Vol. 9 (2) Fall 2000

InterRidge News

Initiative for international cooperation in ridge-crest studies

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Contents continued...

Save your experiments from destruction!

Post your experimental site on the IR website as a reserve now! Protect your long term experiments by informing people about what you are doing and where your study site is located.

InterRidge Office Updates

Coordinator's Update

InterRidge home page

We are continuing to upgrade and improve our web site to maximise information transfer and make it user friendly. We have secured an alias for our website to make the IR URL easy to remember. You can now access the InterRidge home page by simply typing:
http://www.intridge.org

The newest feature on our website is an interactive map (created by Chie Honsho) linked to the "Global hydrothermal vents database". It allows you to search all known hydrothermal vent sites around the world just by clicking on the different areas of the globe! Of course you can still search the database by conventional method by typing in search words in any of the fields. The interactive map can be accessed from the Hydrothermal Vents database menu, just follow the links starting at "InterRidge Databases" on the IR home page. If you have discovered a new hydrothermal vent site remember to send us the information so we can update this database!

We are very pleased to see that the use of the InterRidge website continues to increase. As always, any comments and suggestions are welcome and remember that I always like to receive updates and new information about meetings and ridge related cruises, as well as job vacancies and other ridge related bits and peaces of information. A brief summary of what can be found on the InterRidge website is available at http://www.intridge.org/latest.htm

Member Nations

The membership of Nations actively involved in InterRidge activities continues to grow. India has joined InterRidge as an Associate for the first time in 2000 and Ranadhir Mukhopadhyay is the Indian representative at the Steering Committee. Korea will upgrade its national membership status in 2001 to join InterRidge as an Associate member and become involved in the planning of the next decade "Project plan" at the next Steering Committee meeting in Kobe, Japan.

Both, China and the Philippines have joined InterRidge for the first time as corresponding members in 2000, increasing the number of nations associated with InterRidge to 26.

Upcoming InterRidge meetings

The new millennium will start off with a busy meetings schedule. A number of InterRidge workshops, and other meetings are already scheduled for 2001, as well as 2002. The demand for sharing and exchange of information and ideas continues to grow. An ever increasing demand to pool resources and expertise, on an international level, in order to maximise research output and minimise costs for individual nations is the driving force for organising more international meetings.

The 2nd International Symposium on Deep-sea Hydrothermal Vent Biology

After the success of the 1st International Symposium on Hydrothermal Vent biology in 1997, Madeira, Portugal, the second meeting is scheduled for 8-12 October 2001 in Brest, France. The second circular for this meeting will be distributed electronically to the InterRidge mailing list very shortly. The latest information about the meeting can be found by following the links from the 'Meetings' menu on the InterRidge home page, or directly from the URL, http://www.intridge.org/brestvent.html

InterRidge Steering Committee meeting

The next Steering Committee meting will be hosted by Dr. Nobukazu Seama at the Department of Earth & Planetary Sciences, Kobe University, Kobe, Japan 1 – 2 June 2001. An extra day will be set aside to provide an opportunity for the new Working Group to meet to start formulating the "InterRidge Project plan" for the next decade.

InterRidge MOMAR Workshop 2001

The 2nd MOMAR workshop will take place before Nov. 2001, in the Azores, Portugal. The organisation of the workshop is underway.

InterRidge Theoretical Institute (IRTI): Thermal Regime of Ocean Ridges and the Dynamics of Hydrothermal Circulation

This IRTI is being jointly organized by the 4D-Architecture of the Oceanic Lithosphere working group and the Global Distribution of Hydrothermal Vents working group. The IRTI will have a short course component, which will focus on the modelling aspects of the dynamics of hydrothermal circulation in the crust, a field excursion and a workshop component to synthesize the current models, debate controversies, and outline the future directions for collaborative research. The IRTI will be held during one week in the second half of September 2002, at the University of Pavia, Italy.

SWIR Workshop

A workshop to synthesise current knowledge and identify areas, both disciplinary and geographically that require investigation and decide on future direction of research in this area has been proposed. The plan is to have the workshop in early 2002.

Management and Conservation of Hydrothermal Vent Ecosystems Workshop

This workshop was held at the Institute of Ocean Sciences, Victoria, B.C., Canada, 28 - 30 Sept. 2000 with an aim to bring together

InterRidge Office Updates

scientists, policy makers and mining experts to discuss the future uses and the need for conservation of these unique ecosystems. A workshop report will outline the issues discussed as well as propose a 'code of conduct' for scientists and other users, and suggests management/ conservation strategies. This workshop has generated a great deal of interest at an international level and will certainly increase overall awareness within the general community about the potential threats, as well as prove some guidelines as to how the future of these underwater habitats can be secured.

Steering Committee

During the last Steering Committee meeting, 2-3 June 2000, WHOI, USA, all working groups, as well as the Steering Committee membership were reviewed. M. A. Miranda, P. M. Herzig, M. Cannat, H. Fujimoto, L. Mullineaux and E. Sundvor have all finished their term as representatives on the InterRidge Steering Committee in 2000. Thank you all for your input, time and effort. The new representative for Norway at the SC will be Rolf Pedersen. The new representative for Portugal will be Fernando Barriga.

The InterRidge programme is now in its 3rd, and final stage of the first decade plan. Thus, a new InterRidge Project plan, for the next decade, will need to be established during this three year term of the InterRidge Office. The Steering Committee meeting agreed that a Working Group would be formed before the next Steering Committee meeting in 2001, Kobe, Japan. The members of the working group will be the representatives from Principal and Associate Member countries. The working group will plan a workshop in the first half of 2002, to devise a new InterRidge Project plan for the next decade.

Working Groups

Some important restructuring of the working groups occurred. The Steering Committee noted that the primary aims of both, the 4-D Architecture working group and the Biology working group have been largely addressed. Consequently it was recommended that the 4-D Architecture WG should be dissolved. However, with the progress in biological research in the past five years it was decided that a new and up to date set of research objectives and goals needs to be formulated for the biology WG ad that this working group will continue with new co-chairs: Françoise Gaill (France) and S. Kim Juniper (Canada). A workshop to identify new scientific questions for the Biology WG that will benefit from international cooperation was proposed, to be held immediately after the second hydrothermal vent symposium (8-12 October, 2000, Brest, France).

New InterRidge Working Group – "Hotspot-Ridge Interactions Working Group"

Furthermore, in view of relatively new problems relating to various aspects of looking at hotspot-ridge interactions, a new Working Group "Hotspot-Ridge Interactions " was formed with Dr. Jian Lin, WHOI, USA, as the chair. The membership and a new research plan are being developed to assist and direct global research in understanding the less known aspects of ridge interactions. More details on the WG will appear in the InterRidge web page and the next issue of the InterRidge News.

Proposal for a new working group

The Carlsberg - Central Indian Ridge (CR-CIR) presents a very attractive target for investigation due to a number of interesting geological phenomena. Yet, to date, very few investigations have targeted the CR-CIR region. A proposal has been submitted to create an InterRidge Working group to oversee and coordinate an increased level of research in this area. The proposal article can be found on page 12 and we strongly encourage all your comments and feedback on this proposal.

IR Cruise to the Knipovich Ridge

In an effort to increase and promote the involvement of different nations in InterRidge activities, an InterRidge cruise was organised to investigate the Knipovich Ridge on the *R/V Professor Logachev*, 30 Aug. 2000 (Bergen) – 23 Sept. 2000 (Bergen).

The cruise was co-organised by Russian-Japanese scientists (PIs: K. Tamaki, Japan and G. Cherkashov, Russia) and was a concerted effort to pool knowledge, expertise and resources to create a truly international and multidisciplinary cruise. A total of 37 scientists and from eight countries were involved in the two legs of the cruise. Scientists from China, Taiwan and Korea were invited to participate in the InterRidge cruise to provide an opportunity for increased involvement of Asian countries in InterRidge activities.

Cruise Objectives:

1) Understanding the tectonics of ultraslow sea-floor spreading system of the Knipovich Ridge
2) Finding active hydrothermal vents in the Knipovich Ridge
3) Understanding the magmatism of the Knipovich Ridge.
4) Detecting microearthquake activities at the Knipovich Ridge

The cruise was a great success and a report as well as a number of research articles from the cruise will appear in the next issue of IR news.

Agnieszka Adamczewska
InterRidge Coordinator
November 2000

Send to (address also on the reverse side): InterRidge Office, Ocean Research Institute, University of Tokyo, 1-15-1 Minamidai, Nakano, Tokyo 164-8639, Japan

InterRidge Mailing List Sign up Form

Or sign up on the web at:

http://www.intridge.org/signup.htm

You can use this form to join are regular mailing list to receive *InterRidge News*, to be placed on our electronic mailing list or to be put on the electronic directory on the web (**http://www.intridge.org**). Currently there are over 500 scientists active in mid-ocean ridge research listed on this electronic directory. The directory contains a listing of each researcher's field of interest and expertise as well as their full address information. Links are also provided to personal or departmental web pages.

Indicate whether you would like to

- ☐ *receive electronic notices and information (include your e-mail address)*
- ☐ *receive the IR news and be on our mailing list*
- ☐ *This is a hange of address notice.*

Name (Title, First, Last)

____

Department/Institute____

Address____

____

City____________________ **State/County**____________________

Post Code____________________ **Country**____________________

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

E-mail:____

WWW: ____

What are your fields of interest/expertise?

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

cut

fold *fold*

affix postage

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NEW InterRidge Website

http://www.intridge.org/

The InterRidge office maintains an extensive web site containing various information including upcoming meetings, scheduled ridge related cruises, job vacancies as well as 9 different databases. These databases on the InterRidge website were initiated in response to a request by the international community to have a 'centralised' clearing house for information collected by scientists all over the world so that relevant information is readily available to everybody at one site. A brief summary of what can be found on the InterRidge website is available at http://www.intridge.org/latest.htm

We are very pleased that the use of the InterRdige website is steadily increasing and we continue to encourage you make use of this resource and to continue to submit the latest and up to date information to our office.

The new alias for the IR website makes the URL easy to remember, you can now access the InterRidge home site by simply typing http://www.intridge.org

1) Information section

This section provides links to Ridge related meetings, cruises and other miscellaneous information, as well as a little bit about InterRidge structure and its role.

Below you will find a brief summary of each of the eleven menus found on the InterRidge homepage.

News

This is the section of our web page that is changed and updated most frequently based on the information that is received by the InterRidge office. The date of the latest update appears at the bottom right hand corner of the InterRidge home page, as well as the News page itself.

In the News menu you will find a link to the latest broadcast (distributed by email from the InterRidge Office) and new announcements, as well as a link to an archive of past broadcasts.

I will continue to send out e-mail broadcasts with urgent or important information to all our members that have indicated they wish to receive e-mail notices.

This page also provides a link to vacant job positions that are forwarded to the InterRidge office.

The News page will also contain miscellaneous information of interest to Ridge scientists and relevant to InterRidge activities.

About us

An introduction to what is InterRidge, as well as InterRidge Office contact and mailing address details. A short description of the InterRidge programme, including the objectives of the programme as well as management structure and national membership of IR.

Meetings

A calendar of upcoming conferences, meetings and workshops relevant to ridge studies, with links to further information as it become available.

Upcoming cruises

This table has appeared in the back of the IR news for a long time, but we now also posted it on our website where the information on upcoming cruises can be updated on a regular basis.

2) Activities section

This section is concerned with the scientific and management structure of InterRidge. The menus in this section are relatively unchanged from the ones that were present on the original home page.

Science plan

An outline of the scientific purpose of InterRidge.

Projects and Working Groups

Currently there are nine Working Groups responsible for different aspects of ridge research. An outline of the current working groups and updates of their activities can be found here.

Additionally this section provides links to major projects that InterRidge is currently involved in and projects that are directly relevant to InterRidge activities - such as MOMAR and Marine Protected Areas project.

IR publications

A list of all the publications distributed by the InterRidge office. Many of which are available on request. The most recent publications are available as downloadable PDF files.

InterRidge Office Updates

Member Nations

A list of the InterRidge National Correspondents, and their contact details, from all of our Member Nations.

3) InterRidge databases section

One of the major objectives of InterRidge is to facilitate the advancement of ongoing work of individuals, national and international groups by providing centralised information and data-exchange services. Thus, we maintain a number of databases that contain data submitted from Ridge scientists from around the world. We rely on contributions from individuals to continuously update the information and increase the number of records. I would like to take this opportunity to encourage everyone to become familiar with the databases on our website and contribute information on a regular basis to ensure that this important resource contains current and up to date information. An overview of the databases maintained by InterRidge appears below and can also be found on our website.

Member directory

If you want to find the contact details of somebody involved in Ridge research, this is the place to look for them. Is your name in our database? If its not and you are involved in Ridge related research then please take a moment to fill in our electronic membership: just click the “Mailing list sign up” on the home page or fill in the signup form in this issue.

Reference search

A new database with references related to all aspects of Ridge research. Make sure you check this out and add your ridge related publications to this database!

Other services

Here you will find links to two more reference databases maintained by InterRidge. Again, the reference databases are a great resource and require your regular input.

Furthermore, you can calculate the spreading rate of the sea floor at mid ocean ridges in any place around the globe!

Hydrothermal Ecological Reserves Page

http://triton.ori.u-tokyo.ac.jp/~intridge/reser-db.htm

This page lists all the current ecological reserves that have been proposed at hydrothermal vents. These vary in breadth and scope; at Juan de Fuca the Canadian government has proposed the Endeavour vent field as a pilot marine protected area, while other reserves consist of requests from individual scientists conducting experiments in specific areas. There is also an on-line form to submit reserves to the page.

Overview of databases:-

International MOR & BAB Cruise Database

A database of over 300 cruises compiled since 1992, which have taken place on mid-ocean ridges or in back-arc basins. The database contains the principal investigators, the ship, the study region and a short summary of the cruise objectives. The information for these cruises can also be accessed from an on-line map.

International Vessel & Vehicle Database

A database of vessels and vehicles (submersibles etc) capable of conducting mid-ocean ridge science. Links are provided to that ship’s homepage, for access to up-to-date scheduling information.

Hydrothermal Vent Faunal Database

A database of almost 500 species of fauna found at hydrothermal vents listing the general geographic range of the species and references.

MOMAR References Database

A database of over 300 references from the MOMAR region (the Mid-Atlantic Ridge near the Azores).

Hydrothermal Vent Database

A database listing the known (*i.e*. ground-truthed) and suspected (*i.e*. plumes observed, vents not yet ground-truthed) vents, including the location, general description, and references. Its one of a kind! Have you discovered a new vent site or confirmed an existence of a suspected one? Let us know about it!

This new database now has an interactive map which allows you to search all known hydrothermal vent sites around the world just by clicking on the different areas of the globe !

Hydrothermal Vent Biology Samples

Data on existing hydrothermal vent biology. Samples are presented in two ways: (1) short summaries of the major collections of hydrothermal vent biology samples and (2) a database of existing samples (still under development). Researchers with hydrothermal biology samples are strongly encouraged to submit information to either form.

InterRidge Office Updates

InterRidge Publications

The following InterRidge publications are available upon request. Fill out an electronic request from at http://www.intridge.org/act3.html
or contact the InterRidge office by e-mail at intridge@ori.u-tokyo.ac.jp.

InterRidge News:

Past issues of InterRidge News, are avalable starting with the first issue published in 1992 until the present. Information about the research articles published in each issue can be found on the InterRidge website: http://www.intridge.org/irn-toc.htm

The InterRidge News issues published from 2000 (*ie*. InterRidge News 9.1 and all following issues) are available as downloadable PDF files from the same URL address on the InterRidge website, using Adobe Acrobat 4.0 or later versions.

Workshop and Working Group Reports:

InterRidge **MOMAR (*MO*nitoring the *M*id-*A*tlantic *R*idge)** workshop report, April, 1999.
InterRidge **Mapping and Sampling the Arctic Ridges: A Project Plan**, pp. 25, December 1998.
ODP-InterRidge-IAVCEI Workshop Report: **The Oceanic Lithosphere and Scientific Drilling into the 21st Century**, pp. 89.
InterRidge Global Working Group Workshop Report: **Arctic Ridges: Results and Planning**, pp. 78, October 1997.
InterRidge **SWIR Project Plan**, pp. 21, October 1997 (revised version).
InterRidge Meso-Scale Workshop Report: Quantification of Fluxes at Mid-Ocean Ridges: **Design/Planning for the Segment Scale Box Experiment**, pp. 20, March 1996.
InterRidge Active Processes Working Group Workshop Report: **Event Detection and Response & A Ridge Crest Observatory**, pp. 61, December 1996.
InterRidge Biological *Ad Hoc* Committee Workshop Report: **Biological Studies at the Mid-Ocean Ridge Crest**, pp. 21, August 1996.
InterRidge Meso-Scale Workshop Report: **4-D Architecture of the Oceanic Lithosphere**, pp. 15, May 1995.
InterRidge Meso-Scale Project Symposium and Workshops Reports, 1994: **Segmentation and Fluxes at Mid-Ocean Ridges: A Symposium and Workshops & Back-Arc Basin Studies**: A Workshop, pp. 67, June 1994.
InterRidge Global Working Group Report 1993: **Investigation of the Global System of Mid-Ocean Ridges**, pp. 40, July 1994.
InterRidge Global Working Group Report 1994: **Indian Ocean Planning Meeting Report**, pp. 3, 1994.
InterRidge Meso-Scale Working Group Meeting Report, Cambridge, UK, pp.6, 1992.

Workshop and Symposium Abstract Volumes:

InterRidge Workshop: **MOMAR (*MO*nitoring the *M*id-*A*tlantic *R*idge)** Abstract Volume, pp. 82, Oct. 1998.
InterRidge Workshop: **Mapping and Sampling the Arctic Ridges** Abstract Volume, pp. 30, Oct. 1998.
First International Symposium on **Deep-Sea Hydrothermal Vent Biology** Abstract Volume, pp. 118, Oct. 1997.
Fara-InterRidge **Mid-Atlantic Ridge Symposium Results from 15°N to 40°N**. J. Confer. Abs. 1(2), 1996.
ODP-InterRidge-IAVCEI Workshop: **The Oceanic Lithosphere and Scientific Drilling into the 21st Century**, pp. 126, 1996.

Steering Committee and Program Plan Reports:

InterRidge STCOM Meeting Report, WHOI, USA, 2000.
InterRidge STCOM Meeting Report, Bergen, Norway, 1999.
InterRidge STCOM Meeting Report, Barcelona, Spain, 1998.
InterRidge STCOM Meeting Report, Paris, France, 1997.
InterRidge STCOM Meeting Report, Estoril, Portugal, 1996.
InterRidge STCOM Meeting Report, Kiel, Germany, pp. 22, 1995.
InterRidge STCOM Meeting Report, San Francisco, USA, 1994.
InterRidge STCOM Meeting Report, Tokyo, Japan, 1994.
InterRidge STCOM Meeting Report, Seattle, USA, pp. 6, 1993.
InterRidge Meeting Report, York, UK, 1992.
InterRidge Meeting Report, Brest, France, pp. 39, 1990.
IR Program Plan Addendum 1997, pp. 10, Jan. 1998.
IR Program Plan Addendum 1996, pp. 10, Apr. 1997.
IR Program Plan Addendum 1995, pp.10, 1996.
IR Program Plan Addendum 1994, pp.15, 1995.
IR Program Plan Addendum 1993, pp. 9, 1994.
IR Program Plan, pp. 26, 1994.

InterRidge Office Updates

Overview of InterRidge Working Groups

More information on working groups can be found on our website;
http://www.intridge.org/act2.html

Arctic Ridges
Objective: Coordinate planning efforts for mapping and sampling the Arctic Ridges.
Current Activities: Coordination of international cruise to the Gakkel Ridge in 2001.
Chair: Colin Devey (Germany)
WG members: G. A. Cherkashov (Russia), B. J. Coakley (USA), K. Crane (USA), O. Dauteuil (France), V. Glebowsky (Russia), K. Gronvold (Iceland), H. R. Jackson (Canada), W. Jokat (Germany), Y. Kristoffersen (Norway), P. J. Michael (USA), N. C. Mitchell (UK), H. A. Roeser (Germany), H. Shimamura (Japan), K. Tamaki (Japan)and C. L. Van Dover (USA).

Back-Arc Basins
Objectives: Summarize past work on Back-Arc Basins and coordinate future studies.
Current Activities: Compiling report on past work in Back-Arc Basins.
Chair: J.-M. Auzende (France)
WG members: Ph. Bouchet (France), J.-L. Charlou (France), K. Fujioka (Japan), E. Grácia (Spain), P. Herzig (Germany), J. Ishibashi (Japan), Y. Kido (Japan), R. Livermore (UK), S. Scott (Canada), R. J. Stern (USA), K. Tamaki (Japan), and B. Taylor (USA).

Biological Studies
Objectives: The primary objectives of this working group have been addressed and under new chairman ship a set of new objectives will be set out shortly.
Chairs: F Gaill (France) and S.K. Juniper (Canada).
WG members: new membership structure will be announced in the near future.

Global Digital Database
Objective: Establish a database of global multibeam bathymetry and other data for mid-ocean ridges and back-arc basins.
Current Activities: Compiling data.
Chair: Philippe Blondel (UK)
WG members: J. S. Cervantes (Spain), C. Deplus (France), M. Jakobsson (Sweden), K. Okino (Japan), M. Ligi (Italy), R. Macnab (Canada), T. Matsumoto (Japan), K. A. K. Raju (India), W. Ryan (USA), and W. Weinrebe (Germany).

Global Distribution of HydrothermalActivity
Objectives: Target key areas of the global MOR that should be explored for hydrothermal activity and coordinate international collaboration to explore them.
Current Activities: Organizing the InterRidge Theoretical Institute on the Thermal regime of Ocean Ridges and the Dynamics of Hydrothermal Circulation to be held in the Spring of 2001.
Chair: Chris R. German (UK)
WG members: E. Baker (USA), Y. J. Chen (USA), D. Cowan (UK), T. G. Gamo (Japan), E. Grácia (Spain), P. Halbach (Germany), S.-M. Lee (Korea), G. Massoth (N.Z), J. Radford-Knoery (France), A-L. Reysenbach (USA), D. S. Scheirer (USA), S. D. Scott (Canada), K. G. Speer (France), C. A. Stein (USA), V. Tunnicliffe (Canada) and C. L. Van Dover (USA).

4-D Architecture
The working group was dissolved during the IR Steering Committee meeting in June 2000.

HotSpot-Ridge Interactions
Chair: J. Lin (USA)
The membership and a research plan for this new Working group are being developed and will be available on the IR website shortly.

Event Detection and Response & Observatories
Objectives: Develop detection methods of transient ridge-crest seismic, volcanic and hydrothermal events, and the logistical responses to them.
Current Activites: Development of MOMAR project.
Chair: Chris Fox (USA)
WG member: K. Mitsuzawa (Japan)

SWIR
Objective: Coordinate reconnaissance mapping and sampling of the Southwest Indian Ridge.
Current Activities: Coordinating upcoming cruises.
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), T. Kanazawa (Japan) and C. L. Van Dover (USA).

Undersea Technology
Objective: Foster the development of undersea technology and disseminate information about it.
Current Activities: Development of MOMAR project.
Chair: Alan Chave (USA)
WG members: J. R. Delaney (USA), H. Momma (Japan), J. Kasahara (Japan), M. Kinoshita (Japan), A. Schultz (UK), D. S. Stakes (USA), P. Tarits (France), and H. Villinger (Germany).

Updates on InterRidge Projects

SWIR (Southwest Indian Ridge) Working Group

Catherine Mével, Chair (mevel@ccr.jussieu.fr)

Laboratoire de Pétrologie, Université Pierre et Marie Curie, 4 Place Jussieu, France

Membership
Miquel Canals (Spain)
Chris German (UK)
Nancy Grindlay (USA)
Charlie Langmuir (USA)
Anton le Roex (South Africa)
Chris MacLeod (UK)
Jonathan Snow (Germany)
Kensaku Tamaki (Japan)
Cindy Lee Van Dover (USA)

The SWIR project plan was initiated in 1997. It is now time to consider what has been accomplished since then and what is still left to do.

With two cruises scheduled in early 2001, a complete bathymetric and gravity coverage of the SWIR should be achieved by mid-2001. Furthermore, relatively regular sampling along the ridge axis will have been completed, although at various scales, depending on the area. InterRidge has been influential in the organization of segment scale investigations in the eastern, the particularly cold portion of the ridge (FUJI and INDOYO cruises : Japan, France, UK, Germany : TOBI coverage to investigate magmatic/tectonic interactions, SHINKAI 6500 dives). Some evidence for hydrothermal activity has been documented (nephelometry anomalies, dead chimneys) but no active hydrothermal field sites have been discovered to date.

Detailed geological investigation of one specific area, the Atlantis bank (57°E), around ODP Site 735B, is still under progress (mapping, dregding, ROV, SHINKAI 6500) dives. It is an international effort involving the US, Japan, Canada and UK, linked with ODP.

Biologists have expressed a strong interest in the SWIR because it forms a link between the western Pacific and the South Atlantic ridge systems, naturally, in the absence of documented active hydrothermal fields the biology is still completely unknown on the SWIR. To locate an active site, the necessary next step is to conduct a water column sampling cruise.

Further investigations at regional and local scales are still necessary:
- off-axis studies (temporal variation) to better understand dissymmetry between the two flanks
- determination of crustal structure and lithosphere thickness in areas of different thermal regimes
- seafloor observations and sampling (ROV, submersible) - including, hopefully, an active hydrothermal site

Additionally, the potential for deployment of hydrophones to monitor the seismicity of the eastern potion of the ridge will be explored through consultation with C. Fox.

Scheduled/approved cruises
- water sampling and observations at the Rodrigues Triple Junction, looking for hydrothermal plumes. R/V Kaire and ROV Kaiko, (Japan) PI: Jun Hashimoto, Aug. 2000
- Geology and sampling of Atlantis II Bank. R/V Kaire + ROV Kaiko – PI : E. Kikawa (Japan) and H. Dick (USA), September 2000,
- mapping and sampling the SWIR from 9 to 22° E. MAPRs. Additional proposal to deploy OBSs, to be recovered one year later is still pending. December 2000 - January 2001 - PI : H. Dick and J. Lin (USA). Cape Town 9th Dec. and returns 29th Jan to Durban
- SWIFT : mapping and sampling of the western portion of SWIR from 49° to 35°E. Marion Dufresne - PI: E. Humler (France + Denmark). Feb - March 2001
- Detailed plume biogeochemical prospecting at the Rodrigues Triple Junction. (and possible extension to the easternmost portion of the SWIR), approved but not yet scheduled. PI: C. German and P. Tyler (UK) likely in 2001

Proposed cruises
- seimic tomography of a segment : the Jourdannes mountain TOM SWIR. PI: D. Sauter (France)

Well evaluated, not scheduled yet
France + Germany + Japan

SWIR Workshop

By mid-2001 a lot more data will be available and a workshop is proposed to synthesise current knowledge, identify areas, both disciplinary and geographically that require investigation and decide on future direction of research in this area. The workshop in planned in early 2002.

Past updates of the SWIR working group can be found on the InterRidge web page at:

http://www.intridge.org/wg-sw.htm

Updates on InterRidge Projects

India: InRidge

CARLSBERG - CENTRAL INDIAN RIDGE:
A case for InterRidge Working Group

R. K. Drolia, R. Mukhopadhyay and S. D. Iyer

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The Indian Ocean Ridge System (IORS) is conspicuous for more than one reason. The ridge axis melt beneath the IORS is not only isotopically distinct from the melt present in the other oceans, but notable variations are found even along the length of IORS. The Carlsberg - Central Indian Ridge (CR-CIR), an important part of the IORS, separates the African plate on the west from Australia, Indian plates to the east and the Arabian plate in the north. It extends over a length of 4000 km from the Rodrigues triple junction (RTJ: 25°S, 70°E) to 10°N and takes a westward turn as Sheeba ridge and joins in the Red Sea. It has a full spreading rate that ranges from 55 mm/yr. near the RTJ to 22 mm/yr. in the north.

The CR-CIR presents a very attractive target for investigation due to a number of geological phenomena, including:

- uneven segmentation,
- drastic changes in spreading rate and direction within a short distance,
- geophysical, morphological and geochemical evidence of observed off-axis volcanism,
- interaction of Wide Deformation Zone between 6°S and 10°S,
- first field evidence of over-print magnetisation in the Vema region (Drolia *et al.*, 2000), and
- mass / force balance at Carlsberg Ridge accreting boundary.

This area is also an ideal place to study the mixing of ridge melt and hotspot plumes. Furthermore, the exploration phase of biological and hydrothermal research on CR-CIR is still in the infancy stage. Reported occurrence of *Calyptogena* (INDOYO cruise) is the first evidence of *in-situ* biological communities associated with hydrothermal activity along the CR-CIR. This discovery hints at the propagation route of this community via the South East Indian Ridge (SEIR) and the East Pacific Rise (EPR).

Despite such interesting properties, very few investigations have been focused in the CR-CIR region, although sustained studies have been made along the other arms of the IORS, *e.g.*, the SEIR (Cochran *et al.*,1997; Sempere *et al.*,1997; Christie *et al.*,1998, Coder *et al.*, 2000; Scheirer *et al.*,2000); while that along the South West Indian Ridge is overseen by the dedicated InterRidge SWIR Working Group (Mevel *et al.*,1997,1998; ODP Report # 118). In contrast, Carlsberg - Central Indian Ridge System has been substantially less studied, providing scanty yet encouraging results (ODP leg 115; Chaubey *et al.*,1990; Banerjee and Iyer 1991; Parson *et al.*,1993; Ramana *et al.*, 1993; Mukhopadhyay and Iyer 1993; Iyer and Banerjee, 1993; Briais,1995; Kamesh Raju *et al.*,1994,1997; Dyment *et al.*,1999; Drolia *et al.*, 2000). A significant amount of multibeam mapping and geophysical data, collected during the last decade, particularly near RTJ and north of Marie-Celeste Transform and between 2° - 4°20’N on the Carlsberg ridge are now available.

Petrological and chemical results on widely spaced dredged rock-samples are available from this arm of IORS. Satellite gravity results reveal the overall architecture of ridge segmentation but are insufficient to determine the depth and bathymetry in detail, which are necessary to study focused upwelling and the relationship between gravity, crustal thickness and basalt composition. Recent surveys (Dyment 1999; Mudholkar *et al.*, 1997, 2000) have provided high resolution bathymetric, gravity magnetic data, which reveal zones of contrasting axial segmentation, spreading style and morphology indicative of varying thermal and tectonic regimes.

During the last decade, InterRidge has played a pivotal role in bringing International ridge researchers together through various workshops, symposia, Working Groups and field programmes which led to significant increases in the knowledge about gross-scale features of the World’s Mid-Ocean Ridge System *e.g.* MAR, EPR, SWIR, Arctic Ridge. However, the CR -CIR arm of IORS remained underfed. We strongly suggest that InterRidge may form a Working Group on “CR - CIR” to study this underexplored arm of IORS. The proposed working group (WG) would examine the priority of outstanding problems of CR-CIR to be addressed, the approaches to be adopted, availability of logistic support to carry out the experiments. It would formulate a research plan involving time bound

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multi-disciplinary and integrated studies by utilising a broad range of tools and approaches. The scientific questions to be addressed by the proposed WG are:

- the variability of upper mantle processes *i.e.* how the variations in major forcing functions (plate separation rate, thermal structure, mantle composition and rheology) influence the geometry and rates of mantle upwelling, the locus and amount of melt production, the patterns of rates of delivery of melt to the lithosphere and crust.
- the crustal cooling process, including hydrothermal circulation and alteration, and associated changes in the seafloor.
- how hydrologic parameters (porosity, permeability, and fluid chemistry) vary over magmatic and tectonic cycles?
- how do hydrothermal vents relate to paleotectonics, hydrography, bathymetry and their role in larval dispersal? and
- how do chemosynthetic, biogeographic provinces, on a spatial scale, vary with tectonic setting / type of habitat / time ?

This proposal for the formation of an InterRidge CR-CIR Working Group is placed in accordance with the wishes of the InterRidge Steering Committee meeting, June 2000, WHOI, USA. We welcome and encourage all comments on this article. Please send your views to the InterRidge office.

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

Report of gravid female acanthocephalans in zoarcid fish from EPR 13°N and of a potential amphipod intermediate host for this parasitic worm.

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Acanthocephalans are parasitic intestinal worms that use vertebrates for definitive hosts (where sexual reproduction occurs) and invertebrates for intermediate hosts (where parasite larvae develop). Definitive hosts become infected as they eat parasitised intermediate hosts (Fig. 1). Acanthocephalans are known to alter their intermediate host activity patterns (Taraschewski, 2000), thus influencing predator-prey interactions. Moreover, these worms have recently been reported to accumulate essential elements as well as high levels of certain heavy metals (Sure *et al.* 1997; Zimmermann *et al.*, 1999). Therefore, although few acanthocephalans are reported from deep-sea environments (Campbell, 1983; Wayland *et al.*, 1999), members of this taxon are likely to play an active role in the overall dynamics of hydrothermal vents.

The parasitic intestinal worm, *Hypoechinorhynchus thermaceri* Buron 1988 was originally described from the zoarcid fish, *Thermarces andersoni* from the East Pacific Rise (EPR 13°N). However, the original description of this species lacked gravid females, a fact that could jeopardize the validity of the identification of this species. In May 1999, during the HOPE 99 expedition (INSU/IFREMER; PI: François Lallier, Roscoff), more zoarcid fish (*Thermarces cerberus)* were collected on the EPR 13°N. Of the eleven intestines that were dissected, 6 were infected by the acanthocephalan *H. thermaceri* (54% prevalence). A total of 38 acanthocephalans (10 males and 28 females, 15 of which were gravid) were found, with an average of 6.3 $\pm$ 2.8 worms per host. The finding of gravid females among the specimens recovered has allowed both, the confirmation of the identity of the parasitic species as *H. thermaceri* and *T. cerberus* as one of its definitive hosts. However, studies involving the recovery of more acanthocephalans from these vents will be needed to clarify the phylogenetic affiliation of *H. thermaceri*, which is currently the object of a controversy due to recent taxonomic changes (Pichelin, 1999). *H. thermaceri* is the only species of its genus to parasitise deep-sea fish and an understanding of its phylogeny would allow us to identify the closest host-acanthocephalan system in a non-vent community and hence may help us understand the mechanisms of colonization of the vents.

Numerous other amphipods, which are potential intermediate hosts of *H. thermaceri*, were recovered along with *T. cerberus* during this expedition and examined. Several cysts were found to be associated with amphipods identified as belonging to the family Pardaliscidae (S. France and D. Bellan, pers. com.). Only one of these cysts was found in the haemoceal of one amphipod but all had the morphological configuration of acanthocephalan larvae. While this information is promising it should nevertheless be taken with caution. The infected amphipod was too damaged to be identified with assurance to the species level, thus more material will be needed in order to determine the nature of the cysts before firmly reporting that the amphipod is the intermediate host of *H. thermaceri.*

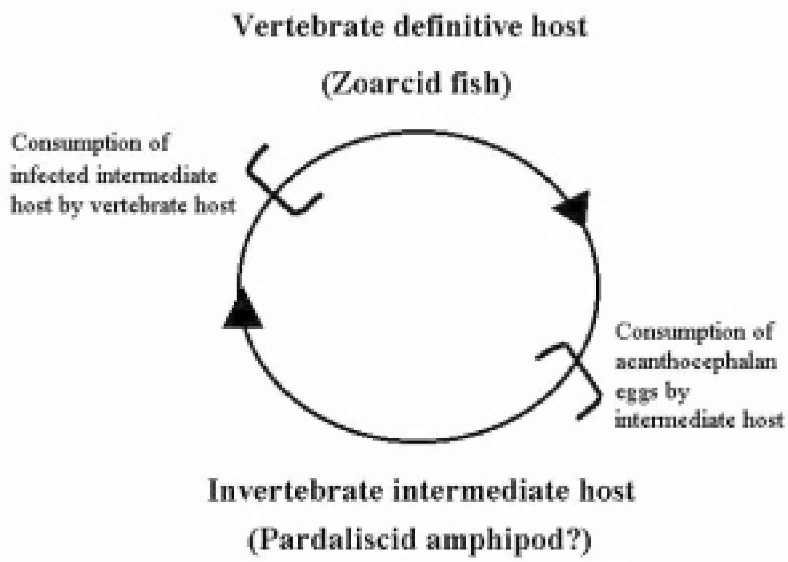

Figure 1. Host-parasite cycle for acanthocephalans - parasitic intestinal worms

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

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

Fishes from the Luchy Strike hydrothermal vent field and the surrounding deep-sea environment: Crista 3 Cruise results

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The bathyal environment surrounding deep-sea venting areas is poor in biomass, so food scarcity is the rule. In contrast, with their high but very local productivity, venting areas show a stark contrast to the general barrenness of the rest of the deep-se floor (Gage and Tyler, 1991). The high concentration of biomass, reaching 8,5 kg wet weight/m^2 at low temperature vents and 2-4 kg wet weight/m^2 at the hottest vents (200-360°C) on the East Pacific Rise, (Fustec, Desbruyères and Laubier, 1988), provides an important food source for both predatory and scavenging species, including fish that are one of the main groups regularly seen living among and around hydrothermal communities (Desbruyères *et al.*, 1982).

Despite the high levels of toxicity in the vent fluids, a large number of bathyal fish species have been shown to visit the MAR hydrothermal vents areas to feed and/or shelter (Saldanha and Biscoito, 1997; Marques and Porteiro, 2000).

Recent studies have shown that the chimaerid *Hydrolagus affinis* actively predates on the endemic vent mussel *Bathymodiolus azoricus* (Marques and Porteiro, 2000). Apart from the question of how vent organisms are able to survive and thrive in this toxic environment, another question is how can fish use such a carbon source without apparently succumbing to cellular damage or disease.

By growing fast and reproducing early, it appears that vent organisms are able to stay one jump ahead of the harmful effects of their heavily contaminated environment (Dixon *et al.*, 2000). This life-history strategy seems to explain the environmental fitness of most of the sessile vent invertebrates, but where vagrant, slow growing and long lived vertebrates are concerned, the cumulative toxicity effect may have a bio/ecological impact yet to be discovered.

The scientific party for Cruise CRISTA 3 assembled in Horta, Azores, on July 13, 2000, ready to board scientific equipment and prepare for departure. The objectives of this cruise were:

1) To collect fish and crustaceans from outside the influence of the hydrothermal vent fields Menez Gwen (MG) and Lucky Strike (LS), in order to analyse their calorimetric values, lipid constitution and stable isotope balance (^{13}C; ^{15}N).
2) To collect tissue samples from fish and crustaceans inhabiting the hydrothermal fields MG and LS for genetic analysis and also to initiate preliminary research into metalothionines and natural products.

The *R/V Arquipélago* sailed from Horta on July 14. On clearing port, passage was made to an intermediate position (37° 22' 69N; 31°58' 25W) (IP), between MG and LS, where the first long line was deployed at a depth of 1683 m. A nine fish trap mooring was deployed successfully at a depth of 900 m. A second long line was deployed the next day at 37° 18' 19N; 32° 13' 95W, depth 1650 m (LS 1). On July 17, a third long line deployment took place at 37° 16' 84N; 32° 17' 87W, depth 1677 m (LS 2).

Subsequently the navigation course was set towards MG (37º 50'N; 31° 31'W), where on arrival the set of 9 fish traps was again deployed, this time near the periphery of the vent field. Shortly after recovery the swell (3/4m) and wind (level 5/6) made further operations impossible. Passage was then made to

Table 1. Sampling locations and number of captured specimens during the Crista 3 cruise.

Species	IP	LS1	LS2	Date	Depth(m)
Etmosterus princeps	12			15-Jul	1683
Etmospterus pusillus	1			15-Jul	1683
Coryphaenoides armatus	1			15-Jul	1683
Synaphobranchus kaupi	2			15-Jul	1683
Aphanopus carbo	1			15-Jul	1683
Etmopterus princeps		62		16-Jul	1650
Centroscymnus coelolepis		2		16-Jul	1650
Coryphaenoides armatus		1		16-Jul	1650
Coryphaenoides macrocephalus		1		16-Jul	1650
Etmopterus princeps			8	17-Jul	1677
Alepocephalidae sp.			1	17-Jul	1677

disembarkation at Horta, on July 18.

Three hundred and twenty samples of fish muscle, liver, guts and gills were frozen in liquid nitrogen on board ship for further analysis at Guia Marine Laboratory. After dissection and removal of the chosen fresh tissue samples, all fish specimens were numbered, preserved in formaldehyde and sent to the Museu Municipal do Funchal (MMF).

The fish trap deployment at MG provided 62 *Chaceon affinis* (47G-15E), which where frozen on board ship for further study at DOP-UAzores.

Further work on this subject is planned as part of the EU-funded VENTOX project (EVK3-CT-1999-00003), which commenced in March this year.

Acknowledgements

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Mercury levels in mussels and shrimp from the Mid-Atlantic Ridge (MAR) hydrothermal vent fields

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Introduction

The hydrothermal vents of the MAR are characterised by high temperatures, high metal concentration, as well as high hydrogen sulphide content, related to interactions of the convective seawater circulation with basaltic rocks inside the ocean crust (Rousee *et al.*, 1997). There is a potential for enhanced bioaccumulation of Hg in biota from hydrothermal vents due to the exposure to hydrothermal fluids that contain high concentrations of heavy metals (Monteiro *et al.*, 1998). Nevertheless, the biological communities at these vents can survive in this inhospitable environment owing to their ability to regulate intracellular metal levels by excretion or accumulation of metal ions in non-toxic forms (Rousee *et al.*, 1997). Unfortunately, there are no published data concerning the heavy metal concentrations (namely mercury) discharged by those fluids.

The aim of the present study was to determine the concentration of total mercury and methylmercury in mussels and shrimp from the MAR hydrothermal vents and to compare the results with similar studies.

Materials and Methods

Samples were collected by the submersible Nautile during the cruises PICO and Saldanha, carried out in June and July 1998 (AMORES, Mast 3, contract no. 950040CT and AMAR, Praxis XXI, 2/2.2/MAR/1748/95, respectively). The hydrothermal sites sampled were Lucky Strike, Menez Gwen and Rainbow. Mussels, *Bathymodiolus azoricus* were obtained from all hydrothermal sites, but shrimp, *Rimicaris exoculata* and *Mirocaris fortunata* were collected only at Rainbow (Table 1).

Total mercury concentration was investigated in the mussels and in both species of shrimp; methylmercury was preliminarily assessed only in *B. azoricus* from Menez Gwen (n=15) due to small sample size from other sites. The analyses were performed on dry tissues by cold vapour atomic absorption spectrophotometry (see

Monteiro, 1991 for details). For analysis mussel shells were removed and only the soft body tissue was used, but the shrimp were analysed whole, *ie*. including the carapace. Due to the small biomass of individuals, animals of the same size range, for each species, were grouped in one sample.

The mercury concentrations obtained for the mussels during this study were compared with previous results obtained by Monteiro *et al.* (1998) for Menez Gwen, Lucky Strike and Logatchev. As the authors had no samples from Rainbow, we compared the Hg concentration of *B. azoricus* from Rainbow and Lucky Strike with that in *Bathymodiolus puteoserpentis* from Logatchev.

Results

Concentrations of mercury and methylmercury are given in Table 1.

Table 1. Size, total mercury and methylmercury concentrations for the samples used in this study. Sizes are given as mean ± SE and mercury values are the median, both with range below

Species	Hydrothermal vent	n	Size (cm)	Total Hg (ppm,d.w)	MethylHg (ppm,d.w)
B.azoricus	Rainbow	25	6±2.7 (1.5-10.5)	0.34 (0.15-0.66)	-
	Lucky Strike	16	4±1.3 (2-6.5)	0.41 (0.18-0.92)	-
	Menez Gwen	15	5±2.4 (1-9)	3.76 (2.26-7.41)	<0.006*
R.exoculata	Rainbow	9	1.5±0.5 (1-2)	0.34 (0.03-0.09)	-
M.fortunata	Rainbow	6	3±1.4 (2-6)	0.34 (0.07-0.22)	-

0.006* - detection limit

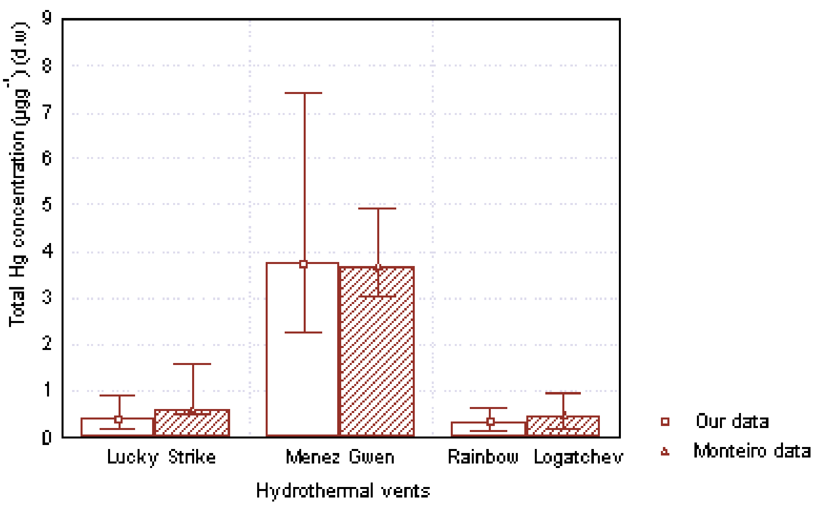

Figure 1. Median total mercury concentration of *Bathymodiolus azoricus* measured in this study (open bars)and *Bathymodiolus puteoserpentis* from Logatchev, (data from Monteiro *et al.*, 1998) (shaded bars). Error bars represent minimum and maximum total Hg concentration.

A significant difference in median mercury concentration was found for *B. azoricus* from the three hydrothermal fields studied (Kruskal-Wallis, $p<0.05$) (Fig. 1). Mussel samples from Menez Gwen clearly had the highest concentration of total mercury (3.76 μgg^{-1}), but there was no significant difference (Mann-Whitney, $p>0.05$) in Hg concentration of *B. azoricus* from Lucky Strike and Rainbow.

Additionally, a significant negative correlation between median mercury concentration and shell size was detected in mussels from Menez Gwen (Sperman, $r_s=0.63$, $p<0.01$), (Fig.2).

Comparing the three species of invertebrates sampled at Rainbow, it is apparent that *B. azoricus* contained the highest concentration of total mercury (0.34μgg^{-1}) and the shrimp *R. exoculata* (0.06μgg^{-1}) the lowest (Fig.3). A significant difference between the two species of shrimp was also detected (Mann-Whitney, $p< 0.05$).

Despite the high concentration of total mercury found in *B. azoricus*, from Menez Gwen, the level of methylmercury was below the detection limit of the analysis technique used in this study.

The comparison between our results and those reported by Monteiro *et al.* (1998) shows a significant difference in total mercury concentrations between the two samples of mussels from Lucky Strike (Mann-Whitney, $p<0.05$) (Fig. 1), but not from Menez Gwen. Furthermore no differences were detected between the Hg concentration in *B. azoricus* from Rainbow and Lucky Strike (median: 0.3μgg^{-1} and 0.41μgg^{-1}, respectively) and *B. puteoserpentis* from Logatchev (median: 0.5μgg^{-1}).

Discussion

The differences in Hg concentrations found in *B. azoricus* from the three hydrothermal fields, may be a result of exposure to fluids with different chemical compositions (Monteiro *et al.*,

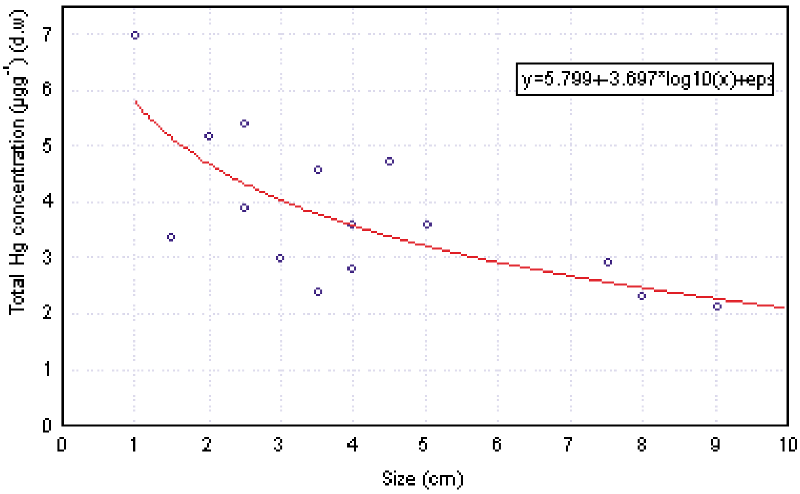

Figure 2. Relationship between total mercury concentration in the soft body tissues and size, in the mussel *Bathymodiolus azoricus* from Menez Gwen.

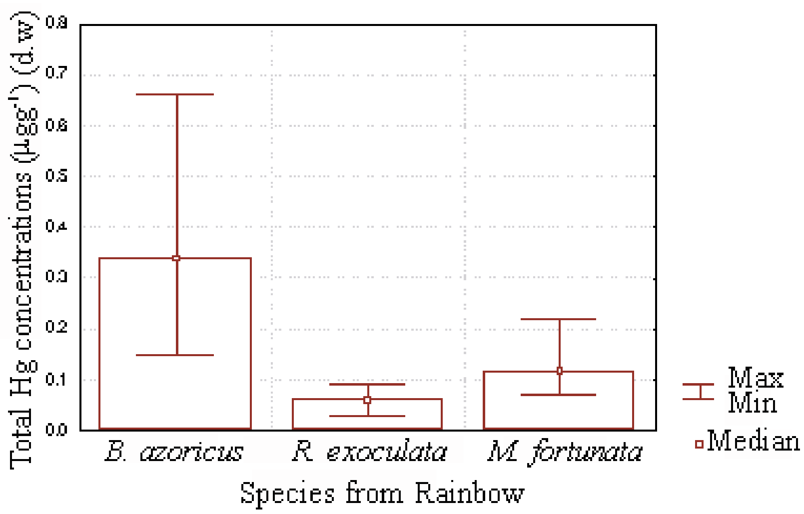

Figure 3. Median concentration of total mercury (error bars represent minimum and maximum concentrations) in the mussel *B. azoricus* and the shrimp, *R. exoculata* and *M. fortunata* from Rainbow.

1998). If this is true, Menez Gwen should produce fluids containing ca. 10 times more Hg than the deeper fields, Rainbow and Lucky Strike. Menez Gwen has the lowest essential metal content of Cu, Fe and Zn precipitates (Fouquet *et al.*, submitted). However, there is no published information concerning the heavy metal concentrations, namely mercury, discharged by those fluids and around these environments, and this is the main constrain in properly interpreting the results obtained in this study.

Studies that investigated the hydrothermal vent mytilid from the East Pacific Rise, revealed the presence of various organic and mineral particles bound by mucus of the gill filaments (Le Pennec *et al.*, 1984). The same authors show that most of the mineral particles seem to be eliminated as pseudofaeces since they are only numerous in the food groove. Nevertheless, some of them go through the digestive tract and are therefore eliminated in the faeces. The failure to detect methylmercury in *B. azoricus* from Menez Gwen, may be a result of this excretion process, but only research on mercury dynamics in different tissues can consolidate this fact.

The enhanced accumulation of total Hg observed in smaller mussels from Menez Gwen, may be due to a higher metabolic rate of smaller individuals, and/or to a greater surface/volume ratio, which increases the relative surface area in contact with seawater and consequently with the environmental mercury. The differences between mussels and the shrimp from Rainbow, may be a result of the tendency for mussels to accumulate more mercury than shrimp, when they are exposed to the same Hg concentration in sea water and food (Fowler *et al.*, 1978).

The shrimp *R. exoculata* developed a culture of bacteria on its mouthparts and under the carapace, to complement nutrient input drawn from bacterial production. It was also suggested that these bacteria are important in the detoxification processes (Segonzac *et al.*, 1993). Examination of gut contents showed *Mirocaris* sp., to be necrophagous (Vereshchaka, 1997). These observations may justify the mercury concentration difference between *M. fortunata* and *R. exoculata*.

The differences found in *B. azoricus* from Lucky Strike, (our results and those by Monteiro *et al.*, 1998) may be a result of the microenvironment surrounding the organisms, which is not only modified by temperature, chemical reactions and dilution with sea water, but also by the organisms themselves (Sarradin *et al.*, 1999). It is know that Lucky Strike has different fluid composition among sites (Fouquet *et al.*, submitted).

Because the deep sea is a major reservoir of highly bioaccumulative methylmercury (Monteiro *et al.*, 1998), the absence of accumulation

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

of organic Hg in *B. azoricus* is noteworthy.

Further studies to describe the hydrothermal heavy metal dynamics are needed to better understand these results. Important research themes for the future include: heavy metal concentration of hydrothermal fluids; metallothioneins dynamic in organism tissues, as a mechanism related to heavy metal detoxification; and shell mercury determinations.

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

Rift Propagation and extensive off-axis volcanic and hydrothermal activity in the Manus Basin (Papua New Guinea): MANAUTE Cruise

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The Manus basin is one of the intra-arc or back-arc basins aligned along the Australian and Pacific Plate boundary (Fig. 1). It is encircled by Manus Island to the north, New Ireland to the east, Papua New Guinea to the west and New Britain to the south. The whole domain constitutes the Bismarck plate. Structurally the Manus basin is bounded by the fossil Manus subduction zone to the north and to the south by the tectonically active system formed by the New Britain trench and the folded and over thrusting suture of Papua New Guinea. The emerged areas surrounding the manus basin constitute an ancient tertiary volcanic arc (Francis, 1988; Stewart and Sandy, 1988), part of the unique arc separating the Australian and Pacific plates at that time and dismembered during the opening of Manus basin about 4 Ma ago (Falvey and Pritchard, 1985). Different models have been proposed to explain the Manus basin creation, ranging from diffuse accretion, up to a complex system combining accretion, microplate rotation and stretching (Martinez and Taylor, 1996) , through to a simple oceanic spreading.

The present day spreading in the Manus Basin is located on 3 successive N45, N65-trending ridge segments offset by N120 transform faults, Weitin and Djaul FZ to the east and Wuillaumez to the west (Tufar, 1986; Binns *et al.*, 1993; Martinez and Taylor, 1996). Two zones of basalt-dominated seafloor spreading in the central and western portions of the basin, are both associated with hydrothermal activity (Tufar, 1986).

In 1995, a joint French-Japanese cruise (ManusFlux) explored the Manus Spreading Centre (MSC) and some sites of the South Eastern Rift (SER) in the Manus Basin with the Japanese submersible Shinkai 6500 (Auzende *et al.*, 1996; Gamo *et al.*, 1997). In the frame of the same joint project New STARMER, the French and Japanese teams recently (March-April 2000) carried out the MANAUTE cruise with the *R/V L'Atalante* and the Ifremer submersible *Nautile*. The objectives of the MANAUTE cruise were to explore and sample volcanic and

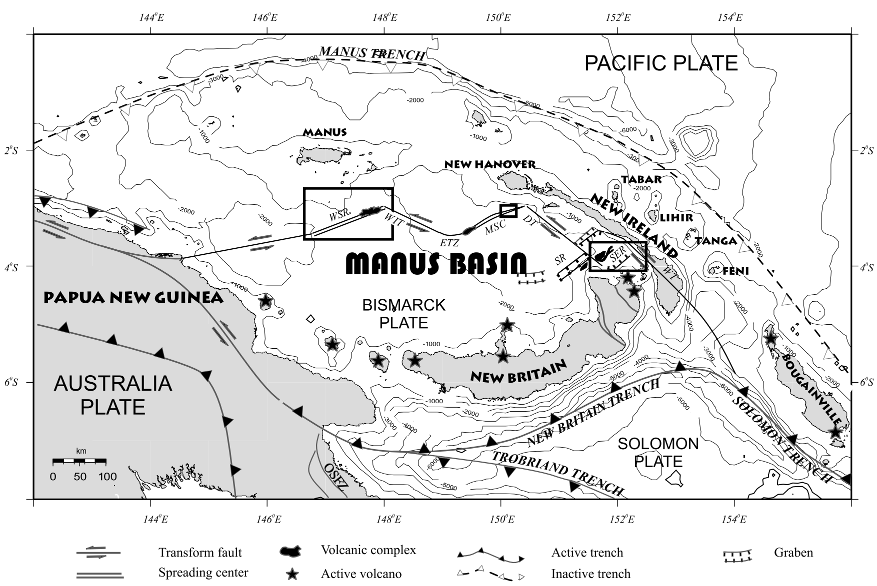

Figure 1. Geodynamical sketch of the Bismark Sea-Manus Basin area (after Martinez and Taylor, 1996)

International Ridge-Crest Research: **Back Arc Basins:** Auzende *et al*. continued...

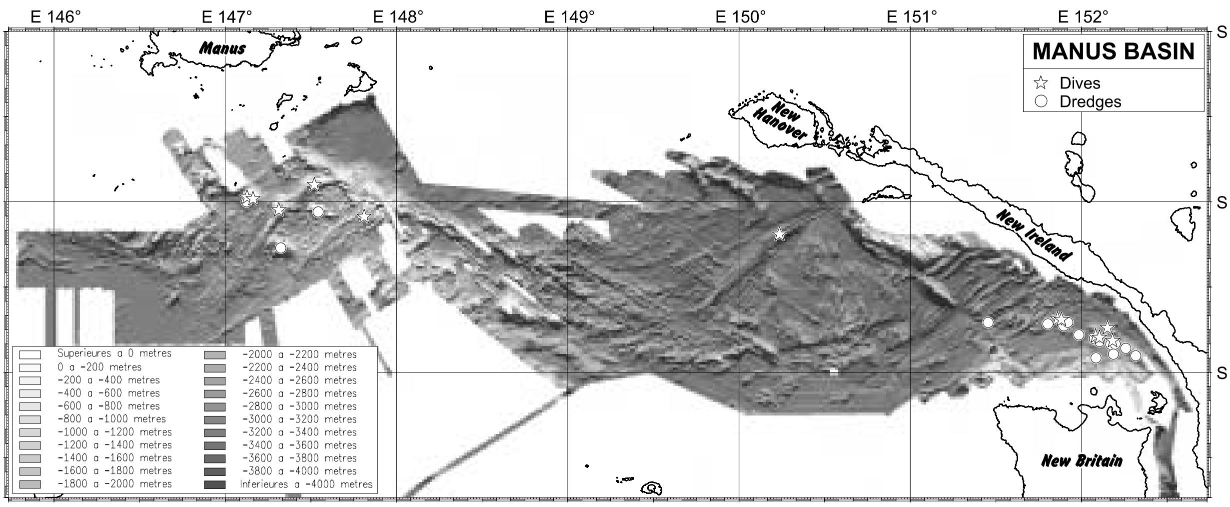

Figure 2. Synthetic swath map of the Manus Basin. Dives are indicated by stars and dredges by rings.

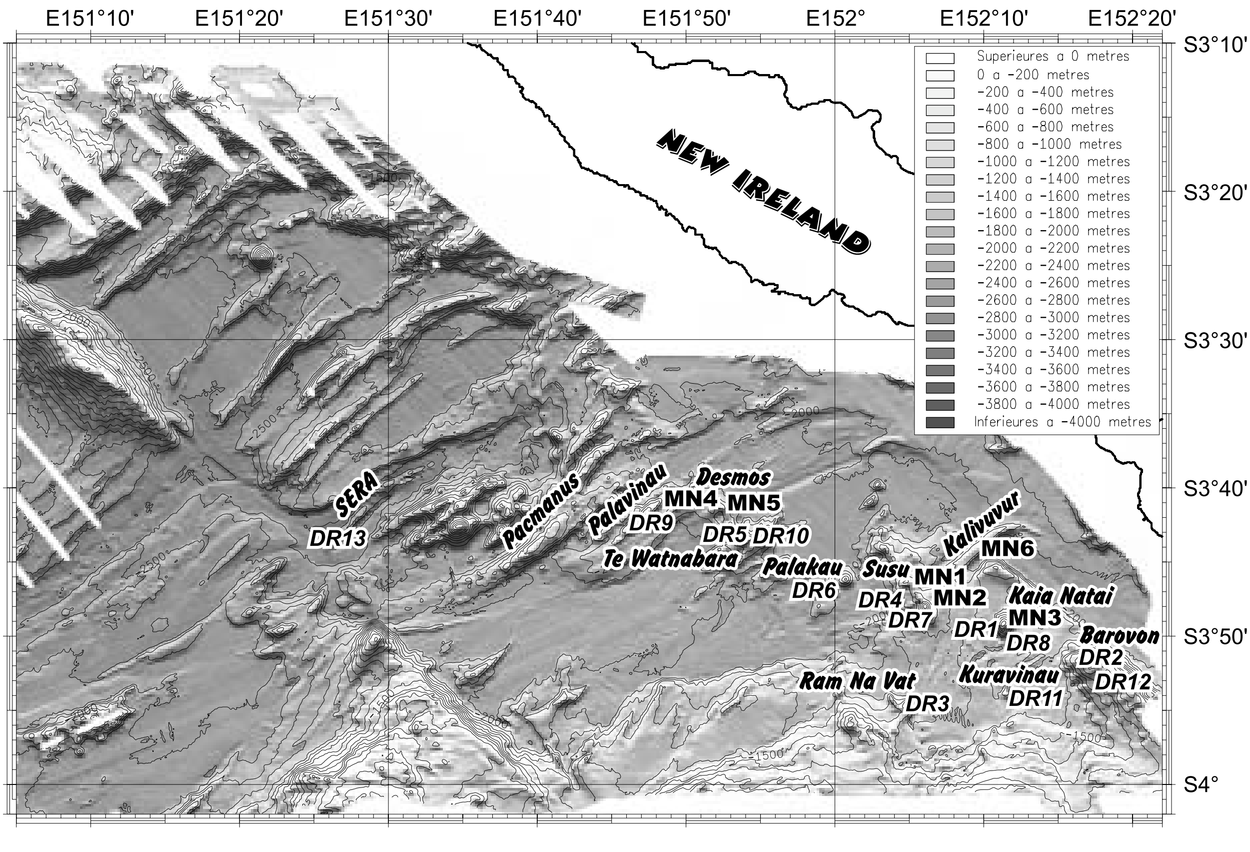

Figure 3. Swath map of the Eastern Manus Basin and location map of dives and dredges. The contour interval is 100 m.

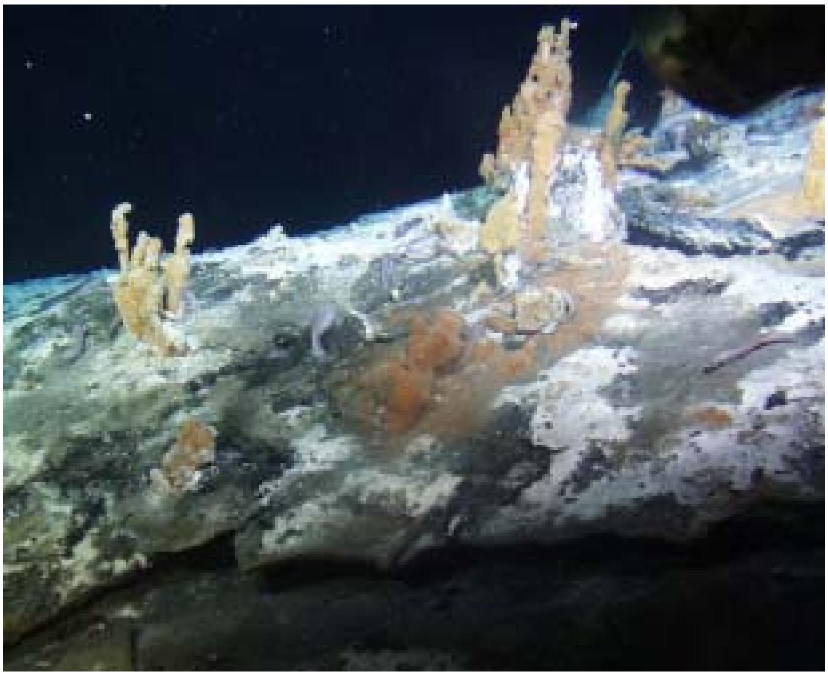

Figure 4. Example of chimneys at the top of Kaia Natai volcano

hydrothermal sites in the eastern part of Manus Basin and on the spreading axis of the Western Ridge (WR).

The eastern Manus Basin (South Eastern Rift-SER) is characterised by a complex system constituted by spreading axes, transform fault segments and massive volcanic features represented either by isolated volcanoes or ridges. Some researchers have proposed that this part of the basin was created by streaching the the back arc crust (*e.g.* Martinez and Taylor 1996). The Western Manus rift (WR) was poorly known and omitted in previous interpretations.

The aim of the MANUATE cruise was to carry out a detailed study of both, the eastern and the western parts of the Manus Basin. Twelve new dives and 18 new dredges were carried out (Fig. 2) in addition to the dives carried out previously in this area during the ManusFlux 95, and the BioAccess 97, 98 and 99 cruises of the New STARMER French-Japanese programme.

The map in Fig. 3 shows that the eastern Manus Basin is located between two left-leral offset fracture zones, Djaul to the west and Weitin to the east. The crust of this part of the basin is about 2000 m deep. It is cut by two N45 propagating axes, the SERA and the Kalivuvur. A succession of volcanoes and volcanic ridges are aligned along the axis at an oblique N110 line. The 6 dives and 13 dredges carried out in this area provided data to confirm that SERA and Kalivuvur are both actively propagating axes. The sampled rocks will give us an answer as to the nature of the volcanism along these axes, acidic or perhaps tholeitic, as on the MSC. The study of the oblique volcanic line shows that all the volcanoes and ridges are active. They are made of acidic rocks ranging from andesites to dacites and show hydrothermal venting. The Susu site is composed of three volcanoes. At the top of the volcanoes active chimneys expel fluids with a temperature range from 50°C on the southern most volcano, to 220-280°C on the other two volcanoes. Hydrothermal deposits (sulphides and oxides) and intense alteration of the volcanic rocks are associated with these vents. The Kaia Natai volcano is covered by a thick layer of hydrothermal deposits ranging from sulphides, sulphates and iron oxides to altered and silicified volcanic rocks. Peculiar hydrothermal vents were discovered. They are characterised by low temperature fluids (38°C) and an abundance of bacterial mats, possibly associated with the acidic nature of the fluids (Fig. 4).

The western part of the Manus basin (Fig. 5) is characterised by two N45 parallel axes propagating rapidly to the SW and located at extremely shallow depth: between 200 and 600 m for the eastern one and around 800 m for the western one. The five dives and four dredges carried out in this area confirmed that the present day magmatic activity is concentrated on these two axes. The sampled rocks were very fresh, vesicular to the pumice stage. Such a type of pumitic rocks were previously observed in the Lau Basin at 1700 m depth (Fouquet *et al.*, 1993) and are thought to reflect the acidic nature of the volcanism.

All the dives have shown Manganese anomalies (detected by a new *in situ* analyser installed on the *Nautile* and developed by J.Knoery at IFREMER/Brest), thus, suggesting the presence of hydrothermal activity. Off axis, the Mata na Kul (Fig. 6) and Vat na Ingiet volcanoes show intense diffusion activity with deposits ranging from iron oxides, manganese-silica and barytine.

In conclusion, the MANAUTE cruise allowed us to determine the spreading pattern of the Manus Basin and also to evaluate the local magmatic and hydrothermal activity.

The newly created crust in the eastern part of the basin is restricted to two small size areas flanking the SERA and Kalivuvur axes. These axes are propagating through the ancient back arc basin crust.

In the western part of the basin the present-day accretion is localised on two axes propagating rapidly to the SW.

International Ridge-Crest Research: **Back Arc Basins:** Auzende *et al*. continued...

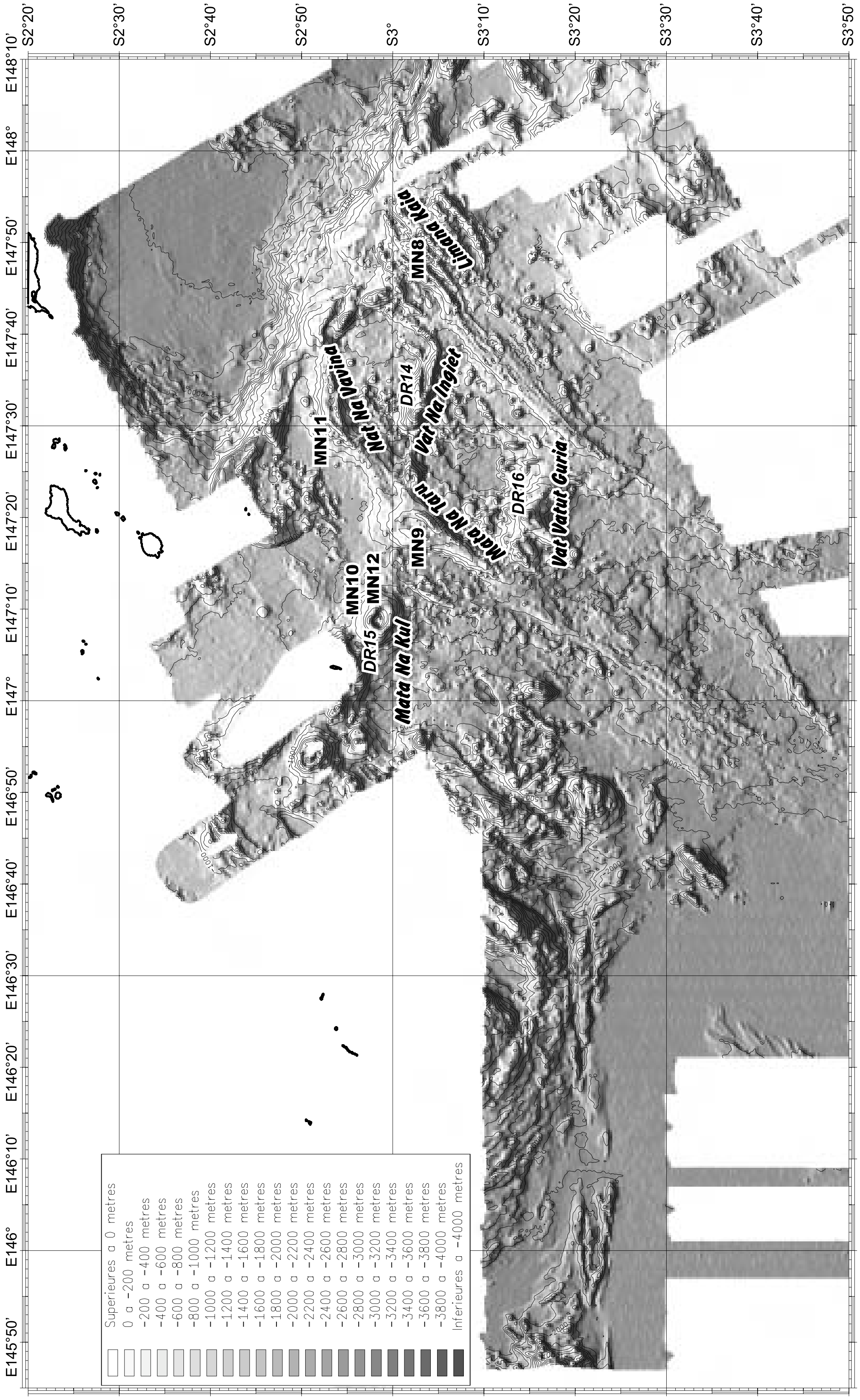

Figure 5. Swath map of the Western Manus Basin and location map of dives and dredges. Contour interval is 100 m.

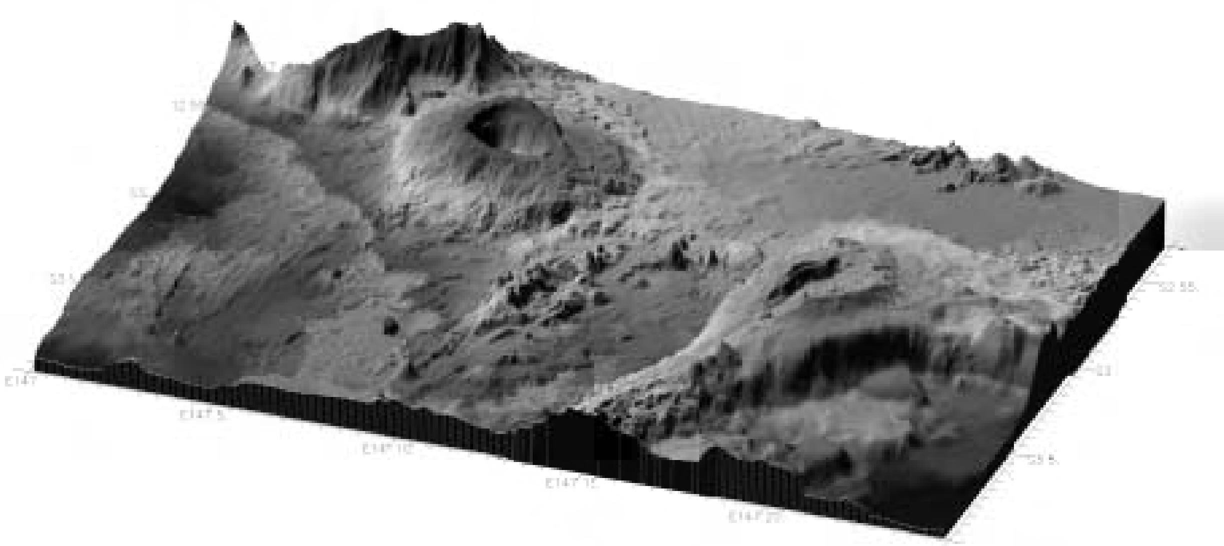

Figure 6. A 3D view of the western axis Mata na Taru (Red eye in Tolai language, PNG) and of the Mata na Kul volcano (Eye of devil in Tolai language)

In both, the eastern and the western domains the magmatic activity is robust on the axes but the nature of the erupted rocks is still considerably influenced by the effect of the New Britain subduction zone. Off axis, the magmatic activity is also related to subduction.

The hydrothermal activity seems to be more intense on the off axis features. The expelled fluids and the deposited products are strongly influenced by the acidic nature of the rocks constituting the manus Basin basement. They are relatively low temperature fluids (50 to 290°C) with a very acidic pH. The hydrothermal deposits cover a variety of compositions, ranging from manganese to sulfides and passing through iron oxides, sulfates and silica.

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

New fields with manifestations of hydrothermal activity in the Logatchev area (14ºN, Mid-Atlantic Ridge)

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Main Logatchev area (Logatchev-1)

The Logatchev hydrothermal area (14°45'N) is the southernmost vent area known to date on the Mid-Atlantic Ridge (MAR). It was discovered in 1993-1994 on the 7th cruise of the *R/V Professor Logatchev* using deep-towed EM and photo systems. The site was studied using submersibles in 1995 (*Mir* and *Nautile* dives), 1997 (*Alvin*) and 1998 (*Mir*). Geological features in the Logatchev area were best studied on the "Main Mound" (Krasnov *et al*., 1995; Bogdanov *et al*., 1995, 1997) and vent communities of the Logatchev were described by Gebruk *et al*. (2000).

The Logatchev area lies between 2900 and 3050 m on the tectonic step 7 km to the east of the ridge axis. The major geological peculiarities of the Logatchev hydrothermal system include its association with gabbro-peridotites, location close to the top of the rift wall and development of "smoking craters". Bogdanov *et al*. (1995) proposed the existence of a specific (deep-seated) type of mineral-forming recycling system at Logatchev. The only other known ultramafic hosted hydrothermal site is Rainbow (36° N on the MAR) . Both Logatchev and Rainbow are characterized by a high concentration of methane in the venting fluid – up to 2220-2310 µM and isotopicaly very heavy methane carbon: ƒÂ^{13}C = -13.4 – (14.3) ‰ (Lein and Sagalevitch, 2000). The Logatchev area extends at least 600 m (north-west to south-east) by 300 m and includes three vent fields: 1) a large sulphide mound "Main Mound" with smoking craters; 2) an active chimney complex "Irina-2" and 3) a diffuse flow through the soft sediments "Anya's Garden".

Logatchev-2

It appeared that the hydrothermal activity at Logatchev extends far beyond the described area, now referred to as Logatchev – 1 (Fig. 1). The new hydrothermal field, known as Logatchev-2, was discovered in 1993-1994 concurrent with Logatchev-1 and studied in detail in 1996-1998 on the 16th and 17th cruises and in 2000 on the 19th cruise of *Professor Logatchev* using video imaging and sampling (including TV-grab, core and dredge). The new field, centred around 14°43.22'N, 44°56.27'W, lies 5.5 km south-east of Logatchev-1 at a depth of 2640-2760 m. The host rocks, as at Logatchev-1, are also represented by gabbro-peridotites. The slope steepness at Logatchev-2 is 10-15°C on the average, but can reach 55°C in places. Terraces 150-200 m wide, separated by scarps are present in the middle and lower part of the field.

Six sulphide mounds were identified at Logatchev-2 within a field ca. 550 x 200 m. The largest mound, located in the centre of the field, is 160 m long, up to 80 m wide and reaches a height of 12 m. Other mounds are smaller, from 20 to 60 m in diameter and 3 to 6 m high. Chimney-like non-active structures, from 0.5 to 1.0 m high, were observed on the central mound. The surface of central mound is covered with crusts, from 0.1 to 0.4 m thick. The crusts consist mainly of manganese oxide, limonite-hematite and atacamite-limonite, with opal and barite associated with atacamite. The samples of sulphide from the top of the central mound were mainly represented by the sphalerite-chalcocite-chalcopyrite mineral association. Massive sulphides sampled by the TV-grab consisted mainly of chalcopyrite-sphalerite and chalcopyrite-sphalerite-chalcocite. The massive sulphides showed extremely high content of the metals: Cu 20.5%, Zn 21.2% and Au 424 ppm (Au range 101.1 to 875.1 ppm). Compared to the Logatchev-1, the sulphides of Logatchev-2 are enriched with Zn, Au, Si and Pb, whereas the concentration of S, Fe and Ag are lower. The unique concentrations of Au, detected by AAS, requires further confirmation by other analytical methods. Metalliferous sediments were present between the sulphide mounds. Recent hydrothermal activity at Logatchev-2 has not been observed.

Area north-east of Logatchev-1

During the recent *Professor Logatchev* cruise (2000) evidence of hydrothermal activity was found 1 km north-east from Logatchev-1 (Fig. 1). This area centred around 14°45.73' N, 44°58.43' W at ~3000 m depth covers an area of approximately 1.2 km^2 and lies on the eastern slope of a volcanic-tectonic ridge formed at the junction of two faults. The indications of hydrothermal activity in this area include presence of metalliferous sediments, geophysical anomalies detected in the near-bottom water and hydrothermal crusts with high concentrations of Au and Ag.

Area south of Logatchev-1

Manifestations of hydrothermal activity have also been identified 3.5 km south of Logatchev-1, within the 2.5 km^2 field at 14°43.15'-14°44.05' N, 44°57.5'- 44°59' W (Fig. 1). The field lies on the western slope of a submeridianal ridge at the junction

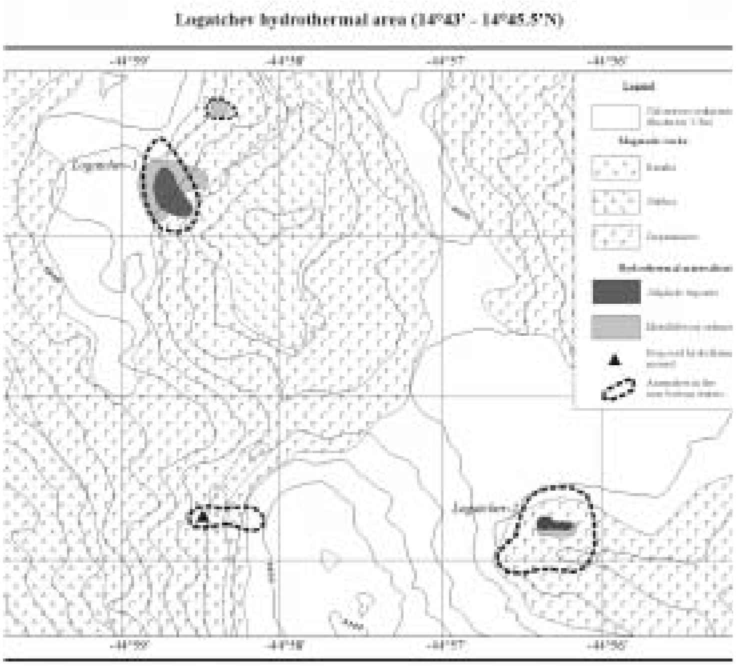

Figure 1. Logatchev hydrothermal area (14°43' - 14°45.5' N).

of a large western tectonic step in the rift valley slope. The depth at the ridge top is 2900-3000 m and reaches 3500-3600 m at the base. The central part of the ridge is crossed by two sublatitudinal zones of tectonic deformations. Indications of hydrothermal activity in this area, first detected in 1991-1992, include sulphide and iron hydroxides in the sediments, which cover hydrothermally altered gabbros. On the 19th cruise of *R/V Professor Logatchev* (2000) a relict mound, 40 m long, covered with crusts was observed on a video transect in this area.

Hydrothermal fauna

One TV-grab sample taken at Logatchev-2 (14°43.2'N, 44°58.3'W, depth 2677 m) included an empty shell of the gastropod, *Phymorhynchus* sp., and the valves of two bivalve species belonging to the family Vesicomyidae. One vesicomyid species was represented by several fragments of subfossil valves with hinge margins. The maximum shell length was ca. 220 m. The fragments belong to the species recorded earlier at Logatchev-1 and tentatively identified as *Ectenagena* sp. aff. *kaikoi* (Gebruk *et al.*, 2000). The second vesicomyid in this sample was represented by a single left subfossil valve, 32.5 mm long, with a damaged hinge margin. Based on the shell outline, this species is close to the group including *Vesicomya donacia* Dall, 1908; *V. stearnsii* Dall, 1895; *V. ticaonica* Dall, 1908; *V. venusta* Dall, 1886; *V. katsuae* Kuroda (in Habe, 1952) and *V. cordata* Boss, 1968. None of these species have previously been recorded at hydrothermal vents. Two species of *Vesicomya* have been reported from cold seep communities: *V. cordata* (Gulf of Mexico, Louisiana slope) and *V. stearnsii* (Monterey Bay) (Sibuet and Olu, 1998). Furthermore, no vesicomyid species have been reported from the open part of the Atlantic Ocean. Thus, this record significantly extends our knowledge about the biogeography of the genus *Vesicomya* and the composition of the Atlantic hot vent fauna.

Aggregations of dead bivalve valves were observed among chimney-like structures on top of the central mound at Logatchev-2.

Dead valves were also been seen (but not sampled) on hard rocks on the field south of Logatchev-1. In the area north-east of Logatchev-1 several subfossil shells of *Ectengena* sp. aff. *kaikoi* were dredged earlier together with live mytilids, *Bathymodiolus* sp.aff. *puteoserpentis*, gastropods *Phymorhynchus moskalevi* and cerithiacea (dredge start 14°45.33' N, 44°58.51'W, depth 3010m, end 14°44.87' N, 44°57.70' W, depth 2780m) (see Gebruk *et al.*, 2000).

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

New data on some major MAR structures: preliminary results of *R/V Akademik Nikolaj Strakhov* 22 cruise.

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The 22nd cruise of *R/V "Akademik Nikolaj Strakhov"* with a joint Russian – Italian geological team took place in the Central Atlantic from 28 April to 1 July 2000. The cruise was conducted in two legs. The first leg - as outlined in the Russian-Italian project (PRIMAR) - was in the eastern part of the Vema fracture zone as a continuation of the previous joint expedition to this region (Fabretti *et al*., 1998). St. Paul F.Z. area was also studied based on the Italian-French programme. The aim of the second leg according to the Russian programme was to map (using a multibeam EM 12S echo sounder) and dredge the poorly studied 5° - 7°20' N MAR area. In the second part of the leg preliminary bathymetric and geophysical (single channel seismic profiling, magnetometric survey) study of the Cape Verde abyssal plain in the area between 26°30' W and 28°30' W (convergence area of latitudinal and south-east trending fracture zones) was conducted.

The Vema fracture zone is one of the unique structures, where a relatively undisturbed section of oceanic crust is exposed along almost 270 km of the south slope of the fracture zone valley. This provides and opportunity to examine variations in crust and mantle composition over 16 My. Study of ultramafic rocks and gabbro collected between 42°08' W and 43°39' W reviled such variations (Auzende *et al*., 1989; Cannat and Seyler 1995; Fabretti *et al*., 1998, Peyve *et al*., 2001).

To get a complete picture of the crust-mantle compositional diversity, we made 12 successful dredges from the eastern ridge transform intersection to 42°03' W. Preliminary result show that ultramafic rocks from this Vema segment are different from segments to the west, where ultramafics with porphyroclastic and milonitic textures predominate. No amphibole peridotites were found here in contrast to west area. There are also some other differences in rock composition.

Bathymetric mapping of the 5° - 7°20' N MAR (Sierra Leone F.Z. area) has shown that the rift valley to the south of 7°10' N F.Z. is divided into several blocks 35-40 km long. They are separated by left lateral zones of "deviations from linearity" and by overlapping rift valleys. In the rift valley, 5°58' N we found an anomalous depth of 4975 m.

Extensive dredging in the Sierra Leone F.Z. area revealed that modern rift from the 7°10 N F.Z. to at least 6°N is composed of basalts and ultramafic rocks distributed in more or less equal proportion. At the dredge station S2244 (6°54' N, 33°57' W) just in the centre of the rift valley peridotites were dredged together with fresh glassy basalts. Variously altered and serpentinised harzburgites and dunites (many tectonicaly rounded) were dredged with white-blue serpentine – talk – chrysotile-asbestos - chlorite mud. Serpentinised ultramafics are light green to red and magenta due to formation of different Fe oxides. Sulfide mineralization is widespread along numerous slick insides. This as well as the wide distribution of carbonate and zeolite veins is a result of widely distributed hydrothermal activity in this area, especially in 6°09' N, 33°25' W. Gabbros are less common. They are mostly olivine varieties up to pure troctolites.

Dredging profile across rift valley at 6°35' N has shown that such type of structure (ultramafic crust with tectonicaly emerged fragments of magma chambers, represented by gabbro and thin fragmented lava flows is not limited only to the modern rift valley. As we see this MAR segment has much in common with the St.Paul F.Z. area.

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International Ridge-Crest Research: **Indian Ridge**

Deep-sea Exploration of the Central Indian Ridge at 19°S

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Introduction

Among the World's mid-ocean ridge system, the Indian Ocean spreading centres have been poorly studied by direct deep-sea exploration. In May-June 2000, the first dives of deep-sea submersible *Nautile* in the Indian Ocean, and the second ever manned deep-sea submersible in this ocean (see Fujimoto *et al.*, 1999), were carried out during the cruise GIMNAUT of *R/V L'Atalante* on the Central Indian Ridge (CIR) at 19°S. Cruise GIMNAUT (acronym for **G**eochronology, ridge-hotspot **I**nteraction, **M**agnetics with ***NAUT****ile*) departed Mauritius Island on May 14th, 2000 and ended in Reunion Island on June 7th, 2000 (Fig. 1). The main objective of this cruise was to address the problem of accurate dating methods for recent processes at mid-ocean ridges, paying particular attention to;

- the combined use of existing short-lived isotope dating methods and K-Ar method for recent Mid-Ocean Ridge Basalt and their intercalibration for the overlapping period. Producing reliable ages is essential to study the magmatic and tectonic processes at mid-ocean ridges; and
- the observation of a dated, continuous sequence of recent geomagnetic intensity variations through the acquisition of near-bottom anomalies and measurement of paleointensity on rock samples.

If the oceanic crust accurately records the relatively well-known sequence of these variations, deep-sea magnetics may ultimately be used to date the ocean floor at high resolution (10-100 ka), on a small-scale replication of what is classically done with surface magnetics at a resolution of a million years.

The CIR at the latitude of Rodrigues Ridge (19°S) is a good target to address this topic because rock samples are enriched in trace elements (Engel and Fisher, 1975; Mahoney *et al.*, 1989; Humler, pers. comm.) and this is of great help in achieving optimal accuracy on the

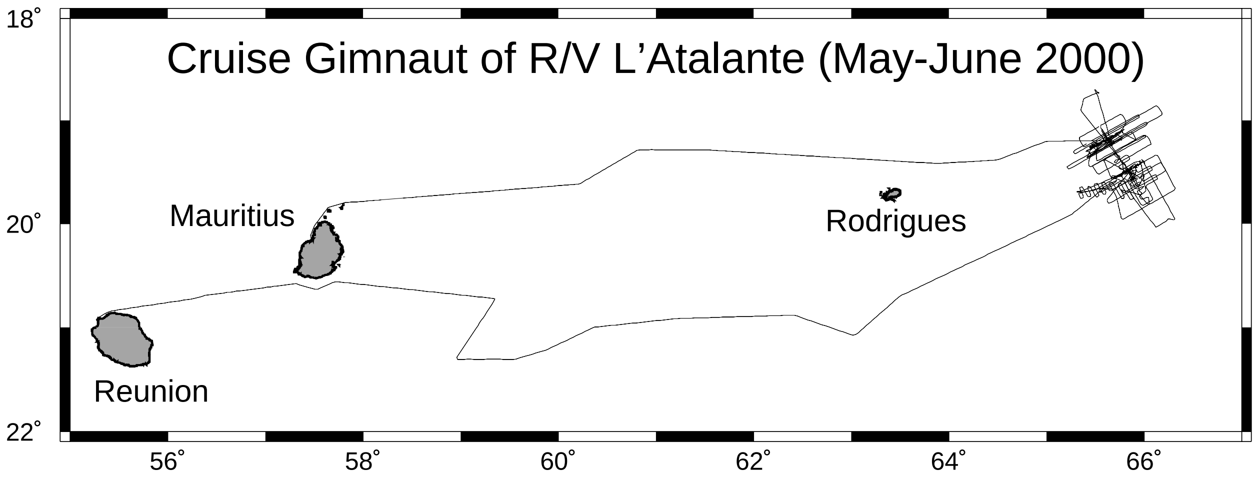

Figure 1. Tracks of the GIMNAUT cruise

ages. Moreover, the full multibeam bathymetric data coverage acquired at the axis up to about 3 Ma during the MAGOFOND 2 cruise (Dyment *et al.*, 1999) was essential in the preparation of each dive. In addition, this area provides the opportunity to study a slow to intermediate spreading centre overlying a hot mantle, in the framework of its interaction with a hotspot, presumably the Reunion hotspot (Morgan, 1978; Engel and Fisher, 1975; Mahoney *et al.*, 1989; Dyment, 1999).

Dive operations and preliminary results

We carried out two transects on the CIR from the axis to the Brunhes-Matuyama magnetic polarity boundaries (about 800 ka), on both the African and Indian flanks (Figs. 2 & 3). These transects intersected the CIR axis at 19°11'S (9 dives, designed as the "northern section") and at 19°29'S (8 dives, designed as the "southern section"), respectively. Three additional dives were devoted to further exploration of the CIR axis. The following techniques of investigation were applied during the *Nautile* dives:

- direct visual observation of tectonic and volcanic structures and of the different types of lithology, using video records (~100 hours) and photography (> 4000);
- continuous acquisition of vector magnetic data with a deep-sea three-components magnetometer (Ocean Research Institute, Tokyo) was successfully carried out on 17 dives. Sea-water turbidity was acquired with a nephelometer (IFREMER DRO-GM, Brest) on the first dive;
- punctual measurements of gravity data on the seafloor (29 stations on 13 dives);
- and collection of rock samples dedicated to petrological, geochemical and rock magnetic analyses.

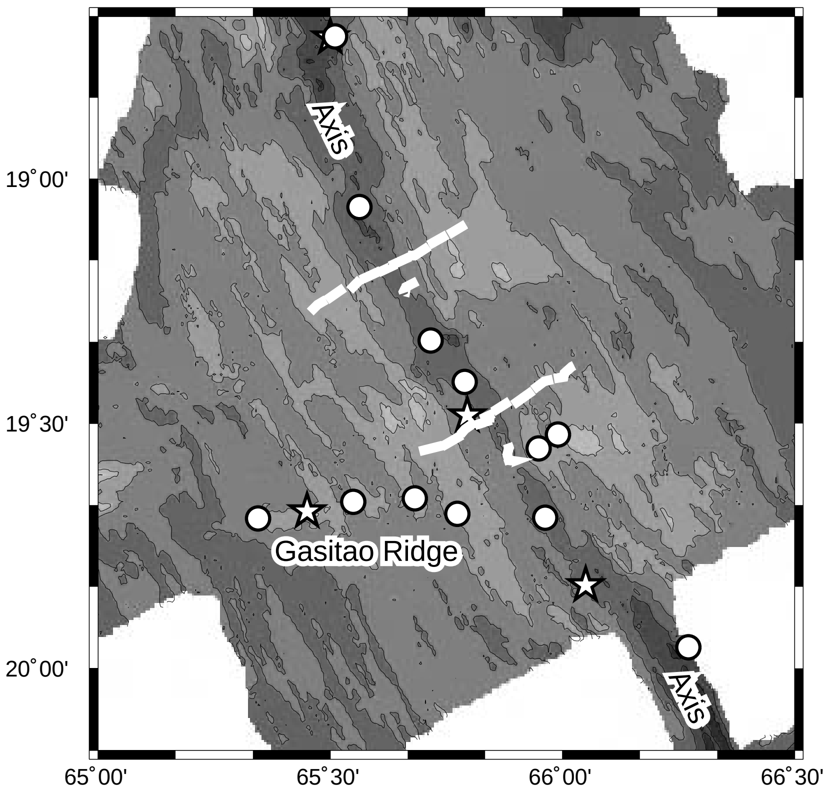

Figure 2. Dives of deep-sea submersible *Nautile* carried out during the GIMNAUT cruise are shown by thick lines; they include the northern section (9 dives), the southern section (8 dives), and 3 isolated dives. Sites successfully dredged during the GIMNAUT cruise are marked by dots, other dredge sites by stars. Isobaths are plotted every 400 meters, between 2000 and 3600 m.

About 150 sites were sampled. The first petrological descriptions and initial measurements of the Natural Remanent Magnetization were carried out onboard. Further measurements, such as isotope ratios, short-lived isotope and K-Ar dating, as well as determinations of absolute magnetic paleointensity, will be carried out in the future. This large data set will need to undergo detailed analyses in the next few years, before any solid conclusions can be established, and the major objectives of the GIMNAUT cruise addressed. However, the initial observations elucidate some preliminary characteristics of the CIR at 19°S;

- all of the observed and sampled rocks are basalts, with a majority of pillow lava and a significant number of dykes. No mafic or ultramafic rocks were collected during either, the dives nor the dredges (see below), the nearest ever recovered gabbros and peridotites came from the Marie Celeste Fracture Zone, about 200 km north (Engel and Fisher, 1975). This observation further substantiates the inference of a "hot" and magmatically robust section of the CIR at 19°S deduced from the bathymetric and geophysical data;
- the high deposition rate of pelagic sediments results in rapid infilling of the structural lows. The undisturbed character of the sedimentary cover observed on the outer dives shows that active tectonics are focused on the inner valley floor and on the inner walls. Similarly, the absence of fresh lava on the outer dives suggests that active volcanism mostly occurs inside the inner valley floor;
- despite reported signs of possible hydrothermal plumes in the water column (Jean-Baptiste *et al.*, 1992), no active hydrothermal site has been observed, although evidence of pervasive hydrothermal circulation is widespread. This evidence includes the frequent occurrence of yellow-

ish and orange products of alteration (sulfurs ?) on young pillow lava and the diffusion of shimmering water out of en-echelon fissures seen at one location on Dive 20.

Other operations and preliminary results

Various operations were carried out during night time in order to complement the data collected in the same area during the MAGOFOND 2 cruise of *R/V Marion Dufresne* in 1998 (Dyment *et al.*, 1999), including :

- the acquisition of deep tow magnetic profiles across the axial magnetic anomaly and the Brunhes-Matuyama boundary several hundred meters above the seafloor. Three such profiles had already been acquired during the MAGOFOND 2 cruise (Pouliquen *et al.*, *J. Geophys. Res.*, in press). Two additional profiles were successfully obtained using deep tow magnetometers belonging to the Ocean Research Institute, Tokyo, and INSU/CNRS, France, respectively.
- the collection of rock samples during 12 dredge hauls (Fig. 2). Six sites were dredged along the CIR axis, adding to the 3 sites sampled previously (Engel and Fisher, 1975; Humler, pers. comm.). These and the samples collected by *Nautile* provide a means to study the geochemical contamination of the ridge magmas by hotspot material at regional and local scales. Of the six dredge hauls devoted to a detailed investigation of the Gasitao Ridge, a small bathymetric feature which continues the Rodrigues Ridge up to the CIR axis (Dyment *et al.*, 1999), four were dredged on the ridge and two on the conjugate area on the Indian plate;
- and finally, the acquisition of multibeam bathymetry and imagery, surface magnetic and gravity data.

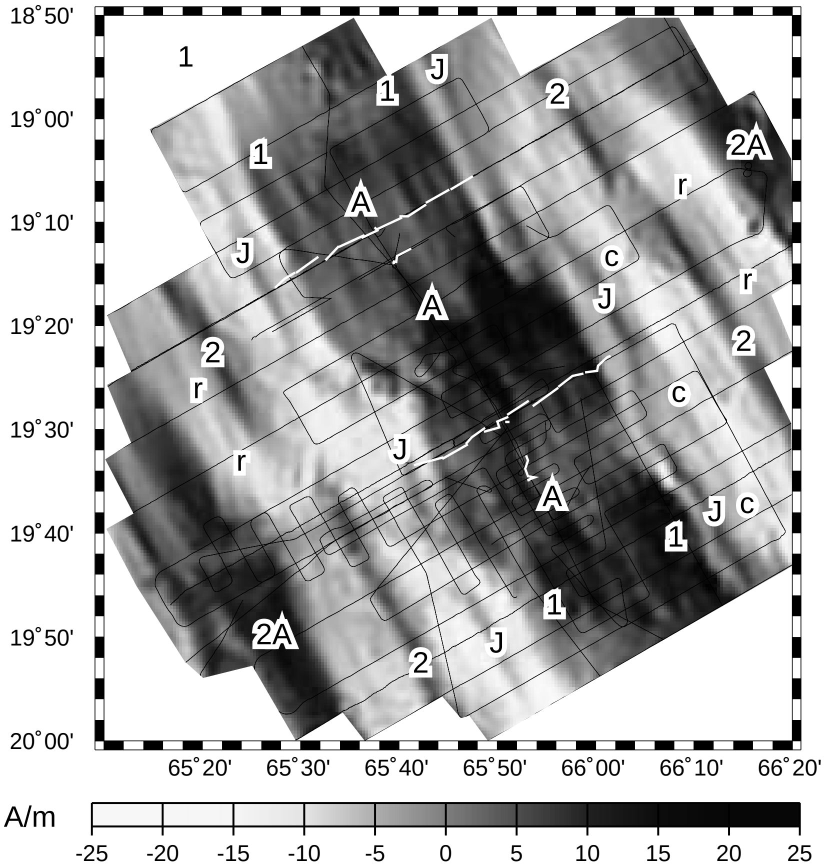

Figure 3. Equivalent magnetization computed from recent (*i.e.* 1995 and later) magnetic anomaly data in the GIMNAUT area. Original magnetic records have been reduced to the IGRF; an additional constant correction of several tens of nanoteslas has been applied to reduce the magnetic anomaly of each survey for systematic misfits at crossing points with the other surveys. Resulting magnetic anomaly data have been gridded using optimal Delauney triangulation and subsequently reduced to the pole. Equivalent magnetization was computed assuming a 500 m-thick magnetic layer and using a pass-band filter between 3 and 128 km. The 1, J, 2, 2A denote: anomaly **1** (*i.e.* the axial anomaly, which corresponds to the Brunhes chron), anomaly **J** (the Jaramillo sub-chron), anomaly **2** (the Olduvai sub-chron), and anomaly **2A** (the Gauss chron), respectively. **C** marks the Central Anomaly Magnetic High. The **r** and **c** show clear occurrences of the Reunion and Cobb events, respectively. Also shown is the location of the sea-surface magnetic anomaly profiles (thin black lines) and *Nautile* dive tracks (thicker white lines).

The multibeam bathymetric data collected with the Simrad EM 12 Dual system of *R/V L'Atalante* validate those collected during the MAGOFOND 2 cruise with the Thomson Marconi Sonar TSM5265 “Sea Falcon” system of *R/V Marion Dufresne*. The dense coverage of sea-surface potential field data allows the computation of gravity and magnetic anomaly grids, on which the study of deep-sea potential field data will rely. Initial analysis presented in Fig. 3 show the equivalent magnetization computed from the bathymetric and surface magnetic data assuming a 500 m-thick magnetic layer. Anomalies 1, J, 2 and 2 A (Brunhes normal chron, Jaramillo and Olduvai normal sub-chrons inside Matuyama reversed chron; and Gauss normal chron) are clearly identified. Secondary linear features are also occasionally seen and agree well with the tiny wiggles recognized by Pouliquen *et al.* (*J. Geophys. Res.*, in press) as geomagnetic features (for example, Cobb and Reunion events). Within the axial (Brunhes) anomaly, two to three such linear features flank the Central

International Ridge-Crest Research: **Indian Ridge:** Dyment *et al.* continued...

Anomaly Magnetic High (CAMH) and will be analyzed together with the deep tow and submersible magnetic anomalies. The tremendous along-axis variations of the equivalent magnetization are associated with the faint, second-order, segmentation depicted by the bathymetry. Higher equivalent magnetization values correspond to segment ends and lower values to segment centres, as observed on other spreading centres.

Advantage was taken from transit periods to acquire bathymetry, imagery, magnetics and gravity, which will complete the data set acquired during the MAGOFOND 2 cruise . A small ridge was discovered northeast of Rodrigues Island during the first transit. This ridge trends N70°E, extends more than 36 km and towers 2000 m over the nearby seafloor (~ 3200 m deep). These characteristics make it very similar to the Three Magi and Gasitao Ridges (Dyment *et al.*, 1999) and suggest a common origin for these features.

Acknowledgements

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Exploration of the Carlsberg Ridge

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Surveys to explore the slow to medium spreading Carlsberg Ridge, which acts as a plate boundary between the Indian and African plates in the northern Arabian Sea, have been ongoing since 1996. A ~ 100 km long section of the Carlsberg ridge was surveyed with multi-beam bathymetry, gravity and magnetics and seabed sampling during the cruise on board *OR/V Sagar Kanya* (SK-114) in June-July 1996. In July-August 2000, a cruise (SK-154) was undertaken to augment the earlier data, and an area of ~ 17,000 km^2 was covered with the multi-beam swath bathymetry (MBS). Concurrent with MBS data, gravity and magnetics were acquired. Geological sampling was carried out at selected locations based on MBS data. The recent exploration was carried out in two blocks separated by about 70 nautical miles.

Major transform faults or transform zones are absent in the region surveyed. However, the ridge axis showed a continuous and gradual shift in the trend. Along the axial valley, occurrence of axial lows of about 4700 m at regular intervals is a unique feature of Block 1 (Fig.1). These axial valley lows appear to influence the changes in the ridge axis trend. Another supportive evidence for this possible interpretation is the presence of the topographic highs along the ridge flanks closer to these axial lows. Near the central part, gradual merging of the ridge axis into the ridge flanks and the absence of linear steep valley walls with a distinct topographic signature observed.

In the second block of the survey (Fig. 2), the axial valley was comparatively wider and showed gradual shallowing up of the axial valley floor to about 3600 m, from ~ 4000 m in Block 1. The contour map of Block 2, shows a non-transform ridge axis discontinuity which is flanked on the northern side by a topographic high

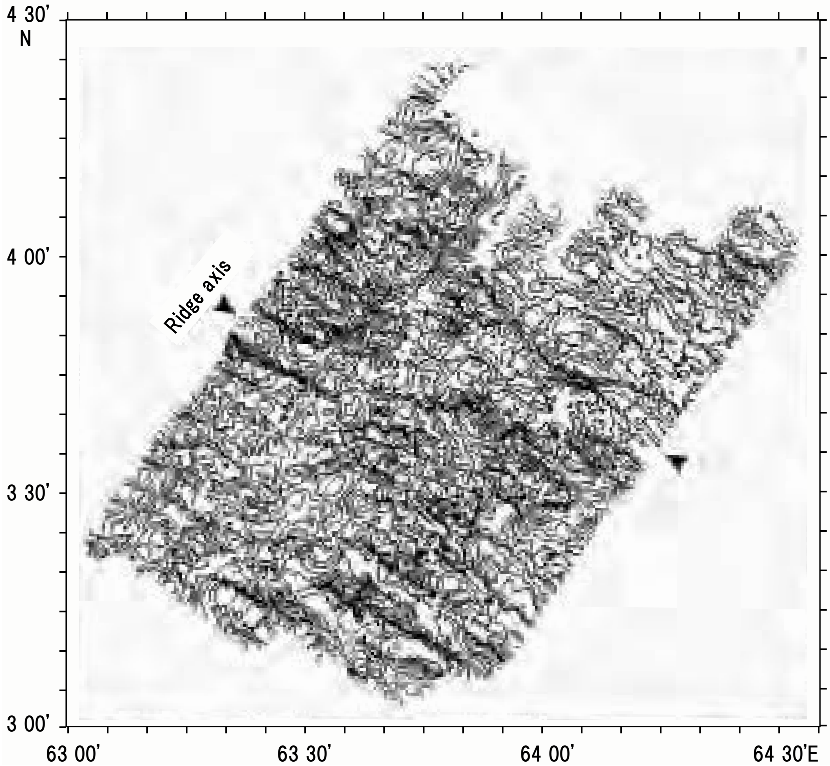

Figure 1. Carlsberg Ridge - Block 1

rising from 3600 m to 1800 m. A general observation is that adjacent to the axial shift, at least on one side of the ridge flank, there are topographic highs reaching water depths of ~ 2000 m.

Geological sampling locations were selected based on the online swath bathymetry records and post-processed (on-board) MBS data. The online MBS data was useful in selecting locations for dredge as well as coring within the axial valley and on the flanks. Sediment cores, collected within the axial valley ~ 1.27 m & 2.7 m long indicated that volcanism was very sparse and/ or occasional. Two sediment cores were recovered from the topographical deeps of ~4600 m from the ridge flanks and average core length was about 5.5 m.

Dredge operations carried out using chain-bag dredge at four locations brought up a variety of rock samples. In general, the dredged basalts were altered; at one location fresh basalts with a thick chilled glass margin were recovered. The glass exhibited conchoidal fracture and broke easily indicating a fragile nature. One of the dredge hauls recovered from an axial high, close to the axial valley, was full of serpentinites with a minor percentage of peridotites (lherzolites/harzburgite). The serpentinites showed varied macroscopic characters from fibrous to blocky type with different shades of green. Some serpentinites were associated with pyroxenes, which were altered and show twinkling when viewed against the light.

With the two expeditions carried out so far, a continuous coverage of ~ 150 nautical miles of the axial and adjacent flank area of the Carlsberg Ridge is mapped. This is the first time such a long axial area of the Carlsberg Ridge has been mapped with multi-beam bathymetry and other geophysical parameters.

Acknowledgements

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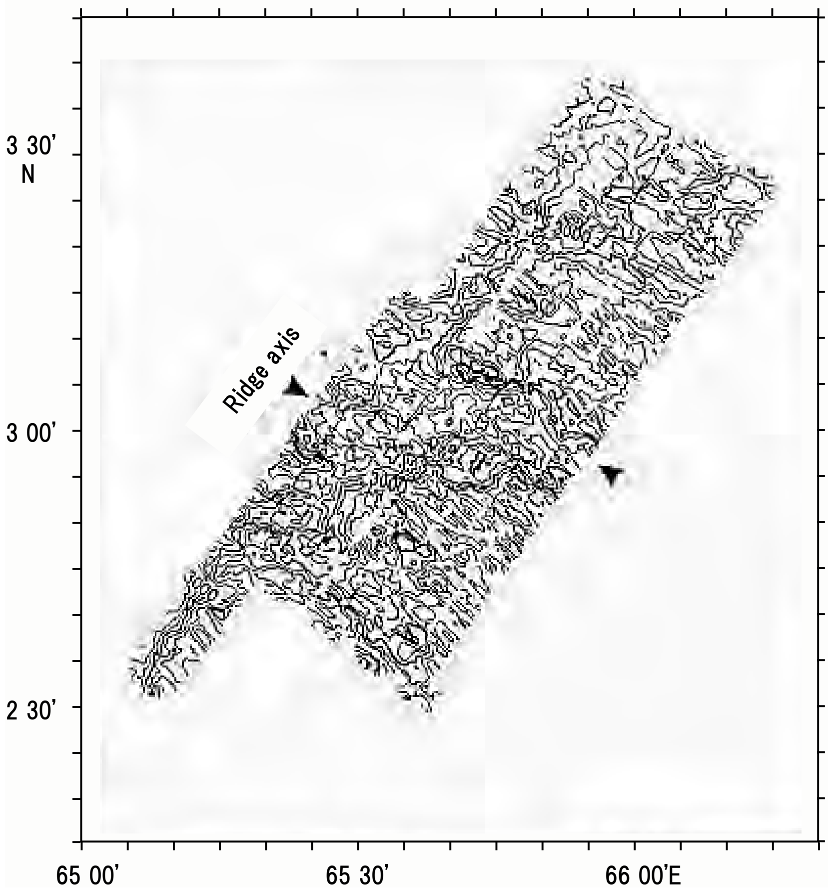

Figure 2. Carlsberg Ridge - Block 2

International Ridge-Crest Research: **East Pacific Rise**

The fourth dimension in ridge studies: Sampling along a flow-line corridor 0-9 Ma at 14°S on the EPR

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The EXCO (EXchange between Crust and Ocean) area (Fig. 1), a region of „normal" Pacific crust formed at the East Pacific Rise spreading centre near 13°S and well away from any extensive influence of major fracture zones or spreading centre jumps, was first studied in 1995 during *Sonne* cruise SO-105 (Weigel *et al.*, 1996). These initial surveys consisted of seismic, topographic, magnetic and heat flow studies of a 720 km long and about 40 km wide strip of seafloor extending eastwards from the spreading axis out to approx. 9 million year (Ma) old crust. The aim of these studies was to examine the effects of low-temperature hydrothermal circulation on the aging of the oceanic crust as it drifted away from the active spreading centre. This circulation was thought to be responsible for large changes in the seismic velocities in the upper oceanic crust (Layer 2) between the axis and older crust. Recent publications suggest that most of the fluid flow in the upper crust is channelled through small volumes of rock and vented into the ocean. This implies that on the flanks of generally thinly sedimented mid-ocean ridges, focussed discharge at the seafloor will be concentrated most likely at outcrops, high-angle normal faults or seamounts. These vents should be associated with a significant heat flow signature. However, up to present, only few observations worldwide support this assumption. The SO-105 results (Grevemeyer *et al.*, 1999; Villinger, 2000) showed a large increase in seismic velocity in Layer 2 away from the axis and large variations in heat flow density in this area correlating with basement topography, interpreted to be associated with inflow and outflow of circulating pore water.

The EXCO II cruises (SO-145 Legs 1 & 2, Dec. 1999 to Feb. 2000) were designed to build on this earlier work and explore in more detail the variations in heat flow (Leg 1) and to sample the pore waters and Layer 2 rocks (Leg 2) in an effort to establish the chemical and mineralogical changes which are occurring in this aging crust. A further aim of the rock sampling programme was to examine the variations in magmatic geochemistry of the crust over the last 9 Ma to establish the extent of heterogeneity of magma production and evolution processes through time for a normal spreading segment. In addition, profiles west of the ridge just south of the Sojourn Ridge were surveyed to investigate a possible asymmetry of the spreading process.

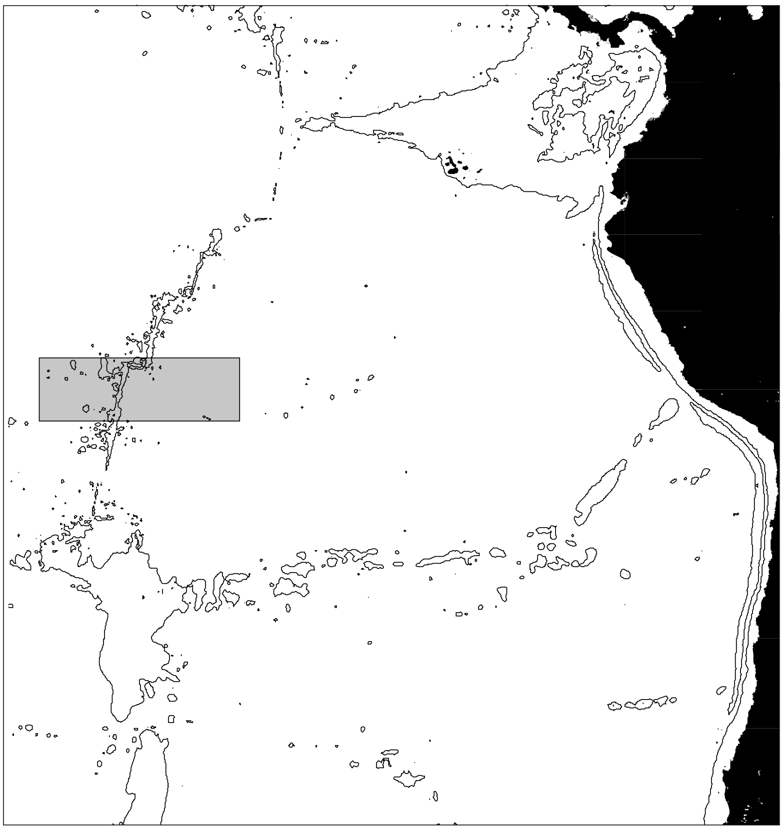

Figure 1. Location of EXCO area on the East Pacific Rise

Results

Bathymetry and seismics

During the cruise about 4400 km of Hydrosweep data were collected,

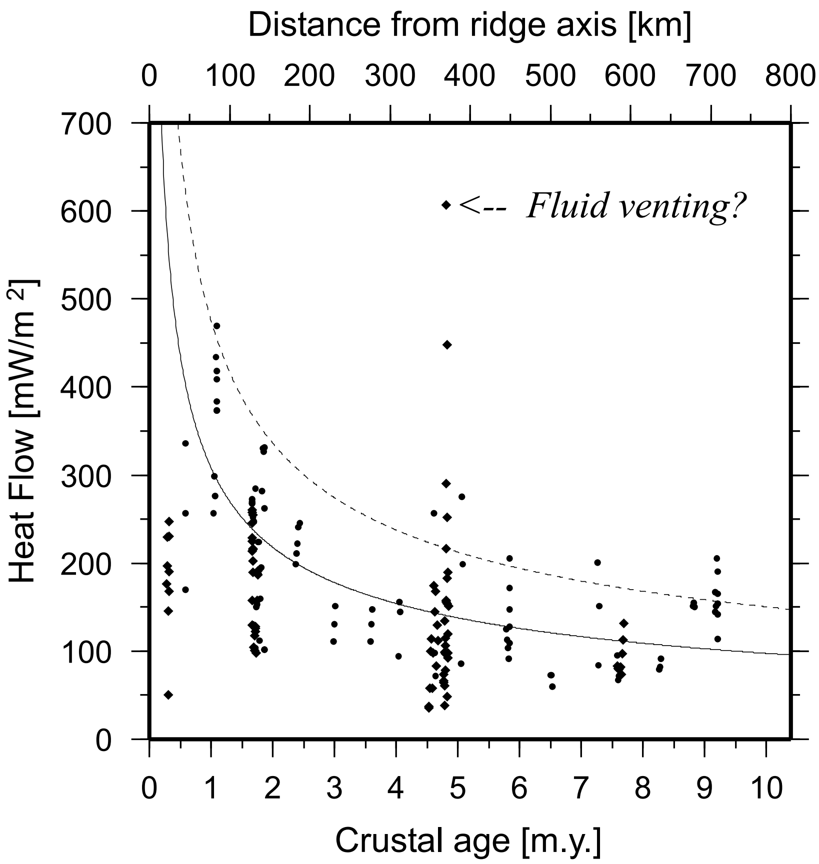

Figure 2. Heat flow vs. distance from ridge and crustal age in the EXCO area.

representing an approximate seafloor coverage of 29000 km². Thus together with data from cruise SO105 (Grevemeyer *et al*., 1997) about 55000 km² of swath data are available for interpretation within the corridor. The minimum water depth of about 800 m was detected over the Sojourn ridge (western flank of the EPR). The bathymetric survey reveals a number of fossil overlapping spreading centres (OSC) at various spatial scales, producing a complex picture of interaction of OSCs during spreading. The abundance of seamounts derived from the new data set is much higher than estimated from SO105 data. Comparing subsidence east and west of the EPR we see a clear asymmetry, with the western flank subsiding much slower than the eastern flank.

In total, about 850 km of single channel seismic data were shot during the cruise, including one long profile of about 450 km length perpendicular to the strike of the axis. It starts south of the Sojourn Ridge (west of EPR) and terminates on the eastern flank on 1.5 Ma old crust. This profile shows very clearly an asymmetric pattern of sedimentation. The western flank is dominated by a comparatively thick sediment cover with well-sedimented basins between abyssal hills. On the eastern flank, the sediment cover is much thinner and covers the crustal topography like a drape. In general it is possible to map a minimum sediment thickness of about 10 m. It is not clear what causes this pronounced asymmetric sedimentation.

Heat flow

Heat flow measurements in the transect with crustal ages from 0.3 to 9.3 Ma (Fig. 2) show the well-known pattern of low values close to the ridge, associated with vigorous hydrothermal circulation of cold seawater through the young upper crust, and a fast recovery to almost lithospheric conductive cooling values at a surprisingly young crustal age at 9.3 Ma. Although the sediment cover is fairly thin, measurements with a 3m violin bow type heat probe were possible almost everywhere within the investigated area. Heat flow across horst and graben structures varied with topography, indicating outflow at basement highs. Pore water chemistry profiles (see later) reveal a slow diffuse discharge of fluid over most parts of the area. A detailed survey between two large seamounts at 4.5 Ma revealed localized extremely high values of up to 607 mW/m² at the foot of the seamount (Fig. 2). This is interpreted as a clear indication of focused discharge of hydrothermal fluid and is an important observation as it helps to explain large scale heat transport systems in young oceanic crust.

Porewater chemistry

Global heat flow suggests that at least 6.2×10^{12}W (*cf*. global human power production is ca. 13×10^{12}W) are removed from mid-ocean ridge flanks by the flow of warm seawater through the crust. Much of this power output must occur through young, thinly sedimented seafloor at temperatures only a few degrees above that of ambient bottom water. Because this seawater flux is potentially large, on the order of 10^{19} g/y, only small changes in the composition of the circulating seawater are required to produce large geochemical fluxes between the oceans and the young crust. To quantify these fluxes, the composition of seawater circulating through and reacting with young basement basalt across the range of crustal ages present in the EXCO corridor was determined. Samples were recovered with a gravity corer and the sediment pore water was extracted in a centrifuge. We collected 30 cores up to 6 m long from four sites, with crustal

International Ridge-Crest Research: **East Pacific Rise:** Devey *et al*. continued...

ages of 0.3, 1.5, 4, and 8 Ma. Our task was facilitated by the fact that 10 cores, from all the sites except that at 8 Ma, penetrated to basement, so that the composition of the deepest sediment pore water sample could be used as a proxy for basement water, whether or not upwelling was found. Variations of chemical parameters with depth, especially for nitrate and fluoride, were used to confirm whether upwelling was occurring. As on other ridge flanks, upwelling was found frequently to occur through thin sediment above basement highs. At the 8 Ma site no upwelling was found, in agreement with the heat flow evidence for a conductive cooling gradient here, so that changes from seawater composition could have resulted from reaction between pore water and sediment of unknown thickness. At the 0.3 Ma site chlorinity increases by 0.3% due to hydration of basement, but the basement water is otherwise indistinguishable from seawater. At the 1.5 Ma and 4 Ma sites there are two fluids: one that has lost Mg and, at 1.5 Ma, gained Ca, while the other has gained Mg and lost Ca. At the 0.3-4 Ma sites chlorinity is within 0.7% of present-day bottom water, implying that water in basement is <2000 y old.

Petrology

The petrological studies had two main aims: (1) to investigate the fluctuations in the spreading process over the last 9 Ma and (2) to investigate the effects of low-temperature water circulation on rock chemistry. Magnetic investigations during EXCO I showed fluctuating spreading-rates (70-116 mm/a) during the last 9 Ma. With the results of our magma chemistry studies, we will investigate the influence of changing spreading rates on composition in one geographical region. Previous examinations, which compared basalts formed at different spreading rates in different ocean basins did not prove any spreading-rate dependence. However, such examinations are plagued by problems of mantle heterogeneity between and within ocean basins and are therefore not ideally suited to investigate only the influence of changing spreading-rates on magma production.

Some initial results of the geochemical studies are shown in Fig. 3, where all older samples have been projected back to their eruption latitude. The trend of Mg# vs Latitude seen on the present-day axis (points labelled "Literature Data") is exactly mirrored by the older samples. This leads to the surprising conclusion that even changes in ridge-lava chemistry which are not associated with any noticable ridge topographic changes (such as those at 14°S and 14°30'S) have existed for up to 9 Ma. This implies either a remarkable stability of the ridge magmatic system or a more deep-seated and hence longer-lived cause for the Mg# variations.

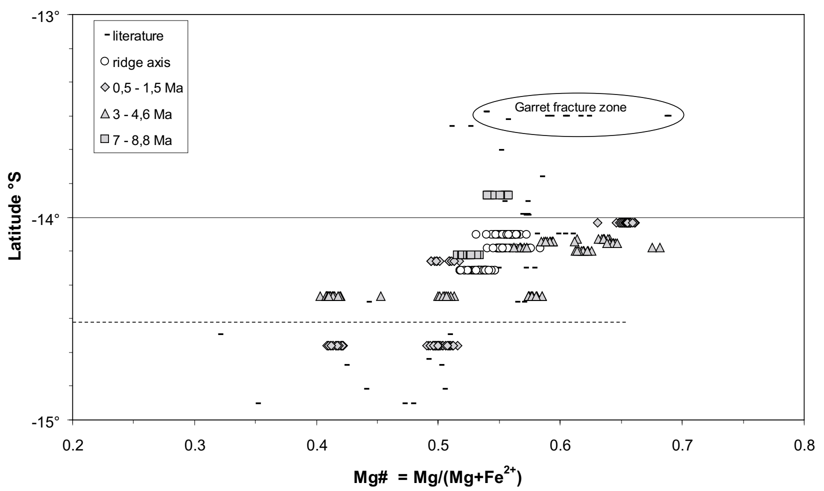

Figure 3: A plot of magnesium number (Mg# = $Mg/(Mg+Fe^{2+})$, all quantities as atomic proportions) against latitude for samples from both the present-day spreading axis and from the off-ridge areas. The latitudes for the off-ridge samples have been recalculated to show the sample´s position at the time of eruption on axis.

Acknowledgements

We thank Captains Andresen and Papenhagen and their crews for the excellent support during the EXCO II cruises. The cruise was financed by the German Research Ministry (BMBF) and follow-up research is supported by the BMBF in Germany and the National Science Foundation (NSF) in the U.S.A.

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KRISE-2000: Constraining the dynamics of plume-ridge interaction to the north of Iceland.

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The geodynamic interactions between mantle plumes and mid-ocean ridge spreading centres give rise to notable variations in ridge morphology, mid-ocean ridge basalt chemistry, crustal thickness, and presumably mantle flow. Iceland and the adjacent mid-ocean ridges - the Reykjanes Ridge to the south and the Kolbeinsey Ridge to the north - provide a natural laboratory for developing a comprehensive model of the dynamics of hotspot-ridge interactions. The influence of the Iceland hotspot on the adjacent ridges, which has been recognized since the 1970s, extends more than 1,000 km away from the plume's centre. Major- and trace-element studies at Iceland and along the slow-spreading Reykjanes and Kolbeinsey Ridges, support a decreasing extent of melting with distance from the plume (*e.g.* Schilling, 1999). In addition, along-axis gradients in trace-elements and isotope compositions suggest mixing between the plume and normal mid-ocean ridge basalt sources. Seismic measurements of crustal thickness within Iceland and along the adjacent mid-ocean ridges also support a decreasing extent of melt production with distance from the centre of the plume (Fig. 1 and references therein).

Despite considerable progress, the exact form of interaction between the Iceland plume and adjacent ridges is poorly understood. In particular, an observed north-south asymmetry in ridge axis elevation and geochemistry is not understood nor predicted by the geodynamic models. Bathymetric profiles show more rapid deepening of the ridge axis to the north along the Kolbeinsey Ridge than to the south along the Reykjanes Ridge (see Fig. 1,an excess of up to 1 km over 400 to 1200 km to the south and a deficit of almost 1 km over 100 to 500 km to the north). Though this topographic signature may be partly due to the reduction in spreading rate north of Iceland, an asymmetry in the effect of the plume on the spreading centre has been proposed. The current seismic measurements of crustal thickness hint at an asymmetry in melt flux at the ridge with crustal thicknesses greater along the Reykjanes Ridge than along the Kolbeinsey Ridge(compare fits I and II, in Fig. 1).

The Kolbeinsey Ridge Seismic Experiment (KRISE) was aimed at measuring the variation in crustal thickness, as an indication of melt flux, on transects north of Iceland, in a region that is poorly studied and critical to further refining geodynamic models of plume-ridge interactions in the North Atlantic region. Apart from being 2-3 times thicker, the crust of Iceland resembles the crust of the ocean basins. Existing seismic measurements of crustal thickness along the spreading system are sparse in the critical range of 200-400 km from the centre of the Iceland plume (Fig. 1). There is only one data point along the ridge to the north of Iceland and constraints on the past melt flux at the spreading centre north of the plume, recorded in the thickness of older off-axis oceanic crust, are sparse.

The Kolbeinsey Ridge formed at 26-36 Ma following a westward ridge jump from the now extinct Aegir ridge. The slow-spreading Kolbeinsey Ridge (full rate ~2 cm/yr) is bounded by the Tjörnes fracture zone to the south and the Jan Mayen transform fault to the north. The southern ridge axis, from the Tjörnes fracture zone at 66°50'N to the right-stepping Spar 34 km offset at 69°N, is clearly delineated by a continuous axial high (~30 km wide and ~500 m vertical relief) and a high-amplitude central magnetic anomaly. Spreading along the Kolbeinsey Ridge was initiated 15 Myr ago and magnetic anomalies can be clearly traced out to at least anomaly 5 (~10 Myr). Just south of the Spar offset, a smaller non-transform discontinuity offsets the ridge by 10 km in a right lateral sense at 68°43'N. Magnetic data show this offset has propagated northward through time and that the southern Kolbeinsey ridge has grown to the

International Ridge-Crest Research: **Hotspot-Ridge Interactions:** Hooft *et al.* cont...

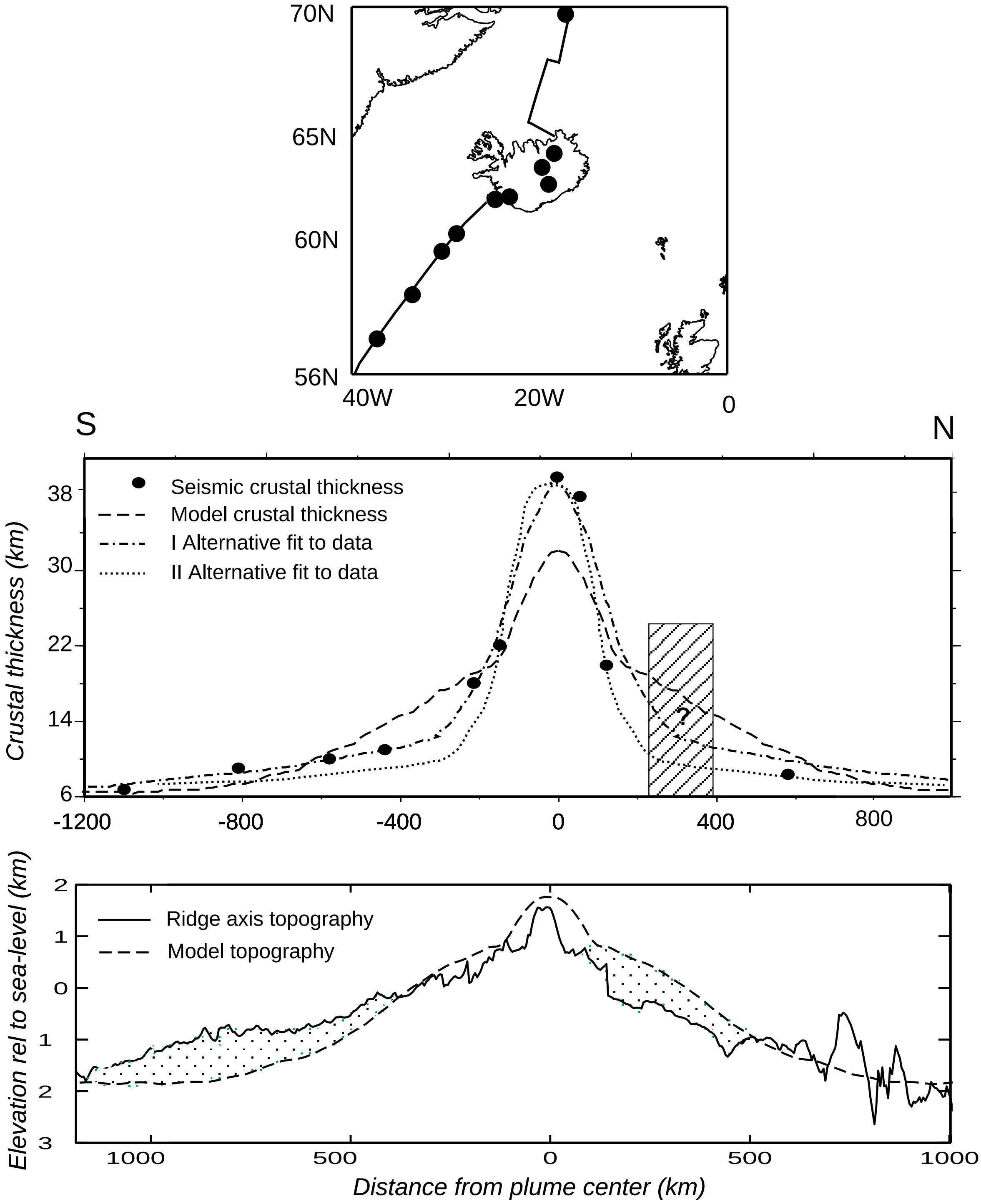

Figure 1. Comparison of predictions from the fluid dynamic model of *Ito et al*.(1999) (dash) with the observed along-axis crustal thickness (middle panel) and ridge axis elevation (lower panel) in the Iceland region, plotted against distance from the plume center (Bardabunga volcano, Iceland). Top panel: Locations of the crustal thickness determinations *(*Darbyshire *et al., 1998* and references therein*;* Weir *et al., 2000*). Middle panel: Two possible alternative fits to the seismic crustal thickness data are shown which have a more rapid reduction in crustal thickness at 200-500 km from the plume center than that predicted by the geodynamic models. The KRISE experiment measured crustal thickness from ~200-400 km from the plume (hatched box). Lower panel: Asymmetric differences between the observed ridge axis elevation and that predicted by the model (~1 km excess and ~1 km default observed to the south and north, respectively - dotted regions).

north at a rate of ~100 mm/yr (Applegate, 1997). This rate is similar to the propagation rate of the V-shaped anomalies on the Reykjanes Ridge and may be caused by an increase in melting at the ridge over the last 6 Myr.

The experiment

The primary objective of KRISE was to collect P_g,P_n and P_mP arrivals along three seismic refraction profiles (Fig. 2). Crustal thickness variations in along-ridge lines may help constrain geodynamic models of the influence of the Iceland hotspot on the spreading centre, while variations in perpendicular directions may reveal temporal variability in the hotspot influence. We also collected magnetic, gravimetric and ministreamer reflection data for the sea floor and basement depths along the refraction lines. We surveyed a 230-km-long along-axis line (Line 1), situated about 10 km east of the Kolbeinsey Ridge, and two cross-axis lines (Lines 4 and 7) which were 138 and 710 km long, and located 180 and 70 km north of the Icelandic coast, respectively.

The three profiles were surveyed during June, 2000, in two OBS deployments using the University of Bergen research ship Håkon Mosby and the Icelandic Coast Guard Cutter Aegir. We used 33 OBSs from the University of Hokkaido, which recorded continuously, and of which 24 were digital instruments. The OBSs were nominally placed at 10 km intervals across the ridge axis, 30 km intervals east of the Iceland margin and at 15 km intervals elsewhere. The seismic source was a four-element airgun array with a total capacity of 4800 cu in mounted on the Håkon Mosby, and the shots were spaced at 200 m, or every 70 s, along the profiles.

The experiment was very successful and Line 7 was extended well into the Norway Basin, *i.e.* to the extinct Aegir rift axis. Initial inspection of the OBS data revealed that all but two of the deployments recorded. A total of 5389 airgun shots were fired during the experiment, all of them in very good sea conditions. In addition to the airguns, two large (M_s>6.5) earthquakes that occurred in the South Iceland Seismic Zone during the experiment were also recorded along Line 7.

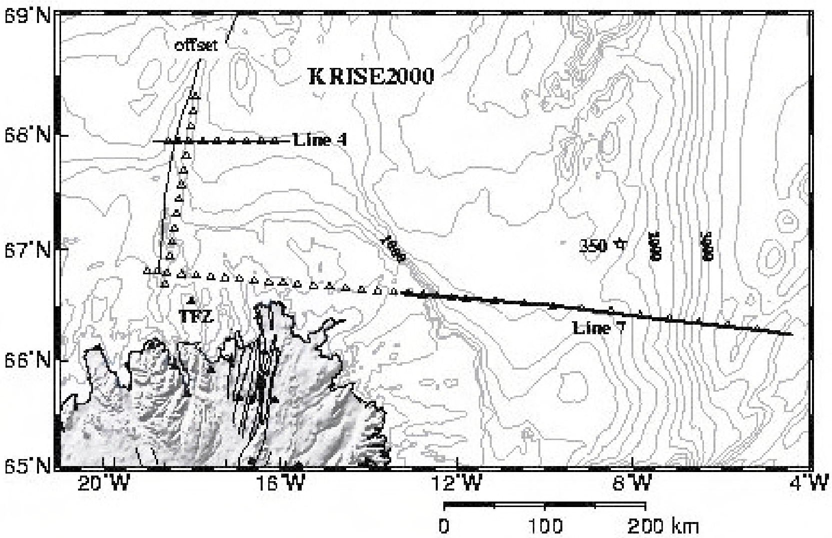

Figure 2. A map of the study area. OBS stations and stations on land, Iceland, are denoted by triangles and lines labelled Line 4 and Line 7 mark the location of ministreamer profiles shown in Figure 3. The location of DSDP-borehole 350 is denoted by a star.

First results

Ocean floor and basement reflections from each of the airgun shots were recorded on a~20-m-long mini hydrophone streamer which was towed behind the Håkon Mosby. The ministreamer profile joins up with an older profile (JM-17D-88), surveyed by the University of Bergen in 1988. After band pass filtering the data between 20-40 Hz with a 48 dB/oct drop off, we selected an AGC window of one second in order to bring out the strong basement reflection east of the Iceland insular margin (Fig. 3; top, right and bottom). This reflection is obscured by several strong water column multiples on the Iceland shelf. Assuming sediment velocities in the range of 2-3 km/s we can infer sediment thicknesses of 1-1.5 km on the western part of the Iceland Plateau, thickening to ~2 km at its eastern margin.

Further north, along Line 4, the sediments are much thinner (Fig. 3; top, left). An abrupt increase in sedimentary thickness is visible on each side of the ridge itself. To the east of the ridge the sediments are cut by more recent faults and extrusives. The refraction data will hopefully allow us to further determine the nature of the two small horsts east of the main ridge, which could be analogous to the V-shaped ridges present along the Reykjanes Ridge. Apart from these irregularities, the basement is fairly smooth.

The rougher basement, just west of the shelf break (Fig. 3; bottom), is most likely related to extension and tectonism associated with the southern extension of the Jan Mayenridge, which is considered to be a continental fragment, sliced off the Greenland margin at the initiation of the Kolbeinsey ridge. The 70-80 km wide rift we observe is characterized by numerous peaks rising 600-900 m above the sea floor. An intra-sedimentary reflector at this site could be of similar origin as horizon A, which has a thickness of 0.4-2 s further north on the Iceland Plateau and in the Norway Basin (Gairaud *et*

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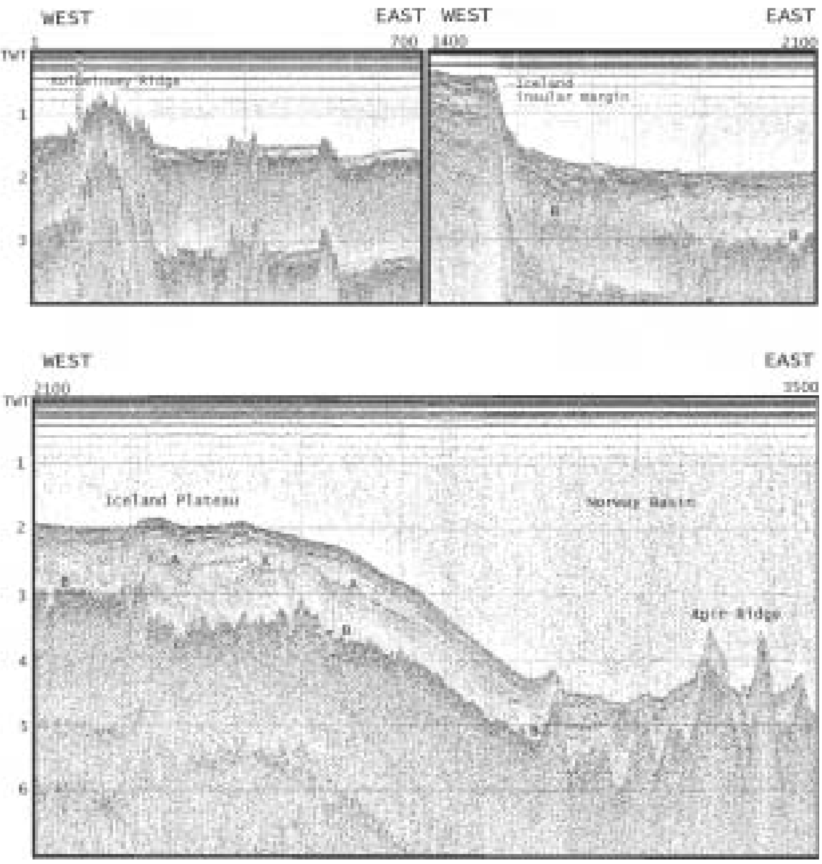

Figure 3. Ministreamer profiles across the Kolbeinsey Ridge (line 4; top, left), and from the Iceland Insular Margin (line 7; top, right) across the Iceland Plateau to the now-extinct Aegir Ridge axes (lower plot). The upper two profiles are close to 140 km (700 shots) each whereas the lower plot is approximately 280 km. The sediment-basement (B)reflector is only visible east of the insular margin, along the Iceland Plateau. Note the intra-sediment reflector (A) at the Iceland Plateau.

al., 1978). This horizon was penetrated at 226.5 m depth in ODP drill hole 350, which is located approximately 70 km north of our profile (Fig. 2). Horizon A is considered to mark the contact between Upper Eocene and the Oligo-Miocene.

The KRISE refraction data will allow us to determine the distance dependence of meltflux at the ridge in the critical range of 200-400 km from the plume centre and the temporal variability of the plume influence on the Kolbeinsey ridge from its initiation at 26-36 Ma. By comparing results from this experiment with the existing seismic data from the Reykjanes Ridge (see Fig. 1) we will be able to solve the issue of any asymmetry in the interaction of the plume with the spreading centres to the north and south and have the necessary data to constrain more refined models of these interactions. From comparison with previous refraction experiments in the Iceland area, we expect to have recorded converted shear wave arrivals which will allow better constraints on the structure and properties of the oceanic crust.

This joint American-Icelandic-Norwegian-Japanese endeavor provided a cost-effective opportunity to carry out the observations needed to further refine models of the effects of the upwelling plume on melting beneath the mid-ocean ridges.

Acknowledgements

The success of this experiment was due partly to the fair weather, but mainly to the professionalism and smooth interaction of the ships' crews (both Håkon Mosby and Ægir),the University of Bergen air gun crew, and the University of Hokkaido OBS crew.

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International Ridge-Crest Research: **Hotspot-Ridge Interactions**

Seismic and Petrologic Investigation of the Effects of Plume-Ridge Interaction at the Galápagos Spreading Centre

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Results from this cruise can be found at URL" http://obslab.whoi.edu/ew0004".

Introduction

Near-ridge hotspots induce the largest physical and chemical anomalies along the Earth's mid-ocean ridges and provide important natural settings to learn how variations in the mantle (*e.g*. upwelling rates, mantle temperature, and chemistry) affect a wide range of ridge crest processes. The Galápagos hotspot and the adjacent Galápagos Spreading Center (GSC) form a classic example of a plume-ridge system (Morgan, 1978; Schilling *et al.*, 1982). The GSC separates the Cocos and Nazca plates in the eastern equatorial Pacific (Fig. 1) at intermediate opening rates of 45-55 mm/yr between 91° and 98°W (DeMets *et al.*, 1994). Associated with the Galápagos hotspot is a bathymetric swell extending ~1300 km along the ridge axis and peaking with an amplitude of ~1.5 km just north of the Galápagos archipelago near 91°W.

With increasing distance away from the hotspot the axial morphology changes from an axial high, typical of fast-spreading ridges, to "transitional morphology", lacking either an axial high or axial valley, and finally to an axial valley, typical of slow spreading ridges (Canales *et al.*, 1997). These geophysical anomalies generally correlate with variations in isotopic ratios (Schilling *et al.*, 1982; Verma and Schilling, 1982) that are thought to reflect the composition of the mantle source, as well as variations in major elements that reflect processes of melt generation and crystallization (*e.g.*, Langmuir *et al.*, 1992; Schilling *et al.*, 1982). Together, these geophysical and geochemical anomalies represent indicators of two fundamental processes concerning plume-ridge interactions: (1) mantle flow and melting, with implications for the origin of hotspot swells, and (2) variations in magma supply and the effects on axial morphology, basalt chemistry, and crustal accretion.

In April-May, 2000, the G-PRIME expedition (*R/V Maurice Ewing* cruise EW00-04) conducted a geophysical and petrological investigation of the Galápagos Spreading Centre between 90°30' and 98°W (Fig. 1). During the cruise, we collected extensive multibeam bathymetric data along the GSC in this region, fully defining the ridge crest and delineating the axial morphology.

To image detailed crustal structure, including crustal magma bodies, approximately 1400 km of multichannel seismic reflection data were collected between 91°15' and 95°W. We also conducted four seismic refraction experiments to provide high-resolution measurements of seismic velocity and thickness of the crust. Three of these experiments were done along the GSC and one was located on the Galápagos platform. The second leg of the expedition was a three-week sampling programme, which will provide petrologic and geochemical data at high spatial resolution along the GSC between 90°30'- 98°W. The expedition was designed to meet four main objectives:

- quantify how compensation of the Galápagos swell is partitioned between variations in crustal thickness and mantle density by measuring crustal thickness variation along the swell and the degree of melting inferred from the chemistry of GSC basalts.
- find an explanation for the chemical paradox at the Galápagos plume-ridge system; *i.e.*, the apparently contradictory observation that variations in basalt geochemistry along the GSC suggest lower extents of melting near the hotspot, while bathymetric and gravity data imply thickened crust and/or hotter mantle near the hotspot.
- determine how crustal magma lens properties such as its thickness, width, depth, or disappearance are related to the transition from an axial high to a rift valley morphology.
- determine how the extent of magmatic differentiation of ridge basalts relates to the presence or absence of a melt lens and proximity to propagating rifts.

Here, we report the initial results of this expedition.

International Ridge-Crest Research: **Hotspot-Ridge Interactions:** Sinton *et al.* cont...

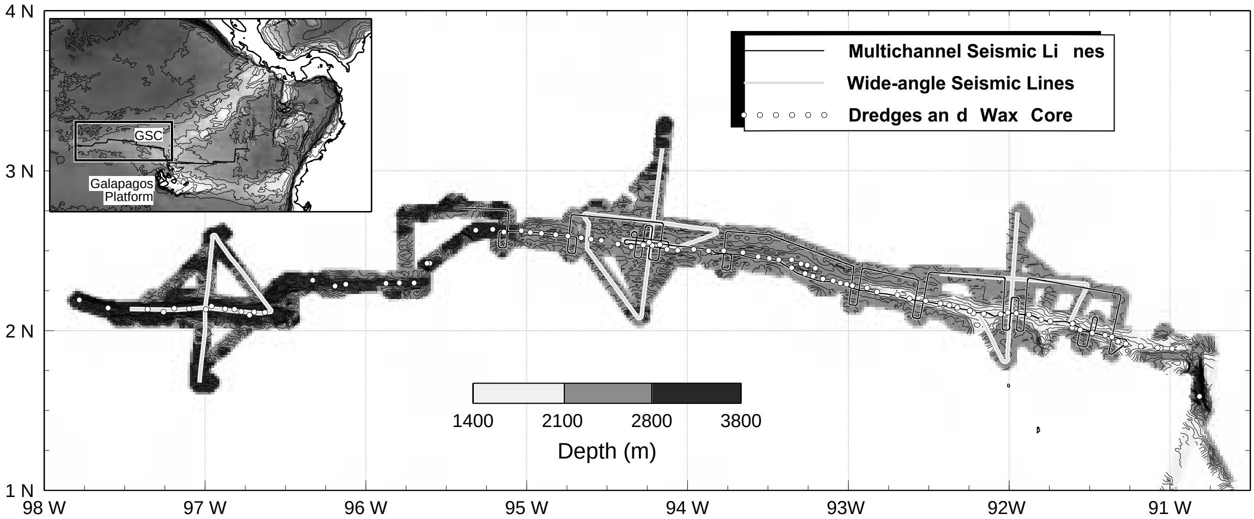

Figure 1. Multibeam bathymetry data are contoured at 100 m intervals. MCS lines are black, wide-angle refraction lines are grey, and circles show rock sampling stations. Inset shows Galápagos region and outlines survey area.

Multibeam Bathymetric Mapping

Multibeam bathymetric mapping was done using the *R/V Maurice Ewing* Hydrosweep system, which provided a swath width of ~1.7 x water depth. Data collection and editing was done nearly continuously during all phases of the cruise. The new data allow us to define three distinct domains based on axial morphology and depth:

1) axial high east of 92°40'W;
2) transitional from 92°40'W to the propagating rift tip at 95°30'W;
3) axial deep west of 95° 30'W.

The axial high morphology is characteristic of many fast-spreading ridges such as the East Pacific Rise. Axial depth in the axial high domain is everywhere less than 2000 m, shoaling to ~1600 m between 91° and 92°W. The axial high domain can be separated into six ridge segments that are separated by small-offsets, mainly right-stepping overlapping spreading centres (OSCs). Where the axis is intersected by NNW-trending lineaments extending away from the Galápagos archipelago, the axis steps to the south. In the region of transitional morphology the ridge axis gradually deepens from 2000 to >3500 m with distance away from the hotspot. The ridge axis mainly lies in narrow grabens that widen to the west with topographic relief of ~200 m. This transitional morphology is typical of ridges spreading at intermediate rates. Rift segments west of 95°30'W are axial grabens similar to those found along slow-spreading ridges. These segments are separated by non-transform, left-stepping offsets located at 95°40' and 96°35'W. The floors of the axial grabens gradually deepen from ~2700 to 3400 m and define axial valleys with a width of ~15 km and maximum depth of ~1 km. Thus even though spreading rate changes very little over this distance of ridge axis, the axial morphology spans a wide range of general characteristics found on Earth's mid-ocean ridge system. These changes are likely to be linked to variations in magma supply and the processes of magma storage in the crust, which we will examine with crustal seismic and petrologic data.

Multichannel Seismic Reflection

The multi-channel seismic (MCS) reflection data was collected using the acquisition system onboard the *R/V Maurice Ewing*. This system included a 480-channel, 6-km-long streamer that produced 80 traces for each reflection point. Onboard data processing was done using the software package (SIOSEIS, *P. Henkart*) and provided near real-time brute stacks.

The primary objectives of the MCS reflection survey were to constrain variations in Moho depth, to identify the presence and measure the physical characteristics of an axial magma lens, and to measure variations in depth of the upper extrusive layer of the crust (layer 2A). To do this we conducted MCS survey lines along the ridge axis, across the ridge axis, and parallel to the ridge axis on the northern flank (Fig. 1). The ridge-flank and across-axis lines were designed to image Moho on mature crust formed at the GSC. Preliminary shipboard processing reveal strong Moho reflections in the axial topographic high sections of the GSC. The deepest Moho reflections appear ~2.5 s (two-way travel time) below the seafloor near 91°30'W (Fig. 2a). In the region of transitional morphology (94°15'W), tentative identification of Moho arrivals appear at a depth closer to 2.1 s below the seafloor. Rough seafloor topography near the 95°30'W propagator introduced high-amplitude noise to our records and the shipboard processing did not reveal a Moho reflector in this region. The

MCS data, in combination with the seismic refraction data, show promise in providing constraints on Moho topography at short and intermediate wavelengths.

The across-axis and along-axis MCS lines were designed to image the detailed structure of zero-age crust. Shipboard processing revealed classic magma lens reflectors over sections of the ridge axis with an axial high. In across-axis lines, the magma lens typically appears beneath a small axial graben on the summit of the axial high. In along-axis lines, the magma lens appears as a bright and flat reflector that is nearly continuous between 91°20'-92°W (Fig. 2b). In this region the magma lens is ~0.75-1 s below the seafloor. In the region of transitional morphology, we imaged deeper reflectors but further processing is needed to identify their source. We see no evidence for a magma lens in the shipboard stacks near 95°30'W. New stacks of the data are also revealing reflections from the base of layer 2A in the region of axial high morphology. Ongoing processing will examine variations in layer 2A thickness as this layer reflects the distribution of magma eruption on the seafloor.

Seismic Refraction Experiments

The primary objectives of the wide-angle seismic refraction experiments were to provide accurate measurements of seismic velocity and thickness of the crust at each of the three different axial morphologies. A secondary objective was to image a possible low-velocity zone along the ridge axis. The *R/V Ewing's* full 20-air gun array shot to 9-10 instruments (OBHs and ORBs operated by WHOI) deployed on the sea floor. We did three refraction experiments which included shooting/receiving lines along, and across the ridge axis (Fig. 1). Two of the experiments (*i.e.* near 94° and 97°W) included refraction lines parallel to, but 10-15 km north of the ridge axis (Fig. 1).

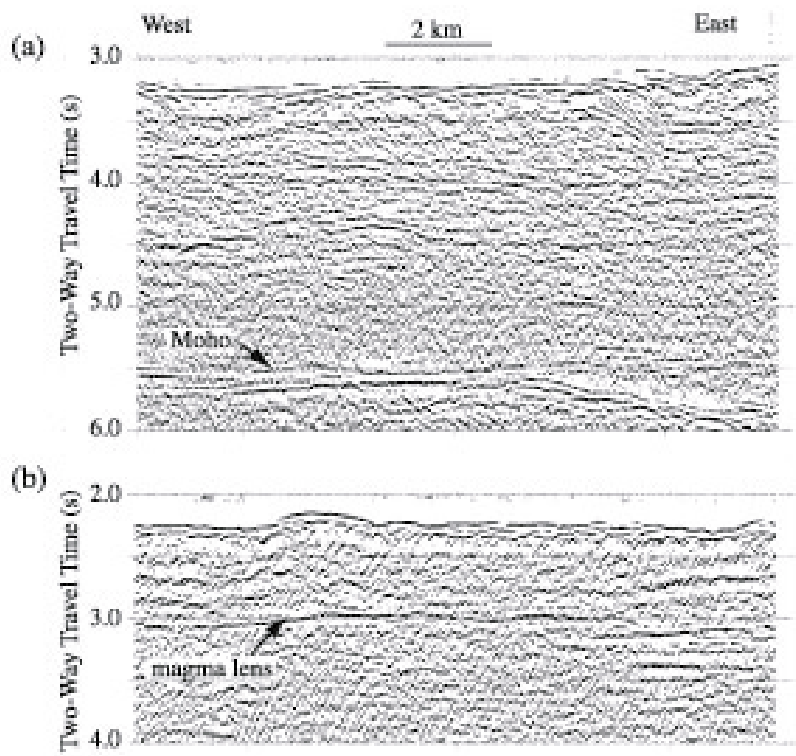

Figure 2(a). Brute stack section of a ridge flank profile, ~25 km north of the shallowest section of ridge axis (91.6-91.7°W). Moho is the flat reflector 2.3-2.4 s below the seafloor. Hyperbolae beneath the Moho reflector are likely side-swipe. **(b)** Along-axis profile (GSC-91.9-92.0°W). Axial magma lens occurs near 0.75 s below the seafloor.

The refraction data clearly reveal crustal (*Pg*) and mantle (*Pn, PmP*) arrivals (Fig. 3). There is clear evidence for an increase in crustal thickness toward the hotspot. For example, in a refraction record from the westernmost experiment (97°W, farthest from the hotspot), the Moho refraction (*Pn*) appears as the first arrival at a shot-receiver offset of ~25 km (Fig. 3a). Whereas at a record from the easternmost experiment (92°W, closest to the hotspot), *Pn* is the first arrival beginning at an offset of ~55 km (Fig. 3b). The greater offset in the later record indicates that the crust is thicker at 92°W than at 97°W. Indeed, travel-time and amplitude modelling of the data estimate crustal thicknesses at 97°, 94°, and 92°W of 5.5, 6.2, and 7.4 km, respectively. The change in thickness between 92° and 94°W is consistent with the difference in two-way travel time of the Moho reflectors recorded by the MCS data. If one assumes isostatic compensation, the ~2 km variation in crustal thickness along the western GSC is likely to contribute no more than half of the observed swell height. The remaining swell topography is most likely supported by anomalously low-density mantle associated with the Galápagos hot spot. This low-density material is likely to arise from both elevated temperature and degree of partial melting near the hotspot. Simple melting models and gravity data will be used to constrain the partitioning between the two possible sources of mantle density, both of which are key to our understanding of upper mantle dynamics and melting beneath the Galápagos plume-ridge system.

In addition, a fourth experiment was conducted to determine crustal

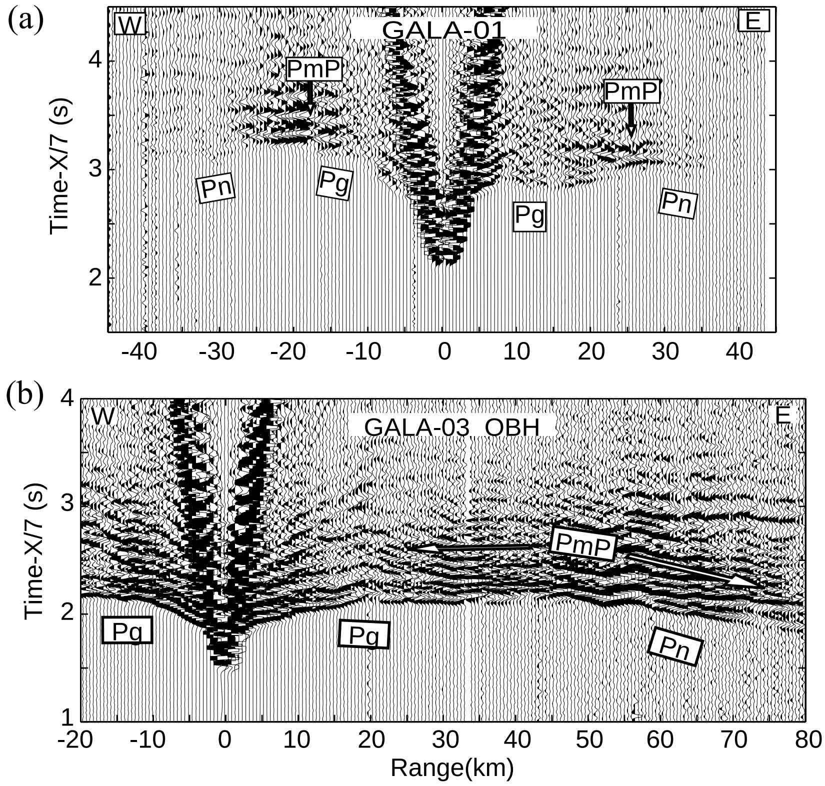

Figure 3(a). Refraction record of an along-axis, E-W shooting line from the westernmost refraction experiment (97°W). Crustal refractions (*Pg*) are first-arrivals at ranges of ~2 to ~25 km and Moho refractions (*Pn*) appear as first arrivals at ranges >25 km. *PmP* are reflections from the Moho. **(b)** Record from an off-axis E-W shooting line from the easternmost refraction experiment (~92°W). *Pn* appears as the first arrival beginning at a greater range of ~55 km.

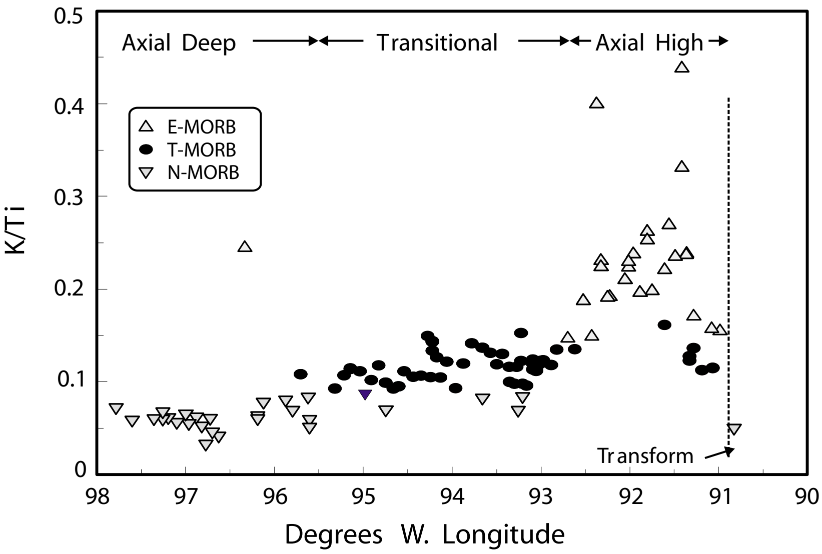

Figure 4. K/Ti from electron microprobe analyses of natural glasses (*Cushman and Sinton*, 2000) versus longitude along the GSC. See text for definitions of E-MORB, T-MORB, and N-MORB. General morphology of the ridge axis, noted at the top of the figure, can be broadly correlated with the chemical variations. The easternmost low K/Ti sample is from the transform zone.

thickness beneath the Galápagos platform. In this experiment we shot to four instruments along a SW-NE trending line that began off of the Galápagos platform, continued on the platform, and ended just east of Santa Cruz Island. Refraction signals were recorded to shot-receiver offsets >200 km which should be more than adequate to place robust constraints on the seismic velocity and thickness of the crust comprising the Galápagos Archipelago.

Rock Sampling Program

The second leg of the G-PRIME expedition was dedicated to the rock sampling programme. We acquired samples from 92 stations between 90°30' and 98°W to yield an average sample spacing of < 9 km. All major ridge segments defined by the bathymetric data were sampled, with several sample sites per segment in nearly all cases. Natural glasses were present in samples at all sites.

Although the principal petrological data will come from shore-based study, the initial dredge sample descriptions allow several preliminary observations to be made. The most common lava morphology recovered over all sections sampled was pillow lava. This result suggests that moderately low-effusion rates dominate this part of the Galápagos Spreading Centre, even along the shallowest axial segments where magma supply presumably is greatest. Samples east of 93°W tend to be nearly aphyric and moderately vesicular, whereas samples further west show greater crystallinity and lower vesicularity. Only lavas that were nearly aphyric were found along the region of the GSC where magma lens reflections were imaged by the shipboard MCS stacks. Correlations between crystal content and seismic magma lens reflectors will be a focus of investigation of the shore-based programmes.

Initial electron microprobe analyses of the glass samples define three compositional types based on K/Ti ratios: E-MORB, with K/Ti ratios >0.15 and K_2O contents

>0.20 wt %; T-MORB, with K/Ti ratios between 0.09 and 0.15; and N-MORB, with K/Ti ratios < 0.09 (Fig. 4). E-MORB rocks dominate the axial high portion of the GSC, T-MORBs dominate the portion of the ridge with transitional morphology, and N-MORBs dominate the axial valley regions. Relative to the other types, E-MORBs have higher K_2O, TiO_2, Al_2O_3, Na_2O, and P_2O_5 contents and lower SiO_2 and FeO* at a given MgO. In addition, E-MORBs have lower analytical totals, suggesting the likely presence of water and/or other volatiles. Although these chemical signatures are consistent with an interpretation that the E-MORBs form from low degrees of melting, preliminary geochemical modeling indicates that even minimal degrees of melting (<1%) of the N-MORB source cannot produce these E-MORBs. Thus, source variations, in addition to variable melting, must be involved in producing the incompatible element enrichment observed closest to the Galápagos hotspot.

Conclusions

The Galápagos hotspot-ridge system provides an ideal setting to address two fundamental problems, one related to the nature of plume-ridge interactions and the origin of hotspot swells, and the second concerning the importance of variations in magma supply on crustal accretion processes. The multi-beam bathymetry, gravity, multi-channel seismic, seismic refraction, petrologic, and geochemical data each reveal separate but closely related aspects of the above problems. With increasing distance from the Galápagos hotspot, axial topography changes from an axial high morphology to an axial valley, crustal thickness decreases by ~2 km, the presence of an axial magma lens is less apparent, and enrichments in incompatible element concentrations decrease. Ongoing analyses are improving constraints and, together with future modeling efforts, are working toward a self-consistent picture for plume-ridge interaction and the associated processes of crustal accretion at the Galápagos Spreading Center.

Acknowledgements

This work is being supported by a collaborative research grant from the RIDGE Program, NSF-OCE. We especially thank the shipboard and scientific crew of the *R/V Maurice Ewing*. With their expertise and dedication essentially all of the survey and data acquisition goals where met. The *Ewing* remains an outstanding vessel for conducting marine seismic work and now rock sampling.

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Editor's Note

The articles appearing in *InterRidge News* are intended to disseminate as quickly as possible preliminary results on recent mid-ocean ridge and back arc ocean cruises. Articles are **not** peer-reviewed and should not be cited as peer reviewed articles. The InterRidge office does edit the articles and strives to correct any grievous errors however all responsibility for scientific accuracy rests with the authors. Comments on articles that have appeared in *InterRidge News* are always welcome.

Agnieszka Adamczewska
InterRidge News Editor

International Ridge-Crest Research: **Hotspot-Ridge Interactions**

Isotope Characteristics of the Mantle Sources of Basalt Magmas on the Canary Archipelago

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Introduction

The Canary Archipelago is located on the western coast of the African continent on the continental uprise of the East African craton, and it is 600 km long. The archipelago is divided into three groups of islands in the south-north direction: the eastern (Lancerote and Fuerteventura), the central (Tenerife, Gran Canaria, La Gomera), and the western (La Palma and Yerro). During the last 5 000 years, all these islands, except La Gomera, experienced intensive volcanic activity. The age of volcanism decreases from 30 - 40 K.y. on the eastern islands to 2 - 4 K.y. on the western islands and reflects the time succession of their formation. The geophysical parameters of the Earth's crust below the islands likewise change in the same direction. According to the data of many researchers (*e.g.* Aranya and Novitskii, 1987; Hoernle and Tilton, 1991; Hoernle *et al.*, 1991) the eastern islands are the closest to the African continent and overlie a 10 km thick sedimentary layer. The structure of the Earth's crust under the central islands is more complicated with inclusions of sedimentary and igneous rocks of the oceanic bottom; these islands also have submarine volcanic intrusions associated with the early volcanism of the Canary Archipelago (Banda *et al*., 1981). The crust under the western islands is typically oceanic. The age of the oceanic crust, according to paleomagnetic data, is estimated at 160 - 180 Ma.

The Source of the volcanic rocks on separate islands is not clear, though the majority of researchers believe that they appeared from one source. The temporal zoning of the archipelago is interpreted by several researchers as the track of a "hot-spot" (Morgan, 1983). Isotope studies of volcanic rocks on the islands of Fuerteventura and Gran Canaria led to the conclusion that the volcanic rocks of the archipelago originated from one source and the source mantle plume was identified by its HIMU composition (Hoernle and Tilton, 1991; Hoernle *et al.*, 1991). The plume interacted with the upper mantle material and also with the continental lithosphere and asthenosphere as a result of reworking and assimilation of the enriched continental mantle (EM) under the West African craton. The early basal volcanic complex of the Fuerteventura Island was melted directly from the plume, thus reflecting a mixture of the plume material and that of the lithospheric mantle (Hoernle and Tilton, 1991; Hoernle *et al.*, 1991). After the Miocene, the plume was located to the west of the island, and the submeridional Miocene-Quaternary magmas had to pass some additional distance along the upper part of the asthenosphere before eruption. This process resulted in greater asthenospheric contamination of these magmas by (DM+EM) material. We have traced a similar regularity for the Gran Canaria volcanics.

The Miocene and Pliocene-Quaternary volcanics form distinct trends on isotope diagrams. The most SiO_2 under-saturated volcanics in every group have a minimal value of radiogenic Sr and a maximal value of radiogenic Pb. Undersaturated Miocene volcanics of Gran Canaria occur in the younger western islands of the archipelago in all correlation diagrams; they also have a high value of $^{238}U/^{204}Pb$, which is close to HIMU. At the same time, the Pliocene-Recent undersaturated volcanics contain less radiogenic Pb owing to the influence of the DM material (the plume moved to the west). The increase of SiO_2 saturation and the degree of differentiation of volcanics is interpreted to be a reflection of assimilation of enriched mantle compenents EM1 and EM2.

In this paper we attempt to systematize the data on isotope research published by different authors with regard to volcanic rocks for all the islands of the Canary Archipelago with the exception of the La Gomera Is. (Hoernle and Tilton, 1991; Hoernle *et al.*, 1991; Ovchinnikova *et al*., 1995). The data examined covers 150 analyses of the isotope compositions of Pb, Sr, Nd in volcanic rocks. The processing of these analyses was conducted both by standard methods (binary diagrams) and with the help of certain original approaches. Thus, based on the Pb isotope composition, the parameter KPb was calculated, which represents the Th/U ratio corresponding to the initial magmatic reservoir. The isotope data systematization was carried out by using the factor method of mathematical analyses, the application of which was first suggested by N.A. Titaeva for isotope data processing.

Results

A standard binary diagram based on the published isotope composition of volcanic rocks of the Canary archipelago is shown in Fig. 1. This diagram also shows the "extreme components", after Zindler and Hart (1986), which are adopted in the chemical geodynamics model. This plot clearly shows that data from volcanics from all the islands of the archipelago, despite different structure, age and petrochemical peculiarities, form a compact field at the centre of the DM-EM-HIMU ternary diagram. At the centre of this same field, there are the so-called "intratetrahedral components" PREMA, F, etc., which are associated, by many researchers, with the material comprising the hotspot plume. On the standard Nd-Sr isotope diagram, the volcanics of the archipelago are also located at the centre of the triangle formed by the "extreme components", a substantial distance from the point of the mean crustal composition. All these indications allow us to join the opinion of those researchers, who suggested that the origin of the volcanic rocks of the Canary Islands is a single source. However, the data from our studies indicate that the plume material has an isotopic composition which is close to the "intratetrahedral" component. It can hardly be conceived that this single source was the HIMU component, because the isotope compositions of the studied rocks on the diagrams are equally far from all points of the "extreme components".

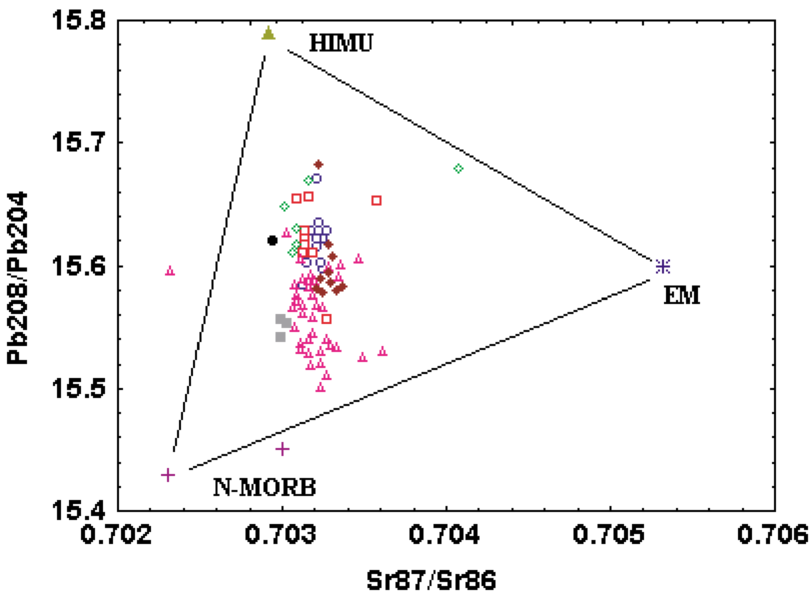

Figure 1. $^{208}Pb/^{204}Pb$ – $^{87}Sr/^{86}Sr$ isotopic relationship in Canary volcanics.

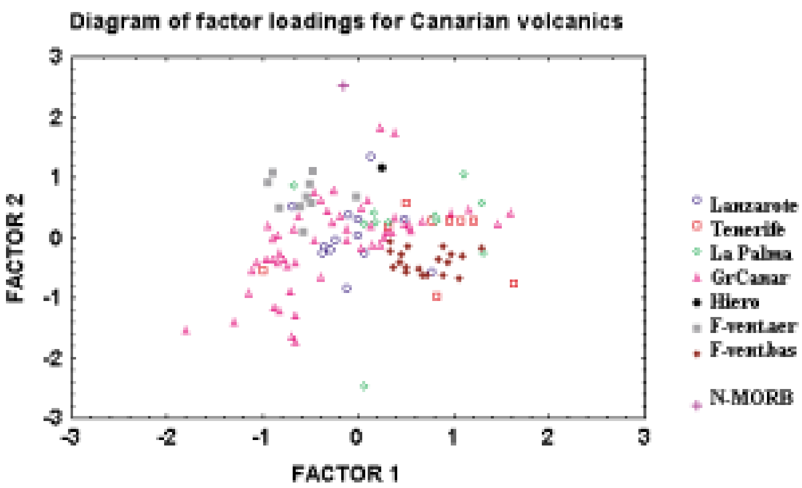

Figure 2. KPb – Age, Ma – relationship for volcanics of Gran-Canaria (1-3) and Fuerteventure (4-6): **1** is < 3 Ma, **2** is 3 - 6 Ma, **3** is 10 - 40 Ma, **4** is <20 Ma, **5** is 20 - 40 Ma, 6 is > 40 Ma.

The application of the KPb variable produces a more differentiated pattern of the distribution of the volcanics. The distribution of this parameter depends on the age of the studied samples (Fig. 2). In accordance with the systematics of the KPb parameter (Titaeva, 1998), its value of 3.95 ± 0.05 corresponds to the value of the primitive mantle (plume?) and to the areas of transition between the mantle and the complementary reservoirs (with respect to the mantle). These complementary reservoirs are simultaneously enriched and depleted in different components. The same value applies to the RPb isotope composition for the "intratetrahedral component" F. The main mass of data on the diagram is located exactly in this area. However, sufficiently clear variations in time are observed; these allow us to trace the main tendencies in the evolution of the compositions of the sources of volcanism on separate islands and the influence on them of individual reservoirs.

The succession of the changes in KPb and in other parameters in the volcanics of the Gran Canaria Is. shows a similar sequence. In the Miocene (12 - 16 Ma), the KPb values for the rocks of both islands were in the same range of values (3.95 - 3.90). The next stage of volcanic activity was marked, as in the Fuerteventura case, by the growth of the influence of the sialic component, as a result of which, in the time interval of 3 - 5 Ma more than a half of the samples had the KPb value in the 4.01 - 4.1 interval. Gradually, as the intensity of volcanic activity attenuated, so did the KPb value, which in the Holocene yet again reached the values typical of the plume. The KPb calculation for the volcanics of another eastern Lancerote Island (15 - 0 Ma), according to the available data (Ovchinnikova *et al.*, 1995), has shown that the main mass of samples are in the region of the enriched reservoir. Only 3 out of 15 samples correspond to the plume, while one sample corresponds

International Ridge-Crest Research: **Hotspot-Ridge Interactions:** Titaeva *et al.* cont...

to N-MORB. The samples from the largest central Tenerife Is. are, on the whole, in the area of the KPb values for the plume. Only three of the samples are located in the "sialic" area of the diagram. All samples, without exception, from the western La Palma and Yerro islands are in the region of the KPb values for the plume or the N-MORB. This distribution of the KPb values leads us to suggest the following scenario for the evolution in time of the source of volcanism in the Canary Archipelago. The Paleogene volcanism was initiated by the intrusion of the plume under the eastern islands, and it started with the effusion of the basal complex of volcanics with the isotope composition of the plume. In the Oligocene, the heating influence of the plume caused the appearance of the intermediate foci in the lithospheric mantle and the change in the isotope composition towards the enriched reservoir. The continuation of this process can be observed on the neighbouring eastern Lancerote Is., where the xenoliths composition represented by the KPb value (4.00) corresponds to the enriched reservoir, whereas the volcanic rocks are a mixture of the plume material and the sialic component. At that period, the plume has already moved to the west, and its influence on the volcanic composition was reduced. By the beginning of the Miocene, the plume was, more likely, located under the central islands (Hoernle and Tilton, 1991).

This started an intensive volcanic activity on the Gran Canaria island and further sustained the volcanism on the Fuerteventura Is. It seems apparent that, unlike the first stage, the oceanic lithosphere was located over the plume and, naturally, a certain contamination of the plume material by the MORB material took place. The next stage of volcanism corresponds to the Pliocene. At that period, the plume again shifted to the west and, apparently, was under the western islands. The effect of the plume on the central islands was reduced. As in the case with the Fuerteventura Is., the foci moved into the crust, and volcanics were to a great extent enriched by the sialic material. The other part of the volcanics still retains the plume composition. That period was the time of the beginning of volcanic activity on the Tenerife, the other central island, where the KPb value also corresponds to the boundary of the plume and the enriched material. It can be supposed that, in the process of formation of the melt, there were no essential assimilation of the sialic material, which is reflected by the slight change in the Sr isotope composition. It is more likely that an extraction of certain elements, such as Pb, occurred from the enclosing rocks, and thereby, changed the KPb value. Another possible source of the material enriched with radiogenic Pb could be the sediments wash-down from the African continent. In fact, the KPb value in sediments, obtained by drilling in the ocean bottom 100 km south of the Gran Canaria (Hoernle and Tilton, 1991) is 4.04 - 4.15, *i.e.* it corresponds to the enriched reservoir. At the same time, the isotope Sr ratio in these sediments (0.7092 - 0.7236) is substantially higher than that of the volcanics from the Canary Islands (0.7029 - 0.7040). The volcanic activity appeared in the Pliocene under the western islands, where the volcanics composition already corresponded to the plume composition contaminated by the material of the impoverished oceanic mantle. This is substantiated by the mantle xenoliths in the basalts of the western island Yerro, which have the value KPb = 0.86 - 0.90,within the N-MORB values.

The binary diagrams do not provide the possibility to synchronously evaluate the influence of all isotope parameters on the composition of volcanic rocks. The factor analysis is free of this drawback and allows simultaneous use of any number of variables. In our example, these variables were: $^{87}Sr/^{86}Sr$, $^{143}Nd/^{144}Nd$, $^{206}Pb/^{204}Pb$, $^{207}Pb/^{204}Pb$, $^{208}Pb/^{204}Pb$, and KPb. According to the correlations obtained, two distinct groups of variables were revealed, which were joined by separate factors. The first factor (F1) included all three isotope Pb relations, while the second factor (F2) contained KPb, the isotope relations of strontium, and the isotope relations of neodymium (with the negative sign). The distribution of the factor loads between the studied samples is shown on the factor diagram in Fig. 3 in the F1-F2 coordinates. On the factor diagram all the points, as on the binary diagrams, cover a compact field in the centre of

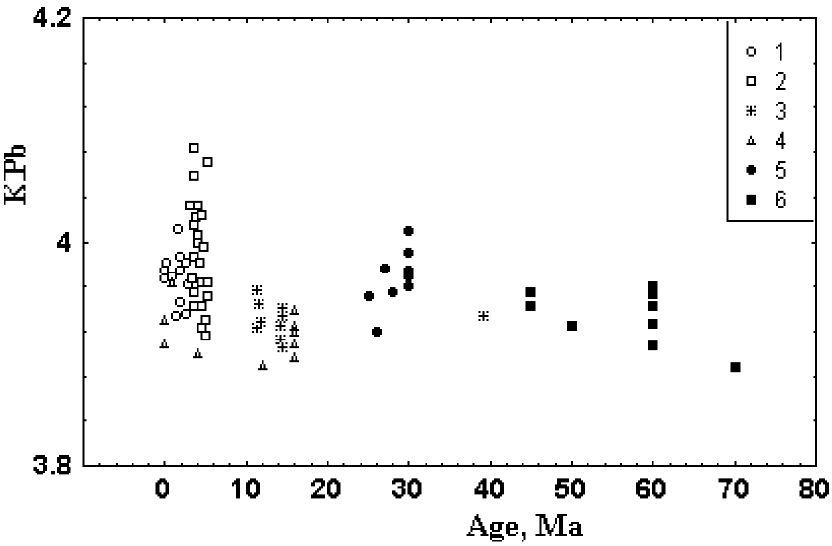

Figure 3. Factor loads for Canary volcanics in factor coordinates F1 ($^{208}Pb/^{204}Pb$, $^{207}Pb/^{204}Pb$, $^{206}Pb/^{204}Pb$), F2 ($^{144}Nd/^{143}Nd$ – $^{87}Sr/^{86}Sr$, KPb).

the triangle formed by the "extreme components", and two tendencies can be observed to simultaneously change in composition, apparently primarily in relation to the homogeneous source of the Canaria volcanics. On the Fuerteventura Is., between the two complexes of volcanics, there is a trend from more ancient to younger basalts, which is parallel with the DM-EM line. More likely, it testifies to the influence of the sialic component brought there with the sediments from the African continent and causing the simultaneous enrichment with radiogenic Sr and radiogenic Pb, and the growth of the Th/U-ratio in the initial source (KPb). The KPb parameter characterizes the ancient Pb and can be associated only with the African sediments. The second trend, which connects the composition of the islands La Palma - Gran Canaria, testifies to the growth of the role of the HIMU component in the east-to-west direction to the Mid-Atlantic Ridge, and which results in the reduction of the KPb parameter and radiogenic Sr with the growth of the share of the radiogenic Nd and Pb.

The analysis outlined above leads us to suggest that the determining factor in the composition of volcanic rocks on the Canary Islands is the plume material, which was somewhat changed over time under the influence of other reservoirs: continental (owing to the assimilation of sediments) and oceanic. These were changed to different degrees as a result of the processes forming the HIMU factor. In this process, the increase of the contribution of the HIMU component occurred simultaneously with the contamination by the N-MORB component.

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Ridge-Hot Spot Interaction Database

A database of references pertaining to the interactions between ridges and hot spots.

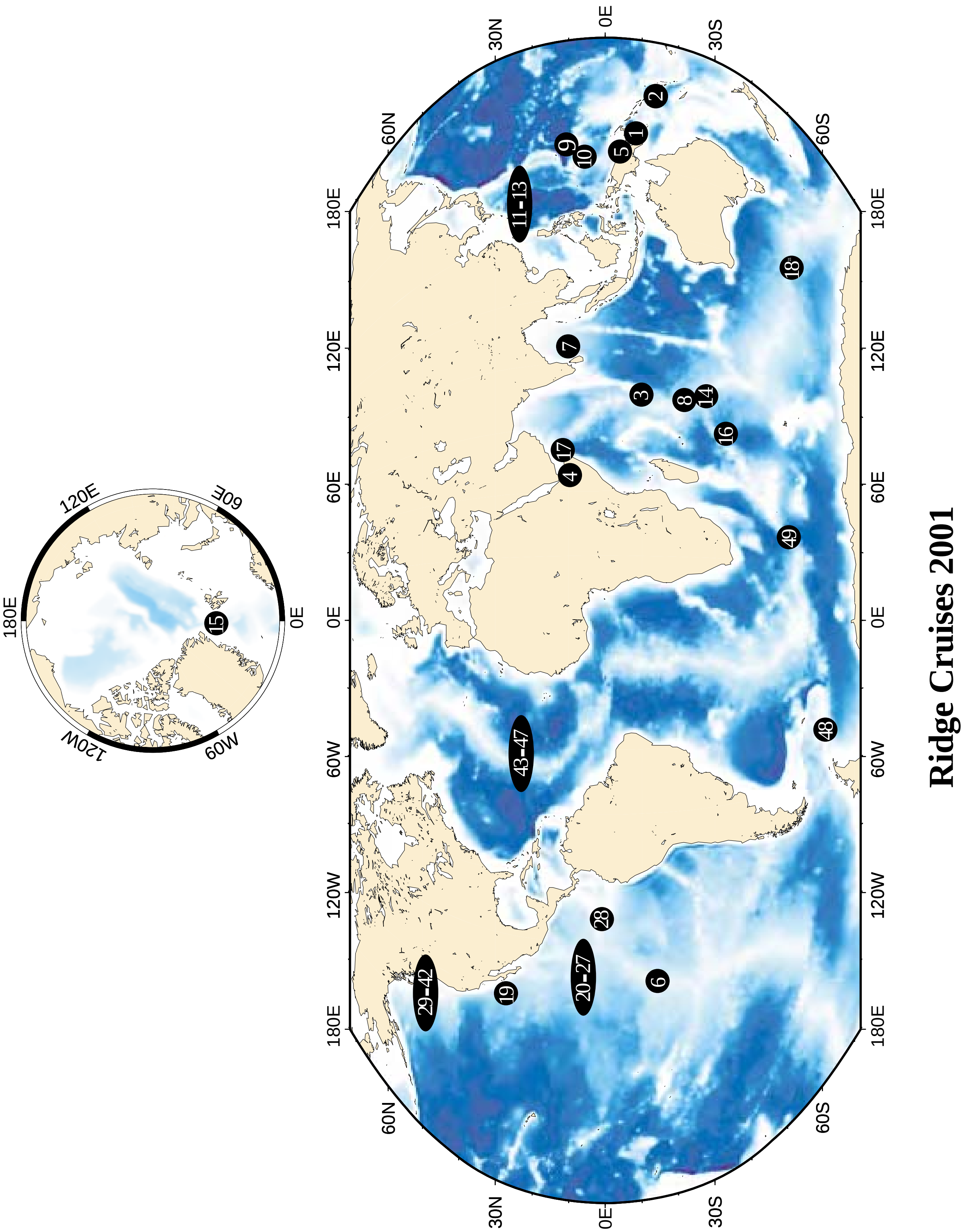
http://www.intridge.org/data4.html

"Hotspot-Ridge Interactions" Working Group

Chair: Jian Lin (WHOI, USA).

A research plan will be formulated by this working group to assist and direct global research to better understand the physical and chemical interactions between mantle plumes and mid-ocean ridges and their effects on seafloor geological, hydrothermal, and biological processes. Watch the working group udates in the next issue of IR news!

World Ridge Cruise Map, 2001



World Ridge Cruise Schedule, 2001, continued...

Map No.	Country	PI	Institution	Cruise ID/Location	Research Objectives	Ship	Dates
1	Australia	Dekker, Binns	CSIRO	Basin, Bismark Sea, Papua New Guinea	Microbe collection for minerals bioprocessing; trials of bottom-tow, instruments for exploration and minearl resource assessment; searching for new hydrothermal sites	Franklin	14 Apr - 4 May '00
2	Australia	McInnes	CSIRO	New Ireland and Solomon and Forearc Basins	Investigation of hydrothermically active submarine arc volcanoes	Franklin	May 5- May24 '00
3	France	Dyment, Hemond	IUEM - UBO	GIMNAUT: Central Indian Ocean	Intercalibration of magnetic and radiometric dating of young basalt, Magnetic structure and properties	L'Atalante, Nautile	27 May - 21 Jun '00
4	France	Leroy, Gente	IUEM - UBO	ENCENS-SHEBA: Gulf of Aden, East Sheba Ridge	Multi-narrow beam mapping and MCS seismics	Marion Dufresne	Jun 3 '00 - Jul 17'00
5	France-Japan	Auzende and Ishibashi	Ifremer - U Kyushu	MANAUT BASIN: Manus Basin(PNG)	Geological study of accretion, magmatism and hydrothewrmal processes in Manus Basin (PNG)	L'Atalante, Nautile	March 25 - Apr 19 '00
6	Germany	Devey, Villinger	U Bremen	EXCOII Leg 1 and 2, EPR at ca. 13 S	Geophysics (mapping, simple seismics and heat flow) and rock, sediment, and pore water sampling on the EXCO corridor from 0-8 Ma	Sonne	Dec. 29 '99 Jan. 27 '00; Jan. 28 - Feb 29' 00
7	India	Raju, Rao	NIO	Andaman Sea	Multibeam mapping, geophysics, sampling CTD	Sagar Kanya	Jan 8 - Feb 11 '01
8	India	Mukhopadhyay	NIO	Central Indian Ridge	Multibeam mapping, geophysics, sampling	Sagar Kanya	May 25 - June 28 '01
9	Japan	Gamo	ORI	Mariana Trough	Search of active hydrothermal area and geological observation of the lower crust outcrops by using ROV Kaiko	Kairei ROV Kaiko	May 6 '00 - Jun 11'00
10	Japan	Fjiwara	JAMSTEC	Mariana Trough 17 deg North	Sea Beam mapping, SCS seismics, magnetics, and gravity measurements	Yokosuka	Dec 6 - Dec 26 '00

World Ridge Cruise Schedule, 2001, continued...

Map No.	Country	PI	Institution	Cruise ID/Location	Research Objectives	Ship	Dates
11	Japan	Kato	JAMSTEC	Southern Okinawa Trough	Seabottom observation and sampling by submersible Shinkai 2000	Natsushima Shinkai 2000	May 10 '00 - May 20 '00
12	Japan	Hashimoto	JAMSTEC	Southern Okinawa Trough	Biological observation and sampling by submersible Shinkai 2000	Natsushima Shinkai 2000	May 21 '00 - Jun 3 '00
13	Japan	Matsumoto	JAMSTEC	Southern Okinawa Trough	Seabottom observation and sampling by submersible Shinkai 6500	Yokosuka Shinkai 6500	Jul 21 '00 - Aug 15 '00
14	Japan	Hashimoto	JAMSTEC	Rodriguez Triple Junction	Biology and geochemistry of hydrothermal areas	Kairei, ROV Kaiko	Aug. 11 - Sep. 3 '00
15	Japan-Russia	Tamaki, Cherkashov	ORI, VNIIO	Knipovich Ridge	Deep-tow mapping, sampling, CTD, OBS	R/V Logachev	Aug 30 - Sep 23
16	Japan	Kikawa	JAMSTEC	SW Indian Ridge	Surveying outcrops of lower oceanic crust	Kairei, ROV Kaiko	5 -29 Sep.
17	Japan	Fujimoto Tamaki	Tohoku U	Gulf of Aden	Seabeam, sampling, CTD, OBM, Geology, geophysics, geochemistry, paleoclimate	R/V Hakuho-maru	4 Dec '00 - 12 Jan '01
18	Japan	Tamaki	ORI	Australia - Antarctic Discordance	OBS/OBM crustal structure, deep-tow magnetics, SeaBeam mapping	Hakuho- maru	Jan-Feb 2002
19	USA	Cary, Luther, Reysenbach	U. Delaware, Rutgers	EXTREME 2000, Guaymas Basin LEXEN	Microbiology centered on diffuse flow chimney environments	Atlantis, Alvin	Jan. 12-23 2000
20	USA	Cochran, Fornari	Lamont-Doherty	9 deg 35'-38'N EPR	Near bottom geophysical data collection on closely spaced E-W lines	Atlantis, Alvin	Jan 27 - Feb. 9 '00

World Ridge Cruise Schedule, 2001, continued...

21	USA	Webb, Evans	SIO, WHOI	9 deg 50'N EPR	Hydrothermal Structure: A Magnetometric Resistivity Survey	Melville	Feb. 17 - Mar. 11 '00
22	USA	Fornari	WHOI	AHA cruise (Autonomous Hydrophone Array), East Pacific Rise, 20 deg N-26 deg S	Near-bottom investigations using Seabeam, DSL-120 sonar, Argo-II, dredging, rock coring, and CTDs over 4 -5 areas suspected of having recent volcanic eruptions.	Melville	Mar 24 - May 10 '00
23	USA	Lutz	Rutgers	EPR	Photography and video documentation of biological and geological temporal changes	Atlantis, Alvin	April 9-27, 2000
24	USA	Manahan, Cary, Felbeck	USC, Delaware, SIO	9 deg N EPR	Dispersal mechanisms and reproductive strategies of vent crabs	Atlantis, Alvin	May 2 -28 2000
25	USA	Cary	W&M	EPR		Atlantis, Alvin	Oct. 06 - Oct. 22 ' 2001
26	USA	Shouten	WHOI	EPR		Atlantis, Alvin, ABE	Oct. 28 - Nov. 25 2001
27	USA	Childress, Van	UCSB, W&M	EPR		Atlantis, Alvin	Nov. 30 - Dec. 21 2001
28	USA	Sinton, Detrick	U. Hawai, WHOI	Galapagos	OBS refraction profiling, multi-channel seismics and petrological dredging	Ewing	April 2- May 21, '00
29	USA	Delaney	UW	Juan de Fuca	Thermal, compositional, microbiological variability in tidally hydrothermal systems	Atlantis, Alvin, JASON	Jun. 10 - Jul. 11 '00

World Ridge Cruise Schedule, 2001, continued...

Map No.	Country	PI	Institution	Cruise ID/Location	Research Objectives	Ship	Dates
30	USA	Trehu	OSU	Juan de Fuca	MCS and OBS	Thompson, JASON	Jun 19 - Jul 03 '00
31	USA	Embley	NOAA	Juan de Fuca	Hydrothermal vent studies on the seafloor with a remote operated vehicle	Ronald H Brown, Ropos	Jun 29 - July 18 '00
32	USA	Plumley, Van Dover,	U. Alaska, W&M, WHOI	Juan de Fuca	Search for photosynthetic bacteria at vents	Atlantis, Alvin	Jul 16 - 28 2000
33	USA	Stakes, Jannasch	MBARI	Juan de Fuca		Western Flyer, ROV, Tiburon	July 20 - 31 '00
34	USA	Rona	Rutgers	Juan de Fuca	Acoustic imaging of hydrothermal flow regimes with in-situ flux measurements	Thompson, JASON	Jul 21 - 31 2000
35	USA	Spiess	SIO	Juan de Fuca	Geodesy	Revell	Jul 25 - Aug 11 '00
36	USA	Carson, Becker	Lehigh, SIO	Juan de Fuca	Instrument recovery, water sampling	Atlantis, Alvin	Aug. 03-15 2000
37	USA	McDuff	UW	Juan de Fuca	Heat Flux	Thompson, ABE	Aug 03-21 2000
38	USA	Fisher	UCSC	Juan de Fuca	SCS & Heat Flow	Thompson, JASON	Aug. 24 - Sep. 23 '00
39	USA	Delaney	UW	Juan de Fuca	Thermal, compositional, microbiological variability in tidally hydrothermal systems	Atlantis, Alvin, JASON	Sep. 2 - Sep. 19 '00

World Ridge Cruise Schedule, 2001, continued...

40	USA	Johnson	UW	Juan de Fuca	Thermal Budget	Thompson	Sep 27 - Oct 08 '00
41	USA	Levin	SIO, NOAA	Juan de Fuca, Methane Seep		Thompson, JASON	Oct. 9 - Oct. 19 '00
42	USA	Johnson	UW	Juan de Fuca	Hydrothermal system	Thompson	Jun 17 - Jul 03 2001
43	USA	Smith	WHOI	Mid-Atlantic Ridge	Recover North Atlantic Hydrophone Acoustic Array	Knorr	Feb. 23- Mar. 20 '00
44	USA	Blackman	SIO	Mid-Atlantic Ridge - 30 deg N	Submersible, sonar & video mapping, deep-tow gravity profiles and oriented samples	Atlantis, Alvin, ArgoII, DSL	Nov 10- Dec. 15 '00
45	USA	Van,Becker, Vrijenhoek	W&M, U Miami, MBARI	MAR		Atlantis, Alvin	Jun. 26 - Jul. 23 01
46	USA	Smith	WHOI	MAR	Mooring recovery	Atlantis	Mar. 18 - Apr. 10 2001
47	USA	Lutz	Rutgers	MAR		Atlantis, Alvin	Jul. 28 - Aug. 21 2001
48	USA	Christeson, Dalziel, Nakamura	UTIG	Bransfield Strait, Antarctica	Ocean Bottom Seismograph refraction profiling for crustal structure in Bransfield Strait, West Antarctica	N.B. Palmer	April '00
49	USA	Dick, Lin	WHOI	Western part of the South West Indian Ridge	Rock dredging and geophysical survey of an oblique section and adjacent segments of the SWIR	Knorr	Dec. 8 '00 - Jan. 21 2001

National News....

New Zealand

RIDGE science projects, but more specifically back-arc basin research, has continued apace since the last New Zealand national update. The Kermadec – Havre arc – back-arc system (and its contiguous extensions north and south), remains the prime focus of studies to understand: (1) the nature, distribution, chemical signatures, and driving controls of hydrothermalism associated with arc magmatism, and (2) the processes of arc rifting and the spatial / temporal evolution to full back-arc spreading, and possible influence to arc – back-arc processes of anomalous terrain collision at the subduction margin.

Since the first discovery of seafloor sulfide mineralisation in 1996, studies of hydrothermalism along the southern Kermadec arc have involved both site specific camera-tow and rock dredge investigations (Stoffers *et al*., 1999a), as well as water-column plume mapping along the arc front, south of 34°50'S, during the NZAPLUME cruise (de Ronde *et al*., 1999). The latter has provided the first systematic survey of hydrothermal venting along a modern active arc front, demonstrating that such sites have a highly variable fluid chemistry and are potentially a significant source of chemical and particulate flux to the ocean. At least 7 of the 13 (55%) surveyed arc volcanoes revealed evidence of a mix of liquid-plus gas-rich, and liquid-poor but gas-rich plumes, and significant changes in Fe/Mn plume ratios even from the same volcano. The first-order factors that determine the distribution and intensity of hydrothermal venting at the arc front are now being developed. Similar plume mapping surveys by GNS – NOAA/PMEL groups have recently been completed along sectors of the Bismark and Solomon arcs and the eastern end of the Woodlark Basin spreading center with Australian colleagues. Results from towed-camera and rock dredging of sulfides from the Brothers caldera (the most vigorous venting site of the southern Kermadec arc) are currently in preparation for publication. Taxonomic description of vent-related barnacles from the Brothers hydrothermal site have been recently published (Buckeridge, 2000). Research cruise proposals are being developed (in collaboration with international partners) for further detailed towed-camera studies, geochemical surveys, and plume mapping of the central Kermadec and Tonga arc fronts north of 34°50'S, and potentially submersible dive observations and sampling of known venting sites. An Australian company has applied for a mining exploration licence for the southern Kermadec arc region, though it has yet to be granted.

Since moving to New Zealand, G. Massoth (GNS) was appointed to the membership of the Inter Ridge Global Distribution of Hydrothermal Activity working group.

Studies of rifting processes and arc volcanism have been based on collaborative cruises with Germany, and the Japanese-French New STARMER programme along the southernmost Lau Basin and Havre Trough – Kermadec arc. Modern multi-beam data now exist for longitudinal sectors of the back-arc system centred at 23°50'S, 24°50'S, 26°S, 30°10'S, and 35°10'S in addition to previous swath data acquired from the Valu Fa Ridge (Lau Basin) and southernmost Havre Trough prior to 1996. OBS and multi-channel seismic reflection data have also been acquired for specific sectors of the system (*e.g.*, Matsumoto *et al*., 1997; Nishizawa *et al*., 1999; Stoffers *et al*., 1999b). The new geophysical data confirm that significant changes in back-arc structure occur at 24°S and 32°S. Between 24°S and 32°S the back-arc, with water-depths typically 1500-2500 m, comprises a western sediment-filled sub-basin adjacent to the remnant arc and an eastern basement high, mostly devoid of sediment cover. Recent rifting and emplacement of volcanic massifs is mostly confined to the east as a variably oblique basement fabric with left-stepping rift segments. South of 32°S the basin deepens to between 2500 and 3800 m water-depth and comprises a series of narrow rift basins (with minimal sediment-fill) and intervening volcanic edifices distributed over the full width of the back-arc. Results from these studies are currently in preparation for publication. Geochemical studies of frontal arc volcanoes are progressing to establish the fundamental longitudinal variations in crustal setting, subduction kinematics, and magma source heterogeneity, which control arc - back-arc magmatism. Part of the latter includes understanding the possible transitory nature of silicic arc volcanism and role of volatile content to eruption style (*e.g*., Wright and Gamble, 1999). Proposals are being currently developed for further research cruises to the region.

Recent results of these tectonic, magmatic, and hydrothermal venting studies were presented within two joint Tectonophysics / Volcanology, Geochemistry, & Petrology sessions of the 1999 AGU Fall Meeting.

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National News....

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Germany:DeRidge

DeRidge received a new lease of life through a two-day congress held in Bremen in July at which over 60 ridge researchers presented their latest results in ridge studies. Topics covered included geophysics, hydrothermalism, biological studies, petrology and volcanology. Particularly notable was the strong geoscience/life sciences connection, with several joint projects presently running. This is certainly one of the key strengths of DeRidge. The congress ended with a presentation from the InterRidge coordinator on the work of InterRidge and a lively debate on the future of DeRidge and the continuing involvement of Germany in InterRidge. Of particular relevance to the InterRidge community is that for 2000 the German InterRidge full-membership contribution is not funded. To at least alleviate the 2000 InterRidge membership problem, a small “fund-raiser” was held and members of various institutions pledged funds from their institute budgets to at least assure a corresponding membership for Germany for 2000. The interest in ridge research in Germany is such that it was unanimously decided to attempt to get DeRidge placed on a more solid footing than the current ad hoc grouping of interested researchers. To this end a steering committee was established with the following structure:

Leader: Colin Devey (U. Bremen)

Representatives:

Magma and mantle dynamics: K.M. Haase (U. Kiel), J. Phipps, Morgan (Geomar, Kiel), J. Snow (Max-Planck, Mainz)

Hydrothermalism: P. Halbach (U. Berlin), P. Herzig (U. Freiberg), H. Villinger (U. Bremen)

Biological communities: C. Borowski (U. Hamburg), L.A. Beck (U. Marburg)

Tectonics: T. Reston (Geomar), I. Grevemeyer (U. Bremen)

Contact was established with the national grant-giving agencies and the DeRidge/InterRidge programme will be presented to the National Commission for the Earth Sciences on 2 Nov. 2000 in Bonn. A positive recommendation from this commission is important if we are to get DeRidge and InterRidge funded on a national level.

To conclude, the research basis for DeRidge is alive and well. We are making every effort to get this grass roots movement officially recognised.

C. Devey, Leader DeRidge

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National News....

France: Dorsales

1) Budget

For the year 2000 the project has an operational budget of 800 kF (100 000 $US). This limited budget is used to fund workshops and a few scientific proposals. In 2000, the call for proposals targeted:
- biogeochemical interactions
- physical and chemical mantle heterogenities.

2) Workshops

Biogeochemical Interactions

A Biogeochemistry workshop was held at Roscoff, January 2000 (organiser P.M. Sarradin) to discuss possible experiments - the main focus was biomineralisation and the origin of life (through the formation of prebiotic molecules). A few proposals suggested as a result of the workshop will be funded.

Ridge/hotspot interaction

A workshop on Ridge/hotspot interaction will be held in Paris in January 2001. The resulting synthesis of ideas, in the form of research proposals, will be submitted for funding by the 2001 budget. synthesise

Biological specimen preservation

F. Lallier will organize a small workshop to collect and summarise basic methods used for specimen preservation of hydrothermal organisms. The aim of the workshop is to produce a technical manual that can be available on all cruises and it will help to standardise the protocols for preserving biosamples.

The report could be written in English and distributed through InterRidge

3) Research Vessels/equipment

IPOCAMP

The year before last Dorsales funded the building of a pressure container. The IPOCAMP pressure container is equipped with a video system and was successfully used on the Atalante in 1999. Similar containers are now being built through the EC program. The next step will be to build a system that allows collection of samples and maintains the *in-situ* pressure from the seafloor while the container is brought on board.

Vessels

A major problem for the French community is the lack of a suitable vessel to operate the submersibles : Nautile (manned) and ROV Victor (unmanned). The Nadir will stop operating in the near future and the Atalante can support the Nautile but the not Victor which requires a dynamic positioning. There is a strong possibility that a new research vessel will be build to replace the Nadir specifically to support submersibles. This would release the pressure on Atalante and leave time for other types of cruises.

The R/V Marion Dufresne will be available 100 additional days per year for scientific cruises. As a result a total of 230 days per year will be open for science on a ship equipped with a multibeam system.

OBS

The academic French community presently does not have access to OBSs to work on mid-ocean ridges. A proposal to purchase 25 OBS units as a national facility in France has been submitted to CNRS.

4) Journées Dorsales 2000

The Dorsales Committee organized a workshop on ridges, in Roscoff, 20-22/9/2000.

One hundred and twenty attended the meeting and 80 oral communications and posters were presented. This meeting was a big success and showed the vitality of the French ridge community.

Dorsales is in the 3rd year of its 4 year funding scheme. At the Roscoff meeting, discussions about the future of the Dorsales program were initiated. A workshop to discuss future objectives will be organized in 2001.

5) "Dorsales" Cruises

2000

ALAUFI (PI: B. Pelletier and Y. Lagabrielle). Mapping of the North Fidji fracture zone - discovery of active Futuna ridge

MANAUT (PI: J.M. Auzende). Nautile dives in the Manus basin hydrothermal fields. *The biology leg was cancelled (due to lack of work authorizations by PNG)*

GIMNAUT (PI: J. Dyment). Nautile dives on the CIR. Intercalibration of magnetic and radiogenic dating

ENCENS-SHEBA (PI: S. Leroy). Mapping of the East Sheba Ridge and the gulf of Aden.

***2001** - Scheduled cruises*

SWIFT (PI: E. Humler). Mapping and sampling the SWIR 35° - 49°E. Feb-Mar 2001, Marion Dufresne

IRIS (PI: Y. Fouquet). ROV Victor dives on Rainbow hydrothermal field - joined cruise investigating biology and geosciences.

ATOS (PI: P.M. Sarradin). ROV Victor dives - biogeochemical interactions. Partly EC funded cruise to the MAR, Lucky strike and Rainbow

Well evaluated, but not yet scheduled

TOM-SWIR (PI: D. Sauter). Seismic tomography beneath the Jourdannes mountains segment (E SWIR - joint with Japan and Germany)

PACANTACTIC II (PI : L. Dosso and H. Ondréas).

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National News....

Korea

Two ridge-related surveys occurred in Korea this year. In May and June 2000, Korea Ocean Research and Development Institute (KORDI) performed a multidisciplinary survey of the Ayu Trough and Woodlark Basin using R/V Onnuri. The Ayu Trough survey is part of a three-year programme by KORDI beginning this year to study the Philippine Sea (PI: Sang-Mook Lee). The Woodlark Basin survey was conducted as part of a three-year hydrothermal programme (PI: Kyeong-Yong Lee). The first phase of the hydrothermal program will end this year. Previous survey areas of the hydrothermal program include the Yap Trench in 1998 and the eastern Manus Basin in 1999.

1) Ayu Trough

The Ayu Trough, located in the south Philippine Sea, is the spreading boundary between the Philippine Sea Plate and Caroline Plate. It is unique in that it is the only place along the boundary of the Philippine Sea Plate that is not a subduction zone and thus thought to hold important information about the motion of the Philippine Sea Plate. Caroline Plate is a small plate located between the Indo-Australian and the Pacific Plates, considered to be rotating in an anti-clockwise direction. The primary objective of the survey was to document the tectonic fabric of seafloor and, if possible, to constrain the recent spreading history of the Ayu Trough. During 6 days of the survey, we conducted multibeam bathymetry, gravity and magnetic measurements between 1°50'N and 3°30'N. The track lines extended as far as 300 km from the spreading axis. Magnetic field was measured using proton precession magnetometer and shipboard three component magnetometer. In the year 2001, we intend to extend the survey further south.

2) Woodlark Basin

The Woodlark basin, located in the Solomon Sea, is one of the well-mapped back-arc basins in the southwest Pacific. It is considered as an excellent place to explore the evolution of extensional basin, from continental rifting to spreading of the seafloor [Taylor *et al*., 1999]. The spreading in the basin is accommodated by 5 smaller segments, which were synchronously reoriented at 80 ka [Goodliffe *et al*., 1997]. An interesting feature of the basin is the contrast between the eastern and western part [Martinez *et al*., 1999]. Although the eastern part is spreading at a faster rate, it is the western part that shows the characteristics of a fast spreading mid-ocean ridge (*e.g*., gravity and magnetic anomalies and axial depth). To date, most of the effort has been concentrated on documenting the geophysical aspects of the Woodlark Basin. There are only a handful of rock samples from the region and little is known about the hydrothermal activity. To better understand the relationship between tectonic processes and rock chemistry, the survey focused on collecting rock samples. CTD castings were made across the spreading centre to look for hydrothermal activity. Unfortunately, due to very rough sea condition, we were only able to finish half of the intended work and the survey was cut short. Most of our samples came from the eastern Woodlark Basin. We also collected new bathymetric data in the previously unsurveyed northern part of the axis. With the exception of one sample, which was aphyic, most of the rock samples that we recovered from eastern Woodlark Basin consist of non-vesicular and phyric pillow basaltic andesite and andesite.

3) Future Research

Korea is expecting to join InterRidge as an associate member early next year. A new multi-year hydrothermal program, the second phase, is expected to begin next year at KORDI. It will become the centerpiece of Korea's involvement in the ridge-related work. At present KORDI plans to complete the survey of the Ayu Trough in 2001 and explore the northern East Pacific Rise in 2002. Marine biologists will play a greater role under this new program.

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National News...

Russia-Ridge

In November 1999 a Workshop of R-Ridge was held in Moscow at the Vernadsky Institute of the Russian Academy of Sciences. The organising Committee of the Workshop proposed to prepare a special issue of the *Russian Journal of Earth Sciences* devoted to contributions from Russian scientists on their research of the Mid-Atlantic Ridge.

The special volume will be published during fall, 2000. An electronic version (also expected to appear in English in the near future) of the journal can be found at: http://eos.wdcb.rssi.ru/tjes/

The titles of contributions made to the special *Russian Journal of Earth Sciences* volume are given bellow: The abstracts are posted on the InterRidge website, at http://www.intridge.org/rus.htm or an electronic version can be obtained from the InterRidge office on request.

The comparison of basaltic magmatism under different spreading rate conditions: the example of Mid-Atlantic ridge (MAR) and East Pacific rise (EPR).
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Evolution of the mantle substratum bellow MAR, 14°-16°N and 33°40'N: The temporal and geochemical constraints from the data on Sm-Nd system
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Age of magmatic and metamorphic events in MAR: An interpretation of data of K-Ar dating
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Magmatism of the spreading centers from North Atlantic – an example of Mona and Knipovich Ridges
N.M. Sushevskaya[1], G.A. Cherkashev[2], T.I. Tsekhonya[1], Yu. A. Bogdanov[3], B.V. Belyatsky[4], N.N. Kononkova[1]
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Geodynamics and magnetism of basalts of Knipovich Ridge (Norway-Greenland Basin)
V.V.Verba, G.P.Avetisov, L.E.Sholpo, T.V.Stepanova
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The formation of avaruite-bearing mineral assamblage in peridotites from 15°20' FZ (Atlantic Ocean) as one of manifestation of the oceanic metamorphism
B.A.Bazylev, Vernadsky Institute, Russian Acad. of Sci., Moscow.

Comparison of the crustal accretion peculiarities in conditions of slow and ultra-slow spreading.
E.G. Astafurova, N.I.Gurevich, E.D.Daniel, S.P.Maschenkov.
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Isotopes of sulphur and carbon in the active hydrothermal fields of Mid-Atlantic Ridge.
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The hydrothermal ore deposits from Logachev and Rainbow fields (Mid-Atlantic Ridge) – New type of hydrothermal deposits of the oceanic rifts
Yu. Bogdanov[1], N.S.Bortnikov[2], E.G.Gurvich[1], A.Yu.Lein[1], A.Sagalevich[1], I.V.Vikentyev[2], G.V.Novikov[1], V.I.Peresypkin[1]
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Reconstruction of ocean ore formation areas in geologic past
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The numerical modeling of the termal - mechanical processes in rift zones of the MOR
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National News ...

InterRidge - Japan

1. Knipovich-2000 cruise was completed

A Japanese-Russian joint research cruise (Kinpovich-2000 Cruise) was conducted to the Knipovich Ridge, a poorly known, ultraslow-spreading system in the Arctic Atlantic Ocean from August 30, 2000 (Bergen, Norway) to September 23 (Bergen, Norway). *R/V Logachev* of Polar Marine Geosurvey Expedition, St. Petersburg was used for the Knipovich-2000 Cruise. Thirty seven scientists participated in the cruise, from Japan, Russia, UK, USA, Norway, Vietnam, China, Taiwan, and Korea. Kensaku Tamaki (Ocean Research Institute, University of Tokyo) and Georgy Cherkashov (Institute for Geology and Mineral Resources of the Ocean (VNIIOkeangeologia), St.-Petersburg,) were co-chief scientists of the cruise. The multi-country scientist party consisted of tectonists, petrologists, biologists, sedimentologists, water-chemists, and geophysicists. The homepage of the Knipovich-2000 cruise is at http://www2.ori.u-tokyo.ac.jp/~asada/k2k/.

For the first 6 days, the ORE sidescan sonar system (30 kHz) with multiple attachments, including an LSS (Light Scattering System - from UK), CTD, Japanese proton magnetometer, and a Japanese pH meter was towed along the axis of the Knipovich Ridge from the southern end toward the northern end with a swath width of 2.5 km. The along axis deep-tow covered 60% along-axis of the Knipovich Ridge. The ORE deeptow sonar images confirmed intensive volcanic activity at most of the topographic highs in the center of the rift. Specifically four large seamounts in the rift valley of the Knipovich Ridge all appeared as active volcanoes with abundant fresh lava flows and pillow mounds. They are identified as the centres of four fundamental segments of the Knipovich Ridge. The scale of each segment was about 100 km. Smaller order segmentation with a length of about 20 km was also identified. Based on the onboard analyses of sidescan data, sites were chosen to conduct10 vertical CTDs, bottom observation, including 4 TV Grab samples, 5 dredge rock samples, 3 sediment core samples and 6 heatflow measurements. Preliminarily, it can be suggested that hydrothermal sites related to basalt magmatism (as at TAG, Snake Pit, etc.) can be expected in the northern part of the ridge, where there is more volcanic activity, whereas in the southern part, the hydrothermal activity related to ultramafic rocks is more likely. Eight Japanese OBSs were deployed at the largest volcanic segment at 76.5° N to observe seismic activity and 7 of them were recovered by *R/V Haakon Mosby* of Norway in Ocotober 2000. The detailed report of the cruise will appear in the 2001 Spring issue of InterRidge News and the initial results will be presented at the EUG meeting in April 2001. Based on the big success of the Kinipovich-2000 cruise InterRidge Japan plans to continue cooperation with the Russian group in the Atlantic in the coming years.

2. New managing system for Japanese submersibles

JAMSTEC (Japan Marine Science and Technology Center) made a drastic change in the management system of their submersibles Shinkai 2000 and Shinkai 6500, ROV Kaiko and the research ship *R/V Kairei* (see http://www.jamstec.go.jp/jamstec-e/ships.html for the system configuration). Previously the cruise plan was made through the ministry, based on a planning system sub-divided into four different ministries. Scientists submitted their proposals to the ministry to which their institute belonged. Each ministry owned their share of dives that had been fixed for many years. The previous system not only made it difficult to make a project proposal with a large number of dives (over 15) but also would not allow an opportunity for cooperation among institutions. Instead the system only allowed for many fragmented diving cruises, except for JAMSTEC-oriented programmes. Now JAMSTEC has setup a single proposal submission system by canceling the ministry based multi-submission system. They also constructed two committees for evaluation and planning, based on the ODP proposal committee system. One is the Science Planning Committee (supposed ODP Science Committee) that evaluates and ranks the proposals. The other is the Planning and Coordination Subcommittee (supposed ODP Operation Committee) that makes a whole cruise plan with the maximum logistics based on the ranked proposals. The evaluation system is based on a peer review system. Most of the committee members are scientists outside of JAMSTEC. The first deadline for proposal submissions for FY2001 was the end of October 2000. JAMSTEC are currently working on devising a FY2001 cruise plan for 65 Shinkai 2000 dives, 60 Shinkai 6500 dives, 50-60 Kaiko ROV dives and two Kairei research cruises. As the participation of foreign researchers is encouraged through the cooperation with Japanese PIs, we hope this new system will enhance the role that InterRidge can play in international research collaborations.

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Upcoming Meetings and Workshops

Calendar of MOR Research related events (2000-2001)

More details about all of the following meetings can be found via the Meetings menu on the InterRidge homepage:

http://triton.ori.u-tokyo.ac.jp/~intridge/info3.html

27 - 30 March, 2000	**Oceanology International 2000 Penrose Conference: Volcanic rifted margin.** Royal Holloway University of London, Egham Surrey, UK
17 - 20 April, 2000	**Geoscience 2000.** University of Manchester, UK
30 May - 3 June, 2000	**AGU 2000 Spring Meeting.** Washington, DC, USA.
16 - 19 April, 2000	**European Geophysical Society, XXV General Assembly.** Nice, France.
23 - 26 May, 2000	**UT '00: Underwater Technology 2000.** Tokyo, Japan.
5 - 9 June, 2000	**ASLO-2000.** Copenhagen, Denmark.
2 - 3 June 2000	**InterRidge Steering Committee Meeting.** Woods Hole, MA, USA
26 - 28 June, 2000	**RIDGE Plume-Ridge Interaction Workshop.** Troutdale, Oregon, USA.
27 - 30 June, 2000	**RIDGE Plume-Ridge Interaction Workshop Troutdale**. Oregon, USA
1 July, 2000	**Ocean Drilling Workshop**. JAMSTEC Yokosuka City, Japan
18 - 22 July, 2000	**IAVCEI.** Bali, Indonesia.
28 July - 1 August, 2000	**RIDGE Theoretical Institute: Subsurface Biosphere.** Big Sky, Montana, USA.
28 August - 2 Sept. 2000	**The XVIII th (New) International Congress of Zoology.** Athens, Greece.
6 - 17 August 2000	**31st International Geological Congress.** Rio de Janeiro, Brazil.
3 - 8 September, 2000	**Goldschmidt Conference.** Oxford, UK.
20 - 22 September, 2000	**Journees DORSALE 2000.** Paris, France.
28 - 30 September, 2000	**IR workshop on Management of Hydrothermal Vent Ecosystems** Sidney, British Columbia, Canada.
15 -19 December 2000	**AGU 2000 Fall Meeting.** San Francisco, CA, USA.
12 - 16 January 2001	**International Conference on the Geology of Oman** Muscat, Sultanate of Oman.
26 - 30 March 2001	**26th General Assembly of the EGS.** Nice, France.
8 - 12 April 2001	**EUG (European Union of Geosciences) XI meeting**, Strasbourg, France
1 - 2 June 2001	**InterRidge Steering Committee Meeting.** Kobe, Japan.
10 - 15 June, 2001	**10th Water-Rock Interaction Symposium.** Sardinia, Italy.
18 - 24 August, 2001	**Second International Conference of Comparative Physiology & Biochemistry in Africa**. Chobe National Park, Botswana.
Fall 2001	**MORMAR** Workshop
8 - 13 October, 2001	**2nd International Symposium on Deep-Sea Hydrothermal Vent Biology.** Brest, France.
September, 2002	**InterRidge Theoretical Institute (IRTI) Thermal Regime of Ocean Ridges and Dynamics of Hydrothermal Circulation.** Italy.

Upcoming Meetings and Workshops

International Conference on the Geology of Oman

Sultan Qaboos University, Muscat, Sultanate of Oman

January 12-16, 2001

http://www.geoconfoman.unibe.ch/

Convenors: Prof. Dr. Tjerk Peters, Bern University, Switzerland, (lina@mpi.unibe.ch)
Dr. Hilal bin Mohammed Al-Azry, Deputy Director General of Minerals, MCI

This conference highlights the last 10 years of geologic research in one of the most fascinating and well exposed outcrop areas of the world. Besides the ophiolites, this conference provides an excellent opportunity to discuss the Southern Tethys, Pangea, the hydrocarbons of the Arabian continent, and the hydrogeology of arid regions. Field excursions will provide insight into the unique geologic features. Some of the field trips will be offered twice, i.e. before and after the conference.

European Geophysical Society (EGS) XXVI General Assembly Meeting

26-30 March 2001, Nice, France

http://www.copernicus.org/EGS/egsga/nice01/nice01.htm

SE9.03. Marine geophysics. Mantle Exposures at Mid-Ocean Ridges: Geophysical Signatures, Mechanisms of Emplacement, and Associated Hydrothermal Plumes and Deposits

Convenor: Gracia, E. (egracia@ija.csic.es)
Co-Convenors: Charlou, J.L., Fouquet, Y.
SessionInformation:http://dg.ija.csic.es/Egs01/egs.html

SE9.04 Marine geophysics: Interaction between hot-spots and mid-ocean ridges

Co-convenors: Javier Escartín (escartin@ccr.jussieu.fr),
Sara Bazin (egracia@ija.csic.es), Wayne Crawford (egracia@ija.csic.es)
Session Information:http://www.ipgp.jussieu.fr/depts/lgm/EGS2001.html

Upcoming Meetings and Workshops

American Geophysical Union Fall Meeting

15-19 December 2000, San Francisco, CA, USA

http://www.agu.org/meetings/fm00top.html

Microbial Processes: Microbial-Mineral Interactions in Deep Subsurface Environments (B11E, B71B)
Microbial Processes: Constraints on Microbial Survival in Geological Environments II (B72D)
Geology and Geophysics of the Mediterranean, Red, and Black Seas Plate Boundries I Posters (T12C, T21E)
Mid-Ocean Ridge Processes Posters (T51D)
Dynamics of Oceanic Plates Posters (T52C)
Measurements and Modeling of Marine Sediments I Posters (T61A)
Pacific and Indian Ocean Trenches and Indian Ocean Ridges: A Session Honoring Robert L. Fisher (T61E, T62B)
Measurements and Modeling of Marine Sediments II (T62E)
Basin-Scale Hydrodynamic Systems: Stress State, Pore Pressure, Fluid Flow, and Deformation I(T71C, T72A)
Ridge Hydrothermals Posters (V52C)

10th Water-Rock Interaction Symposium

10-15 June, 2001, Villasimius, Italy

http://www.unica.it/wri10/

Convenor: Luca Fanfani (lfanfani@unica.it)

Objectives:
To promote advancements in the study of the interactions between aqueous fluids and their geologic environment.
To encourage a wide spectrum of researchers to attend and present their results.
To organize and lead field trips to locations where water-rock interaction has had a significant impact on the environment.

Important Dates:

November 30th, 2000	Submission of symposium papers
December 31st, 2000	Early registration

Upcoming Meetings and Workshops

European Union of Geosciences XI Meeting

8-12 April 2001, Strasbourg, France.

http://eost.u-strasbg.fr/EUG

Convenors: B. Ildefonse benoit@dstu.univ-montp2.fr (France),
C. Garrido carlosg@goliat.ugr.es (Spain), J.Phipps Morgan jpm@geomar.de(Germany)

Important Dates:

November 30th 2000	Submission of abstracts
January 31st 2001	Registration at reduced rate

G2 Structure, composition and accretion of the oceanic crust: geophysical, petrological and geochemical constraints

The objective of this session is to promote comparison of observational and theoretical constraints on oceanic crustal genesis and evolution, with the aim of reaching a better understanding of the processes that create and shape the seafloor. This session will bring together results from recent studies on seafloor magmatic, tectonic, and hydrothermal processes. The session will focus on processes of crustal accretion at spreading ridges, and on along-axis variability of hydrothermal processes and in the composition and structure of oceanic crust.

Second International Conference of Comparative Physiology & Biochemistry in Africa

18-24 August 2001, Chobe National Park, Botswana

http://www.users.bigpond.net.au/morlab/chobe/chobe.htm

Convenors: Aline Fiala and Horst Felbeck

Relevant Session:
Adaptive Physiology and Biochemistry of Organisms of Vents and Seeps

Important Dates:

1st February, 2001	Deadline for registration and accommodation payment
1st May, 2001	Deadline for abstracts

Upcoming Meetings and Workshops

The 2nd International Symposium on Deep-sea Hydrothermal Vent Biology

8-13 October 2001, Brest, France

http://www.intridge.org/brestvent.html

Organisers:
Daniel Desbruyères (France), Verena Tunnicliffe (Canada), InterRidge Office (Japan) in cooperation with "DORSALES" (CNRS - SDV, INSU, IFREMER) France.

Major topics of the Symposium will be:

- Ecology, microdistribution, temporal evolution, Interactions: between organisms and their habitat,
- Physiology and adaptation,
- Microbiology of symbioses and free-living bacteria,
- Biogeography, evolution, genetics and taxonomy,
- Cold seeps communities
- Shallow water hydrothermal vents

Deadlines:
January 2001. Second announcement,
30 April 2001. Deadline for abstracts submission and booking for hotels and excursions.
1 June 2001. Final circular and programme.
1 December 2001. Submission of manuscripts of extended abstracts (to Cahier de Biologie)

InterRidge Theoretical Institute (IRTI)

Thermal Regime of Ocean Ridges and Dynamics of Hydrothermal Circulation

September 2002, University of Pavia, Italy

Objectives:
(1) To foster exchange of information on observational, experimental, and modeling studies of hydrothermal circulation and their implications for thermal evolution of the oceanic lithosphere.
(2) To identify key scientific issues to be addressed in the future.
(3) To educate a broad spectrum of international scientists and graduate students.

Organizing Committee:
Chris German(cge@soc.soton.ac.uk)UK, Jian Lin(jlin@whoi.edu)USA, Mathilde Cannat(cannat@ccr.jussieu.fr)FRANCE, Andy Fisher(afisher@earthsci.ucsc.edu)USA, Riccardo Tribuzzio(tribuzio@crystal.unipv.it)Italy, Agnieszka Adamczewska(intridge@ori.u-tokyo.ac.jp)Japan.

The Institute (4 1/2 days)will consist of a short course, a Field Excursion and a Workshop

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