Vol. 7 (2) Fall 1998

InterRidge News

Initiative for international cooperation in ridge-crest studies

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InterRidge Office Updates

Coordinator Update

Membership

Spain has downgraded to an Associate member this year, and next year they will only be a Corresponding member. SOPAC (South Pacific Geosciences Applied Commission) and Morocco have joined as Corresponding members of InterRidge.

Steering Committee

The InterRidge Steering Committee Meeting was held September 14-15, 1998 in Barcelona, Spain. Eight members will be leaving the Steering Committee in 1999: Miquel Canals (Spain), Juan José Dañobeitia (Spain), Jean Francheteau (France), Lindsay Parson (UK), Roland Rihm (Germany), Roger Searle (UK), Tetsuro Urabe (Japan) and Karen Von Damm (USA). In 1999 Paul Dando (UK), Colin Devey (Germany), Kantaro Fujioka (Japan), and David Kadko (USA) will be joining the Steering Committee.

Publications

The Contributions Volume from the First International Symposium on Deep-Sea Hydrothermal Vent Biology will be published in *Cahiers de Biologie Marine*, 39(3). A December publication date is expected.

InterRidge Workshops

The workshop on *Mapping and Sampling the Arctic Ridges* was just held at BGR, in Hannover, Germany, October 16-17, 1998. It was convened by W. Jokat, P. Michael and H. Roeser, and attended by 43 participants from 9 countries (Canada, Italy, Japan, France, Germany, Norway, Russia, Turkey, and USA). The workshop brought participants up to date on research that has taken place in the Arctic ridge system since the Kiel InterRidge Workshop in 1994. A program plan was drafted for future multi-disciplinary studies of this slow spreading ridge system, and will be published by the end of November.

The MOMAR workshop (Long-Term **Mo**nitoring of the **M**id-**A**tlantic **R**idge) will be held at the University of Lisbon, Portugal October 28-31, 1998. The workshop will focus on the practical aspects of setting up such long-term monitoring south of the Azores on the Mid-Atlantic Ridge. 69 participants ranging in disciplines from biology to geophysics from 10 countries (Canada, Italy, Japan, France, Germany, Portugal, Russia, Switzerland, UK and USA) are expected to attend the workshop.

Ecological Reserves

InterRidge has been concerned with the issue of hydrothermal Ecological Reserves. These reserves are areas that biologists have requested be undisturbed by other researchers while temporal biological observations are being conducted. These reserves are variable in both the spatial and temporal domain, including both a 1 km long segment of the EPR that has been requested off-limits for an indefinite period of time, and year-long experiments that are conducted at a single vent site. However until recently there has been no place for sea-going researchers to know what areas were 'off-limits'. In response to this problem InterRidge has established a web page on Ecological Reserves (http://www.lgs.jussieu.fr/~intridge/reserve.htm) which lists and describes existing hydrothermal Ecological Reserves. So far there have been 7 entries to the webpage, mostly sites on the East Pacific Rise. An article on this issue will be published shortly in *EOS*.

WWW pages

This summer databases were installed on the web site to replace the electronic directory, the international ship listing and the cruise schedules, all of which were in text format, and which were cumbersome to load and read. The biological samples database is now on-line. This database was formed at the recommendation of participants at the First International Symposium on Hydrothermal Vent Biology last October and is intended to facilitate the international exchange of biological samples. All of the Mid-Ocean Ridges and Back-Arc basins cruises which InterRidge has compiled since 1992 are now accessible in database format. In addition a global map and an arctic map are linked to the database, allowing geographical access to the database.

InterRidge Office Transfer

France's term as host country of InterRidge will end at the end of 1999, and the InterRidge Office will move to the country of another Principal member in January 2000. A call for bids will be put out in December 1998 with a closing date in March. The bids will be reviewed by the Steering Committee at the next Steering Committee meeting, which is tentatively scheduled for June.

Coordinator Position

After almost two years of working with InterRidge I will be leaving in mid-February, 1999. While I have enjoyed my term as InterRidge Coordinator, I feel that it is time to get back into active research. It has been a pleasure interacting with the InterRidge community both at meetings and in e-mail communications. I wish all the best to the new Coordinator.

Cara Wilson
InterRidge Coordinator
20 October 1998

The InterRidge WWW Electronic Directory is now in database format!

This past summer the InterRidge Electronic Directories (including a separate directory for biologists) were replaced by one Directory in database format, which is much easier to load, and allows greater seraching capabilities. There over 300 people who are active in Mid-Ocean Ridge research listed in the database on the InterRidge Home Page (**http://www.lgs.jussieu.fr/~intridge**). This directory contains a listing of each researcher's field of interest and expertise as well as their full address information. If you would like to be listed in the directory complete this form and send it to the InterRidge Office. Links can also be provided to your personal or departmental web page. You can also use this form to join are regular mailing list to receive the *InterRidge News*, or to be placed on our electronic mailing list.

Indicate whether you would like your name to appear on:

☐ *the InterRidge Electronic Directory* ☐ *the mailing list*
☐ *the electronic mailing list (include your e-mail address)* ☐ *This is a change of address notice.*

Name_____
Department/Institute_____
Address_____

_____

City_____ **State/County**_____
Post Code_____ **Country**_____

Phone:_____ **Fax:**_____
country code area code number country code area code number

E-mail:_____

WWW:_____

Which InterRidge Program Theme(s) is/are of interest to you?

☐ Active Processes ☐ Meso-Scale Studies ☐ Global Studies

What are your fields of interest/expertise?

☐ Biochemistry	☐ Gravity	☐ Plate kinematics
☐ Biogeography	☐ Heat Flow	☐ Rheology
☐ Biology	☐ Hydrology	☐ Seafloor Morphology
☐ Crustal structure	☐ Hydrothermal vents/plumes	☐ Sedimentology
☐ Ecology	☐ Larval Dispersion	☐ Seismology
☐ Electromagnetism	☐ Magnetism	☐ Structural geology
☐ Engineering/Instrumentation	☐ Microbiology	☐ Sulfide Ores
☐ Event detection and response	☐ Modeling	☐ Tectonics
☐ Genetics	☐ Ophiolites	☐ Volcanology
☐ Geochemistry	☐ Petrology	☐ Other_____

Send to (address also on the reverse side): InterRidge Office, Laboratoire de Pétrologie, Tour 26, 3ème étage, Université Pierre et Marie Curie, 4 Place Jussieu, 75252 Paris Cédex 05, France

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InterRidge Office Updates

InterRidge Publications

All of the following InterRidge publications are available upon request. Fill out our WWW form at **http://www.lgs.jussieu.fr/~intridge/publreq.htm** or contact us by e-mail at **intridge@ext.jussieu.fr.**

InterRidge News:

InterRidge News, 1998, 7, 2, pp. 68
InterRidge News, 1998, 7, 1, pp. 72
InterRidge News, 1997, 6, 2, pp. 64
InterRidge News, 1997, 6, 1, pp. 72
InterRidge News, 1996, 5, 2, pp. 68
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InterRidge News, 1994, 3, 2, pp. 44
InterRidge News, 1994, 3, 1, pp. 28
InterRidge News, 1993, 2, 2, pp. 4
InterRidge News, 1993, 2, 1, pp. 32
InterRidge News, 1992, 1, 1, pp. 26

Workshop and Working Group Reports:

ODP-InterRidge-IAVCEI Workshop Report: **The Oceanic Lithosphere and Scientific Drilling into the 21st Century**, pp. 89.

InterRidge Global Working Group Workshop Report: **Arctic Ridges: Results and Planning**, pp. 78, October 1997.

InterRidge **SWIR Project Plan**, pp. 21, October 1997 (revised version).

InterRidge Meso-Scale Workshop Report: Quantification of Fluxes at Mid-Ocean Ridges: **Design/Planning for the Segment Scale Box Experiment**, pp. 20, March 1996.

InterRidge Active Processes Working Group Workshop Report: **Event Detection and Response & A Ridge Crest Observatory**, pp. 61, December 1996.

InterRidge Biological *Ad Hoc* Committee Workshop Report: **Biological Studies at the Mid-Ocean Ridge Crest**, pp. 21, August 1996.

InterRidge Meso-Scale Workshop Report: **4-D Architecture of the Oceanic Lithosphere**, pp. 15, May 1995.

InterRidge Meso-Scale Project Symposium and Workshops Reports, 1994: **Segmentation and Fluxes at Mid-Ocean Ridges: A Symposium and Workshops & Back-Arc Basin Studies**: A Workshop, pp. 67, June 1994.

InterRidge Global Working Group Report 1993: **Investigation of the Global System of Mid-Ocean Ridges**, pp. 40, July 1994.

InterRidge Global Working Group Report 1994: **Indian Ocean Planning Meeting Report**, pp. 3, 1994.

InterRidge Meso-Scale Working Group Meeting Report, Cambridge, UK, pp.6, 1992.

Workshop and Symposium Abstract Volumes:

InterRidge Workshop: **MOMAR (*MO*nitoring the *M*id-*A*tlantic *R*idge)** Abstract Volume, pp. 82, Oct. 1998.
InterRidge Workshop: **Mapping and Sampling the Arctic Ridges** Abstract Volume, pp. 30, Oct. 1998.
First International Symposium on **Deep-Sea Hydrothermal Vent Biology** Abstract Volume, pp. 118, Oct. 1997.
Fara-InterRidge **Mid-Atlantic Ridge Symposium Results from 15°N to 40°N**. J. Confer. Abs. 1(2), 1996.
ODP-InterRidge-IAVCEI Workshop: **The Oceanic Lithosphere and Scientific Drilling into the 21st Century**, 1996.

Steering Committee and Program Plan Reports:

InterRidge Steering Committee Meeting Report, Paris, France, 1997, pp. 17, January 1998.
InterRidge Steering Committee Meeting Report, Estoril, Portugal, 1996, pp. 17, December 1996.
InterRidge Steering Committee Meeting Report, Kiel, Germany, pp. 22, 1995.
InterRidge Steering Committee Meeting Report, San Francisco, USA, 1994.
InterRidge Steering Committee Meeting Report, Tokyo, Japan, 1994.
InterRidge Steering Committee Meeting Report, Seattle, USA, pp. 6, 1993.
InterRidge Meeting Report, York, UK, 1992.
InterRidge Meeting Report, Brest, France, pp. 39, 1990.
InterRidge Program Plan Addendum 1997, pp. 10, January 1998.
InterRidge Program Plan Addendum 1996, pp. 10, April 1997.
InterRidge Program Plan Addendum 1995, pp.10, 1996.
InterRidge Program Plan Addendum 1994, pp.15, 1995.
InterRidge Program Plan Addendum 1993, pp. 9, 1994.
InterRidge Program Plan, pp. 26, 1994.

Updates on InterRidge Projects

Overview of InterRidge Working Groups

More information on the working groups can be found on our website at http://www.lgs.jussieu.fr/~intridge/wg.htm

Arctic Oceans:

Objective: Coordinate planning efforts for mapping and sampling the Arctic Ridges.

Current Activities: see next page.

Chair: Colin Devey (Germany)

WG members: G. A. Cherkashov (Russia), B. J. Coakley (USA), K. Crane (USA), O. Dauteuil (France), V. Glebowsky (Russia), K. Gronvold (Iceland), H. R. Jackson (Canada), W. Jokat (Germany), Y. Kristoffersen (Norway), P. J. Michael (USA), N. C. Mitchell (UK), R. Rihm (Germany), H. A. Roeser (Germany), H. Shimamura (Japan), K. Tamaki (Japan)and C. L. Van Dover (USA).

Back-Arc Basins:

Objectives: Summarize past work on Back-Arc Basins and coordinate future studies.

Current Activities: Compiling report on past work in Back-Arc Basins.

Chairs: H. Fujimoto (Japan) and J.-M. Auzende (France)

WG members: Ph. Bouchet (France), J.-L. Charlou (France), K. Fujikura (Japan), E. Grácia (Spain), P. Herzig (Germany), J. Ishibashi (Japan), R. Livermore (UK), S. Scott (Canada), R. J. Stern (USA), K. Tamaki (Japan), and B. Taylor (USA).

SWIR:

Objective: Coordinate reconnaissance mapping and sampling of the Southwest Indian Ridge.

Current Activities: see next page.

Chair: Catherine Mével (France)

WG members: M. Canals (Spain), C. German (UK), N. Grindlay (USA), C. Langmuir (USA), A. Le Roex (South Africa), C. MacLeod (UK), J. Snow (Germany), K. Tamaki (Japan), and C. L. Van Dover (USA).

Biological Studies:

Objectives: Increase international collaboration in hydrothermal biological studies and work on integrating ridge-crest biological and geological research.

Current Activities: Establishing an electronic database of hydrothermal biological samples, and coordinating the demarcation of ecological reserves at vents.

Chair: L.S. Mullineaux (USA).

WG members: P. R. Dando (UK), J. R. Delaney (USA), D. Desbruyères (France), D. R. Dixon (UK), S. S. Drachev (Germany), A. Fiala-Médioni (France), C. R. Fisher (USA), H. Fricke (Germany), F. Gaill (France), J. Hashimoto (Japan), S. K. Juniper (Canada), R. A. Lutz (USA), Douglas C. Nelson (USA), S. Ohta (Japan), A.-L. Reysenbach (USA), K.O. Stetter (Germany), and V. Tunnicliffe (Canada).

Event Detection and Response & Observatories:

Objectives: Develop detection methods of transient ridge-crest seismic, volcanic and hydrothermal events, and the logistical responses to them through a strategy of international collaboration, and establish a long-term observatory in the Atlantic.

Current Activites: See page 8 and 9.

Chair: Chris Fox (USA)

Undersea Cables:

Objective: Explore the range of science that can be done at ridges with undersea cables and the logistics involved.

Current Activities: see page 9.

Chair: Alan Chave (USA)

WG members: J. R. Delaney (USA), H. Momma (Japan), M. Kinoshita (Japan), A. Schultz (UK), D. S. Stakes (USA), P. Tarits (France), and H. Villinger (Germany).

Global Digital Database:

Objective: Establish a database of global multibeam bathymetry and other data.

Current Activities: see page 9.

Chair: Philippe Blondel (UK)

WG members: J. S. Cervantes (Spain), C. Deplus (France), M. Jakobsson (Sweden), M. Ligi (Italy), R. Macnab (Canada), W. Ryan (USA), and W. Weinrebe (Germany).

Global Partitioning of Hydrothermal Fluxes:

Objectives: Target key areas of the global MOR that should be explored for hydrothermal activity and coordinate international collaboration to explore them.

Current Activities: There will be a meeting of the working group at this year's Fall AGU meeting

Chair: Chris R. German (UK)

WG members: E. Baker (USA), Y. J. Chen (USA), T. G. Gamo (Japan), E. Grácia (Spain), P. Halbach (Germany), S.-M. Lee (Korea), J. Radford-Knoery (France), D. S. Scheirer (USA), S. D. Scott (Canada), K. G. Speer (France), C. A. Stein (USA), V. Tunnicliffe (Canada) and C. L. Van Dover (USA).

4-D Architecture:

Objective: Promote international efforts to constrain the composition and structure of the oceanic lithosphere, and their along- and across-axis variability.

Current Activities: There are several cruises scheduled in the next year.

Chair: To be decided.

WG members: S. Allerton (UK), D. K. Blackman (USA), M. Cannat (France), J. Dyment (France), J. E. Escartín (Spain), P. Gente (France), K. M. Gillis (Canada), P. B. Kelemen (USA), J. Lin (USA), L. M. Parson (UK), N. Seama (Japan), M. C. Sinha (UK), and M. Tolstoy (USA).

Updates on InterRidge Projects

South West Indian Ridge Working Group Update

Catherine Mével, Chair

Laboratoire de Pétrologie, Tour 26, 3ème étage, Université Paris VI , 4 Place Jussieu, 75252 Paris Cédex 05, France

This working group acts to coordinate cruises and proposals to investigate the ultraslow spreading SWIR. There have been four cruises to the SWIR since the summer of 1997, and more are proposed or scheduled for the future.

Completed Cruises

EDUL, *Marion Dufresne*, Aug. 1997, PI: Mével. Sampling of the SWIR, 49°-69°E.

FUJI, *Marion Dufresne*, Oct. 1997, PIs: Mével, Tamaki. Colloborative French, Japanese and British cruise which made TOBI surveys, OBS deployments and water sampling near the Melville FZ.

ODP Leg 176, *Joides Resolution*, Oct/Nov 1997, Co-chiefs: Dick, Natland. Deepening of Hole 735B to 1500 m depth.

James Clark Ross, April 1998, PIs: Dick, McLeod, Robinson. Used ROPOS to examine the geology of the lower crust with deep-towed magnetics and testing new hard-rock drill (see article on page 39).

Scheduled Cruises

MODE'98, leg 3, *Yokosuka/Shinkai6500*, Sept./Oct 1998, PI: Fujimoto. Diving in eastern part of the SWIR to areas selected from the FUJI data - volcanism/tectonism and hydrothermal objectives

MODE'98, leg 4, *Yokosuka/Shinkai6500*, Oct./Nov. 1998, PIs: Matsumoto, Dick. Diving on Atlantis II bank

Proposed but not yet funded

Bathymetric/geophysical survey and sampling of the central portion of the SWIR. PI: Mahoney

Bathymetric/geophysical survey and sampling of the western portion of the SWIR to the BTJ. PI: Dick

Off-axis survey of the eastern portion of the SWIR (to the RTJ trace). PIs: Patriat, Sauter

The Italians plan to start working along the SWIR starting from the Bouvet Triple Junction

Meetings

There will be a special session at the Fall AGU meeting: T08: Accretionary processes at ultra-low spreading ridges: recent field results from the Arctic and the South West Indian Ridge. The convenors will be K. Crane, C. Mével, K. Tamaki, B. Coakley and J. Georgen.

There has been some preliminary discussions about organizing a SWIR workshop in 1999 or 2000 to synthesize recent results and to organize future plans.

Arctic Ridges Working Group Update

Colin Devey, Chair

Fachbereich 5 Geowissenschaften, Universität Bremen, Postfach 330440, D-28334 Bremen, Germany

Roland Rihm was no longer able to continue chairing the InterRidge Arctic Ridges working group, and at the InterRidge Steering Committee meeting in September Colin Devey was appointed chair.

InterRidge first formally focussed its attention on the Arctic Ridges when it convened the 1994 workshop entitled "Arctic Ridges: Results and Planning" in Kiel. The aim of this workshop was to collect together as much Arctic ridge data as was available at the time and to initiate dialogue between the many researchers with ridge-related interests north of Iceland. The ensuing workshop report, published in 1997, provided a clear overview of the state of Arctic ridge research at that time and contained several clear recommendations for how Arctic ridge studies should progress. Studying the Gakkel Ridge was identified as the overriding priority, as up until that time it had been the subject of several geophysical studies but had been sampled, both for its rocks and sediments, only rarely. The 1994 workshop recommended that both reconnaissance-scale sampling of rocks, sediments and life forms (30-50 km sample spacing) and further geophysical work be carried out urgently.

InterRidge held another workshop "The Arctic Ridges: Mapping and Sampling" convened by Wilfried Jokat, Peter Michael and Hans Roeser October 16-17, 1998. The objective of the workshop was to formulate clear plans for getting these priority targets fulfilled. To achieve this aim the Workshop began with an update of the state of knowledge, after which participants contributed towards the formulation of clear and practicable plan for studying the Gakkel Ridge, including the identification of research platforms (ships, submarines, aircraft) for carrying out the studies and time windows for their use, the identification of specific experiments that should be conducted, and a clear time-frame in which these goals will be achieved over the next five years. This project plan will be published by the end of November.

Hopefully future updates will report on funded or scheduled work on the Gakkel Ridge as a result of this workshop.

Updates on InterRidge Projects

Event Detection and Response Update

Chris Fox, Chair (fox@pmel.noaa.gov)

NOAA/PMEL/VENTS Program, 2115 S.E. OSU Drive, Newport, OR 97365, USA

Meetings

The MOMAR (MOnitoring the Mid-Atlantic Ridge) workshop is planned for October 28-31, 1998 at the University of Lisbon, Portugal.

Events

Volcanic activity was detected by NOAA/PMEL using the U.S. Navy SOSUS on Axial Seamount on the central Juan de Fuca Ridge in January, 1998. The activity lasted for 12 days and produced over 8,000 detectable earthquakes, the most energetic event detected to date. Seafloor and water column instruments were in place before and during the activity. A combined US RIDGE/NOAA VENTS Program cruise on the *Wecoma* sampled hydrothermal plumes from the site and deployed Ocean Bottom Hydrophones. Additional cruises are taking place in the summer of 1998 with seafloor ROV work planned. A special session is planned for the 1998 Fall AGU meeting.

Funded Proposals

Juan de Fuca/Gorda Ridges

Jim Cowen (U Hawaii) and Marv Lilley (U Wash.) were funded to lead a rapid response to the Axial Seamount event using the Wecoma.

Jim Cowen (U Hawaii) and others are funded to pre-deploy oceanographic equipment for use in a rapid response mode following NOAA/PMEL SOSUS detection. Proposal follows the model developed by RIDGE for holding back funds to be made quickly available following detection of an event by SOSUS.

Spahr Webb and Rob Sohn (SIO) are funded to deploy a large array of OBS's over the summit of Axial Seamount for long-term monitoring of passive seismicity.

Bill Menke and Maya Tolstoy (LDEO) are funded to shoot an active seismic experiment to the Axial Seamount OBS array to determine the internal structure of the magma system.

East Pacific Rise

Dan Fornari (WHOI) and others are funded to investigate sites of possible volcanic activity along the EPR identified by the NOAA/PMEL autonomous hydro-phone array. A cruise is scheduled for early 2000.

Mid-Atlantic Ridge

Debbie Smith (WHOI) and Maya Tolstoy (LDEO) and Chris FOX (NOAA) are funded to deploy an array of autonomous hydrophones along the MAR between 15°N and 35°N for two years. Initial deployment is scheduled aboard the *Ewing* for Feb./Mar. 1999 with the first data returned in Dec. 1999.

Acoustic Detection Infrastructure

Northeast Pacific

The SOSUS array in the northeast Pacific required for monitoring the Juan de Fuca and Gorda Ridges are failing, and the U. S. Navy does not have adequate funds to affect repairs. A consortium of Pacific SOSUS users, including Scripps, Univ of Washington, NOAA PMEL, and the Naval Postgraduate School was recently formed with support from the U.S. National Ocean Partnership Program. This consortium, with close cooperation from the Navy, hopes to begin participating in cable repairs using combined university, NOAA and Navy assets.

Atlantic SOSUS

The Atlantic SOSUS arrays are still being decommisioned by the U. S. Navy and no civilian users have stepped up to restore and operate them. It is hoped that a mechanism similar to that developing for the Pacific can be created in the next few years.

Autonomous Monitoring

The autonomous hydrophone arrays deployed by NOAA/PMEL continue to advance. Equatorial Pacific acoustic monitoring is in its third year. A new six component array will be deployed in the North Atlantic in Jan/Feb 1999 for a two-year pilot experiment. These instruments will be able to record for one full year. A new generation of instruments capable of continuously recording seismic frequencies for up to five years is under development. This new technology may allow long-term monitoring of remote ocean areas.

Observatory Infrastructure

RIDGE sponsored efforts continue to develop monitoring technologies for observatories at Endeavour and Cleft. Russ McDuff (U Wash) is funded for heat flow studies at Endeavour segment.

NOAA VENTS is establishing an observatory at Axial Seamount (which was proposed before the eruption) called NeMO (New Millennium Observatory) that will concentrate on rapid collection of microbes expelled from the subseafloor biosphere following seismic events detected by SOSUS. Instrumentation includes water column moorings, seafloor volcanic system monitors, acoustic extensometers, and pre-positioned autonomous underwater vehicles.

Updates on InterRidge Projects:

MOMAR Workshop
(A joint EDR & Observatories WG and Cables WG Initiative)

The InterRidge Cables working group and the InterRidge EDR & Observatories Project are working together in planning and organizing the upcoming InterRidge Workshop on *Long-Term Monitoring of the Mid-Atlantic Ridge (MOMAR)*, which will be held October 28-31, 1998 at the University of Lisbon, in Lisbon, Portugal. 69 participants from 10 countries are expected to attend the wokshop. The meeting is designed to bring together researchers from the international scientific community to plan the establishment of long term multi-disciplinary monitoring on the Mid-Atlantic Ridge near the Azores. The meeting seeks to have a technical emphasis, in order to focus on what can practically be done with current technology.

The workshop will begin with two days of invited talks, divided into three sections. The first section "Review of existing seafloor/Ridge Observatory/monitoring efforts" will be composed of talks about already existing, or planned, long-term monitoring efforts on the seafloor. This section is designed to provide an overview of on-going monitoring to clarify discussion on the possible scope of the what might be done on the MAR. The knowledge of previous efforts is invaluable in knowing what did and did not work from the perspective of scientific goals, logistics and technology. The second section of talks "Site Selection for the MOMAR experiment" will focus on what is known about the MAR in the area of the Azores, and what site or sites would be the most interesting and practical for long-term observations. The third section "Monitoring Technology at the MOMAR Site" will contain talks about the technical capabilities of the community, both in terms of installation as well as actual monitoring equipment. This section will provide ideas on possible experiments that might form part of the monitoring effort. a review of existing seafloor/ridge observatories and monitoring efforts, site selection issues for the MOMAR experiment, and monitoring technology.

In addition to the 26 talks there will be 34 poster presentations. During the second half of the workshop participants will break into smaller groups for discussion about specific experiments to design.

Global Digital Database Working Group Update

Phillippe Blondel, Chair

Southampton Oceanography Centre, Empress Dock, Southampton, SO14 3ZH, UK

The objective of this working group is to establish a global inventory of Mid-Ocean Ridge multibeam and other data in a centralized web site. In the last year efforts has concentrated on finding out who in each country has data, what areas of the ridge the data covers. Data will soon start to be compiled and will be available on a web server hosted at Southampton. A brief status of the data synthesis from various country is listed below:

Canada
Ron Macnab from the Geological Survey of Canada (Atlantic) and the Chair of the Arctic Bathymetry working group of the International Arctic Science Committee (IASC) will be providing Canadian data and Arctic Ridge bathymetry data.

France
A centralized approach to the synthesis of French data has been started by a collaboration between SISMER and Dorsales. The Dorsales program put out a call in June for proposals to compile existing French data from different sections of the ridge. The compiled data will be accessible on the web.

Germany
Some German data is on a web server (http://www.geomar.de/sci_dpmt/geodyn/so112_hiresbat.html) which will eventually be linked with other institutions in Germany.

Italy
A web server (http://terra.bo.cnr.it/BAT) is being established for Antarctica data, including the Bouvet Triple Junction and Scotia Arc. Other data will eventually be archived.

Norway
Data from the 1989 and 1990 cruises to the Norwegian-Greenland Sea was published in atlas format in 1995 and should all be available from K. Crane.

Sweden
Martin Jakobsson (University of Stokholm) will be providing some Arctic Ridge data.

UK
Construction of the BRIDGE database is underway, and it should come on-line on the web at the beginning of 1999. Initially it will just include shiptracks, and eventually will have all the UK proccessed bathymetry in addition to magnetic and gravity data.

USA
The RIDGE multibeam database has been on-line for several years (http://imager.ldeo.columbia.edu).

International Ridge-Crest Research: **Biological Studies**

Comments on Marques and Porteiro (1998)

Thierry Comtet[1,2]

[1]*DRO-EP, IFREMER Centre de Brest, BP 70, 29280 Plouzané, France*
[2]*Station Biologique, BP 74, 29682 Roscoff Cedex, France*

In the last issue of *InterRidge News* (Vol. 7(1)), Marques and Porteiro (1998) reported the first observation of a broken shell of a hydrothermal vent mussel in the stomach of one specimen of the chimaerid fish *Hydrolagus affinis* from the surroundings of the Lucky Strike hydrothermal vent field (from 37°17.62'N, 32°16.15'W to 37°17.44'N, 32°16.86'W, 1575-1734 m depth). Despite the interest of such an observation, the authors are wrong concerning the name *Bathymodiolus thermophilus* they give to the mussel species.

Hydrothermal vent mussels collected to date from the Lucky Strike vent field appear to belong to a new species of the genus *Bathy-modiolus*, the description of which will be published in a paper by Cosel et al. (in press). This new species is clearly distinct from *Bathymodiolus thermophilus* Kenk and Wilson, 1985 by several morphological and anatomical characteristics, such as the degree of ventral fusion of the mantle (Cosel et al., in press). In addition to morphological analyses, molecular biology results confirmed the clear separation between the Lucky Strike mussel and *B. thermophilus* (Jollivet et al., in press). *B. thermophilus* distribution is restricted to hydrothermal vent sites of the East Pacific Rise at 13°N, 9°50'N and 18°S, as well as to vents of the Galapagos Rift (Desbruyères and Segonzac, 1997). The new species at Lucky Strike is also distinct from *Bathymodiolus puteoserpentis* Cosel, Métivier and Hashimoto, 1994 known from the Snake Pit vent field (23°N on the Mid-Atlantic Ridge).

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Editor's Note

The articles appearing in *InterRidge News* are intended to disseminate as quickly as possible the preliminary results from recent Mid-Ocean Ridge and Back-Arc Basin related cruises. Articles are *not peer-reviewed* and they should not be cited as peer-reviewed articles. The InterRidge Office does edit the articles and strives to correct any grievous errors, however all responsibility for scientific accuracy rests with the authors. Comments on articles that have appeared in *InterRidge News* are always welcomed.

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International Ridge-Crest Research: **Biological Studies**

Microbiological Studies at Guaymas Basin and 21°N EPR Hydrothermal Vent Sites: Brief Cruise Report

(*R/V Atlantis* Voyage 3, Leg 18, ALVIN Dive Series 3203-3210, April 25 - May 5, 1998)

Holger W. Jannasch

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Work during this cruise (supported by US NSF's LExEN Program) concentrated on studying dominant, as well as some specific, microbial "extremophiles", mainly hyperthermophiles of both the bacterial and archaeal domains from two characteristic deep-sea hydrothermal vent environments. The main reason for emphasis on the Guaymas Basin tectonic spreading center was the presence of hydrothermally heated sediments. Offering wider gradients of temperature, redox conditions, and concentrations of inorganic and organic substrates, this site promised a higher microbial diversity than "bare-lava" offshore vent sites. For comparative studies, additional polymetal deposits, smoker wall material, and bacterial mats were collected at the nearby well-known 21°N East Pacific Rise vent site.

A complete topographic/photographic survey with temperature measurements of the Southern Guyamas Basin site (roughly between 27°00' to 02' N and 111°40' to 41' W) was completed during the preceding Leg 17 by JASON under D. Yoerger. The data enabled us to choose from a variety of desirable well known or new vent sites. All planned collections, in fact more than expected, of sediment cores with temperature profiles, microbial mats, rocks and reduced or oxidized poly-metal sulfide deposits were obtained during 6 Alvin dives with two more at 20°49.87' N, 109°06.16' W. Work on the samples was started in the ship's laboratory and is now continuing in the cruise participants' various home laboratories. Next to organismic studies, ecological aspects of our work aimed at determining *in situ* processes conducted by the different groups of identified phylotypes or isolated organisms: mainly chemolithotrophic reductive and oxidative sulfur transformations, but also hydrocarbon degradation and microbial iron/manganese oxidation. Phylogenetic aspects and isolations focused on hyperthermophilic bacteria and archaea as well as low-branching eukaryotes. More specifically, the follow-up work includes:

1) The molecular quantification and community structure of hyperthermophilic bacteria and archaea will be assessed at various temperature, redox, and substrate gradients in the sediment by 16S rRNA-targeted PCR-DGGE (polymerase chain reaction-denatured gradient gel electrophoresis) and by hybridization analyses of DGGE blots. Fluorescence *in situ* hybridization (FISH) will be used for direct visual assessment of natural populations (Teske, Fuchs, Wirsen, Jannasch).

2) The position of new bacterial and archaeal phylotypes on the 16S rRNA-based evolutionary tree focuses on the lowest branches, i.e. organisms closest to the single joint ancestor (Teske, Stahl, Stetter, Wirsen, Jannasch). Similar efforts will concentrate on low-branching eukariotes (Stetter, Edgcomb).

3) The isolation of new organisms in pure culture (extremophilic archaea and bacteria and, possibly, protozoa) was started aboard and will be followed by determining their physiological properties and molecular classification (Stetter, Teske, Stahl, Wirsen, Jannasch). Specific research will focus on thermophilic luminescent bacteria, hydrocarbon utilizers, acetogens, and members of the order Ther-motogales (Parsek, Schaefer, Zengler, Noll).

4) The search for sulfate reduction above 100°C involved a temperature gradient block for shipboard incubations as well as in situ incubations and enrichments using an Alvin-positioned bottom lander ORPHEUS with 40×6 cm in situ injection corers and continuous temperature monitoring (Jørgensen, Weber, Fuchs).

5) Other work on thermophilic sulfate reducers will be based on specific primers for the dissimilatory (bi)sulfite reductase, a highly conserved key enzyme found in both the archaeal and bacterial prokaryotic domains (Stahl, MacGregor).

6) The occurrence of alcyl-homoserine lactones as potential control agents for population densities will be examined at various temperature gradients (Parseek, Schaeffer).

7) Stable sulfur isotope determinations will compare measured frac-tionation rates with *in situ* isotope ratios (Canfield).

8) Microbial chitin degradation within the intestinal tract of crabs and the distribution of microbially fractionated stable carbon isotopes within the animal food chain will be studied by our Mexican colleagues (Soto, Romero-Janero).

9) We also completed molecular and physiological studies of the free-living unicellular sulfur-oxidizing bacteria as well as *Beggiatoa* mats, their phylogenetic position and the latter's nitrate accumulating capacity in liquid vacuoles for the anaerobic oxidation of hydrogen sulfide (Teske, Jørgensen, Fuchs). New isolations of iron- and manganese-oxidizing were added to the program (Emerson).

A final cruise report on data from published or to-be-published papers will be prepared in due time.

International Ridge-Crest Research: **Biological Studies**

A Tribute to Holger Jannasch, 1927 - 1998

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The scientific community working at hydrothermal vents lost one of its pioneers with the death of Holger Jannasch on September 8, 1998. Holger passed away after a long battle with cancer at the age of 71.

Holger's first introduction to deep-sea microbiology was in the form of a sandwich retrieved from the submersible *Alvin* after it was recovered from an unplanned stay on the ocean bottom between 1968 and 1969. The sandwich was remarkably well preserved and launched Holger into a series of experiments on microbial decomposition in the deep sea. When the deep-sea hydrothermal vents were discovered in 1977 he was in an ideal position to investigate the role of bacteria in this new and intriguing environment. Holger and his colleagues designed innovative instrumentation for investigation of microbial processes directly on the seafloor. Their experiments on chemosynthetic primary production based on microbial use of sulfur compounds led the way in solving the fundamental question of how vent communities persist in the nutrient-poor deep sea. These and subsequent discoveries were honored in 1996 when a new microorganism, Methanococcus jannaschii was named for Holger. This microbe is a member of the Archaea, one of the three major life groups on earth, and is one of the few species whose entire genome is known. Holger remained active in his lab until a few weeks before his death, and was Chief Scientist on the multinational *R/V Atlantis* cruise to Guaymas Basin in April-May of this year (see report on page 11).

The contributions Holger made to marine microbiology are not limited to vent systems, but encompass a broad range of topics in microbial growth kinetics in seawater and effects of low temperature and high pressure on microbial processes. He was known for his unique ability to plan and conduct scientific experiments at sea using novel approaches and instrumentation, and for his insightful development of concepts in microbial ecology. The best description of his approach and philosophy was his own, as presented in the invited self-portrait "Small is powerful: recollections of a microbiologist and oceanographer" published in *Annual Reviews of Microbiology* in 1997 (51:1-45). The awards and honors Holger received in his long and productive career are too many to list here, but included Corresponding Member of the Göttingen Academy of Sciences, and Foreign Associate of the US National Academy of Sciences, a rare honor. In his dual role as German citizen and US resident, he was an active and effective ambassador of scientific matters between the two countries.

Those of us who worked with Holger Jannasch in Woods Hole and throughout the world have lost a mentor, colleague and friend. But we can carry his spirit forward by remembering his advice: "Science is an adventure, not a career".

International Ridge-Crest Research: **Mid-Atlantic Ridge**

Precise geological and geophysical mapping on both sides of the 15°20'N Fracture Zone on the MAR - tectonic extension and its consequent exposure of ultramafic and plutonic rocks along the magma-poor ridge axis (MODE'98 Leg1 Cruise)

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Background and cruise outline

The Mid-Atlantic Ridge (MAR) from 14°N to 16°N, with the 15°20'N Fracture Zone, a large 180 km offset, and the spreading segments north and south of the fracture zone, is characterized by mantle exposures in a magma-starved portion of a slow spreading ridge, where igneous crust is virtually absent and the composition of the shallow mantle can be determined at sites distributed over about 100 km along strike. This area has been the focus of a long term cooperative French-American, and allied Russian research programme and was surveyed by the FARANAUT cruise by the French submersible *Nautile* in 1992 (Cannat et al., 1997). Significant discoveries through the programme include:

(i) an unusual regional geochemical anomaly, with "hotspot" characteristics, centered at about 14°N,

(ii) nearly continuous outcrops of mantle peridotite exposed on both walls of the rift valley from at least 14°40' to 15°40' N, and

(iii) at least three areas with unique high methane signatures in the water column, including one active hydrothermal field located within mantle peridotite.

This area was also identified as an ideal region for a multidisciplinary study including ODP drilling on along-strike mantle exposures and melt migration processes on the slow spreading ridges at the 1996 Workshop on Oceanic Lithosphere and Scientific Drilling into the 21st Century (workshop reports can be obtained from the InterRidge Office).

MODE'98 Leg1 was carried out at the 15°20'N Cape Verde Fracture Zone (see Fig. 1) in Jun./Jul. 1998 by the Japanese submersible *Shinkai-6500* with her mothership *Yokosuka*. The main objective of both this cruise and future drilling that will happen here is to characterize the upper mantle geochemistry, the melting and melt migration mechanisms, the deformation mechanisms during tectonic seafloor spreading, and the hydrothermal alteration. Particular emphasis is placed on determining the variation of these characteristics along axis, and understanding the processes and the driving force of the "magma-starved" or magma-poor slow-spreading of the seafloor. These are clearly fundamental questions for understanding the global mid-ocean ridge system. Field observations and sampling were carried out using *R/V Yokosuka*, and the deep-diving submarine *Shinkai6500*, under a joint agreement between the Japanese Ma-

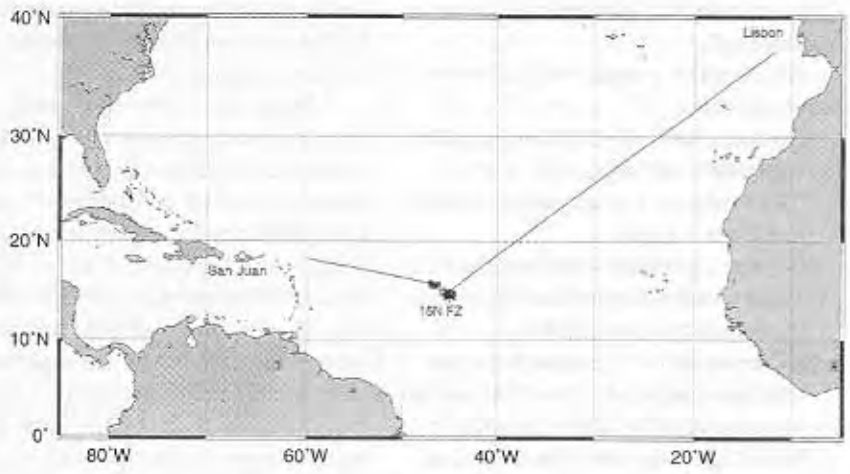

Figure 1. Ship track of MODE'98 Leg1 (17 June - 17 July 1998).

International Ridge-Crest Research: **Mid-Atlantic Ridge:** Matsumoto et al. continued...

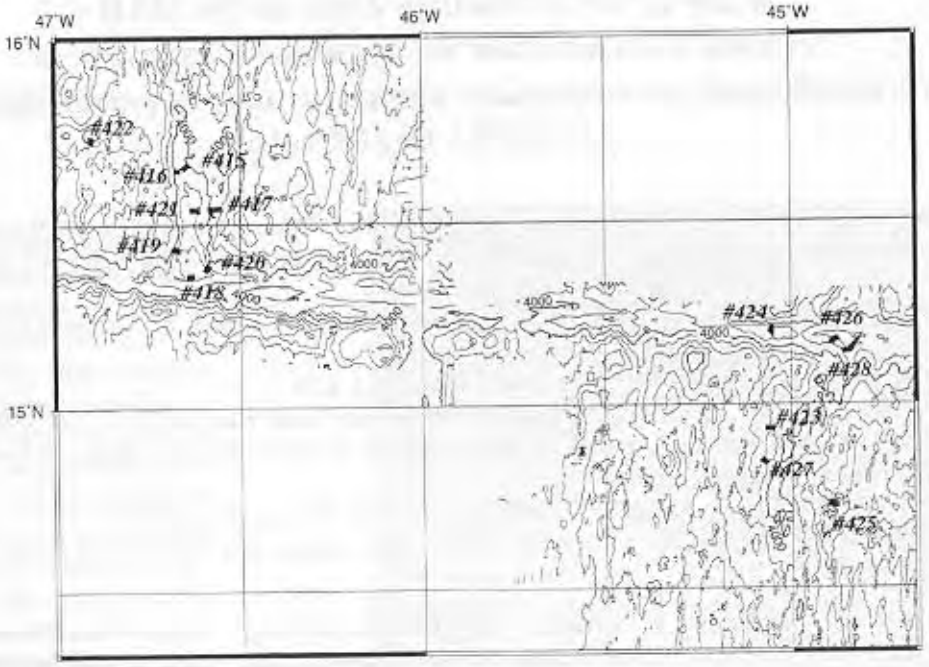

Figure 2. All the submersible tracks of the *Shinkai6500* in the study area of the Mid Atlantic Ridge, 14-16°N.

rine Science and Technology Center (JAMSTEC) and the Woods Hole Oceanographic Institution (WHOI). A pre-site survey for proposed ODP drilling was also carried out through the dive series. The megamullion structure of the outside corner high and the ridge-transform intersections were also studied. Underway geophysical surveys (topography, gravity and magnetics) were carried out at night and during the submersible maintenance days.

Geological surveys in this area targeted:

(i) mantle peridotite tectonites (mylonites),

(ii) the causes of the offset length of the transform fault

(iii) evidence for fluctuation of relative plate motion,

(iv) the age of off-axis features such as paleo-rift axes, suspended valleys, median ridges, etc., and

(v) tectonics of ridge transform intersections, especially in comparison with past studies of the MARK and WMARK ridge-transform intersections at 23°N.

One to three gravity measurements were carried out on the seafloor during each dive. Near-bottom magnetic surveys were conducted with a deep-sea three component magnetometer on the *Shinkai6500* during all dives. These precise geophysical surveys will help to constrain possible models.

Results

1. Mantle peridotites, plutonic gabbros and volcanic rocks along the rift valley

A total of seven dives were made on the rift valley and the topographic highs nearby on both the northern and southern ridge segments.

Mantle peridotites recovered on most dives ranged from fine-grained impermeable mylonites to coarser granular residual peridotites altered to serpentine and related hydrous minerals. Along the tracks of Dives 415-416 (15°39'N) and 425 (14°43'N) (see Fig. 2), low angle normal fault surfaces were exposed on the seafloor, underlain by mantle peridotite. These results suggest that the peridotites are being exposed in the footwall while sedimented pillow basalts are in the hanging wall of a normal fault which forms the rift valley wall.

Coarse-grained gabbros and pyroxenites, as well as peridotites, were recovered on Dives 423, 425 and 427. These were minor and were not systematically distributed on Dives 425 and 427. This, in addition to the direct observation of one coarse-grained dike cutting peridotite in outcrop on Dive 425, indicates that the plutonic rocks sampled on those dives may be small intrusive bodies in mantle peridotite.

Pillow basalts were encountered on Dives 415, 417-421, 425, 426 and 428. Sediment, rather than basalt, dominated the seafloor even within the rift valley. The presence of abundant sediment, and a fairly advanced degree of seafloor weathering of pillow basalts, are striking evidence that volcanism is rare and sparsely distributed along the "active" rift axis.

On the basis of the geological and geophysical results, it seems evident that the western ridge-transform intersection and the area up to 8 km north of the intersection is presently characterized by voluminous volcanism. Formation of abundant volcanics in this area has apparently continued for a long time, based on

the exposures of pillow basalt on the inside and outside corner highs up to 8 km off axis. In contrast, the ridge axis from 15°30' to 15°40'N, 9 to 18 km north of the fracture zone, is largely covered by pelagic sediment, underlain by relatively old volcanic rocks where bedrock is exposed. The rift valley walls in this area are underlain by abundant residual mantle peridotite and gabbro, as well as old volcanic rocks, revealing that the low rate of volcanism in the rift valley has been a long-lived phenomenon. These findings are consistent with the earlier results of the FARANAUT dive expedition to this area (Cannat and Casey, 1995; Cannat et al., 1997).

As a whole the eastern ridge-transform intersection appears to be magma-starved, in contrast to the western ridge-transform intersection. The study area is characterised not by magmatic activity but mainly by tectonic spreading which constructs the rift valley and exposes lower crust-upper mantle rocks.

2. ODP Site Survey

A site survey has been completed for proposed ODP drilling in the 14 to 16°N area along the MAR, to study the magma flow pattern and structural anisotropy along the axis of this slow spreading ridge. Four excellent sites for drilling, with a flat sea floor immediately upslope from outcrops of residual mantle peridotite, were identified via submersible on this cruise, two at about 15°40'N, and two between 14°40' and 14°55'N. Combined with the results from previous FARANAUT submersible cruises, eight such sites have now been identified along the ridge from 14°40' to 15°40'N.

3. Ridge-Transform intersections

The western nodal basin (intersection of the northern ridge segment and the active transform fault) was surveyed by three dives (Dives 418, 419 and 420). Dive 418 traversed very young pillow basalt flows which were abundant right up to the base of the south wall of the Fracture Zone, showing syn-tectonic eruption. Dives 419 and 420 began in sediment-filled basins, and then passed upward over talus and steep, faulted outcrops of pillow basalt. The outcrops were lightly sedimented, indicative of young faulting, but the basalt samples generally have a black alteration halo on their outer surfaces, and could be quite old. As a whole, the basin was completely underlain by basaltic rocks. Recent volcanism at the center of the basin, and subsequent spreading and simultaneous shear deformation along the active transform fault were observed. Steep escarpments observed along the eastern side (inside corner) of the basin may also be an effect of strike-slip deformation along the transform fault zone.

The eastern nodal basin (intersection of the southern ridge segment and the active transform fault) was also surveyed (Dives 428 and 426, in and near the axial valley at 15°09' to 15°10'N). Dive 428 crossed the axial valley not far from the ridge-transform intersection, and Dive 426 climbed from a basin close to the nodal deep up toward the inside corner high. However, unlike the dives in the western ridge-transform intersection, the seafloor along Dives 428 and 426 was heavily sedimented. Basalt was collected on the deeper part while gabbro and peridotite were collected on the shallower part (Fig. 4). Thus, the eastern ridge-transform intersection area is magma starved in comparison to the magmatically robust western ridge-transform intersection, suggesting asymmetry along the transform fault.

4. Transform tectonics

A fault gouge derived from rocks along the transform fault, and a median tectonic ridge within the active transform fault zone, made up of rocks of lower crust and upper mantle, were both observed. Dive 418 at the western ridge-transform intersection encountered abundant, very fresh glassy lava flows. In addition to these lavas, the dive passed over a spectacular outcrop of active strike-slip faults with pillow basalts and sheet flows cut into strikingly symmetrical, parallel slices. Dive 424, along the transform fault zone about 10 km west of the eastern ridge-transform intersection, encountered an excellent exposure of an active fault, including a gouge zone with large included blocks, a cataclastic zone including ultramafic mylonite blocks, and sediments cut by the fault on top. This fault zone is not in the main valley running down the Fracture Zone, and its strike (about 125°) is oblique to the EW trend of the Fracture Zone.

5. Megamullion structure

A dome-shaped topographic high located 30 km west of the northern segment, termed a "megamullion", was identified on the basis of bathymetric data to be the surface of a large, long-lived, low-angle normal fault exposed on the seafloor. Dive 422 traversed the southern flank and the top of the "megamullion" struc-

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http://www.nerc.ac.uk/es/bridge.htm
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International Ridge-Crest Research: **Mid-Atlantic Ridge:** Matsumoto et al. continued...

ture. Gabbroic samples, locally with mylonitic textures, were recovered from the southern flank, and a mixture of residual peridotite, dunite and gabbroic rocks were recovered from the top (Fig. 3). Exposed fault surfaces were observed over 100 m^2 areas at several points along the dive track. One interpretation of this data is that the "megamullion" is a structural dome, exposing increasingly deep seated lithologies toward the central "core". The top of the "megamullion" structure is relatively flat, and lightly sedimented, and constitutes a possible drilling target.

6. Geophysical surveys: preliminary synthesis of geophysical and geological data

Extraordinarily low intensity magnetic anomalies, compared with more magmatically robust parts of the MAR, were observed throughout much of the regional geomagnetic survey area. This is consistent with the exposure of peridotite due to the limited basaltic magma supply.

South of 14°40'N the magnetic intensity increases, and well organised magnetic anomalies can be seen, suggesting that this area, corresponding to the 14°N basalt geochemistry anomaly (e.g., Bougault et al., 1988; Dosso et al., 1991, 1993), has more abundant volcanics (and gabbros?) than the ridge further the north. This change in magnetic intensity to the south is coupled with a transition from a wide axial valley in the north to a much narrower axial valley. Off-axis, ridge-parallel fault scarps and ridges are more continuous in the south, whereas in the north N-S striking topographic feature are shorter, and linear E-W features are relatively common. Together all of these observations suggest that spreading is dominantly tectonic north of 14°40'N, and is accommodated by a larger component of newly formed, magmatic crust to the south.

Shipboard gravity data present an extraordinarily low amplitude mantle Bouguer anomaly, compared with more magmatically robust parts of the MAR, which supports the inference that the area between 15°40 and

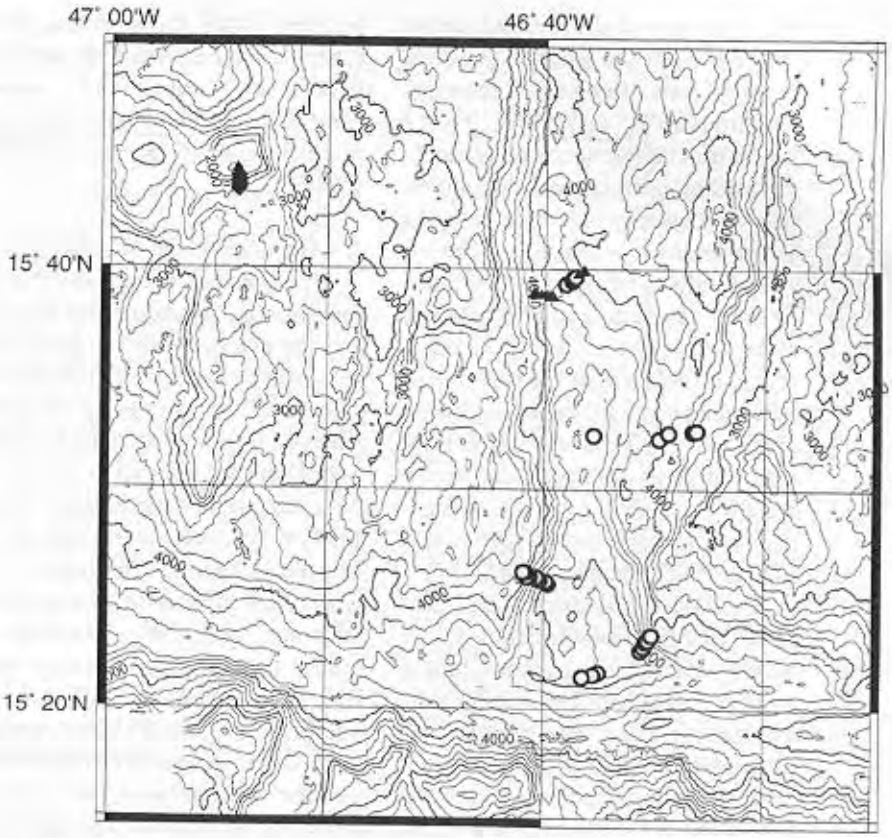

Figure 3. Distribution of the collected samples in the northern segment. ○Basalt ◆ Gabbro ▲ Ultramafic

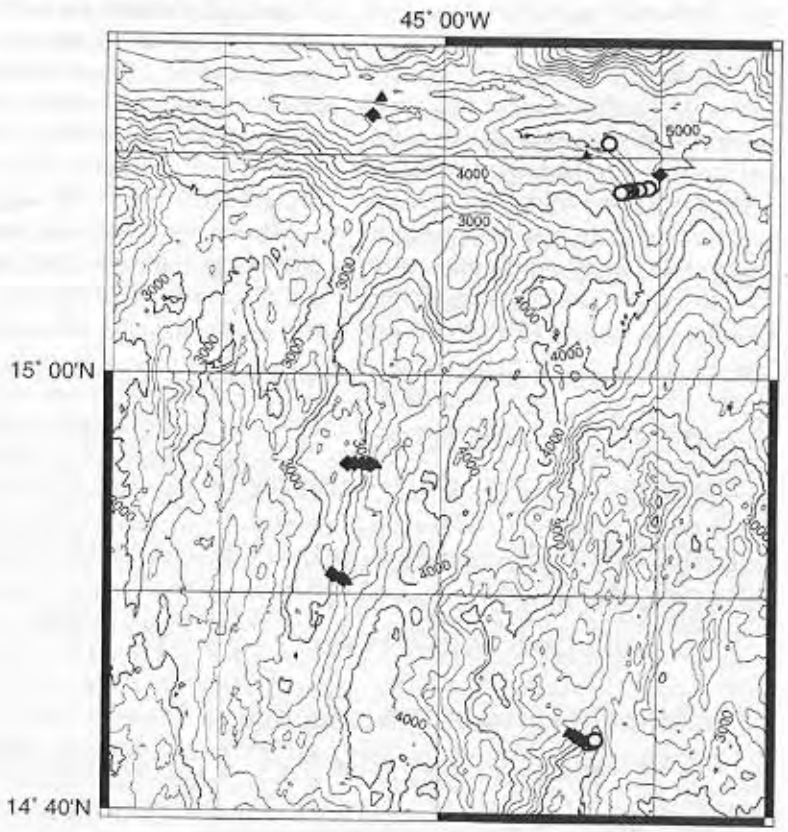

Figure 4. Distribution of the collected samples in the southern segment. ○Basalt ◆ Gabbro ▲ Ultramafic

International Ridge-Crest Research: **Mid-Atlantic Ridge:** Matsumoto et al. continued...

14°40'N has been relatively amagmatic for a long time. This is probably due to the limited magma supply which does not generate thick, igneous oceanic crust, as confirmed by submersible observations.

The largest negative Bouguer and "mantle Bouguer" anomalies are present along the ridge axis at the northernmost and southernmost limits of our survey area. The gravity anomaly maps show roughly concentric, semi-circular contours surrounding these gravity lows, becoming less negative, and finally positive, toward the Fracture Zone from the north and the south. The simplest interpretation of these data seems to be that the large gravity lows represent the centers of unusually large (with a half-length of almost 100 km) magmatic segments at approximately 16° and 14°N. Gravity bulls eyes have generally been interpreted as the result of 3D focussing of solid mantle upwelling and/or 3D focussing of melt extraction (e.g., Phipps Morgan and Forsyth, 1988; Kuo and Forsyth, 1988; Lin and Phipps Morgan, 1992).

Besides the two large magmatic segments centered at 16° and 14°N, the presence of a circular mantle Bouguer low (with an intensity of about -20 mgal and a radius of about 20 km) should be noted. The gravity low is centered at 15°26'N, 46°42'W, slightly west of the axial valley and about 15 km NW of the western ridge-transform intersection. This observation is consistent with the geological and magnetic evidence for abundant magmatism in this area. This small "bulls eye" does not extend beyond the current inside and outside corner highs, which may indicate that abundant magmatism has occurred near the ridge-transform intersection for <2 Ma.

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Going out to sea soon? Did you pack a "Bio-Box"?

A Bio-Box is an insulated container with equipment and supplies for the preservation of any biological samples inadvertently collected during non-biological cruises. This system could be particularly useful in areas that are not frequently surveyed, and areas in which there are no known sites of hydrothermal vents. Samples will be inventoried, archived and forwarded to the appropriate investiagtors.

If you'd like to bring a 'bio-box' on your next cruise, contact:

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International Ridge-Crest Research: **Mid-Atlantic Ridge**

Hydrothermal Processes and Architecture of the Slow-Spreading MAR at TAG and Rainbow Hydrothermal Fields and Dante's Dome Megamullion Site (MODE'98 Leg 2)

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Introduction

A series of 15 dives designed to evaluate heat and material fluxes from active hydrothermal vents and ridge architecture were successfully performed with the deep sea submersible Shinkai 6500 at three sites on the Mid-Atlantic Ridge (MAR) as part of the MODE'98 Leg 2 MEGATRAIN cruise of the *R/V Yokosuka* between Jul 23- Aug. 23, 1998. Detailed multidisciplinary submersible observations were made at the TAG hydrothermal field (7 dives; 26°08'N), the Dante's Dome mega-mullion site (5 dives; 26°40'N), and the Rainbow hydrothermal field (3 dives; 36°14'N; Fig. 1). Hydrothermal fluid and buoyant plume samples, rocks, sediments, biological samples and geophysical measurements were obtained together with video and still photographic visual records along the submersible tracklines. In addition, the *R/V Yokosuka* recorded bathymetric, magnetic and gravity data along survey lines at night. This cruise was preceded by the MODE'94 cruise of the *R/V Yokosuka* and *DSV Shinkai 6500* which made 15 dives at the TAG hydrothermal field in July-August 1994 just prior to Ocean Drilling Program Leg 158 at TAG (Sept.-Nov. 1994).

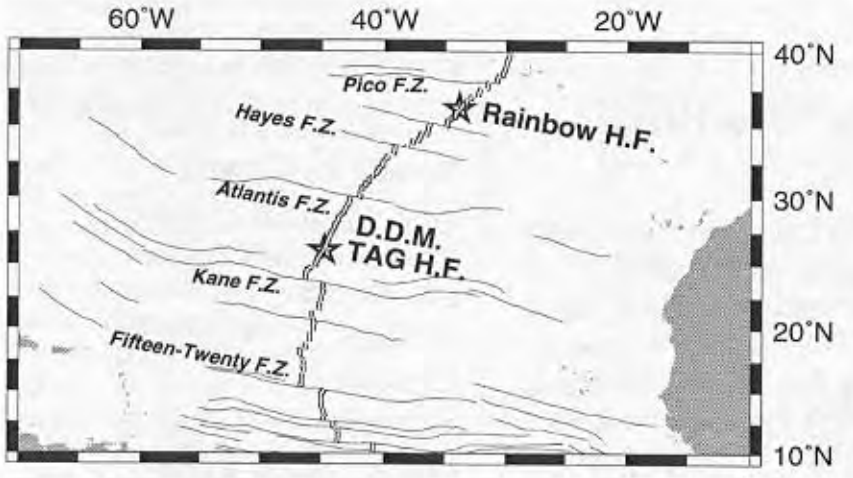

Figure 1: Index map of the three survey areas comprising TAG hydrothermal field, Dante's Dome Megamullion area (D.D.M), and Rainbow hydrothermal field.

The TAG Hydrothermal Field

Objectives

1) Construction of the 3D architecture of the TAG active hydrothermal mound after the 1994 ODP Leg 158 drilling to compare the differences in its whole edifice before and after drilling (Fig. 2a).

2) Time series fluid and plume sampling of black and white smokers, as well as diffuse flow to estimate the geochemical budget and the geochemical evolution of the TAG hydrothermal mound since the first report in 1985.

3) Heat flow measurements of both the active and inactive mounds (MIR and ALVIN zones) to determine the thermal state.

4) Collection of samples from the active chimneys and debris flows from the Mir and Alvin zones, which contain fossil hydrothermal mounds, to date and analyze the chemical composition of the old massive sulfide deposits to determine the chemical and physical evolution of hydrothermal activity in this field.

5) Sampling and observation of micro-organisms in relation to the hydrothermal activity.

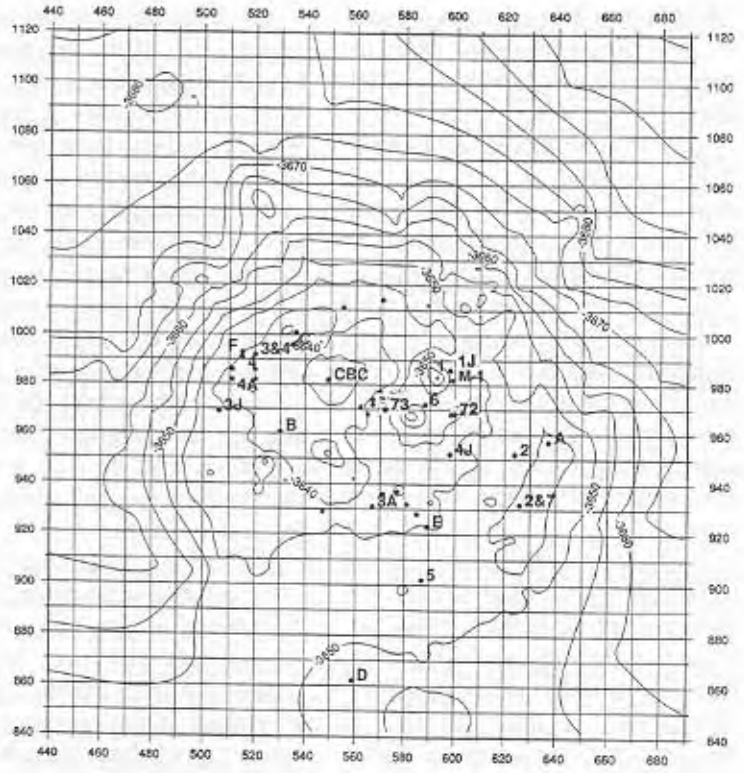

Figure 2a. Bathymetric map (meters) of the TAG active mound showing the location of the markers. Markers 1J to 4J and 72 to 73 were deployed by *Shinkai6500*. The Black Smoker Complex (BSC) is also known as "Laputa".

6) In-situ gamma ray analysis of the active hydrothermal mound to estimate the age of each chimney.

7) In-situ geochemical and geophysical measurements of hydrothermal fluids by CTDT, pH and Eh sensors and of the seafloor with a gamma-ray detector and a three-component magnetometer.

Preliminary TAG Dive Results

1) Changes of the active hydrothermal mound since 1994: Changes of the active hydrothermal mound since 1994 were remarkable, especially for the black smokers at the central black smoker complex (Laputa) which had shrunk and eroded, and for the #72 and #73 sites, (old markers 4 and 1 set up during the MODE '94 cruise) where chimneys were enlarged and growing. The Kremlin and Alvin marker E sites were also changed significantly; white smokers were active in 1994, but now high-temperature clear water is discharging in their place. Two ODP reentry cones were found with hydrothermal precipitates on their surfaces.

2) Mass wasting on the southern margin of the mound: Sink holes and slope failure apparently caused by dissolution of anhydrite and calcite had occurred on the southern margin. An anomalously high heat flow value was measured where southeast margin of the mound onlaps an adjacent volcanic dome.

3) Black and clear smoker fluids at the TAG active mound: Black and clear smoker fluids were sampled at the active mound. Relations between the values of pH, alkalinity, and SiO_2 concentration suggest that the black smoker composition has not changed since the first sampling in 1986. Conditions at the deep-rock/seawater reaction zone must have been stable for at least 12 years. Despite drilling of a 125 m ODP borehole, composition of clear smoker fluids sampled at the Kremlin site seems to be similar to that of white smoker fluids sampled at the upper terrace in 1994.

4) Large inactive massive sulfide mound in the Alvin zone north of the active mound: An inactive hydrothermal mound 70 m high and 200 m in diameter surmounted by intact chimneys was located 2.5 km north of the TAG active mound guided by images from a prior DSL-120 side scan survey (Fig. 3a). This mound is one of the highest seafloor hydrothermal mounds, perhaps the highest, yet known. We propose to name it "Shinkai Mound".

5) Low-temperature Ecosystem: An active low-temperature hydrothermal system was found on a large mound (68 m high by 150 m diameter) at the northern end of the Alvin zone. Clear water is discharging at temperatures of tens of degrees C from the top of the mound and precipitating low-temperature hydrothermal deposits and sustaining a biota composed of anemones, shrimp, eelpout fish, bacterial mats, etc. This "Shimmering Mound" indicates that the northern part of the Alvin zone is still active or undergoing reactivation.

Dante's Dome Megamullion Site

Objectives

Five dives were planned on Dante's Dome (Fig. 2b), arrayed approximately along a dip transect that extends from break away to termination across the southern of two main domes present in the area. Observations and geological/geophysical sampling along this transect addressed the following objectives:

1) To document whether the surface of the megamullion represents a fault surface.

2) If the megamullion surface is a fault surface, to investigate the history of fault development and strain localization from recovered rock samples.

3) To determine whether the surface of the megamullion exposes a cross section of the ocean crust and upper mantle, and to document in detail the composition and structure of this cross section.

4) To analyze the structure of small isochron-parallel steps in the megamullion surface, determine if they are fault scarps, and evaluate them in the context of bending stresses in the rotating footwall.

International Ridge-Crest Research: **Mid-Atlantic Ridge:** Fujiokai et al. continued...

5) To obtain structural data on the mullions that will help to assess their origin.

6) To analyze whether the sea-surface magnetic anomalies can be explained by observed seafloor magnetization (as documented by on-bottom 3-component magnetometry and by laboratory measurements on recovered rock samples).

7) To relate distribution of rock types and rock densities (e.g., gabbro, peridotite, serpentinite) to the observed sea-surface gravity field.

8) To further constrain these relations by obtaining on-bottom gravity measurements along the transect.

9) To determine whether the structure and inferred development of the megamullion is consistent with heat flow measured along the transect of dives.

10) To determine whether venting of hydrothermal fluids may be occurring on the megamullion.

Preliminary Megamullion Results

Preliminary findings from the megamullion dives series are as follows:

1) Where the detachment fault initially nucleated, a steep volcanic depositional slope on the east flank of the ridge at the previously identified breakaway indicates that this is not the true breakaway. Instead, this ridge and a set of smaller ridges to the west appear to constitute a set of "rider blocks" on top of the deeper detachment surface. The actual breakaway zone appears to be about 3 km farther east, located at a steep west-facing scarp.

2) The lithological section exposed by faulting near the breakaway zone is an upper-crustal section. With distance west from the breakaway zone, there is a small but probably significant increase in the occurrence of deeper rocks, suggesting that lower crust and upper mantle may be exposed at least locally.

3) The surface of the domes on the younger part of the megamullion is remarkably flat, and it slopes gently away from the crests of the domes. This unusually smooth surface most likely reflects very smooth basement buried beneath a few meters of sediment, and this basement is interpreted to be the detachment fault surface.

4) Basaltic debris litters the eastern dome of the megamullion (Fig. 3b), but none of it appears to be in place. It is interpreted to be talus that was clipped from the overlying hanging wall and carried onto the megamullion footwall as the detachment fault slipped.

5) Rocks recovered from the base of the eastern dome in the region of the highest residual mantle Bouguer gravity anomaly (RMBA) include a serpentinite and a gabbro. These are interpreted to represent samples of basement rock from beneath the detachment fault. Modeling of the on-bottom gravity data will help to test

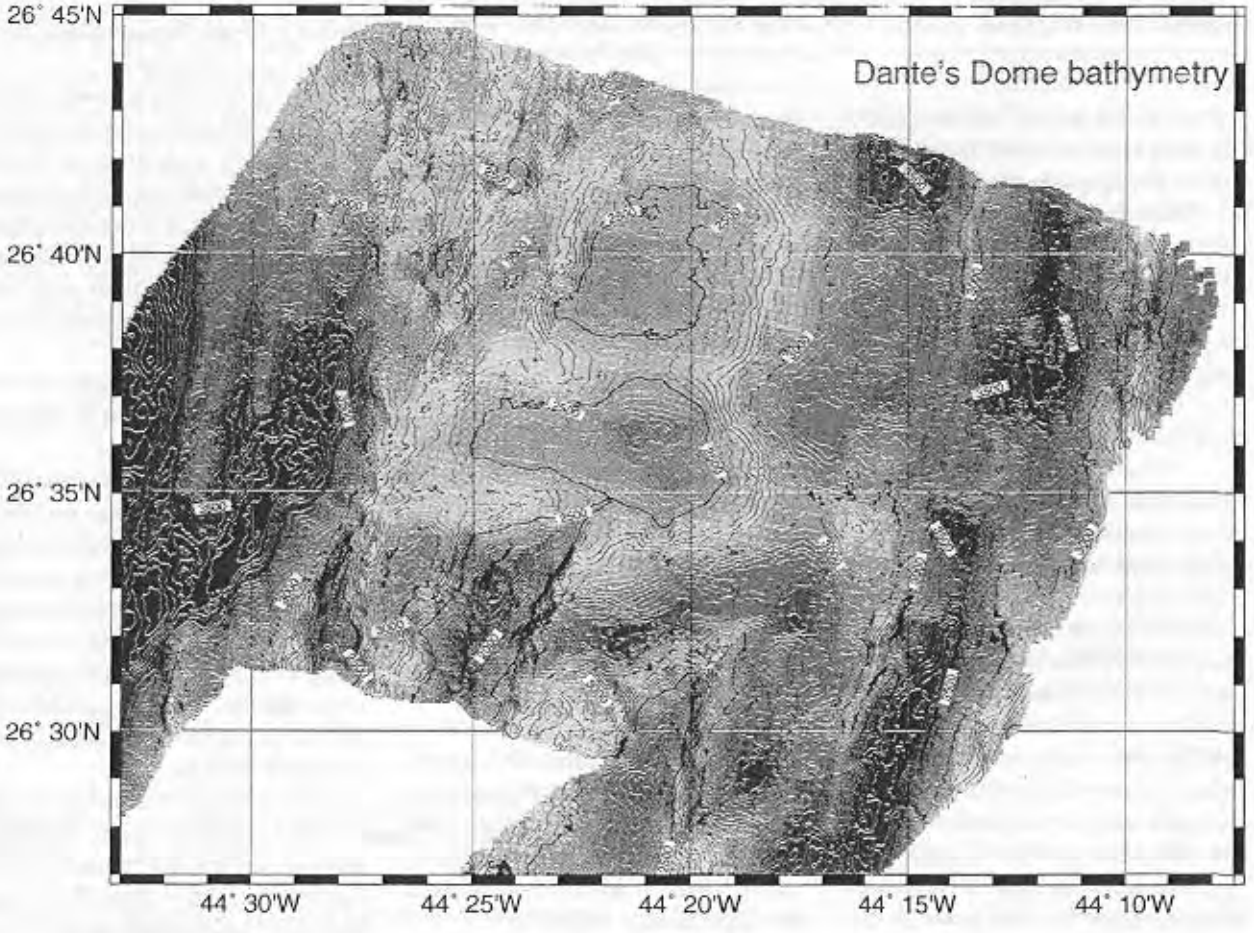

Figure 2b. Bathymetric map of Dante's Dome megamullion area

the validity of this interpretation.

6) The youngest part of the megamullion contains in-place evidence of intrusive and extrusive magmatic activity. This may indicate that the rift valley was becoming more magmatically active late in the period of megamullion formation. This magmatism would have created a thicker crustal section, possibly explaining the decreasing Residual Mantle Bouguer Anomaly over the young part of the megamullion.

7) Igneous debris moving downslope on the gentle flanks of the megamullion domes is captured in unusual rock "fences" that meander for tens to probably hundreds of meters nearly parallel to bathymetric contours. The same debris moving downslope on steeper slopes near the breakaway zone forms chutes and creates significant debris flow deposits.

8) Bottom currents are active in the study area, and they appear to circulate clockwise around the domes. They create extensive field of asymmetrical ripples both in calcareous ooze/marl and in overlying, coarse lag deposits of pteropod and iron-manganese debris. The lag deposits are transported both along-slope by the currents and downslope under the influence of gravity.

Rainbow Hydrothermal Field

Objectives

1) To topographically and geologically map the Rainbow hydrothermal site in order to understand the tectonic control of the hydrothermal system (Fig. 2c).

2) To locate active black smokers, diffuse flow, if possible, and dead chimneys to know the distribution of the chimneys and to estimate the magnitude of the hydrothermal system.

3) To sample sediments by push coring at off-mound locations, to elucidate the distribution of the hydrothermal particles.

4) To sample the plume of the black smoker fluids to characterize the geochemistry of the hydrothermal system.

5) To sample sulfide and host rocks (maybe peridotite) at the various locations, to understand the degree of reaction with hydrothermal solution.

6) To measure heat flow values in an active vent site and off-active site.

7) To make an in-situ measurements of pH, Eh, gamma-ray and CTDT continuously along the submersible track for characterization of the hydrothermal vents.

Preliminary Rainbow Results

1) Location of black smoker vents: At least 3 active black smoker vents were identified at JAMSTEC marker #79 (FLORES #9) of Dive #441, marker #81 of Dive #442, and marker #82 of Dive #443. Possibly seven black smoker vents were observed, including two near marker #79, and five near the marker #82 site (Fig. 3c).

2) Samples at the Rainbow site: Hydrothermal fluids, plume, sulfide, hydrothermal precipitates, and host rocks were collected from the black smoker sites as well as from adjacent areas.

3) Linear distribution of dead chimneys: Many dead chimneys were located during the submersible survey. They are slim and tall (max. 10 m), but they remain standing, and they align in EW and NS directions. The hydrothermal system may be controlled by N-S and E-W trending fault systems. The top of the mound was a long, narrow and steep ridge, and it was difficult for the submersible to access because of strong currents and the steep, rugged topography.

4) Mass wasting and identification of markers: Mass wasting, slope failure, and debris flow deposits were observed along the steep slopes of the hydrothermally altered zone. We located existing markers #10, 27, 35, 36, 41 and FLORES marker #9 during the dives.

5) Geochemical characteristics of the black smoker fluids of the Rainbow site: Three black smoker fluids

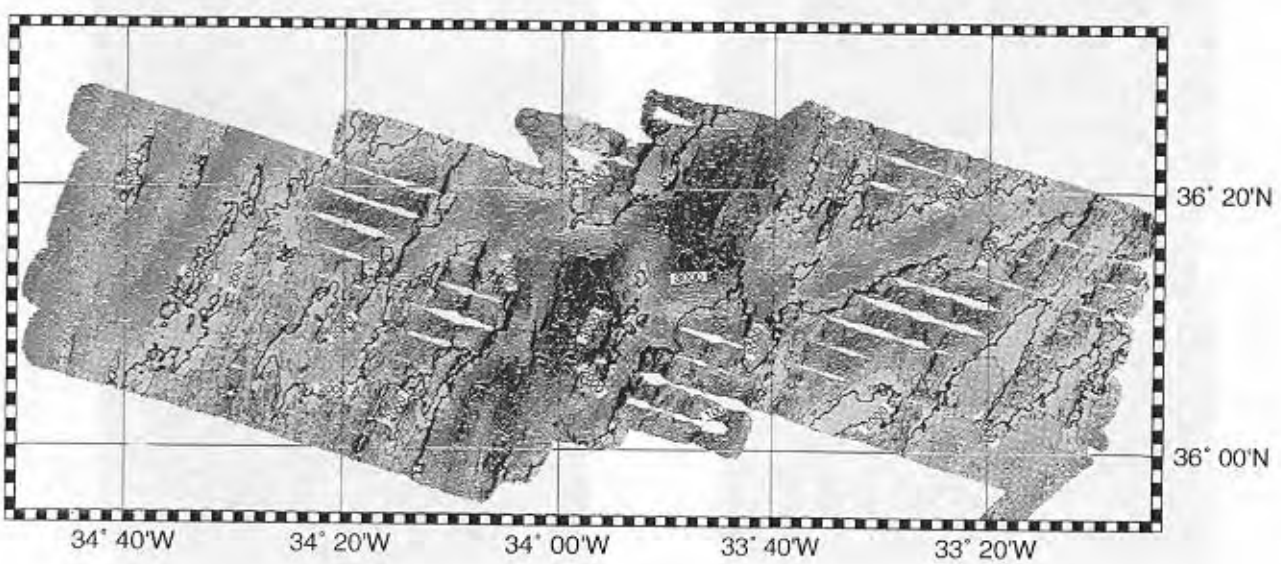

Figure 2c. Bathymetric map of the Rainbow hydrothermal site

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1) Dead chimney;

3) Newly found black smoker with Rimicaris;

2) Kremlin site;

4) Foot of central blacksmoker complex

Figure 3a. Video images of the TAG hydrothermal mound during dive #435.

1) Intrusive body;

3) Scattered rubble, basaltic rocks on the pelagic clay;

2) Highly sheared part of intrusive body;

4) Huge sponges on the rubble .

Figure 3b. Video images of the Dantes Domes area during dive #438.

were sampled at this site. The pH vs. SiO_2 concentration relationships suggest that the black smoker fluid at this site has low SiO_2 concentration, about 1/3 of quartz saturation at the measured temperature. This is probably because the host rock is peridotite, which was sampled in this area, and it may affect the concentrations of components other than aqueous SiO_2. High concentration of gaseous components was also found in these samples. These gaseous components most likely are H_2, CH_4, and H_2S, according to previous studies.

Hydrothermal Plumes

Detection of hydrothermal plumes using CTDT, Eh and pH sensors: Temperature, salinity, transmittance, Eh, and pH of the water mass were continuously monitored during submersible descents and ascents. Simultaneous anomalies in temperature, transmittance, and Eh were detected about 250 m above the seafloor in all dives at the TAG hydrothermal area, and must correspond to a hydrothermal plume originating from the high-temperature venting. The intensity of the anomaly decreases with increasing distance from the active venting area. At the Rainbow field, temperature and transmittance anomalies were detected in all dives, but an Eh anomaly was found in only one dive (#443). This may reflect the difference in chemical nature of the hydrothermal plumes at two sites.

In situ measurement using CTDT, and pH and Eh sensors at active hydrothermal areas: Temperature, salinity, transmittance, pH, and Eh of water masses were successfully measured along the track lines of *Shinkai 6500* at the TAG and Rainbow hydrothermal fields. Temperature, salinity, transmittance, Eh, and pH anomalies were detected simultaneously around venting sites. These anomalies were detected not only at chimneys venting hot fluid, but also at low temperature diffuse flow sites such as the "Shimmering Mound" found at the northern end of the Alvin zone. Anomalies in these factors should be used to locate venting phenomena at the seafloor.

Geophysics

1) We conducted swath surveys using the HS-10 multi-beam system, a gravity meter, and a proton precession magnetometer and a three-component fluxgate magnetometer. The surveys covered 3500 miles of track in box surveys north of Dante's Dome megamullion area and the Rainbow site.

2) *In situ* three-component magnetic measurements were made with *Shinkai 6500* during all dives.

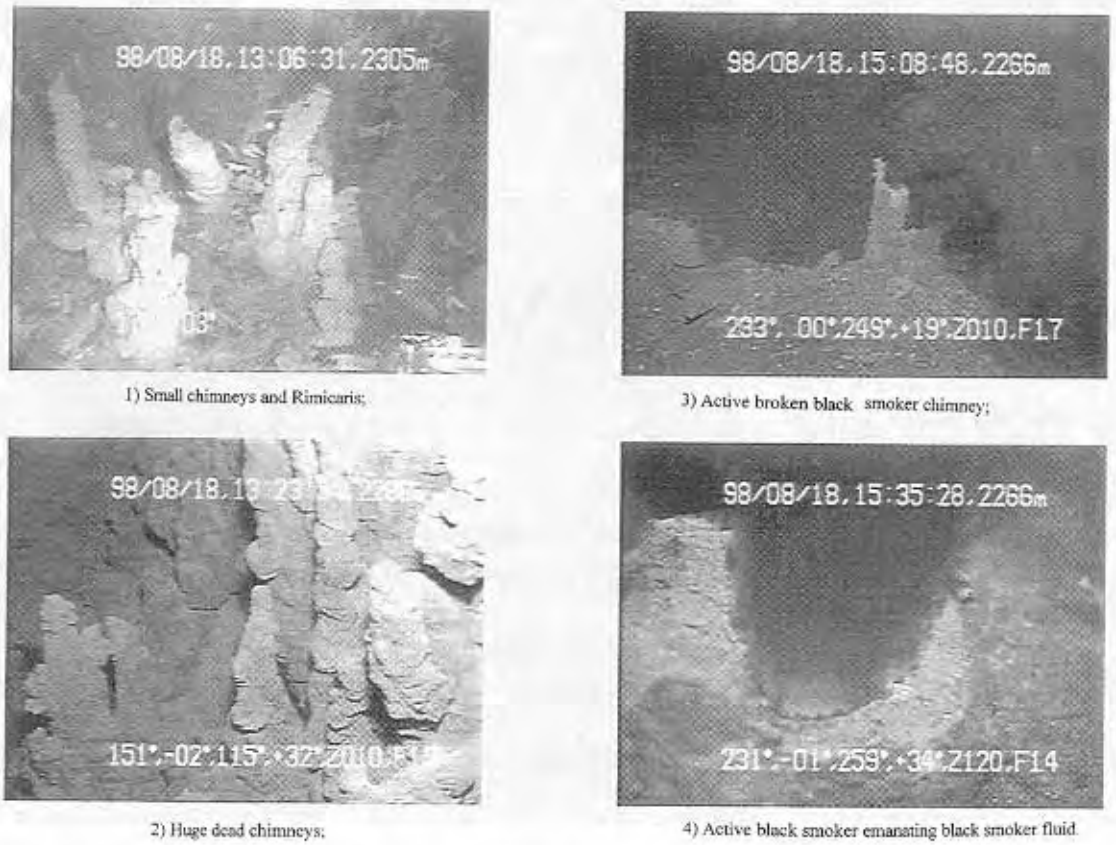
3) Sea floor gravity measurements were conducted across the Dante's Dome area at approximately equal intervals.

4) Heat flow measurements were conducted in 10 localities in the TAG area, at Dante's Domes, and at the Rainbow hydrothermal site.

Biology and Microbiology

1) Dense swarms of shrimp (*Rimicaris exoculata* and to a lesser degree *Chorocaris chacei*), were observed on active chimneys at both the TAG active mound and the Rainbow hydrothermal site.

2) The major food source for the shrimps is thought to be microorganisms associated with the chimneys. The occurrence of sulfur-oxidizing bacteria was indicated by onboard preliminary cultivation.



1) Small chimneys and Rimicaris;

3) Active broken black smoker chimney;

2) Huge dead chimneys;

4) Active black smoker emanating black smoker fluid

Figure 3c. Video images of the Rainbow hydrothermal site during dive #443.

International Ridge-Crest Research: **Mid-Atlantic Ridge**

Dives 1 and 100 at the TAG Hydrothermal Field, Mid-Atlantic Ridge 26°N, 45°W

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The submersible *Shinkai 6500* made the one-hundredth dive at the TAG hydrothermal field during the MODE'98 Leg 2 "MEGATRAIN" cruise on August 4, 1998 according to a review of the records by the cruise chief scientist, Kantaro Fujioka of JAMSTEC. It was my privilege to make that dive (*Shinkai 6500* dive 434), which invoked my memory of the first dive at TAG and the remarkable findings since that time.

John Edmond and I made the first dive at TAG in *Alvin* with Dudley Foster as pilot in May 1986, less than a year after we had discovered and sampled the active high-temperature mound with transponder-navigated camera-temperature tows and a dredge in July-August 1985 (Rona et al., 1986). During the descent of that first dive, I concealed my anxiety for the positional accuracy of the prior navigation fearing to lose our dive time searching for the mound. When we landed on the seafloor within sight of the margin of the mound I silently praised the Lord and announced the heading to our target. John excitedly proclaimed after the dive that the TAG active mound was larger than anything seen in the Pacific at that time, which was a reversal of the community consensus hardly a year before that high-temperature hydrothermal activity could only occur at the intermediate-to-fast spreading rates of the Pacific.

Alexander Lisitsin and his group from the Shirshov Institute of Oceanology of the former USSR Academy of Sciences made the next dive series on the maiden voyage of the two *Mir* submersibles in 1988. We had published our best position for the active mound at that time (26°08.3'N, 44°49.6'W) which was within 100 m of the present position. Using measured lengths of rope to position the dive points of the subs relative to the ship, which we understand was experiencing difficulties with its satellite navigation, they landed on the active mound on the sixteenth and final dive of their TAG series (L. Zonenshain, personal communication). In the search process, they mapped the geology and found a number of the huge inactive mounds of the TAG area (Zonenshain et al., 1989; Lisitsin et al., 1989).

Subsequent dive series became highly efficient at targeting sites and collecting multidisciplinary data sets. We dove with assurance that we would land on target and planned our time to maximize data assimilation. In the meantime, six additional hydrothermal fields have been discovered along the explored section of the Mid-Atlantic Ridge between 14°45'N and 37°51'N (Logatchev, Snake Pit, Broken Spur, Rainbow, Lucky Strike and Menez Gwen). And the one hundredth dive at TAG, *Shinkai* dive 434, found an extensive new active low-temperature area 4 km north of the active mound as our discoveries and understanding of seafloor hydrothermal processes accelerates.

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International Ridge-Crest Research: **Mid-Atlantic Ridge**

Hotspot influence on slow-ridge accretion processes: preliminary results of the TRIATNORD cruise on the MAR north of the Azores (*R/V L'Atalante*, 6/25-7/21/1998)

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Cruise objectives

The Mid-Atlantic Ridge (MAR) has received a lot of attention in recent years due to coordinated international efforts: numerous cruises have been conducted over this ridge, resulting in a fairly complete picture of the domain of the MAR from 15°N to the Azores (e.g. Thibaud et al., in press). However, in spite of the fact that the section of the MAR north of the Azores is probably the section of the world's active ridge system closest to several major European and US academic oceanographic institutions, it has been seldom surveyed. Moreover, most of the cruises north of the Azores were conducted a number of years ago, when 100%-coverage surveys could not be reasonably conducted in limited ship time.

The main objectives of the TRIATNORD cruise were as follows:

The first objective was to investigate the morphology and shallow-structure of a slow-spreading ridge in an area under a notable influence of a major hotspot by observations of the zero-age depths, the rift valley relief, the distibution of tectonic faults and deformation, the evolution of segments lengths (e.g. Gente et al., 1994; Gente et al., 1995), the presence or absence of large fracture zones (e.g. Grindlay et al., 1991; Karson et al., 1987; Thibaud et al., in press), the variations of the crustal thickness (Maia and Gente, 1998) - the presence of a thick crust is to be expected from large magma output in a hot upper mantle thermal regime, and finally, the possible occurence of locally enriched basalts (e.g. Dosso et al., 1993). In these respects, the studies conducted during the TRIATNORD cruise are part of meso-scale studies of the world's active ridge system and, more particularly, of its 4D architecture. Indeed, this section of the MAR probably undergoes a peculiar evolution, due to the anomalous thermal regime of the underlying upper mantle. Studies of hotspot/ridge interactions have received high priority in the French Programme "Dorsales" in recent years.

The second objective was to document the links between observed ridge processes and a possible asymmetry of the Azores plume at depth, the latter being evidenced by the interpretation of global seismic tomography and geoid models (Goslin and Aslanian, 1992; Goslin et al., in press), and by the analysis of geochemistry data (Yu et al., 1997). The first two objectives are part of the "related studies" task 4 of the European Program "Amores", aimed at providing a comprehensive general framework of the interactions between the MAR and the Azores.

Finally, an ancillary objective of the cruise was to refine the recent kinematics of the opening north of the Azores, it terms of both the temporal evolution of the geometry of the ridge axis itself (e.g. Sloan and Patriat, 1992) and, at a broader scale, the kinematics of the Azores triple junction (Luis et al., 1994; Luis, 1996).

The importance of these issues clearly prompted the need for a complete bathymetry and geophysical survey of the MAR recent domain (to address points 1 and 3 above) and for additional sampling of fresh basalts in a precisely controlled tectonic framework (to address point 2).

Summary of cruise operations

Of the 22 days of scientific operations aboard the *R/V L'Atalante*, around 18 days were devoted to underway acquisition of soundings and geophysical data, resulting in 100% multibeam coverage of the MAR's axial domain. This coverage extended up to magnetic anomaly 3A between latitudes 44°10'N and 40°30'N, and up to anomaly 2A over the northernmost part of the survey, between latitudes 44°10'N and 45°N. All profiles were made parallel to the flow-lines (DeMets et al., 1990), heading N100° and N280°. In order to take advantage of the Simrad EM12-dual large swath width, the lines were run 8 miles apart in the northern third of the survey and 5 miles apart in the remaining two thirds, where shallower depths were frequently observed. The ridge axis

International Ridge-Crest Research: **Mid-Atlantic Ridge:** Goslin et al. continued...

was crossed 46 times. Multibeam soundings, reflectance imagery, magnetics (both total-field and three-component data), gravity and 6-channel seismics were continuously recorded. The cumulate length of the 46 lines (excluding tie-in lines at the ends of the profiles) is close to 4600 miles, and 146,000 air-gun shots were recorded.

Dredging operations occupied about 4 days: 21 dredges were deployed at 20 different sites, which were selected in the ridge axial valley on large-scale real-time topographic and image maps plotted on board. 18 dredges recovered rock samples, one dredge contained only compact sediments (TRN-01), and 2 dredges came up empty (TRN-13 and TRN-20).

Preliminary geophysical results

The multibeam survey of the recent domain of the MAR between latitudes 40°30' N and 45° N, conducted during the TRIATNORD cruise, shows three "first-order" domains within the study area (Fig. 1). The southern domain, south of 43°05'N, corresponds to a region where the ridge axis trends globally N0°. The ridge trends close to N15°E in the northern domain, which extends roughly between 43°50'N and the northermost end of the survey. These two domains are separated by a wide intermediate zone, between latitudes 43°05' N and 43°50'N, where the ridge changes trend and where two notable ridge-axis offsets are observed.

A 1 km × 1 km topographic grid was resampled from multibeam data to compute the mantle Bouguer anomaly (MBA). The gravitational attraction of a model with a crust of constant 6-km thickness and of constant 2700 kg/m^3 density was computed at each grid node. Model values were then interpolated at gravity data points along the ship's tracks and substracted from the free-air anomaly data at each point, providing the MBA values, which were then contoured (Fig. 2). In this first step, no corrections were made for the presence of sedimentary cover. As this cover was shown to be notable in places, such a correction will be made in the future

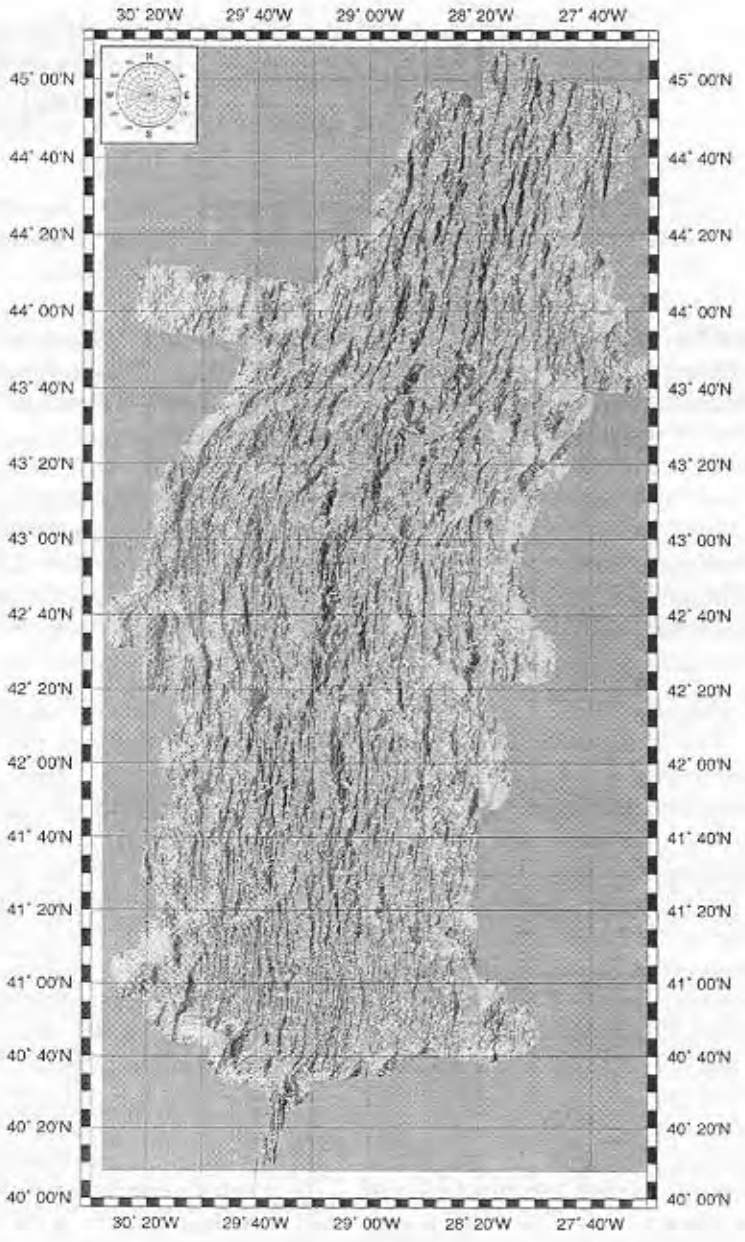

Figure 1. Shaded relief imagery of the axial domain of the MAR north of the Azores based on the EM12-dual multibeam coverage obtained during the TRIATNORD cruise. The relief is illuminated from E110°N, 45° above the horizontal (as shown by star in inset).

to allow interpretations of the MBA at shorter wavelengths. The contribution to the MBA of the cooling of the lithosphere away from the axis was computed over part of the survey (north of 42°30'N), with the help of an age grid derived from the identification of magnetic anomalies. Synthetic isochrons spaced at 250,000 yrs were interpolated between magnetic chrons (axis and chrons 2, 2A, 3 and 3A) and a 1 km × 1 km age grid was produced from these isochrons. The depth of the lithosphere/asthenosphere interface was derived from this age grid. The gravity contribution of this interface was computed, and using a density contrast of -60 kg/m^3 a map of the residual "RMBA" was produced (Fig. 3).

Inspection of Fig. 2 further confirms the proposed division of the TRIATNORD area into two different domains which are separated by a major discontinuity: negative MBA values are observed over the southern domain, indicating a probable large magma output, while more positive MBA values predominate in the north of the survey area. In this latter do-

main, the MBA distribution globally resembles those which have been frequently observed over slow-spreading ridges.

The total amplitude of the magnetic field was recorded by a towed magnetometer. A shipboard three-component magnetometer STCM, developed and operated by the ORI team, was also used to measure the geomagnetic vector field. Magnetic anomaly identifications were based on the correlation between observed profiles and a model generated from an inversion scale, also taking into account the ridge topography. The model used during the cruise was based on a spreading (half) rate of 1.2 cm/yr (DeMets et al., 1990), which proved to be largely adequate. Anomalies recorded along the tracks are shown on Fig. 4, together with the identification of three magnetic chrons. As was observed along other sections of the MAR (e.g. Gente et al., 1996), the identification of magnetic anomalies can be reliably made over the centers of ridge segments, and becomes more difficult over the off-axis traces of the discontinuities (see Fig. 4).

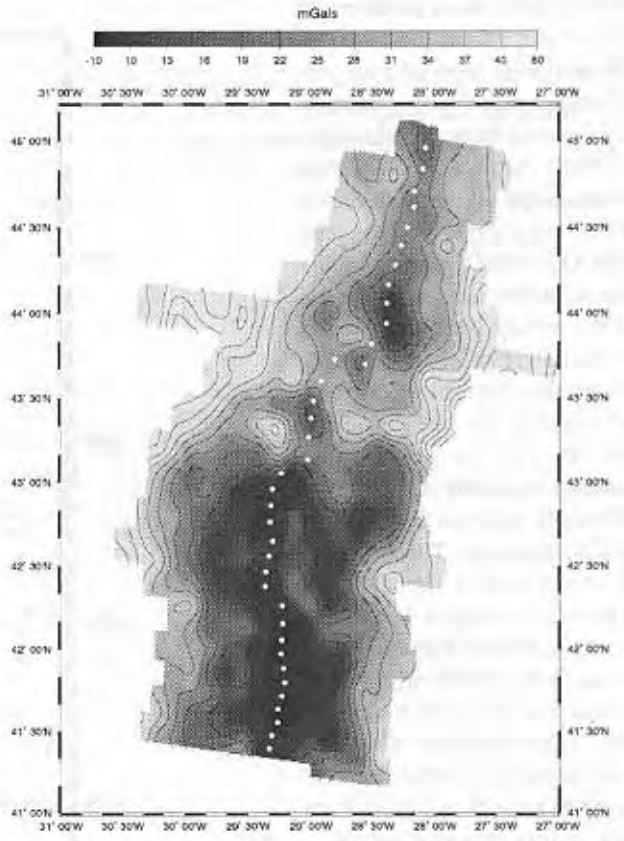

Figure 2. Contoured mantle Bouguer anomaly (MBA) over most of the TRIATNORD area (see text for details on the computation process).

The southern domain (40°30' N - 43°05'N)

Five segments are observed along this section of the ridge axis, whose length range between 30 to 90 km. The segments are separated by northward-pointing V-shaped discontinuities which offset the axis by less than 10 km. Their width can be as much as 20 km and they are made up of either oblique depressions or N-S trending basins lined up in an oblique trend. Between 42°35' and 42°55'N the sinuous geometry of chron 3 on the ridge's eastern flank is related to one of these series of topographic lows trending N315°, suggesting a possible ridge jump in this area. The topographic roughness of the ridge flanks varies quite widely along-ridge over the southern domain: the two southernmost segments are fairly smooth, with low-amplitude, regularly spaced, short-period abyssal hills. This is especially the case for the south-ernmost segment, just north of the Kurtchatov FZ, which is the longest and more robust of all the segments observed in the TRIATNORD area. Seafloor

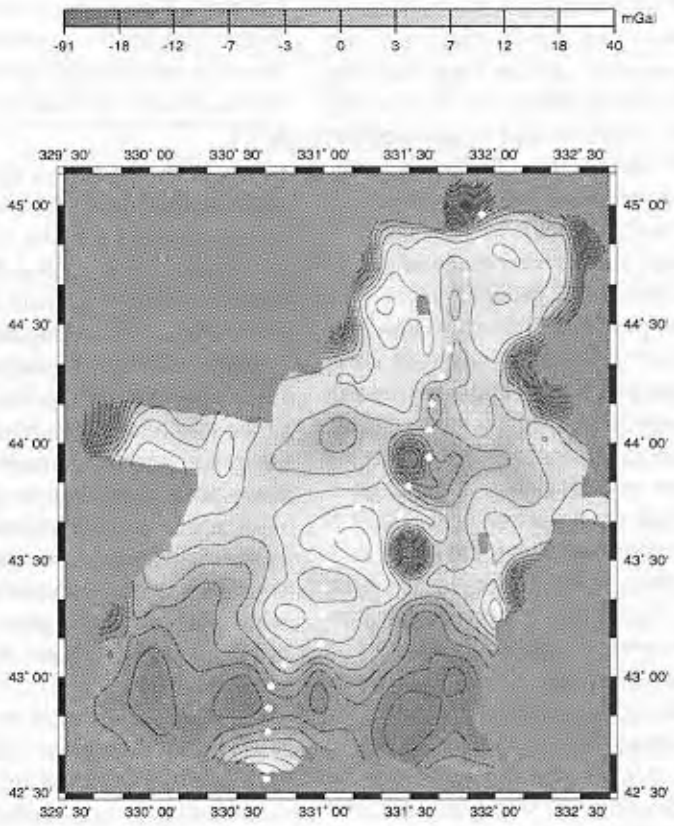

Figure 3. Contoured residual mantle Bouguer anomaly over "RMBA" (see text for details on the computation process). Conspicuously high RMBA values are to be noted over the "central domain".

International Ridge-Crest Research: **Mid-Atlantic Ridge:** Goslin et al. continued...

roughness becomes more pronounced toward the north of the southern domain (abyssal hills have a larger amplitude, and are more widely and less regularly spaced). Recent studies (e.g. Rossi, 1998) have proposed that smooth topography is associated with a hotter thermal regime, which is seen in the TRAITNORD region, as the smoother segments are located to the south of the survey area, closer to the Azores. The rift morphology confirms this latitudinal evolution in the ridge's thermal regime (as proposed by Thibaud et al., in press): the southernmost segments show a wide and shallow rift, whereas the rift relief increases northwards. The northern limit of what could be termed "hot" ridge segments is close to 42°N.

Over the southern domain, MBA analysis confirms that the ridge is segmented in rather short (30 to 40 km) segments. Inter-segment discontinuities are marked by MBA relative highs both on- and off-axis, which are especially visible around 42°40'N.

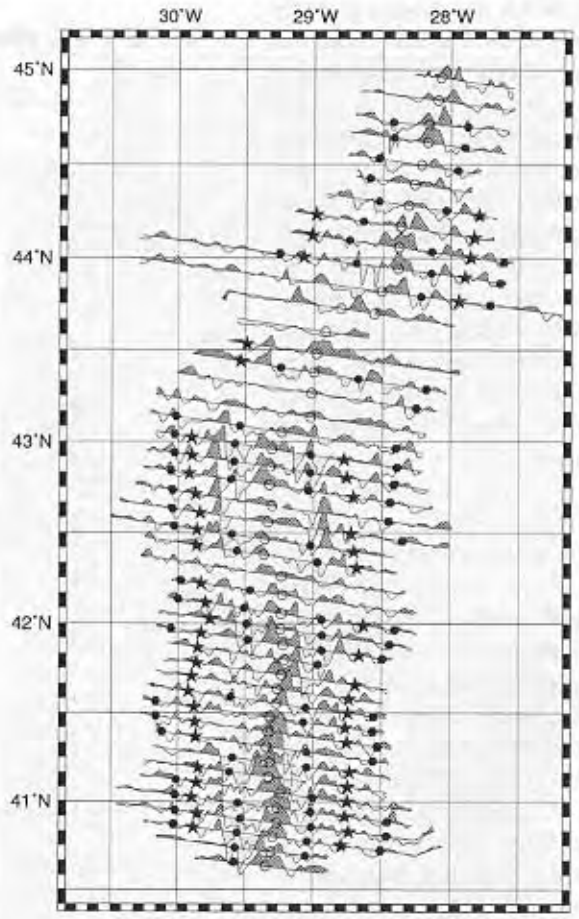

Figure 4. Map of magnetic anomalies plotted along the ship's tracks. Open circles indicate the positions of the ridge's axis, as determined by the free-air anomaly minimum along each track. Locations of chron 2 are shown as filled circles, chron 3 as filled stars and chron 3A as filled hexagons.

The central domain
(43°05'N - 43°50'N)

This domain lies in the center of the survey area and is made up of only one segment, 40 km long. This segment is bordered by two 20-km relay zones, characterized by an especially "soft" morphology. Within these two zones, the location of the active axis is extremely difficult to pinpoint. Two dredge hauls located in these discontinuities brought up serpentinized peridotites (dredges TRN-8 and TRN-10). Off-axis traces of these discontinuities show up as northward-oriented V-shaped features. A very conspicuous topographic "step" is observed on both flanks of the ridge. It parallels the ridge axis up to 43°20'N and widens southwards to merge with the outer slope of the Azores Rise. This large scale feature sharply narrows towards the ridge axis, its tip being located around 43°30' N, in the middle of the central domain.

The central domain has a relative high of large horizontal extent in the RMBA (Fig. 3), which would correspond to the presence of a thin crust. Such a result, which would imply a low magmatic output, is discussed below in the context of the globally shallow depths and the enriched character of the rock samples observed in this area. Finally, magnetic anomalies proved extremely difficult to identify over most of the central domain. No reliable complete anomaly sequence has been identified (Fig. 4), especially in the two relay zones bordering the central segment. Anomalous values have been recorded over these two relay zones (high-amplitude anomalies could possibly be due to the presence of serpentines near 43°45'N, while low-amplitude anomalies are observed in the southern relay zone, near 43°20'N)

In short, the central domain is a remarkable domain in at least two respects: the presence of a 85-km wide discontinuity, which includes only a short active accretion segment, and the closing up of a major topographic feature which is connected further south to the deep escarpment of the Azores Rise.

The northern domain
(43°50'N - 45°N)

This domain extends from the north of the central relay zone to the northern limit of the TRIATNORD survey. Four short (25-30 km) segments divide the ridge axis along this domain. These segments show the more "classical" picture of a slow-spreading ridge, observed south of the Azores. The rift is deep and narrow. Zero-age depths increase towards the segment ends. Inter-segment discontinuities extend off-axis as oblique 10-km wide depressions pointing northwards.

Over this domain, the characteristics of the MBA follow the topographic structures: negative MBAs mark the centers of the segments, while more positive anomalies lie over discontinuities, both over the axis and on the

ridge flanks.

A huge relief, reaching depths as shallow as 450 m, lies in an inside corner position with respect to the ridge axis of the northern domain and the northern relay zone of the central domain. This relief overhangs the adjoining rift valley by more than 2000 m. Totally serpentinized green rocks were dredged on the eastern flank of this structure (see below).

To summarize, our observations show that the TRIATNORD area represents an anomalous section of the MAR. The entire area is characterized by shallow depths, both in the rift valley floor, whose depths range between 2500 and 3000 m, and over the rift shoulders, where depths of 2000 to only 800 m are frequently observed - not to mention the 450 m soundings recorded over the serpentine high! Moreover, all off-axis discontinuities point northward, an indication that the entire area could be under some influence of the Azores hotspot?

Petrology and geochemistry of rock samples

Fig. 5 shows the dredge locations. Except for dredge TRN-6, on the flank of the very large massif (located in an inside corner situation, see above), all dredge hauls were aimed at recovering fresh basaltic rocks. This objective was mostly reached, as only dredges TRN-8 and TRN-10 contained no basalts, but only totally serpentinized peridotites (with no remnants of original mineralogical phases). Both these dredge hauls were located within the central domain. The sampling achieved during TRIATNORD completes that of Schilling (reported mainly in Yu et al., 1997), and allows a full documentation of the along-ridge petrological and geochemical variations of recent basalts north of the Azores.

Thin sections of rocks were cut onboard the ship and a preliminary description the petrology of the sample was conducted from these thin sections. The mineralogical compositions of basaltic samples is fairly homogeneous over the study area in terms of phenocryst content. Most samples contain at least one type of phenocryst (mostly plagioclase). Some rocks are

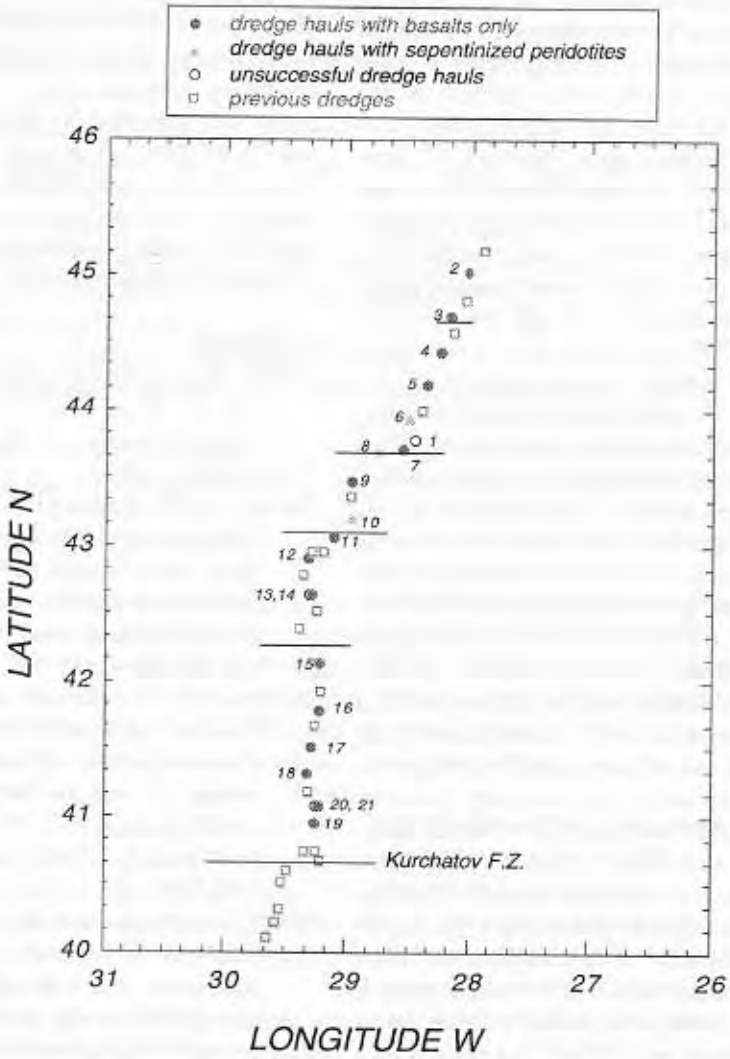

Figure 5. Locations of dredge sites, indexed by numbers (see text for comments).

highly porphyric, the most abundant mineral being in this case, plagioclase (with the exception of one sample from dredge TRN-14, in which olivine phenocrysts are especially abundant). Clusters of phenocrysts are frequently observed and could be the relics of a fractional cristallization episode, having occured deeper in the crust. The basalts range from slightly to very vesicular (vesicules make up as much as 50% of a sample from dredge TRN-11). Most of the samples contain from 1 to 10% of vesicules. Three dredges recovered only very fresh basalts, while most other samples show an oxydized vitreous border, sometimes covered by a Fe-Mn crust. However, the cores of most samples are better preserved.

The concentrations of Nb and Zr were determined onboard for 66 samples from 14 sites by X-fluorescence spectrometry (a containerized analyzer, developed by the DRO/GM Department of IFREMER, was loaded onboard *L'Atalante* for the TRIATNORD cruise). The normalized Nb/Zr ratios reach a maximum close to 2.0 between latitudes 43°10'N and 43°30'N, in the central domain. After a sharp northward decrease towards values close to 1.1 (around 44°N), the $(Nb/Zr)_N$ ratios rise steadily to values close to 1.5 at 45°N. This increase appears to have a longer wavelength that the one documented by Yu et al. (1997). Unfortunately, only one sam-

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ple exists between 45°N and 47°N, thus precluding the determination of the northward along-ridge extent of this second Nb/Zr extremum. Finally, the $(Nb/Zr)_N$ ratios decrease southward from the 43°30'N/43°10'N extremum to a value of 0.8 near 41°30'N. Dredge hauls TRN-14 and TRN-15 show respectively lower and higher $(Nb/Zr)_N$ ratios than those expected from the trend based on previous data. In particular the values of $(Nb/Zr)_N$ ratios in the segment north of Kurchatov range from 0.6 to 1.6.

In short the variations in $(Nb/Zr)_N$ ratios described above raise two interesting questions. It could be considered from the along-ridge variations of these ratios at medium wavelengths that Kurchatov FZ represents the northern "geochemical limit" of influence of the Azores hotspot. Such a result will have to be reconciled with the preliminary analyses of structural data presented above, which places the limit of this influence further to the north. Secondly, the location, between 43°30'N and 43°10'N, of the maximum in the $(Nb/Zr)_N$ ratios, characterizing enriched basalts, is in contradiction with the presence of a thin crust in this area, as derived from the MBA analysis and from the outcropping of serpentinized peridotites as a thin crust would more likely correspond to a low magmatic budget and a colder mantle region.

The shipboard trace element data will be confirmed by onshore lab work which will include the analyses of the concentrations of other major and trace elements, determinations of Sr, Nd and Pb isotope ratios and U-Th radioactive desequilibria studies.

Acknowledgments

The scientific party on board *L'Atalante* for the TRIATNORD cruise wishes to thank G. Tredunit, the ship's master, the officers and the crew for conducting all cruise operations with excellent seamanship, efficiency and permanent availability. Our thanks extend to the GENAVIR technical staff, who ensured flawless inflow of data and rapidly produced high-quality documents which were a major contribution to the real-time survey planning by the scientific party. These documents also allowed most of the preliminary interpretations which are reported in this paper to be conducted onboard. Support for this cruise was provided by IFREMER and CNRS-INSU. The participation of one of us (SM) in the TRIATNORD cruise was made possible by a grant from the Russian Foundation for Basic Research (#98-05-64556).

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International Ridge-Crest Research: **Mid-Atlantic Ridge**

SudAçores cruise: Variations in Magma Supply and the Past Segmentation of the MAR in the Lucky Strike-FAMOUS and Oceanographer FZ Regions

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During the SudAçores cruise on board *R.V. L'Atalante* (Jul. 25-Aug. 26, 1998) we mapped two boxes on the Mid-Atlantic Ridge between 34°N and 38°N. In addition to multibeam bathymetry and reflectivity (SIMRAD EM12, Fig. 1), we recorded gravity, magnetics, and 6-channel seismics. We also collected samples from 11 dredges, all located in the northern part of the survey area.

The Northern Box: A rifted volcanic plateau off-axis from the FAMOUS-Lucky Strike region

The northern part of the surveyed area corresponds to the FAMOUS-Lucky Strike region of the Mid-Atlantic Ridge. The bathymetric map shows anomalously shallow depths (locally less than 400 m) and low Mantle Bouguer Anomaly (MBA) values over two off-axis regions located at distances between 45 and 115 km on both sides of the axis. These two anomalously high regions bear numerous intact volcanic cones, up to 18 km in diameter, and are strikingly devoid of abyssal hills (Fig. 2). The lack of a coherent magnetic anomaly pattern, and the near absence of fault scarps over these two volcanic regions suggest that they were formed over a short period of time, with lavas pouring away from the ridge off-axis over older crust. Magnetic data suggest that this magmatic event took place sometime between An 3A and 4 (5.5 to 8 myrs ago). The two volcanic regions are bounded by prominent inward facing scarps and appear to be the two flanks of a single rifted volcanic plateau. The post-rift return to higher MBA values, to normal seafloor depths, regular magnetic anomaly stripes, and ridge-parallel abyssal hills (Fig. 2) attest to the rapid rifting of this plateau at the time of An 3-3A (4 to 5.5 myrs ago).

MBA values over the plateau are up to 80 mGal lower than predicted for a normal (6 km thick) crust at similar distances off-axis, suggesting up to 6-7 km of crustal thickening. Seafloor depths and MBA values are minimum at the latitude of the Lucky Strike segment (37°30'N). The rifted plateau then deepens southward and is no longer detectable in bathymetry and gravity data collected off-axis from the southern part of the FAMOUS segment (36°40'N). To the north, the two flanks of the rifted plateau connect with "V-shaped" positive lineaments in the Sandwell and Smith free-air gravity map, suggesting that anomalously high magma supply in the FAMOUS-Lucky Strike area some 5 to 8 myrs ago were related to the southward propagation of a magma or mantle influx from the Azores hot spot. The geometry of these "V-shaped" lineaments is consistent with a N240 direction of propagation, parallel to the overall direction of the Mid-Atlantic Ridge between 35° and 38°N, and corresponds to an along-axis propagation rate of about 6 cm/yr.

The Southern Box: Temporal evolution of segment OH-1 during the past 12 Myr

In the Southern Box, we extended the bathymetry, gravity and magnetic coverage of the first segment south of the Oceanographer transform (segment OH-1, Mid-Atlantic Ridge at 35°N) up to 12 Ma off-axis, in order to study its temporal evolution(Fig. 3). Segment OH-1 is considered to be one of the most magmatically robust segments along the Mid-Atlantic Ridge, with very thick crust on-axis as indicated by previous gravity and seismic studies.

Preliminary results show that segment OH-1 was probably created 15 Ma and grew to a length of 50 km at 10 Ma by propagating southwards. It was bounded to the south by a smaller segment, < 30 km long. The two segments remained stable from 10 to 5 Ma. After this time, segment OH-1 grew at a faster rate (8 mm/yr) up to its present 90 km length, while the southern segment also propagated at 8 mm/yr to the south but its length remained unchanged. This smaller segment then disappeared 1 Ma. The sudden in-

International Ridge-Crest Research: **Mid-Atlantic Ridge:** Cannat et al. continued...

crease in the propagation rate coincides with the beginning of the formation of a seamount chain within segment OH-1, parallel to the spreading direction (Fig. 3). The seamounts are presently emplaced at the center of OH-1 but the chain seems to have initiated near its southern end and to have maintained at a constant distance from the Oceanographer fracture zone (45 km). The seamounts are up to 3-4 km in diameter. Off-axis data coverage shows that the Mantle Bouguer Anomaly (MBA) low over segment OH-1 has a triangular shape, pointing towards the south and extending off-axis over the entire seamount chain. The residual MBA indicates that the onset of rapid growth of OH-1, 5 Ma, coincided with the formation of thicker crust over the entire segment. Inferred crustal thickness is greatest beneath the seamount chain. This suggests that the magma supply to segment OH-1 has been enhanced over the past 5 Myr and may have triggered the rapid growth of the segment.

Three relict inside corner massifs south of the Oceanographer transform are associated with pronounced corrugated surfaces and high RMBA values. We interpret these surfaces as detachment faults and therefore propose that large amounts of tectonic extension near a segment end can coexist with large volumes of magma supply to its center.

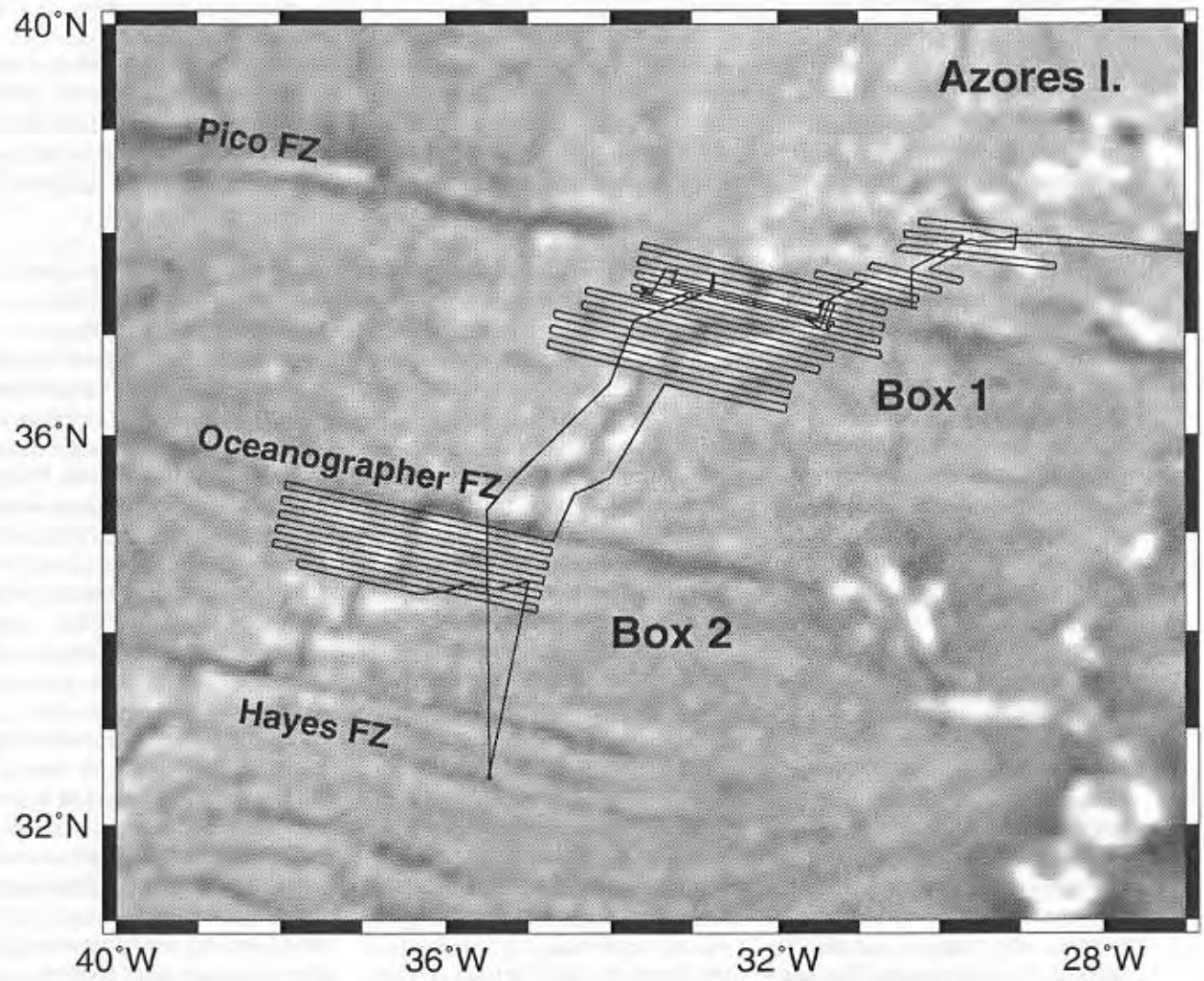

Figure 1. Shiptracks of the SudAçores cruise shown over the Sandwell and Smith satellite-derived free-air gravity map.

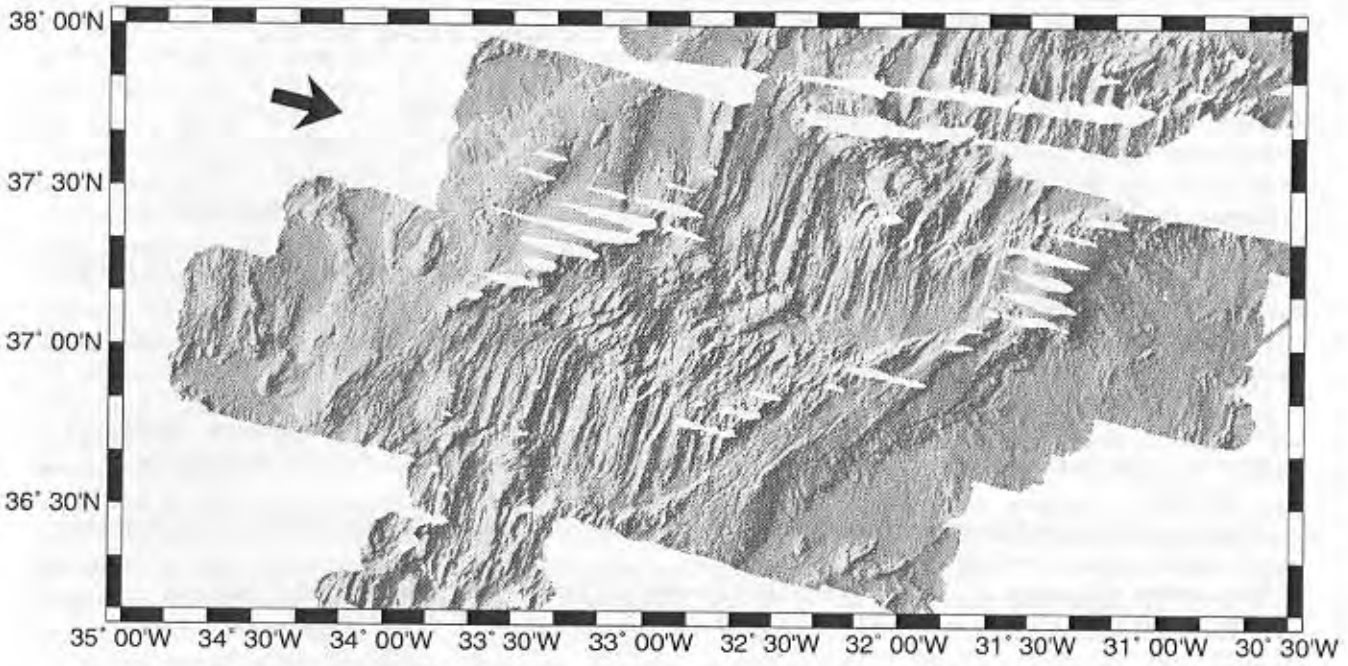

Figure 2. Shaded bathymetry of the northern box (Box 1), showing a strong contrast in morphology between the crust formed during the past 4 to 5.5 myrs (up to magnetic An 3-3A; well developed abyssal hill pattern), and the two flanks of an anomalously elevated rifted volcanic plateau (smooth morphology, with numerous intact volcanic cones). The arrow shows the direction of illumination.

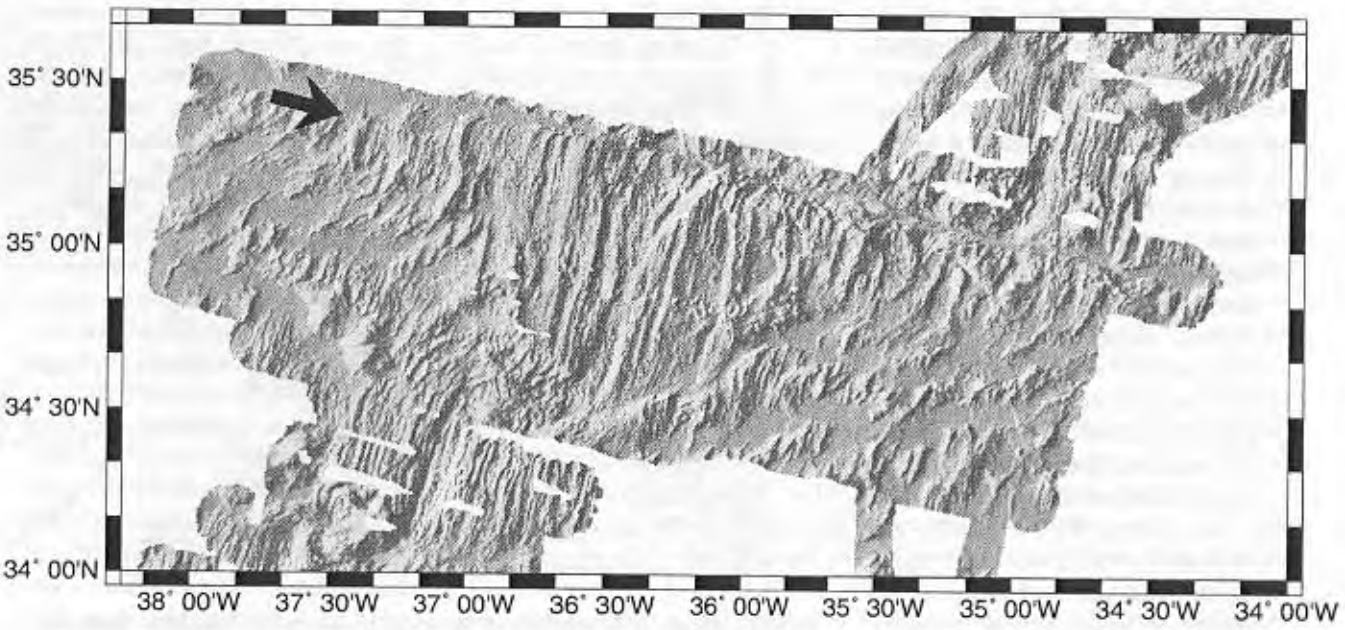

Figure 3. Shaded bathymetry of the southern box (Box 2), showing the southward propagation and growth of segment OH 1 during the past 12 myrs. A ridge-perpendicular chain of seamounts is visible between 35°40 and 36°40'W. It intersects the axis near the present day center of segment OH-1. The arrow shows the direction of illumination.

International Ridge-Crest Research: **Back Arc Basins**

Petrology, Gold Mineralization and Biological Communities at Shallow Submarine Volcanoes of the New Ireland Fore-Arc (Papua-New Guinea): Preliminary Results of *R/V Sonne* Cruise SO-133

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Introduction

Cruise SO-133 of *RV Sonne* conducted detailed mapping and sampling in a zone of recent seismic and volcanic activity and elevated heat flow south of Lihir Island, Papua New Guinea between Jul. 20-Aug. 3, 1998. This cruise was a follow-up program of a reconnaissance survey (SO-94) conducted in 1994, which originally mapped the areas surrounding the Tabar-Lihir-Tanga-Feni island chain (TLTF) to the east of New Ireland (Herzig et al., 1994; Herzig and Becker, 1996). Cruise SO-133 confirmed the occurrence of epithermal style gold mineralization originally discovered at 'Conical Seamount' during cruise SO-94 (Herzig and Hannington, 1995). Conical Seamount is located only about 10 km south of Lihir Island, which is host to the giant (40 million ounces) Ladolam epithermal gold deposit (Moyle et al., 1990). The objectives of cruise SO-133 were to establish the nature and extent of volcanism, hydrothermal activity, and biological communities associated with active extension of the old fore-arc crust of the New Ireland Basin in the vicinity of Lihir Island (Fig. 1) and to further investigate the epithermal gold mineralization at Conical Seamount.

Geological Setting

The Tabar-Feni island chain is located in a fore-arc basin behind the presently inactive Manus-Kilinailau

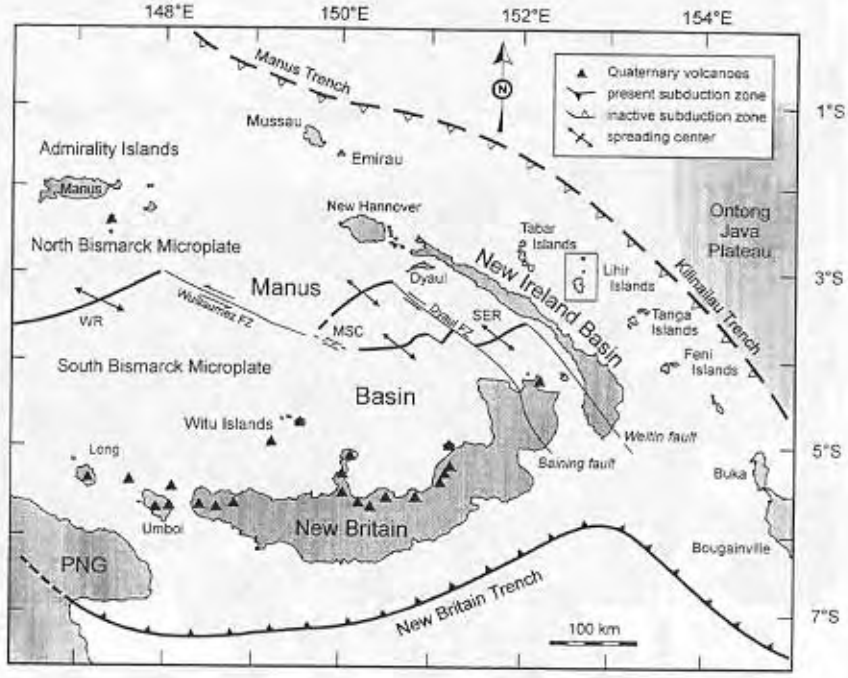

Figure 1. Regional tectonic map showing the location of the New Ireland Basin and the Tabar-Lihir-Tanga-Feni island chain. Box indicates study area of cruise SO-133.

trench northeast of Papua New Guinea. Volcanic activity on the islands, which began about 3.5 Ma ago, appears to be related to extension along northeast-trending structures that cut across the New Ireland Basin (Stewart and Sandy, 1988; McInnes and Cameron, 1994). Since Pliocene-Pleistocene time, partial melts associated with extension in the thickened crust of the New Ireland Basin have risen through the old fore-arc crust along reactivated faults to form the volcanic islands of the Tabar-Feni chain. These structures are thought to be related to regional plate rotation (Exon et al., 1986; Stewart and Sandy, 1988; McInnes, 1992). Although plate rotation has isolated the Tabar-Feni chain from the presently active arc of New Britain, the present volcanism on the islands is most likely related to subduction from the south along the New Britain-Solomon trench.

A conjugate set of NE-NW striking faults that control the volcanism on the islands has been documented in Landsat and airborne magnetics surveys, and similar structures have been identified in the offshore areas (Gulf Research and Development, 1973; Exon et al., 1986). The Lihir island group itself is situated on a large uplifted block, raised by regional southward compression along the Manus-Kilinailau trench. During the late Miocene, nearly 7 km of sediment accumulated in the basin on top of Eocene to early Miocene volcanic basement.

Records of seismic activity between the Lihir group and New Ireland show that shallow earthquake epicenters are confined to a distinctive NE-SW corridor along the axis of the Lihir group (Port Moresby Geophysical Observatory, 1994). The earthquakes define a narrow seismic zone, and the recent tectonic activity along this corridor may be an indication of the beginning of the break up of New Ireland in response to the present subduction of the Solomon Plate and back-arc spreading in the Manus Basin. New Ireland is already noticeably thinned along the portion of the island immediately opposite Lihir.

The few radiometric dates available indicate that the most recent volcanic eruptions on Lihir occurred at about 1.1 Ma (Johnson et al., 1976). The most recent eruption in the island chain was dated at 2,300 years ago at Feni to the extreme southeast (Licence et al., 1987). These eruptions covered wide areas with volcanic ash, ranging from 5 to 30 cm in thickness, some of which was recovered in sediment stations during SO-133. The discovery of even younger volcanic cones in the area south of Lihir implies that volcanism in the New Ireland Basin is now focussed in the active tectonic zone of the Lihir group.

Cruise Objectives

The main focus of cruise SO-133 was the detailed investigation of several young volcanic cones discovered during SO-94 (including Edison Seamount, TUBAF Seamount, and Conical Seamount, Fig. 2) and nearby fault zones associated with the uplift of the pedestal of Lihir.

Specific objectives of the cruise included:

(1) to establish the extent of recent volcanism and extension south of Lihir by investigating all bathymetric anomalies, including major boundary faults and possible volcanic cones, initially mapped during SO-94.

(2) to determine the extent and character of alteration and epithermal gold mineralization at Conical Seamount.

(3) to establish the present status and extent of hydrothermal venting at Edison Seamount, and to document and sample representative suites of vent specific fauna, including smaller and rarer species and meiobenthos.

(4) to determine the source of near-bottom CH_4 anomalies south of Lihir.

(5) to characterize the history of eruptions, and to evaluate the diversity of xenoliths occurring in the alkaline mafic volcanics at TUBAF Seamount.

(6) to sample the recent record of subaerial volcanic activity in deep sediments along the northwest part of the New Ireland Basin.

Principal Results

Petrology

Twelve separate volcanic cones have now been mapped and sampled in the area (Fig. 2), and a preliminary assessment of their age progression implies several episodes of volcanism. Five of the cones have well-defined summit craters, up to several hundred meters in diameter and up to 50 m deep. Volcanic rocks are exposed at the summit of four of the cones, and the remaining volcanoes are heavily sedimented (up to 5-10 m thickness of sediment in the summit craters). The variable sediment thickness implies that volcanic activity in the area has likely been episodic for at least the past 100,000 years. A major swarm of volcanic eruptions during this time would coincide with the age of recent intrusive activity and associated geothermal systems on Lihir.

The volcanic rocks recovered from Edison, Conical, and TUBAF seamounts consist of highly alkaline, SiO_2-undersaturated pyroxene-phyric alkali-olivine basalt and trachybasalt, with locally abundant phenocrysts of pyroxene, magnetite, and phlogopite. The ejecta blanket at TUBAF Seamount comprises mainly fresh, sand-sized ash, lapilli, and small rounded bombs (up to 10 cm). The absence of any pelagic sediment covering the pyroclastic deposits suggests that the last eruption of this cone was very recent. By comparison, the sediment within the crater at Edison is at least several meters deep, suggesting that the volcano has been dormant for thousands of years (sedimentation rates are approximately 5 cm/1000 yr). Nevertheless, Edison Seamount shows a similar eruptive style to TUBAF Seamount, which is much younger. An extensive suite of samples from TUBAF Seamount provides a detailed cross-section of the old New Ireland Basin fore-arc crust, as recorded in xenoliths recovered from the volcanic ash. These xenoliths include a full suite of lithologies from mantle nodules (dunite, peridotite, pyroxenite, wherlite), through

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gabbroic material and plagiogranite, to metasedimentary rocks. Additional sampling at Edison Seamount revealed that this older volcano also contains abundant xenoliths. Distinctive peperitic textures were also found in the samples from Edison Seamount, indicating eruption of the basalt into wet pelagic sediments. Most of the smaller volcanoes in this area with well-defined summit craters appear to be pyroclastic cones, composed of volcanic ejecta blown from the small pit craters.

Alteration and Mineralization

A comprehensive TV-grab sampling program at the summit of Conical Seamount recovered distinctive polymetallic (Zn+Cu+Pb+As+Sb +Ag), epithermal-style vein mineralization and pyritic stockwork material with locally intense clay-silica alteration. The mineralization consists of clay minerals, pyrite, and polymetallic sulfides including pale yellow sphalerite, disseminated galena, minor chalcopyrite, sulfosalts, and As-sulfides (realgar, orpiment). The top of the deposit, in the clay-silica zone, is deeply altered, and the basalt is completely replaced by illite+ smectite+chlorite, some kaolinite, K-feldspar and silica. The original pyroxene phenocrysts in these rocks are pseudomorphed by white clay minerals, and most of the primary magnetite has been destroyed. The intense clay-silica alteration grades outward into weakly altered basalt breccias that are veined by pyrite. The weaker alteration is closely associated with fine-grained disseminated pyrite. Camera surveys across several hundred meters of the top of Conical Seamount revealed widespread but discontinuous patches of stained sediment, suggesting that low-temperature, diffuse hydrothermal vents were formerly active near the summit of the volcano. Fe-oxyhydroxide staining is exposed over a strike length of at least 250 m, and dredging of the flanks of the volcano also recovered intensely altered lavas with weak mineralization and thick Fe-oxide crusts. The abundance of Fe-oxide gossan implies that the hydrothermal system is now extinct and that the mineraliztion is rather old. The most striking feature of the mineralization is the elevated concentration of Pb, Zn, Cu, As, Sb, and Ag, which resembles typical polymetallic vein mineralization in subaerial low-sulfidation epithermal systems (Hedenquist and Lowenstern, 1994).

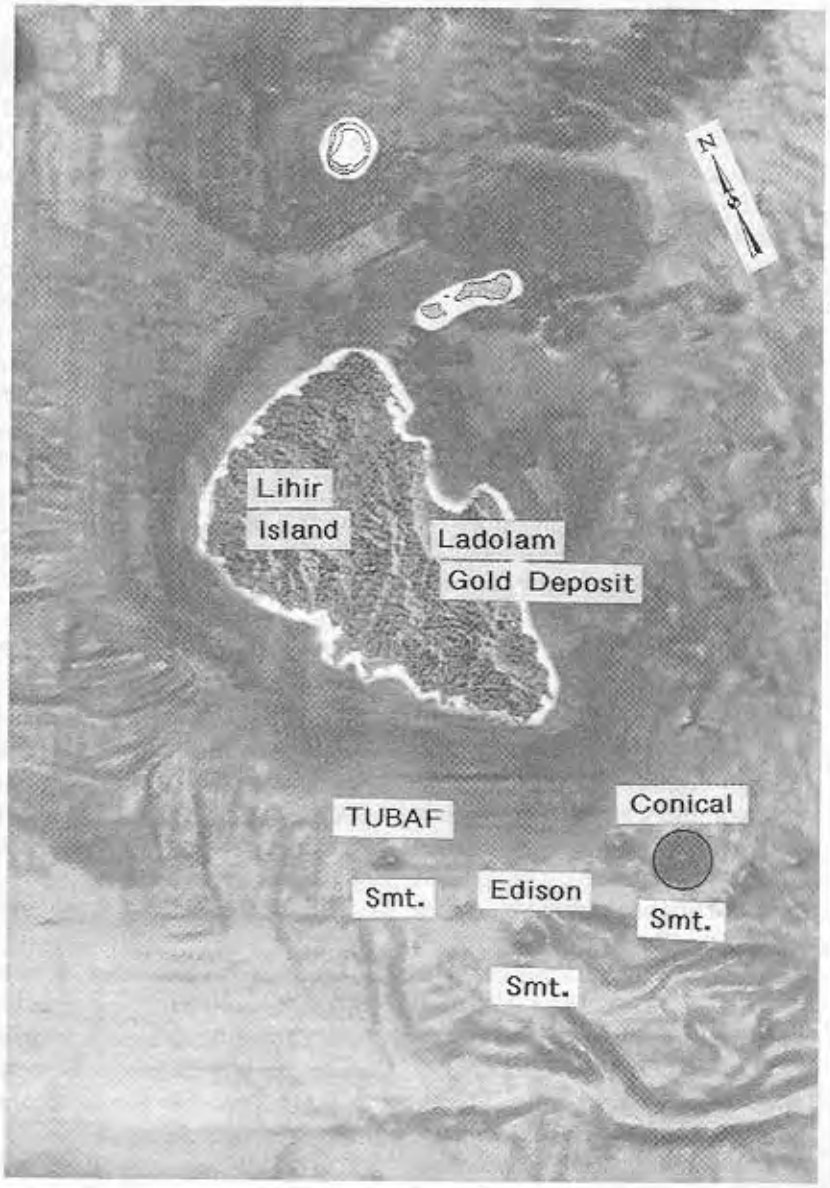

Figure 2. Perspective view of Lihir Island hosting the Ladolam epithermal gold deposit and the location of Conical, Edison, and TUBAF seamounts.

Shipboard analyses of the sulfide-rich material contained an average of 0.8 wt.% Zn, 0.3 wt.% Pb, 0.04 wt.% Cu, 3400 ppm As, 160 ppm Sb, 36 ppm Ag, and 9.3 wt.% S based on 25 samples and 10 gram assays. The most intensely mineralized material contains up to 4.5 wt.% Zn, 2.0 wt.% Pb, 2.0 wt.% Cu, 2.6 wt.% As, 1950 ppm Sb, and 38.0 wt.% S. Shipboard gold analyses (ASV) of these samples have indicated gold concentrations of up to 44 ppm Au. The initial land-based analyses (INAA) reveal a maximum gold value of 45 ppm Au and an average gold concentration of 18 ppm Au

for mineralized samples (n=26). Gold-rich sulfides also contain between 420-1020 ppm Ag.

The present mapping and sampling suggests that the entire upper part of the volcano may be mineralized at depth, however, the difficulty of sampling the broken flows prevents a proper assessment of the 3rd dimension. Drilling of the summit area is required to determine the extent and character of mineralization at depth. The base metal-rich sulfide assemblage and the style of alteration most closely resembles that of low-sulfidation epithermal vein systems on land and have many similarities with the giant 40 million ounces epithermal Ladolam gold deposit on the island of Lihir.

The discovery of epithermal style gold mineralization at Conical Seamount represents a new type of seafloor mineralization. Massive sulfides were not observed, suggesting that relatively little of the hot spring fluid vented onto the seafloor. The proximity of the Conical Seamount deposit to the presently active hot spring environment of the Ladolam deposit suggests that both submarine and subaerial epithermal mineralization may be linked to the same district-scale magmatic events.

Hydrothermal Activity & Cold Seeps

In 1994 evidence for active hydrothermal venting was found at Edison Seamount, where two extensive clam beds associated with diffuse fluid flow were discovered near the crest of the pyroclastic cone (Herzig et al., 1994). The clam beds occur on heavily sedimented surfaces at the crater rim and are surrounded by darkened muds that are stained by sulfide. Samples of the sediment collected in the TV-grab consist of pale green, foraminiferal carbonate ooze with minor smectite, amorphous Fe-sulfides and trace pyrite. Large slabs of indurated sediments and semi-lithified, volcaniclastic breccias in a matrix of foraminferal ooze were also recovered from the clam fields and form a hardened layer up to 10 cm thick, immediately surrounding the vent fields. 4.5 kHz bottom-profiling suggests that layers of indurated sediments may form an extensive carapace over the top of the cone and this may be important for concentrating fluid flow at the crater rim.

The presence of a mussel type, known elsewhere to have methanotrophic symbionts normally associated with cold seeps, and the abundance of carbonate-cemented crusts at Edison Seamount suggests that some of the present diffuse venting may be of cold seep origin rather than hydrothermal. The age of the cone and its location at the intersection of several major fault structures that are leaking CH_4 support this idea. However, the high density and enormous biomass of the clam fields far exceeds that found at cold seeps, and more closely resembles that of H_2S-rich vents associated with higher-temperature hydrothermal activity.

During investigations of a large, near-bottom methane anomaly initially observed in 1994, a major source of methane was located along an uplifted sediment block (horst structure) southeast of Edison Seamount. A maximum concentration of 9000 nl/l CH_4 was measured along the east-facing slope of the horst, opposite Edison Seamount, and this source likely accounts for a widespread mid-depth methane anomaly in the area. No temperature anomaly was observed. Several camera tows and TV-grabs in the area revealed discontinuous cold seep biota over a strike length of at least 2 km, centered on the highest methane anomaly. Large blocks and slabs of carbonate crusts and carbonate-cemented muds recovered from the slopes contain abundant flow channels stained by sulfide. Similar cold seeps were also observed on the southeast flank of a small volcanic cone north of Edison Seamount. This cone may be partly dissected by the fault which is presently leaking methane further to the south. The extensive carbonate cementation is thought to be related to the oxidation of methane within the upper part of the sediment profile. Gas charged (H_2S- and CH_4-rich) sediments were recovered in a core from this area, and obvious gas cavities were found in the sediment cores. White patches were also observed at the locations of the seeps, and these may be an indication of bacterial mats or solid gas hydrates. However, no samples of this material could be recovered. The liberation of methane from gas hydrates in the sediments may be related to the high heat flow in the area or local uplift associated with the rising basement high of the Lihir island group.

The discovery of methane degassing along major structural elements in an active tectonic zone of the New Ireland Basin and widespread faunal communities along the faults may be an indication of the presence of cold seeps similar to those found at accretionary margins (e.g., Cascadia Margin). If the presence of solid methane hydrates is confirmed, this site may be the first documented example of gas hydrates in an intra-arc setting.

Biological Communities

Mapping and sampling of Edison Seamount has established an important time series on the development of mature chemosynthetic biological communities in the region. Large beds of giant clams discovered in 1994 were resampled along with other fauna typically associated with sulfide-rich hydrothermal vents. Additionally a number of new fauna were discovered at this site. Camera surveys during SO-133 suggest that these clam beds may have expanded compared to 1994 and an increase in the population density is apperent.

Sulfide-specific fauna are absent at the edge of the clam beds, but a mussel type normally associated with cold seeps was observed. This type of mussel can have either H_2S- or CH_4-oxidizing symbionts, and further work on the samples is required to identify the bacteria present. Evidence for both H_2S and CH_4 in the fluids would support the idea that a portion of the nutrient flux at Edison may be related to nearby leaky fault structures that

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are degassing CH_4. However, the biomass associated with Edison Seamount is much greater than that observed at the cold seeps, suggesting that a thermal flux associated with the volcano may be enhancing the availability of reduced gases.

On the nearby fault structure, southeast of Edison Seamount, another assemblage of animals was recovered with a quite different character. Mussels and polycheates at this site have colonized areas of carbonate concretions, and both vesitmentiferans and polycheates were collected from the sediments. However, the biomass encountered was considerably lower than in the clam beds at Edison Seamount. High concentrations of methane in the escaping fluids likely contribute the largest part of the nutrient base for the observed biological community.

The presence of diverse biological communities in the vicinity of Edison Seamount suggests two different but closely juxtaposed styles of venting (warm springs and cold seeps). The warm fluids are likely influenced by volcanic processes causing enrichment in reduced sulfur, whereas cold fluids channeled through tectonic features may be remobilizing buried carbon and emerging as fluids enriched in both methane and sulfur. Clams, mussels, and vestimentiferans are known at both warm vents and cold seeps, but many of the animals found at Edison (crabs, shrimps, barnacles, limpets) have their closest relatives at mid-ocean ridges and back-arc hydrothermal sites. Many of the animals at Edison and at the nearby cold seeps are likely to be new species and thus represent a fauna specific to this region. The animals are different from the vent fauna in the nearby Manus Basin and may indicate the presence of a large endemic population elsewhere in the New Ireland Basin.

Acknowledgements

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International Ridge-Crest Research: **SWIR**

Geological mapping of slow-spread lower ocean crust: a deep-towed video and wireline rock drilling survey of Atlantis Bank (ODP Site 735, SW Indian Ridge)

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Introduction

The distribution and morphologies of the world's mid-ocean ridges are now, in the late 1990s, relatively well characterised. However, our understanding of the nature of the plutonic foundation of the ocean crust is very much more limited. This lack of constraint on the processes of magma transport and storage in the lower crust, and the relationship between magmatism and tectonism, has come about in part because of the difficulty of direct access to deep stratigraphic levels - seafloor outcrops of lower crustal rocks are relatively rare - and in part because of the lack of appropriate mapping and sampling tools. We now believe that the lower ocean crust, especially at slow- to very slow-spreading ridges, is very heterogeneous at small scales (e.g. Cannat, 1996), and thus that traditional surveying techniques, such as seismic refraction, may not be investigating the crust at an appropriate length scale. In order to assess the small-scale variability of crustal architecture we need to characterise a single, coherent tectonic block of lower crust on a length scale appropriate to the accretionary process at that spreading rate. At the fast end of the spreading rate spectrum Hess Deep, on the East Pacific Rise, has become our 'natural laboratory'; at the opposite end Atlantis Bank, on the very slow-spreading SW Indian Ridge, fills that role (Batiza et al., 1998). Both areas have been investigated by the Ocean Drilling Program (ODP), and single sections of lower crustal gabbroic rocks have been characterised at each in great detail (Gillis et al., 1993; Robinson et al., 1989). Although invaluable for many purposes, a single sample point, however well studied, is of limited use in constraining the spatial variability of crustal accretion. What is clearly needed are detailed, 'outcrop scale' geological investigations of lower crustal exposures, especially those that are also being targetted by ODP.

The present study, whose preliminary results are presented here, was conceived to investigate crustal architecture and the variability of accretionary processes beneath very slow-spreading ridges. We aimed to do this by mapping and sampling the lower crustal exposures around Atlantis Bank at a level of detail comparable to that possible in on-land geological investigations. This we would do by making a near-bottom video survey, followed by a detailed sampling programme using portable wireline rock drills to take large numbers of short rock cores.

Atlantis Bank

Atlantis Bank (32°40'S, 57°15'E) is a small (~35 km^2), flat-topped platform lying at ~700 m water depth on the eastern rim of the N-S trending Atlantis II fracture zone on the SW Indian Ridge (Fig. 1). The platform is about 9 km long in a N-S direction by 4 km wide, and is the shallowest of a

Figure 1. The Southwest Indian Ocean, showing the location of the Atlantis II fracture zone.

International Ridge-Crest Research: **SWIR:** MacLeod et al. continued...

series of uplifted blocks that are connected by saddles to form a long, linear ridge parallel to the Atlantis II transform fault (Fig. 2). The upper surface of the Atlantis Bank is remarkably flat, with little more than 100 m relief over about 24 km^2, the east and (in particular) west walls of the platform are steep and rugged, such that depths in excess of 6200 m are encountered in the fracture zone floor only 20 km to the west. Atlantis Bank was discovered during the site survey for ODP Leg 118 on *R/V Conrad* by Dick et al. (1991) in the mid-1980s, and partially surveyed with Seabeam. An echo-sounder profile and (unsuccessful!) piston core from the flat crest of the platform were consistent with the results of a limited video survey carried out during Leg 118, which showed a smooth, seemingly wave-cut, bare-rock surface, exposing both foliated and massive gabbro criss-crossed by a regular pattern of joints and covered locally by thin sediment drifts. These observations suggested that Atlantis Bank was (like its legendary namesake) at some stage elevated above sea-level and eroded by wave action, to leave a flat pavement of lower crustal rocks, now subsided to its present-day depth of ~700 m below sea-level.

During ODP Leg 118, in 1987, a 500 m-deep section of gabbroic rocks was drilled on the crest of the flat-topped platform, at Hole 735B (32°43.393'S, 57°15.961'E). The bare rock surface and fresh, crystalline rock made for near-ideal drilling conditions, and core recoveries averaged an unprecedented 87%. In October 1997 Hole 735B was re-entered during ODP Leg 176, and a further 1000 m of gabbro was penetrated, with similarly easy drilling conditions and high core recovery rates.

Hole 735B forms without doubt the most complete and well-preserved section of in situ oceanic basement ever sampled and has become our standard reference section for slow-spread lower crust. Nevertheless, the section drilled by ODP forms only a 1-D view of the architecture of the plutonic foundation of the crust. Virtually nothing else was known of the geology of the area more than 200 m from the drill site, and nothing, therefore, about the stratigraphic setting or wider context of the gabbros drilled in Hole 735B.

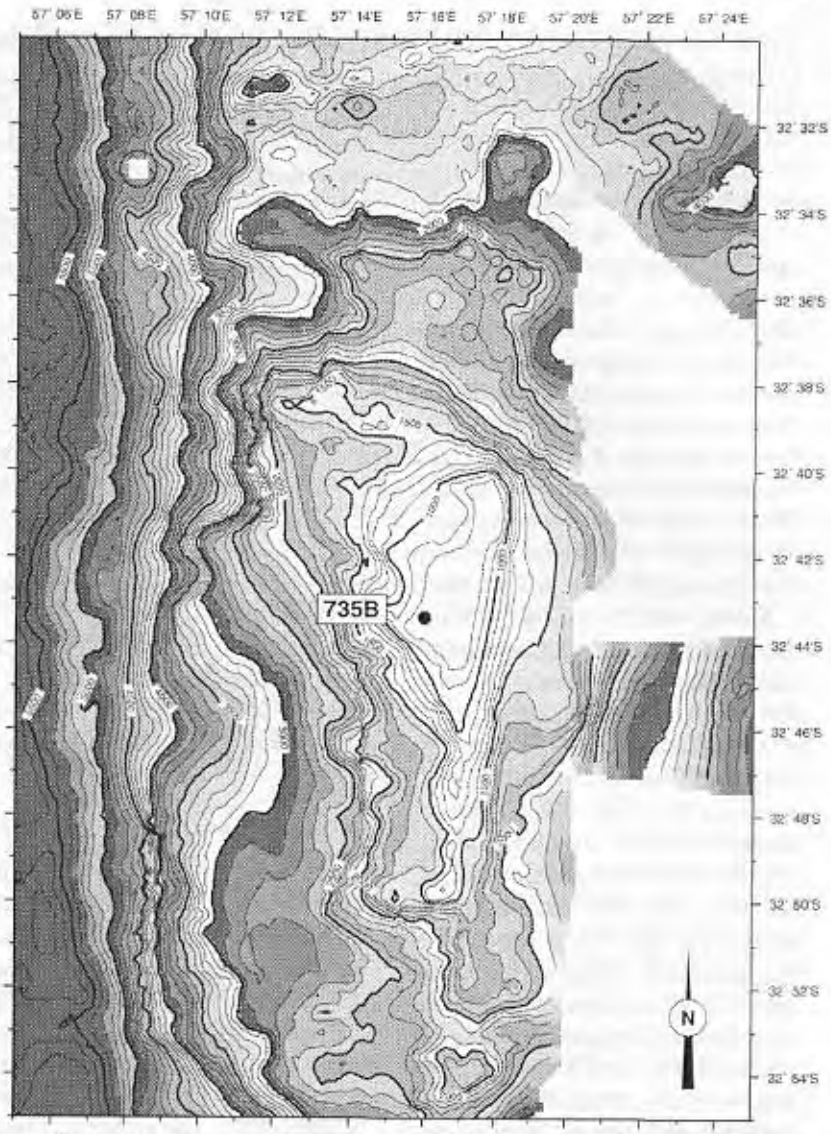

Figure 2. Bathymetric map of part of the eastern wall of the Atlantis II fracture zone. Atlantis Bank forms the shallowest portion of the transverse ridge.

RRS James Clark Ross cruise 31

In March 1998 the British Antarctic Survey research ship *RRS James Clark Ross* left Cape Town on a 7-week cruise to Atlantis Bank. Cruise JR31 was a true multi-national venture, funded by the UK, USA and Canada through grants to Chris MacLeod and Simon Allerton (NERC), Henry Dick (NSF), and Paul Robinson (NSERC), respectively. For logistical reasons the cruise was split into two legs, a brief portcall in Reunion being necessary to change the equipment around half way through.

In the first half of the cruise we made a seafloor video survey of the flat summit of Atlantis Bank using the Canadian 'ROPOS II' remotely-operated vehicle (ROV). ROPOS carries pan and tilt high-resolution video and still cameras, sampling arms and, for this cruise, was fitted with a 3-axis magnetometer. Trial deployments were also made of the MBARI rock drill mounted horizontally in the ROV's undertray (funded in part though an MBARI grant to Debra Stakes). A transponder net was laid to aid near-bottom navigation on the summit of the platform, and was left in place for the drilling operations in Leg 2. Rock dredges were run during

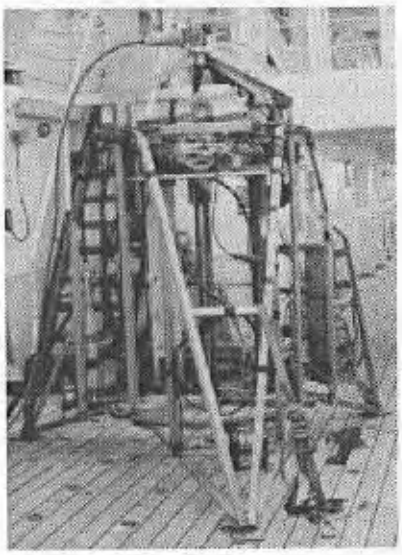

Figure 3. The BRIDGE rock drill.

ROPOS maintenance periods.

The second half of cruise JR31 was devoted to wireline rock drilling operations. Portable rotary drills, mounted vertically on a tripod frame and operated by wireline from a conventional research ship, are a potential way of obtaining large numbers of samples from hard seafloor in a cost-efficient manner. Few drills have, however, been built and/or operated successfully to date. A notable exception is the 5 m rotary corer/vibracorer built and run by the British Geological Survey (BGS) Marine Operations Group in Edinburgh, which has been used - mostly for industrial applications - for many years. This drill is powered electrically from a dedicated conducting cable and winch system, and takes 44 mm diameter cores up to 5 m in length. It has a depth restriction of 2000 m, which restricts its usefulness for mid-ocean ridge studies except, of course, for exceptional cases such as Atlantis Bank.

In addition to the BGS 5 m corer we used, for the first time, a prototype drill commissioned from BGS by Simon Allerton and Chris MacLeod. This new drill, which was funded through NERC's BRIDGE programme, was designed for scientific, and specifically mid-ocean ridge, studies, though its potential applications are many. It is a small, lightweight (0.8 tonnes), electrically-driven rotary corer designed to be operated from a conventional CTD-type conducting cable (Fig. 3). It is specified to water depths of up to 4000 m, and recovers 35 mm diameter cores (Fig. 4a) up to 1.1 m in length. The cores are orientated relative to geographical coordinates by means of an index scriber on the (non-rotating) inner core barrel that is registered to fluxgate compasses mounted on the stainless steel drill frame. Site selection is aided by a monochrome video camera, which is used to take still pictures of the seabed (Fig. 4b). These images, together with other seabed drill sensor information, are relayed up the power cable to be viewed on a surface computer monitor. Although the BRIDGE drill was only undergoing its sea trials on JR31, having never previously cut a core under water, it worked perfectly from the outset and was used as an operational tool throughout cruise JR31. Great credit is due to BGS engineers Dave Wallis, John Derrick and Dave Smith, who built the drill to the preliminary design of the late Jack Pheasant.

Preliminary results

Scientific operations during *James Clark Ross* cruise 31 were extremely successful, though inevitably there were occasional hiccups on the way. We crashed ROPOS into a vertical wall of gabbro on its second dive and destroyed its 'garage' and, although the engineers did a great job

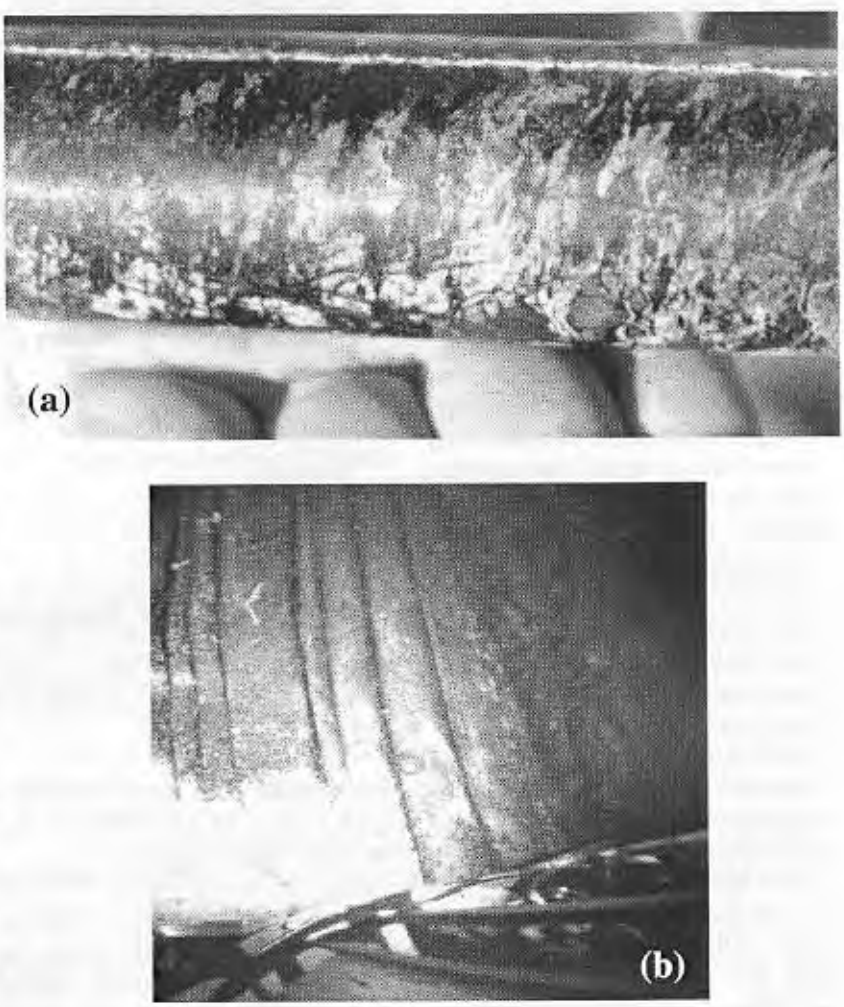

Figure 4. (a) The first core cut by the BRIDGE rock drill: a protomylonite cut by dark amphibole veins. Note the scribe mark (white) at top; (b) Video image from the first BRIDGE drill site, showing a bare-rock pavement crossed by a set of dark, parallel hydrothermal veins.

International Ridge-Crest Research: **SWIR:** MacLeod et al. continued...

in getting it operational again, ROPOS was bedevilled with electrical problems thereafter. Nevertheless, we made ten successful dives, totalling more than 45 km of on-bottom survey, covering most of the summit of Atlantis Bank. We were able to confirm the hypothesis that the flat top is wave cut. Although the ROV survey revealed that shallow-water limestone covers large parts of the platform (especially around the edges), substantial areas of bare-rock pavement do occur, particularly on the central crest. On the video imagery of these outcrops we could identify mylonitic shear zones, several cross-cutting dykes, and observed spectacular networks of hydrothermal veins. We were able to measure the trends of structures directly, and traced the mylonite shear zones from dive track to dive track across the platform.

During the periods of ROPOS down time we undertook a rock dredging programme. Forty-seven deployments were made during Leg 1, and a further six after completing the rock drilling operations at the end of Leg 2. Igneous rocks totalling more than 1.2 tonnes were recovered from 38 out of the 43 dredge sites. The dredges were all short hauls on steep slopes, precisely positioned, and predominantly monolithic, so we are confident that they are representative of the local geology. From this we are currently constructing a geological map of the ~700 km² area around Atlantis Bank (work in progress), providing a framework within which we will be able to constrain the stratigraphic setting of the drill cores, and of ODP Hole 735B. We have, for example, identified and traced for several kilometres a crust-mantle boundary on the west side of the platform, and a section through dykes and lavas to the south.

Sampling operations with the two BGS drills were extremely successful. We have clearly proven that wireline rock drilling is a viable and exciting new means of seabed sampling in mid-ocean ridge studies. We recovered core from 42 sites out of 47 attempted, including not only lower crustal gabbros but also dolerites, basalt, and serpentinised mantle peridotite. The longest core drilled with the BGS drill was 3.8 m, though in general we found it more efficient to drill a larger number of shorter cores. It was useful, however, to have the capability to drill some way below the surface to get through the limestone cover. Limestone was recovered in twenty-eight of the cores, but we penetrated igneous lithologies in all but seven of them. The frame-grab

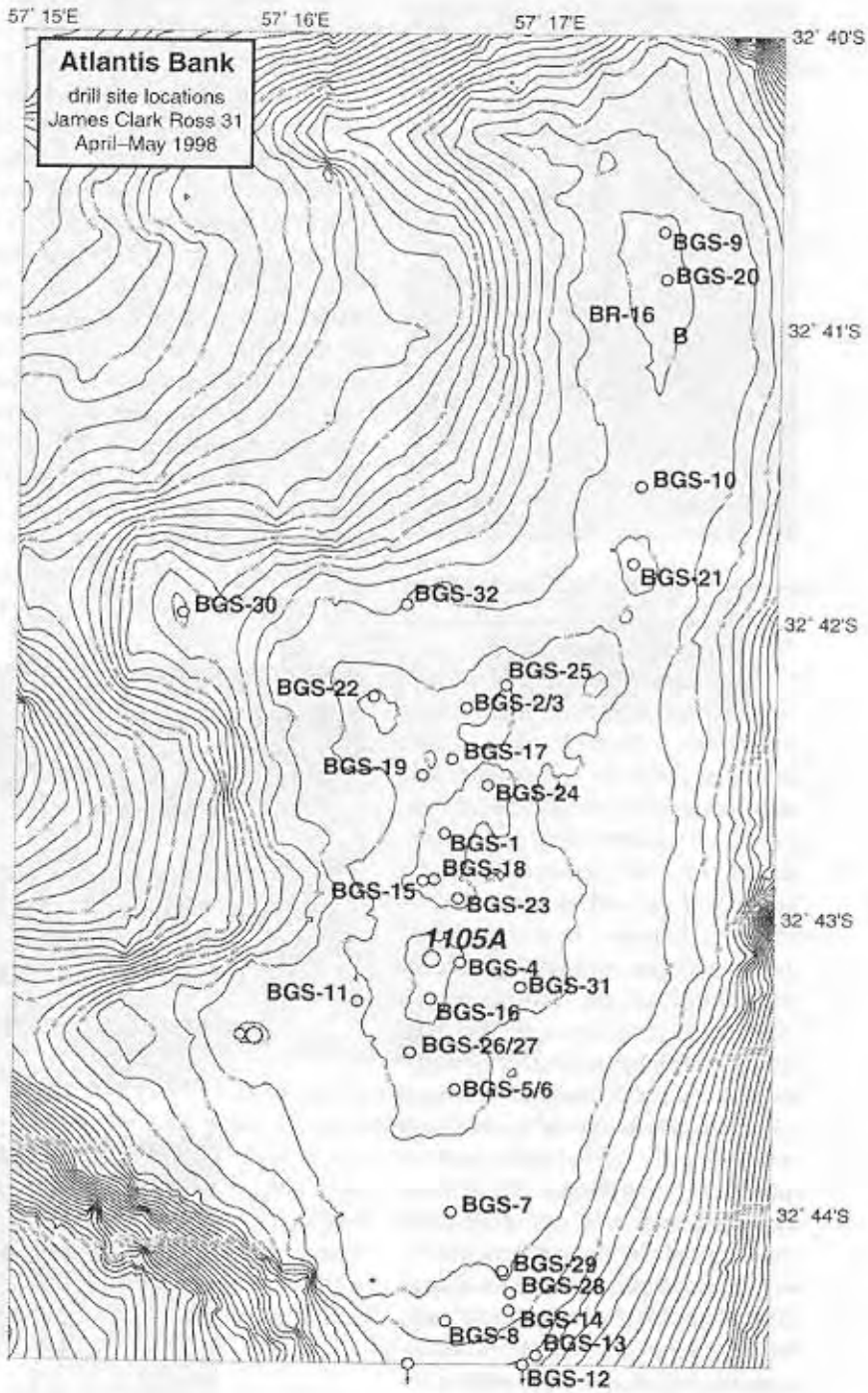

Figure 5. Drill site locations on the summit of Atlantis Bank. The positions of ODP holes 735B and 1105A (the latter drilled during the engineering leg 179 in April 1998) are also shown.

video link on the BRIDGE drill was invaluable in that it allowed us to ensure we were on hard-rock outcrop before we started to drill. We located most of our sites along a north-south flowline down the centre of the flat summit of Atlantis Bank (Fig. 5), thereby avoiding most of the limestone cover.

Assuming an 18 southward tilt for the crustal section of Atlantis Bank (after Pariso et al. 1991), the cores collected during cruise JR31 can be stacked to form a 2.3 km-thick composite section through the gabbros (not accounting for structural repetition or deletion), with an average vertical spacing of only ~75 m. The geographically oriented cores collected with the BRIDGE drill should allow us to examine directly the geometry of ductile and brittle deformation, and derive the orientation of the stable magnetisation direction for the area. With this information we can attempt to reorient the BGS 5 m drill cores and those from Hole 735B. We have also for the first time obtained fully oriented samples from either side of a magnetic reversal boundary. The presence of serpentinised peridotite in core from the summit of Atlantis Bank, at a place where a 'Moho' reflection and typical mantle seismic velocities have been identified at a depth of 7 km below sea level (Muller et al., 1997), offers some of the strongest evidence yet that the 'Moho' represents a serpentinisation front rather than a boundary between igneous crust and upper mantle.

In summary, the JR31 samples constitute an exciting and unique dataset with which to study the nature of the lower ocean crust. Detailed study of these samples is now in progress and should, we hope, lead to significant advances in our understanding of the processes of crustal accretion and deformation at slow- to very slow-spreading ridge environments.

Acknowledgments

We would like to thank the master, officers and crew of *RRS James Clark Ross*, the ROPOS team, the BGS drilling engineers and the BAS technical and logistical support teams for their herculean efforts in making cruise JR31 an outstanding success. CJM and SA would like to thank NERC for their financial support for the cruise.

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InterRidge Working Groups

Arctic Ridges	http://www.lgs.jussieu.fr/~intridge/arctic.htm
Back-Arc Basins	http://www.lgs.jussieu.fr/~intridge/wg-bab.htm
Biological Studies	http://www.lgs.jussieu.fr/~intridge/wg-bio.htm
Event Detection and Response & Observatories	http://www.lgs.jussieu.fr/~intridge/wg-edr.htm
Global Digital Database	http://www.lgs.jussieu.fr/~intridge/wg-gdb.htm
Global Partitioning of Hydrothermal Activity	http://www.lgs.jussieu.fr/~intridge/wg-flux.htm
SWIR	http://www.lgs.jussieu.fr/~intridge/wg-sw.htm
Submarine Cables	http://www.lgs.jussieu.fr/~intridge/cable.htm
4-D Architecture of the Oceanic Lithosphere	http://www.lgs.jussieu.fr/~intridge/4d.htm

International Ridge-Crest Research: **Arctic Ridges**

Manned submersible dives to the Knipovich Ridge, Norwegian-Greenland Sea

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This summer the rift valley of the Knipovich Ridge was investigated using manned submersibles (Fig. 1). The dives to the rift valley were an integral part of a 6 week diving expedition with the Russian vessel *Akademik Mstislav Keldysh* and the onboard *MIR* submersibles. "Submersible investigation of gas and hydrothermal vents and sea floor hydrates along ancient and recent plate boundaries in the Norwegian-Greenland Sea" was the overall theme of this U.S.-Russian-German-Norwegian expedition.

The Knipovich Ridge is the northernmost extension of the Mid-Atlantic Ridge. The ridge is characterized by oblique spreading and the lack of any major ridge offsets. The rift seems to be segmented into widely spaced clusters of sea-mounts separated by long stretches of sediment-filled valley floor.

A site on the Knipovich Ridge was selected at 76°47'N based on a temperature anomaly that had been detected within the rift valley during a cruise in 1996. Five dives to around 3500 meters were carried out during three days at this site. Hydrothermal venting was not observed, but transects across the ridge valley provided new information on the architecture of the rift.

A 150 meter high volcanic ridge that trends southwest-northeast across the rift valley was visited several times during the dives. Most of the lava flows are covered by varying amounts of sediments. The thickness of the sediment cover ranges from a very thin layer of mud, to a thick layer that covers most of the volcanic features. Lava flows that had been extruded onto older, partly sediment-covered flows were observed in several places. The variable thickness of sediments suggests that intermittent volcanic activity has taken place along this ridge for a considerable period of time. The extrusive sequence shows a spectrum of volcanic morphologies that range from smooth-surfaced, half-meter thick sheet flows, to rugged-surfaced, several meter thick block lava flows. The sheet flows appear in general to be several tens of meters across, and they are constrained to depressions developed between or within block lava flows, or to small fault basins. Pillow flows and lava tubes of variable size are also a common feature of this volcanic ridge.

The volcanic ridge is bounded by a sediment filled basin to the southeast. The sediment cover in the central parts of the basin is at least 0.5 meter thick, but it may be considerably thicker. The volcanic sequence that underlies this basin was observed along fault scarps associated with a marginal high that defines the southeastern margin of the basin.

The constructional volcanic ridge, the sedimented basin and the marginal high seem all to be controlled by structures running southwest-northeast. This orientation is oblique to the rift valley, which runs north-south, but it is about perpendicular to the spreading direction.

A suite of samples were collected from the volcanic ridge and from fault scarps associated with the marginal high, and petrologic and microbiological studies of the sampled material are in progress at the participating institutions.

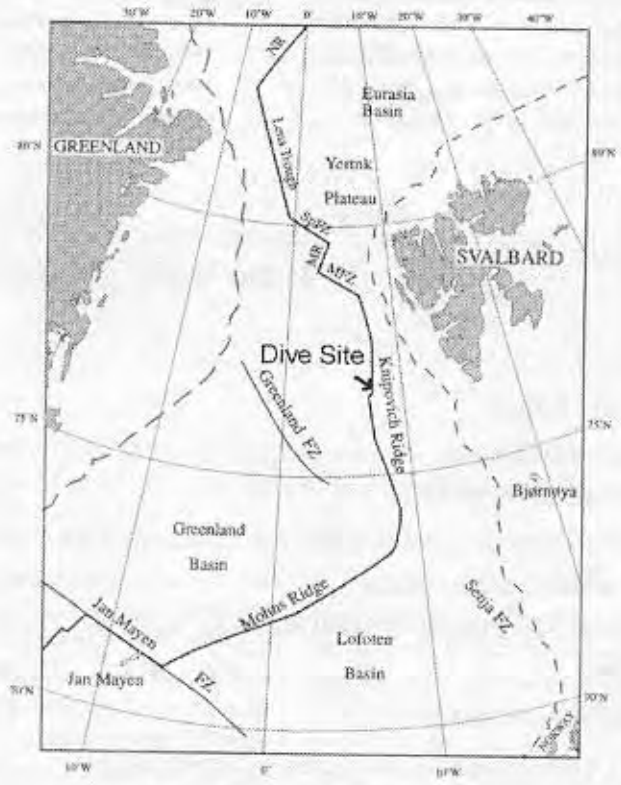
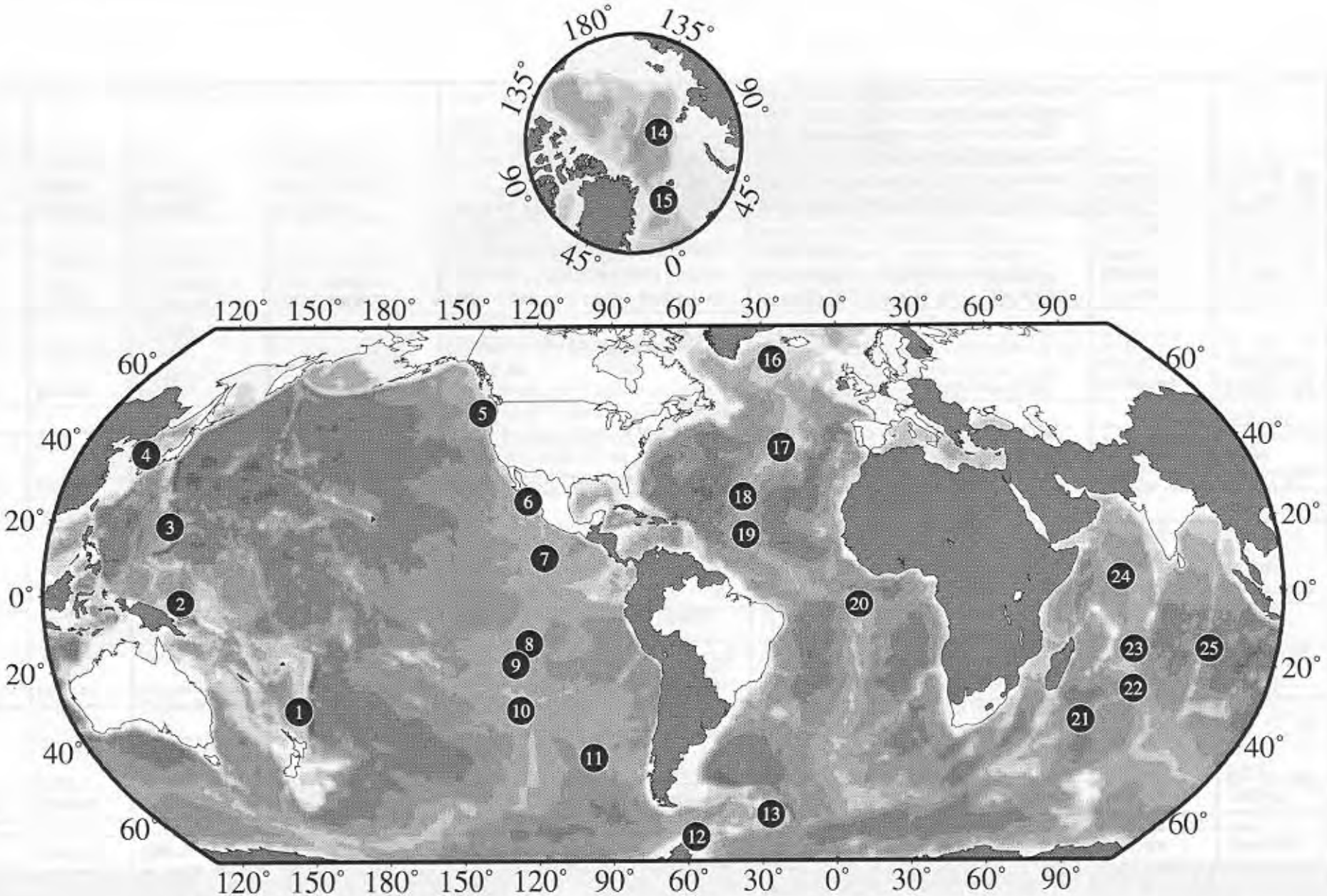


Figure 1. Location of the *Mir* Dives on the Knipovich Ridge.



InterRidge Community (in white) and 1998-2000 Projects

Map No.	Country	PI	Institution	Name/Location	Research Objectives	Ship	Dates
2	Australia	Binns	CSIRO	Pacmanus	Deploy PROD seafloor diamond rig to drill shallow (100 m) holes at Pacmanus	Franklin	Nov.-Dec. '99
5	Canada, USA	Tunnicliffe, Embley	Univ. Victoria, NOAA	Axial Seamount, Juan de Fuca Ridge (see summary on page 54) http://newport.pmel.noaa.gov/nemo_cruise98/	The science plan is being left flexible to permit investigation of new hydrothermal and biological consequences of any eruptions that may have taken place during the week-long seismic event in Jan. 1998	Ron Brown, ROPOS	Aug. 25 - Sep. 20 '98
17	France	Goslin	Univ. Bretagne Occidentale	**TRIATNORD** - axial domain of the MAR north of the Azores, 41°-46°N; both flanks from the present axis to magnetic anomaly 5 (circa 10 Ma).	MAR - Azores hotspot interactions. Influence of the upper mantle thermal tructure on ridge processes. (see article on page 25)	Atalante	Jun. 23- Jul. 22 '98
17	France	Cannat, Rommevaux	Univ. Paris 6	**Sudaçores** - MAR: 34° - 38°N south of the Azores platform, the axis and extending off-axis up to 10-13 myrs.	examine influence of the Azores hot spot on the MAR with multibeam bathymetry, reflectivity, gravimetry, magnetism and single channel seismics survey, and dredges (see article on page 31)	Atalante	Jul 25 -Aug. 25 '98
17	France	Desbruyères	IFREMER	**PICO** (Picking Instruments and Cleaning Operation) on the Azores Triple Junction Area (Menez Gwen, Lucky Strike, Famous and Rainbow)	recover instruments and study temporal evolution. Biological sampling from the main populations to study reproduction and population dynamics.	Nadir, Nautile	Jul 25 -Aug. 14 '98
7	France	Lallier	CNRS, IFREMER, UPMC	East Pacific Rise 13°N, 9-10°N - **HOPE'99** http://www.sb-roscoff.fr/Ecophy/hope99.html	Ecology and physiology of vent organisms.	L'Atalante, Nautile	7 April - 22 May '99
7	France	Prieur	UBO, Roscoff	East Pacific Rise 13°N - **AMISTAD** (**A**dvanced **M**icrobiological **S**tudies on **T**hermophiles: **A**daptations and **D**iversity) .	Microbiology cruise to study procaryotic thermophiles and hyperthermophilic communities	L'Atalante, Nautile	May 23 to 15 June '99
2	France, Japan	Auzende, Urabe	IFREMER, Geological Survey of Japan	**MANAUTE** cruise, Manus Basin in Papua New Guinea, part of the New STARMER (1994-1999) French-Japanese bilateral joint program	study of the spreading processes characterising the three axes in terms of tectonic and magmatic manifestation and study the processes associated with the spreading such as active hydrothermal venting, fossil and active deposits and fauna colonisation	L'Atalante, Nautile	22 Dec - '99 - 27 Jan. '00

20	Germany	Stoffers, Devey	Univ. Kiel	"Ascension", region between Ascension Island and MAR	Investigate ridge/hotspot interaction near Ascension, detailed sampling of MAR and hotspot seamounts	Meteor	Mar/Apr '98
2	Germany, Canada	Herzig, Hannington	TU Freiberg, GSC Otawa	area around Lihir Island, New Ireland Fore-Arc, Papua New Guinea	Gold mineralization, vent fauna, and volcanology (see article on page 34)	Sonne SO-133	Jul. 10 - Aug. 10 '98
1	Germany	Halbach	TU Berlin	**HYFIFLUX** Cruise: Central Fiji Ridge	Investigations of the hydrothermal activity in areas of the Central Fiji Ridge	Sonne SO-134	Aug 11 - Sep. 9 ''98
1	Germany, New Zealand	Stoffers, Villinger, de Ronde, Wright	Univ. of Kiel , Univ. Bremen, NIWA, IGNS,	central Havre Trough	swath bathymetry, seismic reflection, gravity and magnetics, and rock dredge and video grab sampling of central Havre Trough transect and White Island	Sonne SO-135	Sep. 9 - Oct. 15' 98
8	Germany	Devey, Villinger	U. Bremen	EXCOII Leg 1 and 2, EPR at ca. 13°S	geophysics (mapping, simple seismics and heat flow) and rock, sediment, and pore water sampling on the EXCO corridor from 0-8 Ma	Sonne	29 Dec. '99 -27 Jan. '00; 28 Jan. - 29 Feb '00
23, 24	India	Mudholkar, Mukhopadhyay	National Institute of Oceanography,	Carlsberg Ridge and Central Indian Ridge	geophysics and geological sampling	Sagar Kanya	Aug/Sep '98
19	Italy, Russia	Bonatti, Peyve	IGM, GIN,	Vema transverse ridge	geochemical and structural variations along the Vema transverse ridge	Strakhov	Jan./Mar. '98
18	Japan	Matsumoto	JAMSTEC, WHOI	Mid-Ocean Diving Expedition '98 (**MODE1 '98**): Cape Verde Fracture Zone, MAR 15°20'N	study crustal accretion processes and magmatic/hydothermal activities on the MAR (see article on page 13)	Yokosuka, Shinkai 6500	Jun/Jul 98
3	Japan	Taira, Suyehiro, Tokuyama	ORI	North Solomon trench, Nauru Basin and Mariana Trough	Marine geology and geophysical investigations	Hakuho Maru	Jan-Mar. '98
17, 18	Japan	Fujioka	JAMSTEC	**MODE2 '98**: TAG mound and area, and the Rainbow site, MAR	study hydrothermal processes on the MAR (see article on page 18)	Yokosuka, Shinkai 6500	Jul/Aug 98
22	Japan	Fujimoto	JAMSTEC	**MODE3 '98**: SWIR near the triple junction	crustal accretion processes of the super-slow spreading ridge	Yokosuka, Shinkai 6500	Sep. 21 - Oct. 17 '98
9	Japan	Urabe	JAMSTEC	EPR: 17°25'S and 18°26'S	recover long-term monitoring instruments after one year of deployment.	Atlantis, Alvin	Sep. 6 - Oct 6 '98
21	Japan	Kinoshita	JAMSTEC, WHOI	**MODE4 '98**: SWIR, Atlantis II fracture Zone	crustal structure and spreading processes of the super-slow spreading ridge	Yokosuka, Shinkai 6500	Oct/Nov '98
4	Korea	Huh, H.-J. Kim	KORDI - MGG Division	East Sea	East Sea Basin Study	Onnuri	April '98
4	Korea	K.-H. Kim, Moon, Lee	KORDI - Deep Sea Exploration Division	YAP Trench	Investigate manganese nodules, seamount manganese crust and hydrothermal systems	Onnuri	May - Aug. '98

Map No.	Country	PI	Institution	Name/Location	Research Objectives	Ship	Dates
4	Korea	Han	KORDI	East Sea	OBS Seismic experiment taking two 100-km long lines with 60 liter air guns	Prof. Gargarinsky	Aug. '98 (tentative)
4	Korea	S.-R. Kim	KORDI - MGG Division		Deep-Tow test run	Onnuri	Sept. '98
1	New Zealand, USA	De Ronde, Massoth, Wright	IGNS, NOAA, NIWA	southern Kermadec arc - Wright Island	CTD and SUAVE mapping and sampling of hydrothermal plumes along the southern Kermadec and around White Island	Tangaroa	Mar '99
17	Portugal	Marques or Almeida	Univ. Lisbon	CRISTA III - AMORES	Study hydrothermal fish and fauna	Arquipélago	Summer '98
17	Portugal, France	Barriga, Fouquet	Univ. Lisbon, IFREMER	SALDANHA Cruise - South Famous, Menew Gwen and Rainbow, MAR	look for diffuse & discrete venting, biology sampling	Nadir, Nautile	Jul 13-27 '98
18	Russia	Cherkashev, Sorokin	VNIIOkeangeol., PMGE, St. Petersburg	Mid-Atlantic Ridge, 24.5°N	Investigation of relic and active hydrothermal vents. Electric field profiling, CTD, dredging, coring, TV grab, submersible.	Prof. Logatchev	Mar. '98
16	Russia, USA, Germany, Norway	Sagalevitch, Cherkashev, Vogt, Crane, Mienart, Sundvor	Shirhov Inst. Ocean., VNIIOkeangeol., NRL, GEOMAR, Univ. Bergen	Knipovich Ridge and Haakon Mosby mud volcano (Greenland Sea) (see article on page 44)	search for hydrothermal activity on the Knipovich Ridge, side-scan sonar, CTD profilling, sediment coring, water sampling, current meters, basalt dredging, heat flow measurements and study gas hydrates at Haakon Mosby	Akad. Mstislav Keldysh, MIR	Jun/Jul '98
17, 18	Russia,	Sagalevitch	Shirhov Inst. Ocean.	Mid-Atlantic Ridge	diving expedition to the Rainbow and Logatchev vent sites	Akad. Mstislav Keldysh, MIR	Oct./Nov '98
21	UK, USA, Canada	MacLeod, Allerton, Dick, Robinson	U. Wales, Cardiff	SWIR, Hole 735B Atlantis II Fracture Zone (see article on page 39)	geology of lower crust using ROPOS with deep-towed magnetics, and rock drills	James Clark Ross, ROPOS	Mar. 21 - May 9 '98
17	UK, France, Portugal	German	SOC, IFREMER, Inst. Hydrog.	FLAME 2; 36°N	Mooring Recoveries from the Rainbow Plume	Poseidon	19 June - 10 July 1998
16	UK	Peirce, Searle, Sinha	Durham Univ.	MAR: Reykjanes Ridge	seismic mapping of magma chamber	Discovery	Jul/Aug '98
13	UK	Livermore	British Antarctic Survey	JR39 - East Scotia Ridge	Locate hydrothermal vents. Map selected segments with TOBI. Geochemical sampling.	James Clark Ross	Jan/Feb '99

11	USA	Karsten, Klein	U. Hawaii, Duke U.	Northern Chile Ridge, Valdiva Fracture Zone	SeaBeam 2000 bathymetry/side-scan, gravity and magnetics survey, rock dredging, wax coring	Melville	Jan. 15 - Mar. 2 '98
5	USA	Cowen	U. Hawaii	Axial Seamount, Juan de Fuca Ridge-Event Detection & Response Cruise	CTD and OBS deployment at site of Jan 98 volcanic seismicity	Wecoma	Feb. 9-16 '98
10	USA	Hey	U. Hawaii	southern EPR - 28-32°S	integrated geophysical/hydrothermal survey using DSL-120 with CTDs and nephelometers, SUAVE system	Melville	Mar. 5 - Apr. 13 '98
9	USA	Gee	Scripps	ultra-fast spreding southern EPR - 17.5-19.5°S	near-bottom magnetic and rock sampling survey	Melville	Apr. 18 - 6 Jun '98
6	USA	Yoerger	WHOI	Guaymas Basin	map vent structure of the hydrothermal systems in the Guaymas Basin	Atlantis, Alvin	Apr. 18-24 '98
6	USA	Jannasch	WHOI	Guaymas Basin and 21°N, EPR vent sites (LExEN)	study the diversity of extremophilic bacteria and archaea focussing specifically on hyperthermophilic sulfate reducers.	Atlantis, Alvin	Apr. 25 - May 5 '98
7	USA	Mullineaux, Peterson, Fisher	WHOI, UNC, U. Penn. State	EPR, 9°50'N	recruitment of vent organisms	Atlantis, Alvin	May 10 - Jun. 1'98
5	USA	Clague	MBARI	Escaba Trough, northern Gorda Ridge, Cleft segment	High resolution Bathymetry and backscatter, Simrad EM300	Ocean Alert	mid May '98
14	USA	Muench		SCICEX- Arctic Ocean - Gakkel Ridge http://www.ldeo.columbia.edu/SCICEX	Oceanography and geophysical mapping with SCAMP	USS Hawkbill	Apr-Jun '99
5	USA	Becker, Chave, Lilley	U. Miami, WHOI, UW	Juan de Fuca	test a low light CCD spectral imaging system for studing light at vents.	Atlantis, Alvin	Jun. 24- Jul. 4 '98
5	USA	Delaney	U. Washington	Endeavour - Mothra	recover sulfide structure	Thompson, ROPOS	Jun. 25- Jul. 18 '98
5	USA	Cowen	U. Hawaii	Juan de Fuca (LExEN)	deploy instrumentation designed to recover chemical proxies of subseafloor microbialactivity	Atlantis, Alvin	Jul. 8-26 '98
5	USA	Zumberge, Webb	Scripps	Juan de Fuca - Middle Valley, Axial Volcano	Geophysical survey, towed gravimeter, OBS deployment	Thompson	Jul. 21- Aug. 6 '98
5	USA	Fisher	U. Penn. State	Juan de Fuca, 48°N; "Biological Observatory Program" #5, see Juniper et al, *IR News* 3(2)	study tubeworm growth and productivity, examine the roles of bacteria and tubeworms in the nutrition of other fauna.	Atlantis, Alvin	Jul. 29 - Aug. 9 '98

Map No.	Country	PI	Institution	Name/Location	Research Objectives	Ship	Dates
5	USA	Baker	NOAA	Juan de Fuca - Cleft segment, Axial Volcano	continue time-series investigations at Cleft; investigate effects of recent eruption at Axial and prepare for establishment of a seafloor observatory	Ron Brown	Jul 30-Aug. 15 '98
5	USA	Baker	NOAA	Juan de Fuca - Cleft segment, Axial Volcano	continue time-series investigations at Cleft; investigate effects of recent eruption at Axial and continue time series work there in preparation for establishment of a seafloor observatory	Ron Brown	Jul 30-Aug. 15 '98
5	USA	Chadwick, Stakes	Oregon State Univ., MBARI	Juan de Fuca - South Cleft	geological oceanography - JASON and DSL120 survey	Thompson	Aug. 10 -.22 '98
5	USA	Feely, Milburn	NOAA, NOPP	Juan de Fuca	Mooring deployment	Ron Brown	Sep. 20-30 '98
9	USA	Lilley, Von Damm, Collier	U. Washington, UNH, OSU	EPR, 17°-20°S	collect water, sulfide and basalt samples as well as plume studies, biological sampling, rock coring and geological mapping.	Atlantis, Alvin	Oct. 10-Nov. 18 '98
7	USA	Manahan, Cary	USC, U. Delaware	EPR, 9-10°N	study larval dynamics in hydrothermal vent sites, specifically reproductive stategies, early larval growth dynamics, and dispersal mechanisms	Atlantis, Alvin	Nov. 23 - Dec 12 '98
8, 9	USA	Vrijenhoek, Lupton	Rutgers, NOAA	SEPR, 13°-21°S	test hypothesis that dispersal of vent-endemic fauna is unimpeded between the NEPR and the SEPR; extend previous studies of hydrothermal venting rates	Atlantis, Alvin	Dec. 16 '98-Jan. 21 '99
9	USA	Sinton, Van Dover	U. Hawaii, College William & Mary	EPR, near 17°26'S, 18°10'-18°20'S, and 18°37'S	conduct volcanological investigations of single eruptive sequences using deep towed 120 KHz surveys, ALVIN dives, rock dredging and wax coring.	Atlantis, Alvin	Jan. 25 - Mar. 6 '99
12	USA	Klinkhammer	Oregon State Univ.	Deception Island & Bransfield Strait, Antarctica	Search for hydrothermal vents using ZAPS sled	N. B. Palmer	Mar. '99
	USA	Karson, Klein, Hurst	Duke, U. Illinois	a 30 km of the N wall of the Hess Deep Rift	Focus on a section of the uppermost oceanic crust using AMS-120 side-looking sonar; ARGO II imaging of selected areas; Alvin sampling and observations	Atlantis, Alvin, ARGO (15 dives)	12 Mar- 12 Apr. '99

14	USA	??		SCICEX- Arctic Ocean - Gakkel and Lomonosov Ridges http://www.ldeo.columbia.edu/SCICEX	Oceanography and geophysical mapping with SCAMP	USS Hawkbill	Apr-Jun '99
7	USA	Mullineaux, Cavanaugh	WHOI, Harvard	EPR, 9-10°N	Community development and structure at Hydrothermal Vents: Life After Recruitment: final in a series of five cruises investigating biological interactions during colonization of hydrothermal vents.	Atlantis, Alvin	17 Apr. - 4 May '99
5	USA	Menke, Webb	LDEO, SIO	Juan de Fuca Ridge	Active-source imaging of the crustal magma system of Axial Volcano, using airgun sources to already-deployed Scripps OBS's.	Ewing	17 Apr. - 3 May '99
5	USA	Fischer	UCSC	Juan de Fuca Ridge	heat flow measurements	Thompson	May 2-26 '99
7	USA	Cary, Luther, Lutz	U. Delaware, Rutgers	EPR, 9-10°N (LEXEN)		Atlantis, Alvin	8 May - 6 Jun '99
5	USA	Bullock	PMEL/NOAA	Juan de Fuca Ridge	VENTS program	Thompson	25 Jun - 17 Jul '99
5	USA	Bullock	PMEL/NOAA	Juan de Fuca Ridge	VENTS program .	Thompson	21 Jul - 12 Aug '99
	USA	Mutter	LDEO	Woodlark Basin	study of the late stage continental rifting in the Woodlark basin using airguns, OBS	Ewing	24 Aug - 26 Sept '99
	USA	Martinez	HIG	Woodlark Basin	to study lithospheric deformation at different stages of rifting and possible dynamic mantle effects via a series of marine heat flow measurements in continental basement areas in different stages from rifting to incipient seafloor spreading to young conjugate margins.	Ewing	8-21 Aug '99
5	USA	Seyfried, Becker, Kastner, Wheat	U. Minnesota, U. Miami	Juan de Fuca Ridge (LEXEN)	to test the performance of solid state chemical sensors to measure pH and the dissolved concentration of H_2 and H_2S in vent fluids; monitor of vent fluidchemistry over a time period from hours to days	Atlantis, Alvin	23 Aug - 11 Sept. '99
5	USA	Chadwick	PMEL/NOAA	Juan de Fuca Ridge	to deploy an array of acoustic extensometers to measure seafloor spreading events. Part of the south Cleft observatory effort.	Thompson, JASON	24 Aug - 1 Sept '99

Map No.	Country	PI	Institution	Name/Location	Research Objectives	Ship	Dates
5	USA	Cowen	U. Hawaii	Juan de Fuca		Thompson, JASON	2- 16 Sept. '99
5	USA	Fisher, Cavanaugh	U. Penn., Harvard	Endeavour Segment of the Juan de Fuca Ridge	long term studies of vestimentiferan growth and nutritional interactions; examining the molecular and biochemical basis for the tissue stable C isotope signature of vesicomyid clams.	Atlantis, Alvin	16 Sept - 1 Oct. 1999
1	USA	Harding	SIO	Lau Basin - all the major seafloor spreading centers of the Lau Basin from the Central Lau Spreading Center to the Valu Fa Ridge.	collect reflection data to determine how the style of crustal accretion varies within the Basin and to compare it with mid-ocean settings	Ewing	7 Nov-1 Dec '99
7	USA	Lutz, Van Dover	Rutgers, College William & Mary	EPR, 9-10°N	continue time-series analyses of biological and geological changes; Replicate mussel sampling for a regional and global comparison of biodiversity at hydrothermal vents; Sample for phototrophs	Atlantis, Alvin	10 Nov - 3 Dec. '99
7	USA	Manahan	USC	EPR, 9-10°N, LARVE Project	collect for studies of the biology of their larvae and to collect larvae from the field ear vent sites.	Atlantis, Alvin	7-28 Dec. '99
6-10	USA	Fornari	WHOI	**AHA** cruise (Autonomous Hydrophone Array), East Pacific Rise, 20°N-26°S	carry out near-bottom investigations using Seabeam, DSL-120 sonar, Argo-II, dredging, rock coring, and CTDs over 4 - 5 areas suspected of having recent volcanic eruptions based on NOAA Autonomous Hydrophone Array	Melville	Feb/Mar 2000
17	USA	Blackman	SIO	Mid-Atlantic Ridge - 30°N	use submersible, sonar & video mapping, deep-tow gravity profiles and oriented samples to determine the structure and evolution of the oceanic core complex on the inside corner of the RTI	Atlantis, Alvin	Aug/Sep 2000

If you have a ridge-related scheduled or proposed cruise that is not listed here, please inform the InterRidge Office at intridge@ext.jussieu.fr.

National News....

France: Dorsales

There was a review of the Dorsales program in early 1998 and CNRS, INSU and IFREMER decided to continue the program for four more years. A new steering committee was formed, which is chaired by Catherine Mével. The committee includes two researchers outside of the French community to insure a high quality of science. Additionally, these outsiders will serve to strengthen the Dorsales seismics program which the review concluded needed better development.

The Dorsales science program is focusing on the following projects:

- Imaging the lithosphere and mantle over two scales: 0-10 km and 10-100 km.
- Experimental petrology to better interpret samples
- The InterRidge MOMAR project - there is strong support within Dorsales for the French community to be involved with MOMAR, both in the general characterization of the site and in developing sensors for long-term measurements
- High Pressure instrumentation for biological samples
- Biogeochemical interactions in hydrothermal fields
- Symbiosis
- Databank development

For each scientific question there is a working group. The working group focuses on either writing calls for proposals (two of which have already been issued), or devising an experiment if the community is small enough.

Current research is concentrated in three general areas:

- The FARA region of the Mid-Atlantic Ridge (15°N-Azores). In addition to the two recent cruises (see articles on page 25 and 31), a 2 ship MELT type experiment will be proposed in an area of the MAR still under discussion.
- The East Pacific Rise (13°N). This area is a natural laboratory for biologists. Upcoming cruises include the HOPE'99 cruise in April 1999 (PI: Lallier), and the Amistad cruise (PI: Prieur).
- The South West Indian Ridge. This area is important both as an example of an ultraslow spreading ridge, and as the link between the Atlantic and the Pacific for vent species dispersion.

Work in back arc basins in the Western Pacific (MANAUTE99) and at a fast-spreading ridge is also under discussion.

The Dorsales web page was going to be closed and will be re-opened at Jussieu. Currently it is not operational.

Steering Committee

Catherine Mével, Chair	CNRS-UPMC, Paris
Frank Dehairs	Vrije Universiteit Brussle, Belgium
Daniel Desbruyères	IFREMER-Brest
Alain Dinet	Observatoire Océanologique de Banyuls
Jacques Dubois	IPG, Paris
Jérôme Dyment	UBO, Brest
Yves Fouquet	IFREMER-Brest
Françoise Gaill	CNRS-UPMC, Paris
Tim Minshull	Cambridge, UK
Daniel Prieur	UBO, Brest

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National News....

Canada: CanRidge

ROPOS on the SWIR

There was a joint UK-Canadian cruise to the SWIR with ROPOS this past summer. For preliminary cruise results see the article by Macleod et al. on pg. 39.

NeMO98 Cruise

The New Millenium Observatory (NeMO) cruise aboard the NOAA vessel BROWN Aug. 23 - Sept. 20, 1998 was sponsored by four organizations. NOAA provided the shiptime while NSERC (Canada), the National Undersea Program (US) and the SeaGrant Program (US) each provided funding for about a 1/3 of the costs for the Canadian vehicle ROPOS. Robert Embley (NOAA) was the Chief Scientist and the leaders on the other two proposals were David Butterfield (NOAA) and Verena Tunnicliffe (Univ. Victoria). Canadian participants in the scientific party were: V. Tunnicliffe (U. Vic), S. K. Juniper (UQaM), S. Scott (U. Toronto), M. Tsurumi (U. Vic.), D. Grelon (UQaM), J. Marcus (U. Vic.), C. Levesque (UQaM)

For those of us who have supported the development of the Canadian Scientific Submersible Facility and ROPOS for five years, this year's cruise fully realised our expectations and then exceeded our unexpressed hopes. The cruise was a spectacular success. This year, we met with a fortuitous combination of events: for operations, a excellent support vessel, very good seafloor navigation and fine weather; for science, an well-integrated multi-disciplinary team and a volcanic eruption.

Operations:

We were particularly excited by the very low number of aborted dives due to vehicle problems. We were able to use the sub in its 24-hour exploration mode as well as up/down for sample and equipment exchanges.

- A total of 252 hours of bottom time
- An average of 12.5 hours per dive.
- Total of 19 dives for science and two equipment recovery dives.
- Eight heavy equipment deployments (including Tunnicliffe's 1 year time-lapse camera).
- Successful integration of four pieces of science gear onto ROPOS: chemical scanner with direct feedback, multi-port high temperature vent fluid sampler, pencil-beam high-frequency sonar and low light digital camera.
- Extensive visual, sonar and chemical mapping of the seafloor in both detailed block surveys and far-ranging traverses.
- A total of 210 collections of hydrothermal vent samples: organisms, sediments, rocks and fluids.
- Many hours of observations of animal feeding behaviour and fluid flow.

Public Relations

An important part of the cruise was development of a website that was transmitted to shore. It was updated daily by a dedicated educator (retired school teacher) on the ship. Each day, a cruise participant made an addition contribution. Using frame grabs and motion clips from the ROPOS video, we could incorporate extensive visuals in the site. A mediator ashore in Oregon gave daily lectures at the local marine centre and fielded questions from around the world. Many were delivered for answer aboard ship. This site is: http://newport.pmel.noaa.gov/nemo_cruise98/ which will remain on the web for a year.

Canadian Science Program

A large eruption on Axial Volcano was recorded by acoustic and seismic arrays on January 29, 1998. Our most exciting discovery was two areas, several square kilometers in extent, of new lavas. One of these sites we had studied during our NSERC-funded ROPAX97 cruise. A 100 × 50 m field of tubeworms was obliterated by the flow. An instrument mooring line projected from the new rocks and a seismometer remains trapped within the lavas. We are part of a large effort to document the eruption and to study the temporal changes in hydro-thermalism.

Juniper and Scott have embarked on a microbial/mineralogical study of a curious orange deposit that covers the lavas - it appears to have generated *in situ* possibly as a by-product of intense microbial activity post-eruption. Juniper also collected enough samples to characterise microbial activity from the vigorous bacterial mats surrounding hydrothermal sites on the new lavas. Tunnicliffe has embarked on a study of macrofaunal colonization of the new lavas. Animals had already arrived but there were three distinct patterns forming. In conjunction with the NOAA chemists, we hope to determine if faunal recruitment relates to chemical and heat conditions. Tsurumi is studying the condition of the moribund colonies around the edges of the lavas - many seemed in critical condition whilst others were reinvigorated. Levesque is working with Marcus to determine the feeding relation between the abundant scale worms on the new lavas and the bacterial mats. Collaborative studies with two other labs will use population genetics and reproductive assays

continued on next page...

National News....

Canada, continued...

to determine recruitment sources. And a camera was left at a new vent site to take a photograph each day of a vent as it is colonized.

We continued studies in a familiar site: the high temperature ASHES ventfield. Grelon and Levesque concentrated on the alvinellid polychaetes that inhabit chimneys near high temperature flow. They examined behaviour (very aggressive animals!) and collected for isotopic analyses. Marcus collected to examine polychaete population structure across the field. Tunnicliffe coordinated collections with chemical observations to relate community structure and reproductive condition to sulphide and temperature levels. Tsurumi's collection spanning 10 km will contribute to a regional community perspective. Sulphide rocks were collected for mineralogical study by Scott and the GSC. Scott also launched a study of oxide deposits.

We look forward to a return in 1999....a most exciting place to work!

For further information about CanRidge contact:

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Germany: DeRidge

Roland Rihm of Geomar, who led De-Ridge for many years, has unfortunately had to relinquish his reponsibilities due to the pressure of other commitments. His place has been taken by Colin Devey, who as of 1 October 1998 will be taking up the post of Professor for the Petrology of the Oceanic Crust at the University of Bremen. De-Ridge at the moment is languishing somewhat, suffering from a lack of motivation on behalf of the German Ridge scientists to get themselves organised. This is due, in part at least, to the fact that it is still possible to get indivdual ridge-related proposals funded in Germany without being part of some larger coordinating group like De-Ridge. While many ridge researchers realise that this is effectively making rather poor use of the available facilities, time constraints and human nature mean that the extra effort needed to make De-Ridge really function is not being put in. Nevertheless, in order to help the communication and collaboration between ridge researchers in Germany it is planned to hold a two-day meeting in Bremen in 1999 (dates to be announced, certainly late summer - autumn) at which all ridge-related research can be presented. It is hoped that this will provide an incentive to extend and deepen cooperative ties within the community. In the meantime the De-Ridge Homepage is being occassionally updated (time constraints also seem to prevent the preparation of contributions, however!) and contains, amongst other things, contact addresses for German ridge scientists. The Homepage can be accessed at the moment at http://www.gpi.uni-kiel.de/~cwd/DeRidge/deridge.html, it is anticipated that sometime before Christmas it will be transferred to Bremen.

There is a scheduled cruise to the EXCO corridor on the EPR. The two-leg EXCOII cruise (Dec. 1999-Feb. 2000) on the *Sonne*, will do geophysics (mapping, simple seismics and heat flow) and sampling (rocks, sediments, pore waters) near 13°S from 0-8 Ma. The chief scientists will be Colin Devey and Heiner Villinger.

For more information about De-Ridge contact:

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National News...

InterRidge-Japan

MODE'98 diving cruise on the MAR and the SWIR

The Japan Marine Science and Technology Center (JAMSTEC) is carrying out MODE'98 (Mid-Ocean Ridge Deep-Sea Experiments '98), which aims to carry out focused diving surveys on the slow-spreading mid-ocean ridges during a four-leg cruise using the submersible *Shinkai 6500* and the support vessel *Yokosuka*. Legs 1 and 2 were carried out this past summer on the Mid-Atlantic Ridge (MAR), leg 1 targeted the Cape Verde fracture zone on the MAR (see article on page 13), while leg 2 surveyed the TAG and Rainbow sites as well as a megamullion on the MAR (see article on page 18). Legs 3 and 4 will be carried out this fall on the Southwest Indian Ridge (SWIR), leg 3 will visit the northeastern part of the SWIR, following up on work of the EDUL cruise last summer, and leg 4 will survey the Atlantis II fracture zone.

Ridge Flux Program

As part of the Ridge Flux Program funded by the Science and Technology Agency of Japan (STA), Dr. T. Urabe and researchers from governmental research institutes carried out a diving cruise on the southern EPR in Sept. 1998 using the submersible *Alvin* and the *R/V Atlantis*. They recovered instruments deployed July, 1997 in an on-going aim to get observational constraints on the temporal variability of accretion processes.

The 6-year Ridge Flux Program will end in March 1999, and a follow-up program is now planning to be funded after one year of feasibility studies. The new program will focus on sub-seafloor ridge-crest processes.

Drilling Vessel

STA and JAMSTEC plan to start building a new drilling vessel next year. The building has been postponed by the Japanese government in order to solve the budgetary problems, which have been worse than expected due to the recent economic crisis. The ship will be built in 4 years - one year for designing and three years for construction. If everything goes well sea trials should begin in 2003.

AUV for long distance diving surveys

JAMSTEC is now developing an AUV for long distance diving surveys. It will start sea trials in 1999.

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National News...

UK: BRIDGE

As BRIDGE approaches its final year, eight of the 44 funded projects will still be active into 1999. Although some research will continue to the end of next year, plans are already underway for a major presentation of BRIDGE results to the UK government and the media in late 1999 in London.

Recent fieldwork

During the summer the last major BRIDGE cruise, a seismic mapping of the magma chamber under the Reykjanes Ridge, took place. The results from that cruise, led by Christine Peirce from the University of Durham, will be available next year, but preliminary indications are that the geometry of the magma chamber is more complex than initially anticipated.

Also during the summer the moorings deployed during last year's joint EU-BRIDGE 'FLAME' cruise (PI Chris German) were successfully recovered. The results obtained with these moorings will be reported in due course as part of the MAST III 'AMORES' programme.

Since the last newsletter the anticipated test of the BRIDGE hard-rock drill, for taking deep-water oriented cores, was successfully completed (see article on page 39). The drill performed in excess of its design specifications, drilling oriented gabbro cores up to 1.1 m in length. Drilling was conducted on Atlantis Bank on the South West Indian Ridge at 16 sites between 700 and 800 m. A full telemetry test with the drill at 3084 m in open water was also successful. Hopefully this new item of equipment will make a significant contribution to ongoing ridge research after the end of the BRIDGE Programme.

Technology meeting

On 11-12 November 1998 BRIDGE is supporting a meeting sponsored by the Marine Studies Group of the Geological Society of London and the Society for Underwater Technology entitled 'Technology for Deep-Sea Geological Investigations: Developments, Applications and Results'. The meeting is being held at the Geological Society, London and is a memorial to the late Jack Pheasant who designed the BRIDGE hard-rock drill. Further details of the meeting can be obtained from the BRIDGE Programme Manager.

BRIDGE data

The final deadline for the assimilation of BRIDGE data from the programme's Principal Investigators has now passed. The data received will be quality controlled by the management team at Southampton Oceanography Centre and collated before the production of the final BRIDGE dataset which is scheduled for the year 2000.

WWW

In addition to the UK Natural Environment Research Council's BRIDGE web pages at http://www.nerc.ac.uk/es/bridge.htm which were notified in the last newsletter, BRIDGE now has its own dedicated website produced by the BRIDGE Office at http://earth.leeds.ac.uk/~bridge

The site is designed to be accessible to some extent to general readers who stumble across it during web searches and includes a range of less technical articles. For the specialist reader a number of links are provided to aspects of the BRIDGE Programme including the executive summaries of a number of BRIDGE project reports and a copy of the 1994 report on the Diversity of Vent Ecosystems (DOVE). Although several years old this report is a useful introduction to the topic of vent biogeography, especially for students.

A second page of links leads to non-BRIDGE sites dealing with various spects of mid-ocean ridges, technology, ophiolites, and other researchers' homepages.

Further items will be added to the BRIDGE web-site in due course.

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National News...

USA: RIDGE

Changing of the Guard

David Christie has taken over from Karen von Damm as chair of the RIDGE Steering Committee and the office has moved to Oregon State University. Sincerest thanks are due to Karen, Chris and Laureen for their dedication to a strong RIDGE program and a very efficient office.

New Science Plan

The RIDGE Steering Committee has revised the RIDGE Science Plan. In a major shift from previous Science Plans, this version focuses on six broad "Scientific Questions":

- Why are ridge crests segmented, structurally and petrologically?
- What are the causes and effects of variations in magma supply independent of spreading rate?
- What are the mechanics of crustal accretion events?
- What are the relative roles of physiological adaptation, dispersal and historic events in determining the global pattern of organismal distribution and diversity?
- What are the causal linkages and effects among magmatic, tectonic, hydrothermal, and biological processes at ridge crests on time scales up to decadal?
- What are the extent, nature, and implications of the subsurface biosphere?

Copies of the plan will be available in print form and on the web in late October.

Event Response

RIDGE and NOAA VENTS collaborated in an event response to activity at Axial Volcano on the Juan de Fuca Ridge, detected by the SOSUS hydrophone array in January. In February, a response cruise aboard the Oregon State University research vessel *R/V Wecoma*, led by Jim Cowen, reported widespread hydrothermal activity in the summit region. During the summer, follow-on cruises reported ongoing hydrothermal activity and observations of young (but not unequivocally 1998-vintage) lava flows. Additional information at http://newport.pmel.noaa.gov/axial98.html or through the RIDGE website.

Recent Workshops

"The Effect of Seafloor Hydrothermalism on Surface Ocean Productivity" (co-sponsored with NOAA VENTS), was held in Santa Cruz, California in May, 1998, with approximately 20 participants. The workshop Report is available on the RIDGE website.

A Results Symposium on "Field Studies Along the East Pacific Rise, 9°-10°N" was held in Santa Barbara, California in September, 1998, with roughly 95 participants. A report from this meeting will be available soon.

RIDGE will continue sponsor Results Symposia over the next few years in order to encourage cross-disciplinary synthesis of current knowledge focusing on well studied regions or topics of special interest in global ridge-crest research.

RIDGE at AGU Fall Meeting

A special Union Session (U 07), highlighting some of the major scientific achievements of the first decade of RIDGE, will take place on Tuesday morning, followed by an afternoon poster session. On Wednesday evening, the traditional RIDGE Smoker will be held at the Cathedral Hill Hotel. All members of the RIDGE and InterRidge communities are invited.

MELT

Initial results from the MELT experiment were highlighted in the 22 May edition of *Science*. The experiment continues in its data synthesis and modeling phase.

LARVE

The LARVE Project, to investigate larval dispersal and gene flow in deep sea vent environments, begins its first major field programs this summer. Cruises are planned through the year 2000.

RIDGE at OSU

The RIDGE Office has moved from the University of New Hampshire to Oregon State University (OSU). David Christie is the new Chair of the RIDGE Steering Committee. Randy Keller and Carol Chin are the new RIDGE Scientific Coordinators, returning to OSU from the University of Tennessee at Knoxville. Ellen O'Shea brings a diverse background in computer applications, environmental education, office and travel management to her position as the new RIDGE Program Assistant.

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Upcoming Meetings and Workshops

Calendar

More details about all of the following meetings can be found via the Calendar Page on the InterRidge web site.

Oct. 16-17, 1998	**InterRidge Workshop: Mapping and Sampling the Arctic Ridges** Hanover, Germany
Oct. 28-31, 1998	**InterRidge Workshop: Long-Term Monitoring of the Mid-Atlantic Ridge (MOMAR)** Lisbon, Portugal
Oct. 28-31, 1998	**National Academy of Sciences, Ocean Science Symposium - Fifty Years of Ocean Discovery** Washington DC, USA
Nov. 11-12, 1998	**Technology for Deep-Sea Geological Investigations: Developments, Applications and Results** Geological Society, Burlington House, Piccadilly, London, UK
Dec. 6-10, 1998	**American Geophysical Union 1998 Fall Meeting** San Francisco, CA, USA
Dec. 11-12, 1998	**International Workshop on the Hydrogeology of the Oceanic Lithosphere** Santa Cruz, California, USA
Mar. 28-Apr. 1, 1999	**European Union of Geosciences: EUG10** Strasbourg, France
19-23 April, 1999	**European Geophysical Society, 24th General Assembly** The Hague, The Netherlands
May 26-29, 1999	**International Scientific Ocean Drilling Conference** Vancouver, Canada
June, 1999 (tentative)	**InterRidge Steering Committee Meeting** University of Bergen, Bergen, Norway
18-30 July, 1999	**IUGG/IAPSO Symposium P16: Recent Improvements to Deep-Sea Research through use of Submersibles, Acoustic Tomography and In-situ Long Term Observations** University of Birmingham, Birmingham, UK
Sept. 12-15, 1999	**3rd International Workshop on Orogenic Lherzolites and Mantle Processes** Pavia, Italy
March 8-9, 2000	**The Nature and Tectonic Significance of Fault Zone Weakening - A joint Geological Society of London/Geological Society of America/InterRidge meeting** Geological Society, Burlington House, London, UK

Upcoming Meetings and Workshops

American Geophysical Union

6-10 December 1998, San Francisco, CA, USA

Special Sessions relevant to the international ridge community

T71C, T72A: Seismic and Electromagnetic Imaging of Mid-Ocean Ridges After decades of study, the mechanisms of mantle upwelling, melt generation and transport, and crustal construction continue to challenge geoscientists. However, recent high-resolution seismic and electromagnetic experiments have begun to provide direct observational constraints on the processes of mantle flow, and crustal accretion at oceanic spreading centers. This session will bring together results from electromagnetic studies and from a variety of seismic techniques (reflection, refraction, tomography, teleseismic and micro-earthquake studies) which have been used to image the mid-ocean ridge system. Scientific objectives will include (but are not limited to): temporal and spatial scales of variability; interactions of magma with the lithosphere and crust; crustal magma plumbing system; and rates and mechanisms of melt transport. **Conveners:** L. Magde and G. Kent.

V71A: Seafloor Event Detection and Response: The 1998 Event at Axial Volcano Since the introduction of real-time acoustic monitoring in the NE Pacific in 1993, understanding of the physical, chemical, and biological consequences of mid-ocean ridge diking events has grown rapidly. The February 1998 event at Axial Volcano on the Juan de Fuca Ridge was the most seismically active mid-ocean ridge event yet monitored and the first to occur at a site with a preexisting suite of seafloor and water column monitoring instruments. A quick response cruise by RIDGE and NOAA/VENTS investigators following the event found evidence of a substantially invigorated hydrothermal system at the summit of Axial Volcano. Follow-up surface ship, ROV, and submersible cruises are planned for further investigations and to recover those instruments in place during and immediately after the event. This event holds particular interest in light of multi-institutional plans to focus on Axial Volcano as the site of a New Millennium Observatory (NeMO) for the long-term study of the effects of magma movement on the hydrothermal environment and the subsurface biosphere. This session solicits papers on specific results obtained on the detection of and response to the 1998 Axial event, on mature results from previous events, and on new methods and instruments designed to enhance our present capabilities for responding to and monitoring the aftereffects of diking events. **Conveners:** E. T. Baker and J. P. Cowen.

T72F, T11A: New Methods in High-Resolution, Near-Bottom Seafloor Mapping and Imaging In recent years, high-resolution mapping of seafloor terranes in diverse tectonic settings using a variety of near-bottom deep submergence sonar and vehicle technologies has provided a large volume of information on the detailed morphology and topography of the ocean floor. This has been coupled to the advent of routine digital electronic imaging of the seafloor and the compilation of digital mosaics of seafloor features. The session will permit a wide range of investigators to present new data resulting from use of high-resolution, near-bottom seafloor mapping and imaging technologies. Presentations that focus on both the technical characteristics of the systems and the scientific applications and results are enouraged. **Conveners:** D. J. Fornari and D. Scheirer

U72D: Plate Tectonics After 30 Years Thirty years have passed since plate tectonics became generally accepted in the scientific community. This session hopes to frame a serious inquiry into the origins, development, and long-range impact of the theory. Participants include scientists involved in the seminal discoveries that led to the plate tectonics revolution and historians who have studied its historical context and development. Co-sponsored by the AGU History of Geophysics Committee and the History of Earth Science Society. **Conveners:** H. Le Grand, K. Taylor, N. Oreskes and E. Cliver.

T11G, T12C, T22C: Multidisciplinary Approaches to Studying Midocean Ridge Processes The formation of new ocean crust involves geological, thermal, chemical, and biological processes interacting on a variety of spatial and temporal scales. Unraveling the relationships between these interconnected processes is receiving increasing attention in midocean ridge studies, and has been a long-term goal of the RIDGE program. Consequently, the approach to investigating these processes is evolving from sharply focused cruises dedicated to a particular discipline to multidisciplinary cruises with a holistic strategy. This evolution is driven by economic as well as scientific efficiency, as the cost of field work is increasing even as access to large platforms is decreasing. This session solicits papers from field expeditions dealing with multidisciplinary aspects of midocean ridge research, and offers an opportunity to bring together cross-cutting but related groups of observations that might otherwise be fragmented in separate sessions. Laboratory or modelling studies are also welcome. **Conveners:** E. T. Baker and R. N. Hey

U21B, U22A: RIDGE, Approaching a Decade of Multidisciplinary Science For almost a decade, the RIDGE program has fostered inter-disciplinary studies of the global mid-ocean ridge system, from the Earth's deep mantle, through the oceanic crust to the volcanic, hydrothermal and biological systems above and beneath the seafloor. An oral session (mostly invited) will review a decade of progress in

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Upcoming Meetings and Workshops

AGU continued...

mid-ocean ridge science, highlighting the major achievements in mid-ocean ridge science, and briefly discussing future directions. Posters highlighting any aspect of mid-ocean ridge research are especially requested. **Conveners:** D. M. Christie, R. S. Detrick and L. S. Mullineaux

T22B, T31F, T32F: Accretionary Processes at Ultraslow Spreading Ridges: Recent Field Results From the Arctic and Southwest Indian Ridges In the global ridge system, ultraslow spreading ridges represent by length the largest single class. Papers are solicited to present new data acquired on the Arctic and Southwest Indian ridges and theoretical models on geodynamics of these spreading systems. This session will examine the influence of spreading rate and thermal structure on accretionary processes in the ultraslow spreading environment, and will address topics on partial melting, lithospheric thickness, axial segmentation, morphology, architecture of the crust, and basalt and mantle chemistry as well as its ultimate interaction with the seawater above. **Conveners:** K. Crane, C. Mevel, K. Tamaki, J. Georgen and B. Coakley.

V31C, V32D, V41A: Melting and Melt Extraction Study of mantle melting continues to attract great attention, owing to the close relationship between melting and the ongoing geodynamic and geochemical evolution of the Earth. This special session will bring together geochemists, geophysicists, and petrologists to highlight recent progress in understanding mantle melting beneath ridges and arcs and to discuss how integration of these disciplines can advance a consistent understanding of material properties and processes in partially molten regions. Substantial uncertainty remains regarding key aspects of melting that are required for a well-integrated understanding of this process. This is particularly true for melting beneath volcanic arcs, which is complicated by the flux of subduction-related components, but also true in the less-complicated environment beneath ridges. A key goal of this session is to facilitate cross-pollination of ideas and methodologies between those working on sub-ridge melting with those working on sub-arc melting. **Conveners:** M. Hirschmann, M. Spiegelman and T. Elliott

U31D, U32A: Life in Extreme Environments Research on life in extreme environments provides knowledge fundamental to understanding the processes that led to the formation and adaptation of life on Earth and whether and how life may thrive on other planets. Recent discoveries in diverse disciplines provide spectacular opportunities for research progress in this area that combines elements of volcanology, microbiology, chemistry, paleobiology, polar sciences, biotechnology, oceanography, planetary sciences, and astrobiology. **Conveners:** G. M. Purdy and M. A. Meyer

U32b, U41A: Deep Earth Observations From the Seafloor Major new advances in our understanding of the structure, composition, and state of the mantle; lithospheric deformation, fluid flow, and chemical budgets; dynamo and core dynamics; plate tectonics processes; the mechanisms by which life is supported without sunlight; and the ocean's role in climate change require observations on the seafloor for durations spanning years to decades. Seafloor fiber-optic cables, and cellular communications satellite networks, provide a new capability to implement and interact with a global network of multidisciplinary real-time submarine observatories. This session focuses on the scientific challenges, opportunities, and facilities involved in launching this new era of inquiry on and beneath the largely uninstrumented part of our planet — the seafloor. What groundbreaking science could you do if you had access to real-time data from your deep-sea instruments, external power, and intervention capability near the seafloor? Sponsored by the AGU Committee on the Study of the Earth's Interior (SEDI). **Conveners:** A. Schultz, J. Orcutt, A. Chave, J. Delaney, B. Romanowicz and K. Becker.

S42B: Broadband Seismology in the Oceans This session will focus on marine seismology in the frequency band 0.001-10.0 Hz and the issues involved in extending the global seismic network to the seafloor. These issues include observations and theory of the ambient noise field, earthquake signal detection, comparison of results with land stations, borehole versus seafloor stations, seismometer design and coupling, and the engineering challenges of providing power to and recovering data from long-term seafloor seismic observatories. The relevance of ocean floor seismic data to imaging the earth at regional and global scales and the effects of oceanic processes on the broadband ambient noise field will also be addressed. **Conveners:** R. Stephen and F. Duennebier.

V41B, V42E: Recent Submarine Research Studies of Hawaiian Volcanoes Hawaiian volcanoes continue to be a prime venue for studying processes associated with active volcanoes including some of the largest and most dynamic landslides on Earth. Several recent major marine expeditions have mapped and run seismic profiles of some of these landslides, surveyed submarine rift zones and examined the products of recent eruptions using submersibles and a ROV. These expeditions are providing new insights into ocean island volcanic construction and destruction processes as well as valuable analogs to volcanic rifting processes at mid-ocean ridges. This session offers researchers from many different disciplines the chance to share their latest results with colleagues in other disciplines. This kind of cross discipline interaction is essential for developing a comprehensive understanding of processes in volcanic environments. **Conveners:** M. O. Garcia and K. T. M. Johnson.

Upcoming Meetings and Workshops

International Workshop on the Hydrogeology of the Oceanic Lithosphere

December 11-12, 1998 Santa Cruz, California, USA

The oceanic crust is one of the most extensive geologic formations on earth, and from a hydrologic perspective, it may be one of the most diverse. Young oceanic crust is extremely transmissive to circulating fluids, and the heat and chemical fluxes between young oceanic lithosphere and the oceans via ventilated hydrothermal circulation are large. At the other extreme, many sedimentary sections in old ocean basins are characterized by low permeability and may create conditions of great hydrologic isolation. While a useful paradigm for the hydrogeology of the oceanic crust has emerged over the past thirty years, much work is needed to determine the full range of driving forces, permeabilities, and rates of flow, and the consequent local and globally integrated heat and chemical fluxes that result.

A workshop devoted to this subject is being organized with sponsorship from the International Lithosphere Program (ILP), and an application for co-sponsorship from JOI/USSSP is pending. The present state of knowledge about the hydrogeology of the oceanic lithosphere will be reviewed. Particular attention will be given to problems that are considered important but have received little recent attention, and to observational and experimental strategies, including use of the facilities of the Ocean Drilling Program, that can improve our understanding of the influence of water circulation on global mass and heat fluxes and crustal alteration, and increase our knowledge about the full range of variation of hydrologic regimes in the oceanic lithosphere, including those near passive and convergent continental margins.

Conveners:

Earl Davis *davis@pgc.nrcan.gc.ca*
Keir Becker *kbecker@rsmas.miami.edu*
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Jonathan Martin *jmartin@geology.ufl.edu*

For more details see: **http://www.pgc.nrcan.gc.ca/marine/workshop.htm**

The Nature & Tectonic Significance of Fault Zone Weakening

A joint Geological Society of London/Geological Society of America/InterRidge meeting

8-9 March 2000, Geological Society, Burlington House, London

Many faults appear to form persistent zones of weakness that fundamentally influence the distribution, architecture and kinematic patterns of crustal-scale deformation and associated geological processes in continental and oceanic regions. To date, however, our understanding of the mechanisms that lead to changes in fault zone rheology, their many geological consequences and the larger-scale implications that they may have for lithosphere dynamics are still poorly understood. This meeting aims to brings together an international group of Earth Scientists working in both continental and oceanic regions to discuss a broad range of topics centred around the role of weak faults during crustal deformation.

Possible thematic sessions include:

- The nature of shear localisation and fault zone weakening mechanisms
- The detachment fault problem in continental and oceanic regions
- Fluid- and magma-induced changes in fault zone rheology
- Reactivation and seismic hazard assessment
- Weak faults and lithosphere dynamics

Contributors are invited to submit titles or abstracts (one sheet of A4) to the convenors. Deadline for the submission of abstracts will be **Sept. 30, 1999**. We hope to compile a thematic set of papers arising from this meeting and the deadline for the submission of completed manuscripts will be 8th March 2000 (i.e. at the meeting) in order to facilitate rapid publication.

Convenors:

Dr. Bob Holdsworth *R.E.Holdsworth@durham.ac.uk*
Prof. R.J. Knipe *r.knipe@rdr.leeds.ac.uk*
Dr. Jerry Magloughlin *jerrym@cnr.colostate.edu*
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Upcoming Meetings and Workshops

European Union of Geosciences: EUG 10 Meeting

28th March - 1st April 1999, Strasbourg, France

Abstract deadline: **15 November 1998**

Symposium B13: Methane hydrates and the deep sub-seafloor biosphere

Convenors: Judith A. McKenzie (Zürich), sediment@erdw.ethz.ch, and B.U. Haq (Arlington)

The recent resurgence of interest in methane hydrates has resulted from the recognition that they may play important roles in the global carbon cycle and rapid climate change through emissions of methane from marine sediments and permafrost into the atmosphere, and in causing mass failure of sediments and structural changes on the continental slope. A deep microbial source for the methane links the formation of hydrates with an actively metabolising deep sub-seafloor biosphere, which has been recognised during ODP cruises. Methane seeps are also associated with diverse biota in the deep ocean, not unlike the assemblage associated with hydrothermal vents. The methane hydrate role in modulating climate and slope-stability, as well as the related biological activity in the sub-surface and on the seafloor, will be examined.

Symposium C5: The deep biosphere

Convenors: Nils Holm (Stockholm), nilsholm@geo.su.se, J. Parkes (Bristol)

The rapid growth of interest in the existence of a microbial life in the seafloor and continental subsurface has created needs for information synthesis to guide the development of research strategies and programs. The existence of a deep biosphere amounted to speculation only a few years ago. Whatever their origin, bacteria in the deep biosphere are uniquely adapted to survive in exceedingly harsh environments. This knowledge, in conjunction with other recent research into the role that bacteria play in global biogeochemistry, is beginning to influence ideas about nutrient cycling, dolomite formation, biomineralization, biological adaptation and the size of the biosphere beneath the surface of the lithosphere.

Symposium F2: Magmatic, tectonic and hydrothermal processes at mid-ocean ridges and back-arc basins

Convenors: Cara Wilson (Paris), intridge@ext.jussieu.fr, J. Dyment (Brest), R.-B. Pedersen (Bergen)

Mid-ocean ridges are commonly divided into "fast" and "slow" spreading centres. However, recent studies from the Southwest Indian and Arctic ridges, from portions of the Mid-Atlantic Ridge that are near hot spots, from the intermediate spreading Southeast Indian Ridge, and from various spreading centres in back-arc basins, emphasise the potential effects of ultra-slow spreading rates, of variations in mantle temperature, and of complexities in plate kinematics, on mantle melting and on axial magmatic, tectonic and hydrothermal processes. We seek contributions addressing the variability of these processes, and discussing the nature of the controlling physical parameters, in different spreading environments. This session is sponsored by InterRidge.

For more details see: http://eost.u-strasbg.fr/EUG/Meeting.html

Upcoming Meetings and Workshops

Call for Papers IUGG/IAPSO Symposium P16: Recent Improvements to Deep-Sea Research through use of Submersibles, Acoustic Tomography and In-situ Long Term Observations

18-30 July 1999, University of Birmingham, Birmingham, UK

Abstract Deadline: **January 15, 1999**

This special symposium will be held by IAPSO (International Association of Physical Sciences of the Oceans) during the XXII General Assembly of IUGG (International Union of Geodesy and Geophysics). This Symposium will focus on recent progress in understanding phenomena occurring in the water column and/or on the bottom of the deep ocean through use of manned research submersibles, remotely operated vehicles (ROV and AUV), acoustic tomography and *in-situ* long-term monitoring. For example, venting of both hydrothermal and cold fluids from the deep ocean floor has provided a new picture of the mass and heat fluxes between the ocean and solid crust with possible implications for oceanography. Repeated visual and instrumental observation of biological, physico-chemical, geophysical (e.g., heat-flow, micro-earthquakes and hydropressure pulses) and geodetic (by precise determination of axial distance) activity may provide crucial information regarding secular or sporadic variations, if any. Areas investigated during the past several years include mid-oceanic ridges such as the Lucky Strike, TAG and Rainbow sites in the Mid-Atlantic, the East Pacific Rise at 9°N and 17°S, and the Juan de Fuca Ridge as well as back arc basins like the Manus Basin (PNG) and the Mariana and Okinawa troughs. Broader-scale monitoring of seismicity, volcanic events and crustal deformation with global networks and plate-tectonic considerations will further constrain modes of the local and regional variations. Cold seepage sites such as those located near Oregon, the Aleutians, Nankai and Hatsushima (Sagami Bay) may be other targets for monitoring fluid flow in convergent accretionary zones. Acoustic tomography is, on the other hand, capable of yielding 3-D snapshots of oceanographic conditions including vertical patterns of sound speed representing the temperatures, salinity and density of sea water. Recent attempts such as the Acoustic Mid-Ocean Dynamics Experiment (AMODE) have set goals of determining the ocean mesoscale sound speed field, gyre-scale variability and mesoscale eddy kinematics and dynamics in comparison with numerical models. In addition to static profiles, monitoring of time-varying invaluable records of global change. Interaction of bottom phenomena with global-scale oceanographic events (e.g., El Niño) might be revealed in future by these efforts.

We aim to synthesize the present status of these various fields of research and to establish a new vision of oceanography in the next century. Deadline for paper submission (both title and abstract) is **15 January, 1999**. Details of paper submission can be found in the Second Circular of the XXII General Assembly of IUGG available from the Local Organizing Committee (email: iugg99@bham.ac.uk) or or on the web page listed below.

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