Vol. 7 (1)

Spring 1998

InterRidge News

Initative for international cooperation in ridge-crest studies

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InterRidge Office Updates

Coordinator Update

Membership

Italy and Canada have upgraded to Associate members in 1998, and Enrico Bonatti and S. Kim Juniper have joined the InterRidge Steering Committee as their representatives. New Zealand has also joined InterRidge as a Corresponding member.

Publications

Reports from the ODP-InterRidge-IAVCEI Workshop: *The Oceanic Lithosphere and Scientific Drilling into the 21st Century* and from the InterRidge *Arctic Ridges: Results and Planning Workshop* have been printed. Copies are available upon request from the InterRidge Office (see page 5).

A Contributions Volume from the *First International Symposium on Deep-Sea Hydrothermal Vent Biology* held last October will be produced. The papers are currently out for review, and they will be published in a special volume of *Cahiers de Biologie Marine* before the end of the year.

Meetings

There will be an InterRidge workshop on *Mapping and Sampling the Arctic Ridges* in Hannover, Germany, October 16-17, 1998. The workshop objectives are to bring participants up to date on the research that has taken place on the Arctic ridge system since the Kiel InterRidge Workshop in 1994, and to devise a Program Plan for future multidisciplinary studies of this slow spreading ridge. The application deadline is May 31, 1998. More information on the workshop can be found on page 66. The workshop is scheduled to coincide with the *3rd International Conference on Arctic Margins* which will be held nearby in Celle, Germany, October 12-16.

InterRidge is also organizing a workshop on *Long term Monitoring systems of the Mid-Atlantic Ridge (MOMAR)* which will be held at the University of Lisbon, Portugal, October 28-31, 1998. The goal of this workshop is to organize the international community of ridge researchers in biology and geosciences to initiate a long term monitoring of the MAR south of the Azores. The application deadline is June 1, 1998. More information can be found on page 67.

Projects

InterRidge has established a new working group on *Global Partitioning of Hydrothermal Activity*, chaired by Chris German (SOC, UK). The purpose of this working group is to target areas of the global ridge-crest which, to date, remain unexplored for hydrothermal activity and coordinate international collaboration to explore the targeted areas. The initial meeting for the working group will be held in conjunction with the 1998 Fall AGU Meeting in San Francisco in December. For more information see page 7.

Following a recommendation made at the First International Symposium on Deep-Sea Hydrothermal Vent Biology in Madeira last fall, InterRidge will begin collecting information on biological samples, including where they were collected, where they are stored and who is responsible for them, and will make this information available on the InterRidge web site. Initially, this list will be compiled from forms sent along on all future biology cruises to hydrothermal vents. See page 12 for more details.

Additionally a page has been created on the InterRidge web site which will be devoted to the issue of sanctuaries at hydrothermal vents (see pg. 15). This page will create a forum where researchers can propose vent sanctuaries, and where others in the oceanographic community can respond to them. The research sanctuary system will be regulated entirely by consensus, but InterRidge will play a role in disseminating the information and summarizing controversies, if they arise. The web site will be of general use in several ways: seagoing researchers will have a single source of information on regions where ongoing research is being conducted, and the community will have a forum for holding proposed sanctuaries up for scrutiny.

Cara Wilson
InterRidge Coordinator
1 May1998

BRIDGE (UK) home page:
http://www.nerc.ac.uk/es/bridge.htm

DeRidge (Germany) home page:
http://www.gpi.uni-kiel.de/~cwd/DeRidge/deridge.html

RIDGE (USA) home page:
http://ridge.unh.edu

Lost a colleague's e-mail address?

Try finding it on the InterRidge Electronic Directory

There are currently over 300 people who are active in Mid-Ocean Ridge research listed on the InterRidge Electronic Directory 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.

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)*
☐ *The Ridge Crest Biologist Directory*
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Name____________________
Department/Institute____________________
Address____________________
____
City__________ **State/County**__________
Post Code__________ **Country**__________
Phone:__________ **Fax:**__________
country code area code number country code area code number
E-mail:____________________
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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 *fold* *fold*

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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, 1, pp. 72
InterRidge News, 1997, 6, 2, pp. 64
InterRidge News, 1997, 6, 1, pp. 72
InterRidge News, 1996, 5, 2, pp. 68
InterRidge News, 1996, 5, 1, pp. 52
InterRidge News, 1995, 4, 2, pp. 52
InterRidge News, 1995, 4, 1, pp. 72
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:

New! 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.

Symposium Abstract Volumes:

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

Global Digital Database:

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

Current Activities: Developing a common format for the database, promoting international data synthesis and web access to data.

Chair: Philippe Blondel (UK)

WG members: W. Ryan (USA), and C. Deplus (France).

SWIR:

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

Recent/Current Activities: Several cruises to the SWIR took place this last year, and more are planned for the summer of 1998.

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).

Arctic Oceans:

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

Current Activities: Organizing a workshop to be held in Germany next October. The workshop will summarize work taken place since the 1994 workshop and will work on coordinating future Arctic studies (see page 66).

Chair: Roland Rihm (Germany)

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

Global Partitioning of Hydrothermal Fluxes:

Objectives: Target areas of the global MOR which are unexplored for hydrothermal activity and coordinate international collaboration to explore them.

Current Activities: see next page.

Chair: Chris R. German (UK)

WG members: E. Baker (USA), Y. J. Chen (USA), J. E. Escartín (Spain), 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), 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: Lindsay M. Parson (UK)

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

Back-Arc Basins:

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

Current Activities: see pg. 8.

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).

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 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: Involved with organizing the MOMAR workshop (see page 67).

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).

Biological Studies:

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

Current Activities: Establishing a system for international exchange of hydrothermal biological samples, and coordinating the demarcation of vent sanctuaries. See pages 12 & 15.

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).

New InterRidge Working Group: Global Partitioning of Hydrothermal Activity

Chris German, Chair

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

During 1997 it was agreed by the InterRidge steering committee that the "Segment Scale Fluxes" working group should be wound-up. Effectively, it was considered that the water-column components - studying the physics, chemistry and biology of hydrothermal plumes on a segment scale - had been implemented as best as could be achieved through international collaboration through two recent series of cruises to the Mid-Atlantic Ridge at Broken Spur (29°N) and Rainbow (36°N). Simultaneously, in the absence of a volunteer to promote the parallel themes identified by the 1995 InterRidge Workshop on segment-scale fluxes it was agreed that those interests could most satisfactorily be subsumed into the related 4-D architecture working group (Dr. Lindsay Parson, Chair, SOC, UK).

Simultaneously, however, it was recognized that there was an advantage to establishing a new InterRidge Working Group dedicated to implementation of some aspect of hydrothermal circulation research. To this end, Cara Wilson and I convened an open discussion meeting at the American Geophysical Union's Fall Meeting in December 1997 to discuss, at a "grass-roots" level what the new direction of this new Working Group should be. An important term-of-reference for this meeting, I proposed, should be to return to one of the basic premises of InterRidge, namely to target those areas where international collaboration would be most important and effective. An inverted way of expressing the same principal would be to avoid duplication of what could already be achieved through existing national research programs. Possible avenues for development included:

i) Winding up the segment-scale fluxes working group but starting nothing new.

ii) Commencing a working group studying on-axis vs off-axis partitioning of fluxes.

iii) Commencing a working group studying global partitioning of venting around the world's ridge-axes.

Whilst the partitioning between on-axis and off-axis venting remains an important area for future research it was considered that this was already a relatively well-coordinated area of research at the international scale due to the activities of both the Ocean Drilling Program (e.g. recent Leg 168) and the International Lithosphere Project (new program approved in 1997, coordinated by Earl Davis, USA and Harry Elderfield, UK). Therefore, it was decided, following the December 1997 AGU discussions, to pursue the possibility of developing a new InterRidge Working Group dedicated to developing and coordinating international studies of the partitioning of hydrothermal venting around the world's mid-ocean ridge-crests from very slow to very fast spreading rates. A call for expressions of interest was sent out in late December to the InterRidge electronic mailing list with submissions from interested parties invited by the end of January 1998.

16 responses were received from 5 countries, spanning a range of disciplines and expertise from vent biology to theoretical modeling of heat flow and from ridge dynamics to plume dynamics. During discussions in February 1998 with Mathilde Cannat and Cara Wilson at the InterRidge Office we developed an initial list of invitees to form the working group. The membership reflects not only the range of interests expressed, but also the international composition of InterRidge. The process of invitations and acceptance is already well underway and, to date, we have received firm acceptance from 14 members from 8 countries (Canada, France, Germany, Japan, Korea, Spain, UK, and USA). A preliminary meeting is being considered for next December, to coincide with the Fall AGU meeting in San Francisco, USA. The purpose of this meeting - of Working Group Members only - would be to establish/identify/prioritize preliminary areas of interests - with the option of expanding to a full InterRidge Workshop in the future.

InterRidge Global Partitioning of Hydrothermal Activity Web Page

http://www.lgs.jussieu.fr/~intridge/wg-flux.htm

Updates on InterRidge Projects

Back-Arc Basins Working Group Update

Jean-Marie Auzende[1] and Hiromi Fujimoto[2], Co-Chairs

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[2]Ocean Research Institute, University of Tokyo, 1-15-1, Minamidai, Nakano-ku, Tokyo, 164-8639 Japan

Spreading ridges in back-arc basins (BAB), while accounting for only 10% of the global ridge system, offer the opportunity of better understanding important processes such as the influence of subduction on melt generation, hydrothermal venting, and ridge segmentation. Additionally, hydrothermal vent biology in back-arc spreading systems far removed from the mid ocean ridges can be important for understanding vent biogeography and the evolution of species.

A great deal of BAB research has been undertaken by the international community. However, there needs to be better international communication, and coordination of future studies. Towards this end a working group was established last Fall.

The objectives of InterRidge BAB working group are:

1. To compile a list of all the cruises carried out in the BABs for the last 10 years.
2. To compile the publications resulting from these cruises.
3. To emphasize the major input of BAB studies on the knowledge of oceanic accretion.
4. To compare the different styles of spreading in BABs and the associated processes.
5. To coordinate the planned future actions in BABs (cruises, joint projects, workshops, etc.).

This work has already been started, and a compilation of recent BAB cruises can be found on the InterRidge web site.

InterRidge Back-Arc Basins WG Web Page: **http://www.lgs.jussieu.fr/~intridge/wg-bab.htm**
InterRidge BAB Cruise Summary Web Page: **http://www.lgs.jussieu.fr/~intridge/bab-cru.htm**

Arctic Ridges Working Group Update

Roland Rihm, Chair

GEOMAR, Wischofstrasse 1-3, Geb. 12, 24148 Kiel, Germany

Last Fall the report from the 1994 InterRidge *Arctic Ridges: Results and Planning Workshop* held in Kiel was published (see page 5 for ordering information). This 78 page report summarizes the existing knowledge and data about the Arctic Ridges, and details some of the logistical concerns involved with Arctic research. The major conclusion of the Kiel Workshop was that the Gakkel Ridge should be the highest priority for future geophysical and geochemical studies in the Arctic.

The next step in coordinating international research on the Arctic Ridges is to develop a Program Plan to direct future studies. Towards this aim, there will be an InterRidge workshop on *Mapping and Sampling the Arctic Ridges* held next October 16-17 in Hannover, Germany. The objectives of this workshop will be two-fold - to bring participants up to date on work done since the 1994 workshop, and to draft a Program Plan. Participants will be selected by the organizing committee to include broad representation of different relevant disciplines ranging from biology to geophysics. For more information on the workshop see page 65.

InterRidge Arctic Ridges Web Page: **http://www.lgs.jussieu.fr/~intridge/wg-bab.htm**
InterRidge Arctic Ridges 1998 Workshop: **http://www.lgs.jussieu.fr/~intridge/arctic98.htm**

Joint EDR & Observatories WG and Cables WG Initiative: MOMAR Workshop

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. This workshop will focus on the practical aspects of setting up long-term monitoring of the MAR in the area south of the Azores. It is envisioned that the monitoring will include parameters such as the biological and physico-chemical activity at hydrothermal vents, seismicity, volcanic activity, axial deformation and the physical properties of the crust. Workshop participants will draft a Program Plan which will serve as a guide in writing proposals. Potential participants should fill out the application form on the InterRidge web page before June 1, 1998. See page 67 for more details on the workshop.

MOMAR Workshop Web page:	**http://www.lgs.jussieu.fr/~intridge/momar.htm**
MOMAR Application page:	**http://www.lgs.jussieu.fr/~intridge/momar-r.htm**

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

In mid-1997, the InterRidge Steering Committee asked me to assist in renewing the international effort to build a detection and response capability for broad areas of the world ocean. Currently, real-time remote detection of mid-ocean ridge volcanic seismicity is restricted to a few technologies and a small portion of the global ridge system. Even if detection capabilities were more widely available, the logistics, resources, and technologies for field response would remain difficult problems. Despite these hurdles, the potential pay-offs of detection and response are great, allowing the direct study of active ridge processes. There are also valuable opportunities to study ridge processes through non-real-time detections and later field "evaluations" rather than "rapid responses".

In this update, I have provided my personal perspective on the current state of detection and response studies of ridge processes and some suggestions for possible strategies that are tractable in a constrained monetary environment. These ideas are not intended to be the ideal approach, but one that may be achievable through leveraging a wide range of resources. The recently established InterRidge EDR web page is a first step toward improving communications, and I hope it will also kindle further interest for studying the North Atlantic. Please feel free to contact me via e-mail with any suggestions or ideas to accomplish these goals.

Background

"Event Detection and Response" refers to a strategy for studying active ridge processes combining continuous monitoring of activity from long range, either in real-time or non-real-time, localizing that activity, and conducting a wide-range of field observations and sampling at the site as soon as possible. The strategy differs from the concept of an "observatory" in that no specific site is designated and instrumented in advance, but rather, the detection system defines the site, and the instrumentation is emplaced after (or during) the activity. The most difficult approach logistically combines real-time detection with "rapid response". A more tractable, but still challenging, approach combines non-real-time, but still long-range detection, with later event "evaluations" at the site of activity. Over much of the global ridge system, this latter approach is the only one currently feasible.

Event Detection

The concept of "Detection and Response" as a strategy for studying active processes on the mid-ocean

Updates on InterRidge Projects: **Event Detection and Response continued...**

ridge has been proven in recent years through the combined efforts of the U.S. RIDGE Program and the NOAA VENTS Program in the northeast Pacific Ocean. Taking advantage of civilian access to the U.S. Navy's SOund SUrveillance System (SOSUS), NOAA investigators have developed techniques to use underwater acoustics to detect volcanic seismicity at long range and localize the activity to within a few kilometers. On three separate occasions since 1991, U.S. and Canadian investigators have successfully responded to these detected events and documented the geological, chemical, and biological processes taking place on site. Even in the one case where the site could not be visited until after the activity ceased, valuable studies of the effects of mid-ocean ridge processes were conducted.

The development of real-time detection technology in other parts of the global ocean has not been as successful as the northeast Pacific effort. The SOSUS arrays were deployed in response to military needs and therefore cover only limited parts of the global ocean. Although the North Atlantic, for example, is one area with SOSUS coverage, the array geometries are not as well placed for ridge studies as the northeast Pacific. An earlier effort to implement real-time monitoring in the North Atlantic is no longer active and would be difficult to revitalize. Other potential sources of real-time detections are from land seismic networks such as those in Iceland and French Polynesia, but the sensitivity of these systems is lower than hydrophone arrays and the locations less accurate. Other seafloor technologies, such as ocean bottom seismometers or borehole seismometers, could be made real-time if undersea cable or other technologies were applied, but they would still be limited in their spatial coverage compared to hydroacoustic methods. They are probably best used as event response instruments.

Another approach to long-range ocean acoustic monitoring was developed by NOAA for use in the Eastern Tropical Pacific. Since NOAA maintains the eastern portion of the TOGA/TAO buoy array for ocean climate monitoring, access to designated sites by NOAA vessels on a semi-annual basis is assured. An Autonomous Hydrophone Array was deployed by NOAA VENTS in May, 1996, and continues to monitor the East Pacific Rise between 20°S and 20°N and the Galapagos Ridge west of 90°W. Unlike the SOSUS arrays, the data is stored within the instruments and can only be recovered when the instrument is serviced. This array provides the same sensitivity and accuracy as the SOSUS arrays, but presently provides data only at six-month intervals, although effrots are underway to make them real time. The current detection delay precludes "rapid response" in the area, but significant studies are possible through a thorough examination of the active sites with the knowledge of when the site was last active. It is doubtful that a "rapid response" effort could be mounted in the more remote areas even if real-time detection was available.

Event Response

The ability to respond to an active or recent event on the mid-ocean ridge requires the coordination of ships, personnel, and equipment, as well as a new approach to scientific proposal writing and funding. The first and most critical aspect of event response is communication, between investigators performing the detections, investigators coordinating or participating in the response, ship schedulers, and program managers funding the effort. There is also general interest by the broader scientific community, the public, and the media. Experience in the northeast Pacific has shown that the combination of the World Wide Web and programs such as InterRidge have provided an excellent solution. Initial announcement of the detections are broadcast to the scientific community through the InterRidge and associated mailing lists, and web sites set up (by NOAA for the Northeast Pacific examples) to rapidly disseminate detection, and later response, results to the broader community. This model can be improved upon and utilized in the future.

The availability of ships, personnel, equipment, and funding remains the most difficult aspect of this endeavour. In an ideal world, there would be adequate resources to "set aside" some of these needed components for event response. In reality, it is not practical to maintain ships, personnel, and extensive instrumentation "standing by" on the pier to respond to an event that lies at some undeterminable time in the future. Likewise, funding a field program for some undetermined time and place in the world ocean is difficult at best. A great deal of thought has gone into this area by the U.S. RIDGE community and the successes in the northeast Pacific have been due in part to this planning and in part to an ideal set of circumstances.

In the northeast Pacific case, there are many factors working to make the response effort tractable, besides the availability of SOSUS detections. First, the partnership between RIDGE investigators and the NOAA Vents Program has been mutually beneficial. In the past, NOAA has maintained a large fleet of ships in Seattle, WA that increased the possibilities that some time could be allotted to event response. In addition, several Canadian and U.S. UNOLS vessels are based in the area. Also, the NOAA Vents Program has provided a small team of investigators focused on this effort for several years, bringing expertise and basic equipment. The RIDGE community has provided complementary expertise and specialized instrumentation such as cameras, seismometers, geophysics, gas chemistry, etc. to join forces with NOAA's team. The Canadian ROV ROPOS, based in British Columbia, has been invaluable in past efforts. The proximity of the northeast Pacific ridges to shore and the number of research-

Updates on InterRidge Projects: **Event Detection and Response continued...**

ers actively studying in the area have also made it an ideal area for rapid response.

Coordinating responses to more remote areas of the global ridge system with a wider international involvement is perhaps the largest challenge facing the InterRidge project . Funding must first be in place for participants. In the U.S., the NSF has created a funding model in which funds for response preparation may be released to the investigator first, and the remainder for field work is then held until needed. This approach has not yet been tested, but provides a reasonable model for international efforts as well. Ideally, government agencies such as NOAA in the U.S., can be involved in the effort to provide more stable resources. The coordinating of ships, personnel, and equipment are a most difficult proposition that must be addressed.

Current Situation

The current state of detection and response for the global ridge system can best be discussed in terms of detection capability, since without detections there can be no response. The SOSUS monitoring effort in the northeast Pacific continues by NOAA's Vents Program, and it is likely that this capability will remain in place. The same is true of NOAA's eastern equatorial Pacific monitoring effort using autonomous hydrophone arrays. Icelandic and French Polynesian seismic arrays remain active. There are some acoustic monitoring efforts ongoing in New Zealand that may provide detections for activity in that region.

There are also efforts proposed but unfunded at present. These include proposals to deploy an autonomous hydrophone array in the North Atlantic and field expeditions targeted at evaluating active ridge sites defined by the existing autonomous arrays in the eastern Pacific. Many of the relevant SOSUS arrays in the North Atlantic have been decommissioned, although there are some efforts within the U.S. to reoccupy those stations for scientific use. The previous research program that was using the active military SOSUS in the Atlantic is no longer active and there are no known investigators interested in revitalizing that effort.

There is an active community of researchers beginning to exploit the use of undersea cables for scientific use (another InterRidge working group), but there are no large scale monitoring efforts planned for the near term. There are also plans for new cabled, underwater acoustic arrays for use in monitoring underwater nuclear testing, but they are several years away. Development has begun at NOAA/PMEL to allow real-time transmission of acoustic data from autonomous hydrophone arrays using buoy and satellite technology rather than more expensive cables, but this capability is also several years away.

Recommendations

In the near term, significant progress in event detection and response can be derived by using the current detection technologies to best advantage while developing new technologies for the future. On the detection side, many of these efforts are underway with acoustic, seismic, and undersea cable efforts. Other potential technologies may be discovered in the coming years. For the response side, many possible strategies offer themselves.

Detection

Although the NOAA/PMEL effort has provided proven real-time detection capabilities using hydroacoustics, there is much more to be learned using these techniques that can not be undertaken by the small NOAA research group. Questions in acoustic propagation, location accuracy, interpretation of the source parameters, and other inversions can be taken much further than at present. To address these questions does not, however, require the collection of new major data sets. The NOAA data, particularly the unclassified data from the autonomous systems, is available for study and there are several ocean bottom seismometer data sets collected within hydrophone coverage to allow direct comparison. On the technology side, there may be other monitoring strategies beyond hydroacoustics that can provide valuable understanding of the ridge systems, based on cables, satellites,

Related Web Sites

http://www.lgs.jussieu.fr/~intridge/wg-edr.htm	InterRidge ED&R Web Page
http://ridge.unh.edu/edr	U.S. RIDGE ED&R Web Site
http://www.pmel.noaa.gov/vents/geophysics.html	NOAA Vents Program Acoustic Monitoring Project
http://www.pmel.noaa.gov/vents/oceanseis.html	Pacific Seismicity Theme Page

Event Detection Response Sites

http://newport.pmel.noaa.gov/axial98.html	Axial Seamount (1998)
http://www.pmel.noaa.gov/vents/eruption.html	Gorda Ridge (1996)
http://www.pmel.noaa.gov/vents/coax/coax.html	CoAxial Segment (1993)

tomography, etc. that have not been exploited.

Rapid Response

There are certain problems that can only be addressed with rapid response, where instruments are emplaced while the event is active. Studies in ground deformation, plume dynamics, and the subsurface biosphere all require that investigators arrive at the active site near the time of the activity (days to weeks). For these types of study, investigators are encouraged to participate in the one area of the ridge system that has an existing real-time hydroacoustic monitoring capability and some infrastructure for rapid response: the northeast Pacific spreading centers. For studies of active volcanic processes, or perhaps the subsurface biosphere, highly active targets off the ridges may be attractive, such as Loihi Seamount off Hawaii (with an operational real-time observatory) or 'Kick'em Jenny' in the Lesser Antilles. Also, the Icelandic seismic array is capable of detecting activity on the Mid-Atlantic Ridge near Iceland, and was in fact the site of one of the first response efforts. So as new areas become available in the future for real-time monitoring, the technology and expertise developed at these sites can be transferred, but for the foreseeable future, the northeast Pacific is the best available site for rapid-response ridge crest studies.

Event Evaluation

This is the area that has the most promise for new discoveries. Monitoring technology for hydroacoustic detection is in place in the equatorial Pacific and is currently being proposed for the North Atlantic. A better understanding of these ridge systems, which differ substantially from the Juan de Fuca system, could be a valuable focus for field research in the coming decade. These could take the form of targeted field experiments or "opportunistic" investigations using available monitoring results with scheduled cruise to the general area. Such investigations would lead directly to a better understanding of the active processes of ridge systems as well as providing important ground truth for the monitoring effort.

Biology Working Group Update:
Recent Progress on Facilitating International Exchange of Biological Samples

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An international group of scientists who work on vent organisms gathered during the International Vent Biology Symposium in Madeira, Portugal for an evening discussion on exchange of biological samples. The motivation for this meeting was the ongoing effort of InterRidge to facilitate open exchange of preserved and frozen samples from mid-ocean ridge hydrothermal vent sites to foster collaborative research, and to address global questions such as the biogeography and evolution of vent species. Such an exchange program was intended to help to avoid duplicate sampling, which is costly in human, monetary and ecological terms. The specific objectives of the meeting were to formulate a plan to:

- Foster exchange of biological samples collected by individual vent biologists
- Facilitate the collection and distribution of biological samples from "bioboxes"
- Draft a revised sample exchange agreement

This discussion followed a two-year effort by the InterRidge Biology *ad hoc* Committee to draft a formal Sample Exchange Agreement, which was to have been signed and ratified by InterRidge national correspondents or other appropriate representatives (for example, potential sample curators). The response we received from the curators and other biologists involved in the effort made it clear that individual investigators and their sponsoring nations all had very different mechanisms for dealing with samples, and that any agreement needed to be informal and flexible. Furthermore, we found that the bioboxes (kits of supplies, preservatives, containers and instructions provided to science parties on cruises without participating biologists for collection of biological specimens), while spectacularly successful in some instances, were being utilized less widely than we had hoped. With few exceptions, the individuals supplying the bioboxes and curating and distributing the specimens were doing so with little financial support from their national funding agencies.

After an evening of spirited discussion, the major recommendations from the workshop participants were:

1. InterRidge should make available to the community a list of biological specimens and samples. This listing would include information on where the samples were collected, where they are currently stored and who is responsible for them.

Initially, this list will be compiled from forms sent along on all future biology cruises to hydrothermal vents. The Chief Scientist or other appropriate principal investigator will be asked to supply information about biological collections on the form. Scientists who wish to obtain specimens from these collections can then contact the responsible individual and make a request. The terms of the exchange will be up to the individuals involved, and the curator of the specimens may well refuse if he/she needs the specimen for ongoing investigations. Suggestions for the terms of an exchange are provided in the 1995 InterRidge workshop report on "Biological Studies at the Mid-Ocean Ridge Crest" (copies available from the InterRidge Office, see pg. 5) and on the InterRidge web site. These sorts of international exchanges occur commonly in our community - the improvement suggested by the workshop participants is to catalog the samples and make this information available to the community. This objective is currently being implemented.

Ultimately, InterRidge should strive to make available a listing of biological samples from both present and past cruises. Although specimen lists from a few past cruises may be easily accessed, creation of a comprehensive database will require a substantial investment of effort and funds. Compiling and organizing information on existing collections in individual scientists' laboratories will not be an easy task, since the scientists are not likely to have the time or motivation to catalog their specimens. Assistance would need to be provided to scientists by one or more individuals who were dedicated to the task of creating the database. The role of InterRidge would be to encourage member nations to make the development of such a biological database a high priority for national funding agencies. Ideally, funds from national or other sources would support an effort to gather and organize information on biological specimens (both frozen and preserved) and make the database accessible from the web. This objective could be be fully implemented only if funds became available.

2. InterRidge should continue to support the biobox concept. This support consists of publicizing the need for distribution of bioboxes to cruises lacking biologists, and emphasizing the need for financial support from national funding agencies for curation of the resulting samples. Very few national programs have allotted the resources necessary to sort and identify specimens from bioboxes, or from other mixed-species samples collected secondarily during biological investigations at vents. National curators will be asked to provide information on biobox collections to the InterRidge web site of biological samples described above. No simple solution exists for some of the biobox problems (i.e., low acceptance and return rate, funding for curation and distribution of samples), but InterRidge can continue to give the concept support and visibility.

In response to these recommendations, InterRidge has devised a draft form to send to sea with biologists, and to post on the web. This form will be modified and finalized based on comments from "beta" users. InterRidge is also developing a web page to display the contributed listings of biological specimens from present and future cruises. Mechanisms by which InterRidge can encourage national efforts to compile a biological database will be discussed at the next Steering Committee meeting. The general consensus of the workshop was that an effort to collect, organize and disseminate information on biological samples would facilitate international sample exchange more effectively than a formal written agreement.

Biology Working Group Web Page
http://www.lgs.jussieu.fr/~intridge/wg-bio.htm

Sample Exchange Agreement Web Page
http://www.lgs.jussieu.fr/~intridge/samp-exc.htm

Database of Biological Samples Web Page
http://www.lgs.jussieu.fr/~intridge/samp-db.htm

Updates on InterRidge Projects

Report on the Hydrothermal Vent Biology Symposium

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In 1995 a group of hydrothermal vent biologists, under the umbrella of the InterRidge Biological Studies *Ad hoc* Committee suggested that an international symposium should be convened to bring together the expanding international community of biologists researching deep-sea hydrothermal vents and cold seeps. In response, the First International Symposium on Deep-Sea Hydrothermal Vent Biology, was held in Madeira, Portugal in October, 1997. This InterRidge Symposium was organized by Manuel Biscoito, Craig Cary, David Dixon, and Heather Sloan, and was hosted by Manuel Biscoito.

During the five days 120 participants presented 59 oral presentations and 24 posters, which were organized in six sessions: (1) Ecology/ Microdistribution/Temporal Evolution, (2) Physiology/Adaptation, (3) Biological Cycles/Larval Dispersal/ Plankton, (4) Microbiology/Ultra-thermophiles/Bacterial Symbiosis, (5) Cold Seeps, and (6) Biogeography/ Evolution/Genetics/Taxonomy. At the beginning of each session an invited speaker gave a general talk on the subject.

Prof. John Delaney of the University of Washington, USA, opened the Symposium with a talk on the possible existence of hydrothermal vents on some of Jupiter's moons, establishing a comparison of this type of phenomena to different parts of our solar system.

The Ecology, Microdistribution and Temporal Evolution session was opened by Dr. Daniel Desbruyères of IFREMER, Brest, who gave a general perspective of the dynamics and temporal evolution of vent ecosystems on the East Pacific Rise (EPR). The contributed presentations discussed vent ecosystems from areas including the Mid-Atlantic and Juan de Fuca Ridges (MAR and JdF), the Lau Basin, the EPR and the Aegean Sea.

The Physiology and Adaptation session was opened by Prof. Charles Fisher, from Pennsylvania State University, USA, who gave a general talk on the physiological ecology of hydrothermal vents and cold seeps. During this session several physiological aspects and adaptations of *Riftia*, *Branchypolynoe*, *Alvinella*, *Bathymodiolus*, and vent shrimps, among others, were extensively discussed.

Prof. Paul Tyler of the University of Southampton, UK, opened the session on Biological Cycles, Larval Dispersion and Plankton with a keynote presentation on reproduction at vents and cold seeps in which he compared the current accumulated mass of data to a jigsaw, casting light on our ignorance of these processes. Presentations covered the reproductive biology of mytilid bivalves from the MAR and vestimentiferans from cold seeps of the Gulf of Mexico, as well as molecular identification and distribution of early stages of Bresiliid shrimps from the MAR. Species colonization on the EPR, 2 or 3-dimensional hydrothermal communities at the MAR, and reproductive biology and population structure of hydrothermal vent invertebrates at the MAR and JdF were also discussed.

A session convened by Dr. Daniel Prieur, from the Station Biologique de Roscoff, France, was dedicated to Microbiology, Ultra-thermophiles and Bacterial Symbiosis. The session was opened by Prof. Douglas Nelson from the University of California at Davis, USA, who summarized the recent findings in microbiology of hydrothermal vents and seeps. The session focused not only on sulfur-oxidizing bacteria, epibionts, symbionts and hyperthermophiles, but also on chemolithoauthotrophic bacteria capable of reducing Fe or Mn. Two new species of hyperthermophilic Archaea found in the North Fiji Basin were presented.

Cold seeps were covered in a session convened by Prof. Robert Hessler, from the University of California at San Diego, USA, and Chair of the Symposium's Scientific Committee. Prof. Jörg Ott, from the University of Vienna, Austria, presented an opening talk on chemoautotrophic symbioses in shallow marine ecosystems. Seeps from the Aleutian trench, the Gulf of Mexico and the Monterey Bay and Canyon were discussed, as were fossil cold seep faunas from Barbados, and affinities between whale-fall, seep and vent chemo-autotrophic communities.

Finally, a session dedicated to Biogeography, Evolution, Genetics and Taxonomy ended the Symposium. Professor Verena Tunnicliffe, from the University of Victoria, Canada, presented a talk on the biogeography relations among the world's vent faunas, stressing in the end the need for appropriate training and funding of taxonomists in order to continue the work in vent biogeography. The contributed presentations covered topics ranging from global geographical patterns and the discovery of new vent faunas in general, to molecular phylogeny of thermophilic microbes, Polychaetes, Vestimentiferans, Gastropods and Bivalves.

Copies of the Symposium abstract volume are still available upon request to either Manuel Biscoito or the InterRidge Office. Short contributions from the Symposium will be published by the end of the year in a special volume of the *Cahiers de Biologie Marine*.

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

Deep-Sea Sanctuaries at Hydrothermal Vents: A Position Paper

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The concept of sanctuaries has a long history of acceptance for ecological studies and environmental preservation in both terrestrial and marine environments. For deep-sea vents, the idea of designating sanctuaries was informally introduced during discussions at international meetings and symposia in the early 1990s. A more formal recommendation to explore the concept of seafloor sanctuaries in terms of respect for ongoing experiments and instrument deployment as well as biodiversity issues was made by a committee of biologists who met in 1995 at the InterRidge at the Biological Studies *Ad Hoc* Committee Workshop.

The main objective of this article is to formally propose the concept of deep-sea hydrothermal vent sanctuaries to the research community, and to recommend ways to facilitate a fair and equitable process for establishing sanctuaries and disseminating information about them.

We are now entering the third decade of biological research at deep-sea hydrothermal vents. The first two decades embraced a remarkable period of discovery - of new sites, novel organisms and unusual adaptations. Dozens of new vent fields and hundreds of new species later, exploration of unknown areas of the global ridge system is no longer the primary driver for discovery in hydrothermal vent biology. A diminished exploration effort is tied to new developments in vent research that emphasize temporal processes, therefore requiring time series observations at fixed locations. Shifting of investigative effort to the time domain is resulting in the concentration of sampling, observation and instrumentation at a small number of well known hydrothermal sites. The potential returns from coordinated, multidisciplinary time-series studies are tremendous, and organizations in several countries are encouraging biologists and earth scientists to work together at single locations to investigate linkages between the processes they study. Meanwhile in the field, we are discovering that certain research activities are incompatible, and that even more cooperation and coordination will be required in order to resolve potential conflict. The main issue is the incompatibility of investigations that are trying to understand how vent systems function by monitoring them in an undisturbed state, with those that study processes by manipulating the system and/or collecting parts of it.

Imagine this scenario - You are the chief scientist on a research expedition to study deep-sea hydrothermal vents. You have a ship full of investigators who represent many nations and who all have specific needs for imaging, measuring and collecting a variety of entities, including rocks, seawater and organisms. The scientists are bringing cameras and other instruments that will be towed at the end of a long cable, current meters that will be moored on stations and containers full of gadgets to attach to the submersible. You are responsible for ensuring that none of these activities has a negative impact on the others. On top of all this, you have a set of instructions from another set of investigators forbidding you to manipulate, or perhaps even to visit, some of the most intriguing vent fields in the vicinity of your study site. How can you possibly accommodate everyone's requests while optimizing the scientific productivity from your cruise?

This dilemma is now faced by virtually every research team that visits hydrothermal vent systems along the Mid-Atlantic Ridge, the East Pacific Rise, and the northeastern Pacific. The problem is likely to spread to other vent sites as they become more frequently visited. The observers wish to set aside areas (sometimes quite large) for sanctuaries, to be monitored and measured, but not disturbed. The experimentalists want to have access to systems to manipulate and observe, and also set aside restricted areas. The collectors want free access to all sites. Ideally, the vent system will be best understood through a combination of these various approaches, but that goal requires altruism and cooperation among all scientists involved in field investigations of vent systems. The culture of science and the reality of international research prevent the imposition of top-down regulation by any one individual or organization. Instead, the cooperation must be obtained through consensus.

The case for establishing research sanctuaries at hydrothermal vents is compelling. Long-term observations of vents and their associated communities have provided a wealth of information and new understanding. There is no question that disturbance by researchers can have a substantial impact on vent systems, particularly on faunal communities. Anthropogenic changes in the distribution and occurrence of vent fluid flows and of associated vent communities have been well documented at vents along the East Pacific Rise, on the Juan de Fuca Ridge and at the TAG field on the Mid-Atlantic Ridge. A complete understanding of vent systems, however, requires a diverse and balanced approach of observation and experimentation. In response to the need for facilitating this balanced approach, InterRidge is in the process of setting up a web site on deep-sea

International Ridge-Crest Research: **Biological Studies:** Mullineaux et al...

sanctuaries at hydrothermal vents.

The InterRidge web site will create a forum where researchers can propose vent sanctuaries, and where others in the oceanographic community can respond to them. If, for instance, a large sanctuary is proposed at a site where experimentalists have a history of working, then that sanctuary is not likely to be acknowledged by the community. If, on the other hand, a small sanctuary is proposed in a region where it will not prevent ongoing manipulative research, then it will likely be honored. The research sanctuary system will be regulated entirely by consensus, but InterRidge will play a role in disseminating the information and summarizing controversies, if they arise. The web site will be of general use in several ways: seagoing researchers will have a single source of information on regions where ongoing research is being conducted, and the community will have a forum for holding proposed sanctuaries up for scrutiny.

Recognition of the need for 'no touch' sanctuaries also carries with it the requirement to provide for the needs of those seagoing scientists who require fresh specimens. Some pressure on the more popular vent sites can be relieved by a modest exploration effort designed to identify new vents to provide fresh material for shipboard physiological and biochemical studies. Just as we must educate funding agencies and the peer review community as to the importance of the sanctuary concept, we must also convince them of need to spend valuable submersible bottom time looking for new vents in the vicinity of the protected areas. Adding one or two dedicated exploratory dives to future cruises could go a long way toward easing the task of the chief scientist as he/she juggles the interests of the observers and the samplers.

The concept of deep-sea sanctuaries has much broader implications than those related to the competing goals of a handful of scientists. The preservation of biodiversity in these vulnerable habitats is also a currently debated issue. Especially with the recent disclosure of plans to extract minerals and metal from vent habitats in the South Pacific, environmentalists and ecologists are calling for establishment of specific vent areas as sanctuaries from mining or any other harmful human activities. Scientists have an obligation to provide sound information on the distribution, structure and function of vent communities to the national and international governing agencies that will be deciding their fate. We also have the opportunity to provide a model for coordination and cooperation among diverse interests in the resources at vent systems.

Hydrothermal Vent Sanctuaries Web Page
http://www.lgs.jussieu.fr/~intridge/sanct.htm

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

Biology and Physiology Studies of the Tubeworm *Riftia Pachyptila*: New Perspectives

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The mouthless, gutless tubeworm *Riftia pachyptila* (Jones, 1981), commonly found around East Pacific Rise (EPR) hydrothermal sites, is the most renowned species of the deep-sea hydrothermal vent communities. This "autotrophic" organism derives the energy necessary for its growth and metabolism from chemo-autotrophic sulfur-oxidizing endo-symbionts located inside a highly vascularised organ, the trophosome (Cavanaugh, et al., 1981; Felbeck, et al., 1981a, b). Consequently, *Riftia* must fuel its symbionts with oxygen, sulfide and carbon dioxide (Fig. 1). To transport these compounds, *Riftia* possesses three different hemoglobins (Hb) dissolved in the vascular blood and coelomic fluid (Zal et al., 1996a, b). These Hbs have a high affinity for oxygen (Arp et al., 1990), an ability to reversibly bind sulfide (Arp et al., 1987, Zal et al., 1997a, b), and a negligible ability to combine with carbon dioxide (Toulmond et al., 1994).

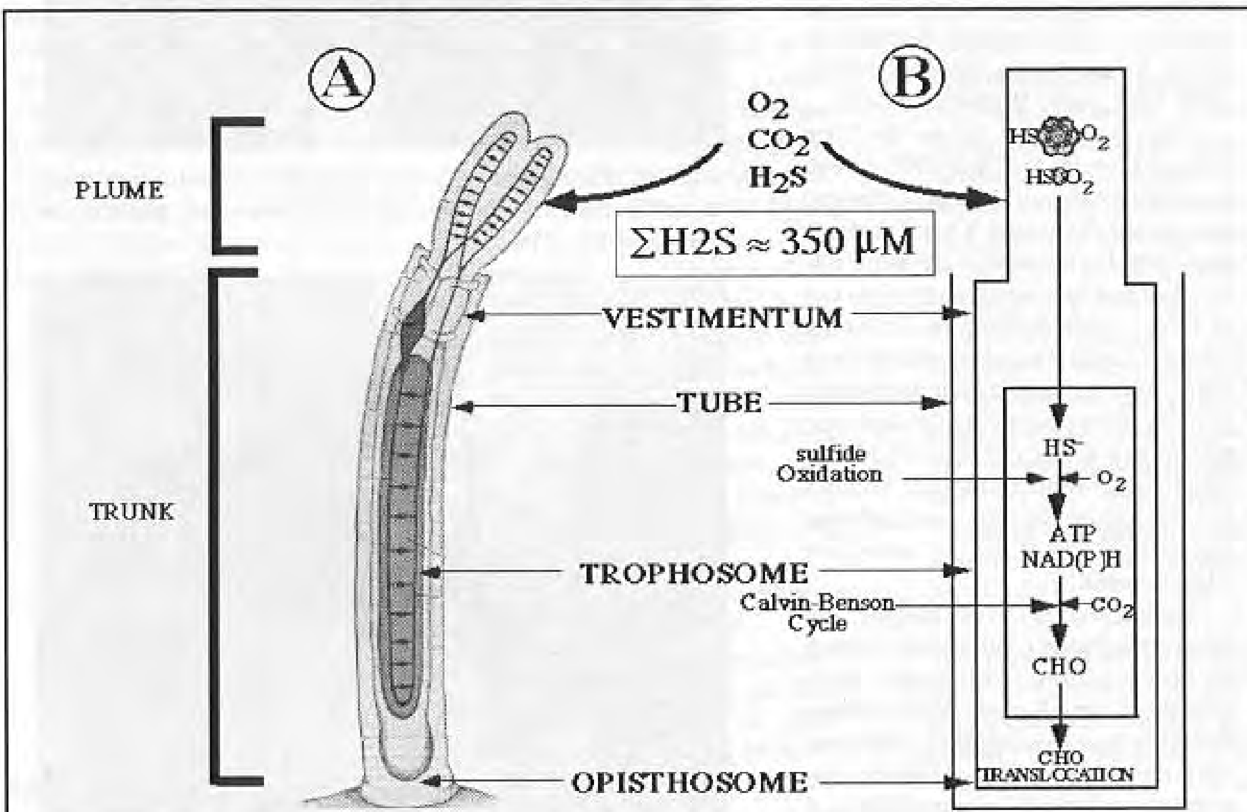

Figure 1. Scheme of the gas uptake by *Riftia pachyptila*, adapted from Childress et al. (1987). A - *Riftia* is maintained inside its protective outer tube by a ring of muscle, the vestimentum. At its anterior part is a respiratory gill, the plume. The posterior end is constituted by an anatomical structure, the opisthosome. B - Oxygen, sulfide and carbon dioxide absorbed through the plume filaments are transported by two extracellular hemoglobins (V1 and V2), contained inside the close vascular system, to the cells of the trophosome. The trophosome is the site of chemosynthesis and fills up much of the coelomic cavity which also contains a small Hb C1. Dense colonies of chemoautotrophic sulfide-oxidizing endosymbionts live inside the trophosome and provide nutrients to the worm during the chemoautotrophic process.

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For the last several years, we have been studying *Riftia*'s modes and rates of nutrient acquisition, (Childress and Fisher, 1992; Goffredi et al., 1997a, b). To that end, we have focused our efforts on simulating the vent habitat with our experimental high pressure aquaria (Quetin and Childress, 1980). This system was conceived and designed by Dr. James Childress at the University of California, Santa Barbara. It consists of a high pressure pump capable of 250 atmospheres, custom-built high pressure vessels and other components which are used to reproduce the natural conditions encountered by *Riftia*. This system has been routinely used for roughly 10 years at sea. During that time, there were several attempts to bring live *Riftia* back to the laboratory which were unsuccessful due to technical problems. However, recent scientific and technological progress has allowed us to successfully maintain the worms for nearly two months (Holden, 1998; Huet, 1998; Barthélémy, 1998).

Last December during the "Hot Times'97" cruise at 9°50 N EPR, we collected thirty *Riftia* (10 - 15 cm tube length) and placed them into a high pressure aquarium. On board ship, the entire system was kept in a refrigerated cargo van at 15°C. After docking on December 25th, the vessel was sealed, placed into a truck, and brought to our laboratory (Fig. 2). We reconstructed the shipboard system and began our round-the-clock monitoring of water conditions. Within a day, we had established simulated vent conditions and suffered only one tubeworm death.

During the next two months, the tubeworms clearly exhibited tube growth (up to 40% of the original length). Their plumes (i.e. the gill across which nutrient flux takes place) maintained a healthy red color, due to the presence of high Hb concentration, and exhibited normal behavior (Fig. 3). Unfortunately, during one of the worst storms that California suffered during February due to the El Niño phenomenon, the campus sea water supply was contaminated with freshwater run-off and silt. Shortly thereafter, all the worms had pulled into their tubes, a behavioral response which seems linked to poor water quality. Within a few days they had all died. Examination of the system's filters and mixing column confirmed the

Figure 2. Photograph of the tubeworm life support system prior to arrival at UCSB. Tubeworms can be seen on the platforms in clumps of 10-12 per tier.

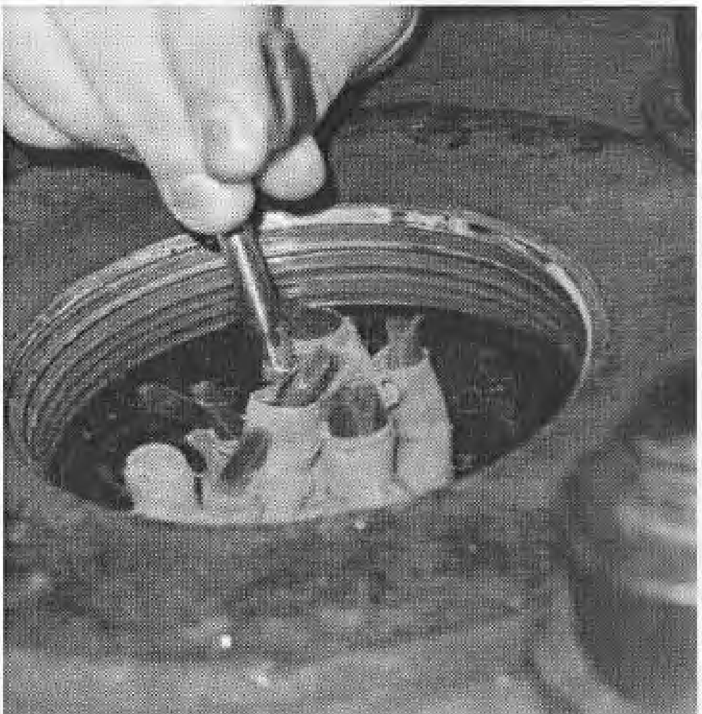

Figure 3. Photograph of the plumes of 10-12 *Riftia pachyptila* as they are being lowered into the pressure aquarium. The aquarium was opened weekly for cleaning and maintenance (Franck Zal's picture).

contamination.

The success of this effort (in spite of their unfortunate deaths) clearly demonstrates that we are capable of sustaining *Riftia* in the laboratory. This event is a first in deep-sea hydrothermal vent biology. The ability to maintain these organisms in the laboratory has opened up exciting new research possibilities. With some effort, this could be carried out on a larger scale, allowing scientists to conduct some of their experiments on land instead of at sea.

Acknowledgements

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

Chromosome numbers and genome size in deep-sea hydrothermal vent organisms

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During the recent FLAME and MARVEL cruises to the northern vent sites on the MAR (Menez Gwen, Lucky Strike, Rainbow), in the summer of 1997, an investigation was carried out to determine the feasibility of working with the chromosomes of hydrothermal vent species: (1) from the point of view of cytotaxonomy, and (2) for the study of chromosomal abnormalities stemming from exposure to toxic vent emissions, which are known to contain substances with well documented mutagenic and carcinogenic properties (e.g. arsenic, heavy metals, radionuclides). Given that vent species have been subjected to heavily contaminated conditions over millions of years, their responses and evolutionary adaptations to this hostile environment are of great interest to ecotoxicologists and may hold important insights relevant to heavily polluted aquatic and terrestrial environments closer to home.

An essential prerequisite for chromosome studies is an abundant supply of dividing cells. It is already well documented that vent organisms have extremely fast growth rates (e.g. Lutz et al., 1994), and it was therefore expected that their cell division rates would be correspondingly high. To test this out practically, a range of tissue types (gonadal and somatic tissues) from several major vent taxa (gastropods, a bivalve mollusc, *Bathymodiolus* sp., a commensal polychaete, *Branchiploynoe*, and three caridean shrimps, *Rimicaris exoculata*, *Chorocaris chacei* and *Mirocaris fortunata*) were processed for slide manufacture and then screened for the presence of dividing cells. The amount of DNA in the diploid cell nuclei of each species was determined using a Vickers M85 integrating densitometer, after the cells had first been stained using the Feulgen method (e.g. Gambi et al., 1997). Apart from measuring DNA content of individual cell nuclei, the densitometer also allowed the proportion of non-dividing cells which were nonetheless undergoing DNA synthesis to be determined, which thus gave a more accurate indication of cell division rate (data not shown).

A striking difference was found between the rates of cell division in vent and non-vent organisms. In keeping with the their fast growth rates and correspondingly high levels of repro-

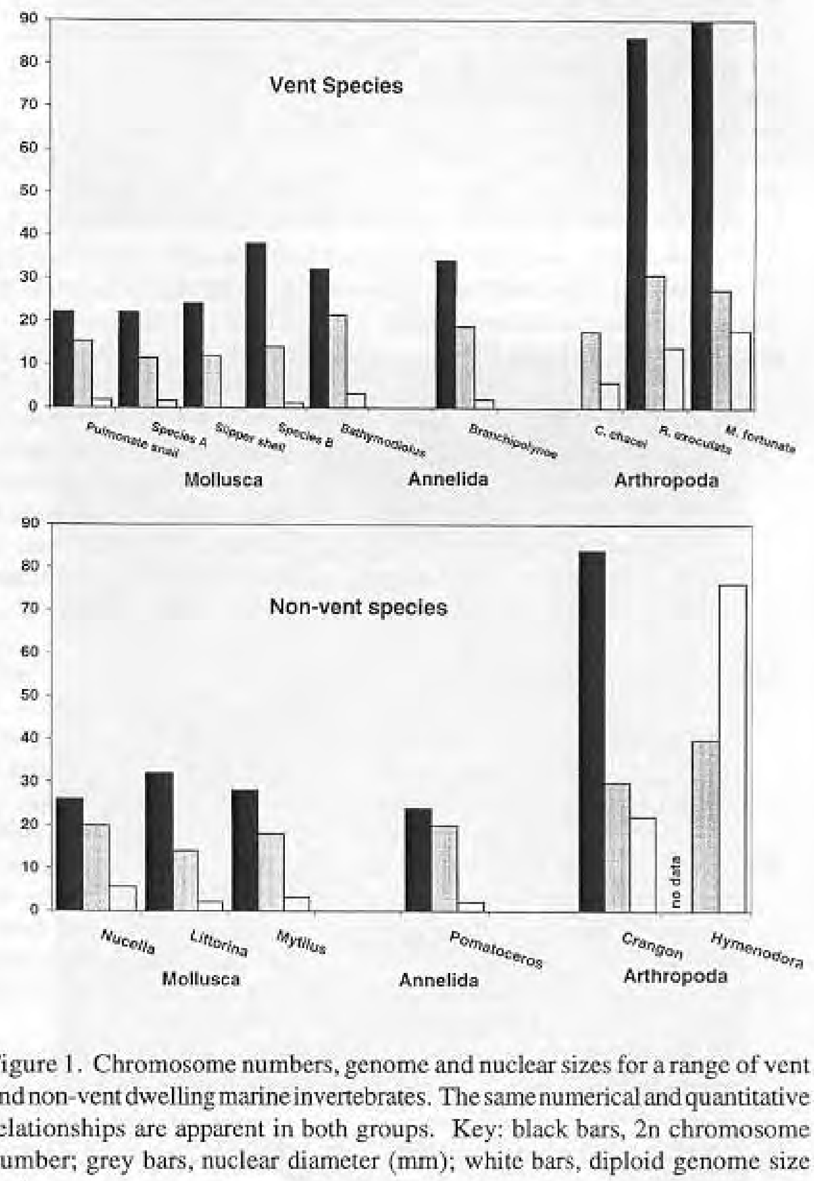

Figure 1. Chromosome numbers, genome and nuclear sizes for a range of vent and non-vent dwelling marine invertebrates. The same numerical and quantitative relationships are apparent in both groups. Key: black bars, 2n chromosome number; grey bars, nuclear diameter (mm); white bars, diploid genome size (pg).

ductive activity, the majority of vent species, irrespective of the phylum they belonged to, contained significant numbers of dividing cells. In contrast, the deep-sea species contained virtually no dividing cells (surprisingly, this included their embryonic stages, e.g. *Gnathophausia*), while in terms of cell division rate the shallow-water species occupied an intermediate position between the other two groups. In comparison to the vent animals, the deep sea crustaceans *Hymenodora* and *Gnathophausia* appeared to be in a state of virtual suspended animation, although this may reflect periodicity in growth rate linked to infrequent bouts of feeding activity. These high rates of cell division have only once before been seen by us and that was in juvenile mussels (*Mytilus*) which had been maintained under artificial culture conditions at relatively high temperature (20°C) and where food was not limiting and was of high quality (Dixon and Clarke, 1982). The similarity with the vent conditions is striking and points to the possibility that there may be nothing intrinsically different between vent organisms and other marine invertebrates which cannot be explained simply in terms of temperature and food supply.

Fig. 1 shows chromosome numbers and genome and nuclear sizes for a range of vent and non-vent invertebrates. In contrast to the differences in cell division rates, no differences were found between vent and non-vent species in their taxonomic group values for chromosome numbers, nuclear diameters or genome sizes. While the vent organisms exhibited a wide range of chromosome numbers, these values were in agreement with those typical of their non-vent relatives (Thiriot-Quievreux, 1994). Vent gastropods, for example, displayed a range of chromosome numbers ranging from low to medium 2n values, 22-38 (Fig. 1), whereas in keeping with other decapods the vent crustaceans, *Rimicaris exoculata* and *Mirocaris*

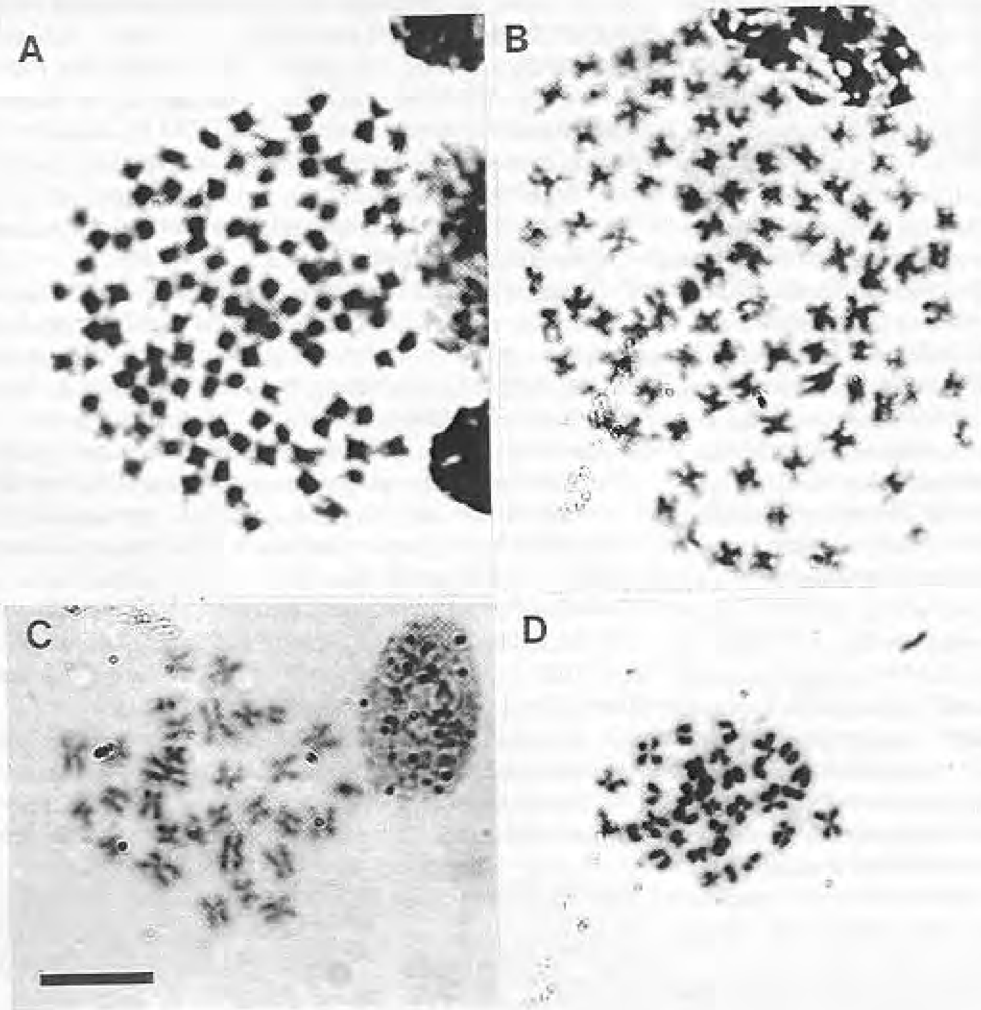

Figure. 2. Representative chromosome spreads from a range of hydrothermal vent species: A. Decapoda, *Rimicaris exoculata* (2n = 86, provisional count), B. Decapoda, *Mirocaris fortunata* (2n = 90), C. Annelida, *Branchpolynoe* sp. (2n = 34), D. Mollusca, *Bathymodiolus* sp. (2n = 32, provisional). Scale bar, 10 μm.

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fortunata had chromosome numbers in the high diploid range, 80 - 90 (Fig. 2). This indicated that chromosome number as a character was conserved within the different animal groups irrespective of habitat type. A similar pattern was recorded for genome size and nuclear diameter (Fig. 1). From these cellular characteristics it would appear that hydrothermal vent organisms, despite their long history (e.g. Tunnicliffe, 1991), have not diverged significantly from their non-vent dwelling ancestors. It remains to be seen, however, whether adaptation to the vent environment has involved more subtle changes to chromosome structure and DNA composition (e.g. Dixon et al., 1992).

It is already well recognized that marine invertebrates are extremely sensitive to damage inflicted on their DNA and chromosomes by environmental mutagens and clastogens (e.g. Dixon, 1983; Jha et al., 1996). The findings of the present study clearly demonstrate the potential of hydrothermal-vent organisms as subjects for cytotaxonomy and mutation studies. Given their extremely harsh environmental conditions, it remains to be seen whether the specialized vent fauna is at risk from genetic disease and birth defects induced by environmental contaminants in a similar way to species living elsewhere, including ourselves. Environmental toxicity clearly posed a major hurdle to vent colonization which had to be overcome in order for them to be able to exploit the rich food energy potential and lowered competition at the vents. Interestingly, during the MARVEL cruise, newly hatched vent gastropods were observed which displayed similar types of shell abnormalities as those found previously in low water quality, shallow-water marine environments (Thorson, 1946; Dixon and Pollard, 1985).

Clearly, there is still much to be discovered about the hydrothermal vent biota, particularly in the fields of mutation research and pollution genetics. Given the immense time intervals which are involved, vent species offer a unique opportunity to study the adaptations and responses of marine life to acute and chronic exposure conditions over geological time periods. These studies may yield important insights into the control and treatment of pollution in aquatic and terrestrial environments elsewhere.

Acknowledgements

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Hydrothermal vents mussel *Bathymodiolus thermophilus* (Bivalvia, Mytilidae): diet item of *Hydrolagus affinis* (Pisces, Chimaeridae)

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The ichthyofauna of the Lucky Strike and Menez Gwen hydrothermal vents (Mid Atlantic Ridge) were studied previously by Saldanha (1994) and Saldanha and Biscoito (in press). The authors found a great abundance of chimaerids in the Lucky Strike field. One of the most abundant species in this field was *Hydrolagus pallidus* (reported as *H. mirabilis* by Saldanha, 1994).

Also, *in situ* observations and video records were made during submersible dives (*Nautile*, MARVEL Cruise, AMORES, 1997) at Lucky Strike, which provided new images of *Hydrolagus* sp. hovering near the vent areas (pers.observ.).

During June and November of 1997 we made 2 cruises (CRISTA 1 and CRISTA 2) to the hydrothermal vent fields to collect fish specimens. These cruises were part of the EC-AMORES project and took place aboard the N/I *Arquipélago* of the University of the Azores (DOP-Departmento de Oceanografia e Pescas).

A bottom long-line was used with 1000 hooks (50% n° 9 and 50% n° 12) that were baited with salted sardine and mackerel.

During both cruises several specimens of *Hydrolagus pallidus* and *H. affinis* were caught. This latter species, *H. affinis* is referred to by Stehmann and Bürkel (1984) to inhabit slopes and bathyal plains from 300 m to 2400 m or more, and to feed mainly on small fishes and invertebrates. The fishes caught during CRISTA cruises are the first record of *H. affinis* in the Mid-Atlantic Ridge area.

One specimen was captured during the CRISTA 2 Cruise, on November 11, 1997. We also captured in this trial thirty-four *Etmopterus princeps*, one *Centroscymnus coelolepis*, five *Hydrolagus pallidus*, three *Synaphobranchus kaupi* and one *Chiasmodon niger*. The drop-out geographical coordinates of the long-line were 37°17.62'N, 32°16.15'W and 37°17.44'N, 32°16.86'W at 1575-1734 m depth.

The fish was an adult male measuring 101 cm (TL). The stomach content weighted 53.1g and consisted of one specimen of the hydrothermal vent mussel, *Bathymodiolus thermophilus*. Examination of the broken shell pieces allowed us to estimate the mussel length at 66 mm. The body tissues and the byssal threads were not digested.

It was not possible to reconstruct the mussel shell, which may imply that it was broken when the fish extracted it from the substrate when some pieces were probably lost.

This work records for the first time the predation of *B. thermophilus* by a fish. We now know of three fish species that feed on hydrothermal vent fauna. Previously, a specimen of *Cataetyx laticeps*, that was caught in Lucky Strike during an Alvin dive (FAZAR Cruise) had in its gut the shrimp, *Chorocaris fortunata* and the crab, *Segonzacia mesatlantica* (Saldanha, 1994; Saldanha and Biscoito, in press). Also, Saldanha and Biscoito (in press) mention the shrimp *C. fortunata* in a stomach of a *Gaidropsarus sp*. However, it is quite possible that other species use the fauna at vent sites as a source of food. Our knowledge about the fish fauna associated with hydrothermal vents is still very limited.

Acknowledgements

We thank both the crew of *Arquipélago* and the DOP-UAÇORES group for the precious help and friendship while aboard. This work was funded by the EC MAST 3-AMORES project.

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International Ridge-Crest Research: **Hydrothermal Fluxes**

FLORES diving cruise with the Nautile near the Azores - First dives on the Rainbow field: hydrothermal seawater/mantle interaction

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Introduction

The FLORES diving cruise was part of the three years MAST III AMORES (1995-1998) program funded by the EEC (Contract n° 95-0040CT) which followed the previous MAST II MARFLUX/ATJ program conducted between 1993 and 1995. The MAST II program is a collaboration of five EEC countries (France, UK, Portugal, Ireland and Belgium) to investigate four volcanic segments along the Mid-Atlantic Ridge (MAR) between south AMAR and the Azores Triple Junction (ATJ) (Fig. 1). The major objectives of the program are: (1) to compare the physical, geochemical and biological fluxes from different hydrothermal fields on a segment scale, (2) to study the geological setting, structure and composition of hydrothermal systems on a vent field scale, and (3) to examine the influence of depth on hydrothermal processes and its consequences on vent ecosystems.

South of the ATJ, the ocean crust has a southward gradient in: (1) depth (from 800 m to 2800 m), (2) chemical properties of rocks, (3) nature of volcanism and (4) certain characteristics of the segmentation of the ridge axis. All of these characteristics are directly or indirectly controlled by the Azores hot spot.

During the summer of 1997 three cruises were coordinated through AMORES: Flame, Flores and Marvel. The objectives of the Flame surface cruise (May/June) were to pinpoint the location of the Rainbow hydrothermal field from physical and chemical tracers, and to study mixing processes, the dispersion of the neutrally buoyant plume, and biogeochemical fluxes in the Rainbow area and in the Famous segment (Fig. 1) (German et al., 1997; German et al., 1998). The Marvel diving cruise (Aug./Sept.) focused on biological studies.*

Following up on the results of the Flame cruise, (German et al., 1998) diving operations were conducted during the Flores cruise (July/Aug.) to find the Rainbow field and to study various aspects of hydrothermal processes on the MAR between 36°N and 37°N. Prior to the cruise two hydrothermal sites, Lucky Strike (Langmuir et al., 1997) and Menez Gwen, were known in this area. Three major factors were considered in selecting the dive targets for the Flores campaign: magma budget, rock composition and depth variations. Two targets were selected at central topographic highs where the magmatic budget is at a maximum within the segment (Menez Gwen and Lucky Strike). On the basis of previous nephel and CH_4 plume anomalies (Charlou et al., 1997; German et al., 1997) two other targets were selected at the end of two ridge segments where tectonic activity dominates volcanic activity (South Famous and Rainbow). The depth in the study area varies between 2400 m at Rainbow, 2800 m at south Famous, 1700 m at Lucky Strike and 800 m at Menez Gwen. There were three main objectives of the cruise: (1) to quantify the variability of hydrothermal activity, (2) to compare the nature and composition of fluids and massive sulfide formations in the four different environments, and (3) to sample fluids from diffuse flow, and from high-temperature, focused venting at Menez Gwen and Lucky Strike to assess temporal variability.

*Editor's Note: See the Dixon et al. article on pg. 20 for some results from the Marvel cruise.

Cruise operations

The FLORES cruise took place between Jul. 6 - Aug. 10, 1997 aboard the French R/V *L'Atalante*, the mother vessel of the manned submersible the *Nautile*. The night program conducted high resolution mapping (slow speed and narrow beam) with an EM12 multibeam system and took a series of vertical hydrocasts to optimize diving targets. The *Nautile* submersible was equipped with a CTD and minirosette water sampler, a H_2S *in-situ* analyzer, a nephelometer, titanium syringes and gas tight titanium samplers for hot vent fluids, bottles for particles sampling, a push core system, and markers to identify new sites. Additionally, a Medusa system for diffuse flow sampling, and time lapse temperature probes were placed on the seafloor for long term sampling and measurements.

A total of 29 dives were success-

Hydrothermal Fluxes Research: Fouquet et al. continued...

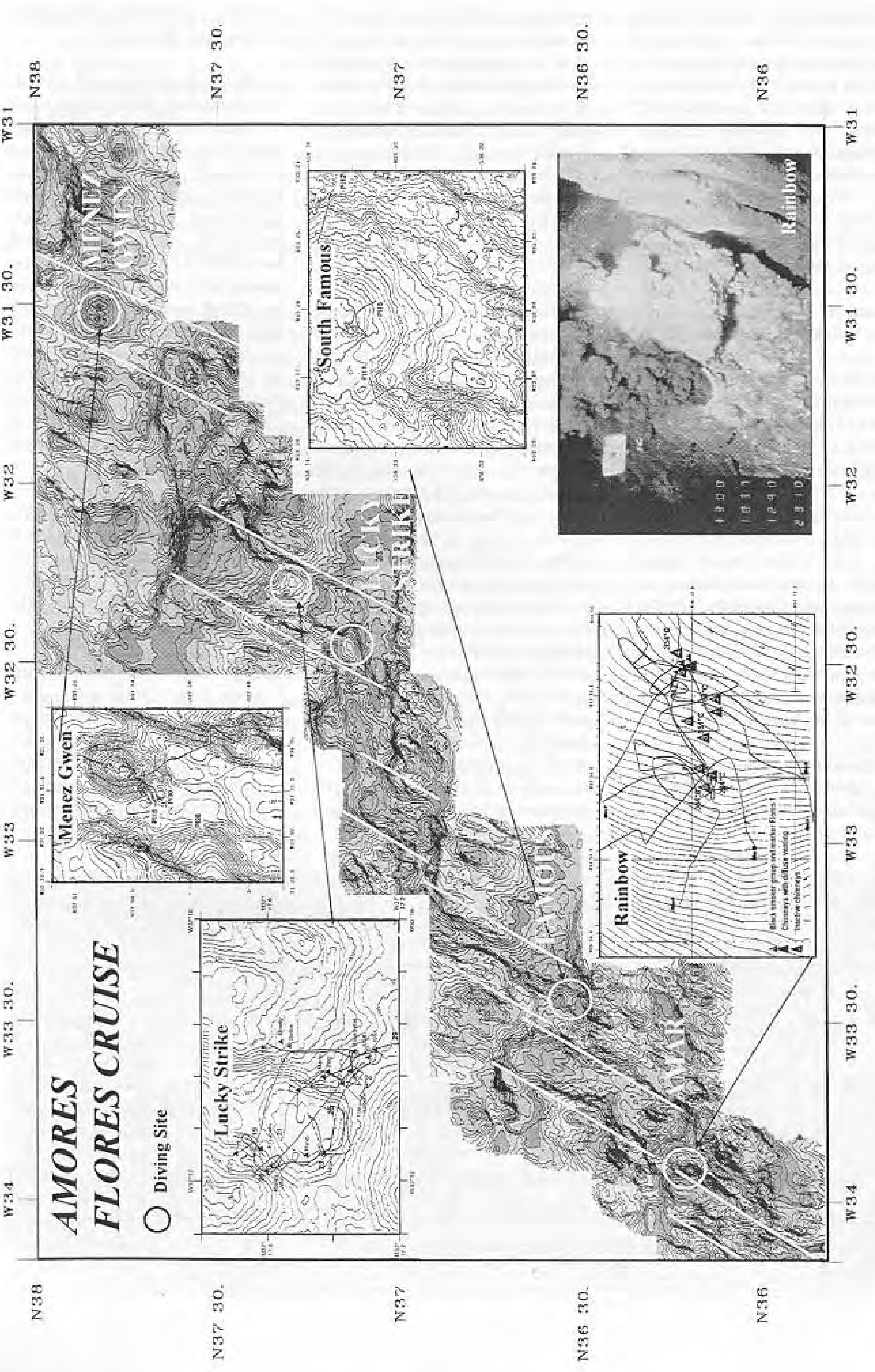

Figure. 1. Location of the 5 diving areas during the Flores cruise. Detailed maps show the diving tracks and the major active chimneys in the main diving targets.

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fully performed at water depths ranging between 2800 m and 800 m. The 149 hours spent on the seafloor covered 68 km of track and completed 7 minirosettes, 29 horizontal CTD tracks, 11 *in situ* H_2S analyses, 6 Medusa operations, and collected 57 vent fluid samples and 200 rock samples. The night program completed 18 vertical hydrocasts, 9 dredges and extensive high resolution mapping and imagery in the four segments.

Principal Results:

The Rainbow hydrothermal field

One of the major findings of the FLORES cruise was the discovery of the Rainbow active site in an environment of ultramafic rocks from the mantle. Ultramafic rocks were also recovered in the South Famous and the south Lucky Strike segments at places where intense methane anomalies have been identified (Charlou et al., 1997). The results from the FLORES cruise demonstrate that the composition of hydrothermal fluids and mineral deposits, and the associated chemical flux into the ocean, will vary depending on the geological setting and the underlying rock composition (E Morb vs. Ultramafic rocks).

Regional tectonic environment

RAINBOW and FAMOUS are two sites of quite distinct hydrothermal activity (Charlou et al., 1997; German et al., 1997). Both are located in second order discontinuities cutting the MAR south of the Azores (Parson et al., 1997) and have been surveyed and sampled during the FLORES cruise. The high temperature venting at the Rainbow site occurs along the shoulder of a W-facing hanging wall of a tilted ultrabasic block, the shoulder of which is cut by a network of intersecting N-S and NE-SW faults. Active and relict hydrothermal activity indicates persistent and precise tectonic control of this vigorous site at a range of scales. Around the site, and throughout the non transform discontinuity (NTD) a relative chronology of normal dip-slip extensional faulting, conjugate transtensional faulting and Riedel populations can be determined in the context of the evolution of the offset and the venting. At the southern end of the FAMOUS segment, the combination of new high-resolution multibeam bathymetry, sidescan sonar, dive data, and strong CH_4 hydrothermal anomalies (Charlou et al., 1997) indicates that venting is associated with serpentinisation of an unroofed ultrabasic diapir in this area. Similarly, elevated Crystal blocks mapped within non transform discontinuities on the MAR further point to significant tectonic/ultrabasic controls on hydrothermal circulation at slow spreading ridges.

Geological setting and sulfide composition of the Rainbow field

Based on the nephel, CH_4 and TDM (total dissolvable manganese) anomalies observed during the FLAME cruise, (Charlou et al., 1997; German et al., 1997; Radford-Knoery and Aballéa, 1997) one month before the FLORES cruise, ten dives were conducted at the Rainbow ridge on the AMAR segment. The active vent field (Rainbow), 250 m long and 100 m wide, is located at 36°13.80N-33°54.12W, on the western flank of the Rainbow ridge, between 2270 and 2320 m depth (Fouquet et al., 1998; Fouquet et al., 1997). This vent field is unique in several ways:

1. It is one of the most active hydrothermal field along the MAR in terms of heat and chemical flux, with about 10 major groups of extremely active black smokers dispersed over the entire field.

2. High resolution EM12 bathymetric maps (slow speed and narrow beam) and detailed submersible investigations show a clear tectonic control of the hydrothermal field that is located at the intersection between the non-transform

fault system (N40) and the ridge faults (N00). The western border of the field is a 25 m high fault scarp where stockwork mineralization is observed.

3. The entire vent field is located in an ultramafic environment. Only a small veneer of old basalt occurs at the east tilted summit of the Rainbow ridge, 1 km east of the active vents.

4. Chimneys and massive sulfides are enriched in Cu, Zn, Co and Ni compared to other sites in basaltic environments. At Lucky Strike and Menez Gwen the E-MORB composition of the source rocks results in Ba and Pb enrichment in the deposits, while at Menez Gwen phase separation results in hydrothermal precipitates which are mainly anhydrite, barite and silica with minor sulfides.

Hydrothermal alteration

The Rainbow hydrothermal site is hosted by serpentinite which composes the Rainbow crest. The rocks consist mostly of coarse- and fine grained, porphyritic and non-porphyritic serpentinites with well developed mesh textures. Additionally, a few samples show brittle and/or ductile deformation, with at least partial preservation of the original mesh structure. The main components of the Rainbow serpentinites are serpentine group minerals (antigorite/lizardite+fibrous chrysotile in late fractures), magnetite (chromite) and aragonite in late veins (Barriga et al., 1997). Bastite phenocrysts are present in some specimens. No relics of igneous silicates were found in any of the specimens. The lack (or scarcity) of brucite suggests that most serpen-tinization took place at temperatures between 350-500°C (Barriga et al., 1997). The textures of the serpentinites suggest that they may derive from a serpentinite diapir and not from a major shear zone, such as a transform fault. A serpentinite diapir origin is also supported by the local ridge topography. The basalts and spilites from Famous depict intense hydrothermal alteration at least up to the greenschist facies. Some epidosites were collected. Submarine weathering/low temperature alteration is superimposed on high temperature events.

Fluid composition

The vent fluids from Rainbow exhibit temperatures of 360°C with pH between 2.9 and 3.1, and they have a uniform chemical composition for the major and minor trace elements as well as for gases (Charlou et al., 1997; Donval et al., 1997; Douville et al., 1997). Chlorinity is above 750 mmol/kg and silica is around 7 mmol/kg. Although the H_2S content is relatively low, all fluids show extraordinarily high H_2 and CH_4 content, compared to other fluids collected along the MAR. The fluid chemistries of the revisited Lucky Strike and Menez Gwen vents were close to those measured in 1993 and 1994. Variability in the composition of fluids from vents located around the lava lake was again observed at Lucky Strike. Menez Gwen fluids had a uniform composition and the low salinity has been stable for at least three years. Pressure, controlling the phase separation process, influences the chemistries of both these sites. On the AMAR segment, the Rainbow fluids, which are high in H_2 and CH_4 are issued from an ultramafic environment where serpentinization is occurring. These results show that fluid chemistry is affected by serpen-tinization, which generates a high flux of H_2 and CH_4 along the axis of the slow spreading MAR.

Biology

Contrary to the Lucky Strike and Menez Gwen vent fields, which are dominated by dense colonies of mussels, the Rainbow biological communities are dominated by shrimps. However, unlike other sites in the Atlantic many of the vents have no animals. Only three dense swarms (a few m² in total at each site) of the caridean shrimp*Rimicaris exoculata* (Bresiliidae) (Desbruyères et al., 1998), as found at TAG, Snake Pit and Broken Spur, are observed. Two other species occur, *Mirocaris fortunata* (Bresiliidae) and *Chorocaris chacei*, in lower abundance than other species (Desbruyères et al., 1998). Mussel-beds are much smaller and the densities of Mytilid are lower than in the shallow Lucky Strike and Menez Gwen fields.

Preliminary conclusions

The results from the FLORES cruise indicate that even if the hot spot influence increases to the north, for a single segment there is a strong contrast between the shallow central topographic high with a large magmatic budget and the ends of the segments where ultramafic rocks and high methane anomalies have been observed for three of the four investigated segments. In addition the occurrence of active hydrothermal systems in these two distinctly different environments enlarges considerably the areas where potential hydrothermal fields can be found on slow spreading ridges. The composition of hydrothermal fluids and mineral deposits, and the associated chemical flux into the ocean, will vary depending on the geological setting and the underlying rock composition (E Morb vs. Ultramafic rocks). Our results show that fluid chemistry is affected by serpentinization, which generates a high flux of H_2 and CH_4 along the axis of the slow spreading MAR.

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International Ridge-Crest Research: **SWIR**

Imaging an ultra-slow spreading ridge: first results of the FUJI cruise on the SWIR (R/V *Marion Dufresne*, 7/10-3/11/97)

C. Mével[1], K. Tamaki[2], and the FUJI scientific Party (P. Blondel[3], D. Boulanger[4], A. Evans[3], H. Fujimoto[2], C. German[3], Olga Gomez[5], S.-M. Lee[6], Y. Osada[2], L. Parson[3], P. Patriat[7], G. Pouliquen[7], C. Rommevaux-Jestin[1], D. Sauter[4], R. Searle[8], C. Tamura[2], T. Yamada[9], and T. Yama-ashi[2])

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The InterRidge program has selected the South West Indian Ridge (SWIR) as an area where efforts should be focused to understand accretionary processes at an ultra-slow spreading mid-ocean ridge. The FUJI cruise was organized in this context, to collect TOBI (deep-towed sidescan, bathymetry, magnetics and nephelometry), sea-surface bathymetry, gravity, magnetic and OBS data. FUJI stands for **F**rench - **U**K - **J**apanese **I**nterRidge cruise. The French R/V *Marion Dufresne* was co-funded by Japan and France, the TOBI was funded through a European Union grant (European Access to Seafloor Survey Systems - EASSS) and the OBSs were provided by the Japanese group. In addition, MAPRs, Miniature Autonomous Plume Mappers, (Baker and Milburn, 1997) were kindly provided by E. Baker from NOAA. The FUJI cruise can therefore be considered an excellent example of international efforts coordinated through the InterRidge program.

The main objective of the cruise was to document relationships between magmatic and tectonic activity in an ultra-slow spreading and cold ridge system. The SWIR, which separates the African and Antarctic plates between the Rodrigues triple junction to the east and the Bouvet triple junction to the west, opens at a full rate of 16mm/year. For most of its length, its general orientation is oblique to the spreading direction. Between the Rodrigues triple junction and 49°E, complete bathymetric coverage documents a large and deep axial valley (Mendel et al., in press; Patriat et al., 1995), consistent with a cold thermal regime which is also inferred from global seismic tomography. A segmentation pattern emerges from detailed analysis of the bathymetric and geophysical data which suggests that the Melville fracture zone forms a boundary between two disparate domains (Mendel and Sauter, 1997; Mendel et al., in press; Rommevaux-Jestin et al., in press; Cannat et al., 1997). To the east, the axial valley is

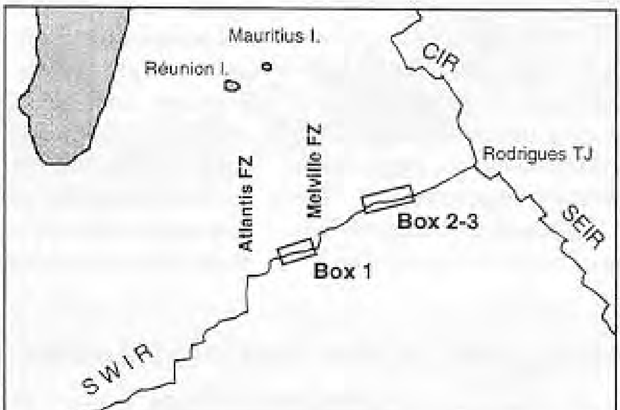

Figure 1. Location map of the boxes surveyed during the FUJI cruise.

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

on average deeper and the segmentation style is irregular - the depth amplitude of adjacent segments is quite variable. By contrast, to the west, the axial valley is shallower and the segmentation style becomes more regular, similar to what is observed in the Mid-Atlantic Ridge. Such differences are inferred to reflect a colder thermal structure to the east. These observations led to the selection of two areas, east and west of the Melville FZ, for three TOBI surveys (Fig. 1). Box 1 consists of two parallel along axis tracks, covering 180 km of ridge along three adjacent segments west of the Melville FZ (Fig. 2A). Box 2 consists of two parallel along axis tracks covering 230 km of ridge along four segments east of the Melville FZ (Fig. 2B). The westernmost segment of Box 2 corresponds to the Jourdanne mountains, a huge magmatic accumulation which fills the axial valley. Box 3 consists of a cross-axis survey, extending up to anomaly 2, and positioned across the Jourdanne mountains and their transition to the inter-segment discontinuity to the west; it was designed to look at temporal variations (Fig. 2B).

Preliminary analysis of the side scan sonar images of the longitudinal surveys indicates that axial volcanic ridges (AVR) occur along the SWIR. They are identified by their characteristic acoustic textures interpreted as pillow flows (hummocky terrains), sheet flows and large rounded volcanoes with axial calderas. They occur at segment centers and are systematically oriented E-W, perpendicular to the spreading direction. Some have started being disrupted, suggesting a discontinuous volcanic activity. The large inter-segment discontinuities correspond to intensively fissured and faulted terrains that accommodate the obliquity of the ridge. A major result is that the relative proportion of fresh looking volcanics to intensively fissured terrains is much smaller on the SWIR than on the MAR, suggesting less magma supply. The axial valley is bounded by fault scarps that expose massive-looking rocks. The fact that some of these are exposures of serpentinized peridotites, which have been dredged (Mével et al., 1997), suggests a thin magmatic crust. However, the TOBI images also point out a major difference between the areas west and east of the Melville FZ. To the west, small neovolcanic ridges may be present in the discontinuities. To the east, by contrast, no fresh looking ridges occur in the discontinuities. Moreover, one whole segment, 80 km long, displays no fresh looking volcanic textures at all and therefore seems to be in a completely tectonic stage. This observation suggests less abundant magma supply to the East, in accordance with a deeper axial valley and colder thermal structure.

The cross-axis survey points out a major difference between the northern and southern flanks. To the north, volcanic textures can still be identified although they are dismembered by numerous small faults. To the south, by contrast, faults are less numerous but with larger throws and expose massive-looking rocks. Moreover, a 10 × 20 km corrugated surface was identified on a small dome that occupies the position of an inside corner high, south east of the Jourdanne mountains. Striations are oriented N-S, parallel to the spreading direction. This striking feature is tentatively interpreted as a low angle detachment surface (Cann et al., 1997). These observations suggest a strong asymmetry in the spreading mechanism that resulted in a dominantly volcanic northern flank and tectonic southern flank.

Another objective of the FUJI cruise was to look for hydrothermal plume signals in the water column. During the along axis TOBI surveys, an array of MAPRs (Baker and Milburn, 1997), covering a depth interval of about 150 m, was attached to the lower part of the TOBI cable to measure nephelometry as the instrument was towed approximately 500 m above the seafloor. 10 turbidity signals were documented, 5 in each box. They are interpreted as the first evidence of hydrothermal plumes on the SWIR (German et al., submitted).

Finally, an OBS experiment was conducted on the Jourdanne mountains. The objective was to constrain seismic activity and crustal structure beneath this massif that fills in the axial valley. 10 OBSs were deployed. A refraction experiment was conducted, with shooting along three radiating lines. Two OBSs were recovered at the end of the cruise. The remaining eight were left on the seafloor to record natural seismicity until the end of Dec. 1997, when the *Marion Dufresne* returned from a logistical rotation to Kerguelen Islands. Unfortunately, only four OBSs could be recovered. Analyses of the data collected are in progress.

In conclusion, preliminary results suggest a very low magma budget at the SWIR, particularly to the east of the Melville fracture zone, accommodated by intense tectonic extension. Despite the low magma budget, a number of hydrothermal plumes have been documented in the water column.

Acknowledgments

We thank Captain Regnier and the crew of the *Marion Dufresne*, and Y. Balut, B. Ollivier and the IFRTP team for their efficiency during the FUJI cruise. We are also grateful to the TOBI team (C. Flewellen, R. Wallace and D. Matthews) who operated the vehicle.

Investigation of the Southwest Indian Ridge: A Project Plan

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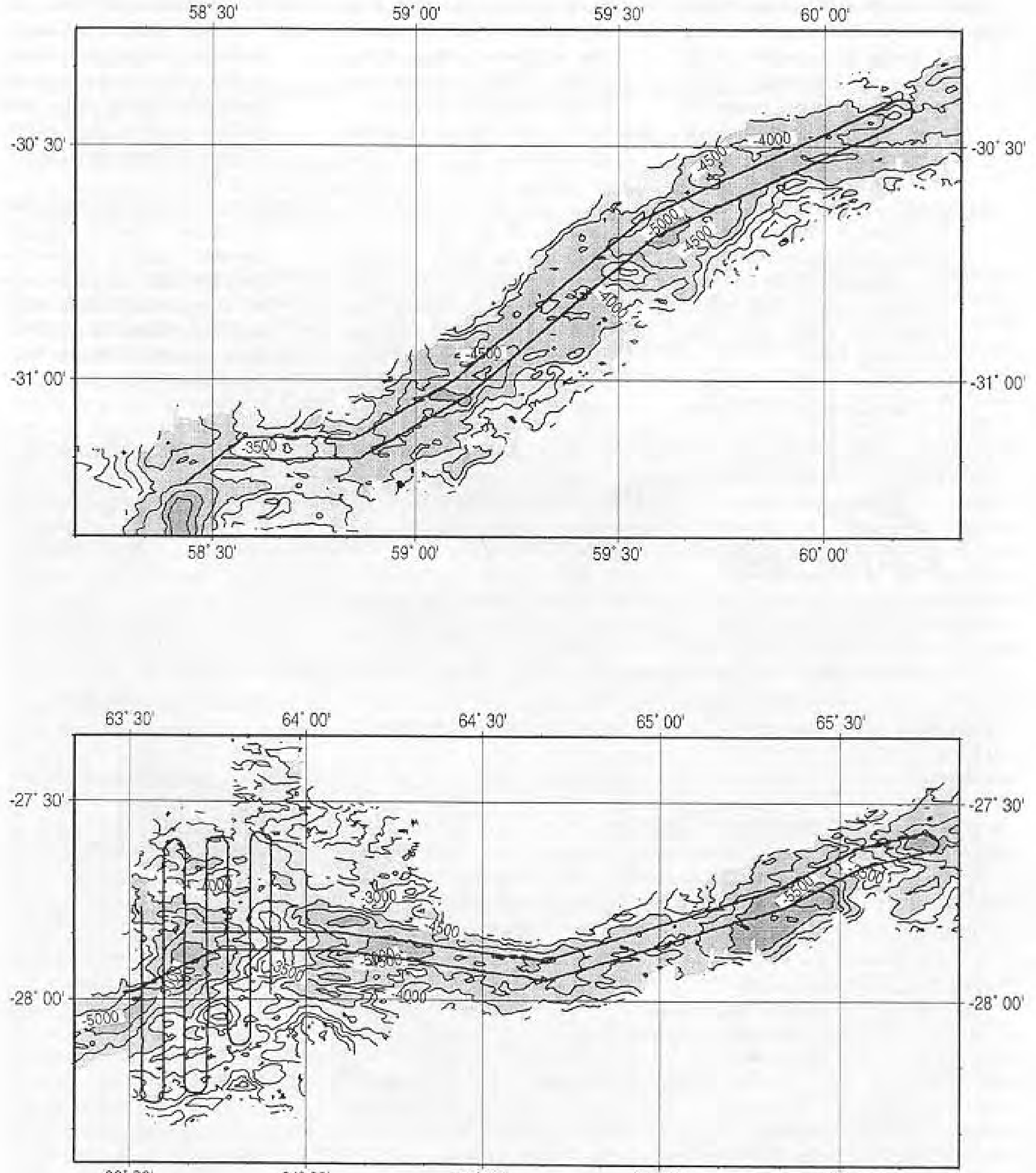

Figure 2. Bathymetric maps of the area surveyed with TOBI. Black lines correspond to the ship tracks. A: Box 1, B: Box 2 (along axis) and 3 (off axis). The OBS experiment was centered on the Jourdanne mountains.

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

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International Ridge-Crest Research: **4D Architecture**

The *ARAD* 3-D Seismic Experiment: A Detailed Reflection and Tomographic Investigation of the 9°03'N Overlapping Spreading Center, East Pacific Rise

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The *ARAD* (**A**natomy of a **R**idge-**A**xis **D**iscontinuity) 3-D Seismic Experiment is an international collaborative project between investigators at the Scripps Institution of Oceanography and the University of Cambridge, with financial support from the RIDGE program/National Science Foundation (USA), British Institutions Reflection Profiling Syndicate (BIRPS), and the Natural Environment Research Council (UK). Additional matching funds for computer visualization were provided by Scripps Institution of Oceanography. The cost of seismic data acquisition, differential GPS, and navigation reduction was shared equally between USA and UK funding agencies.

Segmentation Primer

Early investigation into the geometry of mid-ocean plate boundaries was based on widely spaced profiles of limited resolution which led to an idealized picture of mid-ocean ridges as linear features occasionally offset by large transform boundaries. The advent of high-resolution swath mapping in the late seventies, however, provided dramatic images of ridge-axis structure indicating a highly complex system which was segmented on a variety of scales. Multibeam images measured significant variation in axial depth, and uncovered a rich diversity of plate boundary structures including propagating rifts, overlapping spreading centers (OSCs), and deviations in axial linearity. The larger of these ridge-axis discontinuities were usually sited along deeper portions of the ridge crest, and were associated with regions of disturbed off-axis topography in the form of "wakes" suggesting that these features were not static, but migrated along the axis of spreading, shortening and lengthening the adjoining segments.

Petrologic sampling along mid-ocean ridges revealed similar patterns of geochemical segmentation (Langmuir et al., 1986) suggesting an intimate connection between tectonic and magmatic segmentation of the ridge-crest. Many models of magmatic segmentation propose enhanced upwelling beneath the shallowest portions of the ridge crest, and, by inference, places OSCs along magmatically starved sections of the ridge (e.g. Macdonald et al., 1984), although there are models suggesting the opposite (Lonsdale, 1983). Other indicators of magma budget such as axial volume (Scheirer and Macdonald, 1993) and mantle Bouguer anomaly (Magde et al., 1995) tend to support the notion that shallower, more inflated ridges, are sites of magma injection from the mantle, which serve as the locus for redistribution of melt toward the distal ends of the segment. Seismic data from the northern East Pacific Rise (Kent et al., 1993) and the Valu Fa Ridge (Collier and Sinha, 1992) suggest a complex relationship between ridge-axis discontinuities and the underlying pattern of magmatic segmentation; reflection images from these two locales show an increase in melt sill width toward two large OSCs. The robust nature of the 9°03'N OSC is further supported by an increase in travel time "thickness" of both layer 2A (Harding et al., 1993) and Moho (Barth and Mutter, 1996) reflections, although Wang et al. (1996) argue that the observed increase in crustal thickness toward the OSC can be explained through efficient along axis transport of melt away from the localized center of upwelling at 9°50'N.

Quantifying melt distribution and crustal structure across ridge-axis discontinuities is essential for understanding the relationship between magmatic and tectonic segmentation of spreading centers; the geometry and continuity of melt across these features can have a profound effect on the composition of erupted lavas, and may give insights into the underlying pattern of mantle flow. Previous multichannel seismic (MCS) surveys of ridge axes have been reconnaissance in nature with an along-strike spacing of kilometers at best — sometimes 10 km or more. Moreover, widely-spaced profiles are susceptible to out-of-plane contamination or 'side-swipe', which can result in significant imaging errors in the presence of 3-D structure. To test competing models of magmatic segmentation, we have conducted the first 3-D seismic reflection and tomographic survey of a mid-ocean spreading center at the proto-typical 9°03'N OSC, East Pacific Rise. The combined 3-D seismic experiment will bring an unprecedented level of detail to seismic images of the oceanic crust. Just as the increased resolution of swath bathymetry provided new insight into the dynamics of the mid-ocean ridge system, we believe that these 3-D images will provide significant insights into the interplay between magmatic and

International Ridge-Crest Research: **4D Architecture:** Kent et al. continued...

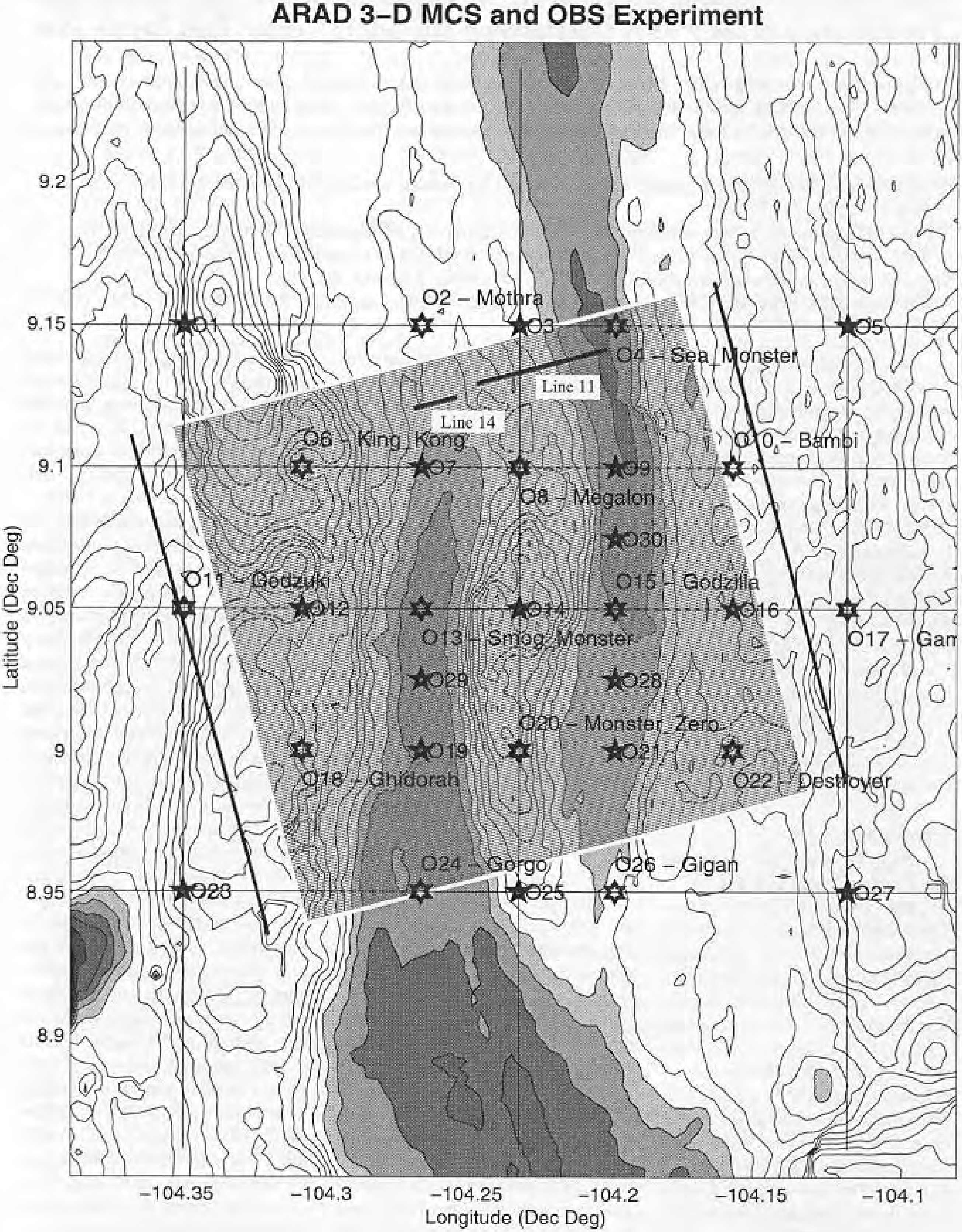

Figure 1. Site location map for *ARAD* 3-D MCS and OBS Experiment. Shallow regions of the overlapper have been gray-shaded to highlight structure. OBH/S locations are shown as stars; closed stars (5-points) represent IGPP Lcheapo sites, while open stars (6-points) mark Cambridge instrument locations. 201 MCS profiles are also placed on the bathymetric map to outline the extent of the 3-D MCS experiment. Parallel lines outside of box denote location of ship-turns after completion of each profile.

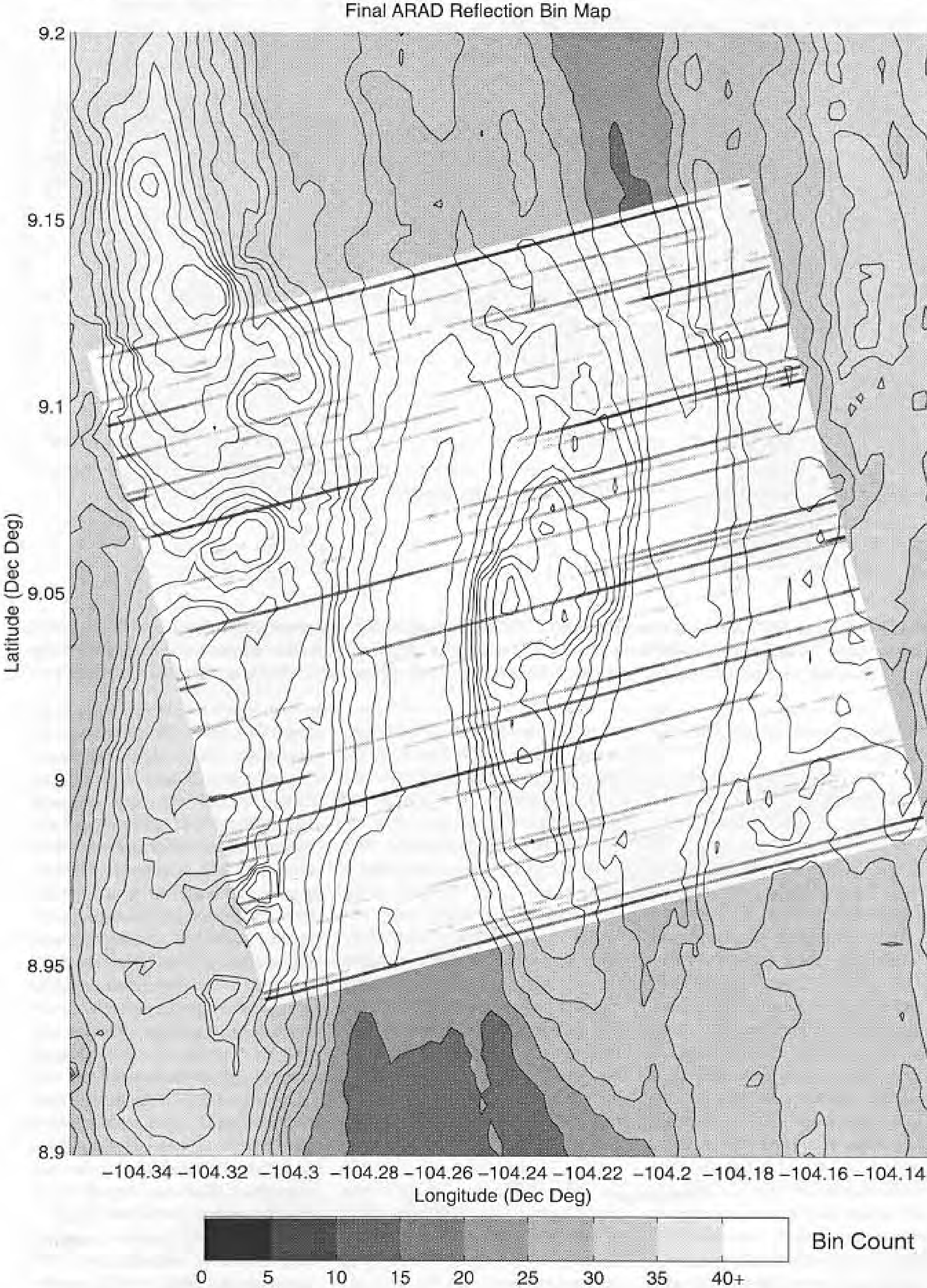

Figure 2. Final *ARAD* reflection bin map. Bin coverage is overlain on bathmetry map near OSC; white represents 40+ common mid-point "bounces" within each reflection bin (25 m by 100 m), whereas more gray and black tones indicate incomplete coverage.

International Ridge-Crest Research: **4D Architecture**: Kent et al. continued...

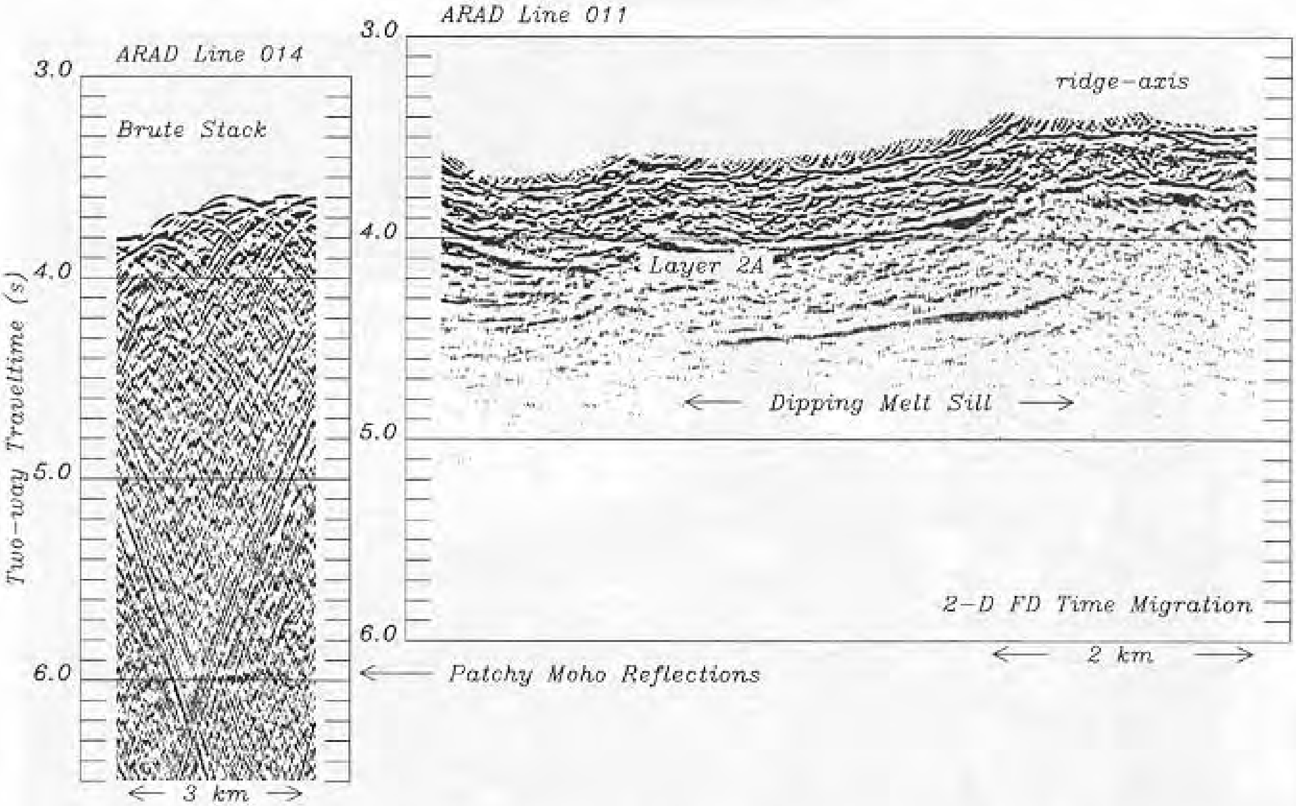

Figure 3. Sample MCS profile located just north of OSC basin. (right) Rise-axis structure showing both dipping melt sill, and layer 2A reflections. AMC is roughly 3 km in width, and slightly displaced to the west of limb. (left) Patchy Moho observed west of the rise axis; note the 2.4 s TWTT of this event, some 700 ms greater than observed near 9°50'N.

tectonic segmentation along the East Pacific Rise.

3-D Experiment

The ARAD 3-D Seismic Experiment was conducted aboard the R/V *Maurice Ewing* during Sept.-Oct. of 1997. We deployed an array of 30 on-bottom instruments including 14 Scripps Lcheapo hydrophones, 11 Cambridge mini-DOBS hydrophones, and 5 Cambridge developmental 4-component seismometers. The *Ewing*'s 3100-m-long (124 channel, 25 m group spacing) Digicon DMS-2000 streamer was towed at ~12 m depth, and deployed throughout the entire experiment. Shipboard navigation was achieved through an INMARSAT-based differential GPS system supplied by John E. Chance & Associates which was accurate to within a few meters. Streamer positioning was reconstructed using bearing measurements (few tenths of a degree accuracy) from 12 Digicourse compass birds placed at 250 m intervals along the streamer; streamer positioning was checked against occasional radar and GPS fixes from the PGS tailbuoy, which confirmed our streamer solution with along- and cross-track errors no greater than 10-20 m and 10-30 m, respectively. Both MCS and OBS operations used a highly tuned 10-gun 3050 cu. in. (50 l) source array. The airgun array was floated at ~8 m depth to ensure consistency of waveforms throughout the survey. The source signatures were recorded on Lcheapo *Godzilla*, which was anchored ~1 km above the seafloor to avoid interference from bottom reflections.

The layout of the ARAD 3-D experiment is shown in Fig. 1. The dimensions of the on-bottom array extend ~22 km along-strike by ~25 km cross-strike, with an instrument spacing which varied between ~3 km to ~10 km. Eleven OBS profiles were shot at 110 s (~250 m) intervals along (7 lines) and across (4 1/2 lines) the OSC in a pattern designed to delimit the shape of the underlying low-velocity zone, and to constrain any variation in crustal thickness near the overlapper. The 3-D reflection dataset was shot in a 20 km by 23 km grid (rotated N15°W due to blockage of the INMARSAT antenna by the *Ewing*'s radar platform) centered on the OSC basin; cross-track line spacing was nominally 100 m, with a along-track shot spacing of ~38 m. Approximately 31 days of continuous shooting were required to collect the MCS volume (13+ million traces), with an additional 3 days to acquire the lower density OBS dataset. During the roughly 5 weeks of active shooting, 158,000 "MCS" shots were fired, with an additional 2000+ temporally less-frequent "OBS" shots; to the credit of the *Ewing*'s captain, science officer and crew, the acquisition system was down for < 24 hours — mostly due to gun failure shortly after 100,000 shots. Throughout the cruise, real-time streamer navigation was monitored and compiled to assess reflection bin coverage; subsequent to collecting the 201 required "sail lines", 8 additional lines were shot to fill-in the most seri-

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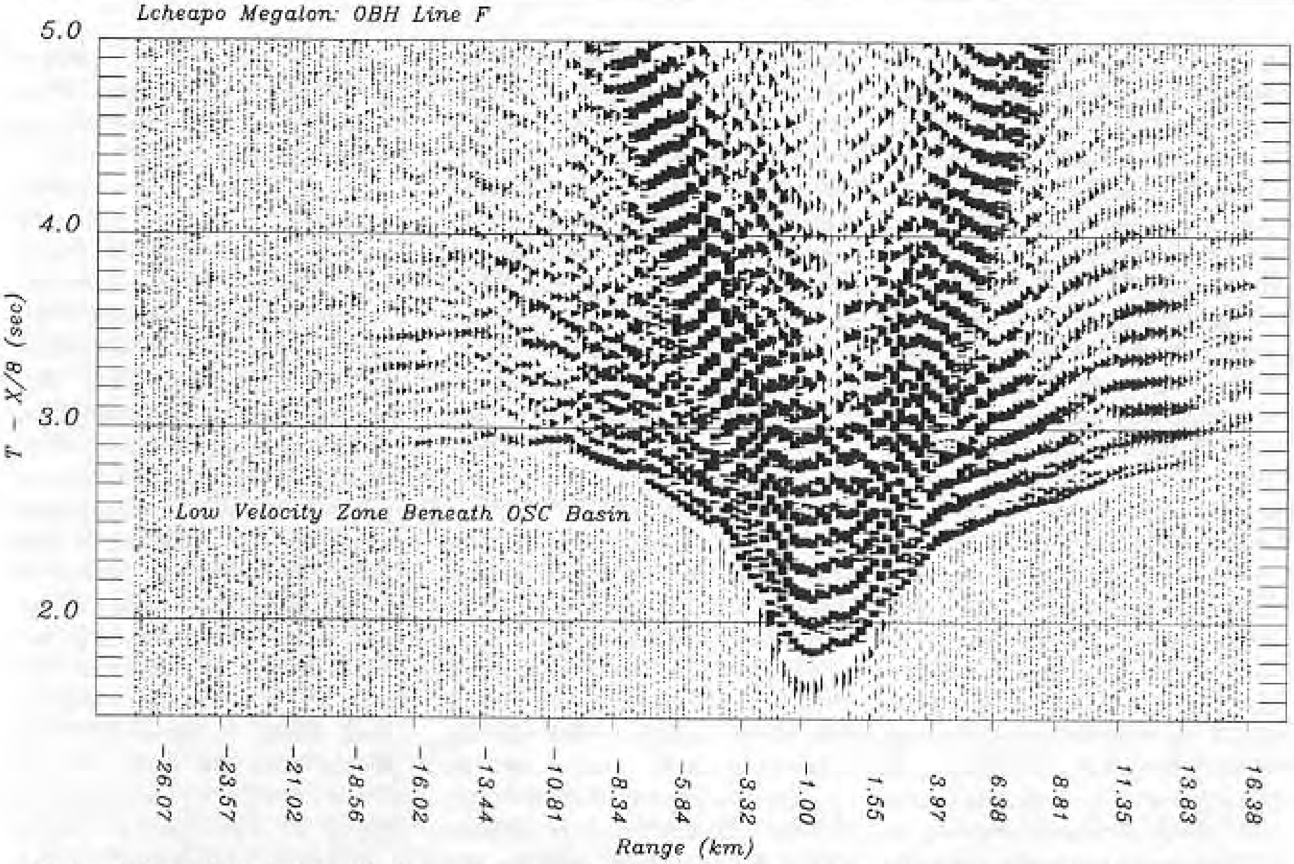

Figure 4. Record section from Lcheapo *Megalon* showing a shadow zone beneath the overlap basin, suggesting the presence of melt between the paired limbs. Other record sections which are outside the influence of the low velocity zone show well developed PmP phases out to ~40 km range. Shot spacing is roughly 250 m.

ous gaps in data coverage due to streamer feathering. The resulting bin coverage (Fig. 2) is remarkably even with only minor dropouts which can be easily accommodated through bin-extension. The MCS profiles were brute stacked in quasi-real-time (20 minute delay) with a generic ridge-crest velocity function hung from the seafloor; this process was for both QC purposes, and to catch any acquisition problems early on. Thereafter, these images where placed into a "flip book" to provide some insight into changes in crustal structure across the overlapper.

MCS data quality was excellent throughout the experiment, with the exception of a few "sail lines" shot while Hurricane Linda was some 350 nm distant. An example of MCS data is shown in Fig. 3. Near the rise-axis, images of both layer 2A and the axial magma chamber reflector (AMC) were imaged; unlike the 1985 MCS dataset (Detrick et al., 1987; Harding et al., 1993), the additional offset (500+ m) has allowed more robust imaging of layer 2A reflections near the OSC.

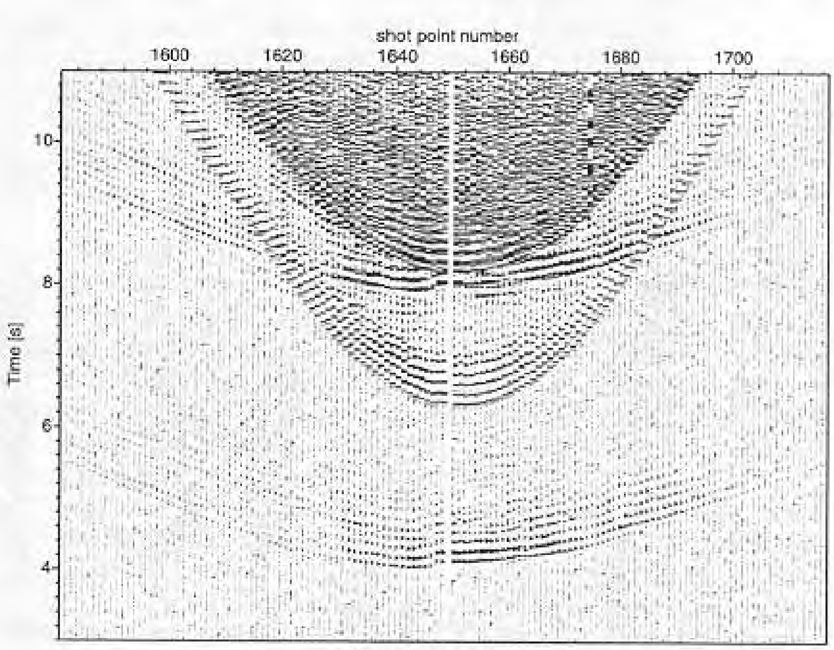

Figure 5. Record section from Cambridge miniDOBS 39, showing same axial profile as Figure 4, but recorded on a station situated off-line, west of the OSC. The section runs from north (left) to south, reaching a maximum offset of about 18.5 km at both ends, and a minimum offset of around 8.2 km at the point of closest approach.

International Ridge-Crest Research: **4D Architecture**: Kent et al. continued...

Images of Moho reflections were also captured within the NW and SE quadrants of the 3-D grid, although most of these events are patchy in character. Of the 30 on-bottom instruments deployed, only one mini-DOBS instrument was lost due to flooding; data recovery rates for all instruments was ~83%, including a 100% data recovery-rate for the 14 Scripps Lcheapos. Thus, some 45,000+ source-receiver pairs were recorded by the on-bottom array if only the less frequently fired (110 s) shots are considered. A representative OBH record section for instrument *Megalon* is shown in Fig. 4; this receiver-gather was shot along the longitudinal axis of the overlap basin, and highlights the presence of a low-velocity zone beneath this feature. Fig. 5 shows the same profile as Fig. 4, but recorded on a Cambridge miniDOBS hydrophone sited approximately 8 km to the west of the overlap axis. Since the seabed array was recording continuously throughout the experiment, there are a very large number of off-line profiles, which will give full 3-D sampling of the subsurface at every azimuth and offset. The "MCS" shots are also clearly visible, although the ~16 s repetition-rate produces a significantly noisier environment, which limits the maximum recorded offset to ~10 km (Fig. 6). These events will provide an unprecedented coverage of layer 2 (< 1-2 km depth), providing a potential 75,000 source-receiver pairs per instrument, or some 1+ million traces combined. Localized stacking of the OBH/S data volume may also extend the 10 km cut-off range to beyond 15 km for those instruments positioned near the edge of the MCS grid. Nevertheless, the densified OBH/S picks should provide tight constraints on upper crustal velocities and anisotropy throughout the survey area; these data will also provide a clearer window into the processes which form the lower crust. Lastly, particularly as it incorporates some four-component stations, this dataset is extremely well suited for studying anisotropy of the extrusive layer and sheeted-dike complex, which should be of special interest near the propagating tip of the OSC.

The MCS dataset is now archived on the IGPP mass-store giving the investigators on-line access to the entire 3-D data volume. Shipboard and streamer navigation has been finalized; work now turns toward gathering MCS data into individual "dip" lines using 3-D binning algorithms. OBH/S instrument relocation will be required before final record sections can be distributed between the groups (some 3000 record sections in total will be archived as well). Production of the first 3-D MCS image is currently underway at both Scripps and BIRPS (through a commercial contractor Robertson Research International, LTD). Large-scale tomographic inversions of the OBH/S dataset will be led by investigators at Scripps, while detailed 3-D velocity inversions of the shallow crust which include "MCS" arrivals will take place

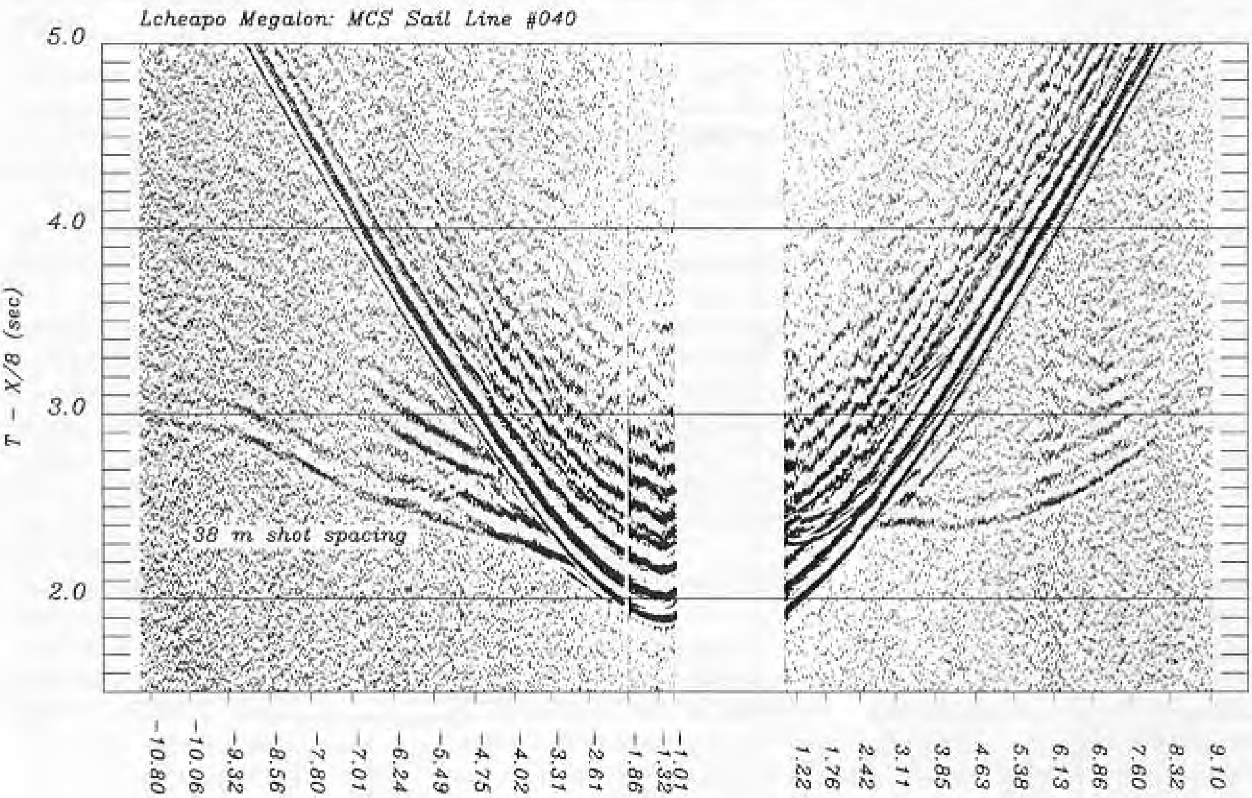

Figure 6. Record section from Lcheapo *Megalon* using the frequent "MCS" shots. Events are visible to ~10 km of offset. In total, some 1 million+ source-receiver pairs were generated from the 3-D reflection shoot. Shot spacing is 38 m.

at Bullard. It is hoped that "first-cut" versions of both crustal reflectivity and velocity will be presented at the Fall, 1998 AGU Meeting in San Francisco.

New Insights

Preliminary results from both2-D brute stacks of the MCS data, range-weighted stacks of the MCS data, and generation of QC-grade OBH/S record sections suggest the following:

(1) The melt sill does not appear to be continuous beneath the overlap basin, although it is observed underlying the northern half of this feature. Elsewhere, the melt sill beneath the eastern limb is quite large (2-4 km), and displaced to the west, while the melt sill underlying the western limb is quite narrow (< 1 km).

(2) A detached magma body is observed beneath the ridge tip of the propagating limb, similar in nature to that proposed by Sinton et al. (1983); these isolated bodies are thought to be responsible for the generation of highly magnetized Fe-Ti basalts.

(3) Evidence from both MCS images and wide-angle refraction arrivals suggest anomalously thickened crust in the region surrounding the overlapper; reflections northwest and southeast of the overlap basin are between 2.3-2.4 s TWTT indicating a crustal thickness in excess of 1-2 km relative to the segment center at 9°50'N in accordance with observations by Barth and Mutter (1986).

(4) Record sections indicate that the overlap basin is underlain by a significant low-velocity zone; this observation raises questions regarding the source of thickened crust in the region (Wang et al., 1996). This observation along with our present knowledge of melt morphology near the overlapper, likely discounts the notion of any significant along axis migration of melt within the crustal magma chamber or lower crust. To the contrary, it would appear that melt is upwelling beneath this ridge-axis discontinuity.

(5) Range-weighted stacks of the "melt" sill highlighting P to S conversion suggest that cross-strike differences in melt content exist. The dipping melt sill observed in "sail-line" 011 (Fig. 3) appears to be segmented with the down-dip half composed of mostly melt, while the up-dip half appears to be mushy. Application of this methodology (Singh et al., 1998) to the entire dataset would allow not only the morphology of the magma chamber to be determined beneath this offset, but a mapping of melt content as well.

Acknowledgments

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International Ridge-Crest Research: **4D Architecture**

Preliminary results from the first InRidge cruise to the Central Indian Ridge

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The InRidge program, the Indian initiative for ridge research, was launched in 1997, primarily to study the Central Indian Ridge (CIR). The program plans targets geophysical and geological studies around four major fracture zones of the CIR - the Vityaz (5°44'S), Vema (8°45'S), Argo (13°45'S) and Marie Celeste (16°37'S) fracture zones and the ridge segments between them. The program envisages documentation of the regional tectonic fabric, with special reference to the growth and evolution of fracture zones and near-axis seamounts. Petrological implications of fracture zones on the generation of new crust and the sub-crustal hydrothermal budget are other objectives of this program.

During the first InRidge cruise aboard the ORV *Sagar Kanya* (Jul./Aug. 1997) single beam bathymetric, magnetic and gravity surveys were carried out along the CIR axis between the Zhivago and Vema fracture zones and also across the Vema fracture zone. Geological sampling was also carried out at the Vema and Vityaz fracture zones.

Sea-floor depth along the ridge axis varies between 1500 m to 6200 m in the Vema area, but on average is between 2500 to 3800 m, although the north-eastern part of the ridge is generally deeper. The topography is rugged with relief ranging from a few hundred meters to 2700 m. The average width of the axial valley is 15 km. The depth of the valley across fracture zones ranges from 2000 m to 6000 m, with the deepest parts being in the center of the fracture zones, which are about 35 km wide.

The steep valley walls and elevated topography along the ridge axis in the VM area are associated with magnetic anomalies of a few hundred nT (upto 400). The northernmost part of the ridge axis appears to be an active spreading center and spreading can be traced upto anomaly 3. The north-eastern side of the ridge is deeper and is associated with more conspicuous magnetic anomalies. Magnetic anomalies associated with the fracture zones are more subdued. The anomaly associated with the central part of the Vema fracture zone is of the order of 200 nT and appears to be offset to the south-east.

Free air gravity anomalies measured along the axial valley in the VM area are of the order of 150 mGal. The trend of these values agrees with the bathymetric and magnetic anomaly observations. Across the Vema fracture zone the free air gravity anomalies are variable with a maximum of 200 mGal recorded in the steepest part of the fracture zone. Dredging operations were carried out along the axial valley walls near the Vityaz fracture zone and at the ridge-transform intersection between the fracture zone and the ridge axis. Basalts recovered from the ridge axis were fresh and phyric, containing abundant plagioclase phenocrysts. The basalts had a coating of basaltic glass between 0.5 and 5 cm and Fe-Mn crusts of variable thickness.

The dredge haul from the ridge-transform intersection yielded variably altered basalts. They occur as substrates and nuclei for the ferro manganese oxides, which are upto 3 cm thick. Some of the encrusted materials were extensively bioturbated and had burrow holes. In addition, buff white calcareous clayey sands were recovered. These sands occur as substrates for Fe-Mn deposits. Other samples recovered in this dredge consisted of porous red-black material which contained calcareous clayey sands and ferro-manganese deposits. Other samples with flat and tubular and at times honeycomb coralline structures were also dredged. The ferro-manganese nodules are extremely rich in iron and have Mn/Fe ratios in the range of 0.63 to 0.83, indicating that they are probably hydrothermal in origin.

In summary, the bathymetric, gravimetric and magnetic data from the CIR between the Zhivago and Vema fracture zones agree with each other and indicate the presence of an active spreading center. The only igneous rocks recovered from geological sampling in the ridge axis and the ridge-transform intersection at the Vityaz fracture zone were basalts. Analysis of the ferro-manganese nodules recovered in the Vityaz fracture zone ridge-transform intersection indicates the presence of hydrothermal activity in the region.

Japanese Ridge Flux Project Group has started Long-term Sea Floor Monitoring in the Southern East Pacific Rise

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Introduction

The recent time-series experiments at Juan de Fuca Ridge and East Pacific Rise 9°N site completely changed our view that hydrothermal activity on mid-ocean ridges is stable in terms of temperature, salinity, chemistry, flow rate, etc. Such change, which may be triggered by frequent magmatic events at intermediate- to fast-spreading ridges could be best determined by setting up a multi-disciplinary and multi-instruments sea-floor observatory at the most active ridge in the world. We selected the superfast-spreading (>14 cm/year) southern East Pacific Rise (SEPR) as a target where magmatic events could recur in intervals as short as 10 years. Scientists from the Ridge Flux group in Japan, in collaboration with scientists from USA and the UK, installed multi-disciplinary, long-term sea-floor observatory equipment at two hydrothermal sites, RM28 (18°26' S) and RM23/24 (17°25'-32'S), during the recent Shinkai 6500/*Yokosuka* Ridge Flux '97 EPR Cruise. The cruise was conducted in two legs between July 10 and Sept. 19, 1997 (Urabe and Mitsuzawa, 1997).

We deeply appreciate the devotion and skill of the R/V *Yokosuka* crew (Captain S. Ishida) and Shinkai team (Commander M. Ida) for the successful deployment of a large number of heavy (up to 900 kg in air) instruments onto the ridge axis.

The observatory sites were selected based on the results of the R/V *Melville* and Shinkai 6500/*Yokosuka* cruises which were conducted in 1993 and 1994, respectively (Urabe et al., 1995). The chemical analyses of suspended particulate matter in the hydrothermal plumes over the RM28 site show high Fe and Cu contents, suggesting their origin from high-temperature vents (Feely et al., 1996). Whereas, over the RM23/24 site the particulate matter has a high S/Fe ratio and bacterial density indicative of a recent eruption and subsequent low-temperature venting (Maruyama et al., in prep.). We found high temperature venting in the axial graben at RM28, and extensive, low-temperature diffuse venting on an extremely fresh, glassy, lava flow at the RM23/24 site. At both sites the venting was directly below the plume center.

Observatory sites

The RM23/24 site is a magmatically robust area and is covered by an extremely fresh lava flow (>19 km long and ca. 1 km wide), probably less than several years old. The area is underlain by an axial magma chamber (AMC) which is the shallowest (800 m below the sea floor) in the world (Mutter et al., 1995). At the RM24 site (17°26'S, 113°12'W), five black smoker chimneys were found during the Shinkai 6500 dives in 1997 on fresh (L0) lobate lava mounds. Low-temperature diffuse vents ("Oasis site") were also identified at the site (17°25.4'S, 113°12.3'W) within an older (L1) sheet lava. Rich and dense colonies of fish, eels, giant clams, mussels, sea anemones, crabs and shrimps were observed in and around the collapsed lava lakes. In contrast, the diffuse vents observed at the RM23 Site (18 km south of RM24) had cooled from 5.2° to 2.1°C in 3

Table 1. Long-term monitoring instruments deployed on the southern East Pacific Rise during the Ridge Flux'97 cruise. Instruments in plain font were deployed and recovered during the cruise, while those in bold are currently working.

	Instrument	Site	Latitude (S)	Longitude (W)	Depth	Beacon (MHz)	X-ponder
1	**Medusa flow meter #3**	**RM23**	**17°32.472'**	**113°14.058'**	**2,612 m**	**none**	**#10**
2	Manatee observatory #02	RM23	17°32.665'	113°14.198'	2,613 m	40.05	#16
3	**WaDaR thermometer #A**	**RM24**	**17°25.867'**	**113°12.369'**	**2,599 m**	-	
4	**WaDaR thermometer #B**	**RM24**	**17°25.813'**	**113°12.247'**	**2,588 m**	-	
5	**WaDaR thermometer #C**	**RM24**	**17°25.346'**	**113°12.037'**	**2,595 m**	-	
6	**WaDaR thermometer #D**	**RM24**	**17°25.795'**	**113°12.341'**	**2,598 m**	-	
7	**WaDaR thermometer #E**	**RM24**	**17°25.389'**	**113°12.302'**	**2,605 m**	-	
8	ZABUTON heat flow meter	RM24	17°25.935'	113°12.351'	2,593 m	-	#14
9	**Medusa flow meter #1**	**RM24**	**17°25.811'**	**113°12.329'**	**2,594 m**	-	**#13**
10	**Medusa flow meter #2**	**RM24**	**17°25.872'**	**113°12.370'**	**2,599 m**	-	**#11**
11	**ZABUTON heat flow meter**	**RM24**	**17°25.313'**	**113°12.327'**	**2,609 m**	-	**#17**
12	**Heat Flow Array**	**RM24**	**17°25.372'**	**113°12.308'**	**2,603 m**	-	
13	**Manatee observatory #02**	**RM24**	**17°25.367'**	**113°12.275'**	**2,602 m**	**40.05**	**#15**
14	**Shuttle Elevator #4 (*)**	**RM24**	**17°25.395'**	**113°12.267'**	**2,601 m**	-	
15	**SedimentTrap #4**	**RM24**	**17°25.866'**	**113°12.357'**	**2,601 m**	-	
16	**SedimentTrap #2**	**RM24**	**17°25.578'**	**113°12.648'**	**2,635 m**	-	
17	**SedimentTrap #1 (**)**	**RM24**	**17°25.433'**	**113°12.338'**	**2,620 m**	-	
18	**SedimentTrap #3**	**RM24**	**17°25.562'**	**113°11.811'**	**2,616 m**	-	
19	**OBPR pressure meter #1**	**RM28**	**18°25.660'**	**113°23.098'**	**2,593 m**	**43.528**	
20	**OBPR pressure meter #2**	**RM28**	**18°25.583'**	**113°23.294'**	**2,671 m**	**43.528**	
21	**OBPR pressure meter #3**	**RM28**	**18°25.548'**	**113°23.349'**	**2,641 m**	**43.528**	
22	**SeaFAR range finder #1**	**RM28**	**18°25.561'**	**113°23.050'**	**2,594 m**	**43.528**	
23	**SeaFAR range finder #2**	**RM28**	**18°25.399'**	**113°23.523'**	**2,625 m**	**43.528**	
24	**Long-term OBS #500**	**RM28**	**18°26.133'**	**113°23.446'**	**2,679 m**	-	#12
25	**Long-term OBS #550**	**RM28**	**18°25.937'**	**113°23.337'**	**2,670 m**	-	
26	Ocean Bottom Seismogr. #1	RM28	18°25.306'	113°22.961'	2,618 m	159.48	
27	Ocean Bottom Seismogr. #2	RM28	18°25.870'	113°23.859'	2,618 m	159.48	
28	Ocean Bottom Seismogr. #3	RM28	18°26.298'	113°22.643'	2,657 m	43.528	
29	Ocean Bottom Seismogr. #4	RM28	18°26.510'	113°23.785'	2,647 m	43.528	
30	**SMAT moored thermister**	**RM28**	**18°25.490'**	**113°23.256'**	**2,660 m**	**43.528**	
31	Moored current meter (S)	RM28	18°25.458'	113°23.330'	2,660 m	-	
32	Moored current meter (L)	RM28	18°25.409'	113°23.512'	2,650 m	-	
33	**Manatee observatory #01**	**RM28**	**18°26.003'**	**113°23.362'**	**2,652 m**	**40.05**	#16
34	**Medusa flow meter #4**	**RM28**	**18°25.979'**	**113°23.308'**	**2,649 m**	-	#14

(*) Raman Lasar Spectrometer, Gamos-III in-situ chemical analyzer, and pH sensors are in the basket.

(**) Launched location. All other locations are calibrated.

years, and the previosly associated rich colonies probably perished due to the change in fluid chemistry.

The RM28 site (Hump area; 18°26'S, 113°23'W) is believed to be in a tectonic stage (Auzende et al., 1995). We noticed evolution in fluid composition of a black smoker from vapor to brine in the 3 years since 1994 (Butterfield et al., 1997, Ishibashi et al., 1997). The chimney itself has been broken (and re-built) due to mass wasting possibly caused by fault movement.

Monitoring Objectives

The questions to be addressed through the monitoring include:

(1) How do oceanic plates spread at the MOR? There are two contrasting hypotheses: episodic rupture or slow deformation due to silent earthquakes. No systematic measurements have previously been made in fast- and superfast-spreading MOR and the present effort will address this crucial question. Another fundamental question includes the coupling/synchronicity between spreading and magmatism.

(2) How do fluid compositions evolve with time? Are they coupled with magmatic events or with tectonic events? What is the system response to tidal forces? Why are semi-diurnal and diurnal variations so obvious? Are there any longer, as yet unknown, cyclicities or variations?

(3) What is the mechanism of phase separation and differential discharge of these fluids?

(4) What are the real heat/mass fluxes on a global scale?

Observatory Instrumentation

The observatories consist of twenty five independent long-term monitoring instruments (Table 1). Among them, 8 were deployed at RM28, 8 at RM24, and 2 at RM23 to compare temporal variations at the two different sites 110 km apart, and to see the evolution at locations of different stages (i.e., volcanic vs. tectonic). This grand design will enable us to see the difference in system response to events such as magma injection and tidal loading, and to evaluate the entire evolution history of the MOR. Descriptions of some instruments are given below.

Site RM28

Two geodetic instruments were deployed to measure the lateral extension and inflation/deflation of the ridge crest: the SeaFAR (Sea Floor Acoustic Ranging system, Y. Nagaya, JHD) and the OBPR (Ocean Bottom Pressure/Temperature Monitoring System, H. Fujimoto, ORI). The SeaFAR is a twin unit which exchanges a chirp signal at 30 - 50 kHz frequency between the units on the sea floor at an interval of one per day for a period of one year. The OBPR aims to detect vertical crustal movement associated with volcanic or tectonic events for a period of one year. Three instruments were deployed across the axial valley of the spreading center. Each of them is equipped with a quartz pressure gauge and a quartz thermometer. It is designed to detect vertical crustal movements with a resolution of a few centimeters from relative pressure variations, after corrections for the temperature variations and ocean tides. It can also monitor the horizontally averaged temperature through acoustic range measurements among the three instruments. An array of moored thermometers were deployed to monitor the temperature change of the bottom sea water.

Two kinds of OBSHs (Ocean Bottom Seismograph and Hydrophones, T. Kanazawa and M. Mochizuki, ERI) were deployed: long-term OBSs and standard OBSs. The long-term OBS are each equipped with one vertical and two horizontal geophones installed at the bottom of a titanium pressure case. The natural frequency of the geophones is 1 Hz. Signals are continuously recorded on a hard disk recorder at a sampling rate of 64 per second. The recording period is more than six months. This seismograph monitors several kinds of seismicity related to the magmatic and hydrothermal activity around the ridge axis region.

An integrated long-term observation platform called Manatee (K. Mitsuzawa, JAMSTEC) was deployed near a black smoker vent. This platform consists of still and video cameras, a hydrophone, a CTD, a transmissometer, an electro-magnetic current meter, a gamma-ray counter, and a transponder with acoustic release Each component is installed to a moored frame made of steel pipe and is controlled by its own delay and interval timer. The mooring height of the frame is 2 m above the sea floor due to the limitation of its lighting.

The MEDUSA system (T. Urabe, GSJ; instrument designed by A. Schultz, Cambridge U.) is an instrument to measure the temperature and velocity of hydrothermal effluent flowing out of seafloor hydrothermal systems. It is designed to sample two bottles of fluid under a data logger timer control. It was placed on a diffuse flow site near the Manatee.

The dispersion of the hydrothermal plume at the RM28 site was measured by several methods during the cruise: deployment of a current meter for a period of one month, CTD-transmissiometer measurements during descent/ascent of the Shinkai 6500 dives, and a SF_6 (sulfur pentafluoride) experiment (D. Tsumune and K. Shitashima, CRIEPI), which involved discharging a small amount (4.6E-2 mole) of SF_6 into a black smoker and repeated sampling afterwards using the Shinkai 6500.

Site RM24

Monitoring instruments similar to those at the RM28 site, including one Manatee, two Medusa 3c/j, and six WaDaR (miniature temperature recorder, O. Matsubayashi, GSJ), were deployed at this site. However, geodetic instruments were not used here since neither fissures nor faults were observed on the sea floor, which is covered by a fresh glassy lava flow. Heat flow instruments, sediment traps, and other chemical sensors were also deployed here.

The thermal-blanket type heat flow monitoring system ZABUTON (M. Kinoshita, Tokai U.; instrument developed by P. Johnson, U. Washington) is designed to measure a conductive heat flux through sediment-free

EDR and Observatories: Urabe et al. continued...

seafloor on ridge axes for up to one year. This instrument was first deployed for a short period of time (Matsubayashi et al., 1997), and then left on the seafloor for one year. It recorded semi-diurnal temperature variations of 0.06°C which suggest tidally-induced fluid movement within the permeable lobate lava flow beneath the sea floor. The ZABUTON was deployed near a moored long-term heatflow monitoring system (M. Kinoshita, Tokai U.).

Four moorings of sediment traps were deployed. The basic mooring configuration placed a descending particle collector (H. Kawahata, GSJ) at a depth near the base of the hydrothermal plume, and an ascending/descending particle flux trap (J. Cowen, U. Hawaii) near the top of the plume. These traps have sequential sampling capabilities. In addition, three current meters, three Eh sensors (K. Nakamura, GSJ) one pH sensor (K. Shitashima, CRIEPI), and eight miniature temperature recorders (J. Cowen) were attached to these moorings to obtain time-series observations of the hydrothermal plume.

The LECMOS (Long-term electro-chemical fluid monitoring system; K. Nakamura, GSJ) is an instrument to monitor the temperature and Eh of hydrothermal fluid every 10 minutes, and will take a chrono-amperometric measurement by a compact potentiostat once a week for a period of one year. The chrono-amperometric measurement is expected to semi-quantitatively clarify the cations in the diffuse hydrothermal fluid.

Other instruments

Other instruments used during the cruise include a Sub-borne Fluxgate Magnetometer (K. Sayanagi, GSJ), a CTD, a transmissiometer, a GAMOS (Geochemical Anomaly MOnitoring System, K. Okamura and T. Gamo, ORI), and an *in-situ* Laser Raman spectrometer (N. Ytow, U. Tsukuba). The GAMOS is an *in-situ* manganese and iron analyzer which uses a flow-through chemiluminescence detection method. The instrument was attached to the payload basket of Shinkai 6500 to map the metal concentration around the vent fields. The Laser Raman spectrometer is a sub-borne instrument to measure the spectra of organic matter and microbial cells in sea water and in hydrothermal fluid. The latter two instruments can be used as stand-alone monitoring instruments for one month.

We frequently used a shuttle elevator and a Mini-Transponder/ROV-Homer during the deployment. The shuttle elevator deploys and recovers instruments and/or samples to and from the sea floor, and consists of a buoy, a release transponder, a basket to put instruments in, and a sinker. The Mini Transponder is a light-weight range finder unit manufactured by Sonardyne Ltd. for relocating instruments on the sea floor from the sub. The monitor unit determines distance and azimuth with an accuracy of 0.1 meter within a distance of 800 meters. The transponder was extremely useful for reducing the searching time.

Recovery

These instruments will be recovered during an Alvin/*Atlantis* cruise which is scheduled Sept. 1 - Oct. 1, 1998, about one year after the deployment.

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Urabe, T. et al. The effect of magmatic activity on hydrothermal venting along the superfast-spreading East Pacific Rise. *Science*, 269, 1092-1095, 1995.

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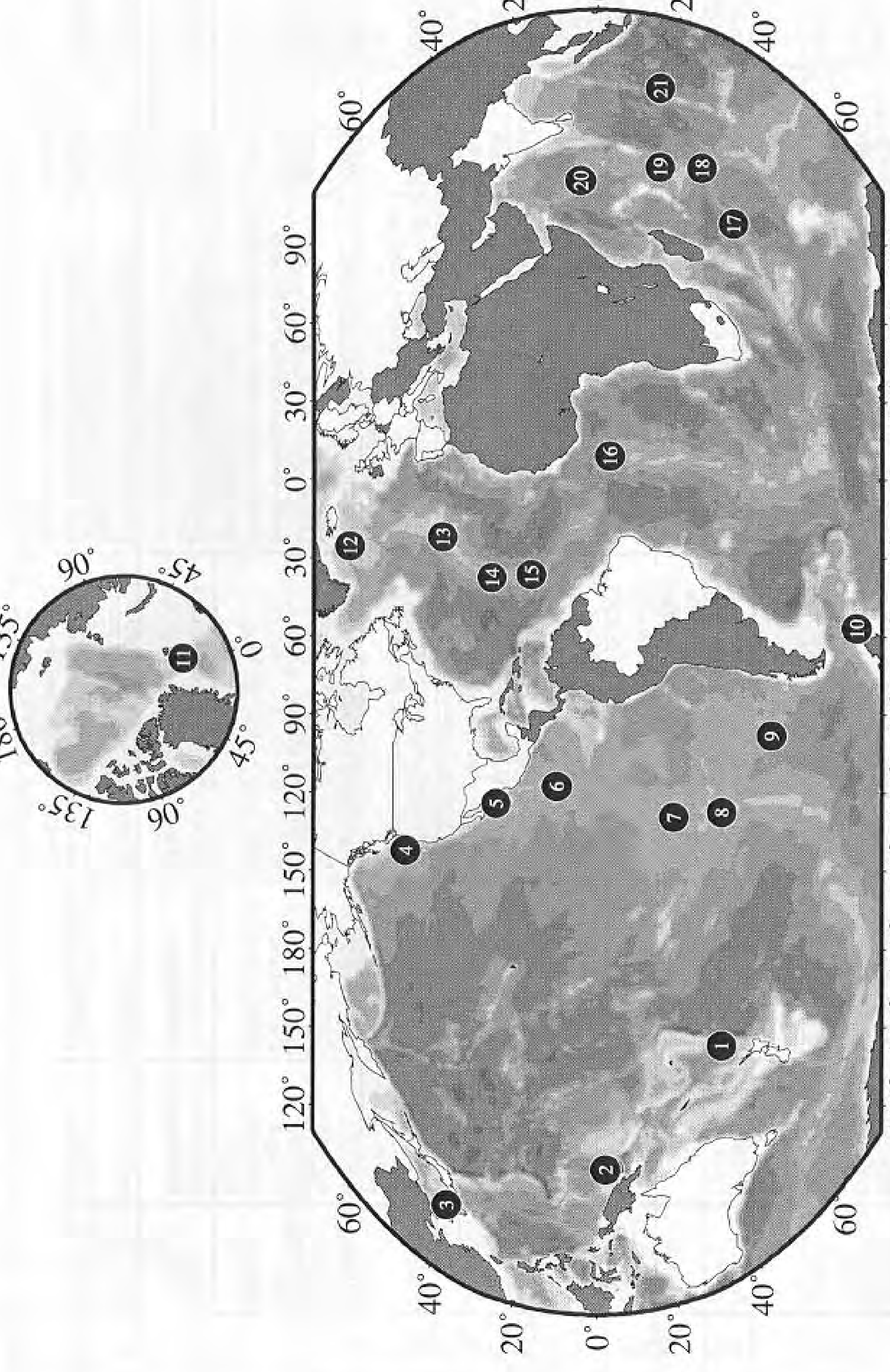
World Ridge Cruise Map, 1998-1999



InterRidge Community (in white) and 1998-1999 Projects

World Ridge Cruise Schedule, 1998-1999

Map No.	Country	PI	Institution	Name/Location	Research Objectives	Ship	Dates
4	Canada, USA	Tunnicliffe, Embley	Univ. Victoria, NOAA	Axial Seamount, Juan de Fuca Ridge	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
13	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.	Atalante	Jun. 23- Jul. 22 '98
13	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	Atalante	Jul 25 -Aug. 25 '98
13	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
16	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	Sonne	Jul. 10 - Aug. 10 '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	Sep. 9 - Oct. 15' 98
19, 20	India	Mudholkar, Mukhopadhyay	National Institute of Oceanography,	Carlsberg Ridge and Central Indian Ridge	geophysics and geological sampling	Sagar Kanya	Aug/Sep '98
15	Italy, Russia	Bonatti, Peyve	IGM, GIN,	Vema transverse ridge	geochemical and structural variations along the Vema transverse ridge	Strakhov	Jan./Mar. '98
15	Japan	Matsumoto	JAMSTEC, WHOI	Mid-Ocean Diving Expedition '98 (MODE '98): Cape Verde Fracture Zone, MAR 15°20'N	study crustal accretion processes and magmatic/hydothermal activities on the MAR	Yokosuka, Shinkai 6500	Jun/Jul 98

World Ridge Cruise Schedule 1998-1999, continued...

14	Japan	Fujioka	JAMSTEC	MODE '98: TAG mound and area, and the Rainbow site, MAR	study hydrothermal processes on the MAR	Yokosuka, Shinkai 6500	Jul/Aug 98
18	Japan	Fujimoto	JAMSTEC	MODE '98: SWIR near the triple junction	crustal accretion processes of the super-slow spreading ridge	Yokosuka, Shinkai 6500	Sep. 21 - Oct. 17 '98
7	Japan	Urabe	JAMSTEC	EPR: 17°25'S and 18°26'S	recover more than 30 long-term monitoring instruments after one year of deployment.	Atlantis, Alvin	Sep. '98
17	Japan	Kinoshita	JAMSTEC, WHOI	MODE '98: SWIR, Atlantis II fracture Zone	crustal structure and spreading processes of the super-slow spreading ridge	Yokosuka, Shinkai 6500	Oct/Nov '98
3	Korea	Huh, H.-J. Kim	KORDI - MGG Division	East Sea	East Sea Basin Study	Onnuri	April '98
3	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
3	Korea	Han	KORDI	East Sea	OBS Seismic experiment taking two 100-km long lines with 60 liter air guns	Prof. Gargarinsky	Aug. '98 (tentative)
3	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
13	Portugal	Marques or Almeida	Univ. Lisbon	CRISTA III - AMORES	Study hydrothermal fish and fauna	Arquipélago	Summer '98
13	Portugal	Barriga	Univ. Lisbon	SALDANHA Cruise - South Famous, Menew Gwen and Rainbow, MAR	look for diffuse & discrete venting, biology sampling	Nadir, Nautile	Jul 13-27 '98
14	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
13	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)	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

World Ridge Cruise Schedule 1998-1999, continued...

Map No.	Country	PI	Institution	Name/Location	Research Objectives	Ship	Dates
17	UK, USA, Canada	MacLeod, Allerton, Dick, Robinson	U. Wales, Cardiff	SWIR, Hole 735B Atlantis II Fracture Zone	geology of lower crust using ROPOS with deep-towed magnetics, and rock drills	James Clark Ross, ROPOS	Mar. 21 - May 9 '98
12	UK	Peirce, Searle, Sinha	Durham Univ.	MAR: Reykjanes Ridge	seismic mapping of magma chamber	Discovery	Jul/Aug '98
9	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
4	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
8	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. 12 '98
7	USA	Gee	Scripps	ultra-fast spreding southern EPR - 17.5-19.5°S	near-bottom magnetic and rock sampling survey	Melville	Mar. 5 - Apr. 12 '98
5	USA	Jannasch	WHOI	Guaymas Basin and 21°N, EPR vent sites	study the diversity of extremophilic bacteria and archaea focussing specifically on hyperthermophilic sulfate reducers.	Atlantis, Alvin	Apr. 25 - May 5 '98
6	USA	Mullineaux, Peterson, Fisher	WHOI, UNC, U. Penn. State	EPR, 9°50'N	recruitment of vent organisms	Atlantis, Alvin	May 10 - Jun. 1'98
4	USA	Clague	MBARI	Escaba Trough, northern Gorda Ridge, Cleft segment	High resolution Bathymetry and backscatter, Simrad EM300	Ocean Alert	mid May '98
4	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. 22- Jul. 2 '98
4	USA	Delaney	U. Washington	Endeavour - Mothra	recover sulfide structure	Thompson, ROPOS	Jun. 25- Jul. 18 '98
4	USA	Cowen	U. Hawaii	Juan de Fuca	deploy instrumentation designed to recover chemical proxies of subseafloor microbialactivity	Atlantis, Alvin	Jul. 6-21 '98
4	USA	Zumberge, Webb	Scripps	Juan de Fuca - Middle Valley, Axial Volcano	Geophysical survey, towed gravimeter, OBS deployment	Thompson	Jul. 21- Aug. 6 '98
4	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. 27 - Aug. 7 '98

World Ridge Cruise Schedule 1998-1999, continued...

4	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
4	USA	Chadwick, Stakes	Oregon State Univ., MBARI	Juan de Fuca - South Cleft	geological oceanography - JASON and DSL120 survey	Thompson	Aug. 10 -.22 '98
4	USA	Feely, Milburn	NOAA, NOPP	Juan de Fuca	Mooring deployment	Ron Brown	Sep. 20-30 '98
7	USA	Lilley	U. Washington	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. 5 - Nov. 13 '98
6	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. 18 - Dec 7 '98
6	USA	Vrijenhoek, Lupton	Rutgers, NOAA	EPR, 9-10°N	biology	Atlantis, Alvin	Dec. 11 '98- Jan. 16 '99
7	USA	Sinton	U. Hawaii	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. 20 '98- Feb. 26 '99
10	USA	Klinkhammer	Oregon State Univ.	Deception Island & Bransfield Strait, Antarctica	Search for hydrothermal vents using ZAPS sled	N. B. Palmer	Mar. '99
17, 21	ODP	Casey, Pettigrew	U. Houston, ODP-TAMU	Leg 179 - Hole 735B and 90°E Ridge, Indian Ocean	Engineering leg - test the hammer drill-in casing near Hole 735B and drill a hole to install a broadband seismometer	Joides Resolution	Apr. 16 - Jun. 4 '98
2	ODP	Huchon, Taylor	CNRS, U. Hawaii	Leg 180: western Woodlark Basin, Papua, New Guinea	investigate the role and nature of low angle faulting in continental faulting	Joides Resolution	Jun. 9 - Aug. 4 '98

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.

Canada: CanRidge

Canada has upgraded to Associate membership in InterRidge in 1998.

The coming months will see Canadian ridge researchers participation in two cruises with the Canadian remotely-operated vehicle ROPOS on foreign support vessels.

1. **Southwest Indian Ridge (SWIR)**: Paul Robinson of Dalhousie University (Halifax, Nova Scotia) will participate in a two leg cruise to the SWIR on the *James Clark Ross*, a vessel operated by the British Antarctic Survey. This is a joint Canada-US-UK cruise. In the first leg (March 21- April 16, a series of ROPOS dives will be conducted at the ODP site 735 on the Atlantis Plateau. Co-chief scientists will be Henry Dick (WHOI) and Paul Robinson (Dalhousie). Work will involve site survey and collection of drill cores from basalt using the MBARI multi-barrel rock drill mounted on ROPOS. Both vertical and horizontal drilling will be carried out. The second leg (April 16 - May 9) will employ the British rock drill in the same area.

2. **Axial Seamount**: This joint Canada-US cruise will take ROPOS on the new NOAA ship *Ron Brown* to Axial Seamount on the Juan de Fuca Ridge from August 25 to September 20. Participating institutions include NOAA-PMEL, the University of Washington, the University of Victoria, Western Washington University, the University of Toronto, and the Université du Québec à Montréal. The planned multidisciplinary program will continue studies in the known hydrothermal fields of the caldera of Axial Seamount. However, since this area was the focus of a week-long seismic event and probably an eruption in January 1997, the planned science program is being left flexible to permit investigation of new hydrothermal and biological consequences of any eruptions that may have taken place. Chief Scientists will be Robert Embley (NOAA) and Verena Tunnicliffe (University of Victoria).

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France: Dorsales

1997 was the fourth year of existence of the DORSALES program. The funding agencies (CNRS and IFREMER) decided to conduct an evaluation, to help decide whether the program should continue. Besides a document highlighting the results obtained on ridges by the French teams during the last four years which was distributed to outside experts for review, the DORSALES committee organized two days of scientific presentations and discussions, "Les Journées Dorsales", held in Paris Nov. 24-25, 1997. This meeting, attented by over a hundred scientists, was aimed to present the major results, but also to discuss prospectives.

The result of the evaluation was positive, despite some criticisms. Mainly, the lack of real interaction between geosciences and biology was pointed out. Given the positive reviews, the funding agencies decided to continue the program for four more years, with a renewed Scientific Committee, and with the mandate of a better focus of the actions of the French scientific communities. The level of funding should remain the same. Catherine Mével was asked to chair this new committee.

The membership of the new committee is not finalized yet. However, discussions have already started about the short and medium term priorities. The French community wants to play a major role in setting up the Azores seafloor observatory (see page 67). The East Pacific Rise at 13°N will remain a major field of investigation for the biologists who want to continue repeated cruises to constrain temporal variations. The investigation of the Southwest Indian Ridge (see article on page 29), an example of a very slow and cold spreading center, will be pursued. We hope that a phased approach will allow documentation of hydrothermal activity on the seafloor, to meet the requirements of the biologists. A detailed scientific plan for the next four years of the Dorsales program will be published in the next issue of the "Lettre Dorsales" in June, and will be available on the Dorsales web page.

The Dorsales web page will be moving to a new server and is temporarily shut down during this transfer.

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(The Dorsales web page is temporarily shut down while it is being moved to a new server).

National News....

Germany: DeRidge

Informal discussions at the ODP meeting in Freiburg lead to the formulation of a plan to organize a German ridge researchers congress in 1999. Colin Devey has agreed to take over the organization of this meeting in Bremen assuming the successful conclusion of his appointment as Professor there. Details of dates etc. are not finalized (the meeting should not collide with any other geological/geophysical/biological meeting), but a two-day congress based on talks and some posters was deemed best. DeRidge activities are still running at a fairly low level compared to equivalent programs in other countries, a fact which is leading to an underutilisation of available resources. It is the hope of those who were present at the Freiburg meeting that the congress in 1999 will provide a way of achieving closer integration between the various ridge-related disciplines.

Meanwhile there will be several German cruises in 1998 which are of interest to the mid-cean ridge community. In March a cruise on the R/V *Meteor* (Colin Devey and Peter Stoffers) investigated the interaction between the Ascension hotspot and the Mid-Atlantic Ridge. There will be a joint German-Canadian cruise on the R/V *Sonne* (Peter Herzig and Mark Hannington) in July to study mineralization, vent fauna and volcanology in the New Ireland Fore-Arc off Papua New Guinea. Next September the R/V *Sonne* (Peter Stoffers, Heinrech Villinger, Peter Herzig, Cornel de Ronde Ian Wright, and Mark Hannington) will be in the Havre Trough. This joint German-New Zealand cruise will be conducting swath bathymetry, seismic reflection, gravity and magnetics, rock dredges, and video grabs.

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National News....

Iceland

The unique geological position of Iceland means that a significant part of all geological and geophysical research there is ridge related without being ship dependent.

There are three types of research funding in Iceland - a direct contribution determined in the annual government budget, service contracts, and grants obtained from various local and international funds. The proportion of these three vary for the different institutions but there is a tendency towards decreasing the level of direct funding. However, the level of the grant funding has not increased accordingly. Through Iceland's membership in the European Economic Zone (a half way EU membership of sorts), Iceland contributes to the EU science funds and has equal access to these funds. Due to this program and other circumstances there has been a notable increase in international collaborations in recent years. Following is a brief overview of Icelandic institutions involved with ridge research. Further information and details can be found on their web sites.

Icelandic Research Council

The Icelandic Research Council (Rannsoknarrad Islands) is responsible for general science policy and for science and technological research grants. Application deadline is the 1st of November each year for science applications. The small number of individual grants awarded reflects both the small population of the country, and the large number of highly graded applications and static funding.

Marine Research Institute

The Marine Research Institute (Hafrannsokanrstofnun) is responsible for both biological and oceanographic research. One of its prime responsibilities is to advise the government on fishing quotas. The two oceanographic research vessels R/S *Arni Fridriksson* and R/S *Bjarni Saemundsson* are operated by the Marine Institute. They are extensively used for monitoring fish stocks but also for oceanographic and ridge related studies. A new full scale research vessel is presently under construction. Cruise schedule and other information can be found on their homepage.

University of Iceland

The University of Iceland (Haskoli Islands) has both geological and geophysical departments. Teaching is at the undergraduate and master level but PhD is being introduced. Ridge related research includes seismic studies, paleomagnetics, geothermal chemistry, petrology and general geology.

Meterological Office

The Meterological Office (Vedurstofa Islands) is responsible for monitoring seismic activity in Iceland and conducts research in related fields. Data from their network of seismometers and other information is available on their home page.

National Energy Authority

The National Energy Authority (Orkustofnun) is responsible for research related to the utilisation of both geothermal and hydroelectric resoucs. This involves extensive geological mapping, hydrological studies, geophysical and geochemical prospecting.

Icelandic Institute of Natural History

Icelandic Institute of Natural History (Natturufraedistofnun) is responsible for general geologic mapping of Iceland and the maintenance of geological samples.

Nordic Volcanological Institute

Nordic Volcanological Institute (Norraena eldfjallastodin) is financed by the five Nordic countries for research on volcanic phenomena. The main emphasis has been monitoring crustal movement, mapping, and the geochemistry of volcanic products.

WWW pages

Icelandic Research Council	http://www.rannis.is
Marine Research Institute	http://www.hafro.is
University of Iceland	http://www.hi.is
Meterological Office	http://www.vedur.is
National Energy Authority	http://www.os.is
Icelandic Institute of Natural History	http://www.nattfs.is
Nordic Volcanological Institute	http://www.norvol.hi.is

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National News....

Italy

Background

For several years Italian groups have been conducting research projects on mid-ocean ridges (MOR). These projects have been conducted mostly by the Istituto di Geologia Marina (IGM) of the Italian National Research Council (CNR), located in the city of Bologna. However, researchers from other institutions such as the University of Pisa, the University of Padova, the University of Firenze and the University of Bologna have also participated.

Current Italian ridge research has built on studies of Red Sea centers of incipient oceanic crust secretion that took place in the late seventies and early eighties and led to several publications (Table 1).

Although they do not strictly concern the MOR, there have been numerous Italian studies on the centers of crustal accretion in the Tyrrhenian Sea, which can be considered a back-arc basin. The most recent effort along this line is an ongoing IGM project to map the entire Tyrrhenian basin with high resolution multibeam morpho-bathymetry. The southern part of the Tyrrhenian has already been surveyed, resulting in new data on crustal accretion at the Marsili and Vavilov ridges.

Two main areas of the MOR are currently being investigated (Fig. 1): (a) the equatorial portion of the Mid-Atlantic Ridge (MAR) roughly from the Chain Fracture Zone at 2°S to the Vema FZ at 11°N; (b) the Bouvet region in the South Atlantic, where the MAR, the Southwest Indian Ridge (SWIR) and the American Antarctic Ridge (AAR) converge in a triple junction.

The major objective of these projects is to determine the influence of different upper mantle thermal regimes on the structure and composition of ridges. Thus, we have chosen two contrasting regions: the equatorial Atlantic, strongly affected by a mantle thermal minima, and the Bouvet Triple Junction, affected by positive mantle thermal anomalies.

Much of this field work has been carried out in cooperation with the Geology Institute of the Russian Academy of Sciences, under an agreement called PRIMAR (Russian/Italian Mid Atlantic Ridge Project). A strong collaboration also exists with scientists from Lamont-Doherty Earth Observatory of Columbia University

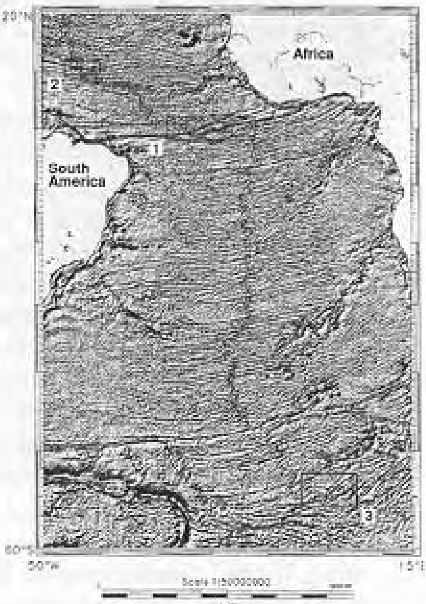

Figure 1. Satellite gravity imagery of the Central and South Atlantic (Sandwell), showing the areas discussed. Area 1: Romanche FZ area; Area 2: Vema FZ area; Area 3: Bouvet Triple Junction area.

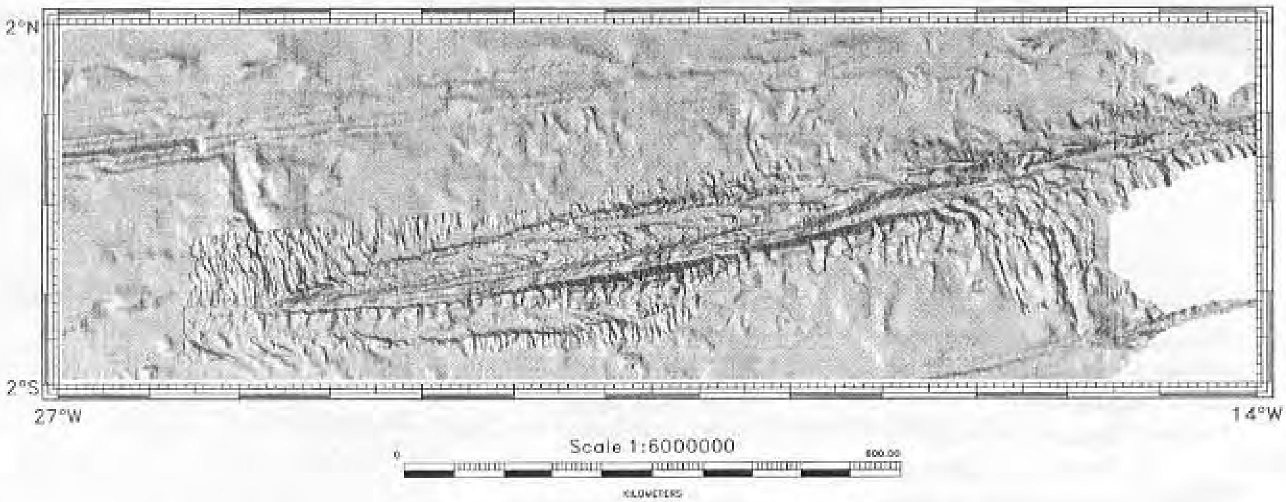

Figure 2. Shaded relief imagery of the Romanche F.Z. system, based on multibeam data obtained partly by Italian ridge researchers in cooperation with Russian scientists, combined with French and British published data.

National News: Italy continued...

Table 1. Papers Resulting from Italian ridge research up to 1997

Bonatti, E., D. Daniele and A. Peyve - Peridotites from the Chain fracture zone in the equatorial Atlantic: preliminary report. ***Acta Vulcanologica***, 2, 65-71 (1993).

Bonatti, E., Y. Raznitsin, G. Bortoluzzi, et al. - Geological studies of eastern part of the Romanche Transform, equatorial Atlantic: a first report. ***Giornale di Geologia***, 53, 31-48 (1993).

Bonatti, E., M. Seyler, N. Sushevskaya - A cold suboceanic mantle belt at the Earth's equator. ***Science***, 261, 315-320 (1993).

Bonatti, E.- The Earth's mantle below the Oceans. ***Sci. Amer.***, 270, 26-33 (1994).

Bonatti, E. and M. Ligi - L'evoluzione geologica dell'Atlantico equatoriale. ***Le Scienze***, 305, 34-44 (1994).

Bonatti, E., M. Ligi, L. Gasperini, A. Peyve, Y. Raznitsin and Y.J. Chen - Transform migration and vertical tectonics at the Romanche fracture zone, equatorial Atlantic, ***J. Geophys. Res.***, 99, 21779-21802, (1994).

Bonatti, E., M. Ligi, E. Vera., L. Gasperini, G. Carrara - Imaging crustal uplift, emersion and subsidence at the Vema fracture zone in the Atlantic. ***EOS***, 75, 371-372 (1994).

Seyler, M. and E. Bonatti - Na, ^{6}Al and ^{4}Al in clinopyroxene of subcontinental and suboceanic ridge peridotite: a clue to different melting processes in the mantle. ***Earth Planet. Sci. Lett.***, 122, 281-289 (1994).

Bonatti, E. Anomalous opening of the equatorial Atlantic due to an equatorial mantle thermal minimum. ***Earth Planet. Sci. Lett.***, 143, 147-160, (1996).

Bonatti, E. - Long-lived oceanic transform boundaries formed above mantle thermal minima. ***Geology***, 24, 803-806, (1996).

Bonatti, E., M. Ligi , A.M. Borsetti, L. Gasperini., A. Negri and R. Sartori - Lower Cretaceous deposits trapped near the Mid Atlantic Ridge and the opening of the equatorial Atlantic. ***Nature***, 380, 518-520, (1996).

Bonatti, E., M. Ligi, G. Carrara, L. Gasperini, N. Turko, S. Perfiliev, A. Peyve and P.F. Sciuto. Diffuse impact of the mid Atlantic Ridge with the Romanche transform: an ultracold ridge/transform intersection. ***J. Geophys. Res.***, 101, 8043-8054, (1996).

Carrara, G., G. Bortoluzzi, N. Zitellini, E. Bonatti, D. Brunelli, A. Cipriani, P. Fabretti, L. Gasperini, M. Ligi, D. Penitenti, P.F. Sciuto, A. Mazarovich, A. Peyve, N. Turko, S. Skolotnev and D. Gilod - The Bouvet Triple Junction Region (South Atlantic): a report on two geological expeditions. ***Giornale di Geologia***, ser. 3°, vol. 59/1-2, 19-33, (1997).

Gasperini, L, E. Bonatti, D. Brunelli, G. Carrara, A. Cipriani, P. Fabretti, D. Gilod, M. Ligi, A. Peyve, S. Skolotnev, S. Susini, P. Tartarotti and N. Turko - New data on the geology of the Romanche F.Z., equatorial Atlantic: PRIMAR-96 cruise report. ***Giornale di Geologia***, ser. 3°, vol. 59/1-2, 3-18, (1997).

Gasperini, L., E. Bonatti, M. Ligi, E. Sartori, A.M. Borsetti, A. Negri, and S. Sokolov - Stratigraphic and paleoenvironmental analysis of the carbonate platform on the Romanche transverse ridge, equatorial Atlantic. ***Mar. Geol.***, 136, 245-257, (1997).

Ligi, M., E. Bonatti, G. Bortoluzzi, G. Carrara, P. Fabretti, D. Penitenti, D. Gilod, A.A. Peyve, S. Skolotnev and N. Turko - Death and Transfiguration of a Triple Junction in the South Atlantic. ***Science***, 276, 243-245, (1997).

Seyler, M. and E. Bonatti. Regional scale melt-rock interaction in lherzolitic mantle in the Romanche Fracture Zone, Atlantic Ocean. ***Earth Planet. Sci. Lett.***, 146, 273-287, (1997).

Table 2. Italian ridge-related cruises, 1992-1998

Country	PI	Institution	Location	Research Objectives	Ship	Dates
Italy, Russia	Bonatti, Raznitsin	IGM, GIN	Romanche, Chain FZs	vertical movements and origin of the transverse ridge; equatorial mantle thermal minima	Strakhov	Dec '91- Feb '92
Italy	Bonatti	IGM, GIN	Vema FZ, western RTI	imaging crustal uplift, emersion and subsidence at the Vema FZ	OGS-Explora	Aug '92
Italy, Russia	Bonatti, Peyve	IGM, GIN	Romanche FZ	Multibeam, seismic reflection, and sampling	Strakhov	Jan/Mar '93
Italy, Russia	Bonatti, Peyve	IGM, GIN	Romanche FZ eastern RTI	seismic reflection images of the sedimentary transverse ridge near the eastern RTI	Strakhov	Feb '94
Italy	Zitellini, Peyve	IGM, GIN	Bouvet Triple Junction and FZ	mantle thermal anomalies and seafloor spreading processes	Strakhov	Mar/Apr '94
Italy	Bortoluzzi, Peyve	IGM, GIN	Bouvet Triple Junction	constraints on the Bouvet Triple Junction geometry	Gelendzhik	Mar/Apr '96
Italy, Russia	Bonatti, Peyve	IGM, GIN	Romanche West. RTI and St Peter-Paul island	morphobathymetry of the Romanche FZ western RTI	Gelendzhik	Apr/Jun '96
Italy, Russia	Bonatti, Peyve	IGM, GIN	Vema transverse ridge	geochemical and structural variations	Strakhov	Jan/Mar '98

National News: Italy continued...

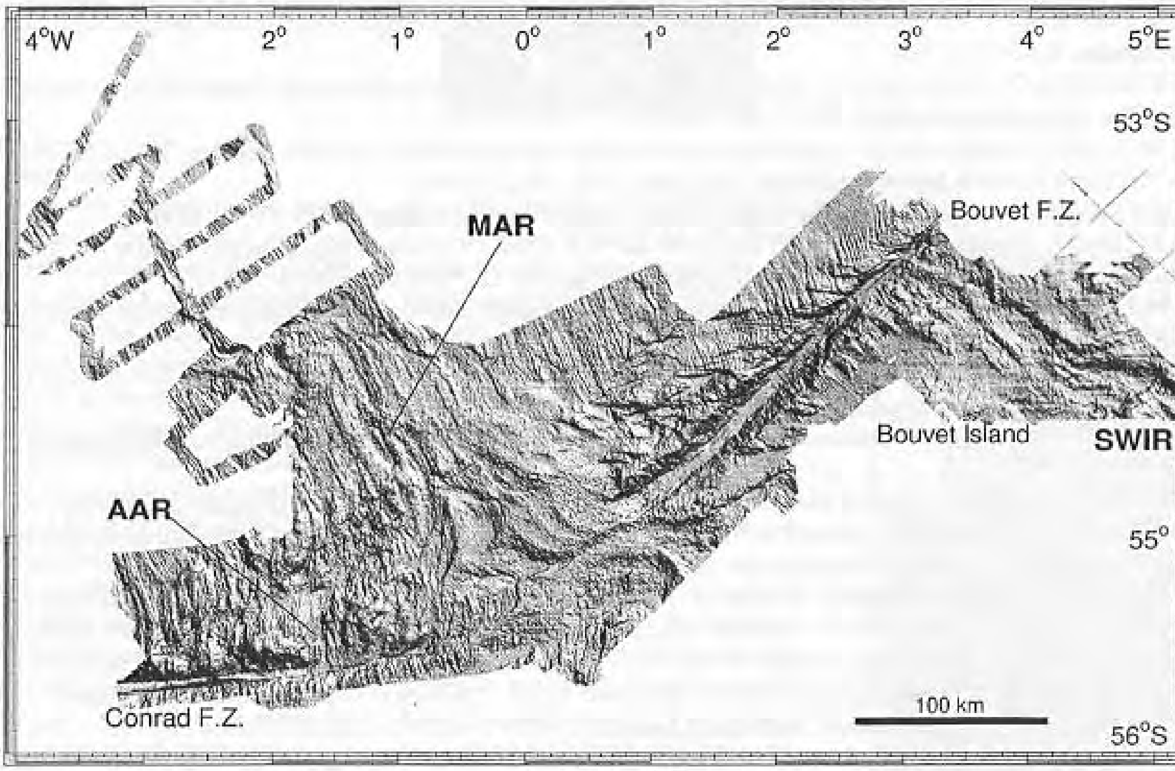

Figure 3. Shaded relief imagery of the Bouvet Triple Junciton area based on multibeam data obtained by Italian ridge researchers in cooperation with Russian scientists (from Ligi et al., 1997).

(USA) and from IFREMER (France).

Equatorial Mid Atlantic Ridge

The objective of this progam is to shed light on the structural and petrological processes that have led to an anomalous opening of the equatorial Atlantic, where the Mid Atlantic Ridge is segmented by a number of long offset transform/fracture zones (Fig. 2). These fracture zones can be traced across the Atlantic from coast to coast, indicating that they were active boundaries since the early stages of continental separation. A number of expeditions were carried out in the equatorial Atlantic (Table 1), particularly at the Romanche and Vema FZ and the adjacent ridge segments. During these expeditions multibeam morphobathymetry, multi- and single-channel seismic reflection profiling, magnetometry, gravimetry and rock and sediment sampling were carried out. This research was supported mostly by the CNR.

Bouvet Triple Junction Region

The influence of mantle positive thermal anomalies on the evolution of triple junctions is one of the main focuses of the Italian research program in the region of the Bouvet Triple Junction, where the Antarctic, African and South American plates converge (Fig. 3). Two expeditions were conducted in this region in 1994 and 1996 (Table 2). Multibeam morphobathymetry, as well as seismic reflection, magnetometric and gravimetric data were collected on each of the three ridges that converge at the Triple Junction. Extensive bottom rock sampling was also carried out. This research was supported by the Italian Antarctic Research Program (PNRA).

Summary

Some of the publications resulting from the equatorial Atlantic and Bouvet projects up to 1997 are listed on Table 1. Both projects are continuing, and shore-based processing of data and study of samples are in progress.

Future development will hopefully include new field programs in both areas of interest, and, in addition, a cruise to the Red Sea/Gulf of Aden System to study some aspects of the transition from a continental to an oceanic rift.

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Korea

Despite the recent economic turmoil and looming plans for government restructuring and downsizing in Korea, a number of sea-going projects are planned for 1998. The following is a brief summary of the projects at the Korea Ocean Research and Development Institute (KORDI) which may be of interest to the international mid-ocean ridge community.

Preparations are underway (PI: Sang-Joon Han) for a major OBS seismic experiment in the Korean continental margin in the East Sea (Japan Sea). This experiment, tentatively scheduled for August 1998, will be conducted onboard a Russian R/V *Professor Gargarinsky* which has a large 60-liter airgun. The airgun will be shot along two perpendicular lines, each 100 km long. The study is a follow-up of an earlier OBS experiment conducted in 1991 jointly by Korean and Russian scientists in which new evidence for oceanic crust was found in the Ulleung Basin [Kim et al., 1994, GRL]. The main objective of this study is to investigate how the continental crust gives way to the backarc basin crust. When this latest information about the crustal type and its distribution is incorporated, it is expected that further insight may be gained into the tectonics of the East Sea and the formation of back-arc basins.

KORDI recently added a deep-tow system to its pool of instruments. This system, developed by Datasonics Inc. (model SIS-3000), employs Chirp acoustic technology and is capable of operating at depths up to 6 km. The vehicle delivered to KORDI is equipped with side-scan, sub-bottom profiling, phase swath bathymetry capabilities, and a magnetometer fish. The deep-tow vehicle was tested last year off the coast of Korea at a depth of 2 km, during which several technical problems were identified such as bad cable connections and frequent power failures. These problems are currently being addressed, and a second test trial (PI: Seong-Ryul Kim) is planned for September 1998. Once operational, the deep-tow system should provide greater capability for KORDI's deep-sea exploration.

As a part of the government's ongoing effort to study the marine resources around within the Exclusive Economic Zone, a multi-disciplinary survey is again planned this year using R/V *Onnuri* (PI: Hai-Soo Yoo). Some of the data obtained last year include 56-channel seismic data, gravity and magnetic fields measurements, and 3.5 kHz sub-bottom profiles taken over a total length of 700 km. These data are currently being analyzed and should serve as a reference for understanding geological and tectonic processes around Korea.

Over the last several years, Korea has been a major participant in the manganese nodule exploration in the Pacific Ocean seafloor. This summer, from May to August, R/V *Onnuri* will be deployed to survey manganese nodules in an area west of the Clarion and Clipperton Fracture Zone (PI: Ki-Hyune Kim). However, this year the expedition includes two additional legs. The first leg is a reconnaissance type study of a manganese crust formed around old Cretaceous seamounts (PI: Jai-Woon Moon), and the second leg involves exploration for hydrothermal vents and mineral deposits in the forearcs of the YAP trench (PI: Kyeong-Yong Lee). Although the primary aim of these surveys is in the exploration of valuable minerals for economic purposes, the collection of useful marine geological/geophysical data from these parts of the Pacific plate is expected to generate a greater interest in global tectonic issues within the Korean scientific community.

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National News...

New Zealand

New Zealand joined InterRidge as a Corresponding member in 1998. New Zealand marine geology and geophysics research is mostly concentrated on understanding the late Cretaceous to present-day evolution of the Australian-Pacific plate boundary through the largely submerged New Zealand sub-continent. Of these studies the most relevant to InterRidge are those defining the tectonic and magmatic evolution of the numerous back-arc basins to the north of New Zealand including the actively widening Lau-Havre back-arc system, associated with modern subduction along the Tonga-Kermadec convergent margin, and the southward propagation into the active Taupo Volcanic Zone (TVZ) rift system within continental New Zealand. This back-arc basin research has received a recent boost with (i) the discovery of hydrothermal sulfide mineralisation along the southern Kermadec arc front, and (ii) recent and forthcoming international research cruises within the Havre Trough and southern Lau Basin.

Kermadec-Havre Hydrothermalism

The first evidence of high-temperature hydrothermal sulfide mineralisation within the Kermadec-Havre arc-back-arc system was recovered during rock dredge sampling in Feb. 1996 during investigations of southern Kermadec silicic calderas. High-temperature sulfides were recovered from the caldera walls of the Brothers and Rumble II (West) arc volcanoes within water depths of ~1500 m. The Brothers and Rumble II (West) caldera are, respectively, mostly dacitic and basaltic in composition. Two specimens of the carid vent shrimp *Alvinocaris* cf *lusca* have been also fortuitously recovered from the Brothers caldera. This evidence of hydrothermalism and associated sulfide mineralisation has stimulated a new collaborative initiative between NIWA (National Institute of Water and Atmospheric Research) and IGNS (Institute of Geological and Nuclear Sciences) to study these hydrothermal sites. The first cruise is scheduled for March 1999 onboard the RV *Tangaroa* with cruise participants of Cornel de Ronde (IGNS), Ian Wright (NIWA) , Gary Massoth, and Ed Baker (NOAA/PMEL). The cruise will undertake (1) hydrothermal plume mapping and sampling along the southern Kermadec arc front (particularly within the Brothers and Rumble II (West) caldera volcanoes and the submarine region of White Island (an active, partially emergent arc volcano), and (2) further rock dredging at sites of discovered active hydrothermal venting. The hydrothermal plume mapping will involve deployment of the towed NOAA SUAVE sensor system with *in-situ*, real-time dissolved Mn and Fe measurements, standard CTD with transmissometer and nephelometer, and water sampling for dissolved gases and particulates.

Havre Trough Investigations

A completed cruise of the RV *Yokosuka* in Feb. 1997 (see *InterRidge News* vol. 6(2)), and a forthcoming cruise of the RV *Sonne* during Sept.-Oct. 1998, both within the Havre Trough and southernmost Lau Basin, will provide a significant new dataset to document the tectonic and magmatic evolution (including hydro-thermalism) of this active present-day back-arc basin complex. Both cruises will acquire swath bathymetry, seismic reflection, gravity and magnetic data, and rock dredge samples (and video grab samples in the case of the *Sonne* cruise). The *Sonne* cruise will concentrate on establishing the tectonic structure and associated magmatism within a transverse sector of the arc - back-arc system nearest the partially emergent Kermadec Islands. The *Sonne* cruise is a collaborative German-New Zealand project and includes cruise participants of Peter Stoffers (University of Kiel), Heinrich Villinger (University of Bremen), Peter Herzig (University of Freiberg), Mark Hannington (GSC), Cornel de Ronde (IGNS), Ian Wright (NIWA) and researchers from the University of Auckland.

Regional Seafloor Morphology

G. Ramillien, a recent PhD graduate from France, has begun a NIWA Post-Doctoral project to invert satellite altimetry data into a revised predicted seafloor topography model initially for the region bounded by 57°S, 157°E, 167°W, and 24°S. This region will include areas of seafloor spreading fabric between anomaly 32 and ~25 of the Pacific- Antarctic Ridge, abutting the Campbell Plateau, spreading fabrics of the Tasman Sea, and the back-arc basin structural fabrics to the north of New Zealand. It is hoped that the incorporation of otherwise unavailable ship-borne bathymetry and gravity data, and possibly constraints of crustal structure and sediment thickness, will provide further refinement to the global models of predicted seafloor topography currently available.

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National News...

Portugal

Ridge research in Portugal has been developed since the eighties by research groups working in geophysics, petrology, sedimentology, tectonics and biology (see article on page 22). The main initiative contributing to the convergence of these efforts was the Portuguese participation in the MASTII and MASTIII EU programs and the InterRidge initiative, where Portugal has been an Associate Member since 1994. Most of the work done so far relates to the Azores, namely, the triple junction area and the neighboring Mid-Atlantic Ridge.

The groups currently working include the CGUL (University of Lisbon, Geophysics - Luis Mendès Victor, e-mail: lmvictor@fc.ul.pt and J. M. Miranda), the IMAR (Institut for Marine Research, Biology - A. Almeida, e-mail: aalmeida@fc.ul.pt), the DGUL (University of Lisbon, Geology - F. Barriga, e-mail: Fernando.Barriga@fc.ul.pt) and the University of Algarve (Geophysics - Joaquim Luis, e-mail: jluis@ualg.pt, and Sediment Studies - J Alveirinho Dias, e-mail: jdias@ualg.pt). These teams have all been involved in MARFLUX/ATJ project, actively collaborating in most of the international initiatives related to the Azores Triple Junction and hydrothermal research; and they are now participating in the MASTIII projects AMORES and ISO-3D.

Last Fall the First International Symposium on Deep-Sea Biology was held in Funchal, Madeira, Portugal and hosted by Manuel Biscoito. Over 120 biologists from 12 countries attended this Symposium (see page 14 for more details).

Deep sea research vessels in Portugal are managed by the Instituto Hidrográfico, a Navy institution. New research ships (D. Carlos and D. Amelia) are now being adapted to work in the deep sea. Until these new ships are available, most research is being done in collaboration with RVS (UK) and IFREMER (France).

The Portuguese InterRidge coordination is managed by ICTE, a network of earth and space sciences research groups.

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Russia-Ridge

Research Projects

Russia has been affiliated with InterRidge as a Corresponding Country since 1993. The first meeting of Russian scientists interested in InterRidge projects (Russia-Ridge) was held in 1995 in St. Petersburg during an international conference on the geology and geophysics of Mid-Ocean Ridges.

The Russia-Ridge scientific community includes more than 100 active scientists, comprised mostly of geologists, geochemists and petrologists. Russian researchers have participated in many ridge-related research projects, which have covered all of the main aspects of crustal accretion at mid-ocean ridges: mantle melting, evolution of parental melts, evolution of residual peridotites, formation of plutonic complexes, metamorphism, and hydrothermalism. Biologists have also been involved in Ridge-crest cruises. Many of the Russian investigations were cooperative programs involving the participation of a number of international institutions, including Hunter College (USA), IFREMER (France), Istituto de Geologia Marina, Bologna (Italy), Smithsonian Institute (USA), University of Houston (USA), University of Tasmania (Australia), and Woods Hole Oceanographic Institution (USA). The main interest of these investigations has been the Mid-Atlantic Ridge (MAR). There currently exists in Russia large geophysical, petrological, and geochemical data sets of the mid-ocean ridges.

Russian scientists were active participants in the 1996 ODP/InterRidge/IAVCEI/JOI Workshop which outlined a strategy for scientific drilling into the 21st Century. S. A. Silantyev and L. V. Dmitriev (Vernadsky Institute of Russian Academy of Sciences) are contributors to a proposal recently submitted to drill a serpentine belt at 15°N along the MAR.

National Funded Projects

Project: Petrological-Geochemical analysis of ultramaphic-gabbro-basalt assemblages at mid-ocean ridges (Mid-Atlantic Ridge, 12°-17°N).
Period: 1995-1998.
PIs: L. V. Dmitriev, S. A. Silantyev, and B. A. Bazylev.
Objective: An examination of genetic conformity and unconformity between main members of crustal sequences (basalt-gabbro-peridotites) in the MAR crest zone.

Project: Origin and transportation of mantle derived melts in major geodynamic settings.
Period: 1996-1998.
PI: A. V. Sobolev.
Objectives: The reconstruction of the nature and mechanisms of mantle melting and magma segregation, transport and storage in mid-oceanic ridges, mantle plumes, and suprasub-duction environments by the study of liquidus mineral assemblages and magmatic inclusions in near-liquidus phenocrysts combined with a study of residual mantle after melt extraction.

Project: Structural-Tectonic Assembleages of the equatorial Atlantic.
Period: 1997.
PIs: A. O. Mazarovich, S. Yu. Sokolov, K. O. Shapovalova, V. N. Efimov, G. V. Agapova, and N. N. Turko.
Objectives: Interpret digital multibeam and single channel profiling data, and prepare structural assemblage maps.

Project: New 3-D density model of lithosphere structure of the North Atlantic Ocean.
Period: 1995-1997.
PIs: S. P. Mashenkov, and A. V. Zayonchek.
Objective: Interpretation of the results of detailed geological and geophysical surveys of the central part of the Canary-Bahamas geotransect.

Future Projects

Project: The relationship between magmatism, metamorphism and hydrothermalism along the MAR.
Period: 1998-2000.
PIs: L. V. Dmitriev, S. A. Silantyev, B. A. Bazylev, A. A. Plechova, and S. Yu. Sokolov.
Objective: Analyse the influence of endogenous and exogenous factors on the tectonic architecture and the geochemical features of hydrothermal systems in the axial zone of the MAR.

Project: Petrological and geochemical parameters of residual peridotites as a reflection of the geodynamic character of magmatism and metamorphism of mid-ocean ridges.
Period: 1997-1999.
PIs: S. A. Silantyev, B. A. Bazylev, and L. V. Dmitriev.
Objective: Use the distributions of indicator parameters of residual peridotites along the MAR strike to reconstruct the geodynamic conditions of mantle diapirism in different MAR segments.

Project: Petrological and geochemical aspects of the dynamics and evolution of the mantle under slow-spreading ridges.
Period: 1996-1999.
PIs: N. M. Suschevskaya, B. V. Belyatsky, A. Ju. Borisova, and T. I. Tsehonya.
Objective: Model the petrological and geochemical constrains of MAR mantle melting from MORB composition.

Project: The relationship between magnetic and gravity anomalies and MAR spreading rate.
Period: 1997-1999.
PIs: A. M. Gorodnitsky, E. G. Astafurova, and S. P. Maschenkov.
Objective: Magnetic and gravity modeling of the relationship between geophysical and petrological construc-

tion of the MAR (23°-29°N) and the South Atlantic MAR segment (Angola-Brazil geotransect).

Research Vessels

The scientific institutions of Russia have many different research vessels including modern ships such as the R/V *Akademik Nikolai Strakhov*, the R/V *Akademik Boris Petrov*, and the R/V *Akademik Mstislav Keldysh* which is the mothership of the MIR submersibles. All of these ships have the equipment necessary for geophysical and bathymetric surveying as well as for dredging and hydrochemical measurements. Unfortunately, the current financial difficulties in Russia prevent the regular operation of the scientific fleet.

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Russian Institutes of Ridge-Research

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Vernadsky Institute (Moscow), Russian Academy of Sciences
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Moscow State Lomonosov University (Moscow)
Central Research Institute of Geological Prospecting for Base and Precious Metals (Moscow)
VNIIOkeangeologia (St.Petersburg)
TETHYS Geodynamical Research Center (St.Petersburg)
United Institute of Geology, Geophysics and Mineralogy, Siberian Branch of Russian Academy of Sciences (Novosibirsk)
Far East Geological Institute of Far East Branch of Russian Academy of Sciences (Vladivostok)
Pacific Oceanological Institute (Vladivostok)

Russian Ridge-Related WWW sites

MIR hydrothermal dives	http://www.sio.rssi.ru/sagthe_e.htm
MIR-1 and MIR-2 Research Submersibles	http://www.sio.rssi.ru/sagdes_e.htm
R/V *Akademik Mstislav Keldych*	http://www.sio.rssi.ru/keld_e.htm
Russian Academy of Sciences	http://www.ras.ru
Siberian Branch of Russian Academy of Sciences	http://www.sbras.nsc.ru
Shirshov Institute of Oceanology	http://www.sio.rssi.ru
Vernadsky Geological Museum	http://www.sgm.ru
O.J. Schmidt United Institute of Earth Physics	http://geology.scgis.ru
United Institute of Geology, Geophysics and Mineralogy	http://geology.uiggm.nsc.ru/engl/index.htm
VNIIOkeanologia	http://www.vniio.nw.ru

National News: Russia continued...

Proposal for the Joint Operation of the R/V *Akademik Boris Petrov*

The Vernadsky Institute of Geochemistry and Analytical Chemistry of the Russian Academy of Sciences is proposing the joint operation of the R/V *Akademik Boris Petrov* to carry out complex marine expeditions in the frame of InterRidge research. The total price for operation of the ship will be about $5,000-6,000 USD per day, which includes fuel, water and food, docking, equipment use, insurance, and salary for the crew and scientific personnel.

Main particulars of the R/V *Akademik Boris Petrov*
2600t Research Vessel. Built by "Holming LTD" Shipyard (Finland).

Length oa	75.5m
Breadth, mld	14.7m
Depth to main deck	7.3m
Draught, design	4.5m
Deadweight at 4.5m	about 860t
Speed at design draught	13 knots
Duration of autonomous sailing	60 days

The vessel has been designed and built in conformity with the class requirements for unrestricted service of the Register of Shipping to have a class notation: KM*L1 1 A2 (research vessel). During construction special attention was paid to vibration and noise reduction and to designing the hull for good seakeeping characteristics.

The Ocean System Department of the Shipyard has developed and assembled the integration of the research equipment. This integrated scientific system consists of computers, analytical equipment and system software.

The vessel is also equipped with:
Helicopter deck,
Multibeam Echo Sounder,
GPS,
Continuous seismic profiling,
Multichannel seismic reflection,
Ocean bottom seismograph,
Magnetometer,
Gravimeter,
Thermoprobe (heat flow),
Heavy winch for long seismic streamer,
Heavy winch for dredging and core sampling.

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National News...

UK: BRIDGE

With less than two years of the BRIDGE Programme remaining, more than half the BRIDGE awards have been completed: 26 of the 44 projects have ended and analysis of the scientific results is well underway. BRIDGE data management began at the end of December with the first wave of BRIDGE data submitted by BRIDGE PIs to Philippe Blondel at Southampton Oceanography Centre. The next submission of data is due by the end of April; the final submission will be made by the end of September.

As the programme matures the scientific information increases and this was never more apparent than at the January 1998 BRIDGE Annual Meeting at the University of Bristol. All those attending recognised this as a high quality meeting and as usual presentations ranged over the full scope of BRIDGE interest including: dimensions and dynamics of megaplumes; symmetry of accretion at a slow spreading segment; the nature of crystalline Silica from TAG; and the microbiology of metalliferous sediments from inactive hydrothermal mounds. Abstracts will be published in BRIDGE Newsletter 14.

The annual meeting this year coincided with press interest in the recent granting of exploration and development licences for commercial investigation of hydrothermal deposits in the Manus Basin, SW Pacific. During the BRIDGE meeting the UK national television news featured Chris German and Paul Tyler, both members of the BRIDGE Steering Committee, in a related item on hydrothermal deposits.

At Bristol, David Dixon from Southampton Oceanography Centre reported the testing of his new BRIDGE-funded autonomous plankton sampler, 'PLASMA', during the joint BRIDGE-MAST III 'FLAME' cruise led by Chris German in 1997. PLASMA has been developed to study larval dispersal in vent environments. Following its test cruise it was deployed during further MAST III work off the Azores. Several instruments are currently on the seabed taking pre-programmed samples for later molecular analysis.

Two cruises remain in the BRIDGE cruise schedule. The marine oriented hard-rock corer developed with BRIDGE funding at the British Geological Survey in Edinburgh will be tested in the next few weeks on the Southwest Indian Ridge from RRS *James Clark Ross*. This is not a BRIDGE research area, however attempts to organise a test cruise for the drill at BRIDGE locations have repeatedly been foiled. This cruise, led by Chris MacLeod from Cardiff and Simon Allerton, a BRIDGE Research Fellow at Edinburgh University, is one of the first to visit a near ridge crest hard rock deep-ocean site with the deck space and on-board technical skills to handle the new drill. The drill's capabilities should enhance the cruise objectives if the corer lives up to its promise.

The 18th and last BRIDGE-funded cruise will be the electromagnetic and seismic study of the magma chamber under the Reykjanes Ridge mentioned in the last InterRidge Newsletter. The cruise ('RAMESES II') will be led by Christine Peirce from Durham University in July and August aboard RRS *Discovery*. An outline of the objectives can be found in BRIDGE Newsletter 13.

Finally, the manuscripts for the BRIDGE-sponsored Geological Society of London Special Publication "Modern Ocean Floor Processes and the Geological Record", mentioned in the last InterRidge Newsletter, are now with the printers and should be published later this year. The 15 papers cover the gross structural form of spreading centres; hydrothermal alteration; hydrothermal sediments; chimney structure; and faunal colonisation of vent fields, from both modern and ancient perspectives. This volume should be a useful and timely contribution to the literature.

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New WWW address! **http://www.nerc.ac.uk/es/bridge.htm**

National News...

USA: RIDGE

In December, the Workshop Report on the *Detection and Rapid Response to Events on the Mid-Ocean Ridge* was published. A digital version is available on the RIDGE website. From this Workshop Report, Event Detection and Rapid Response (EDRR) proposal guidelines were established, and in early January the RIDGE office released a request for EDRR proposals. To facilitate EDRR communication, the RIDGE website has been expanded to include an EDRR equipment database, links to important sites, contact information, and an online bulletin board.

As the EDRR request was released, the NOAA VENTS program detected an event on Axial Volcano using SOSUS. In mid-February, a RIDGE/NOAA VENTS funded response cruise arrived on site for several days of water column surveying. Eight ocean bottom hydrophones (Spahr Webb, SIO) were deployed around the intersection of the south rift zone and the summit caldera, the earliest by far that such instruments have been deployed after a seismic event. Sixteen CTD/water sampling stations were occupied, sufficient to document extensive new venting at Axial Volcano. Although no event plume was located, hydrothermal discharge from the summit of Axial is roughly an order of magnitude greater than before the event. Plumes with temperature anomalies approaching 0.2°C and intense light attenuation values fill the south end of the caldera, rising at least 200 m above the bottom. For more information, follow the Event Detection and Response link from the RIDGE website.

The first LARVE cruises will go to sea this year; and a series of acoustic extensometers will be deployed as part of the RIDGE Seafloor Observatory effort. To help coordinate Observatory research, RIDGE hosted a public meeting at the Fall AGU in San Francisco. A summary of this meeting is available on the RIDGE website. The RIDGE website will also host the Juan de Fuca Cruise Information Database for 1998. In the past, Ed Baker (NOAA/PMEL) has compiled this information. If you have a research cruise in the Northeast Pacific during the 1998 field season, please fill out the online Cruise Information Form found at:

http://ridge.unh.edu/observatory/

In early Spring, the RIDGE Office mailed postcards to all members of the RIDGE mailing list. To help us update our records, please confirm or correct the information on these cards and return them to the RIDGE Office. For non-US members, it may be easier to email this information to the RIDGE Office at **ridge@unh.edu**.

Following the RIDGE Steering Committee meeting in early April, a draft of the revised RIDGE Science Plan will be placed on the RIDGE website for comments from the community. The final draft of the RIDGE Science Plan will be distributed early in the summer.

A RIDGE/NOAA VENTS co-sponsored workshop on the *Effects of Hydothermalism on Surface Ocean Productivity* will be held in Santa Cruz, CA in mid-May. Several other RIDGE Workshops, Schools, and Results Symposia are in the planning stages, including:

•A Results Symposium on the *East Pacific Rise from 9°-10° N*

•A Results Symposium on *Why Ridges are Segmented and Why Rifts Propagate*

•A Results Symposium on the *Juan de Fuca Ridge*

As planning continues, information will be posted on the RIDGE website.

Next Fall, the RIDGE Office will rotate from the University of New Hampshire to Oregon State University, when Dr. David Christie becomes Chair of the RIDGE Steering Committee.

(*Until* September 1, 1998)

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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.

May 12-13, 1998	**RIDGE Workshop: The Effect of Seafloor Hydrothermalism on Surface Ocean Productivity,** Santa Cruz, CA, USA
May 18-20, 1998	**Geological Association of Canada & the Mineralogical Association of Canada Joint Annual Meeting** Quebec City, Canada
May 26-29, 1998	**American Geophysical Union Spring Meeting** Boston, MA, USA
Jun. 28-Jul. 3, 1998	**Gordon Research Conference: Interior of the Earth** New England College, Henniker, NH, USA
Jul. 11-16, 1998	**IAVCEI - International Volcanological Congress** Cape Town, South Africa
Jul. 21-24, 1998	**AGU Western Pacific Geophysics Meeting** Taipei, Taiwan
Aug. 9-14 1998	**Gordon Research Conference: Organic Geochemistry** Holderness School, Holderness, NH, USA
Sept. 13-17, 1998	**GSA Penrose Conference: Ophiolites and Oceanic Crust: New Insights from Field Studies and Ocean Drilling Program** Marconi Center, Tamales Bay, CA, USA
Sept. 14-15, 1998	**InterRidge Steering Committee Meeting** Barcelona, Spain
Sept. 18-22, 1998	**2nd EUROFORUM ODP Meeting** Edinburgh, Scotland, UK
Oct. 21-24, 1998	**29th Underwater Mining Institute Conference** Toronto, Canada
Oct. 12-16, 1998	**3rd International Conference on Arctic Margins** Celle, Germany
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
Nov. 11-12, 1998	**Technology for Deep-Sea Geological Investigations: Developments, Applications and Results** Geological Society, Burlington House, Piccadilly, London, UK
Dec. 7-11, 1998	**American Geophysical Union 1998 Fall Meeting** San Francisco, CA, USA
Spring, 1999	**International Scientific Ocean Drilling Conference** To be announced
Sept. 12-15, 1999	**3rd International Workshop on Orogenic Lherzolites and Mantle Processes** Pavia, Italy

Upcoming Meetings and Workshops

InterRidge Workshop: Mapping and Sampling the Arctic Ridges

October 16-17, 1998

BGR, Hannover, Germany

Application Deadline: May 31, 1998
Abstract Deadline: Sept. 15, 1998

Workshop Objectives

- to bring participants up to date on rock sampling and geophysical, hydrothermal, and biological experiments that have taken place in the Arctic ridge system since the Kiel InterRidge Workshop in 1994 (Report available from the InterRidge Office).
- to devise a Program Plan for future multidisciplinary studies of this slow spreading ridge system and reinforce international cooperation. This will include discussions of scientific priorities, the use of "alternate" platforms and the development of innovative sampling tools for use in ice-covered regions.

The Arctic Ridge system includes the Kolbeinsey, Mohns, Knipovitch, and Gakkel Ridges. The major conclusion of the 1994 workshop in Kiel was that the northenmost and least studied portion of this system (Gakkel Ridge), should have the highest priority, at least in terms of geophysical and geochemical studies. Critical issues in these disciplines are how exceptionally slow spreading rates have influenced melt production in the mantle, melt migration through the lithosphere, crustal genesis and tectonism. Very little is known of biological communities at ridge vents north of Iceland. One critical issue is therefore to determine whether the vent faunas of Arctic ridges have evolved independantly from the rest of the global ridge system, or whether they are derived from Atlantic faunas. The potential for new faunas with perhaps novel adaptations seems high, given the shallow sills that isolate the deep waters of the Arctic basin from the Atlantic.

Potential participants should send a letter of application to Cara Wilson at the InterRidge Office by May 31st 1998. Prefered submission format is via our www form (**http://www.lgs.jussieu.fr/~intridge/arc-reg.htm**) or by e-mail. Applicants should include a brief statement indicating their area of interest, the relevance of their recent work to the theme of the workshop, and, if they wish to present a poster, a prospective title (the abstract deadline is **September 15, 1998**). Participants will be selected by the organizing committee to include broad representation of different relevant disciplines.

The workshop is organized by the InterRidge Arctic Working Group, chaired by Roland Rihm. Cara Wilson at the InterRidge Office will centralize the applications and abstracts.

Third International Conference on Arctic Margins

The Workshop will be help just after the Third International Conference on Arctic Margins (ICAM, Celle Germany, Oct. 12-16 1998). Although this conference does not have a special session on ridges, it will be a good opportunity to become familiar with issues of Arctic geology. Information about the ICAM conference is available on the web (**http://www.bgr.de/b3/icam3.html**). A bus transfer from Celle to Hannover (40 minutes) and back will be organized for workshop participants who will attend the ICAM conference and wish to stay in the same hotel. The registration deadline for the ICAM conference is **July 30, 1998**.

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For more details see: **http://www.lgs.jussieu.fr/~intridge/arctic98.htm**

Upcoming Meetings and Workshops....

InterRidge Workshop: Long-Term MOnitoring of the Mid-Atlantic Ridge "MOMAR"

October 28-31, 1998
University of Lisbon, Lisbon, Portugal

Application Deadline: June 1, 1998
Abstract Deadline: Aug. 1, 1998

There is an opportunity, over the coming years, for the international community of ridge researchers in biology and geosciences to initiate a comprehensive long-term program to **MO**nitor the **M**id-**A**tlantic **R**idge near the Azores (MOMAR). This program could combine long term monitoring of biological and physico-chemical activity at hydrothermal vents, with broader scale monitoring of seismicity, volcanic activity, axial deformation and the physical properties of the crust in the study area, as well as with instruments integrated into global-scale geodynamics monitoring networks. This may involve instruments that would be attached to a cable, autonomous monitoring equipment, and a variety of time-series experiments. An emphasis will also be placed on allowing data to be retrieved in real time.

Scientific objectives for a ridge crest observatory have been discussed and outlined at a number of international workshops during the last few years:

- how does the mid-oceanic ridge environment change with time (in terms of seismicity, volcanism, hydrothermal venting and the distribution and characteristics of biological populations)?
- how do these changes affect heat and chemical transfer to the overlying ocean, ecosystem development, faunal succession and biological productivity?
- what are the components and space/time extent of the subseafloor biosphere?
- what are the dominant controls on volcanism, hydrothermalism and faulting at the ridge axis, and how are these processes connected?

The Mid-Atlantic Ridge near the Azores is well located to address these objectives: it is near port, allowing for short transit times for the deployment and retrieving of tools, and it has been the focus of a great number of cruises in the past few years. The geological-geophysical background of this region is therefore well constrained, as are the general characteristics of hydrothermal vents, and the broad diversity of the associated ecosystems.

In order to launch the MOMAR project, InterRidge is organizing an international workshop in Lisbon, Oct. 28-31, 1998. The workshop will be hosted by Drs. M. Miranda and L. Mendès Victor of the University of Lisbon and will have 50-60 participants, ranging in disciplines from biology to geophysics. The Organizing Committee reflects this range of disciplines and is co-chaired by Maya Tolstoy (Lamont Doherty) and Pascal Tarits (Université de Brest). The workshop will focus primarily on the practical aspects of setting up long-term monitoring in this area, such as the design and installation of various types of instrumentation, and the writing of a Program Plan to serve as a guide in the preparation of proposals.

Potential participants should send a letter of application to Cara Wilson at the InterRidge Office by **June 1 1998.** Prefered submission format is via our www form (**http://www.lgs.jussieu.fr/~intridge/momar-r.htm**) or by e-mail to intridge@ext.jussieu.fr. US applicants should fill-out the form on the RIDGE web page (http://ridge.unh.edu/meetings/momar/). Applicants should include a brief statement indicating their area of interest, the relevance of their recent work to the theme of the workshop, and a title and brief description of their proposed poster topic (the final abstract deadline is Aug. 1, 1998). There may be travel funding available for young European scientists. There is a limited amount of travel funds for US participants available from RIDGE.

MOMAR Organizing Committee

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For more details see: **http://www.lgs.jussieu.fr/~intridge/momar.htm**

Upcoming Meetings and Workshops...

IAVCEI - International Volcanological Congress

11-16 July, 1998, Cape Town - South Africa

OCEANIC VOLCANISM

Papers are invited that address processes active at, or below, mid-ocean ridges and ocean islands and seamounts. In particular, papers which address global problems or yield testable globally-relevant models on the following topics are encouraged: relationship between tectonic setting and basalt geochemistry (local and global scale); melting regimes; hydrothermal vent activity; mantle plumes and ocean island volcanism; mantle plume-ridge interactions.

Convenors: Anton le Roex (alr@geology.uct.ac.za) and Colin Devey (cwd@gpi.uni-kiel.de)

For more details see: **http://www.uct.ac.za/depts/geolsci/ivc98**

2nd EuroForum ODP Meeting

19-22 September 1998, Edinburgh, UK

Programme

Saturday Sept. 19	Fieldtrip to Ballantrae ophiolites, S W Scotland; leader Phil Stone
Sunday Sept. 20	Day off in Edinburgh (Self-guide geological tour available)
Monday-Tuesday Sept.21-22	Programme of talks and posters

Invited Talks

THEME A CONTINENTAL MARGINS

1. **North Atlantic Rifted Margins**
   R. Whitmarsh (U.K.)
2. **North Atlantic Volcanic Rifted Margins**
   H.-C. Larsen (ESF)
3. **Mediterranean Basins**
   M. Comas (ESF)
4. **Slope stability**
   P. Weaver (U.K.)

THEME B: RESOURCES

1. **Gas hydrates**
   J. Minert (Germany)
2. **Deep Biosphere**
   J. Parkes (U.K.)
3. **Hydrothermal Processes and metallogenesis**
   Y. Fouquet (France)
4. **Organic-rich sediments (Sapropels)**
   J. Rollkoter (Germany)

THEME C: EARTH'S INTERNAL PROCESSES

1. **Spreading Ridge Processes**
   M. Cannat (France)
2. **Subduction Processes**
   P. Huchon (France)
3. **Arc-back arc systems**
   J.-Y. Collot (France)
4. **Large Igneous Provinces**
   D. Weis (ESF)

THEME D EARTH'S EXTERNAL PROCESSES

1. **Sea-level change**
   C. Betzier (Germany)
2. **High Resolution Stratigraphy**
   E. Jansen (Germany)
3. **Glacial History**
   J. Thiede (ESF)
4. **Climate Change**
   N. Shackleton (U.K.)

Joint Convenors

Alastair Robertson
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Julian Pearce
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Upcoming Meetings and Workshops...

Gordon Research Conference: Interior of the Earth

June 28 - July 3, 1998, New England College -- Henniker, New Hampshire

Michael Gurnis, Chair   John Vidale, Vice Chair

In 1996, the Gordon Research Conferences held its first general geophysics conference in two decades. Concentrating on the composition, structure, and dynamics of the deep interior of the Earth, the meeting was a great success. New and exciting results were presented in a wide variety of fields with an enormous amount of open exchange between disciplines and between scientists, young and old. The conference has been renamed to the "Interior of the Earth", reflecting its general character. The 1998 meeting will focus more on "shallow" topics (although still quite deep for most Earth scientists), such as the connection between mantle processes and geological/ geochemical observations, magmatism and mantle processes, the connection between plate tectonics and mantle convection, etc. We will have a wide range of invited talks from geochemists, seismologists, geodynamists, rheologists, and others on a wide variety of topics on how solid earth processes work on large scales.

PROGRAM SESSIONS

- Mapping the Upper Mantle, Lithosphere, and Crust
- Magmatism and the Upper mantle
- Poster and video overview
- Long term tectonic cycles
- The Continental Lithosphere and Tectosphere
- Rheology of Lithosphere and Upper Mantle
- Poster and video overview
- Plate Tectonics and Mantle Convection
- Unresolved problems and future directions

For more details see: **http://www.grc.uri.edu or**
http://www.gps.caltech.edu/~gurnis/gordon.html

Geological Society of America Penrose Conference

Ophiolites and Oceanic Crust: New Insights from Field Studies and Ocean Drilling Program

September 13-17, 1998, at Marconi Center, Tamales Bay, California

Main themes of the conference

1. Structure/tectonics of ophiolites and ophiolite-ocean crust analogy
2. Structural and magmatic processes at spreading centers
3. Hydrothermal alteration, serpentinization & mineralization
4. Petrology and geochemistry of ophiolites and oceanic crust
5. Sedimentation and sedimentary cover of ophiolites and oceanic crust
6. Fracture zone tectonics in ophiolite/ocean crust geology
7. Ophiolite emplacement, melange problem, and metamorphic soles
8. Outstanding problems and future studies in ophiolite/ocean crust geology
9. Drilling into oceanic crust in the 21st Century

Conference Co-Conveners

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For more details see:
http://www.geosociety.org/admin/penrose.htm#Ophiolites

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