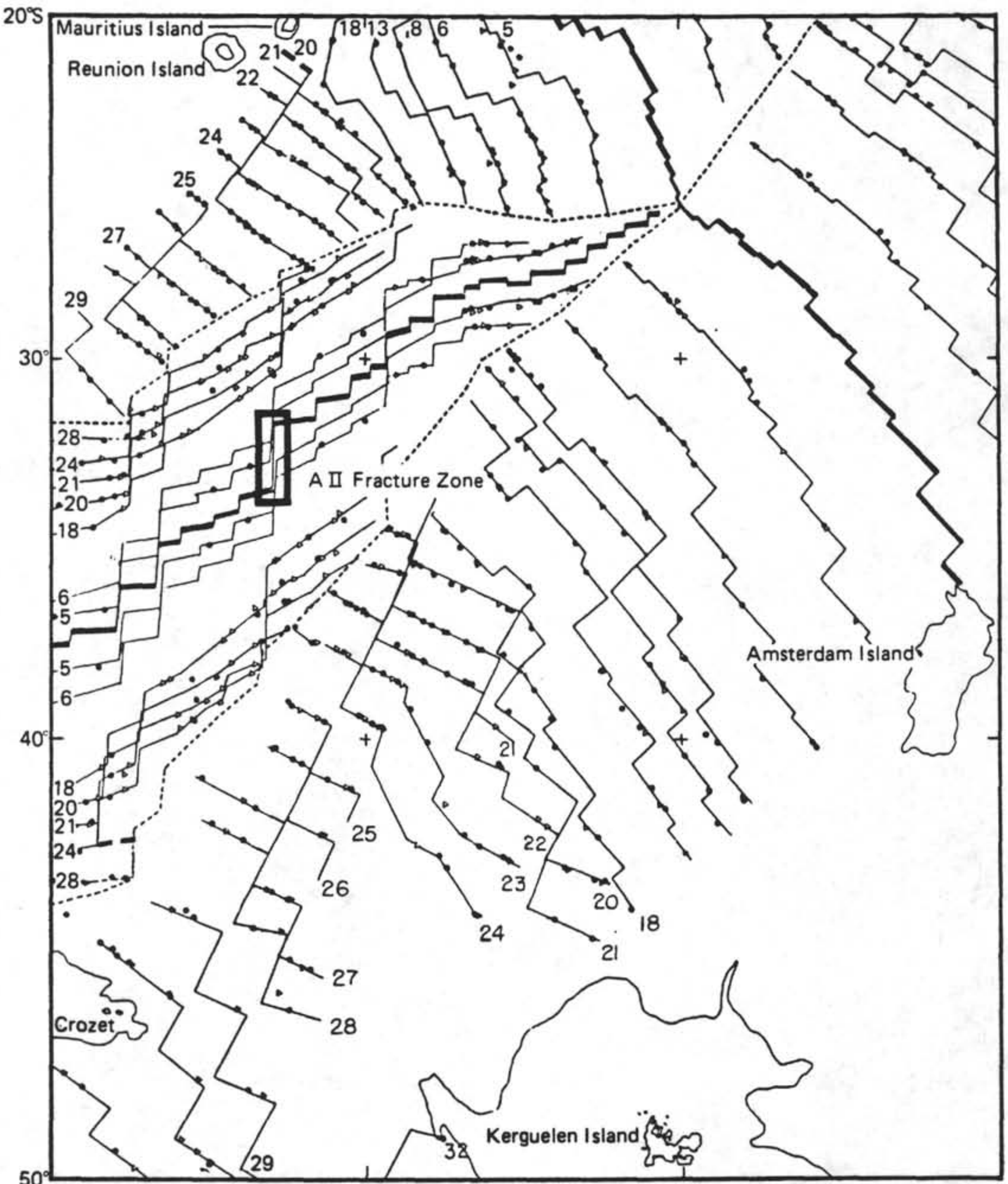

Africa
Mascarene Plain
Madagascar
Reunion Is.
Mauritius Is.
CENTRAL INDIAN RIDGE
Madagascar Basin
SOUTHEAST INDIAN RIDGE
Mozambique Basin
Madagascar Ridge
SOUTHWEST INDIAN RIDGE
Sites 732-735
Melville F.Z.
Atlantis F.Z.
Crozet Basin
Gallien F.Z.
Indomed F.Z.
Discovery F.Z.
20°S
30°
40°
40°E
50°
60°
70°
80°

Figure 1.



20°S
Mauritius Island
Reunion Island
18
13
8
6
5
21
20
22
24
25
27
29
30°
28
24
21
20
18
A II Fracture Zone
6
5
5
6
40°
18
20
21
24
28
25
26
27
28
21
22
23
20
18
24
21
Amsterdam Island
Crozet
Kerguelen Island
32
29
50°
50°E
60°
70°

Figure 2.

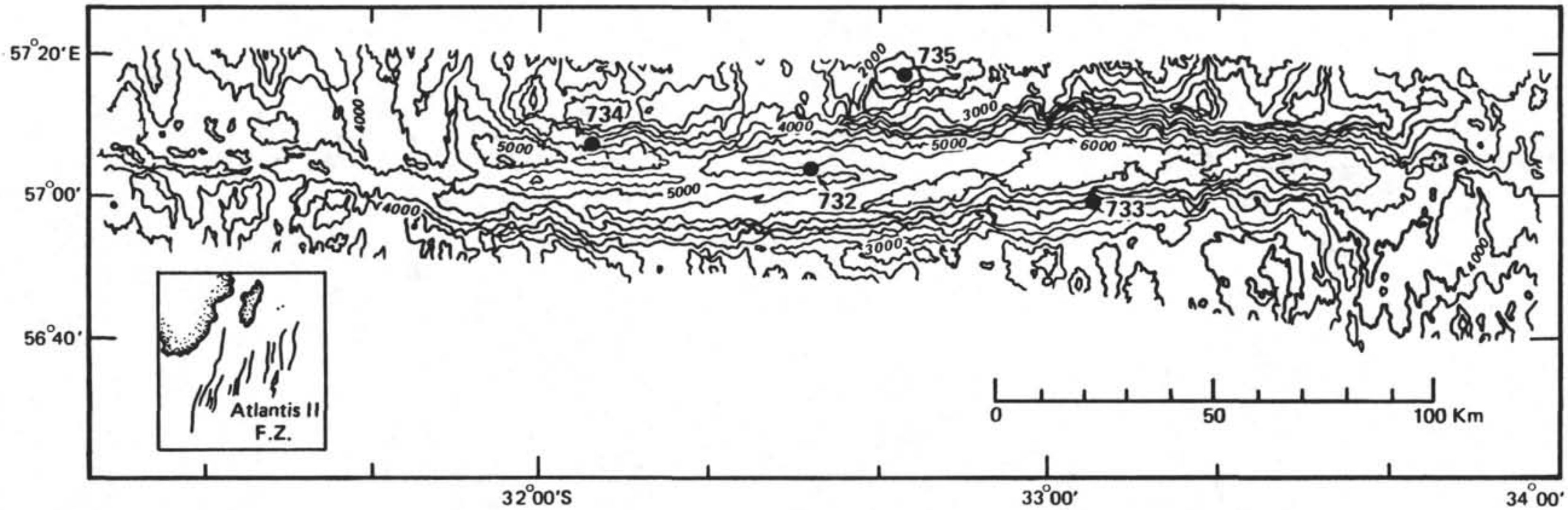

57°20'E
57°00'
56°40'
32°00'S
33°00'
34°00'
735
734
732
733
2000
3000
4000
5000
6000
Atlantis II
F.Z.
0
50
100 Km

Figure 3.

TABLE 1
SITES DRILLED DURING LEG 118

HOLE	LAT/LONG	WATER DEPTH (m)*	TOTAL PENETR. (mbsf)	% RECOVERY
732A	32°32.81'S 57°03.29'E	4893.0	3.0	0.33
732B	32°32.81'S 57°03.29'E	4889.4	8.0	23.75
732C	32°32.81'S 57°03.29'E	4896.5	24.0	1.45
732D	32°32.85'S 57°02.70'E	4826.0	6.0	1.00
732E	32°32.85'S 57°02.70'E	4819.0	7.0	2.57
732F	32°32.85'S 57°02.70'E	4818.0	15.8	1.90
733A	33°05.25'S 56°58.65'E	4494.0	16.6	0
733B	33°05.30'S 56°58.65'E	4498.0	4.3	2.09
733C	33°05.30'S 56°58.65'E	4498.0	5.7	3.57
733D	33°04.91'S 56°59.37'E	5219.0	23.6	1.99
734A	32°06.83'S 57°07.81'E	3670.7	7.6	0.66
734B	32°06.82'S 57°07.80'E	3681.5	57.0	1.93
734C	32°06.36'S 57°06.24'E	3706.0	20.0	0
734D	32°06.36'S 57°06.24'E	3720.0	19.5	4.05
734E	32°06.76'S 57°07.74'E	3746.2	9.5	0
734F	32°06.76'S 57°07.74'E	3436.0	14.0	0.71
734G	32°06.95'S 57°08.10'E	3428.5	31.0	19.19
735A	32°43.30'S 57°16.30'E	738.0	7.0	1.43
735B	32°43.42'S 57°15.97'E	731.0	500.7	86.84
735C	32°43.44'S 57°15.95'E	753.9	0	0

*Water depths are from drill-pipe measurement, and include the 11-m distance from the rig floor dual elevator stool to the water line.

TABLE 2
OPERATIONAL SUMMARY FOR LOGGING IN HOLE 735B

ORDER/START TIME[a]			LOG/EXPERIMENT
First pipe trip (clean-out/logging bit)			
	0800	5 December	Reenter hole
(1)	0930	5 December	Schlumberger DIT/LSS/GR/CAL - sonic log good, induction and caliper failed.
(2)	1500	5 December	Schlumberger LDT/CNTG/NGT/GPIT/AMS - data good.
(3)	1815	5 December	Schlumberger GST/ACT/CNTG/NGT/GPIT/AMS - 2 passes. Data excellent.
(4)	0730	6 December	Schlumberger DIT/GR/CAL - repeat of run #1. Data good.
(5)	1045	6 December	Schlumberger DLL - data excellent.
(6)	1300	6 December	USGS temperature log #1 - good results, temp higher toward top of hole.
(7)	1630	6 December	LDGO BHTV - both tools failed. No data collected.
(8)	0030	7 December	LDGO MCS - data good except for top 100 m of hole.
(9)	0700	7 December	USGS magnetometer - data good.
(10)	1600	7 December	Univ. Washington magnetometer/magnetic susceptibility tool - magn data good, susc data miscalibrated.
(11)	2015	7 December	USGS magnetic susceptibility tool - data good.
(12)	2315	7 December	LDGO MCS - repeat of Run (8). Good data over missing 100 m of hole.
(13)	0300	8 December	USGS temperature log #2 - good data, most of hole cooling since run #1.
(14)	0630	8 December	WHOI VSP - partially successful. Log bottom of hole then hydraulic arm clamping problems on one tool, other tool did not work.
(15)	1215	8 December	LDGO BHTV - good data. Centralizer bracket top-plates left in hole.
(16)	2300	8 December	WHOI VSP - unsuccesful, both tools failed.
(17)	0100	9 December	Schlumberger WST - shot 22 stations (approx 5 shots each with water gun and air gun.

(18) 0245 9 December WHOI VSP - problems gone when tool set properly. 24 clampings at 15-25 m intervals. Good data.

2045 9 December Pull out of hole.

<u>Second pipe trip</u> (packer in BHA)

0145 10 December Reenter hole.

(19) 0345 10 December 6 successful packer sets at 778, 780, 954, 954, 1030, and 1120 mbsf. Slug and flow tests good.

2200 10 December Pull out of hole - time expired.

Note [a]: Start time refers to the time each logging tool left the rig floor. In the case of the packer experiment, this refers to the time the first go-devil seated in the packer.

OPERATIONS REPORT

The ODP Operations and Engineering personnel aboard JOIDES Resolution for Ocean Drilling Program Leg 118 were:

Operations Superintendent	Charles Hanson
Special Tools Engineer	Steve Howard
Operations Specialist	Barry Harding

Other operations personnel aboard included:

Schlumberger Logger	Lee Geiser*

*Address:
Schlumberger Offshore Services
369 Tristar Drive
Webster, TX 77598

OPERATIONS SYNOPSIS
LEG 118

PORT LOUIS PORT CALL

Leg 118 commenced at Port Louis, Mauritius, at 0700 hr, 18 October 1987, when JOIDES Resolution dropped anchor in Port Louis harbor. The scientific staff boarded the ship during the morning, the Schlumberger cable was changed and inspection of the drill pipe was started. At 2145 on 19 October the ship moved to a dock, and fuel and air cargo were taken aboard. During 20 and 21 October, surplus equipment was unloaded to make room on the ship for the hard-rock guidebase and a large amount of ancillary hard-rock drilling equipment. JOIDES Resolution sailed for the first site at 1200 hr 22 October.

The voyage to the first site was uneventful. At 0900 hr, 25 October, the ship was slowed to begin the site survey. At 1030 the beacon was dropped at 32°32.75'S, 57°03.10'E. The voyage of 771 nmi had been made in 71.5 hrs at 10.8 kt.

SITE 732: PROPOSED SITE SWIR I

The beacon landed just east of the median ridge summit in about 4800 m of water. The TV/sonar was deployed to locate a suitable hard-rock site to drill. Ideally, the site needed to be on a slope less than 20°, in an area of sufficient area to land the hard-rock guidebase, and located on peridotite. An E-shaped survey was made along the crest of the ridge with three transects downslope to the east. The seafloor was observed to be sediment with only scattered outcrops of rock.

Hole 732A

The operational plan was to test-drill the site before committing the hard-rock guidebase (HRB). The test drilling would determine if a hole could be started with an unsupported bottom-hole assembly (BHA) at the site, and would also identify the lithology.

Hole 732A was cored from 4893 to 4896 m (0-3 mbsf) with the drilling motor. A pressure leak developed in the drill-string weight indicator system. It was necessary to pull the bit above the seafloor to repair the leak. The core barrel was pulled, and a fragment of mylonitized serpentinite was recovered.

Hole 732B

Hole 732B was spudded near Hole 732A. The bit was observed on TV to penetrate about 5 m of very soft sediment before it began to take weight. The hole was cored from 4889.4 to 4897.4 m (0-8 mbsf). There it became evident that the space-out of the bit relative to the hard sea floor at 5 mbsf would not permit a drill pipe connection with the bit below stable formation. The core barrel was removed, and 1.9 m of clay and sand was recovered with clasts of basalt, diabase and serpentinite.

Hole 732C

The ship was offset a few meters. The hole was cored from 4896.5 to 4920.8 m (0-24 mbsf). When the bit was raised off bottom for a drill pipe connection, the hole fell in. It was redrilled to 4916 m (19.5 mbsf). More hole was lost. Because of the bad caving conditions and the unknown thickness of the rubble, we concluded that this location was not a suitable guidebase site. A total of 0.7 m of rubble composed of basalt, gabbro, and sandstone was recovered in the core barrel.

Hole 732D

The shipboard scientists speculated that a site near the top of the median ridge would have less rubble. The ship was moved 900 m west toward the crest of the ridge. The seafloor was located at 4821.0 m by TV observation. The bit was pushed through 5 m of soft sediment and took weight at 4826.0 m. The hole was stable, but the drilling rate was very slow. It took 5.25 hr to core 6 m, at which time the bit stopped drilling. The drilling rate suggested that the bit was worn out, so the pipe was tripped out of the hole. When the bit reached the surface, we were surprised to find that it was in a near-new condition.

Hole 732E

Hole 732E was spudded close to Hole 732D. Because of the 5 m of sediment cover, we concluded that a spud-in with a conventional rotary-driven BHA was possible, the advantage of the rotary system being its ruggedness and relatively low cost compared to the coring motor. Not only are the motors costly, the only two in existence were on the ship, and their loss in the event of a BHA failure would prevent future coring.

The bit took weight at 4819 m, and the hole was cored to 7 mbsf in 68 minutes; then the pipe stuck and required 150,000 lb overpull to free it. When it came free, the combination of pipe stretch and the finite response time of the motion compensator jerked the pipe out of the hole. A wireline trip was made for the core barrel, and 0.18 m of basalt and diabase rubble was recovered.

Hole 732F

The ship was moved 15 m west toward the median ridge crest. The bit took weight at 4818 m. The coring rate was satisfactory, but nearly every time the bit was picked up from the bottom of the hole, the hole collapsed. At 4833.8 m (15.8 mbsf) the bit was raised to 4 mbsf to recover the core barrel. Although the hole was mud filled, it collapsed. The bit struck bottom a couple of times on down heaves of the ship as the hole continued to fall in. It was necessary to pull the bit clear of the seafloor to protect the drill string from compressible damage.

The test spud-ins at Site 732 suggest that the median ridge is capped by soft sediment atop sand and gravel containing boulders of considerable size and quantity. The thickness of this material is unknown; it is not stable for drilling. Hence, Site 732 was deemed unsuitable for guidebase deployment.

SITE 733: PROPOSED SITE SWIR II

SWIR II is positioned on the west wall of the transform fault. JOIDES Resolution made the journey in 5 1/2 hr, including a site survey. The beacon was dropped at 1400 hr, 31 October, at 33°05.300'S, 56°58.866'E, onto a very rough seafloor. It came to rest halfway down the wall in about 4075 m of water.

The TV/sonar was used to do two nearly parallel survey lines. These lines were about 4 km in length and separated by 400 m to 500 m, and were carried out in a southwest-northeast direction on opposite sides of the beacon. These profile lines crossed the benches that were expected from the SeaBeam maps. Sediment, rubble, and large boulders were on the benches.

Hole 733A

The mud motor with a C-4 bit was picked up, and the pipe was started in the hole. The bottom was sighted on TV at 4494 m. A core was cut to 16.6 mbsf in 180 minutes. Hole conditions were stable, except for an overpull of 60,000 lb at 10 mbsf. Four runs with the wireline were required to latch and retrieve the core barrel. A piece of rubber from the drill pipe stabbing guide had jammed in the latch fingers and prevented engaging the overshot. Fortunately, the same piece of rubber had jammed the core barrel fishing neck in the overshot, resulting in the barrel being recovered. Core recovery was zero.

Hole 733B

The bit tagged bottom at 4498 m. The hole was stable, but drilling was very slow. The hole was cored to 4.3 mbsf in 11.25 hours, at which point the hole was abandoned because of the slow drilling rate. Only 0.09 m of metagabbro and amphibolite was recovered.

Hole 733C

One core of 5.7 m was cut in 11.75 hr. A total of 0.3 m of basalt and amphibolite was recovered.

In summary, Holes 733A, -B, and -C were drilled essentially at the same location in a sediment-filled basin on the western transform wall. The area is covered with about 4 m of sediment underlain by a basement of very hard material. Drilling indications are that the sediment contains some rubble. The decision was made to move to a different location in an attempt to find easier drilling and peridotite.

Hole 733D

The next location was also a sediment-filled basin about 700 m down the transform wall. The bit was observed on TV to contact very soft seafloor at 5219 m, and the bit took little or no weight for 15 m. The next 5 m drilled at a reasonable rate of penetration. Extremely hard material was then encountered. The first core recovered 0.41 m of gabbro, and the second contained 0.05 m. The hole was abandoned 8.5 m into the hard material after 23 rotating hours because of the slow drilling rate and the lack of peridotite.

If ODP drilling operations return to the west wall, the Hole 733D area should be considered as an operating site. The 15 m of sediment offers the opportunity for a casing wash or drill in. The formation below the 15 m of surface sediment is stable but very hard.

SITE 734

Because of the lack of success in finding massive outcrops of easily drillable peridotite on the west wall, the scientific party elected to move to a site on the east wall where peridotite had been dredged. JOIDES Resolution departed the west wall area at 2130 hr, 5 November, and traveled about 60 nmi north and a little east. Because of the large area of interest, two beacons were dropped, one in 4400 m of water and a second in 4100 m of water. A 33.75-hr TV/sonar survey was conducted. The survey lines consisted of three profiles run downslope. The first and northernmost profile was between water depths of 3300 m and 4400 m where the wall sloped 25-30°. Several rock outcrops that were possibilities for drilling were observed and two sites were selected for test spud-in on the northernmost survey line: a sediment bench at 3400 m that appeared to be underlain by a massive outcrop and a bare rock surface at 3800 m.

Hole 734A

The coring motor was used for the test spud-in. The seafloor was contacted by the bit at 3670.7 m. The hole was cored to 7.6 mbsf in 75 min, at which depth it was necessary to make a drill pipe connection. Although the bit was 4 mbsf, it pulled out of the hole when the ship heaved. The core barrel was recovered; two latch fingers were left in the motor, and it was necessary to pull the drill string to assure that the segments were not in a potentially damaging position.

Hole 734B

The rotary drilling system with a 9 7/8 in. RBI C-4 bit was used in an effort to obtain a deep penetration. It took weight at 3681.5 m, and the bit was advanced 9.5 m in 10 min. A core 1.1 m long composed of gravel, ooze and sand was recovered. Four more cores were attempted. The recovery was zero. Little or no weight was required, and the drilling time was only 2-4 min. Suspicions were that the bit was going down the face of a cliff. The next core was cut with no bit rotation. This was final confirmation that the bit was sliding downslope.

Hole 734C

The bit was pulled well clear of the seabed and the ship was moved about 50 m northwest. The bit tagged bottom at 3706 m. It was run in 20 m with no bit rotation. No doubt, the bit was sliding down the side of a mountain again.

Hole 734D

The ship was moved 50 m north. The bit tagged bottom at 3720 m. Progress was 19.5 m in 6 min. Once again it was going down the slope. A total of 0.79 m of sand and gravel was recovered.

Hole 734E

It was apparent that we were not going to be able to spud a hole by probing on bottom blindly. The TV/sonar was run, and an 8-hr TV/sonar survey was conducted. A flat area was located that appeared suitable for spudding. The TV/sonar was recovered, and the bit took weight at 3746.2 m. The pipe was rotated for 90 min and advanced 9.5 m. Indications were that a successful spud-in had been achieved with the rotary system. At 9.5 mbsf the bit suddenly became stuck. The pipe was worked with up to 200,000 lb overpull for 45 min. The stuck pipe was drawn up the hole about 4 m, at which point it came free. Because of stretch, the drill pipe rebounded out of the hole.

The wireline was run to recover the core barrel, but the barrel could not be latched. The drill pipe was tripped to the surface; the bit sub had been torn from the bottom drill collar and the collar was bent 12 ft from the pin end.

Hole 734F

The TV was again run and a flat area was found 15 m west and upslope of Hole 734E. The drilling motor was picked up because of the earlier problem of the bit going downhill with the rotary drilling assembly.

The sea bottom was contacted at 3436 m. The bit was observed on TV/sonar to skid around on a hard flat bottom, but after a few minutes a hole was started. A few inches of hole was made before the view was obscured by a cloud of cuttings in the water. The TV/sonar was raised several meters to remove it from the worst of the drill pipe vibration. Surface indications were that new hole in a soft formation was being made, and a total of 14 m of hole was made in 14 min. The dust cloud was allowed to settle, and the TV/sonar was lowered to observe the new hole. The bit had managed to unseat from the hole and had once again "walked" down a steep slope.

Hole 734G

The bit was raised to 3423 m, and the ship was moved a few meters while looking for a better drill site. A likely spot was found and Hole 735G was started at 3428.5 m. The first core penetrated 13 m, but there were serious problems with the hole falling in when the bit was raised off bottom. Before attempting to retrieve the core barrel, the hole was filled with 10.2 PPG ultra-high viscosity mud. The core recovery was zero. The second core advanced the bit 9.5 m in 3.4 hr. Although over 100 barrels of mud was used in slugs, the hole kept falling in. While the barrel was being retrieved, 8 m of hole was lost. Recovery was zero.

The third core advanced the bit 8.5 m in 7 hr. The torque and drag were not abnormal, but nearly every time the bit was raised from bottom, the hole filled in under the bit. At 31 mbsf an attempt was made to retrieve the core barrel. The barrel could not be latched in three runs; eventually the collapsing hole drove the bit up to the mudline and the hole had to be abandoned. The recovery for the hole was 5.95 m of drill cuttings/breccia.

ODP Engineering and Operations personnel and the scientific party concluded that Site 734 was not suitable for deep penetration drilling. The decision was made to move to a wave-cut terrace located in 700 m of water east of the eastern wall.

SITE 735

The ship arrived on 14 November after a passage of 8.5 hr. A recallable beacon was launched at 32°43.3'S, 57°16.3'E. A 5.5-hr 200-m-square box pattern survey was made with the TV/sonar. The bottom appeared to be massive flat rock with a scattering of thin sediment.

Hole 735A

A test spud-in was made with the mud motor. The bottom, at 738 m, was stable but very hard. Seven meters was cored in 11.6 hr, and then the bit stopped drilling. The core barrel could not be retrieved with the wireline, and the drill string was tripped to the surface. The bit sub pin had failed and the bit was left in the hole. Two cored pieces of gabbro were recovered.

Engineering and Operations personnel advised that the site was stable and drillable, but the coring rate was likely to be no more than 1-2 cores per day. The scientific party voted unanimously to set the HRB and drill whatever rock lay below.

Assembly of the HRB began at 1300 hr, 15 November. The installation of the HRB was completed 42 hr later on 17 November. The entire operation was nearly flawless.

Hole 735B

The coring motor was used for the unsupported spud-in. As expected, the coring rate was slow. The first core advanced the bit only 6.5 m in 13 hr and recovered 2.3 m. The hole was no longer expendable with the guidebase in place, so it was prudent to be conservative in the number of hours the bit was run; it was pulled after the first core.

The second bit advanced 14.5 m in 14.8 hr and recovered 6.25 m of foliated metagabbro; the bit was not seriously worn.

The third bit was a hybrid. The core guide between the cones was geoset diamonds, and the intent was for the guides to trim the core and guide it into the grasp of the core catcher. The bit was advanced 18.2 m in 17.0 hr, and the recovery was 5.5 m of foliated metagabbro. The bit was recovered. The cone inserts were in good condition, but the diamonds were worn and chipped severely.

The fourth bit was a Christensen impregnated diamond bit. It was of a design commonly used in the mining industry, but one of this size has rarely if ever been used in hard rock. It was run 2.25 hr, and was pulled because no penetration was evident. A surprise in the core catcher was 0.08 m of gabbro. The bit was badly worn, and it was apparent that this particular design was not a match for the hard, abrasive gabbro.

During the afternoon of 20 November, sailing ships Amorina and Soren Larson, bound from London to Fremantle and the Australian Bicentennial, hove to near Resolution. The Z-boats ferried people to and fro all afternoon. Dr. Henry Dick gave 6 lectures in 2 hr on the history of the fracture zone. An Australian TV film crew interviewed many of Resolution's staff and shot film footage for Australian TV.

The diamond bit run terminated at 44.5 mbsf. At that point, sufficient hole had been made to safely justify running a rotary-driven BHA. The first rotary-driven 9 7/8 in. bit was an RBI C-7. It was run with only 15,000 lb of weight to reduce BHA flexure. In spite of the light weight, it made 16.8 m in 19 hr and recovered 13.31 m. The recovery (79.2%) was a significant increase from the 36.02% recovery with the motor-driven system.

The next bit was run 13 hr, advanced 12.3 m and recovered 8.46 m. It was pulled because of a core jam in the bit throat. The next bit made 25.5 m in 18.5 hr and recovered 14.84 m. A noticeable increase in rate of penetration and recovery was evident. The following bit run was 24.67 hr long; a total of 33.4 m was recovered from 37.5 m of advancement. This was followed by a 24-hr run that advanced the bit 39.5 m and recovered 36.7 m of core; the bit weight was increased from 15 to 22 thousand pounds during this run. The next bit cut 67 m and recovered 64.48 m for 96.3% recovery. The last available C-7 bit made 67.5 m in 30 hr and recovered 64.87 m for a recovery of 96.1%. The penetration was now 305.5 mbsf.

The supply of C-7 bits was exhausted, but C-57s were available. The first C-57 advanced 109.0 m in 29.17 hr and recovered 103.4 m (94.86%). The time left for coring was short. The final bit was run into the hole on 2 December. By this time all DSDP/ODP records for coring and recovering hard rock had been shattered; but the depth was 424.0 mbsf, and the possibility of a half-kilometer hole was a tantalizing goal.

Core 118-735B-85R took 195 minutes to cut 9.5 m and reached 481 mbsf. The prospect of reaching 500 mbsf in the assigned coring time was not good, but the next core took only 145 minutes and reached 490.5 mbsf. The allocated coring time had run out, but the logging scientists graciously loaned the drillers a couple of hours. Core 118-735B-87R from 490.5 to 500.0 mbsf reached the deck at 0505 hr on 3 December.

Hole 735B had been cored from 731 to 1231 m (0-500 mbsf). RCB recovery for the hole was 434.11 m (86.8%).

NAVI-DRILL

A period of 24 hr had been set aside for testing the Navi-Drill. This system is complementary to the APC/XCB system. A mud-driven motor with a 15-ft core barrel on the bottom of the motor is landed inside the bottom drill collar. The design purpose of the system is to obtain a sample of basement rock at the end of an XCB hole. The tool had worked well in land tests but had failed two shipboard tests.

After extensive surface testing, the Navi-Drill cut a 0.7 m core at the bottom of Hole 735B (500-500.7 mbsf). The drill pipe was then pulled above the guidebase, and the ship was offset about 70 m. A bare rock spud-in was attempted (Hole 735C), but the BHA apparently was pumped off the sea bottom by the hydraulic force of the drill, and the inner core barrel was bent. Additional testing time was not available.

LOGGING

The ship was positioned over Hole 735B, and the hole was reentered at 0800 hr on 5 December. The first logging run was with the Schlumberger DIT/LSS/CAL/GR (see Table 2, Scientific Report). The caliper and induction failed, but the sonic log was successful. Log run #2 was the Schlumberger LDT/CNTG/NGT/GPIT/AMS. The third run was the Schlumberger ACT/GST/CNTG/NGT/AMS/GPIT; results were excellent. Run #4, started on 6 December, was the Schlumberger DIT/GR/CAL. This log was a repeat of the one that had partially failed earlier; results were good. Run #5 was the Schlumberger DLL log, which produced excellent results. Run #6 was the temperature log. The results were good, and an unexpected find was that the temperature in the upper portion of the hole was slightly higher than at the bottom. Run #7 was the BHTV; both tools failed and no data were recorded. Run #8 was the MCS tool which produced good data except in the top 100 m of hole. The ninth log was the USGS magnetometer, and a good log was obtained. Run #10 was the U. Washington magnetometer/susceptibility log which gave good results. Run #11 was the USGS susceptibility log which worked well. Run #12 was a repeat of the MCS log, and good data were obtained in the missing interval of the hole. Run #13 was a repeat of the temperature tool, which showed most of the hole cooling since the first temperature run. Run #14 was the WHOI VSP experiment. The run was not a success; the hydraulic arm that holds the tool against the wall kept slipping down the hole. The second tool had did not pass its deck test; the arm would not extend properly. While the VSP tools were being worked on, the BHTV was deployed during run #15. This time it worked, but two small (3" x 5/8" x 3/32") centralizer bracket top plates were left in the hole. Run #16 was the WHOI VSP experiment, but again the tool failed to function. Because of the problems with the WHOI VSP equipment, the Schlumberger WST tool (vertical component VSP) was deployed for run #17. More than 20 stations were taken obtaining good data, but noise was a problem. There was also a problem with the tool sliding down the hole when it was clamped at a station. This suggested that the problem with the WHOI tool not remaining stationary might be the inability of the clamping arm to grip the hard, slick rock, since the arm worked on deck. The WHOI VSP tool was used again for run #18. There was a problem with the WHOI tool slipping down the hole, but the winch operator developed techniques to set the tool. The experiment was a success; 24 clampings at 15-25 m intervals produced good data.

The drill pipe was tripped out of the hole, and the inflatable packer was attached and run into the hole. Six successful inflations were made. Data from the packer are excellent, and showed that the hole is permeable in the upper part and very impermeable toward the bottom.

The total time required for downhole measurements and logs was 5.84 days. This includes hole conditioning and drill pipe trips.

JOIDES Resolution departed for Port Louis, Mauritius, at 0730 hr on 11 December 1987. The first line was ashore at 0615 hr on 14 December 1987, ending Leg 118.

SITE SUMMARY
LEG 118

HOLE	LAT/LONG	TOTAL DEPTH (m)*	# CORES	METERS CORED	METERS REC'D	% REC'D	METERS DRILLED	TOTAL PENETR (mbsf)	DAYS ON HOLE	DAYS ON SITE
732A	32°32.81'S 57°03.29'E	4896.0	1	3.0	0.01	0.33	0	3.0	0.92	
732B	32°32.81'S 57°03.29'E	4897.4	1	8.0	1.90	23.75	0	8.0	0.42	
732C	32°32.81'S 57°03.29'E	4920.5	3	24.0	0.35	1.45	0	19.0	1.00	
732D	32°32.85'S 57°02.70'E	4832.0	1	6.0	0.42	1.00	0	6.0	0.95	
732E	32°32.85'S 57°02.70'E	4826.0	1	7.0	0.18	2.57	0	7.0	0.61	
732F	32°32.85'S 57°02.70'E	4833.8	1	15.8	0.30	1.90	0	15.8	0.92	4.82
733A	33°05.25'S 56°58.65'E	4510.6	1	16.6	0	0	0	16.6	1.41	
733B	33°05.30'S 56°58.65'E	4502.3	1	4.3	0.09	2.09	0	4.3	0.71	
733C	33°05.30'S 56°58.65'E	4503.7	1	5.7	0.20	3.57	0	5.7	0.30	
733D	33°04.91'S 56°59.37'E	5242.6	2	23.6	0.47	1.99	0	23.5	1.89	4.31
734A	32°06.83'S 57°07.81'E	3678.3	1	7.6	0.05	0.66	0	7.6	1.15	
734B	32°06.82'S 57°07.80'E	3738.5	6	57.0	1.10	1.93	0	57.0	1.01	
734C	32°06.36'S 57°06.24'E	3726.0	1	20.0	0	0	0	20.0	0.07	
734D	32°06.36'S 57°06.24'E	3739.5	1	19.5	0.79	4.05	0	19.5	0.13	
734E	32°06.76'S 57°07.74'E	3755.7	1	9.5	0	0	0	9.5	0.52	
734F	32°06.76'S 57°07.74'E	3450.0	1	14.0	0.10	0.71	0	14.0	1.10	
734G	32°06.95'S 57°08.10'E	3459.5	3	31.0	5.95	19.19	0	31.0	0.71	4.69
735A	32°43.30'S 57°16.30'E	745.0	1	7.0	0.10	1.43	0	7.0	1.23	
735B	32°43.42'S 57°15.97'E	1231.7	88	500.7	434.81	86.84	0	500.7	17.63	
735C	32°43.44'S 57°15.95'E	753.9	1	0	0	0	0	0	0.26	19.12
		TOTALS		780.3	446.82	57.26				32.94

*Meters below dual elevator stool (11 m above sea level) to bottom of hole.
Note: Total "Days on Site" does not include underway survey, TV survey, in port, or guidebase deployment times.

OCEAN DRILLING PROGRAM
OPERATIONS RESUME
LEG 118

Total days (17 October - 14 December 1987)	56.97	
Total days in port	4.21	
Total days under way (including survey)	7.17	
Total days on site	45.59	
Coring, including wireline time		18.44
Condition mud and circulate		0.16
Trips		11.26
Downhole science		5.84
TV/sonar survey		5.05
Reentry operations		0.15
Hard-rock guidebase deployment		1.75
Other		2.94

Total distance traveled (nmi)	1752
Average speed (kt)	10.5
Number of sites	4
Number of holes	20
Total interval cored (m)	780.3
Total core recovery (m)	446.82
% core recovery	57.26
Total interval drilled	0
Total penetration (m)	780.3
Maximum water depth (m, from drilling datum)	5219
Minimum water depth (m, from drilling datum)	731

TECHNICAL REPORT

The ODP Technical and Logistics personnel aboard JOIDES Resolution for Leg 118 were:

Laboratory Officer	Burney Hamlin
Curatorial Representative	Daniel Quoidbach
Computer System Manager	John Eastlund
Electronics Technician	Michael Reitmeyer
Electronics Technician	Barry Weber
Yeoperson	Michiko Hitchcox
Photographer	Christine Galida
Marine Technician	Wendy Autio
Marine Technician	Mary Ann Cusimano
Marine Technician	Jenny Glasser
Marine Technician	Ted "Gus" Gustafson
Marine Technician	Matt Mefferd
Marine Technician	Joe Powers
Marine Technician	Kevin Rogers
Marine Technician	Don Sims

PORT CALL

Docking was delayed until 19 October because another ship was in our berth, precluding freight movement, but smoothing technician crossover; the oncoming technicians were ferried by water taxi to the ship while she was at anchor in the harbor. While at anchor, a diver was retained for 19 October to make hull bottom bolt impressions for a flanged pod to house a 3.5-kHz transducer array. The diver could not get under the ship in the shallow harbor, and docking was delayed till the late evening tide. Incoming air freight spotted on the dock in the afternoon was lifted aboard and covered.

X-ray lab technicians exchanged an X-ray tube in the ARL XRF and performed preventive maintenance service. It was also necessary to replace a spline in the Haskris water chiller motor-pump linkage.

All Leg 117 air freight was off-loaded and our surface freight came aboard and was dispersed. A plastic bottle of developer concentrate broke in one of our plastic containers and the remaining items and container had to be cleaned. Eighteen Arctic parkas were sent ashore for cleaning in time for our December return. Also left behind were twelve cushions from the lounge furniture to be reupholstered.

The Bridge GPS unit was packed to return to Magnavox in the Leg 117 air freight shipment, but it had to be located to remove an external standard card used with the bridge Rubidium time reference. The card, however, was not in the unit and was eventually found in the SEDCO Electrical Supervisor's office. The GPS unit would still not work with the card, which will be returned to Magnavox for inspection.

Prior to sailing, two K-boxes of DOT boxes and vermiculite were put ashore for storage and eventual return to ODP.

UNDER WAY

The ship sailed at noon on 22 October for the 2 1/2 day steam to the first site. The magnetometer and seismic gear were streamed soon after leaving port to acquire transit speed seismic records for evaluation. The sunny tropical weather soon degenerated into cold Force 5 headwinds. There was considerable reliance on the seismic traces to keep the spotty returns from the depth recorders in the correct range as the bottom got rougher near the fracture zone where the sites were located.

Magnetometer data at full speed was too noisy to be useful but was fine during the surveys. This problem at full speed has been addressed but not resolved.

Seawater crossing the main deck on the transit south inhibited some work, so the underwater TV and frame preparation was done after the survey. A survey was made of the area, relying on GPS satellite navigation and a fine SeaBeam survey of the area made by Woods Hole Oceanographic Institution. The frame with the subsea TV camera and MESOTEK sonar scanner (TV/sonar) was deployed for the first of numerous surveys over the next three weeks.

These surveys were done with a free descent of the frame without drill pipe. A compass was mounted in the camera's field of view and was helpful on the free descents but was ineffectual when deployed with the drill string. Potential site locations, selected from the SeaBeam charts and augmented by information gained from bottom dredges, were inspected with the TV/sonar prior to spudding attempts at the 3 sites and 17 holes. The panorama of geologic features with occasional biological bottom communities unfolded on the shipboard monitors and held everyone's attention. A chain and black-painted 12-in. radar reflector suspended by light rope below the frame in the camera's field of view provided a size scale reference, a bottom indicator for the winch operator, and an indication of character of the sediments as the "drag ball" went through. Numerous 2-3-ft red snapper type fish basked in the light over Site 735 in 750 m of water, making the "subsea TV channel" ever interesting. VHS video tapes representing almost 48 hr of of bottom survey were recorded at the various sites.

Fantail GPS results diminished until only TRANSIT satellites were available for navigation and placed reliance on the bridge set. Replacement cards for the unit will be available in port to effect a repair on the fantail unit.

CORE LAB

The lab was quiet the first half of the leg. The physical properties scientists learned about the shipboard equipment and associated computer programs. Standards and a few core samples were studied.

The beginning of rotary drilling in Hole 735B in mid-November changed the pace, as core after core of hard rock was delivered to the catwalk. Scientists and technicians worked together to process the unprecedented recovery of nearly 450 m of gabbro.

During coring, samples were taken only for shipboard analyses. Where possible, samples were used for more than one study, for example, minicores were run through the magnetics lab and physical properties lab, and ended in the X-ray lab where they were powdered for XRF analyses (the minicore cutoffs were used for thin sections). Personal sampling was done after drilling was completed, in "sampling parties" when all scientists marked the locations of their samples and then technicians cut, bagged, and labeled each sample, after entering the sample information into the computer. The total number of samples taken was 1734.

Two pieces of gabbro were left unsplit, to be used for engineering tests if IHP approval is granted for this sample request. The section of gabbro cored by the Navi-Drill at the bottom of Hole 735B was also left whole so that it could be studied as is by ODP Engineering before it is split, described, and sampled.

The physical properties scientists had a pair of grinding jigs made to smooth the cuts on their samples, allowing a very high degree of precision as they measured sonic velocities through three axes of the cubed samples. A device meant to measure sonic velocities of samples under hydraulic pressure (in situ) worked and was compatible with our measuring system but proved to be too time-consuming to fit into the flow of samples.

Thermal conductivity measurements of the rock samples were made though there were some problems with equipment and software to contend with during the high recovery period. Dr. Dick Von Herzen modified the thermal conductivity procedures for hard rock, and a memo explaining these procedures is filed with papers in the lab and office.

Some soft rock and sediment instruments like the GRAPE, vane shear, and P-wave logger were not used.

The highly magnetic samples were measured in the paleomagnetics lab using various techniques. The MINISPIN magnetometer was used exclusively, sometimes in conjunction with the thermal and AF demagnetizers. Susceptibility measurements were made also.

Several of the recovered cores proved troublesome to cut. They were so stressed that a cut the width of the saw kerf was closing in behind and pinching the blade. Innumerable mini rock labels were hand written though some were printed using small fonts and copier reductions. It wasn't handy enough to reduce the tedium and some numbers still had to be hand-written.

CHEMISTRY LAB

The chemistry lab facilities were used primarily for X-ray sample preparation. Specimens were ground and weighed, and the vessels were cleaned there. After several of the chemistry lab instruments were repaired with new parts and calibrated, the chemist worked with the technicians in the core lab and on the deck work involved with preparation for the VSP experiment.

X-RAY LAB

The XRD scanned 25 samples this hard rock leg, but two technicians found themselves fully occupied with the XRF when the cores began arriving regularly. A technician familiar with the XRD was trained to operate, calibrate and maintain the XRF unit. The unit worked well and more than satisfied the geochemists aboard; 110 samples were run for major and minor elements.

SEM

Though there was little work generated for the SEM this leg, the equipment was used by a paleontologist who brought material with her to study.

THIN SECTION LAB

Samples from dredging done previously in the area allowed this lab to prepare for the demand 9 petrologists and 2 physical properties scientists placed on it. Requests for 315 thin sections were filled; 25% of these were the 2-in. x 3-in. size necessary when the crystals are very big, as in gabbros. Polarized microscope views of these slides were spectacular and several were selected as possible color frontispieces when the Proceedings volume for this leg is published.

COMPUTER SERVICES

The leisurely beginning of the leg allowed the computer-oriented scientists ample time to attend CTOS and PICSURE classes and learn the software pertinent to their work areas. As several had used IBM machines, the two available on board were in continual use.

Software updates and debugging for the physical properties lab software absorbed a major amount of time. A PRO/SCIENTECH balance system was installed in the physical properties area and the system in the X-ray preparation area was tested. MATMAN software updates were made and corrected, and search requests from ODP Logistics were made. A plotting routine for survey navigation was prepared to match SeaBeam records.

PHOTO LAB

Photographic lab activities, while slow in the first weeks, picked up considerably when core recovery began in earnest. There were some equipment problems with which to contend. The 3/4-in. video recorder began malfunctioning during the filming of the lowering of the guidebase. The unit would not stay on and will be returned to ODP for repair.

The air tempering compressor in the KREONITE film processing station failed and a new unit was ordered. Developing time was adjusted to compensate for the slightly warmer room air temperatures. Routine maintenance was performed on the film processers.

ET SHOP

Routine maintenance of the wide assortment of equipment occupied the usual amount of ET time. Electric motors, lab instruments, terminals, monitors, and computer all were addressed. The ODP ETs assumed responsibility for the subsea re-entry camera system and frame. Much time was also spent inventorying and organizing the considerable collection of spare parts that support the TV/sonar system. The system itself was trouble-free with the exception of some last-minute problems worked on during preventive maintenance service.

STOREKEEPER

The oncoming shipment was received in good condition and with few problems. The shipment was unpacked and efficiently checked in by the technicians. Usage of most expendables was low this leg with few shortages. The exceptionally high hard-rock recovery, however, did strain shipboard stores of DEVCON 2-part epoxy, core liner dividers, and diamond blades.

A trial use of MATMAN's shipment program was evaluated and sent via computer to the technical and computer groups ashore. The S2S program for shipping organization was approved for this leg's use and for the Leg 119 transfer of supplies to the MAERSK MASTER at their rendezvous.

GYM

After the D-tubes were again removed the gym was used extensively by all hands. Ping pong tourneys dominated the group events, while rowing and weight-lifting occupied the determined solitaries. Aerobics work-outs were conducted in the lounge because the gym VCR was needed to replace the unit that failed in the Dynamic Positioning shack. It was selected, as it had the most recent VHS enhancement circuitry and was used to record some 48 hr of subsea camera surveys.

The Captain arranged for CATERMAR to mop the rubber tile deck, removing much of the accumulated dirt.

SPECIAL PROJECTS

Pressure transducers were installed in the junction boxes on the fantail and piped into the high-pressure air below the air regulators. The transducers monitor the state of the guns when under way by producing records of the pressure drop-and-build cycles. Deviations in the pattern recorded on a chart recorder reflect gun problems. The electrical wiring was completed last leg.

The current meter was deployed at the engineers' request for values that could pertain to drilling and future wireline reentry attempts at Hole 735B. The system was configured, checked out, and deployed with few problems. Day-long measurements at a particular depth provided data sets that our normal programs didn't handle well. An ODP ET worked on fixing this problem and the record of the current speeds and directions was given to ODP Operations and Engineering personnel.

This was the first cruise where private two-way letter correspondence was offered to all parties aboard ship. Shipboard VAX mail files were BLASTED each Sunday and shore mail files picked up. The 30 individuals participating were pleased with the service and a cost lower than first estimates. Several files of letters were lost along the way and had to be re-sent. We found it prudent to send a separate note to the shorebased receiver with the number of letters to expect. A file was left for the oncoming Lab Officer with our instructions from shore, the authorization forms to receive mail, and how we did it. Billing and accounting were handled by the Lab Officer. All BLAST traffic was recorded on a floppy disk and the VAX.

PROBLEMS

The ODP Computer Services Group requested another test of the Uninterruptable Power Service (UPS), as was done on Leg 117. This is a battery backup system that will allow the VAX to close files in an orderly manner if our regulated power fails. Primary concern for doing the test at this time rested on the XRF. Weeks of time had been spent stabilizing and calibrating the unit. Taking the optimistic view that the test would be concluded in an hour and sensitive to logistics concerns of getting new replacement cells into a surface shipment and Computer Service Group's concern with whether the system would work as planned, the Lab Officer recommended going ahead with the test. We followed last leg's plan by plugging six 7-amp ovens, 5 hot plates (3 ea. 2200 watt, 2 ea. 1300 watt), and one heat gun into several circuits of the regulated power to replace some of the sensitive equipment (VAX, XRD, XRF). The test was conducted at approximately one fourth of the normal 70-80 amps per phase (I do not believe the amp readings reported in the battery test report reflected the load (ovens, etc.) that was added to the circuits when the test began). The test was conducted with the batteries sustaining the reduced load some 3 min 7 sec. This was an improvement over last leg but was short of the desired 5-10 min. Five internally shorted batteries were tagged for immediate replacement. Some 70 others need further cycling to improve their condition.

The power was brought back on line incrementally and we were asked to turn things back on. The XRF warnings indicated poor power, so only enough was left on to sustain the vacuum and temperature. The ship's Engine Control Room called to report that the power was being regulated poorly but that it was likely an artifact of the deep amp draw the battery charging system was using. Troubleshooting began on what was termed a "floating power problem." We hooked up the Drantz Power monitor and found the power in a window between 110 and 140 volts. Some of the PRO 350 cabinets began humming resonantly as did equipment cooling fans; two fluorescent desk lights pulsed. With the Drantz information this provoked a general disconnection of everything on regulated power. The Computer System Manager was flipping breakers in the Liebert Power Distribution Module when one of its varistors failed. This coincided with a 600-amp fuse failure and later two 350-amp fuses blew in the ECR. This ended regulated power for several hours. When the fuses were replaced the regulated power system came up normally. No explanations are available. The varistor was replaced in the Liebert module and, after checking the power, an attempt was made to bring up the VAX. One fuse was replaced, as on Leg 117, in the expansion cabinet power supply. Other casualties included a surge protector in the XRD Tektronix terminal and some unusual colors on the monochrome XRF video monitor. These failures could be attributed to the possible power surge when the large fuses failed. The XRF came up clean without losing calibration.

The new Semi Automatic Monitor (SAM) checks the power too infrequently to be of use (every 10 min). This should be handled by a dedicated processor that would know immediately that the power was not right and start the VAX on an orderly shutdown. To increase the length of time the batteries last, least necessary regulated loads should be shed. A computer controlled switching module with a concept like the commercial X-10 remote control system should let the VAX or the stand-alone instrument shed instrument loads, or switch the load to unregulated power, believing it to be better than no power at all.