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InterRidge News

Initiative for international cooperation in ridge-crest studies

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Reports and announcements

Professor Christopher German awarded the MBE medal

Paul Tyler

Southampton Oceanography Centre, UK

A well-known and well-respected member of the InterRidge community, Chris German was awarded the honour of a Member of the British Empire (MBE) in the 2002 New Year's Honours list. The ceremony was held on the 2nd May 2002 at Buckingham Palace with HRH Prince Charles conferring the medals.

These honours are awarded for contributions to the UK above and beyond the normal call of duty. Chris has been awarded his MBE for his outstanding contributions to marine science in the UK. Two sets of awards a year - New Year's (Jan 1) & Queen's Birthday (June 2). This year was special because it's the Queen's golden anniversary.

Chris studied for his undergraduate degree at the University of Cambridge and graduated in the Natural Science tripos. For his doctoral thesis he elected to research 'Redox processes in the sea' under the guidance of Professor Harry Elderfield FRS. On completion of his doctoral thesis Chris was awarded at NATO post-doc at MIT working with Professor John Edmonds FRS, and in 1990 was appointed as a marine chemist at the Institute of Oceanographic Sciences in the UK, moving with IOS to the Soutahmpton Oceanography Centre in 1995. During this period he rapidly developed his interests in hydrothermal chemistry and from 1997 was chair of the InterRidge working group on 'the Global distribution of hydrothermal activity'. In the last two years Chris has truly established his credentials by gaining a personal chair in the School of Ocean and Earth Science at the University of Southampton, giving the Royal Institution young scientist lecture in 2001 and being awarded an Individual Merit Promotion (IMP) by NERC, one of the youngest scientists in the UK to be so.

Chris continues to be exceptionally active in the field of hydrothermal chemistry and has been a prime mover in the establishment of the 'Biogeography of Chemosynthetic Environments' programme (ChEss) and in the commissioning of a deep—submergence ROV for the UK marine science community. Chris will continue to make great contributions to the global marine science community particularly in the field of hydrothermal chemistry.

Chris has served on the IR Steering Committee as a UK national representative and has led the very successful IR Working Group: "Activity and Distribution of Hydrothermal Vents Working Group". Congratulations to Chris and thank you for your contribution to Ridge science and to InterRidge.

Prof. Chris German was awarded the MBE medal for his outstanding contributions to marine science in the UK. Photo copyright: Charles Green.

Reports and announcements

IR Outstanding Student Award Winners

SWIR Workshop, April 2002, SOC, UK

Laura Font is originally from Barcelona, Spain.

She did her Geology degree at the University of Barcelona (4 years degree, the title obtained she obtained is called "Licenciatura en Geologia", which is equivalent to the English BsC. Hons. degree). She finished her degree in 1997. In 1998 Laura obtained an EU Scholarship within the Socrates-Erasmus-Programme to study the volcanism in the Central Bransfield Basin, Antarctica. This project was a collaboration between the 'Universite de la Bretagne Occidentale', France and 'Universitat de Barcelona', Spain. This project was supervised by Dr.Miquel Canals (University of Barcelona) and Dr. Yves Lagabrielle (Institut Universitaire Europeen de la Mer). In 1999 she was awarded a three years fully funded Ph.D. studentship at the School of Ocean an Earth Sciences from the University of Southampton, UK. The Ph.D. project was to do a study of melt inclusions trapped within olivine and plagioclase crystals in basalts from slow spreading ridges with the objective to study the composition of primitive magmas before they fractionate and mix and melting processes under slow spreading ridges. This research was supervised by Dr. Bramley Murton and Dr. Steve Roberts. At the moment Laura is am finishing the writing up of the Ph.D. manuscript, which she hopes to finish by January 2003. At the moment Laura is applying for Post-doctoral research positions.

Laura's interests outside of academia are travelling, which she feels, she just can not do as much as she would like to. She also likes hiking in the mountains, especially in the Pyrenees. Other interests are pottery, which she just started a year ago. Laura also very much likes the cinema, music and reading.

IR Theoretical Institute: Thermal Regime of Ocean Ridges and Dynamics of Hydrothermal Circulation, September 2002, Pavia, Italy

Amy Davis graduated in 1999 from Imperial College London with a first class honours degree in Geology, specialising in structural geology. In 1999, she started a Natural Environment Research Council (NERC) funded PhD at the Department of Earth Sciences, University of Cambridge working initially with Prof. Adam Schultz, and later with Prof. Mike Bickle and Dr Damon Teagle (Southampton Oceanography Centre). She participated on a research cruise aboard Atlantis (with Alvin and ROV Jason) to the Endeavour Segment of the Juan de Fuca Ridge in 2000 – helping Adam with his Medusa instruments. Amy's PhD research involves using strontium isotopic alteration profiles through ocean and ophiolite crust to constrain the geometry, magnitude and evolution of oceanic hydrothermal systems. The focus of this work was two-fold, including:

a) using the degree of ocean crust alteration to constrain oceanic hydrothermal fluxes; and
b) detailed characterisation of a multiphase ancient hydrothermal regime in the Semail Ophiolite, Oman - commissioned (and funded) by the Government of Oman to develop mineral deposit exploration techniques.

The Omani work combines field mapping, petrology and geochemical analysis to understand the temporal and spatial evolution of hydrothermal regimes associated with varying magmatic environments. In her spare time (when she has any) she enjoys ridge-walking in mountainous areas, travel and painting.

Abstracts of these outstanding presentations are on pages 16-17 of this issue of IR news.

All of the winners of IR Outstanding Student awards are listed on our website: *www.intridge.org/irosaward.htm*

Reports and announcements

W.B. Clarke – Reflections on his Career
(Including his discovery of primordial helium)

W. J. Jenkins

Woods Hole Oceanographic Institution, USA

Dr. William Brian Clarke passed away on September 3, 2002 while visiting his son in Palo Alto, California. He was 65 years old. Brian Clarke obtained his PhD in physics at McMaster University in 1962 working with H.G. Thode on heavy noble gas isotopes in meteorites. After a brief post-doctoral stint at McMaster, he spent a couple of years at UCSD (Scripps) as a post-doctoral with the Nobel Laureate H. Urey. In 1965, he returned to a professorship at McMaster, where he remained until retiring.

It was during his tenure at Scripps, and on his return to McMaster that his interests turned to the ocean. At the time there was considerable interest in determining the amount of heat-producing radioactive isotopes in the earth, and some workers had tried to measure the earth's emanation of the by product of their decay, ^{4}He, by measuring the concentration of helium gas in the deep ocean. Unfortunately various other natural processes conspired to mask this subtle signal, and the results were not very clear. Brian had the very clever idea of measuring the isotopic ratio of helium, since the resultant ratio change would be unambiguous. Making the measurement to an accuracy necessary to resolve the signal, however, was not so simple. In fact, most textbooks back then would say it was impossible.

This, however, didn't deter Brian, who was a very clever and inventive experimentalist; and a determined one at that. After a lot of ingenious effort and hard work, he made the measurements, and the rest is history. I use the term "history" advisedly, for what Brian discovered revolutionized both geochemistry and oceanography. What he found was that not only was there this excess ^{4}He emanating from the decay of the heat-creating radioisotopes within the solid earth, but also an even greater (and far more surprising) excess of ^{3}He, a primordial isotope that was incorporated in the earth during its formation. He had discovered direct evidence of primordial degassing. Brian immediately recognized the significance of this discovery, and published his seminal 1969 paper with his student (Mudassar A. Beg) and Harmon Craig (Clarke *et al*., 1969).

The paper marked a punctuation point in modern geochemistry. It spawned a fierce response in the literature, and a number of lines of significant scientific inquiry, many of which have formed the basis of good scientific careers. There are at least four major ongoing research areas that find their roots in this work. First is the use of helium isotopes to study the structure and evolution of the earth. This forms a central pivot on which our ideas about how the earth and atmosphere were formed and have evolved over time. Second is the use of this isotope ratio to prospect for and study deep-ocean hot springs. These hot springs are perhaps the most visible and exciting ocean discovery in the popular press, but the finding of primordial ^{3}He was a contributing factor on which this discovery was based. Third is the tracing of helium-3 plumes in the deep ocean, learning about abyssal ocean circulation and mixing. These plumes are seen throughout the deep oceans of the world, extending for tens of thousands of kilometres around the globe. Fourth, this discovery lead to a new ocean dating technique called tritium-helium dating.

The last particularly indicative of Brian's experimental and scientific genius. Recognizing that there was an interference in the primordial helium-3 "signal" due to the decay of bomb-produced tritium (tritium decays to ^{3}He with a 12.5 year half-life), he sought to correct the observed ^{3}He values in the shallow ocean for this interference. In order to do this, however, you had to know how old the water was (that is, how long it had been away from the ocean surface). When he found out that nobody really knew this time, he realized that this was a way of determining the age of the water. Thus tritium-helium dating was born. This technique has now been used extensively in the oceans, teaching us about ocean circulation, ventilation, and biological productivity.

Brian also recognized that the traditional ways of measuring tritium was difficult and demanding. He used his mass spectrometric expertise to develop a new way of measuring tritium from the regrowth of ^{3}He during storage (Clarke *et al.*, 1976). This revolutionary approach ultimately bettered the old techniques by a hundredfold in sensitivity, and is now the technique mostly used in oceanic tritium measurements. The 1976 paper not only revolutionized tritium measurement techniques, it contained two other valuable nuggets. The first is that he determined the absolute atmospheric helium isotope ratio: a measurement that still stands a quarter of a century later as the definitive number. The second nugget is that he uncovered an inconsistency in his results with the then-reported half-life of tritium. Within a few years, the NBS/NIST and IAEA subsequently re-determined and corrected the half-life. His 1976 paper was remarkable tour-de-force, since it required an incredible mixture of experimental ingenuity, extreme attention to detail, and remarkable insight. This typified Brian's genius.

And the work continued. Along the way, Brian pioneered two other dating techniques in lunar and terrestrial rocks (Al-Mg and Xe-Xe). He invented a new generation of branch-tube mass spectrometers that he unselfishly shared with others (and now used throughout the world). He extended his helium isotope techniques into lake and groundwater research, and uranium prospecting. He pioneered the measurement of lithium and boron at ultra-trace levels in human blood protein, and others. It was very clear that Brian's scientific horizons were very broad indeed.

Thus it is fair to say that Brian has left an indelible mark on earth and ocean science, and history must recognize his many contributions. And rest assured that his work is still being carried on by his students, and his students' students… and their students too.

I must end, however, with a personal observation of Brian that I treasure the most. As one of his PhD students, I had the pleasure and benefit of his personal tutelage. I learned perhaps only a portion of the many skills that he had in the laboratory, and I continue to try to emulate some of his intellectual acuity and observational prowess. I have to think that the few things I've accomplished in my work are but a cloudy reflection of his brilliance. But the most powerful tool Brian gave to me was his sense of humour, and his enjoyment in doing science. He had a twinkle in his eye, and an infectious laugh that was impossible to resist. He not only worked in the lab ... he played. You could tell he was having fun. He was intensely involved in his science, and enjoyed challenges. He had a remarkable ability to think laterally around problems. Brian really liked people, and people genuinely took to him on first contact.

I always carry a little of Brian with me, wherever I go, whatever I do. Whenever I encounter a challenging problem, the thing that comes to my mind is "what would Brian do here?" I shall miss him very much.

October, 2002

References

Clarke, W.B., M.A. Beg, and H. Craig (1969) Excess ^{3}He in the sea: evidence for terrestrial primordial helium. *Earth and Planetary Science Letters*, 6, 213-220

Clarke, W.B., W.J. Jenkins, and Z. Top (1976) Determination of tritium by mass spectrometric measurement of ^{3}He. *International Journal of Applied Radiation and Isotopes*, 27, 515-525.

Call for Cruise Reports

The IR office will publish cruise reports, submitted as PDF files, on the IR website

Links to all submitted cruise reports will be made available from the "International MOR & BAB Cruise Database". This database now contains over 400 ridge related cruises since 1992. If you wish to make your cruise report available to the international community please contact the IR office: (*intridge@ori.u-tokyo.ac.jp*).

To add a cruise to the "International MOR & BAB Cruise Database" just fill in the online form at: ***http://www.intridge.org/cruisefm.htm***

InterRidge Office Updates

Coordinator's Update

Member Nations

The number of nations involved in InterRidge activities continues to grow. This year, Mauritius has joined InterRidge as a Corresponding Member nation. We welcome Dr. Daniel P. E. Marie from the Mauritius Oceanography Institute is the National Correspondent for Mauritius. This brings the total number of InterRidge member countries to twenty eight.

Upcoming InterRidge meetings

IR Steering Committee meeting

The next IR Steering Committee meting will be hosted by Dr John Chen, Beijing, China, 27-28 June 2003. During this meeting the final version of the "Next Decade Plan" will be officially approved and the new host Chair for the next term of the IR office will be selected. Just to remind you, the IR office will be moving to a new location with a new Chair and Coordinator at the end of 2003. Bids for hosting the next term of the IR office will be sought by the IR office before March this year.

InterRidge Workshop

"Opportunities and Contributions of Asian Countries to the InterRidge Next Decade Initiative", Beijing, China, June 23-25, 2003. The meeting will be co-chaired by John Chen and Jian Lin.

Symposium and Workshop

"Ridge-Hotspot Interaction: Recent Progress and Prospects for an Enhanced International Collaboration". To be held in Brest, France, September 8-10, 2003. Co-chaired by Jerome Dyment and Jian Lin. See the back of this issue for an outline of the objectives of this meeting.

Joint R2K-IR Teoretical institute: Backarc Basins and Spreading Systems

The second IR theoretical Institute will take place on the Jeju (Cheju) Island, a shield volcanic island, located at the southern end of Korean peninsular, from 24-28th May, 2004.

The IRTI will consist of 2 days of invited lectures and short courses, a one day field excursion, and then a 2 day workshop devoted to discussions by subgroups.

Please contact the IR office (*intridge@ori.u-tokyo.ac.jp*) to pre-register your interest in attending.

The InterRidge office

The original IR Science Programme plan will be finishing at the end of 2003. The IR office will remain in Tokyo until the end of the duration of the current Programme in 2003. From 2004 the IR office will move to a new Host country under the appointment of a new Chair. Thus, the IR office is sending out a request for bids to host the next IR office and for nominations for a new IR Chair. The period of tenure of the Chair is not precisely defined, but is normally expected to be three years. The final decision on the bids will be made during the InterRidge Steering Committee meeting in 2003. The request for bids will be sent out by email to the entire IR mailing list but those of you not on the list can access all the details from the IR website by viewing the "Archive Broadcasts" at: *http://www.intridge.org/bcast.htm*

Principle Themes for InterRidge Next Decade Science plan will include:

Ultraslow-spreading Ridges
Ridge-Hotspot interactions
Back-arc Spreading Systems/ Back-arc Basins
Mid-oceanic ridge Ecosystems
Monitoring and Observatories
Deep Earth Sampling
Global Exploration

Visit the IR website to find out if the ND plan is already available.

InterRidge meetings in 2002

This year was a very busy one for IR meetings, there was something for everyone!

SWIR Workshop

Held 17-20th April, 2002, at SOC, UK. The workshop was a great success with over 70 delegates from 13 countries participating. The abstracts volume from this workshop is available as a downloadable PDF file from the IR website, and can be found in the "IR publications" menu, or directly *http://www.intridge.org/absswir.pdf*. A proceedings volume from the meeting will be published as a "Theme" in the electronic journal, G-cube (*http://g-cubed.org/*).

The winner of the InterRidge "Outstanding student award" for the best student presentation at this workshop was Laura Font for her presentation: "Melt inclusions in plagioclase and olivine phenocrysts in basalts from the Southwest Indian Ridge: Insights into melt extraction and magma chamber processes.". CONGRATULATIONS Laura! You can view the abstract of this presentation in this issue of IR news on page 17.

Next Decade Workshop

The Next Decade Workshop was held 10-12th June 2002, Bremen, Germany. We had a tremendous input from the IR community about what IR should focus on in the next decade. Firstly, thank you all for your input. Secondly, I'd like to reassure you that all of your comments were taken into consideration during the for-

InterRidge Office Updates

mulation of the "Next Decade Plan". The final document produced as a result of this workshop has been undergoing a number of revisions since then as further input from National correspondents has been sought. The Steering committee discussed the proposals and in principle approved the "IR Next Decade Plan" with some final revisions, which are currently being incorporated. As soon as the final document is approved you will be informed about it via email (if you are on the IR e-mailing list) and it will be available to everybody from the IR website for downloading as a PDF file.

InterRidge MOMAR II Workshop

The 2nd MOMAR workshop was a great success, it took place 15-17th June 2002, Horta, Azores (Portugal). The main goals of this workshop were addressed and you can find a more detailed update on page 13 of this issue. The abstracts volume from this meeting is available as a downloadable PDF file from the IR website *http://www.intridge.org/act3.html*

InterRidge Theoretical Institute (IRTI)

The first IRTI:Thermal Regime of Ocean Ridges and the Dynamics of Hydrothermal Circulation, held 9-13 September 2002, at the University of Pavia, Italy was also a very successful meeting. You can read the update from the IRTI on page 14 of this issue. The abstracts volume from this meeting is available as a downloadable PDF file from the IR website *http://www.intridge.org/act3.html*

The winner of the InterRidge "Outstanding student award" for the best student presentation at this workshop was Amy Davis from the University of Cambridge, Cambridge, UK for her poster: "Understanding the contribution of hydrothermal activity to the ocean strontium budget.". CONGRATULATIONS Amy! You can view the abstract in this issue of IR news on page 16.

IR Steering Committee members

Thank you to Philippe Blondel (UK), Chair of the Global Digital Database WG to and the national representatives Catherine Mével (France) and Enrico Bonatti (Italy) who have finished their term as representatives on the IR Steering Committee.

We welcome Masataka Kinoshita as the new national representative for Japan and Damon Teagle as the new national representative and correspondent for UK. New national representatives for France and Italy will be announced in 2003.

Working Groups

The current working group structure will be revised in the "Next Decade Plan", which will be available to the entire community once it is finalised. In the mean time the current IR Working Groups continue to work on finishing their projects and working on their goals.

Past and current information about IR working groups and projects can be found on the IR website:
http://www.intridge.org/act2.html

IR Outstanding Student Presentation

The IR Steering committee has decided to encourage students involved in Ridge research by awarding certificates of Excellence and prize money to best student presentations at IR meetings. This year the IR Student Awards were handed out during the SWIR workshop (UK) and the IRTI (Italy). Background about students that receive the IR award and abstracts of their presentations appear in this issue of IR news and can be accessed from the IR website: *http://www.intridge.org/irosaward.htm*

InterRidge website

We are continuing to upgrade and improve our web site to maximise information transfer and make it user friendly. To make our homepage more interactive it is divided into two frames. The latest information about IR meetings, announcements and any other current, ridge related items is now at your fingertips, accessible directly from the left hand side frame on our homepage. The right hand side frame contains the familiar menus with lots of ridge related information. Due to the volume of information on our website a brief outline of what can be found there is available on page 11 of this issue.

Remember, you can always access our home page by simply typing in: *http://www.intridge.org*

The IR databases are unique, they provide an international pool of information about all manner of issues related to mid ocean ridges. The "Global hydrothermal vents database" as well as the "Ridge-Hot Spot Interaction Reference Database" can be searched by conventional method, by typing in search words in any of the fields but also these two databases contain interactive area maps to make searches easier. Thus, you can do your search by location just by clicking on the different areas on the globe. The databases take a lot of work to maintain but we relay on your input to keep them up to date!

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 also available at *http://www.intridge.org/latest.htm*

Acknowledgements

Many thanks to Dr Daniel Curewitz for his assistance in editing the articles in this issue as well as for compiling the "World Cruises" Map and Tables in the back of this issue.

Agnieszka Adamczewska
InterRidge Coordinator
November 2002

Call for bids to host the next InterRidge Office

Bid sumbission deadline: 31 March 2003

General Conditions

All Ridge Scientists are eligible to submit bids to host the next InterRidge Office. (Bids will be accepted from those countries who are not currently Principal Members, if the bid is accompanied by an undertaking to become a Principal Member by 1st January 2004).

The proposed location for the Office must be that of the home institution of the proposed InterRidge Chair.

Each Member nation may submit more than one bid, with the understanding that the Steering Committee will be the final arbiter

The new office will be responsible for implementing the "Next Decade Science Plan" for IR.

Final decision

The Steering Committee will examine the bids during the northern Spring and early Summer 2003.

The successful bid, modified if appropriate by mutual agreement, will be formally accepted by the InterRidge Steering Committee at its Summer meeting in June 2003 and the InterRidge community informed.

Full details about submission of bids, including the General Conditions, Presentation and the Final decision of the Steering Committee are available from the IR office on request (*intridge@ori.u-tokyo.ac.jp*).

The call for bids to host the next IR office will also be distributed via the IR E-mail list.

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 Symposium Abstract Volumes:

A full list of Abstract Volumes availabe from the IR office can be found on the IR website at the following URL: *http://www.intridge.org/act3.html#abs* . The latest Abstract Volume additions include:
IR Theoretical Institute: Thermal Regime of Ocean Ridges & Dynamics of Hydrothermal Circulation, pp.84, Sept. 2002.
InterRidge Workshop: MOMAR II (Monitoring the Mid-Atlantic Ridge), pp. 24, June 2002
InterRidge Workshop: SWIR (South West Indian Ridge Workshop), pp. 79, April 2002.
InterRidge Workshop: MOMAR (Monitoring the Mid-Atlantic Ridge), pp. 82, October 1998.

Workshop and Working Group Reports:

IR **MOMAR (*MO*nitoring the *M*id-*A*tlantic *R*idge)** workshop report, April, 1999.

IR **Mapping and Sampling the Arctic Ridges: A Project Plan**, pp. 25, December 1998.

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

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

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

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

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

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

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

IR 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.

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

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

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

Steering Committee and Program Plan Reports:

IR STCOM Meeting Report, Kobe, Japan, 2001.
IR STCOM Meeting Report, WHOI, USA, 2000.
IR STCOM Meeting Report, Bergen, Norway, 1999.
IR STCOM Meeting Report, Barcelona, Spain, 1998.
IR STCOM Meeting Report, Paris, France, 1997.
IR STCOM Meeting Report, Estoril, Portugal, 1996.
IR STCOM Meeting Report, Kiel, Germany, pp. 22, 1995.
IR STCOM Meeting Report, San Francisco, USA, 1994.
IR STCOM Meeting Report, Tokyo, Japan, 1994.
IR STCOM Meeting Report, Seattle, USA, pp. 6, 1993.
IR Meeting Report, York, UK, 1992.
IR Meeting Report, Brest, France, pp. 39, 1990.
IR Program Plan Addendum 1997, pp. 10, Jan. 1998.
IR Program Plan Addendum 1996, pp. 10, April 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

InterRidge Website

http://www.intridge.org/

The InterRidge office devotes a considerable amount of effort into maintaining an extensive web site with updated information as it comes into the Office. Our website also provides you with various ridge related 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 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 information to our office. To make our homepage more interactive we have divided it into two frames. On the left hand side frame you now have at your fingertips the latest information about meetings, announcements and any other current, ridge related items. The right hand side frame contains the familiar menus, the general contents of which are outlined below. As always any comments and suggestsions are always welcome.

The alias for the IR website makes the URL easy to remember, you can now access the InterRidge home page 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, including: Latest ridge related News; an introduction to what is InterRidge, with a short description of the InterRidge programme, outlining the objectives of the programme as well as management structure and national membership of InterRidge; as well as a calendar of international conferences, meetings and workshops.

2) Activities section

This section is concerned with the scientific and management structure of InterRidge. The 'Activities' section includes an outline of the scientific purpose of InterRidge. A description of the activities of the IR working groups, which are responsible for directing different aspects of ridge research with updates of their activities can be found here. You can also find links to major projects that InterRidge is currently involved in and projects that are directly relevant to InterRidge activities - such as MOMAR and the Marine Protected Areas project. Additionally, in this section, you can find a list of all the publications distributed by the InterRidge office as well as 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 continually 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. A list of the databases maintained by InterRidge with a brief introduction can be found on our web site at: *http://www.intridge.org/data1.html*

The IR office also maintains a database with contact details of scientists involved in ridge reserach. We are slowly building this database and it is still incomplete.

Furthermore, there is a neat little program, which you can use to calculate the spreading rate of the sea floor at any place around the globe!

Hydrothermal Ecological Reserves Page:
http://www.intridge.org/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.

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.
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), K. J. Young (Korea), N. C. Mitchell (UK), H. A. Roeser (Germany), H. Shimamura (Japan), Y. Nogi (Japan), C. L. Van Dover (USA) .

Back-Arc Basins
Objectives: Summarize past work on Back-Arc Basins and coordinate future studies.
Chair: Sang-Mook Lee (Korea)
Current Activities: Organise a BAB Theoretical institute, see the back of this issue for details.
WG members: Ph. Bouchet (France), J.-L. Charlou (France), K. Fujioka (Japan), E. Grácia (Spain), P. Herzig (Germany), J. Ishibashi (Japan), Y. Kido (Japan), S-M. Lee (Korea), R. Livermore (UK), S. Scott (Canada), R. J. Stern (USA), K. Tamaki (Japan), and B. Taylor (USA).

Biological Studies
Objectives: Objectives of the New biology WG are outlined on the IR website.
Chairs: Franocise Gaill (France) and S. Kim Juniper (Canada).
WG members: M. Biscoito (Portugal), O. Gierre (Germany), J-H Hyun (S. Korea), A. Metaxas (Canada) T. Shank (USA), K. Takai (Japan), P. Tyler (UK) and F. Zal (France)

Global Digital Database
Objective: Establish a database of global multibeam bathymetry and other data for mid-ocean ridges and back-arc basins.
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 Hydrothermal Activity
Objectives: Target key areas of the global MOR that should be explored for hydrothermal activity and coordinate international collaboration to explore them.
Current Activities: See update on the IRTI in this issue of IR news on page 14.
Chair: Chris R. German (UK)
WG members: E. Baker (USA), Y. J. Chen (USA), D. Cowan (UK), T. 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 (USA), C. A. Stein (USA), V. Tunnicliffe (Canada) and C. L. Van Dover (USA).

HotSpot-Ridge Interactions
Objectives: This WG was formed during the 2000 Steering Committee meeting to promote and facilitate 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.
Current Activites: The agenda for this WG is being developed.
Chairs: Jian Lin (USA) and Jerome Dyment (France)
WG members: R.K. Drolia (India), J. Escartín (France), J. Freire Luis (Portugal), E. Grácia (Spain), D.W. Graham (USA), K. Hoernle (Germany), G.T. Ito (USA), B. Murton (UK) N. Seama (Japan), F. Sigmundsson (Iceland)

Monitoring and Observatories
Objectives: Develop detection methods of transient ridge-crest seismic, volcanic and hydrothermal events, and the logistical responses to them.
Current Activites: Finalisation of the second MOMAR workshop Report. See update in this issue of IR news on page 13.
Chairs: J. Escartin (France) and R. Santos (Azores, Portugual)
WG members: Chris Fox (USA), K. Mitsuzawa (Japan), Pierre-Marie Sarradin (France), Adam Schultz (UK), Paul Snelgrove (USA), Paul Tyler (UK).

SWIR
Objective: Coordinate reconnaissance mapping and sampling of the Southwest Indian Ridge.
Current Activities: Finalising the proposal for the future.
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.
Chair: Spahr C. Webb (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

Monitoring and Observatories Working Group

Ricardo Serrao Santos (DOP, U of Azores, Horta, Portugal) and
Javier Escartin (IPGP/CNRS, Paris, France)

The II MOMAR Workshop, convened by the Monitoring and Observatories Working Group, took place last 15-17 June 2002 in Lab-Horta (Horta, Azores, Portugal). The goal of the meeting was to establish an implementation plan for long-term observations along the Mid-Atlantic Ridge in the MOMAR area (South of the Azores), which includes the Lucky Strike, Menez Gwen, Rainbow and Menez Hom hydrothermal sites. The review of existing data and previous studies carried out in the area allow the installation of autonomous instruments to monitor key environmental parameters (*i.e.*, seismicity, temperature of venting fluids…) in the short term (<3 years). Development of technology (*e.g.*, chemical sensors) is required for more permanent, on-bottom instrumentation and infrastructure in the area, and requires longer-term efforts (>5 years). A MOMAR Committee will be nominated before the end of 2003 to implement the conclusions of the II MOMAR Workshop (see *http://www.ipgp.jussieu.fr/~escartin/MOMAR/index.html* for data, Workshop Reports and other related information).

The I MOMAR (Monitoring the Mid-Atlantic Ridge) Workshop (Lisbon, Portugal, 28-31 October 1998) established the scientific basis for long-term observations and monitoring of active processes at the crest of the slow-spreading Mid-Atlantic Ridge. The MOMAR area, located south of the Azores Islands, was identified as the preferred site for the concentration of multidisciplinary studies over a long period of time, as required to understand the active processes (magmatic, tectonic, hydrothermal , biological, biochemical, microbial…) and their casual links taking place at active mid-ocean ridge hydrothermal systems. The Lucky Strike vent field was also recognized as the favoured target for small-scale studies, as required for the study of biological and hydrothermal processes. In the years following the I MOMAR Workshop, scientific cruises and projects have been carried out in the MOMAR area, and additional projects are planned in the near future (see the Poster Abstracts Volume at: *http://www.intridge.org/momar2abs.pdf*). However, few of the long-term or observatory-type experiments outlined in the I MOMAR Workshop have been implemented (*i.e.*, deployment of autonomous underwater hydrophones – see poster abstracts by Bazin *et al.*, Dziak *et al.*; Biological sampling and observation time-series at LabHorta – Colaço *et al.*). It has also been recognized, based both on recent technological developments and the better scientific knowledge of the different MOMAR sites, that a coordinated action to monitor the Mid-Atlantic Ridge is possible, requiring a more organized structure than previously available.

The goals of the II MOMAR Workshop were: 1)to establish a realistic short (<5 years) and long-term (> 5 years) plan of experiments to monitor the Mid-Atlantic Ridge at the MOMAR area; 2) Better definition of the geographical scope and targets of the MOMAR project; 3) Establish the basis for the data and site management associated with MOMAR projects, and 4) decide on the follow-up structure of MOMAR. This II Workshop was convened at the same time as two Letters of Intention for European projects were submitted to the VI European Framework Science Program for future consideration. In addition, a more specific Vent-Sites Management Workshop took place immediately after the II MOMAR Workshop.

The 1st day (15th June) of the Workshop was dedicated to summary talks on different scientific disciplines (biology, hydrothermalism, geology and geophysics) and on the planning and philosophy of the Ridge2000 Integrated Sites, followed by short discussions. These sessions were intended to provide a common basis of understanding of the needs, scientific goals, and limitations for each discipline, required to establish effective inter-disciplinary projects. The 2nd day (16th June) was dedicated to three series of discussions by Working Groups. At the request of the biological community, two disciplinary groups (Biology and Earth Sciences Working Groups) were established to briefly outline their goals. These were followed by discussions on site projects and planning (Lucky Strike Working Group and Rainbow, Menez Gwen and larger MOMAR area Working Group). The afternoon was dedicated to more general discussions on management and future requirements for the implementation of MOMAR (Data Management Working Group, MOMAR site Management Working Group, and Technology Development Working Group). The morning of the last Workshop day (17th June) was dedicated to the presentation of the results of the different Working Groups, and the discussion of the follow-up structure for MOMAR. All reports, data and updates will be posted on the following web site: *http://www.ipgp.jussieu.fr/~escartin/MOMAR/index.html* as the information becomes available.

Updates on InterRidge Projects

1st InterRidge Theoretical Institute

Thermal Regime of Ocean Ridges and Dynamics of Hydrothermal Circulation

Co-chairs: Chris German (SOC, UK) and Jian Lin (WHOI, USA)

Co-organisers: Mathilde Cannat (UPMC, France), Andy Fisher (UCSB, USA)
Riccardo Tribuzio (U.Pavia, Italy) & Agnieszka Adamczewska (InterRidge, Japan)

This meeting, the first theoretical institute organised under the auspices of InterRidge, was convened in Italy from September 9-13, 2002 but starting with an ice-breaker reception held at the University of Pavia on Sunday Sept. 8th. The structure of the course was a 2-day short-course followed by a one day field trip to local Northern Appenine ophiolite outcrops and concluding with two further days of workshop discussions. Overall the meeting, which was co-sponsored by both the US Ridge 2000 programme and the European Science Foundation, attracted 72 registered participants from 11 different countries, this included 20 invited speakers and discussion leaders from 6 different nations.

The Short-Course

Day 1 of the short course commenced with a series of four invited talks (each 45 mins with 15 mins for discussion) presenting the current state of the art concerning the thermal structure of the ocean crust. These papers were presented from the perspectives of: subseafloor geophysical techniques (Martin Sinha & Rob Evans); the rheology and morphology of the ocean lithosphere (Javier Escartin); theoretical modelling (John Chen) and constraints from petrologic observations (Mathilde Cannat & Joe Cann). Formal presentations were brought to a close in mid-afternoon to allow for an extended poster presentation session. A remarkable total of 42 posters were presented subdivided into the areas of: Modelling of crustal thermal structure and hydrothermal vents; crustal cooling rates and rock mechanics; acoustic imaging and EM sounding; hydrothermal vent-fluid chemistry; rock geochemistry and hydrothermal alteration; Lost City and Saldanha Mount sites on the Mid-Atlantic Ridge; Global hydrothermal vent distributions. Encouragingly, a very healthy proportion (>40%) of these posters were presented by graduate students who, consequently, were eligible for the recently instigated InterRidge Best Student Paper Award. All these presentations were to a very high standard but, upon much deliberation, a winner was eventually selected (see below). After several hours of active discussion in front of the posters, conversations continued long into the night at the magnificent Conference Dinner organised by our hosts in Pavia and held at a restaurant (Bardelli's) on the banks of the River Ticino.

For Day 2 of the short course, the emphasis was switched more directly toward hydrothermal circulation at Mid-Ocean Ridges beginning with papers addressing what can be learned from the compositions of individual vent-fluids (Bill Seyfried) and from the distributions of hydrothermal vent-fields on larger (up to global) length scales (Ed Baker). The next pair of papers concentrated on investigations into what can be achieved from time-series observations of hydrothermal venting in all its forms (Adam Schultz) and from theoretical modelling of seafloor hydrothermal circulation (Bob Lowell). The short course concluded with a presentation on what petrologic observations can tell us about seafloor hydrothermal circulation (Debbie Kelley) which merged neatly into an introduction to the next day's field trip to visit hydrothermally altered sections of the Northern Appenine ophiolite (Riccardo Tribuzio). Day 2 ended with a guided tour of the Science Museum of the University of Pavia, but not before the announcement of this meeting's winner of the InterRidge Best Student Paper Award. This award (with an accompanying cash prize of $700 US) was presented by Prof. Kensaku Tamaki, InterRidge Chair, to Ms. Amy Davis (University of Cambridge, UK) for her poster: "Understanding the contribution of hydrothermal activity to the ocean strontium budget."

The Field-Trip

Day 3 started early with the departure of two buses for our IRTI field-trip "The ocean-floor evolution of the gabbro-peridotite association from the northern appenine ophiolites". This was the first time that many of us, including some quite senior professionals in the field, had been exposed to ophiolitic outcrops. Well-blessed with warm and dry weather our first stop was on the coast SW of Genoa (about 2.5 hours' drive from Pavia) at Bonassola where gabbros exposed at the coast exhibit high temperature shear zones cross-cut with hornblende bearing veins. After a break for lunch on the outcrops it was back to the buses for Stop 2 (the disused Ophicalcite quarries at Montaretto) and Stop 3 in the Vara valley where we were able to observe an overturned sequence grading upward from serpentenised mantle peridotites via ophicalcites

Updates on InterRidge Projects

and gabbroic breccias into cherts intercalated with gabbroic sandstones. It was a great opportunity to gain field-experience in an ophiolite particularly relevant to slow-spreading ridges, an important focus of debate in the discussions still to come on Days 4 & 5. We are greatly indebted to Riccardo Tribuzio and his colleagues familiar with the locales for production of a superb guidebook to accompany the fieldtrip and for providing us with such a range of enthusiastic expertise during our day visiting the outcrops. After leaving the final outcrop the buses turned to Sestri Levante overlooking the Mediterranean Sea. Here the meeting was divided in two. Those staying for the continuing workshop disembarked the bus with their luggage whilst the remained returned by bus to Pavia, overnight, and then home.

The Workshop

Day 4 of the meeting started with a plenary discussion of objectives of the workshop and identification of key subjects to discuss over the two days available. By mid-morning consensus was reached on two initial subjects for discussion:

a) establishing the recent geologic history of the oceanic crust (Discussion leader: Roger Searle) and

b) Fluid circulation and heat transport in the ocean crust (Discussion leader: Bill Seyfried).

These groups met separately throughout most of Day 4, reporting back in plenary session late in the afternoon to present their recommendations (see later). At the end of Day 4 a new set of three working groups were established who met until mid-morning of day 5 before reporting back in plenary. These were:

a) investigating downflow in hydrothermal systems (Discussion leader; Will Wilcock);

b) the role of serpentenisation (Discussion leader: Catherine Mével) and

c) heat transport to the shallow crust (Discussion leader; Colin Devey).

The discussions in these working groups flowed smoothly and fruitfully resulting a series of recommendations which were reported directly to the annual InterRidge Steering Committee meeting, which started business that same afternoon:

- There is need for a concerted international effort to conduct a detailed study of ocean crustal history at the scale of a single segment. In the first instance, such effort should be focussed at a slow-spreading ridge to complement past and continuing progress at fast and intermediate ridges such as the northern East Pacific Rise and the Juan de Fuca Ridge. A useful starting point might be to coordinate such efforts with the MOMAR InterRidge initiative which is targeting the area 36-40°N on the Mid-Atlantic Ridge.
- There is need to make much better, coordinated, use of IODP drilling in the investigation of fluid circulation in the ocean crust. It should be recognised that drilling does not simply represent a mechanism for sub-seafloor sampling of lithologies. Drilled holes themselves also represent important infrastructure from which to investigate physical properties of the ocean crust and fluid circulation through it.
- Identifying areas of down-flow, requiring intensive heat-flow investigations, should remain a high priority. Once such areas have been identified, drilling should be exploited to investigate the hydrology of the underlying crust and to provide for long-term time-series "observatory"-type investigations.
- Exploration for further ultramafic-hosted hydrothermal activity of the types observed at Lost City, or possibly as observed at Rainbow, should be conducted along both slow and ultra-slow spreading ridges to determine whether such recently-discovered and quite distinct styles of venting may be widespread.

Information on the activities of InterRidge Working Groups can be found on the IR web site under the menu "Projects & WG" or by going directly to:

http://www.intridge.org/act2.html

The **abstracts volume** from the IRTI is avilable from:

http://www.intridge.org/act3.html#abs

InterRidge Outstanding Student Award Winners - presentation abstracts

Understanding the contribution of hydrothermal activity to the ocean strontium budget

A.C. Davis[1], M.J. Bickle[1] and D.A.H. Teagle[2]

[1] *Department of Earth Sciences, University of Cambridge, Cambridge, UK*
[2] *School of Ocean and Earth Sciences, Southampton Oceanography Centre, Southampton, UK*

Current geochemical and thermal estimates of high-temperature ocean ridge hydrothermal fluxes differ by up to an order of magnitude – and these differences remain very difficult to reconcile. Seawater strontium isotope ratios should provide a robust estimate of the high-temperature hydrothermal flux, calculated relative to the measured riverine input flux and the buffering effect of carbonate diagenesis. However, the flux predicted is up to six times greater than thermal model estimates and is inconsistent with hydrothermal fluid characteristics and the degree of strontium isotopic exchange recorded in ocean crust profiles. Figure 1 illustrates that this would require 100% exchange of seawater strontium for basaltic strontium over a 950m section of MORB-like crust – or lower alteration intensities over greater depths. One suggested solution to this discrepancy is that low-temperature flank circulation (although not expected due to sluggish kinetics) makes a significant contribution to the cumulative hydrothermal flux. Strontium isotope data for ocean crust, ophiolite crust and hydrothermal fluids has been used to assess the high-temperature hydrothermal contribution and, by mass-balance, derive an estimate of the low-temperature flank flux required to balance the oceanic strontium budget. This study indicates that low-temperature flank exchange cannot reconcile the oceanic strontium budget, because the ocean crust is insufficiently altered to supply the necessary flux – requiring 100% exchange of seawater strontium for basaltic strontium over a 700m section of MORB-like crust (Fig. 2) – allowing for increased hydrothermal activity associated with arc-related hydrothermal systems. A sustainable cumulative hydrothermal strontium flux of ~3.6×10^9 mols basaltic Sr yr^{-1} is predicted, based on observation of crustal profiles and hydrothermal fluid characteristics. This shows good agreement with thermal hydrothermal flux estimates, but remains only a third of the flux required to balance the oceanic strontium budget.

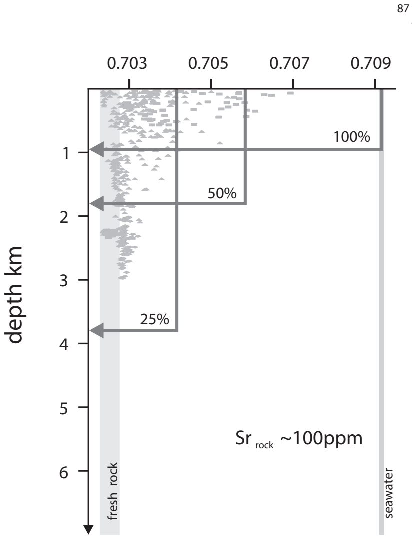

Figure 1. Predicted impact on the crustal profile of removing the basaltic Sr fluxes required to balance the oceanic Sr budget.

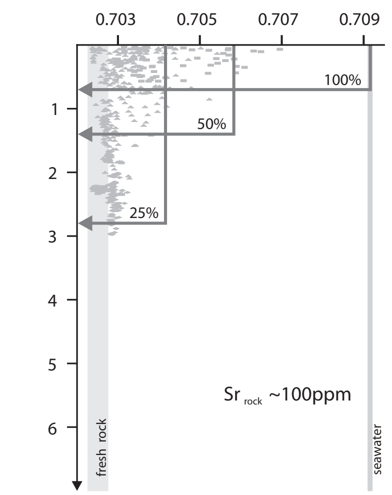

Figure 2. Predicted low-temperature alteration required to balance the oceanic Sr budget, given the predicted high-temperature condition.

Biographies of the two students (Laura Font and Amy Davis) recently awarded the "InterRidge Outstanding Student Award" can be found on page 4 of this issue.

These Awards are granted at selected IR meetings to encourage students involved in Ridge research by awarding certificates of Excellence and prize money.

All of the winners of IR Outstanding Student awards are listed on our website:
http://www.intridge.org/irosaward.htm

InterRidge Outstanding Student Award Winners - presentation abstracts

Melt inclusions in plagioclase and olivine phenocrysts in basalts from the Southwest Indian Ridge: Insights into melt extraction and magma chamber processes.

Font, L. [1], Murton, B. [1], Roberts, S.[1], Nesbitt, R. [1], Tindle, A. [2].

[1] *Southampton Oceanography Centre, European Way, SO14 3ZH Southampton, UK.*
[2] *Open University, Dept. of Earth Science, MK7 6AA Milton Keynes, UK.*

Glassy primary melt inclusions trapped within plagioclase and olivine phenocrysts and the matrix glass of basalts of the Southwest Indian Ridge (SWIR), collected between 49°E and 70°E, were studied to investigate the compositional evolution of the parental melts, melt extraction and magma chamber processes during ultra-slow spreading. Specifically we test the hypothesis that the depth of melting, melt fraction, the shape of the melting zone, the extraction and mingling of melts increments and magma residence time change as spreading evolves from rift propagation in the East to steady-state in the West.

The matrix glass of basalts from the SWIR is similar in composition to N-MORB, except for high concentrations of Na_2O and TiO_2, some trace elements and the REEs. Samples at 64°E, close to the Rodrigues Triple Junction, are more enriched in highly incompatible elements than samples at 50°E. The Mg# of the matrix glass decreases progressively (from 65.6 to 52.5 respectively) along the SWIR from East to West, which is indicative of increasing fractionation towards the West. However, the melt inclusions do not show this decrease in Mg#. As a result, the difference in Mg# between the melt inclusions and their matrix glass increases towards the West. This indicates an increase in the degree of fractionation between the parental melts (represented by the melt inclusions) and the final magma erupted (represented by the matrix glass). It is probable that this increase is the result of longer residence time for the magma in the lithosphere, either in increasingly large magma chambers or during ascent through thicker crust towards the west. The correlation between increasing residence time with shallower and thicker crust towards the West indicates a link to melt flux.

To assess changes in melt fraction, two normalisation methods are applied to the melt inclusions: one to remove the effect of host crystal interaction (by normalising the melt inclusion composition to an equivalent MgO of 8 wt.% , denoted by the suffix [8]) and the second to remove the effects of the fractional crystallisation (by normalising to a common Mg# e.g. 60, denoted by the suffix (60)). The latter is applied to both the matrix glass and melt inclusions alike. Because it is not necessary to apply the host correction to the matrix glass, the element [8](60) normalised compositions of the melt inclusions are comparable to the element (60) normalised compositions of the matrix glass. The normalised melt inclusion compositions show decreasing $K_2O_{[8](60)}$ and $Na_2O_{[8](60)}$ from East to West, but have similar $P_2O_{5\ [8](60)}$ and $TiO_{2\ [8](60)}$. The matrix glass also show decreasing $K_2O_{(60)}$ and $Na_2O_{(60)}$ towards the West, as well as $P_2O_{5\ (60)}$, $TiO_{2\ (60)}$, but increasing $FeO_{(60)}$. For the eastern samples, the matrix glasses generally have higher $TiO_{2\ (60)}$ and $P_2O_{5\ (60)}$ compared with their melt inclusions, but similar $K_2O_{(60)}$ and $Na_2O_{(60)}$. For the western samples, the matrix glasses have lower $TiO_{2\ (60)}$, $P_2O_{5\ (60)}$, $K_2O_{(60)}$ and $Na_2O_{(60)}$, compared with their melt inclusions. The progressive decrease in $K_2O_{(60)}$, $Na_2O_{(60)}$, $P_2O_{5\ (60)}$ and $TiO_{2\ (60)}$ for the matrix glasses from East to West is compatible with a general increase in partial melting. This is also compatible with the decreasing depth and thickening of the SWIR crust to the West.

The $K_2O_{[8](60)}$, $Na_2O_{[8](60)}$ and $FeO_{[8](60)}$ concentrations of both the melt inclusions and their matrix glass overlap in the eastern samples but become increasingly different towards the West. The melt inclusions of the eastern samples probably represent partial melts coming from the upper edges of the melting zone while the matrix glass represents melts averaged from the centre of the melt column. The lower $FeO_{[8](60)}$ in the East compared with the West indicates a shallower average depth of melting. In contrast, the enrichment of the melt inclusions from the West, compared with their matrix glass, indicate an origin as small melt fractions probably coming from the margins of a deeper, triangular-shaped melting column. The lower $FeO_{(60)}$ in these melt inclusions, compared with their matrix glass, indicates that the edges of the melting column are shallower than the centre of melting column suggesting a concave shape to the base of the solidus. The increase in depth and change in shape of the melting zone are interpreted as the result of steepening and focusing of isotherms beneath the ridge axis as spreading increasingly tends towards steady-state with distance westwards.

International Research: **Biological Studies**

Hydrothermal fauna discovered at Lost City (30ºN, Mid-Atlantic Ridge)

A.V. Gebruk, S.V. Galkin, E.M. Krylova, A.L. Vereshchaka, G.M. Vinogradov

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Introduction

The Lost City hydrothermal field is among the newest discovered on the Mid-Atlantic Ridge (MAR) (Kelley *et al.*, 2001). It is located at 30ºN on the Atlantis massif that is found at the inside corner of the intersection of the MAR and the Atlantis transform fault. The active field lies at a water depth between 700 and 800 m near the top of the massif. The Lost City field is most distinctly different from all other known hydrothermal fields in that it is located nearly 15 km from the spreading axis, is underlied by ultramafic rocks and is dominated by spectacular steep-sided carbonate chimneys (Kelley *et al.*, 2001). Some of the carbonate structures exceed 70 m in height.

Kelley *et al.* (2001) reported dense microbial communities found on the carbonate structures and very abundant at Lost City. At the same time, communities of typical hydrothermal vent animals were not found at this field and it was thought that vent obligate fauna at Lost City is lacking. In the present paper we report preliminary evidence of obligate hydrothermal fauna present at Lost City and also some details of other macrofaunal communities.

Material and site description

The Lost City field was revisited in July 2002, on the 47th cruise of the RV *Akademik Mstislav Keldysh*. Six dives (including two biological) of *Mir* submersibles were made in total at Lost City between 3rd and 5th July (Stations from 4364 to 4370). Biologists were present on the *Mir-1* Dive 19/312 (St. 4367, observer S.V. Galkin) and the *Mir-2* Dive 19/325 (St. 4368, pilot Viktor Nischeta, observers A.V. Gebruk and A.L. Vereshchaka).

Both dives with observers-biologists on board spent most of the time working on one of the tallest columnar towers, with two spires on top, one of them marked with the marker "3"(depth 723 m). Both spires were actively venting from their tops. The base of the tower complex at 799 m depth was marked by blocks of ultramafic rocks. The whole complex is located on the socle made of such blocks.

Hydrothermal fauna

At the base of the tower complex socle at 830 m depth the aggregation of bivalve shells was found during the *Mir-2* Dive # 19/325. About 20 valves and fragments covered an area of ca. 1m^2. Two subfossil valves and 6 fragments were sampled with a slurp-gun (Fig. 1). The length of complete valves was 49.0 and 58.2 mm. Morphological characters of the valves correspond to the species *Bathymodiolus azoricus*. This is the first record of true hydrothermal (vent obligate) fauna at Lost City.

Other possible representatives of hydrothermal fauna include limpets Peltospiridae: several empty shells of at least two species were found in the sediment at the base of the complex with the tower "3" at 799 m. Peltospiridae are common at all known hydrothermal fields on the

Figure 1. Two valves and two fragments of *Bathymodiolus azoricus* from the Lost City hydrothermal vent site.

MAR (Warén and Bouchet, 2001). Numerous valves of the bivalve *Thyasira* were found in the same biotope with peltospirids. Often feeding as symbiotrophs, these burrowing bivalves are common in shallow-water hot vent and cold seep communities and in the regular deep-sea. In the deep-sea hydrothermal community they were first recorded at Logatchev (14º45'N, MAR) (Gebruk *et al.*, 2001).

The records of the remains of obligate hydrothermal fauna at Lost City indicate that live hydrothermal communities might be present somewhere in this area. Alternatively, it can be suggested that geochemical conditions at Lost City are not suitable (or stable) to support rich hydrothermal fauna. The depth of the area is also close to the critical below which rich hydrothermal communities and obligate hydrothermal fauna develop in the modern ocean: this depth barrier lies at ca. 500 m (*e.g.* Mironov *et al.*, 2002).

Hydrothermal species at Lost City were also found in the near-bottom water layer: one of the dominant forms there was the amphipod *Bouvierella* aff. *curtirama* (see also Vereshchaka *et al.*, this issue). The species *B. curtirama* has been previously recorded only from Lucky Strike.

Notably, the closest to Lost City known localities of two hydrothermal species, *Bathymodiolus azoricus* and *Bouvierella* aff. *curtirama*, are Rainbow (36º14'N) and Lucky Strike (37º17'N) correspondingly. Although, the closest to Lost City known hydrothermal field at the MAR is Broken Spur (29ºN). The four fields are located at the following depth: Lost City at 700-800 m, Lucky Strike at 1600-1700 m, Rainbow at 2200-2400 m and Broken Spur at 3000-3050 m. Thus, Lost City shares species with shallower, although more remote areas. It shows that at this scale of the ridge segment depth is a more important isolation factor for the vent fauna distribution than the distance.

Other fauna at Lost City

Fauna has been sampled using submersibles at various parts of hydrothermal structures. Most of material is being currently analysed, so that only preliminary account can be made.

Tower tops - Occasional soft echinoids *Araeosoma fenestratum*, large pink shrimp (not sampled), various hydroids and sponges, Demospongia, were present in this zone. At least two crab species, including the swimming crab *Bathynectes* aff. *maravigna*, were recorded. On bacterial mats and above them the amphipods *Bouvierella* aff. *curtirama* were present. Also swarming in the water were numerous euphausiids *Nematoscelis* and hyperiids *Paraphronima* and *Streetsia*.

The population of bacterial mat was studied in two microbiotopes in this zone: in the mat marked with shimmering water ("warm") and without the latter ("cold"). Common in the "cold" mat were giant (up to 1 cm long) nematodes, polychaetes, bivalves Cuspidariidae and harpacticoids. The population of the "warm" mat was poorer and included large nematodes, polychaetes and tanaidaceans.

Tower walls - This zone was dominated by echinoids *Araeosoma fenestratum*, and *Cidaris* sp., Ceriantharia and short arm asteroids (resembling *Ceramaster*). Ceriantharias, usually living in the soft substrate, in this biotope occurred in crevices and pores of the carbonate structures filled with the sediment. Also common in this zone were sponges Demospongia and Hexactennelida, hydroids, gorgonarians, solitary madreporarian corals and the deep-water coral *Lophelia*. The latter formed bushes up to 2 m across.

The complex base - At the base of the tower complex at 800-830 m large red shrimp and galatheids *Munida* were recorded. Sedentary polychaets Spirorbidae and Serpulidae were common on the hard substrate. Valves of *Bathymodiolus azoricus* were also found in this zone.

In the soft sediment where the shells of Peltospiridae and *Thyasira* were found, also recorded were numerous brachiopod and pteropod shells, valves of the bivalve *Asperarca nodulosa* and foraminiferans.

Periphery of the field and the background were dominated by fan-shape gorgonarians, sponges Hexactenellida, anemones, serpulid polychaetes. Also common were large ophiuroids. Abundant ichtyofauna was observed in the area and recorded on video, however, it remains to be identified.

Acknowledgements

The authors thank the crew of *Akademik Mstislav Keldysh* and the *Mir* submersible group for their expert help and understanding. Thanks are also due to A.N. Mironov for identification of echinoid species.

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Biogeochemical interactions in extreme environmental conditions: an integrated study (PHARE 2002/ EPR 13°N)

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Introduction

Over the last 20 years, a set of biological cruises have been dedicated to the study of hydrothermal vent communities on the 13°N East Pacific Rise segment. These cruises have emphasized some of the most striking features of these communities. As reviewed in (Desbruyères *et al.*, 1998), the two alvinellid species, *Alvinella pompejana* (Fig. 1) and *Alvinella caudata* are especially remarked for their ability to dwell in the hottest and, presumably, most hypoxic and toxic conditions found in this biotope. Although *Alvinella* spp. are also known as the very first metazoans colonizing newly grown hydrothermal substrates, in a second stage, other invertebrates such as the polychaete worms *Paralvinella grasslei, Hesiolyra bergi* or the crabs *Bythogrea thermydron* and *Cyanagrea predator* are found, in various abundance, in this extreme habitat. The abundance and the close association of microbial communities to *Alvinella* spp., as epibiotic bacteria or in their immediate surrounding, was also particularly underlined (Taylor *et al.*, 1999; Jeanthon, 2000).

In these harsh environmental conditions, biological development and adaptation as well as community structuring are expected to be mostly driven by biogeochemical processes. Still, the genetic, biological, ecological, and geochemical features of these interactions are poorly known. The PHARE 2002 (Peuplements Hydrothermaux, leurs Associations et Relations avec l'Environnement) cruise was devoted to an integrated study of this "hot pole". From 2002 April 30 to June 3, a multidisciplinary project was held including biologists, ecologists, chemists, microbiologists, and geologists from different French research institutions. This cruise was planned under the frame of the national Dorsales program.

Figure 1. *Alvinella pompejana*, the Pompeii worm

Instrumentation used at depth and on-board

The work at sea was based on innovative instrumentation, developed by the PHARE participants for *in situ* and *in vivo* approaches: *in situ* chemical analysis (ALCHIMIST) coupled to imaging and scaling devices, bacteria and larvae collection and alvinellid colonization devices (TRAC), pressurized aquaria equipped with a chemical and thermal monitoring system (IPOCAMP and SYRENE) and pressurized incubation chambers (PICCEL).

ROV, Victor 6000 - The new French deep-sea ROV, VICTOR 6000 was operated from the *R/V Atalante* (Fig. 2) for its first implementation on the EPR. It was equipped with watertight boxes to collect geological and biological samples and their associated microflora, minimizing contamination from shallow waters. Chemical samples were collected with titanium syringes (for black smoker hot fluids) or a sequential sampler equipped with 200 ml bottles or large volume bags with 0.45 µm filtering units.

VICTOR 6000 was also equipped with various imaging systems (digital camera, 3-CCD video camera) and 4 lasers for scaling. Dives were planned overnight for 12 to 14 hour duration. A total of 20 dives provided 250 hours working time on the seafloor.

In situ chemical analyser and temperature probes - The chemical analyser, ALCHIMIST (Le Bris *et al.*, 2000) was deployed on the VICTOR 6000 and was operated from onboard. It enabled the determination of profiles of dissolved ferrous iron and sulphide content, together with pH and temperature, over the studied alvinellid communities. The analyser inlet tube was coupled to the VICTOR's temperature probe, and handled by the submersible arm. The inlet was also equipped with a small video camera. In addition to short term measurements, autonomous temperature probes (Micrel S.A.) were deployed to monitor the medium-term variability of temperature at the experiment sites.

Figure 2. The deep-sea ROV, VICTOR 6000

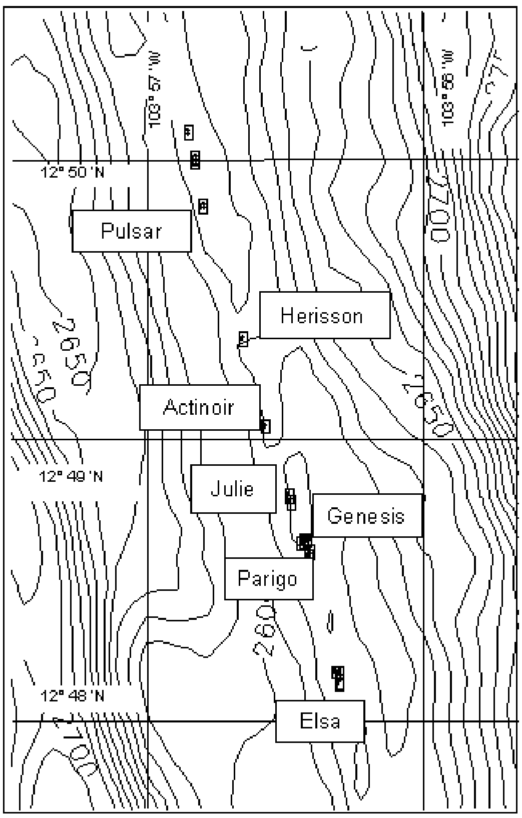

Figure 3. Sites of the PHARE 2002 integrated study

High pressure vessels - Together with ambient pressure aquaria, two high pressure IPOCAMP devices, with 20 litres thermoregulated chambers, were operated on board (Shillito *et al.*, 2001). The systems were coupled to a chemical regulation system (SYRENE) to control dissolved gases content (O_2, CO_2) and pH. Pressure chambers for egg and embryo incubations (PICCEL) were also implemented on board (Pradillon *et al.*, 2001).

***In situ* experimentation**

Segment-scale variability - Identification and description of previously known actives sites from 12°48'N 103°56'W to 12°50'N 103°57'W was assessed. Seven different sites were then repeatedly visited (Fig. 3). These sites, consisting in one or a group of active chimneys, exhibited marked differences in their dimension (from less than 1m to 20m high) and morphologies. Contrasting faunal assemblages were described at these sites. They displayed important changes in their morphologies and/or fauna distribution with respect to the last 1999 cruises. These data will complete the long-term evolution pattern of this segment (Jollivet, 1993).

Focused, *in situ* chemical analysis and temperature measurement over the alvinellid dominated communities suggested marked difference in the thermal and chemical conditions sustained at the different sites. A combination of chemical and thermal characterisation with photographic and videoscopic

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records, and animal sampling will enable to relate the composition of faunal assemblages as well as genetic and demographic population structures, of *Alvinella* spp. or some associated species, to environmental features.

Colonisation dynamic and biogeochemical interaction - To describe the temporal succession of microbial and biological communities colonising a new substrate, TRAC devices (Titanium Ring for Alvinella Colonisation) were implemented. Seven deployments were performed over selected alvinellid colonies, over different chimneys. Each TRAC was equipped with autonomous temperature probes. Chemical and thermal profiles associated to the fluid-seawater mixing gradients in the immediate vicinity of a TRAC were investigated by *in situ* techniques and fluid sampling. Pompeii worm tubes, associated bacterial mats and mineral deposits, formed after 5 to 21 days, were recovered from the TRAC. The mineral composition as well as the mineral content of particles associated with the tubes will be examined in detail to investigate biogeochemical interactions at the nanoscale level between the worm and its epibiotic bacteria. Mineral structures associated to the Alvinella tubes on chimney walls will also be considered through a combined biological, geological and chemical approach.

"Microscale" diversity - The microscale variations of faunal distribution and of alvinellids population genetic differentiation were studied over single edifices. Thermal and chemical measurements were carried out in conjunction with biological sampling. High resolution photography and video were used to complete this approach.

Additionally, the deployment of microorganism collection devices at different positions within the temperature gradient will enable the investigation of microbial diversity in relation to environmental factors. The diversity of microorganisms associated to the Pompeii worms and the nearby minerals and their metabolic activities will be considered by cultural and DNA-based approaches. For the first time on this 13°N EPR site, the microeucaryote diversity will also be considered.

In vivo experimentation

Dives were also partly dedicated to the collection of live animals for *in vivo* experiments. Special attention was paid to try and recover these animals in the best possible physiological condition, particularly by limiting the delay between collection and recovery on board. When not associated to an extended study of chemical, thermal and faunal characteristics, the biological samples dedicated to *in vivo* experimentation were related to *in situ* temperature measurement, immediately before collection, with the VICTOR temperature sensor.

Temperature tolerance - In this highly turbulent environment, large spatial and temporal temperature variations were confirmed. The tolerance of metazoans to high temperature, however, remains enigmatic and the mechanisms of adaptation to such a constraint still poorly understood. The behavioural and biochemical response of different species of the *Alvinella* spp. habitat to thermal stresses will be analysed, from the video-recordings and samples of on-board heat shock experiments under simulated pressure conditions

Chemical stress - The resistance of animals to chemical toxicity was another topic of *in vivo* experimentation. The effect of hypercapnia (excess CO_2) on the respiratory function of the crab *B. thermydron* was investigated at ambient atmospheric pressure and at 260 bar. Potential adaptation to anoxic and oxic stresses was also investigated in the pressurised aquaria.

Embryo development - To study the environmental conditions that may determine the early stages of *Alvinella pompejana* development, *in vitro* fertilization experiments were performed on board. Embryos were then incubated under simulated or natural conditions.

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Biological studies using *Mir* submersibles at six North Atlantic hydrothermal sites in 2002

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The 47th cruise of the R/V *Akademik Mstislav Keldysh* with 2 manned submersibles *Mir* started on 17th May 2002 from Kaliningrad, Russia, and ended on 14th August in Hamburg, Germany. The cruise was aimed at the studies of geological and biological processes at 6 hydrothermal vent fields on the Mid-Atlantic Ridge (MAR) and at the wreck site of the battleship "Bismarck" that lies at 4500 m depth in the Porcupine abyssal plain. In the present paper we focus on biological studies at the hydrothermal fields Snake Pit, TAG, Broken Spur, Lost City, Lucky Strike, and Rainbow.

Overall attention was focused on the entire hydrothermal ecosystems: benthic, benthopelagic, and planktonic components were examined with equal priority. The biological team consisted of Vladimir Dyakonov (computation biologist), Vladimir Gagarin (primary production, deck work), Sergey Galkin (benthos distribution, mapping and landscape approach to the vent communities), Andrey Gebruk (benthos distribution and ecology), Elena Krylova (benthos distribution, mytilid biology), Alexander Vereshchaka (coordinator of biological studies, water column and near-bottom ecology, shrimp biology), Georgy Vinogradov (water column and near-bottom ecology, amphipod biology). Three guest researchers participated in biological works: Christian Borowski (Max Planck Institute, Bremen, bacteria-animal symbiosis), Joshua Osterberg (Duke University Marine Laboratory, behaviour of scavengers), and Diane Poehls (Woods Hole Oceanographic Institution, shrimp genetics).

Water column studies

The Mid-Atlantic vent fields between 23° N and 30° N are located in the areas where the primary photosynthetic production is estimated as ca. 200 mgC_{org}/m^2/day. Seven dives were devoted to a plankton research program at the MAR vents. During these dives, large planktonic animals (0.5 cm and larger) were visually studied (see details of the method in Vereshchaka and Vinogradov, 1999). In addition to the visual observations, a vertically hauled BR $^{113}/_{140}$ plankton net (opening area 1 m^2, mesh size 500 ìm) was used. Above all vent fields the near-bottom layer was sampled, the net position was controlled with a pinger ("Benthos"). The sampled layers corresponded to different water masses recorded by preceding vertical probing with a CTD Rozette.

The MAR vent sites can be divided into 2 principal groups: the southern abyssal vents below the central part of the North Atlantic halistatic area (Snake Pit, TAG, Broken Spur) and the northern bathyal vents below the periphery of the halistatic area (Lost City, Lucky Strike, Rainbow).

Southern abyssal vent fields

The plankton distribution above these sites showed three maxima (Fig. 1). The main maximum was positioned in the lower part of the main pycnocline at 700-1000 m. This is a common phenomenon in the deep North Atlantic and usually related to a high abundance of various mesopelagic animals. The second, much less prominent, maximum was located at ~2000 m and might be associated with the presence of Mediterranean water masses, which were well marked by the salinity curve. Appendicularians and chaetognaths dominated in the plankton community in the second maximum.

The third maximum was observed adjacent to the hydrothermal plumes and was mainly composed of gelatinous animals (including voluminous appendicularian "houses"). Similar increase of the appendicularian abundance near the bottom has been previously reported from the Rainbow vent field, and from a non-vent site off Newfoundland near the wreck of the *Titanic* (Vinogradov and Vinogradov, 2002 a, b). Later in the cruise, we found a similar pattern at

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the *Bismarck* wreck site. We suggest that suspension-feeding appendicularians may be attracted by the suspended organic matter concentrated in the nepheloid layer and in hydrothermal plumes. Ctenophores are the second group of gelatinous animals that contribute to the plankton maximum associated with the hydrothermal plume (see also Vereshchaka and Vinogradov, 1999). They tend to aggregate along the plume boundaries and avoid the core.

While the general pattern of the plankton distribution is similar at all southern fields, differences appear in total numbers of major plankton groups in the layer of the main pycnocline. For example, at Broken Spur located in a relatively productive oceanic area carnivores are more abundant. The TAG is characterised by high concentrations of large (>0.5 cm) detritus particles, which appear as long "slime threads" and "marine snow" and are almost evenly distributed in the water column beneath the main pycnocline. This phenomenon was observed 6 years before above the same vent site and thus is not occasional.

Northern bathyal vent fields

The taxonomic composition of the plankton community differs from that at the southern fields. The major plankton taxa are more abundant, and the share of large gelatinous animals is generally higher in the near-bottom maxima than above the abyssal fields. Because these sites are shallower, the bottom interfaces either the main pycnocline (Lost City) or the plankton-rich water masses just below the pycnocline (Rainbow and Lucky Strike). As a result, animals such as chaetognaths, pelagic shrimp, and siphonophores are abundant throughout the entire water column (Fig. 2). Biomass of the euphausiid *Thysanoessa* sp. and the copepod *Calanus helgolandicus* was very high (wet biomass 2.1 and 3.3 mg/m^3, respectively), *C. helgolandicus* is mainly concentrated in the layers 1000-1700 m. At Lucky Strike, where depths are 1700-1800 m, the copepod aggregations directly contact with the benthic communities, whereas they are well separated at the deeper Rainbow field (> 2000 m).

Lost City (depth ca 800 m) is a comparatively shallow site and washed by the waters of the main pycnocline. Its relative proximity to the Broken Spur vent field is reflected by a generally similar vertical distribution pattern of the main planktonic groups. However, the absolute plankton abundance is 2 to 3-fold higher at Lost City than at Broken Spur. This enrichment may be a local meso-scale orographic phenomenon, because the site is located on the Atlantis Seamount. It is feasible that potentially occurring local quasi-permanent orographic upwellings or Taylor columns, which are both known to cause plankton enrichment, influence the area. Local enrichment of the chemosynthetic organic matter, which can attract and provide an additional food source for animals, may also be important, especially if coupled with the patterns of the water circulation. However, these conclusions are very preliminary and require further studies.

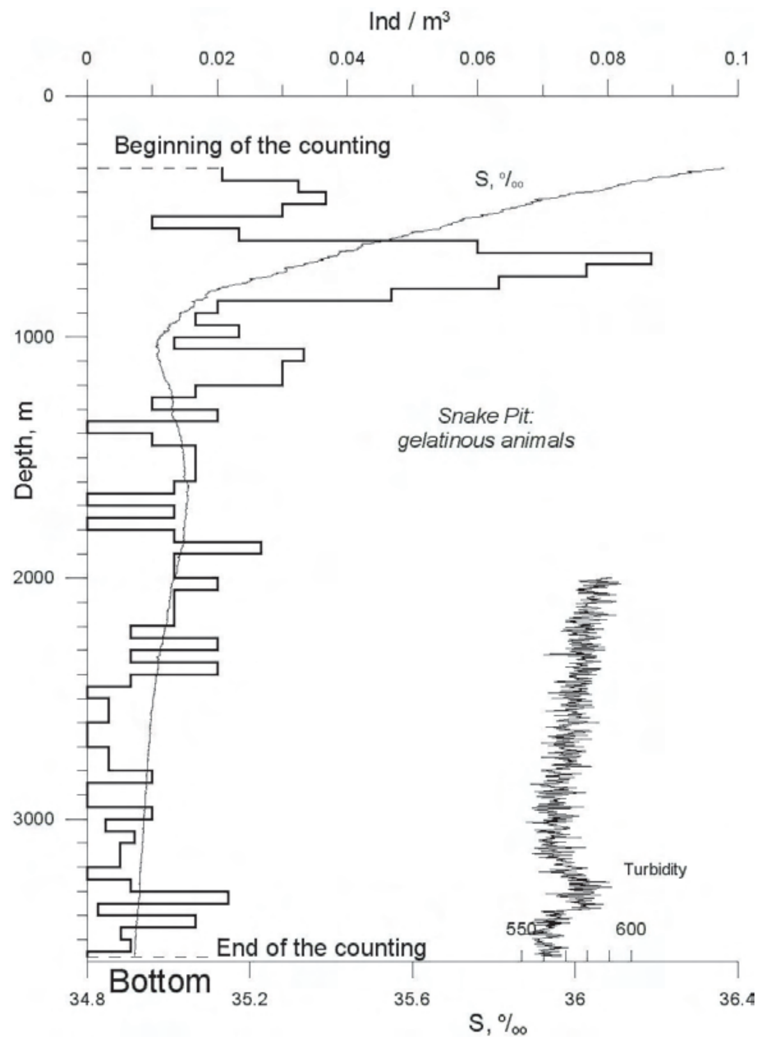

Figure 1. Distribution of the gelatinous animals above the Snake Pit hydrothermal vent field in the whole water column.

Near-bottom studies

Like the pelagic communities in the whole water column, near-bottom benthopelagic communities may be divided into 2 principal groups: southern abyssal vents below the central part of the North Atlantic halistatic area and northern bathyal vents below the periphery of the halistatic area.

Southern abyssal vent fields

While the near-bottom layer is only scarcely populated by pelagic animals, the abundance of benthopelagic larvae of the vent shrimp is extremely high. These larvae create dense aggregations within 1 m above the seafloor, where they can reach 1 ind/m^3; above this layer their numbers decrease exponentially (Fig. 3). The pelagic animals are represented by appendicularians, ctenophores, medusa, copepods, and chaetognaths. Their total abundance hardly reaches 0.001-0.01 ind/m^3 and thus is too low to provide any prominent pattern of their distribution near the bottom. The thickness of the benthopelagic zone, where the bottom-related organisms (mainly shrimp larvae) dominate, ranged from several tens to a few hundreds of meters.

Although the southern vent field communities share common patterns, significant variations may also be observed. At Snake Pit, 2-3-cm large juveniles of *Rimicaris exoculata* (crustacea) dominated in the 0-1-m layer with abundance higher than in any other field (1 ind/m^3). These animals are almost evenly distributed in various microhabitats of the entire Snake Pit field and are found at 200-300 m above the bottom. At TAG, the benthopelagic component is not abundant and is mainly represented by only 3-4-mm large shrimp larvae. Notable abundance of 0.05 ind/m^3 was only observed within the lower 10-m layer. At Broken Spur, the small 3-4-mm larvae dominate as well; however, their vertical distribution ranges over several tens of meters above the sea floor, and their abundance in this entire layer reaches only 0.02 ind/m^3. A similar observation was made in 1996, suggesting that this is a permanent distribution pattern for the Broken Spur benthopelagic animals.

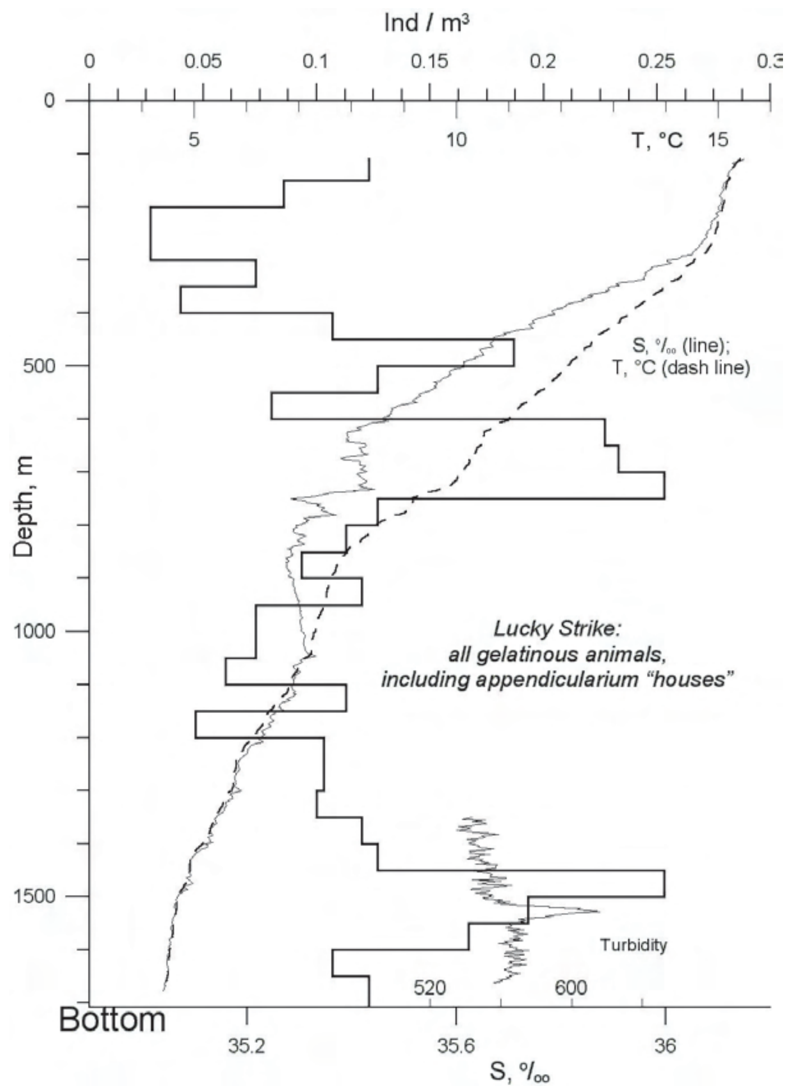

Figure 2. Distribution of the gelatinous animals above the Lucky Strike hydrothermal vent field in the whole water column.

Northern bathyal vent fields

These sites are characterised by a high abundance of pelagic animals, while the share of benthopelagic larvae is smaller than at the southern fields. Pelagic syphonophores, chaetognaths, appendicularians, cyclothones, medusa, and ctenophores are regularly observed near the bottom. The dominant species of temperate pelagic communities, such as *C. helgolandicus* and *Thysanoessa* spp., build up a high biomass (several mg/m^3) in the near-bottom layer. Larvae of benthopelagic shrimp are either absent (Lost City) or occur in small numbers. Therefore, the benthopelagic zone is poorly marked and its thickness hardly reaches several meters.

In contrast to the southern vent fields, the benthopelagic component in the North is largely represented by amphipods (mainly *Bouvierella*). The presence of carnivorous euphausiids of the genera *Nematoscelis* or *Thysanoessa* also characterises the near-bottom plankton communities. These animals are found in unusual depths with maximum abundance at 1500-2000 m.

At Lost City, the amphipod *Bouvierella* aff. *curtirama* and the eu-

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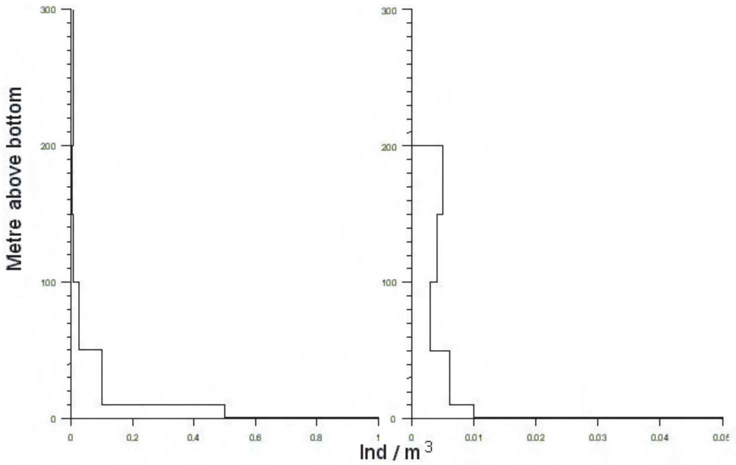

Figure 3. Distribution of the vent shrimp larvae (horizontal axis, abundances as ind/m^3) above Snake Pit (St. 4333, left) and TAG (St. 4340, right) hydrothermal vent fields in the near-bottom layer. Vertical axis is the distance from the bottom (m).

phausiid *Nematoscelis* were dominant. *Bouvierella curtirama* has been previously reported only from Lucky Strike. We observed *Bouvierella* at the bases and along the slopes of hydrothermal structures of Lost City, usually swimming within half a meter above the ground. This behaviour was periodically interrupted by short excursions to the rocky sea floor and the adhering bacterial mats on which they probably feed. *Nematoscelis* was found in a depth range of up to 10 m above ground at the base and along the slopes of vent mounds. Their abundance reached 0.5-5.0 ind/m^3 near the bottom and rapidly decreased by 1-2 orders of magnitude in the upper zone of their occurrence. At Lucky Strike and Rainbow, pelagic animals were more scattered than at Lost City, *Nematoscelis* was replaced by *Thysanoessa*. Although amphipods were also found at Lucky Strike, they were rare and rather associated with the benthic than with the benthopelagic community.

Benthic studies

Studies were focused on two principal aspects:
1) distribution of hydrothermal species and communities along the Mid-Atlantic Ridge and
2) biology of dominant species.

Specific problems included clarification of the biogeographical boundary between the "northern" (Menez Gwen, Lucky Strike and Rainbow) and "southern" groups of hydrothermal areas (Logatchev, Snake Pit, TAG and Broken Spur). Special attention was given to the soft sediment infauna – the poorest known component of hydrothermal communities. Samples of soft sediment were collected using the *Mirs* from all visited areas for laboratory analyses.

Bresilioid shrimp and mytilids of the genus *Bathymodiolus* dominate the vent communities on the MAR. Numerous samples were taken to study special features of symbiosis between shrimp and mussel species and bacteria. Studies of shrimp ectosymbionts were focused on the genetic characterisation of the symbionts of *R. exoculata* and *Chorocaris chacei* from different hydrothermal areas along the MAR. In the studies of mytilid symbionts, special attention was paid to
1) the relationship between methane and sulphide oxidisers in mytilids from different areas along the MAR;
2) comparison of trophic strategies in *Bathymodiolus puteoserpentis* and *B. azoricus;* and
3) the mechanism of acquisition of both types of symbionts in the ontogenesis.

Another priority was given to the symbiosis between *Bathymodiolus* and the polychaete *Branchipolynoe seepensis*. Numerous samples of various age stages of both species of mytilids were taken at Snake Pit, Lucky Strike and Rainbow. Frequency of occurrence of polychaetes, their sex, size and morphological damage caused to the host will be analysed in the laboratory.

Notes on the distribution of mytilids along the MAR and their reproduction cycle.

Bathymodiolus has been reported from all hydrothermal fields known on the MAR, except TAG, Lost City and Saldanha. Two species are known at present: *B. puteoserpentis* and *B. azoricus*. The former occurs in the "southern" group of areas, Logatchev and Snake Pit, with depths ranging from 3000 m to 3700 m. There is evidence that the species at Logatchev differs from that at Snake Pit (type locality) (Gebruk *et al.*, 2000). The species *B. azoricus* is known from the "northern" shallower areas, Menez Gwen, Lucky Strike and Rainbow, where depths range from 850 to 2400 m. Broken Spur and Lost City occupy an intermediate location between northern and southern areas, making their species composition especially interesting from the biogeographical perspective. For example, the location of boundary between species ranges of *B. puteoserpentis* and *B. azoricus* remains unclear.

The mytilids at Broken Spur were reported in the early 90s, although the species identification was not provided. Preliminary genetic information suggested that either both species occur at Broken Spur (Maas *et al.*, 1999), or two species hybridize in this area (see Van Dover, 2002). Preliminary morpho-anatomical analysis of mussels collected at Broken Spur on our cruise showed that all sampled specimens belong to the species *B. puteoserpentis*, despite some morphological variation compared to the specimens from the type locality. Mytilids at Broken Spur are relatively rare, they don't form large populations and often occur solitarily. Clumps, if they are formed, include not more than 5 specimens.

Mytilids at Lost City belong to the species *B. azoricus* (see Gebruk *et al.*, this issue).

Thus, the species range of *B. puteoserpentis* includes the following areas: Logatchev (with some doubts), Snake Pit (type locality), and Broken Spur, the depth ranges from 3000 to 3700 m. *B. azoricus* occurs at Menez Gwen, Lucky Strike, Rainbow and Lost City, at depths from 830 to 2400 m. It seems likely that depth plays a major role in the separation of two mytilids species along the MAR.

The stage of reproductive cycle was different in the specimens of *B. puteoserpentis* (collected between 20 and 29 June) and *B. azoricus* (collected between 9 and 25 July). Gonads of deeper living *B. puteoserpentis* were ripe, filled with gametes and ready for spawning. Juveniles in samples were lacking. Conversely, in *B. azoricus* the reproduction period was over (or about to finish): the majority of specimens had empty gonads, larvae and juveniles were numerous in the samples. The condition of gonads was similar in specimens from Lucky Strike and Rainbow, as was the occurrence of juveniles in the two areas, indicating a synchronous reproduction despite the difference in depth (1700 and 2400 m correspondingly).

Brief account on new observations at all visited hydrothermal fields along the MAR:

S n a k e P i t . The composition and distribution of the benthic fauna was studied at Moose, Beehive (eastern part of the field), and Nail (western part of the field).

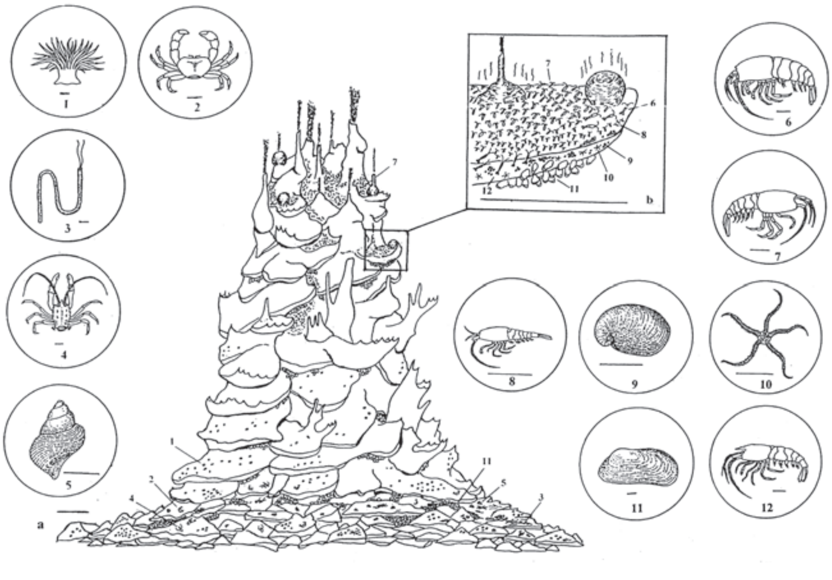

Figure 4. Reconstruction by S.V. Galkin. Distribution of the fauna at the vent field Snake Pit on the site named 'Moose'. **a** – general view; **b** – enlarged view of the upper part. Main fauna: 1 - *Parasicyonis ingolffi*; 2 - *Segonzacia mesatlantica*; 3 - Polychaeta Chaetopteridae; 4 - *Munidopsis crassa*; 5 - *Phymorhynchus* sp.; 6 - *Chorocaris chacei*; 7 - *Rimicaris exoculata* (adults); 8 - *Rimicaris exoculata* (juveniles); 9 - Gastropoda Peltospiridae; 10 - *Ophioctenella acies;* 11 - *Bathymodiolus puteoserpentis;* 12 - *Alvinocaris markensis.* Scale bars are shown as horizontal lines: **a** and **b** - 1 m; animals (1-12) - 1 cm. Depth of base 3491m, reconstruction made based on 3 dives in the submersibles "Mir" (St. 4330, 4332-4333) and videotape recordings.

The Moose complex lies at the depth of 3488 m and is 16 m high, its base is about 6 m wide (Fig. 4, reconstruction by S. Galkin). The bivalve *B. puteoserpentis* is especially abundant at the base of Moose (hundreds of individuals per 1 m^2) close to the shrimp aggregations, where low-temperature fluids occur. Gastropods Peltospiridae create dense patches (hundreds of individuals per few dm^2) in the vicinity of shimmering water. Active shimmering water is marked by dense aggregations of *R. exoculata* that cover large areas at the top 1/3 part of the construction. Shrimp were represented only by juveniles of different age stages form isolated patches in the shimmering water and these patches did not appear to mix with each other. Carnivorous and scavenging shrimp *C. chacei* and *Alvinocaris* spp. are distributed throughout Moose but are more numerous outside the *R. exoculata* aggregations. The Moose complex has an elaborate morphology and various forms of fluid discharge that exclude a simple zonality.

Beehive hosts very dense aggregations of *R. exoculata* living in the black smokes and lacks any trace of mytilids. In spite of its small size (3-4 m high), Nail reveals a complete biological zonality, from 2 galatheids and a single zoarcid fish at the base – to a small swarm of juvenile *R. exoculata* on the top where the white smoke occurs.

T A G . Observations were focused on the communities at the base of the main complex and point "D", which is one of microbiotopes located some distance from the main complex. These microbiotopes were selected since they are less known than any other biotope (*e.g.* slopes of the main complex and the black smokes area) at TAG. These biotopes are dominated by *R. exoculata*, both juveniles and adults, which do not create dense aggregations. Other shrimp, *C. chacei*, *M. keldyshi*, and *Alvinocaris* spp., are also common in this area, their abundance reaches 50 ind/ m^2. Outside the shimmering water, crabs *Segonzacia*, gastropods *Phymorhynchus*, actinians, and chaetopterid polychaetes are common. Moults and corpses of *R. exoculata* form "cemeteries" in the sediment depressions and attract scavengers *Phymorhynchus* and *Alvinocaris*.

Broken Spur. Hydrothermal communities were studied at 5 sites: White Mushroom, Saracen's Head, Bogdanov Site, Triple Chimney, and Spire. Active structures were dominated by the shrimp *R. exoculata;* adults in black smokes and juveniles in the shimmering water. The second dominant shrimp, *M. fortunata*, was common in the shimmering water and formed aggregations of hundreds of individuals per m^2. Slow-flow areas were covered with bacterial mats. Crabs *Segonzacia*, gastropods *Phymorhynchus*, brittle stars *Ophioctinella acies* (tens of individuals per dm^2), and shrimp *M. fortunata* and *Alvinocaris* were all common in this area. Gastropods Peltospiridae and Fissurelidae formed patches of very dense aggregations. Mytilids *B. puteoserpentis* were very few and present in the cracks at White Mushroom, point "D", Spire, and Triple Chimney.

Each vent site at Broken Spur has its own features. In general, shimmering water is marked by shrimp *M. fortunata*, crabs *Segonzacia*, gastropods (*Phymorhynchus* and Peltospirodae), brittle stars *O. acies*, and small (1-2 cm) actinians. Black smokes are occupied by aggregations of *R. exoculata*. Morphology of the structures does not provide enough substrate washed over with the shimmering water, that explains comparatively low abundance of this species.

Lost City. Preliminary data on biological communities of Lost City are given separately (this issue, Gebruk *et al.*). This recently discovered vent field is characterised by unique carbonate structures that develop at a depth of about 850 m and dominate at 750-800 m. The structures form massive columns 10-12 m high and 3-4 m in diameter. Central part of the complex consists of numerous columns >30 m high tapering in snow-white tops of fragile material. Week shimmering water is found on the tops and between the columns. Valves of *Bathymodiolus azoricus* were found at the base of the central complex. This is the first record of the obligate hydrothermal fauna at Lost City. Other possible hydrothermal species are represented by the peltospirid limpets (shells of at least 2 species were found), the bivalve *Thyasira* and the amphipod *Bouvirella* aff. *curtirama* (see above), similar to the species found before only at Lucky Strike.

Lucky Strike. Composition and distribution of benthic fauna were studied in the southern and eastern parts of the field at the sites Eiffel Tower, Sintra, Mark 2806, and Mark 4. Observations on Eiffel Tower were most detailed. Mytilid generations were spatially separated: in the lower part of the Eiffel Tower small mytilids covered 20% of the substrate, larger animals were less abundant and dominated the top of Eiffel Tower. In the middle part of the structure, there were white smokers and shimmering water; bacterial mats covered 20% of the surface. Abundance of the shrimp *Mirocaris fortunata* in this zone reached 1000 ind/m^2. The shrimp *C. chacei*, *Alvinocaris* spp., and the crabs *Segonzacià* were common.

Rainbow. In general, this area was dominated by the shrimp *M. fortunata* and the mytilid *B. azoricus*. Most of the mytilids were represented by small animals; the central part of the field was covered with dead valves of various size. The shrimp *R. exoculata* was represented almost entirely by mature specimens, only few juveniles were collected. During previous visit in 1998, mytilids of all sizes and juvenile *R. exoculata* were common. Observed faunal changes suggest catastrophic events (change in hydrothermal activity) in this area between 1998 and 2002.

Acknowledgements

The authors thank Diane Poehls and Joshua Osterberg for their valuable help in the work at sea.

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International Research: **Mid-Atlantic Ridge**

Evidence of a Probable Magmatic Episode at the Lucky Strike Segment, Mid-Atlantic Ridge, March 2001

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Introduction

During March 16-17, 2001 a swarm of 128 earthquakes occurred along the Lucky Strike segment of the Mid-Atlantic Ridge (MAR) near 37EN (Fig. 1). The earthquakes were detected and located using six NOAA/PMEL autonomous hydrophones moored within the ocean sound channel along the flanks of the MAR from 15E-35EN. The hydrophones were first deployed in February 1999 (see InterRidge News 8.1, March 1999) by a consortium of U.S. investigators (National Science Foundation and NOAA) and the experiment will continue to at least February 2007. The hydrophones are deployed and recovered on a yearly schedule with data being processed within 6 months of recovery. Generally, hydroacoustic monitoring provides a lower threshold for detecting MAR earthquakes than land-based seismic networks

The Lucky Strike spreading segment is strongly influenced by its proximity to the Azores Hotspot, and is magmatically robust compared to other segments of the MAR (Scheirer *et al.*, 2000). The segment is characterized by a broad rift valley (~12 km wide), and exhibits the greatest depth contrast of any segment on this part of the MAR (Detrick *et al.*, 1995). The center of the segment is dominated by the 8 km wide, 1 km high Lucky Strike Seamount. The seamount hosts a vigorous hydrothermal system and a lava lake (Humphris *et al.*, 2002). Recently, the MOMAR Project was formed to pro-

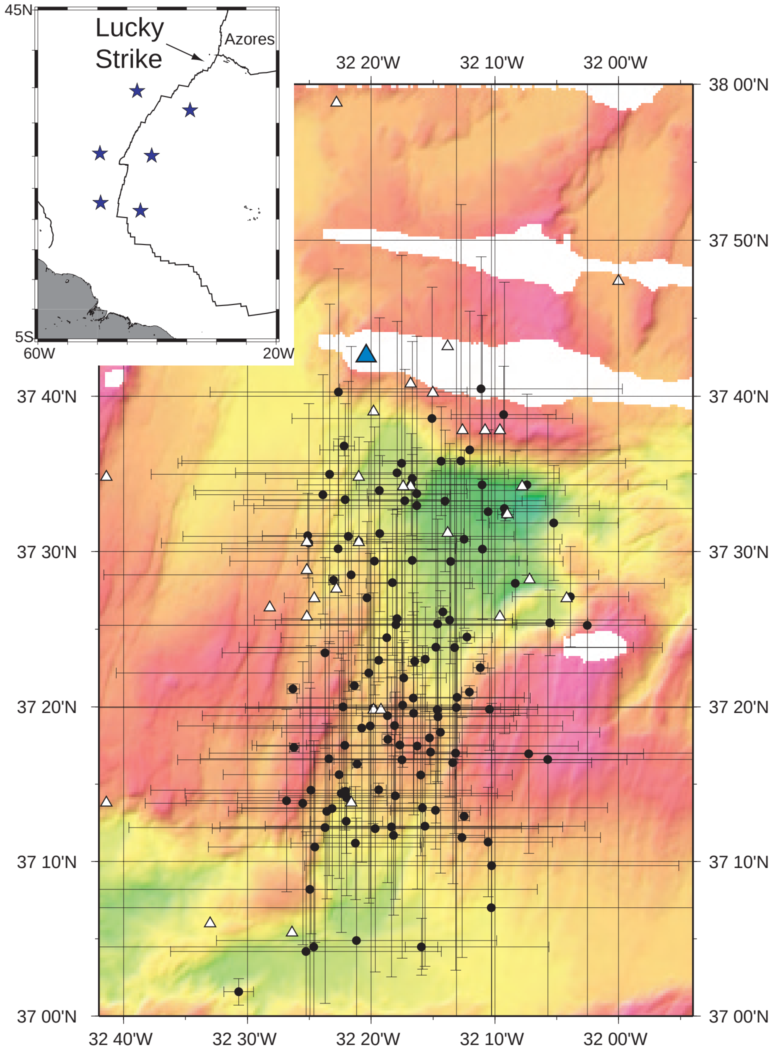

Figure 1. Bathymetry and earthquake locations from the Lucky Strike Segment. Black circles show hydroacoustic earthquake locations (128 events; error bars = 1σ), white triangles show teleseismic locations (30 events) from the March 16-17 2001 swarm. Dark triangle shows teleseismic location of largest event detected (M_w=5.0) during the swarm. Inset map shows location of hydrophone array (stars) and Lucky Strike Segment along the Mid-Atlantic Ridge.

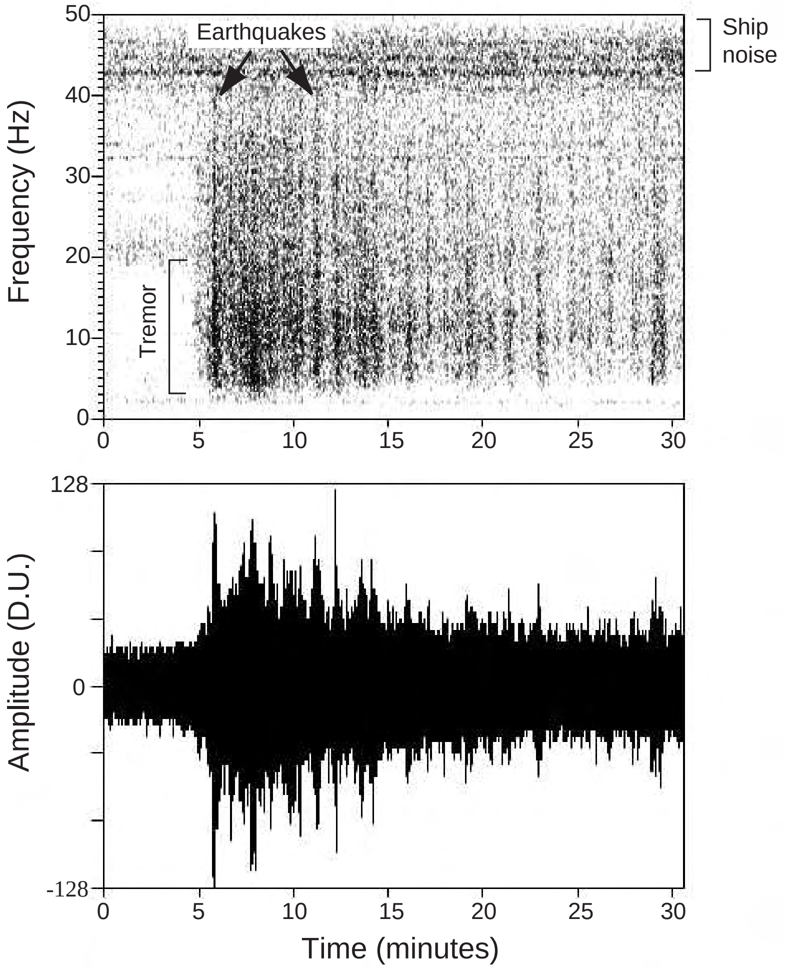

Figure 2. Time series and spectrogram of the northeast hydrophone (closest to the Lucky Strike Segment) showing the onset of the earthquake swarm. Broadband, impulsive earthquake arrivals standout against a background of low-frequency (3-15 Hz) continuous tremor energy.

mote international cooperation to establish long-term multidisciplinary MOnitoring on the Mid-Atlantic Ridge near the Azores region. The Lucky Strike area was selected at the first MOMAR workshop as the most appropriate site to begin vent and segment scale monitoring experiments.

Event Description

The Lucky Strike earthquake swarm recorded on the hydrophone array began on March 16 at 1528Z and continued for 29 hrs until 2036Z on March 17. Nearly half of the 128 events occurred in the first 1.5 hrs reaching a peak of 42 events/hr, but thereafter activity rapidly declined to #5 events/hr. The first four earthquakes of the swarm occurred along the summit and flanks of the Lucky Strike Seamount and were accompanied by continuous, low frequency (<15 Hz) tremor-like energy (Fig. 2). Within minutes, however, the events began locating north of the volcano and within the Lucky Strike rift valley (Fig. 1, black dots), giving the appearance that the entire Lucky Strike segment was undergoing a seafloor spreading episode. The earthquake locations in Figure 1 are shown with attendant errors (1F), which are somewhat higher than location errors for earthquakes within the array. While it is not possible to associate earthquakes with individual faults or volcanic features, it seems clear the Lucky Strike segment is the source of the seismicity. Furthermore, analysis of the time-distribution and magnitudes of hydroacoustic seismicity suggests this was not a mainshock-aftershock (tectonic) sequence, but fits the definition of an earthquake swarm with a likely magmatic component.

The U.S. National Earthquake Information Center (NEIC), using land-based seismometers, located 30 earthquakes (3.6 # mb # 5.0) from the Lucky Strike swarm (Fig. 1; white triangles). NEIC locates three of the earthquakes along the Lucky Strike segment, the rest are located in an intraplate region north of the rift valley. The teleseismic locations of the Lucky Strike earthquakes differ significantly from the hydroacoustically derived locations. This is likely a function of the more accurate ocean sound-speed models available from years of oceanographic sampling and proximity of the hydrophones to the earthquake source (Smith *et al.*, 2002). The largest earthquake (M_w=5.0; large triangle on Fig. 1) has a normal-fault CMT solution, but occurred 5.5 hours into the swarm after the majority of the hydroacoustic seismicity (78 events) had occurred, supporting the interpretation that this was not a mainshock-aftershock sequence. Relative event depths, estimated from the rise-time of each earthquake's hydroacoustic signal, suggest events were shallow during the initial 5 hrs of the swarm, then deepened following the M_w=5.0 earthquake.

Summary

Analysis of the seismic and hydroacoustic data from Lucky Strike indicate that several characteristics present in this episode are similar to the documented plume-producing, extrusive events observed on the Juan de Fuca Ridge (JdFR) (*e.g.* Fox, 1999). These include a vigorous earthquake swarm (30 earthquakes/hr during the first two hours), continuous tremor-like energy at the swarm's onset, and no initial mainshock. Intrusion tremor observed at Krafla Volcano in Iceland is very similar to the tremor observed here, with a broad spectrum and predominant frequencies >3 hz (Brandsdottir and Einarsson, 1992). Small earthquake swarms (<100 events) at Krafla (Bjornsson, 1985) and Axial Volcano along the JdFR (Dziak and Fox, 1999) have been shown to represent intrusions of magma beneath the volcano's summit and into adjacent rift zones. Intrusion tremor and earthquakes typically stop once magma reaches the surface or the dike stops propagating.

There are, however, notable elements missing as compared to previously documented mid-ocean ridge eruption episodes. Typically eruptions on the JdFR produce earthquake swarms with durations from one to several weeks, while the Lucky Strike swarm lasted only 29 hrs. Documented eruption events have also exhibited significant (>10 km) migration of earthquakes that are caused by the lateral propagation of a magma dike into the shallow crust of the rift zone. The Lucky Strike swarm showed no obvious earthquake migration, rather the seismicity appeared to occur almost simultaneously at the summit of Lucky Strike Seamount and northward along the ~50 km ridge segment.

In addition, previously documented mid-ocean ridge eruptions have produced an abundance of seafloor and water-column observations confirming magmatic activity. Preliminary analysis of *in situ* observations of the Lucky Strike hydrothermal field obtained from submersible dives during July 2002 suggest an increase in diffuse venting, especially along the sides and base of the black smoker mounds, since the site was last visited in 1997 (T. Shank, pers. com.). However, no evidence of recent lava flows has yet been observed, and all pre-existing hydrothermal vents appear to still be intact.

We interpret the March 2001 earthquake swarm at Lucky Strike as representing a probable magmatic/dike-emplacement episode that may have occurred without an eruption of lava on to the seafloor. Even without a seafloor eruption, a dike emplacement event would in all likelihood have produced a measurable increase in the fluid temperatures and flux rates at pre-existing hydrothermal systems. The earthquake activity itself, independent of any magmatic influence, can cause significant changes (via ground motion) to vent fluid temperatures and flux rates which can have a profound effect on the populations of macro- and microorganisms inhabiting the hydrothermal vent sites (Dziak and Johnson, 2002).

The March 2001 Lucky Strike earthquake swarm was very similar to the small swarms, detected only using hydrophones, at Axial Volcano (JdFR) during the 7 years prior to a massive eruption in 1998. Thus the Lucky Strike swarm could be a precursor to increased seismic and volcanic activity at Lucky Strike Seamount. Since only two years of MAR hydrophone data have been processed to date, it remains to be seen how the March 2001 earthquake swarm fits into the overall volcanic cycle of Lucky Strike Seamount. Nevertheless, this earthquake swarm provides strong evidence that the Lucky Strike area is an excellent candidate for monitoring volcanic activity, seafloor deformation, and hydrothermal vent processes along the MAR.

Contact Information and Acknowledgements

For additional information regarding this and other significant Mid-Atlantic Ridge hydroacoustic seismicity, visit: *http://www.pmel.noaa.gov/vents/acoustics/seismicity/mar/LuckyStrike2001.html*.

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International Research: **Mid-Atlantic Ridge**

Uranium, its minerals and parageneseses in massife sulphides of the Logatchev-2, MAR ore field

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Ore manifestation "Logatchev-2" was discovered during the course of the 7th cruise of the *R/V "Professor Logachev"* (1994), located at the base of the eastern slope of the rift valley Its coordinates are 14°43'22''N and 44°56'27''W, covering an area of 0,15-0,2 km^2. As a result of teleprofiling, 6 ore bodies were found at an average depth of 2700 m. The ore field is found exclusively on a depleted serpentinite substrate. E-MORB basalts of the Mid-Atlantic Ridge found nearby lack ore mineralisation.

The composition of the ores was studied in the bulk sample (120 kg) of station 384, sampled in the near-top part of the large ore body by PMGRE and characterised by accreted tubes with conic shape. The tubes have zonal structure manifested by changing of dominating chalcopyrite mineralisation in their centres, with sphalerite ore at their margins. Cramped "graphical" intergrowths of chalcopyrite and sphalerite, and their rhythmical alternation are typical for the central parts of the tubes and indicate practically simultaneous crystallization. The quantity of opal that covers and replaces sulphides reaches 10 vol.% in places.

Mineral phases were analysed by electronic microscope ABT-55 (Japan) with link-10000 under accelerating voltage 25 kV in the Institute of Precambrian Research (analyses M.D. Tolkachev, M.R. Pavlov). The time of impulse accumulations ranged from 30 up to 300 sec.

The elements with contents exceeding 2σ were considered to be significant. The width of the electronic beam was estimated to be 3 microns. First determination of uraninite was made in "Mekhanobr-Analyt" by methods of electronic microscopy and electronic microanalysis (Camsca-4DV, Link LZ-5), under accelerating voltage of 30 kV (analysis Yu.L. Kretser).

Uraninite was found in sample 384-3 in colloidal cryptocrystalline form. The general content of U determined by thermoluminescence analysis (Chemical Lab of VSEGEI, St. Petersburg) is 1590 ppm.

Uraninite in the sample is variously ball-shaped, concentrically zoned, found in chains in opal, and found coating the external boundaries of sphalerite, chalcopyrite, and chalcocite (Fig. 1, Fig. 2). This habit resembles native gold grains within similar mineral associations. The grain sizes vary, with a maximum of 15 microns. The chemical composition of uraninite is relatively homogenous and comprises U-71.8 wt.%, Ca from 0 to 1.0 wt.%. Admixtures of Zn, Fe, Cu (0,n) are recorded. Due to the small sizes of mineral phases, we have not yet completed microstructural analyses, determination of the ratios of UO_2/UO_3, or determined their optical features. As a consequence, the precise determination of mineral species is not yet available.

Chalcocite in contact with uraninite is enriched in iron in central regions (up to 15.1 wt.% Fe), and is depleted in iron along the margins (7.3 wt/% Fe and less). This may point to evolution of the hydrothermal solution towards lower iron content and temperature over time. Admixture of uranium is recorded in hosting opal (up to 0.8 wt.%) and in marginal zones of chalcopyrite (up to 1 wt.%). With the exception of chalcocite, zoned sphalerite and chalcopyrite with similar zoned structures were found in the sample. According to iron content in sphalerite (from 12 wt.% in the centre up to 5 wt.% in marginal zones) the temperature interval of crystallization was determined to be 200-300°C. Galenite, attributed to late paragenesis, as well as gold, was found mainly in the opal matrix and contains up to 4 wt.% Se (possibly as an admixture of fine grained clausthalite). As rare accessories, lead sulphates, tetrahedrite, coloradoite have been

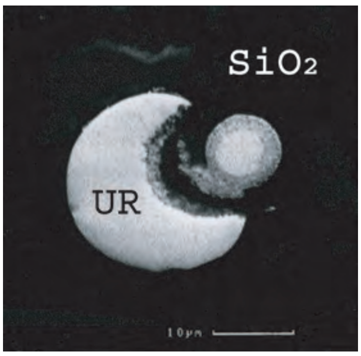

Figure 1. Uraninite in opal matrix with sphalerite, bse image

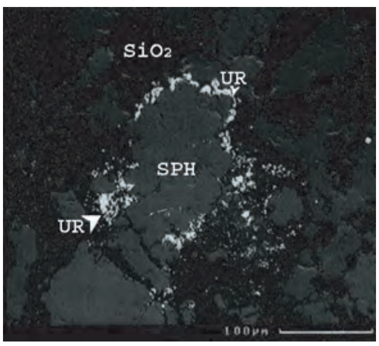

Figure 2. Uraninite surrounding sphalerite in opal matrix, bse image

found. Gold and electrum, with sizes up to 5 microns are traced along the marginal zones of sulphides and interstitial opal. The REE-bearing phase $(La_{0.18}Ce_{0.48})Fe_{1.06}O_2$ with a size of 40 microns was found with uraninite in the opal matrix.

The mineral association of uraninite with gold and sulphides is well known within continental formations. The described manifestation of uraninite in massive sulphides is unique. The reported content of uranium in massive sulphides of the TAG reach only 40 ppm (Miller, 1998). The discovery of anomalously high uranium content (1560 ppm), thorium (15 ppm), gold (up to 50 ppm), and mercury (up to 9.15 ppm) (Torokhov *et al.*, 2001), suggest the input of incompatible elements of mantle origin. This is supported by the high He^3 content (Prasolov *et.al.*, 2002).

Analysis of the U-O-H_2O-CO_2 diagram (Fig. 3) shows that in the course of pe evolution of a hydrothermal solution, *i.e.* increase of pe, uraninite should crystallize and exist in a solid phase even earlier than sulphides.

The presence of silica indicates extremely high pH values (min. 8) of the hydrothermal solution. This suggests that uraninite could be formed during earliest paragenesis (in the form of gel particles or spheres of different sizes) and concentrated later in residual (after sulphide crystallization) liquid with final placement in the opal matrix. This also means, from our point of view, that a significant part of the uraninite and a lesser part of uranyl complexes could be removed from the hydrothermal solution into the hosting oceanic water, changing the uranium and radium (as a daughter element) balance of the local water column.

Conclusions

1) Formation of uraninite takes place within earliest paragenesis with the consequent transport and conservation of ball-shaped forms into the opal matrix.
2) Probable source of uranium is oceanic mantle, as is suggested by the high contents of Hg, Th, Au, Ag, He^3 etc, as well as by confinement of this ore body to serpentinite massifs.
3) More serious attention should be paid to precise determination of radioactive elements in massive sulphides
4) Environmental impact of radioactive elements should be taken in account in case of mining

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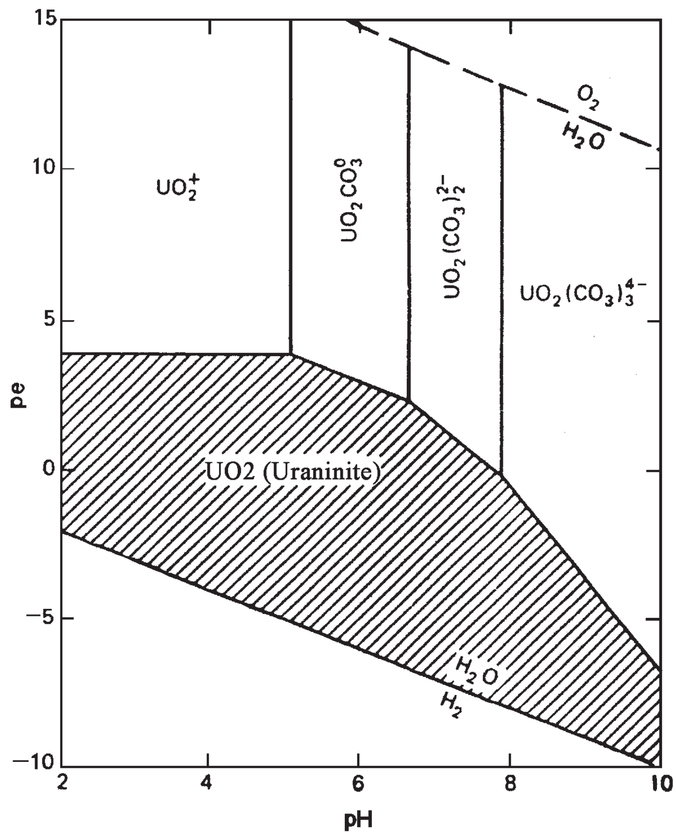

Figure 3. Simplified pe-pH diagram for the system U-O-H_2O-CO_2 under 25°C and $P_{CO2}=10^{-2}$ atm, showing stability forms of ideal solid uraninite and soluble uranyl forms. Limits of solubility are given for 10^{-6}mol of dissoluted U (from Drever, 1985).

International Research: **Back Arc Basins**

Kairai KR03-01: Mantle peridotites in a backarc basin setting

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Abstract

The study of backarc spreading systems has a strong bearing on two important aspects of the Earth's evolution, as it relates to both subduction zone and mid-ocean ridge dynamics. However, this important tectonic setting is much less well studied than are arcs or mid-oceanic ridges. Ultramafic rocks are currently known only from very few dredge hauls in the Parece Vela Basin (PVB) in the Mariana backarc. Geophysical mapping suggests, however, that lower crustal and upper mantle rocks probably make up a significant fraction of the total outcrop in this area. The cruise KR03-01 in January 2003 will conduct intensive sampling in the PVB in order to address issues of mantle composition, melting dynamics and lithospheric exhumation in an apparently amagmatic backarc basin.

Introduction

Serpentinized peridotites are important components of oceanic lithosphere and are exposed at slow-spreading mid-oceanic ridges; these are referred to as abyssal peridotites (Dick, 1989). Abyssal peridotites crop out at "tectonic windows" developed as major faults or escarpments on the seafloor. Observations at these tectonic windows provide important constraints on the architecture of oceanic lithosphere, on the nature of the seafloor spreading process in time and space, and on the composition of the oceanic lithosphere itself.

In backarc basins, peridotite exposures are only known from the Parece Vela Basin (PVB), and the Mariana Trough, both in the Philippine Sea (Fig. 1) (see Ohara *et al.* (2002) and references therein). Thus we know relatively little directly about the deeper lithospheric architecture and composition of backarc basins. Detailed petrologic studies on the few available samples by Ohara and others reveal fundamental characteristics of peridotites from the two Philippine Sea backarc basins (Ohara *et al.*, 2001; 2002; Ohara and Stern; submitted). In addition to

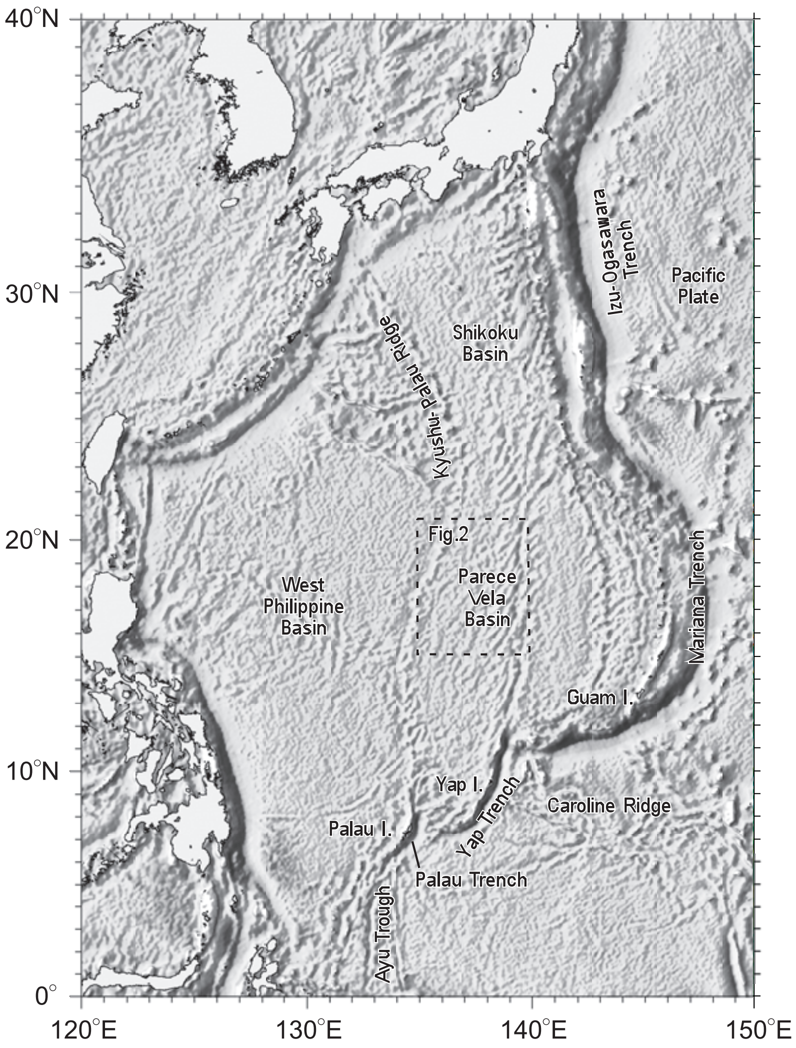

Figure 1. Satellite altimetry map showing the tectonic feature of the Philippine Sea. Dotted box indicates the location of Fig. 2.

these, Ohara *et al.* (2001) argued for amagmatic tectonics in backarc basin setting. However, little is known at present about the details of this process.

There has been a long controversy about whether the large, well-preserved ophiolites, like those in Cyprus and Oman, formed at mid-ocean ridges or above subduction zones (*e.g.*, Miyashiro, 1973). In order to tackle the so called "ophiolite problem" from the point of view of mantle rocks, we need to know the composition of backarc basin upper mantle. Although many scientists consider that ophiolites originate from backarc basins, a lack of backarc basin upper mantle samples hinders our ability to test this hypothesis.

The KR03-01 cruise aboard the Japan Marine Science and Technology Center (JAMSTEC)'s *R/V Kairei* is scheduled to better understand deeper lithospheric architecture and composition of a backarc basin. In this article, we will briefly introduce our cruise plan, with an aim to stimulate "inter-project" studies in this poorly constrained tectonic setting, since study of backarc basins is deeply related to both the InterRidge and MARGINS communities.

Geological background

The Philippine Sea occupies a large part of the western Pacific, and is composed of three large basins separated by the Kyushu-Palau and West Mariana ridges (both are remnant arcs; Fig. 1). East of the Kyushu-Palau Ridge, the Shikoku Basin and the PVB are extinct backarc basins. The central PVB is characterized by a N-S trending chain of right-stepping en-echelon depressions (the Parece Vela Rift) bordered by escarpments extending ~ N20°E from the depressions into the surrounding basin floor (Fig. 2). The escarpments and depressions (maximum depth ~ 7500 m) are fossil fracture zones and extinct segmented-spreading axes (first-order segments), respectively. The PVB had a two-stage spreading history (Okino *et al.*, 1998; 1999), the first of which was E-W rifting and spreading with spreading axes trending N-S beginning at ~ 29 Ma (spreading rate: 8.8 cm/y full-rate) (Okino *et al.*, 1998; 1999). The second stage involved counter-clockwise rotation of spreading axes from N-S to NW-SE at ~ 19 Ma (spreading rate: 7.0 cm/y full-rate) (Okino, unpub. data; Ohara *et al.*, 2001). PVB spreading ceased at ~ 12 Ma (Okino, unpub. data).

Mapping by Ohara *et al.* (2001) revealed rough topography in the PVB, suggesting amagmatic extension in the basin. The most distinct topographic feature is a set of megamullions in the Parece Vela Rift (PVR). Recently discovered "megamullions" in slow-spreading ridge have been interpreted as exhumed footwalls of low-angle normal faults, characterized by distinct corrugation normal to spreading axis (*e.g.*, Cann *et al.*, 1997; Tucholke *et al.*, 1998). The PVR megamullion is the

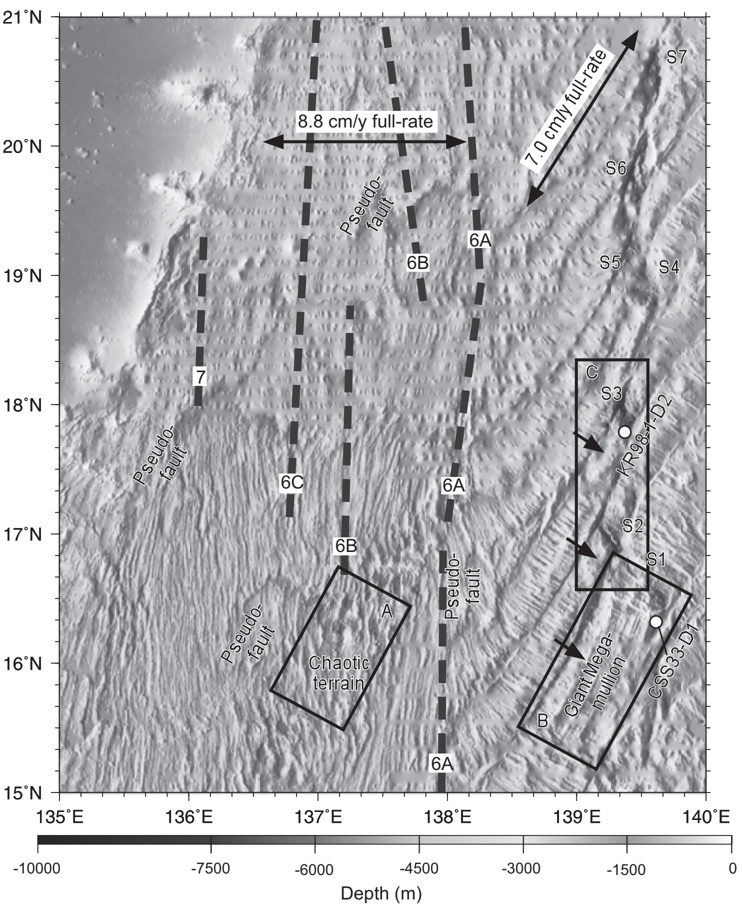

Figure 2. Interpreted shaded structural image of the PVB after Ohara and Stern (submitted) illuminated from 270°. Dotted grey lines are magnetic anomaly isochrons with anomaly number taken from Okino *et al.* (1998). The short, first-order segments are labelled as S1-S7 (Ohara *et al.*, 2001). Distinct mullion structures indicated by short arrows, are developed at segments S1-S3. The chaotic terrain characterized by rough bathymetry is identified in the western PVB, also suggesting amagmatic extension occurred there. Some notable pseudofaults are indicated. The dredge haul CSS33-D1 by *S/V Takuyo* recovered peridotites and gabbros, whereas KR98-1-D2 by *R/V Kairei* only peridotites (Ohara and Stern, submitted). We will conduct detailed dredging and geophysical mapping on the Boxes A to C in order to meet the cruise objectives described in the text.

International Research: **Back Arc Basins:** Ohara *et al.*, cont...

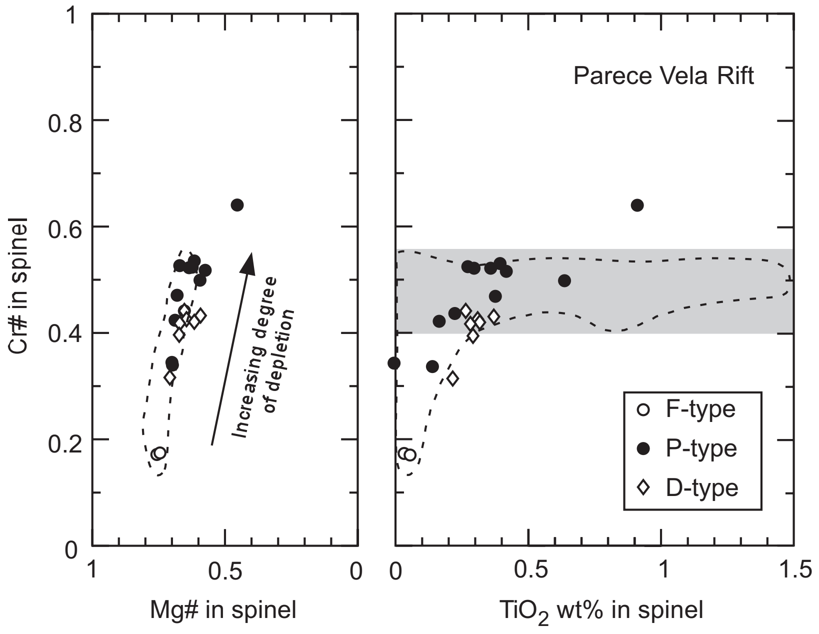

Figure 3. Spinel compositional plots after Ohara and Stern (submitted), with fields for abyssal peridotite indicated by dotted line for comparison (Dick and Bullen, 1984). F-type: fertile type; P-type: plagioclase-bearing type; D-type: dunite. Hatched area is the TiO_2 compositional range for most abyssal plagioclase-bearing peridotites (Dick and Bullen, 1984).

largest seafloor megamullion known. Ohara *et al.* (2001) named it the Giant Megamullion, as it is ~ 10 times larger than the MAR megamullions. The other distinct topography is a rugged "chaotic terrain" in the off-axis region of the western PVB. This terrain consists of isolated and elevated blocks (maximum relief is ~ 1500 m), capped by corrugated axis-normal lineations, and associated deeps (maximum depth ~ 6000 m). The chaotic terrain has a distinctly higher mantle Bouguer anomaly, about 30 mgal, indicating a thinner crust beneath the area (Okino *et al.*, 1998). The morphology and the gravity signature of these individual blocks are again very similar to the MAR megamullions. Similar off-axis rugged topography is known at the "high" intermediate-spreading Australian-Antarctic Discordance (AAD; 7.4 cm/y full-rate) (Christie *et al.*, 1998) and reflects a long-term magma deficiency associated with a mantle cold spot (*e.g.*, Christie *et al.*, 1998).

Two dredge hauls from the PVR recovered peridotite (Fig. 2; Ohara and Stern, submitted), though we have no sampling from the chaotic terrain. Mantle peridotites in the PVR are closely associated with the mullion structures. The most notable characteristic of PVR peridotites is small-scale juxtaposition (i.e., a single-dredge-haul scale) of fertile peridotite (spinel Cr # ~ 0.17) and depleted peridotite (plagioclase-bearing peridotite and dunite), suggesting melt-mantle interaction was important in the upper mantle beneath the PVR (Fig. 3), despite the apparent lack of an extrusive cover in this area. The Philippine Sea backarc basin upper mantle is essentially undepleted and is more similar to slow-spreading ridge abyssal peridotites (Ohara and Stern, submitted) than to ophiolitic peridotites, which are frequently highly depleted. The existence of fertile peridotite indicates that PVR peridotite experienced only a little melting (~ 3-4 % near-fractional melting of a MORB-type mantle), most likely due to the cold upper mantle thermal regime beneath the area (Ohara and Stern, submitted). The large water depth of the PVR (maximum depth ~ 7500 m) also supports the existence of cold upper mantle. The estimated low degree of melting of the PVB upper mantle is, to a first approximation, consistent with bathymetric features suggesting amagmatic extension.

The rugged topography of both AAD and PVB is unique in its occurrence at relatively "high" intermediate-spreading rates. The 8.8 cm/y full-rate is at the high end of intermediate-spreading rate (4-9 cm/y). Some pseudofaults identified in the western PVB (Fig. 2) indicate ridge propagation and jump (Okino *et al.*, 1998; Ohara *et al.*, 2001), suggesting active mantle flow (or higher melt supply rate). "High" intermediate-spreading rate (8.8-7.0 cm/y full-rate) is consistent with an interpretation of active mantle flow (or higher melt supply rate), but is difficult to reconcile with the apparent amagmatic nature of PVR extension.

Cruise plan

The study of backarc spreading systems has a strong bearing on two important aspects of the Earth's evolution, as it relates to both subduction zone and mid-ocean ridge dynamics. Study of backarc basins thus has deep impact on both the InterRidge and MARGINS communities. In addition, the Philippine Sea region (the Izu-Bonin-Mariana "IBM" region) is one of the focused research targets in the MARGINS Subduction Factory program. Following the reconnaissance studies by Ohara and others, the PVB appears to be an excellent place to investigate the composition and evolution of the backarc basin lithosphere. During the *R/V Kairei* KR03-01 cruise, we will conduct an extensive dredging and geophysical mapping program (Fig. 2). The ship will leave Yokosuka, Japan on January 6, 2003 for 20-day cruise to the southern Philippine Sea region.

The geodynamic characteristics shown in the previous section are

International Research: **Back Arc Basins:** Ohara *et al.*, cont...

largely based on bathymetric and gravimetric mapping results as well as petrological study on peridotite samples from just two dredge hauls. The primary objective of this cruise is thus, to conduct a detailed sampling and geophysical mapping of the PVR. The individual objectives are mainly three-fold:

(1) To provide a comprehensive sampling data set of an amagmatic backarc basin, thereby enabling comparative study of abyssal peridotite between from backarc basins and from other spreading systems.

(2) To better characterize the amagmatic tectonics in the PVB. Precise age determination on basalts or gabbros is an important issue.

(3) To clarify inter-segment and intra-segment geochemical variations of the PVR.

In order to meet these objectives, we will conduct ~ 25 dredge hauls and an extensive geophysical mapping program. This is the virtually first cruise focused on extensive sampling in this region, which shall provide an unique data set for future studies.

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International Research: **Back Arc Basins**

Deep-tow sonar "WADATSUMI" survey in the Okinawa Trough

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Introduction

The Okinawa Trough, located between Japan and Taiwan, is an incipient backarc basin formed by the extension within continental lithosphere behind the Ryukyu trench-arc system (Fig. 1). The continuous formation of new oceanic crust has not occurred yet, however, the crustal thinning and rifting is ongoing and many normal faults have developed. The early rifting phase was dated late Miocene, however, the date of the beginning of the extension and the characteristics of the early phase are still being debated (*e.g.* Kimura, 1996, Park 1998). The second rifting phase started about 2 Ma, indicated by the normal or listric faults trending 065° and the associated tilted faults blocks in the northern and middle Okinawa Trough. The faulting and the subsidence in the second phase have formed the present wide depression of the Okinawa Trough. The most recent phase of the extension is characterized by 085° normal faults. The faults are mainly located in the south-

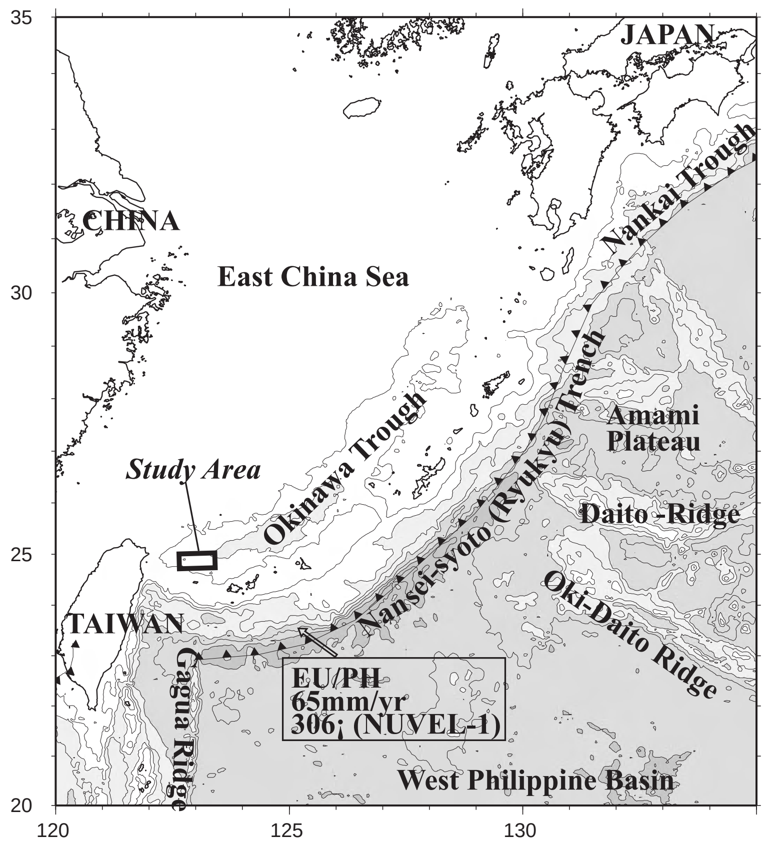

Figure 1. Location of the survey site, southwestern tip of the Okinawa Trough, backarc rifting zone behind the Ryukyu arc-trench system.

western Okinawa Trough and the distribution of faults is restricted within an east-west trending 13-km wide band (Sibuet *et al*., 1998). Volcanic rocks from the central grabens in the middle and southwestern Okinawa Trough show that magmas emplaced in the area are bimodal in composition, with basalt and rhyolite as the dominant modes (*e.g.* Shinjo et al, 1999) and their ages are younger than 1 Ma (*e.g*. Ishikawa *et al*., 1991).

In the Okinawa Trough, the southwestern part of the trough is most active and contains many interesting features, such as, numerous volcanoes crossing the rift zone (cross backarc volcanic trail: Sibuet *et al*., 1998), high heat flow, and active hydrothermal activities (Matsumoto *et al*., 2001). A French-Taiwanese co-operation cruise in 1996 has provided a seafloor bathymetry map and the seismic profiles of the region. During the R/V Hakuho-maru KH02-1 cruise in June 2002, we conducted detailed geological, geophysical and geochemical experiments in this area based on the previous studies. The main purposes of the cruise were 1) to investigate the process and evolution of continental rifting based on high-resolution sonar imaging, 2) to characterize the hydrothermal activity in relation to rifting, 3) to understand the genesis of volcanism in the backarc continental rift zone, and 4) to examine the thermal structure in the hydrothermal region. The main survey item was the high-resolution seafloor imaging by the deep-tow sidescan sonar "WADATSUMI" and the name of the research cruise was assigned as "HOTWATER (Hakuho-maru Okinawa Trough WadaTsumi ExpeRiment) " cruise. The cruise was planned and conducted under the international cooperation among Japan, Taiwan and France.

Instrumentation

The HOTWATER cruise started from Naha on June 10 and ended at Tokyo on June 24, 2002. The instruments used during the cruise included:

1) Deep-tow side-scan sonar system "WADATSUMI" (100kHz) with self-recording MAPRs (Miniature Autonomous Plume Recorder / provided by E. Baker in NOAA)
2) Hull-mounted SeaBeam2120 (20kHz) multibeam echo sounder and 3.5 kHz sub-bottom profiler
3) Dredge sampler
4) CTD Carousel Multi-Sampling system with a DO sensor and light transmissometer
5) Probe-type heat flow meter (4.5m)
6) Piston core (15m)

The deep-tow vector sidescan sonar "WADATSUMI" (Fig. 2) is the 100 kHz system, which provides not only high-resolution backscattering images but also phase bathymetry. The system also includes a 3-6 kHz chirp sonar to investigate sub-bottom structure. The swath width was 1 km and the towing altitude ranged from 100 to 350 m. The pixel size of the collected images is 50 cm. The towfish positioning was done by ISBL (inverted short baseline) system, in which the signal transmitted from the ship is received at the towfish and the all information is sent to the onboard control unit using a co-axial cable. Four MAPRs were equipped on the deep-tow system to detect the hydrothermal activities using its thermometer and nephelometer. Three MAPRs were attached to the towing cable with spacing 1, 50 and 100 m above the depressor and another one was suspended 50 m below the depressor (Fig. 2). In addition total 5 CTD hydrocasts, 6 dredges, and 2 piston cores were done in the area. Eight heat flow measurements were conducted near the hydrothermal vent reported in the previous submersible dives.

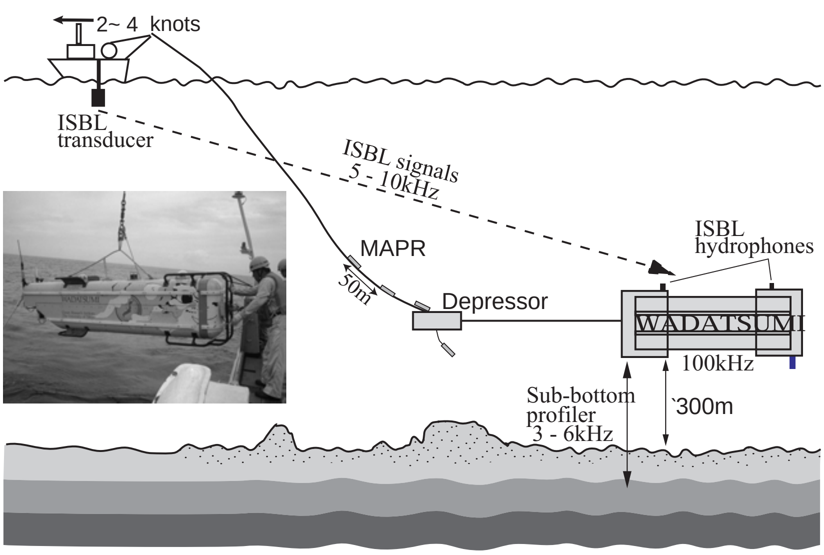

Figure 2. Schematic diagram showing the WADATSUMI deep-tow sonar and attached MAPRs. Insert – WADATSUMI deployment

Preliminary results

The WADATSUMI sonar system attached with MAPRs was towed within the central rift valley of the western Okinawa Trough from 122°35'E to 123°16'E (Fig. 3). Total 300 miles backscatter image and phase bathymetry data were obtained. During the 5-day survey, we mapped the major regions of the Yonaguni Graben (westernmost segment of the Okinawa Trough rift axis). Within the graben, a set of rift-parallel lines covers about 70~80% of the axial valley width including the steep northern rift wall. Another set of lines oblique to the rift axis was planned to cover the volcanic/hydrothermal area and to investigate the sub-surface structure using the

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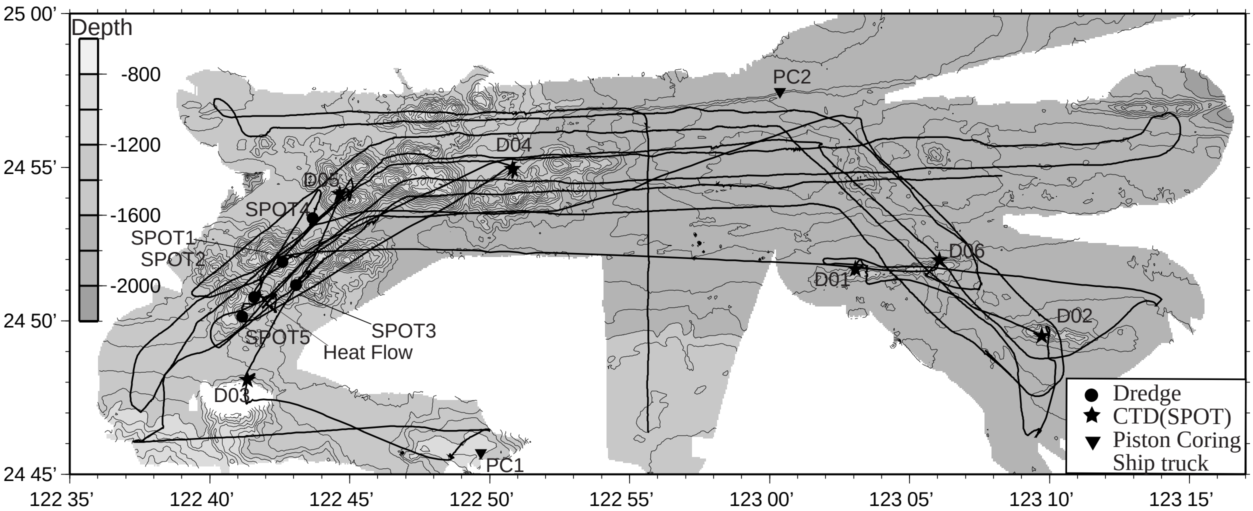

Figure 3. Ship's track and locations of stationary operations during the HOTWATER cruise on the bathymetry map.

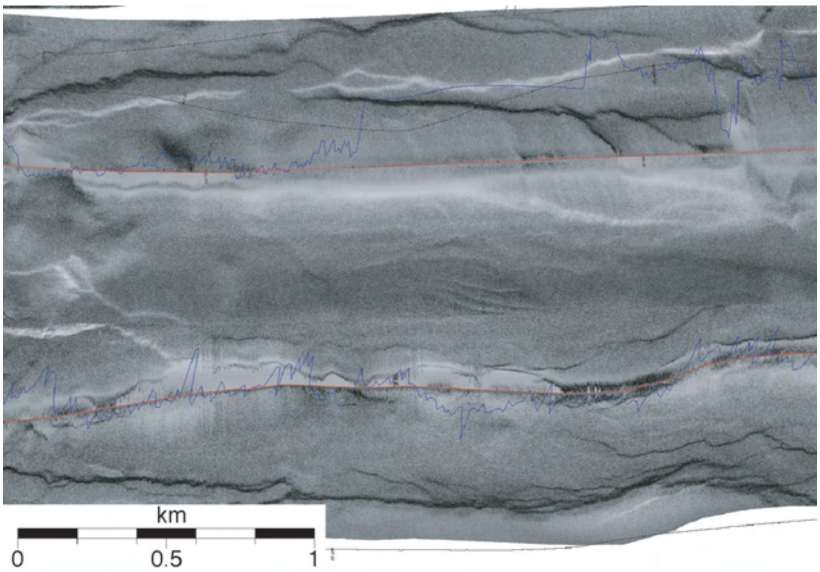

Figure 4. Example of mosaic image of the fault-dominant area within the central rift axis.

chirp sonar attached to the WADATSUMI. The towfish position was determined using the ISBL system, however, the quality of the positioning varied among lines mainly due to miss communication between the transducer and the towfish.

The WADATSUMI images revealed the detailed volcanic and tectonic structure of the area (Fig. 4). In the western part the seafloor is dominated by volcanic constructions, including hummocks, sheet flows, and blocky lava terrains. Small volcanic cones with crater pits are aligned in E-W direction, which may build an elongated volcanic ridge within the graben. On the other hand, the eastern part of the survey area is a sedimentary, deep (~1900m) depression, where the numerous normal faults are observed. The combination of elongated sedimentary pond and E-W trending narrow horsts characterize the area. The sub-bottom profiler on the WADATSUMI clearly reveals the structure of these horsts. E-W step faults are also recognized near the rift wall and the slope failure and debris flow mound modify the original tectonic landform in some locations. One of the most important targets of the sonar analysis is the relationship between the volcanism and tectonic deformation. Further processing of the sonar imagery as well as the phase bathymetry will provide new information for understanding the magmatic/tectonic process of the backarc rift zone.

The MAPRs were deployed with WADATSUMI in six survey lines. The nephelometric anomalies suggest that the hydrothermal activity is restricted in the western part of the survey area. The locations of these anomalies correspond to the ryolitic volcanism in the western volcanic area and occur close to the known hydrothermal active site (SPOT site). Based on the MAPR results, five CTD hydrocasts were focused on the western volcanic area. Station SPOT-5 (Fig.3) showed the highest light transmission anomaly up to ~5% within 300 m above the seafloor. The pH profile also showed negative pH anomalies at almost the same depths, indicating the effect of acidic hydrothermal fluids.

Heat flow measurements were done at 8 sites along two crossing lines near the known hydrothermal vent area. The preliminary analysis shows high heat gradient suggesting very high heat flow in the area. Precise heat flow values will be calculated by using thermal conductivity directly measured from the piston core samples.

Six dredge hauls were conducted during the cruise, three in the eastern E-W elongated minor ridges and others in the cross backarc volcanic trail. Volcanic rocks were recovered from two sites. Pumiceous rhyolite samples were obtained at D-05 and some samples have mafic inclusion. Aphyric basalt samples with glass rind were dredged at D06 (Fig. 3).

Besides the tectonics and hydrothermarism, the study area is also a good site for understanding the Kuroshio warm current, which has played an important role to constrain the paleo-environment of the region. Two piston core samples were recovered during the cruise to confirm the migration of the Kuroshio Current axis during last 20 Ka.

The collected dataset contributes to our knowledge on the interaction of the magmatism, tectonics and hydrothermal activity in the backarc rifting zone. The detailed analyses of various measurements are in progress, and we hope to integrate the analyzed results in the near future.

Acknowledgements

We thank the officers and crew of the R/V Hakuho-maru for their efficiency during the cruise. We also thank K. Tamaki for his encouragement and advice. T. Matsumoto provided us his compiled bathymetry data of the area.

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A late Archean arc-back arc system: recorded by a MORB-arc basalt-adakite association in the 2.5 Ga Wutai greenstone belt of the North China Craton

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Introduction and geological setting

The Wutai greenstone belt, situated in Shanxi province of northern China (Fig.1), and metamorphosed from greenschist to amphibolite facies, is perhaps the best-preserved greenstone belt in China, and is associated with high-grade gneisses of the adjoining Hengshan and Fuping Complexes and late Archean granitoids. All of these units lie in the central segment of the Trans-North China Orogen, which separates the North China Craton into two distinct Archean blocks, the Eastern and Western Blocks (Zhao *et al.*, 2002).

The Fuping Complex contains mainly tonalitic-trondhjemitic-granodioritic (TTG) gneiss, amphibolite and some marble. SHRIMP U-Pb dating indicates that the TTG gneisses were mainly emplaced between 2577-2514 Ma (Zhao *et al.*, 2002). The Hengshan Complex also contains mainly TTG gneiss, amphibolite and some supracrustal rocks. SHRIMP U-Pb dating indicates that the TTG gneisses were emplaced between 2526 and 2455 Ma (Kröner *et al.*, in review). The Wutai Complex is mainly composed of volcanic and sedimentary rocks, metamorphosed at low to medium-grade. In this paper, we subdivide the Wutai Complex into four units (Fig. 1): the Southern Jingangku formation (S-JGK), the Northern Jingangku formation (N-JGK), the Wutai greenschist assemblage (WT), and the subgreenschist facies turbidites. The formation time of the Wutai greenschist assemblage is well con-

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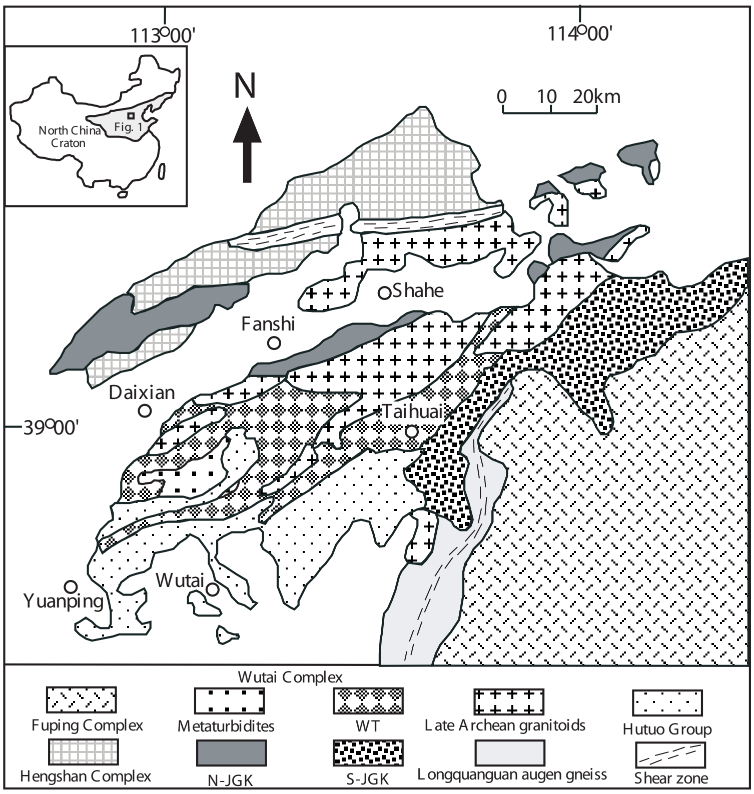

Figure 1. Geological map of the late Archean Wutai greenstone belt. Abbreviation: WT = Wutai greenschist assemblage; N-JGK = Northern Jinganku formation; S-JGK = Southern Jinganku formation. Inset shows location of the study area within the North China Craton.

strained by SHRIMP U-Pb dating of the felsic volcanic rocks at ca 2525 Ma (Wilde *et al.*, in press). No reliable SHRIMP U-Pb data are currently available for either the N-JGK or the S-JGK. ~2.5 Ga granitoids intrude both the N-JGK and S-JGK (Wilde, S.A., unpublished data), implying that they also formed in the late Archean.

The Wutai Complex is unconformably overlain by the Hutuo Group (Fig. 1), which is composed of low-grade metasedimentary rocks, including conglomerate, quartzite, phyllite, slate and dolomitic marble, and local volcanic rocks. The Fuping, Hengshan and Wutai Complexes are tectonically separated by several ductile shear zones (Fig. 1). The north shear zone is within the Hengshan Complex and is mainly composed of sheared TTG gneisses and mafic intrusions with steep foliations and near horizontal lineations. The southeast shear zone generally separates the Wutai and Fuping Complexes and largely consists of augen gneiss. SHRIMP U-Pb dating indicates that the granitoid precursors to the augen gneiss formed at ca 2543 and 2507 Ma (Zhao *et al.*, 2002).

Precambrian granitoid intrusions are widely distributed throughout the area (Fig.1). SHRIMP U-Pb dating indicates that most of the intrusions were emplaced between 2566-2513 Ma (Wilde *et al.*, 1997).

Petrography, analytical methods

Amphibolites and metabasalts of the WT, S-JGK and N-JGK are composed dominantly of amphibole and plagioclase with minor amount of quartz and iron oxides. In some samples, amphibole is replaced by biotite, and plagioclase by epidote. Palimpsest amygdaloidal, porphyritic, and ophitic textures are common in the mafic rocks. Basalts of the WT assemblage are either massive or have pillow structures, with amphibole and plagioclase set in a groundmass of chlorite and albite. Basalts, basaltic andesites and andesite of the WT assemblage typically are chlorite greenschists with variable schistosity, and mainly comprise chlorite and albite with minor amount of relict quartz and plagioclase phenocrysts. Felsic volcanic rocks are dominated by quartz and feldspar (both plagioclase and alkali feldspar), with minor biotite.

Altered margins were carefully removed from the selected samples with a hammer. Samples were then manually crushed in a steel mill, and subsequently reduced to powder in an agate shatterbox. Analyses for major, trace and rare-earth elements were performed at the Laboratory of Lithosphere Tectonic Evolution, Institute of Geology and Geophysics, Chinese Academy of Sciences by XRF and ICP-MS techniques.

Geochemistry

The rocks from the Wutai Complex were plotted onto standard classification diagrams such as TAS and other major element plots, and show a range from basalt, through andesite and dacite, to rhyolite. The K_2O-SiO_2 diagram reveals that most rocks fall in the low- and medium-K fields, and in the Zr-TiO_2 diagram, the rocks all fall within the basalt and andesite fields.

Pillow and massive basalts in the Wutai greenschist assemblage (WT) show a range of SiO_2 of 45-50 wt%, TiO_2 0.5-1.9 wt% and MgO 7-9 wt% over a range of Mg# (Mg#=100Mg/(Mg+Fe^{total})) from 47 to 62 (Fig. 2). They are characterised by: (1) primitive mantle normalised patterns similar to those of N-MORB; (2) obvious Zr and Hf troughs; (3) progressive depletion from La to Th, consistent with a depleted mantle source; (4) near-flat REE patterns. Basalts, basaltic andesites and andesite with greenschist facies from the WT have SiO_2 contents of 50-58 wt%, TiO_2 of 0.7-0.9 wt% and MgO of 5-8 wt% over a range of Mg# from 52 to 64 (Fig. 2). On a primitive mantle normalised diagram, these rocks are characterised by large negative anomalies for Zr and Hf, moderate negative anomalies for Nb and Ta, and slightly negative anomalies for Ti and Y. Chondrite normalised REE patterns indicate that these rocks are LREE-enriched with variable negtive Eu anomalies.

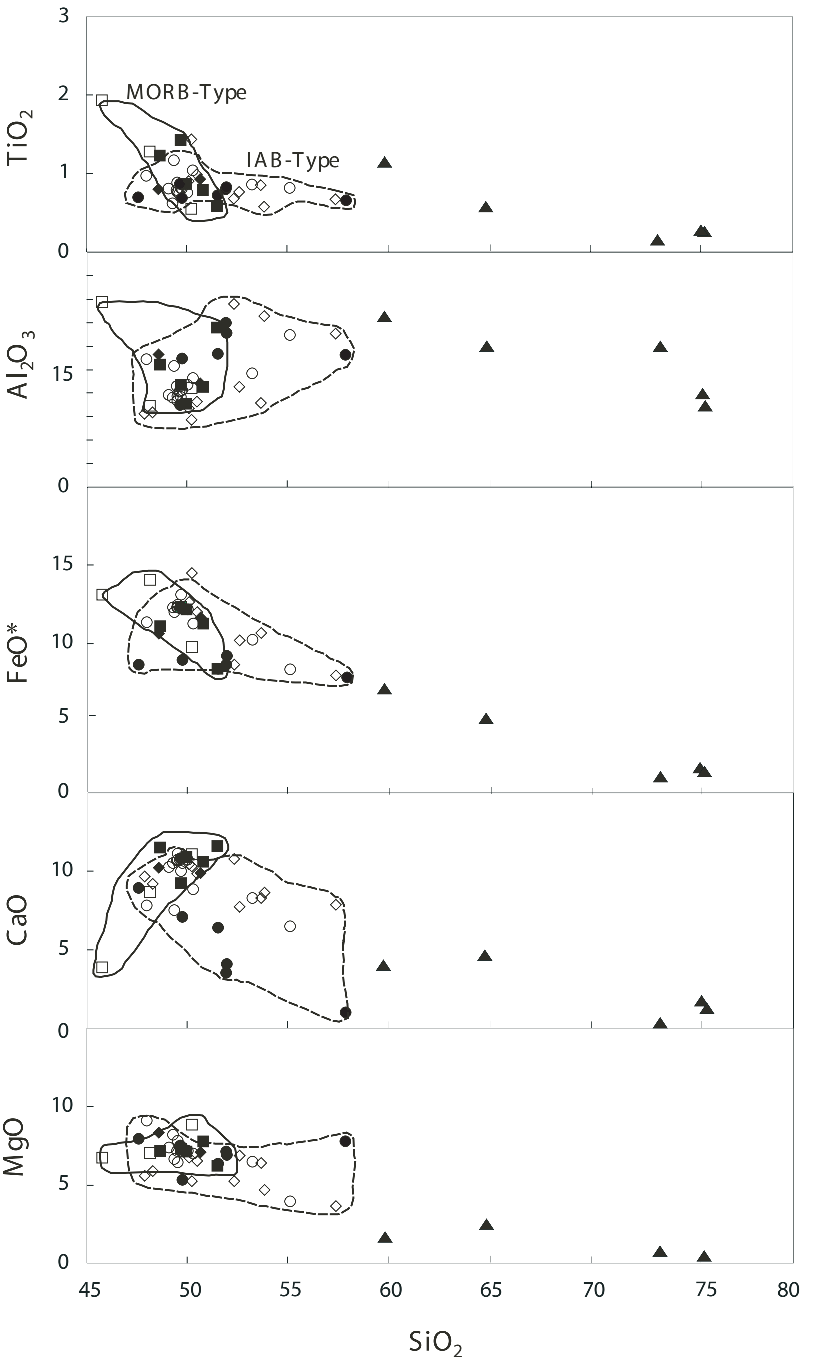

Figure 2. Plots of TiO_2, Al_2O_3, FeO*, CaO and MgO versus SiO_2 for rocks in the Wutai Complex. Symbols are: felsic volcanic rocks = solid triangles; type 3 amphibolites of N-JGK = solid squares; WT basalts = open squares; WT basalts, basaltic andesites and andesite = solid circles; S-JGK amphibolites = open circles; type 1 amphibolites of the N-JGK = open diamonds; type 2 amphibolites of the N-JGK = solid diamonds.

Amphibolites in the S-JGK have SiO_2 contents of 45-55 wt%, TiO_2 between 0.6-1.5 wt% and MgO 6.5-9 wt% over a range of Mg# from 46 to 60 (Fig. 2). They have the following trace element characteristics: (1) variable but strong negative Nb anomalies on a primitive mantle normalised diagram; (2) slight Zr, Ti and Y troughs; and (3) LREE-enriched chondrite normalised REE patterns with weak negative Eu anomalies.

Amphibolites in the N-JGK can be classified into three types. Type 1 amphibolites have SiO_2 values of 48-57 wt%, TiO_2 0.6-2 wt% and MgO 4-7 wt% over a range of Mg# from 40 to 56 (Fig. 2). On a primitive mantle normalised diagram, they show variable but strong negative Nb anomalies, and slight Zr, Ti and Y troughs. They have LREE-enriched chondrite normalised REE patterns with weak negative Eu anomalies. Type 2 amphibolites, comprising only two samples, have SiO_2 contents of 48.6-50.7 wt%, TiO_2 0.8-0.9 wt% and MgO 7-8 wt% over a range of Mg# from 52 to 58 (Fig. 2). They show moderate Nb and slight Ti and Y troughs on a primitive mantle normalised diagram, and have LREE-depleted or near-flat chondrite normalised REE patterns. Type 3 amphibolites have SiO_2 contents of 48.6-51.5 wt%, TiO_2 0.6-1.4 wt% and MgO 6.2-7.8 wt% over a range of Mg# from 51 to 57 (Fig. 2). They are characterised by: (1) similar primitive mantle normalised patterns to those of N-MORB; (2) progressive depletion from La to Th, consistent with a depleted mantle source; (3) near-flat or LREE-depleted REE patterns.

The felsic metavolcanic rocks were sampled from each of the three units; with one sample from the Wutai greenschist assemblage and the N-JGK, respectively, and three samples from the S-JGK. They have a range of SiO_2 of 60-75 wt%, TiO_2 of 0.1-1 wt%, Al_2O_3 of 13.5-17 wt% and MgO of 0.1-2.4 wt% (Fig. 2). On a primitive mantle normalised diagram, they are characterised by strong Nb, Zr and Ti troughs and have similar

International Research: **Back Arc Basins:** Wang and Wilde, cont...

patterns to those of Cenozoic adakites. They have LREE-enriched chondrite normalised REE patterns, also consistent with those of Cenozoic adakites.

A late Archean MORB-arc-back arc basalt-adakite association

Pillow and massive basalts in the Wutai greenschist assemblage and type 3 amphibolites in the N-JGK both are characterised by: (1) primitive mantle normalised patterns similar to those of N-MORB; (2) progressive depletion from La to Nb and to Th; and (3) near-flat or LREE-depleted REE patterns. Their Nb/U and Nb/Th ratios are 26-49 and 8-16 respectively, and most data plot above the primitive mantle lines (Fig. 3). These geochemical characteristics are comparable to N-MORB.

Type 2 amphibolites in the N-JGK have near-flat primitive mantle trends with moderate Nb and minor Ti and Y troughs, and LREE-depleted or near-flat chondrite normalised REE patterns, comparable to modern back arc basin basalts (BABB).

Basalts, basaltic andesites and andesite with greenschist facies in the WT, most amphibolites in the S-JGK and type 1 amphibolites in the N-JGK have similar trace element characteristics such as negative Nb (Ta), Zr (Hf), Ti and Y anomalies on primitive mantle normalised diagrams, and LREE-enrichment on chondrite normalised REE diagrams, indistinguishable from modern arc basalts.

Cenozoic adakites and the Archean, high-Al TTG suite have comparable geochemistry and are characterised by: $SiO_2 \geq 56$ wt%, $Al_2O_3 \geq 15$ wt% at 70 wt% SiO_2, and MgO < 3 wt%, low Y (< 18 ppm, mostly 5-10 ppm) and Yb (< 1.9 ppm), and high La/Sm_n, La/Yb (average of 19.3) and Zr/Sm ratios (Drummond *et al.*, 1996). The felsic volcanic rocks in the Wutai greenstone belt have SiO_2 contents of 60-75 wt%, Al_2O_3 13.5-17 wt% (the majority higher than 15 wt%) and MgO 0.1-2.4 wt%, low Y (mostly 8-11 ppm) and Yb (mostly 0.9-1.2 ppm), and high La/Sm_n (2.5-6), La/Yb (16-24) and Zr/Sm (13-28) ratios, conforming to most of the compositional criteria for Cenozoic adakites. On the SiO_2-MgO diagram (not shown), all the samples plot in the field of adakites and high-Al TTG as defined by Drummond *et al.* (1996). Moreover, they have similar primitive mantle normalised trace element patterns and chondrite normalised REE patterns to those of Cenozoic adakites.

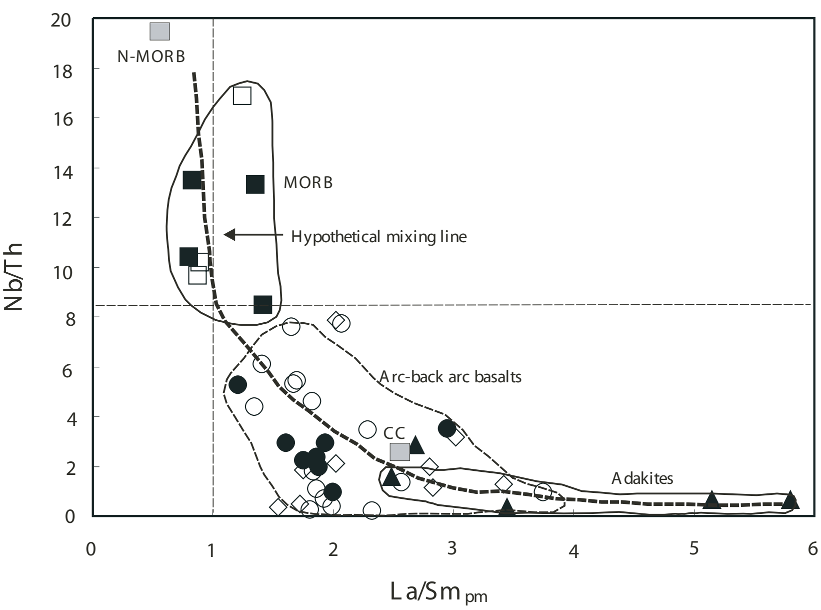

Figure 3. La/Sm_{pm} vs Nb/Th variation diagram showing mixing hyperbola defined by MORBs, arc-back arc basalts and adakites in the Wutai Complex. Symbols as in Fig. 2.

There are generally two interpretations for the origin of adakite-like rocks. Firstly, they are associated with the subduction of oceanic crust that is young and warm. The subducting basaltic crust will melt and then generate slab melts of adakite composition. Secondly, adakite-like magmas found in areas of thick crust may result from melting of underplated basaltic crust, possibly associated with delamination. Whatever the detailed origin, several authors have recognised that, in the Archean, hotter, smaller and shallower subducting plates would favour slab melting over slab dehydration and mantle wedge melting, thus explaining the prevalence of high-Al TTG suites and adakites. We prefer to interpret the adakite-like suite in the Wutai Complex as slab melts, for the reason that these felsic volcanic rocks are coeval with typical arc magmas (arc-like basalts and TTG) in this region. Furthermore, a general lack of zircon inheritance in the felsic volcanic geochronology samples (Wilde *et al.*, in press) and the fact that the TTG rocks of the adjacent Hengshan and Fuping complexes are coeval (Zhao *et al.*, 2002; Kröner *et al.*, in review) seems to preclude a model involving thickened pre-existing crust.

Geodynamic interpretation for the Wutai greenstone belt

The late Archean MORB-arc-back arc, basalt-adakite association in the Wutai greenstone belt plots along a hyperbolic curve on the La/Sm_{pm}-Nb/Th diagram (Fig. 3). This may imply that magma mixing occurred between MORB-like melts and subduction-related melts (IAB-BABB-like melts and adakite-like melts).

The identification of a late Archean MORB-arc-back arc, basalt-adakite association in the Wutai greenstone belt and the proposed mixing of MORB-type magmas and subduction-related magmas, prompt us to put forward an alternative model for the geodynamic evolution of this belt. We consider that intra-oceanic subduction occurred in a proto-ocean between 2.6-2.5 Ga, involving slab melting of subducting oceanic crust and consequent formation of adakites. Subsequently, magma mixing presumably occurred between MORB-like melts, generated by mantle upwelling in an extending back arc basin (represented by the MORB-, BABB- and IAB-type amphibolites of N-JGK), and subduction-related melts (IAB-BABB-like melts and adakite-like melts). The closure of the back arc basin led to accretion of the Wutai arc (represented by the IAB-type amphibolites of S-JGK(lower part) and the IAB-type greenschist rocks of WT (upper part))-back arc complexes, and some of back arc basin fragments (represented by MORB-type basalts of WT) thrust onto the arc. These may have formed part of multiple arc complexes or, conversely, reflect a collage of island arc-back arc fragments tectonically interleaved with an evolving magmatic arc sequence along the western margin of the eastern block of the North China Craton at this time (Wilde *et al.*, in press; Kröner *et al.*, in review).

This new interpretation is different from previous tectonic models for the area and also for other Archean greenstone belts, where mantle plumes or interaction between subduction zones and mantle plumes are considered to have played a significant role in the processes of Archean magmatism and crustal growth. This implies that the styles of crustal growth in the late Archean are comparable to Phanerozoic counterparts.

Acknowledgements

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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 Research: **World Databases**

Databases as fundamental tools for interdisciplinary research: PANGAEA Network for Geological and Environmental Data and the World Data Center for Marine Environmental Sciences (WDC-MARE)

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Introduction

Increasing amounts of analytical data in geosciences and an increasing cooperation of various scientific disciplines makes it necessary to establish efficient data information systems. Such a system should be able to handle all kinds of geoscience data.

InterRidge maintains several databases containing ridge related data especially metainformation on vessels and vehicles, research cruises, location and general information on known hydrothermal vent areas, vent biological information, ridge related references and the linked Petrological Database of the Ocean Floor (PETDB) at Lamont-Doherty Earth Observatory. Like PETDB WDC-MARE/PANGAEA contains measured and calculated numerical data, textual data and pictures. Among others, parameter groups like geochemistry of rocks, sediments, water (*e.g.* CTD), compositional data of sediments like grain size, particle association, fossil distributions, physical properties etc. are available. All data sets are georeferenced (latitude, longitude, depth/elevation/age) and include information about the source (publication), investigator(s), research area, and parameters inclusive pertaining analytical/calculation methods.

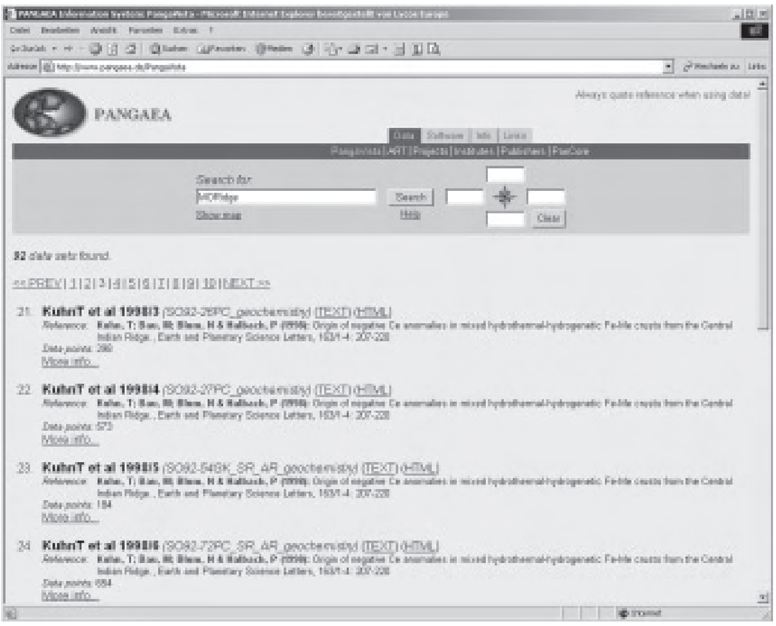

Figure 1. PangaVista is a simple search engine, which allows retrieving desired data sets by seeking matches to user-specified keywords and geographical constraints. Here a number of data sets were found for the query 'MORidge'. The map shows the corresponding data points

WDC-MARE/PANGAEA data information system

The World Data Center for Marine Environmental Sciences (WDC-MARE) was founded in 2000 and is a member of the ISCU World Data Center system [1]. As an operating platform for WDC-MARE PANGAEA is used, which is an information system for processing, long term storage, and publication of georeferenced data related to earth sciences. Essential services supplied by WDC-MARE / PANGAEA are project data management and the distribution of visualization and analysing software. Organization of data management includes quality check and publication of data and the dissemination of metadata according to international standards.

The challenge of managing the heterogeneous and dynamic data of environmental and geosciences was met in the PANGAEA system through a flexible data model which reflects the information processing steps in the earth science fields and can handle any related analytical data (Diepenbroek *et al*., 1999; in press). The basic technical structure corresponds to a three tiered client/server architecture with a number of clients and middleware components controlling the information flow and quality. On the server side a relational database management system (RDBMS) is used for information storage. The web-based clients include a simple search engine (PangaVista, Fig. 1) and a sophisticated data mining tool (ART). The client used for maintenance of information contents is optimised for data management purposes. Analysing and visualization of metainformation and analytical data is supported by a number of software tools.

With its comprehensive graphical user interfaces and the built in functionality for import, export, and maintenance of information, PANGAEA is a highly efficient system for scientific data management and data publication.

The PANGAEA and the WDC-MARE are operating on a long term basis. The institutional frame is supplied by MARUM in cooperation with the Alfred Wegener Institute (AWI), Bremerhaven. Several people are responsible for the technical and scientific organization and development. The data management totals about six fulltime scientists. Data management services on an international level are available since 1996. Until the beginning of 2002 WDC-MARE / PANGAEA was a partner in 34 projects covering all fields of environmental sciences (*http://www.pangaea.de/Projects/*).

The WDC-MARA/PANGAEA tasks in detail

1) "Pooling" of project relevant data and metainformation (data description), which includes the acquisition and incorporation of data into the information system as well as a harmonisation of data and a final quality control. Part of this task will also be "data mining" for and revision of already existing data relevant to ridge research.
2) General access for individual scientists or any interested groups. The pooled data will be accessible through the general web interfaces of PANGAEA and a project specific web page, which reflects the actual status of the data management at any time, will be available. The functionality of PANGAEA also allows for the distribution of restricted data, which is important during the runtime of the project. Project members can define flexible access rights to their data sets.
3) Long term archiving and publication of data. Publication of data includes linkage of data with corresponding publications and attachment of data specific abstracts/comments. For further propagation metadata will be disseminated into international clearinghouses as *e.g.* the Global Change Master Directory (GCMD).
4) Support for processing and synthesis of data, in particular the harmonization of project data and preparation of compiled data sets for visualization and analysis in GIS.

The InterRidge Next Decade-workshop emphasized the importance and fundamental meaning of databases for global and interdisciplinary research efforts like InterRidge. Scientists of different research fields need an effective information exchange system to combine data from different kinds of ridge related studies (*e.g.* to combine data from hydrothermal vent biota with fluid chemistry). Extensive experiences in project data management , *e.g.* the opportunity to manage JGOFS final data synthesis as a most recent example, encourage the WDC-MARA/PANGAEA group to offer InterRidge the data handling and publication of cruise and post-cruise data. This is thought as a tool for InterRidge researchers to overview existing data, plan future research, and distribute the own results for more efficient scientific communication. The database is easily accessible and usable by common internet browsers. WDC-MARE/PANGAEA database is available at *http://www.wdc-mare.org*, *http://www.pangaea.de* or via *http://www.pangaea.de/Projects/INTERRIDGE/* . This link is accessible from the InterRidge website through the "IR Databases" menu.

WDC-MARA/PANGAEA will be the major data management system for the future German Ridge activities (Priority program of the Deutsche Forschungsgemeinschaft DFG).

Last but not least, the helpfulness of a database depends on the readiness of scientist to publish and archive their results in the database. We encourage everybody to contact the WDC-MARA/PANGAEA group (*info@pangaea.de*) to discuss data storage and data exchange.

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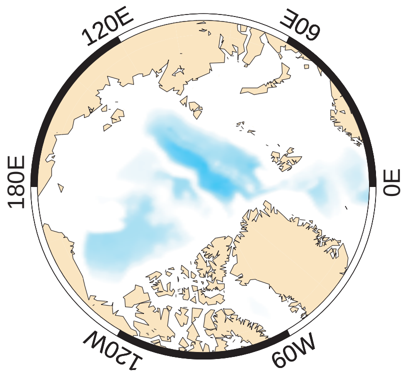
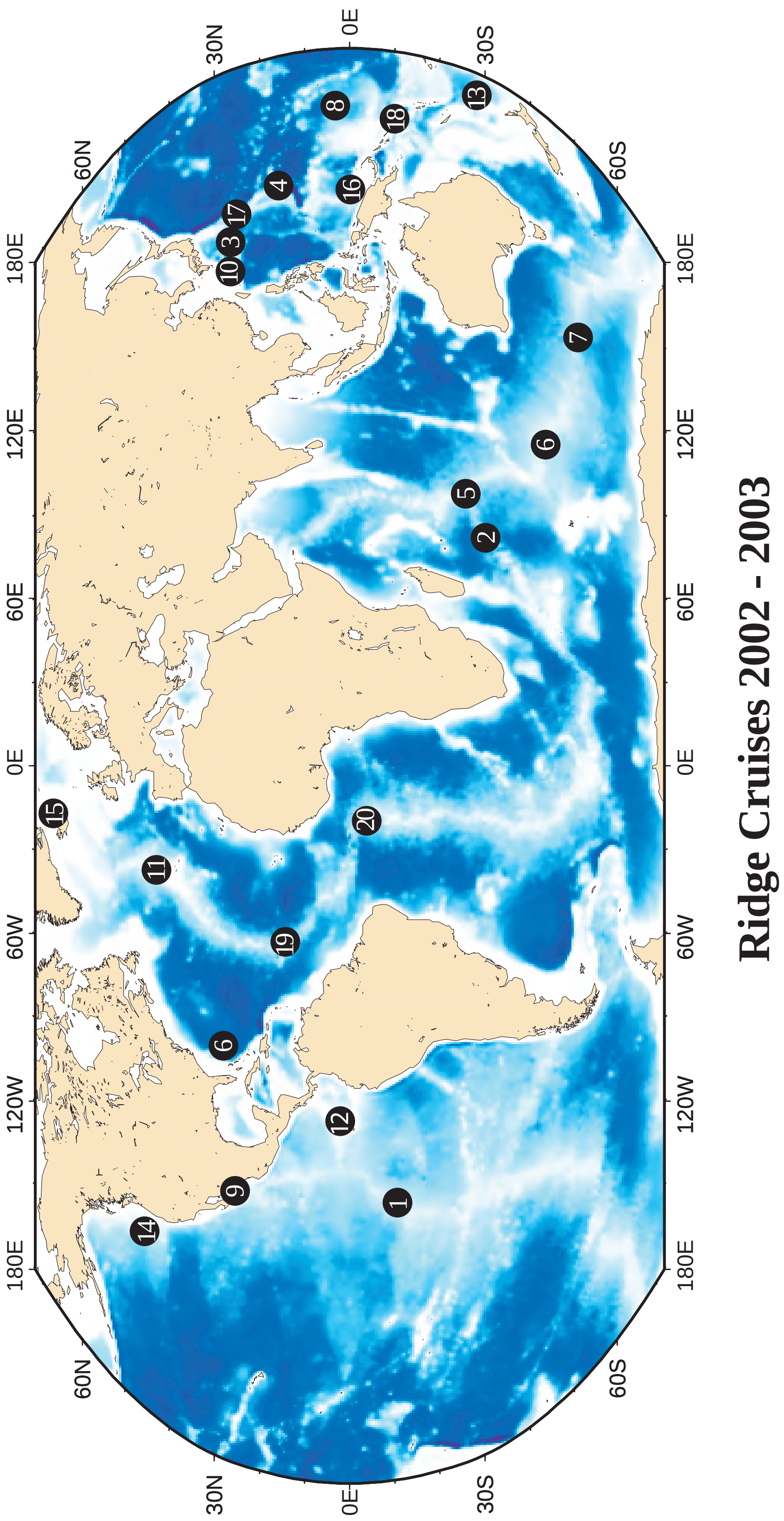
http://www.intridge.org/irn.htm

World Ridge Cruise Map, 2002-2003

A listing of international ridge cruises, compiled by Daniel Curewitz can be found on the following pages. Each cruise is coded with a number, which represents it's location on the map below. The list of world cruises is organised by date. Please submit scheduled and upcoming cruises by filling in the online form at: *http://www.intridge.org/cruisefm.htm*





World Ridge Cruise Schedule, 2002 -2003, continued...

Map No.	Country	PI	Institution	Cruise ID/Location	Research Objectives	Ship	Dates
1	USA	Childress Fisher Van Dover	UCSB Penn State Wm&Mary	East Pacific Rise	Physiological Ecology of Hydrothermal Vent Chemoautotrophic Symbioses. Species Composition and Biodiversity in Mussel Bed Communities of Hydrothermal Vents	Atlantis	Dec 9, '01 - Jan 1, '02
2	Japan	Matsumoto	JAMSTEC	Southwest Indian Ridge Atlantis II FZ	Shinkai 6500 submersible dives at lower crust and mantle outcrop	Yokosuka	Dec 21, '01 - Jan 15, '02
3	Japan USA	Ohara	Hydrogr. Dept. Japan	Parece Vela Basin Philippine Sea	Petrological investigation of the Parece Vela backarc basin spreading center.	Kairei	Jan 6 - Jan 25, '02
1	USA	Von Damm	UNH	East Pacific Rise	East Pacific Rise Hydrothermal Systems: Continued Chemical Instability at 9-10 degrees N vs. Stability at 21 degrees N	Atlantis Alvin	Jan 6 - Feb 10, '02
4	Japan	Arima	Yokohama Ntnl. Univ.	Mariana Trough and Mariana Arc	Sediments and microbio sampling at a hydrothermal area	Kairei	Jan 8 - Feb 24, '02
5	Japan	Takai	JAMSTEC	Rodriguez triple junction	Shinkai 6500 submersible dives at hydrothermal sites	Yokosuka	Jan 21 - Feb, '02
6	USA	Cochran	LDEO	Southeast Indian Ridge	Effects of Changes in Mantle Temperature on Melt Supply and Crustal Accretion: An MCS Reflection and OBH Refraction Study of the Southeast Indian Ridge	Maurice Ewing	Jan 26, '02
7	Japan	Shinohara	ERI	Australia-Antarctica Discordance	Crustal study by OBMs and high resolution deep-tow magnetometer	Hakuho Maru	Jan 27 - Feb 12, '02
8	USA	Larson	URI	Southwest Pacific Basin	Mid-Cretaceous Tectonic Evolution of the Tongareva Triple Junction in the Southwest Pacific Basin	Melville	Mar 24 - Apr 13, '02
10	Japan	Inagaki Chiba	JAMSTEC	Southern Okinawa Trough	Shinkai 2000 submersible dives at hydrothermal sites	Natsushima	April 17 - May 4, '02

World Ridge Cruise Schedule, 2002 -2003, continued...

Map No.	Country	PI	Institution	Cruise ID/Location	Research Objectives	Ship	Dates
9	USA	Cowen	U of HI	Guaymas Basin	The Fate and Implications of Removal of Hydrothermally-Injected NH4+ from Plume Waters	Atlantis Alvin	Apr 26 - May 11, '02
1	France	Gaill Bris	U. Pierre	East Pacific Rise - PHARE	In-situ experiments and biogeochemical interactions	L'Atalante ROV Victor	May '02
10	Japan	Tamaki	ORI	Southern Okinawa Trough	Deep tow sidescan sonar survey of the rift zone	Hakuho Maru	May 7 - Jun 24, '02
10	Japan	Fujikura	JAMSTEC	Southern Okinawa Trough	Vent biology by Submersible Shinkai 2000	Natsushima	May 13 - Jul 5, '02
1	USA	Schouten Tivey Fornari Macdonald	WHOI UCSB	East Pacific Rise	Central Anomaly Magnetization High: Constraints on the Volcanic Construction and Architecture of Young Upper Oceanic Crust	Atlantis Alvin/ABE	May 14 - May 23, '02
11	France US Portugal	J. Goslin	U. Brest	Azores-Gibralter (SIRENA - North Atlantic)	Deployment of six moored autonomous hydrophones 1) to monitor the seismicity of the MAR between the Azores and Gibbs FZ; 2) to produce a high-resolution tomographic model of the upper mantle below a ridge in a ridge/hotspot context	Le Suroit	May 23 - Jun 10, '02
12	USA	Hammond Embley Fornari Shank	NOAA WHOI	Galapagos Rift	Galapagos 25th Anniversary	Atlantis Alvin	May 24 - Jun 4, '02
13	New Zealand	Wright	NIWA U. Kiel VUW	Southern Kermadec Arc, 35-30 S	Multibeam mapping, rock dredging, seafloor photography, and epibenthic fauna sample along volcanoes of the arc front	Tangaroa	May 24 - Jun 14, '02
14	USA	Spiess	SIO	Juan de Fuca Ridge	Juan de Fuca Plate Geodesy: Juan de Fuca Ridge and Cascadia Subduction Zone	Roger Revelle	Jun 8 - Jun 22, '02
10	Japan	Tokuyama Okino Tamaki	ORI	Southern Okinawa Trough	High resolution deep-tow sonar mapping with geochemical sensors	Hakuho-maru	Jun 10 - Jun, 24, '02

World Ridge Cruise Schedule, 2002 -2003, continued...

13	New Zealand	de Ronde Massoth	GNS NOAA U. Kiel Kyushu Univ.	Southern Kermadec Arc, 35-30 S	CTD and in situ chemical mapping and fluid sampling if hydrothermal plumes associated with active volcanoes	Tangaroa	Jun 16 - Jun 29, '02
15	Germany Iceland	Devey Scholten	U. Bremen	Tjoernes Fracture Zone	Volcanology of spreading north of Iceland Hydrothermalism of the Grimsey field Geochemistry of the plume-ridge transition	Poseidon	Jun 26 - Jul 14, '02
14	USA	Carbotte	LDEO	Juan de Fuca Ridge	New Content and Functionality for the RIDGE Multibeam Synthesis	Maurice Ewing	Jul 8 - Aug 7, '02
18	Korea	K-Y Lee	KORDI	North Fiji Basin	KODOS 2002 - Reconnaissance survey of hydrothermal vents.	Onnuri	Jul 14 - Aug 15, '02
17	Japan	Urabe	GSJ	Izu-Bonin Arc Suiyo Seamount	Shallow drilling at hydrothermal site of Suiyo Seamount, Izu-Bonin Arc for sub-vent biosphere	Hakurei-Maru	Jul 17 - Jul 27, '02
11	Portugal France India	Barriga	U. Lisbon	Seahma-1, MOMAR Region South of Azores	Geological and Biological cruise: Survey, detailed imaging, mapping and sampling (deployment of mussel cages) of Menez Gwen, Lucky Strike, Saldanha, Rainbow, and Menez Hom	Atalante ROV Victor	July 29 - Aug 14, '02
17	Japan	Ishibashi	Kyushu Univ.	Izu-Bonin Arc Western Pacific	Sampling of fluid, microbes and sediments from Suiyo Seamount, Archaean Park	Shinsei-Maru	Aug 3 - Aug 15, '02
14	USA	Cowen	U. Hawaii	Juan de Fuca Ridge Endeavour	The Fate and Implications of Removal of Hydrothermally-Injected NH4+ from Plume Waters	Atlantis Alvin	Aug 4 - Aug 25, '02
12	USA	Klein	Duke Univ.	Hess deep	Collaborative Research: Geochemical and Geological Investigation of the Incipient Rift at 2°40'N, east of the East Pacific Rise	Melville	Aug 5 - Sep 2, '02
17	Japan	Kinoshita	JAMSTEC	Ogasawara (Bonin) Arc	Longterm observatory at vent sites by Submersible Shinkai 2000 and ROV	Natsushima	Aug 22 - Sep 18, '02

World Ridge Cruise Schedule, 2002 -2003, continued...

Map No.	Country	PI	Institution	Cruise ID/Location	Research Objectives	Ship	Dates
16	Korea	S-M Lee	KORDI	Daeyang Program 2002 Leg 1 Western Bismark Sea volcanoes, PACMANUS	Geophysical, multichannel seismic, near bottom observation, and geochemical and biological investigations of New Ireland Forearc Basin,	Onnuri	Aug 24 - Sep 9, '02
14	USA	Johnson Sharma Voight	UW Dartmouth Field Museum	Juan de Fuca Ridge	Collaborative Research: Direct Sampling of the Oceanic Sub-Surface Biosphere at Old and Young Seamounts.	Atlantis Jason II	Aug 29 - Sep 23, '02
16	Korea	S-M Lee	KORDI	Daeyang Program 2002 Leg 2 Sorol Trough and Caroline Plate	Seafloor mapping and geophysical investigation of the eastern boundary of the Caroline Plate and Sorol Trough, equatorial western Pacific.	Onnuri	Sep 10 - Sep 27, '02
16	Germany Canada UK	Herzig Hannington Skinner	Freiberg	New Ireland Basin SO-166, CONDRILL	Shallow drilling (5m) of an epithermal (gold) mineralization on top of Conical Seamount	Sonne	Sep 13 - Oct 11, '02
9	USA	Lizarralde	Georgia Tech	Gulf of California	Margins: Collaborative Research: Seismic and Geologic Study of Gulf of California Rifting and Magmatism	Maurice Ewing	Sep 17 - Nov 4, '02
14	USA	Cary Taylor Cavanaugh	U Delaware WHOI NOAA	Juan de Fuca Ridge	Collaborative Research: Eurythermal Adaptations to an Extreme Environment by the Symbionts of the Hydrothermal Vent Polychaete, Alvinella Pompejana. Microbiology and Ecology of Filamentous Sulfur Formation.	Atlantis Lexen, Alvin	Oct 20 - Nov 16, '02
4	Japan	Seama	Kobe Univ.	Mariana Trough	Upper mantle structure by electromagnetic study	Kairei	Oct 28 - Nov 12, '02
1	USA	Forsyth	Brown Univ.	East Pacific Rise	Collaborative Research: Investigation of the Origin of Non-hotspot, Intraplate,Volcanic Ridges and Cross-Grain Gravity Lineations	Melville	Nov 2 - Dec 5, '02

World Ridge Cruise Schedule, 2002 -2003, continued...

1	USA	Childress	UCSB	East Pacific Rise	Collaborative Research: Studies on the Physiological Ecology of Hydrothermal Vent Chemoautotrophic Symbioses	New Horizon (w/Atlantis)	Nov 9, '01 - Jan 3, '02
12	USA	Becker	U Miami	Costa Rica Rift	Long-Term Monitoring of Off-Axis Hydrogeology on the Costa Rica Rift Using an Instrumented Wireline Multi-Packer System	Atlantis Alvin	Nov 20 - Nov 26, '02
1	USA	Childress Fisher	UCSB Penn State	East Pacific Rise	Collaborative Research: Studies on the Physiological Ecology of Hydrothermal Vent Chemoautotrophic Symbioses	Atlantis Alvin	Nov 30 - Dec 22, '02
14	USA	Voight	Field Museum	Gorda Ridge Monterey Fan Valley seeps	Biological collections at vents and seeps, chemical and geological studies, mapping	Atlantis Alvin	2003
3	Japan USA	Ohara	Hydrogr. Dept. Japan	Parece Vela Basin, Phillipine Sea	Comprehensive petrological investigation of the Parece Vela backarc basin amagmatic spreading center. 25 to 30 dredge hauls.	RV Karei	Jan 6 - Jan 25, '03
2	USA	Dick Lin	WHOI	Southwest Indian Ridge	Rock dredging and geophysical studies to investigate the influence of ridge geometry on cresutal accretion and mantle structure of an ultra-slow spreading ridge	RV Melville	Jan 19 - Feb 9, '03
19	France	Cosson Lallier	ISOMer Roscoff	MALABAR/MAR (Logatchev), Barbados (Orinoco-El Pilar)	Sampling of microbes to study their biodiversity and adaptations to hydrothermal vents and cold seeps.	L'Atalante Nautile	Mar 12 - Apr 8, '03
19	USA	Dziak Smith	NOAA WHOI	Mid Atlantic Ridge (10°-35°N)	Deploy and recover autonomous hydrophones monitoring seismicity along the northern Mid Atlantic Ridge	RV Maurice Ewing	Apr 17- May 14, '03
19	Germany	Herzig	Freiberg	MAR 15°N	Hydrothermal and biological investigations	RV Meteor	July '04
20	Germany UK	Devey Rhein	U Bremen, SOC U Hamburg Freie U GEOMAR	MAR 2°-11°S	Detailed bathymetry and side-scan (TOBI) of this section of the MAR. Locating and exploring hydrothermal sites with BRIDGET, CTD, and new Bremen 4000m ROV	RV Meteor	Nov 9 - Dec 30, '04
20	Germany	Reston	GEOMAR	MAR 8°S Ascension Fracture Zone	Variation in crustal and upper mantle structure within and between spreading segments. Wide-angle seismic refraction and reflection, microseismicity and tomography.	RV Meteor	2004

National News....

Canada: CanRidge

Canadian researchers participated in two submersible cruises to the Juan de Fuca Ridge in July and August 2002.

Thompson-ROPOS

The first was a collaborative mission with the VENTS group of the NOAA Pacific Marine Environment Laboratory. The Canadian ROV ROPOS was mobilized on the R/V Thomas G. Thompson. Nine Canadian university researchers participated in the two-leg cruise that began and ended in Victoria, BC. Dive operations were conducted at two field sites : Axial Volcano, on the Juan de Fuca Ridge, and Explorer Ridge, a spreading centre located to the north of the Juan de Fuca Ridge.

Canadian work at Axial Volcano concentrated on using the ROPOS submersible to service experimental arrays left on the seafloor the previous year, and to sample near-bottom plankton communities and particulate organic material associated with seafloor hydrothermal vents. All collection objectives were met. The experimental array servicing involved recovering and replacing arrays that had been on the seafloor since the previous summer. The arrays contained larval settlement plates (A. Metaxas) and blocks of polymetallic sulphide for weathering experiments (R. Léveillé, SK Juniper). Recovery and replacement of the arrays required a complex series of manipulations by the submersible, and use of a newly-modified deep-sea elevator provided by the ROPOS group. The elevator permits the recovery of payloads that are too heavy to be transported in the submersible's manipulator arms. Experiments at 4 sites were successfully serviced.

The second leg of the cruise visited vent fields on Explorer Ridge. These vent fields have been little studied since their initial discovery cruise in 1984, primarily because of the poor weather conditions that prevail in the Explorer Ridge area. Having ROPOS on a larger support vessel made the difference this year and only 1 dive day was lost to weather, out of the 10 days spent on site. The unusual polymetallic sulphide deposits of the Explorer Ridge vent fields were a major focus of the Canadian research effort at this site (A. Williams-Jones, R. Léveillé, SK Juniper, SD Scott). Several of the very large sulphide deposits at Explorer are in an advanced state of weathering and degradation, much of which is probably the result of microbial activity. The CanRidge team sampled a series of deposits, at different stages of weathering, to examine microbial colonisation and metabolic activity, in relation to the elemental and mineralogical properties of the samples. As well, high-resolution mapping of the site by our NOAA colleagues earlier in the summer, will permit interpretation of the weathering story within a regional geological context. Altered basalts were recovered from the flanks of one of the deposits with the aim of determining conditions of fluid-rock interaction in the "stockwork zone" of volcanic-hosted sulphide deposits (K. Gillis). Fresh basalts were also recovered to provide a geochemical "baseline" for the basalt alteration study (B. Coussens). In addition, the Pb isotopic composition of these fresh basalts and associated sulphides will be determined to examine whether or not enriched lavas make up the entire crustal thickness or form only the youngest surficial lavas. Other samples collected at the Explorer vents include particulate organic matter for microbiological and biochemical analysis, faunal samples for study of faunal diversity at the site (V. Tunnicliffe) and near-bottom larval samples for a study of recruitment of hydrothermal vent communities (A. Metaxas)

Marine Protected Areas in Canada

University of Qubebec, Endeavour hot vents area:

http://www.er.uqam.ca/nobel/oasis/

Marine Protected Areas programme:

http://www.dfo-mpo.gc.ca/oceanscanada/newenglish/htmdocs/mpas/endeavour.htm

http://www.pac.dfo-mpo.gc.ca/oceans/mpa/pilots.htm

The Remotely Operated Platform for Ocean Science: *http://ropos.com/*

National News....

Tully-ROPOS

A second ROPOS cruise was staged on the Canadian Coast Guard ship John P. Tully, with the destination of the hydrothermal vent fields of the Endeavour Segment on the Juan de Fuca Ridge. Scientific objectives included sampling hydrothermal fluids for study of viral ecology (A. Ortmann & C. Suttle), to service experimental arrays on the seafloor, to sample near-bottom plankton (V. Tunnicliffe) in relation to near-bottom bottom temperature and density conditions (R. Thomson) and to collect particulate organic material from two contrasting tubeworm assemblages for study of microbial diversity (SK Juniper). The cruise was severely impacted by an unusually lengthy spell of bad weather. Sea conditions (Seastate 6-8) remained well beyond the level permitting dive operations for the first 5 days of the 8-day cruise. Only during the final two days on site were we able to do any diving with ROPOS. During these final 48 hours we managed to conduct 4 dives, two at each of the two vent fields. A minimum suite of samples was collected for all investigators but the experimental arrays (A. Metaxas, R. Léveillé) could not be completely serviced because weather did not permit deployment of the ROPOS elevator. New arrays were added to the time series but the two arrays scheduled for recovery in 2002 had to be left in place.

Plans for 2003

A joint cruise to the Endeavour Segment hydrothermal fields is planned with the University of Washington in August 2003. The ROPOS submersible would be staged on the R/V Thomas G. Thompson. Canadian researchers will focus on sulphide weathering, community ecology and recruitment, hydrothermal alteration of basalt, microbial ecology and the ecology of suspended particulate matter.

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Germany:DeRidge

The German Ridge community, bundled now in the Concentrated Research Programme Number SPP1144 of the DFG (with the title “From mantle to ocean: material, energy and life cycles on spreading axes”) has begun work on its focussed research areas, around 15°N and between 2-11°S on the Mid-Atlantic Ridge. This work has consisted of getting proposals ready for the special research programme (proposal deadline 1 March 2003, successful proposals to then start in Oct. 2003) and getting ship time in place.

Heroic efforts by some of the SPP1144 members lead to 3 cruise proposals for the German research vessel Meteor being accepted and scheduled in 2004. These include a 40+ day hydrothermal-biological cruise in July 2004 to 15°N lead by Peter Herzig, a 30+ day geophysical cruise to the Ascension Fracture zone region in October 2004 lead by Tim Reston and a 45 day oceanographic-volcanological cruise to 2-11°S in November/December 2004 lead by Colin Devey.

At the end of December 2002 the SPP1144 group will meet in Bremen at the request of the Meteor planning committee to discuss ship time needs up to the end of the 6-year lifetime of the SPP1144 programme.

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De Ridge The German Section of InterRidge

DeRidge homepage

http://www.Ozeankruste.de/DeRidge/deridge.html

National News....

United Kingdom

The U.K. expects to have its deep (6500 m) ROV, a *JASON-II* clone to be called *ISIS*, delivered in January 2003. A meeting of the marine science community will be held at SOC on September 19-20 2002 to discuss the funding for the vehicle and plans for its future use. At present the only U.K. research vessel definitely capable of handling the ROV is the Antarctic vessel James Clark Ross, which passes through the Atlantic twice a year. NERC is planning a replacement for the Charles Darwin and a consultation exercise for the requirements of the scientific community has just been completed. The facilities needed for use of the ROV will be one of the requirements for the new vessel.

A funding decision on B-DEOS, which will have a strong ridge component, is expected in February 2003. UK scientists have participated in the submission of expressions of interest to the EC on ridge-related programmes including MOMAR and EURECO (European Ridge Ecosystems).

Planned ridge-related cruises for the near future include:

August 2003 *Charles Darwin* NW Indian Ridge - Bramley Murton

August 2003 *Thalassa* Azores area ROV pilot training

Proposed cruise 2004 South Atlantic - Chris German

Update by Paul Dando

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India: InRidge

National Institute of Oceanography, Goa, India, initiated studies related to the Indian Ridge system and back arc basin in the mid-90s. During these studies a substantial segment of the Carlsberg Ridge (CR) (area between 62°15'N to 66°N) has been mapped and sampled. Sections of the axial valley from Sea Lark and Vityaz, Vema fracture zones from the Central Indian Ridge have also been surveyed and sampled (IR News, 6 (1), 9(2), and 11(1)).

The emphasis now is to undertake an inter-disciplinary research program involving major national laboratories such as National Institute of Oceanography, Goa, National Geophysical Research Institute, Hyderabad and universities. This program receives funding support from Council of Scientific & Industrial Research (CSIR) as well as from the Dept. of Ocean Development (DOD), Govt. of India. During the first phase (2002 - 07) of the program it is planned to carry out multi-disciplinary investigations along the CR, CIR and the Andaman back arc basin. During the second phase detail surveys with deployment of ROV/ AUV for *in situ* observations has been planned. This program also envisages the collaboration with other national and international organisations active in the Indian Ocean region.

In this perspective, the planed InterRidge sponsored Indian Ridge meeting in January 2004 holds promise to:

1) discuss and compare the present status of the ridge surveys/ studies along the Indian Ridge segments vis-à-vis MAR and EPR,
2) identify the knowledge gaps and interesting areas for future studies and
3) evolve collaborative programs covering the various aspects of the Indian Ridge system.

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National News....

InterRidge - Japan

Recent activity of the Japan InterRidge can be currently grouped under the following projects:

1) Archaean Park Project

Archaean Park project is an interdisciplinary research project on the interaction between the sub-vent biosphere and the geo-environment. It is funded by MEXT, Japan, as a five-year program (2000-2004) with a major evaluation in 2002.

In 2001 and 2002 we carried out intensive surveys in the Suiyo Seamount, a dacitic arc volcano in Izu-Ogasawara Arc, western Pacific, where there is high-temperature hydrothermal activity on the caldera floor. We drilled ten holes (average depth = 5.6m) using a tethered, submarine rock-drill system BMS (Benthic Multi-coring System) and used the holes for sampling and data acquisition/monitoring by utilizing an ROV and the manned submersible Shinkai 2000. We conducted long-term monitoring using geochemical/geophysical equipments lowered from surface ship. The Suiyo Seamount hydrothermal system is characterized by a localized and shallow circulation combined with uniform, deep-seated and stable reservoir. Although an archaeal population was low, its microbial diversity in hydrothermal surface to sub-surface environment of Suiyo Seamount was proved to be large.

The Archaean Park reserach community is now under a review process for the second phase (2003-2004), and has submitted ship-time proposals for the survey in Mariana Trough hydrothermal area.

2) Mid oceanic ridge study (at Kairei Site, Rodriguez Triple Junction, Indian Ridge)

The YK01-15 cruise of *R/V Yokosuka* with DSRV Shinkai 6500 (JAMSTEC) was successfully conducted from January to March 2002. The chief scientist was Dr. Ken Takai (JAMSTEC). They revisited the Kairei hydrothermal site to take hot fluid and microbiological samples. There is now, for the first time, evidence of the existence of HyperSLiME (Hyperthermophilic Subsurface Lithoautrophic Microbial Ecosystem) beneath the active hydrothermal floor, which comes from cultivation experiments and isotope signatures of trace gases.

3) Backarc basin study (at southern Okinawa Trough, southwest of Japan)

Geological, geophysical and geochemical surveys were carried out during the KH-02-1 cruise of the *R/V Hakuho Maru* in the Yonaguni depression, southwestern Okinawa Trough, in June 2002 (PI: Prof. H. Tokuyama, Ocean Research Institute, Univ. Tokyo). The cruise participants included Dr. Jean-Claud Sibuet (IFREMER, France) and Prof. Chao-Shing Lee (National Taiwan Ocean Univ.). In order to acquire hydrothermal plume data during the WADATSUMI sidescan sonar tows, with self-contained sensors called MAPR, developed by NOAA (Bs VENTS Program, were attached to the WADATSUMI system to elucidate successfully two- dimensional plume distributions.

In addition, there are some other activities currently undergoing, that will impact the Japanese InterRidge community. The operation program of the submersible Shinkai 2000 (JAMSTEC) will close at the end of FY2002. Development of a new AUV, with a diving limit to about 4,000 m depth, is in progress (PI: Prof. T. Ura, Univ. Tokyo).

A symposium will be held at Ocean Research Institute in November in order to discuss research cruise plans using *R/V Hakuho Maru* during the forthcoming Fiscal Years 2004 to 2006.

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(Hokkaido University, Sapporo) and
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Previous updates from various Nations can be found on the IR web site under the menu "Member Nations" or by going directly to:

http://www.intridge.org/act4.html

National News....

New Zealand

RIDGE science projects in New Zealand continue to focus on the Kermadec – Havre arc – back-arc system to understand processes of arc rifting, oceanic crust accretion, hydrothermalism including associated mineralisation and vent biology, and petrogenesis of arc and back-arc magmatism.

The major advance of Ridge-related projects has been the mapping and hydrothermal surveying of the arc front between 35°S and 30°S during two *Tangaroa* cruises in April - June 2002. The swath-mapping cruise (PI, I. Wright, NIWA) with collaborators from University of Kiel has mapped 13 new volcanoes over 10 km in diameter including one volcano 25 km wide and over 2100 m in elevation. Together with previously work, the Kermadec arc front is mapped over a distance of 890 km from its southern termination near 36.4°S (Clark volcano) to Raoul Island. This segment contains 27 major volcanic massifs (>1000 m relief) at an average spacing of 33 km. Taking all volcanic constructs, and assuming the present-day arc is <1 Ma old, the edifice construction rate is at least 17 km^3/km/Ma. The magma production rate will be higher. Silicic volcanism and associated caldera-forming eruptions are a major component of the Kermadec intra-oceanic arc, supporting recent discoveries at the comparable Izu-Bonin arc. At least 13 volcanoes from 29.3°–36.4°S have erupted dacite or dacitic pumice, representing ~38 % of the 34 volcanoes with ^{3}5 km basal diameters. Seven of these 13 have calderas ^{3}3 km in diameter. The caldera-forming eruptions are not restricted to the volcanic front, nor do they necessarily terminate silicic volcanism. A substantial set of 200 rocks samples from this segment of the arc front are now being analysed in New Zealand and Germany. Sixty-six biological samples were also taken (using rock dredge and epibenthic sled) from 12 of the volcanoes studied, as part of a NIWA research programme investigating seamount ecosystems. An initial on-board appreciation of the biotic assemblage composition would suggest that diversity is generally low on individual volcanoes, particularly where the substrates was represented by fresh lavas or pumice. However, where volcano substrates were represented by older more weathered lavas (particularly at relatively shallow water-depths) species diversity was relatively high. Of particular note were hydrothermal vent assemblages in the vicinity of Macauley Island and Volcano "L". The Macauley cone site contained vent biota including *Bathymodiolus?* sp., and an unknown white clam; both currently being described by B. Marshall, Museum of New Zealand Te Papa Tongarewa).

The second hydrothermal plume-mapping cruise (PI's C. de Ronde and G. Massoth, GNS) with collaborators from NOAA and University of Kyushu, was the first and successful deployment of the new MINTS system that measures real-time pH and light-scattering. Plume mapping for this 540 km length of arc only identified three active hydrothermal vents – the Macauley cone within the Macauley caldera, Volcano "L", and the previously known Vulkanolog site south of the Curtis Island. Rock sampling of the Macauley and volcano "L" sites recovered mineralised samples. The paucity of hydrothermal venting between 30° and 35°S (with 3 sites over 540 km) contrasts with venting south of 35°S with 7 sites over 260 km. Such longitudinal variation of venting is a surprise and is stimulating thought of what parameters of arc magmatism drive such differences. Laboratory analysis for dissolved Fe and Mn, methane and helium are currently in progress. Thermophilic bacteria from water samples were successfully cultured at sea at temperatures of ~60-70°C. The cruise also revisited known hydrothermal sites south of 35°S (see *InterRIDGE News* 8(2): 35-39), establishing an initial time-series for the Brothers, Healy, Rumble V hydrothermal sites. An additional hydrothermal vent has been discovered on the Healy volcano.

Preliminary results of these two cruises have been presented by Gary Massoth and Cornel de Ronde (GNS) to recent conference meetings including the Australian Institute of Mining and Metallurgy, the InterRidge Theoretical Institute meeting on thermal regimes of hydrothermal circulation, and Geological Society of America.

Further hydrothermal studies are planned within the Lau basin in collaboration with Australian colleagues. Proposed targets include the Valu Fa spreading ridge and the adjacent Tonga arc.

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National News....

Russia-Ridge

In September 2002 the meeting "Plume Magmatism" was held at Petrozavodsk, NW Russia. A special section of this Meeting was devoted to peptrologic and geochemical aspects of plume magmatism in contemporary oceanic basins. Most principle results of last years investigations of Russian scientists concerning this problem were presented in following talks presented at the meeting:

- Plume and Spreading Basalt Assemblages in the Global System of the Mid-Ocean Ridges (L. Dmitriev – ldmitr@geokhi.ru, S. Sokolov).
- Mesozoic-Cenozoic Mineragenic Provinces, Wilson Cycle and Plume Tectonics (Yu. Gatinsky, D. Rundquist – dvr@sgm.ru).
- The Fourth Layer of the Earth Crust beneath Iceland – Influence of the Mantle Plume on the Interior Structure (Yu. Genshaft, A. Saltykovsky).
- Mantle Plumes as Reflected in the Earth Gravity Field (M. Kaban)
- Fluid Regime of Mantle Plumes (I. Ryabchikov)
- The Relationships of Plume Magmatism and Mantle Metasomatism below Mid-Atlantic Ridge (0°-60°N) (S .Silantyev – silantyev@geokhi.ru, B. Bazylev, L. Dmitriev, H. Bougault, L. Dosso, S. Karpenko, B. Belyatsky)

The Organizing Committee of this Meeting proposed to prepare a special issue of the *Russian Journal of Earth Sciences* (electronic version URL – *http://eos.wdcb.ru/rjes/*) relating to some of the topics listed above. This special issue will be published during 2003.

In October 2002, a three day Conference on Earth Sciences dedicated to the ten-year Jubilee of the Russian Foundation for Basic Research (RFBR) was held at Moscow. The RFBR has provided the most common source of financial support of Russian scientists during last decade. Some lectures presented at this conference were concerned with different problems related to processes occurring at Mid-Ocean Ridges:

The Experimental and Theoretical Modeling of Hydrodynamics and Heat Flows in Astenosphere and on Mantle-Core Boundary (N. Dobretsov dobr@uiggm.nsc.ru, A. Kirdyashkin).

Mechanism and Conditions of Formation of Magmatic Melts in Mantle Plumes (I. Ryabchikov).

Geodynamic Globe constructed for Global Monitoring of Divers Geological Processes (D. Rundquist – dvr@sgm.ru, V. Ryakhovsky, Yu. Gatinsky, E. Chesalova).

Conditions of Magmas Generation in Mantle: Synthesis of Experimental Data on Melt-Olivine-Orthopyroxene Equilibria (A. Girnis).

Endogenous and Exogenous Factors Specified Geochemical Image of the Oceanic Crust (S. Silantyev – silantyev@geokhi.ru).

The next Workshop "Russian Ridge" will be held in Moscow (Vernadsky Institute of Rusian Academy of Sciences) in September, 2003.

The Workshop will be held to discuss the results of interdisciplinary studies of Mid-Ocean Ridges obtained for the period of 2001-2003 and to coordinate further investigations.

Subject of the Workshop: Interdisciplinary Studies of Slow- and Ultra Slow-Spreading Centres: From Mantle Melting to Biota Formation at Hydrothermal Vents.

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Minerals of the Ocean – Integrated Strategies Symposium

25-30 April,2004, St. Petersburg, Russia

Suggested DiscussionTopics: Massive sulphides
Ferromanganese Oxide and phosphorite ores
Gas hydrates

Deadlines: Registration - 31st April, 2003
Abstracts - 1st February, 2004

Registration form and detailed meeting information at:
http://www.intridge.org/minerals04.pdf

National News....

USA: R2K

The Ridge 2000 Program (R2K) is now one year old and the program is quickly gaining momentum. Since our last report, the implementation plans for the three initial Integrated Study Sites (8°-11°N on the EPR, the Endeavour segment of the Juan de Fuca Ridge, and the eastern back arc spreading centre in the Lau Basin) were designed during an open community workshop in Albuquerque, New Mexico. Draft plans were posted for community comment shortly after the workshop. After this input was incorporated, the final versions were posted on the R2K website for use by scientists while writing their grant proposals for the US National Science Foundation August 15 target date.

The implementation plans describe the rationale and advantages for studying each site, and the general types of studies that will be necessary to accomplish the main program objective of a holistic understanding of the ridge system. Integrated studies will be carried out at various spatial scales that are defined by the particular scientific objective. That is, each site can be visualized as a target consisting of concentric bands about a designated focal point or bull's-eye. Proponents are required to show the relationship of the proposed science to a vertically integrated type-section at the focal point. The plans outline the scientific goals to be reached within the next 5 years. Each site will have a coordinator whose duties are listed in the plans. Site specific considerations, such as obstacles present on the seafloor, and links to other programs are also part of each plan. For example, R2K recognizes that the success of the Lau Basin site requires a strong connection to both SOPAC and InterRidge, and explicitly states this in the Lau implementation plan.

The R2K program also developed and approved a data policy that is predicated on the realization that timely open sharing of data is essential to the success of the program. In order to facilitate the sharing and integration of diverse types of data, R2K issued a Request for Proposals (RFP) for the development of a data management system and a data management office. This data management system will catalogue multiple levels of metadata with user-friendly, web-based tools for searching and accessing data. The data policy, the RFP, and the implementation plans can all be viewed on the R2K website (r2k.bio.psu.edu).

The first NSF target date for Integrated Study Site and data management system proposals was August 15, 2002. Thirty proposals were submitted; most of these were multi-PI and multi-institutional, indicating an excellent start for an interdisciplinary program. The first R2K Relevancy Review panel met just before the recent Steering Committee meeting that was held in New York City. The majority of the proposals were found to be central to the program and ready to go forward at any time.

Education and Outreach (E&O) is a growing part of R2K. A new E&O plan, soon to be published on the R2K website, was produced from several workshops and from the input of the newly formed R2K E&O sub-committee. The plan includes a sequence of outreach projects to help bring R2K science to the public, to the K-12 community, and to the scientific community. Two new projects that will begin immediately are the development of curricular material with student-oriented web-based cruise coverage and the development of a R2K Distinguished Lecture Series, patterned after the successful ODP Series.

At its recent meeting, the R2K Steering Committee discussed R2K co-sponsorship of several upcoming workshops. These include a workshop to define a slow-spreading integrated study site on the MAR, a Summer School in Iceland, a Theoretical Institute focused on Back-Arc Basin Spreading Systems (with InterRidge), an "Exploratory Studies" workshop (along with the ChEss program of the Census of Marine Life, InterRidge and NOAA's Ocean Exploration program). All were endorsed, with various levels of support from R2K recommended. More information on each of these will be forthcoming as plans mature.

Four members rotated off the Steering Committee and all will be missed: David Christie, Maya Tolstoy, Colleen Cavanaugh, and Deborah Kelley. Mike Perfit agreed to replace David Christie on the Executive Committee. Dave Christie's service to the RIDGE and R2K programs went beyond the call of duty and he deserves many thanks. The new members who have accepted their invitations to join the steering Committee for a three-year term are Bob Lowell from Georgia Tech, Suzanne Carbotte from Lamont, Geoff Wheat from the University of Alaska Fairbanks and MBARI, and Anna Louise Reysenbach from Portland State. Look for short biographies on our new members on the website soon.

The R2K Office looks forward to seeing you at our booth and the Ridge 2000 Smoker at AGU in December.

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Upcoming Meetings and Workshops

Calendar of MOR Research related events

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

http://www.intridge.org/info3.html

9 - 12 July, 2002	**Western Pacific Geophysics Meeting** Wellington, New Zeland
4 - 7 September, 2002	**Plume Magmatism,** Petrozavodsk, Russia
9 - 13 September, 2002	**InterRidge Theoretical Institute (IRTI) Thermal Regime of Ocean Ridges and Dynamics of Hydrothermal Circulation**., University of Pavia, Italy
13 - 14 September, 2002	**IR Steering Committee Meeting,** Sestri Levante, Italy
25 - 26 September, 2002	**Unmanned Underwater Vehicle Showcase,** SOC, UK
24 - 26 October, 2002	**Global Bathymetry for Oceanography, Geophysics, and Climatology** IGPP Scripps Institution of Oceanography
5 December, 2002	**Deep Submergence Science Committee (DESSC) Fall Meeting** San Francisco, USA
4 - 6 December, 2002	**15th Annual Geological Convention of the Geological Society of the Philippines,** Manila, Philippines.
6 - 10 December, 2002	**AGU 2002 Fall Meeting,** San Francisco, USA
7-11 April, 2003	**EGS-AGU-EUG Joint Assembly,** Nice, France
4 - 6 June, 2003	**Oceanology International Americas,** New Orleans, Luisiana, USA
16 - 18 June, 2003	**Biogeography and Biodiversity of Chemosynthetic Ecosystems: What do we need to understand?** *SOC, UK*
23 - 25 June, 2003	**IR Workshop: Opportunities and Contributions of Asian Countries to the IR Next Decade Initiative,** Beijing, China,
27 - 28 June, 2003	**IR Steering Committee Meeting,** Beijing, China,
24 - 27 June, 2003	**Scientific Submarine Cable workshop,** Tokyo, Japan
30 Jun. - 11 July, 2003	**International Union of Geodesy and Geophysics (IUGG),** Sapporo, Japan
8 - 10 September, 2003	**Ridge-Hotspot Interaction: Recent Progress and Prospects for Enhanced International Collaboration,** Brest, France
22 - 26 September, 2003	**7th International Conference on Gas Geochemistry,** Freiberg, Germany
8 - 12 December, 2003	**AGU 2003 Fall Meeting,** San Francisco, USA
14 - 16 January, 2004	**The fifth International Conference on Asian Marine Geology** Bangkok, Thailand
26 - 30 January, 2004	**Ocean Sciences Meeting,** Portland, OR, USA
16 - 19 March, 2004	**Oceanology International,** London, UK
25 - 30 April, 2004	**"Minerals Of The Ocean - Integrated Strategies,** St.Petersburg, Russia
26 - 30 April, 2004	**European Geosciences Union (EGU) XXVIX General Assembly** Nice, France
17 - 21 May, 2004	**Joint Meeting: AGU and the Canadian Geophysical Union,** Montreal, Canada
24 - 28 May, 2004	**R2K-IR Theoretical Institute: Backarc Basins and Spreading Systems,** Cheju Island, Korea
16 - 20 August, 2004	**Western Pacific Geophysics Meeting,** Honolulu, Hawaii
13 - 17 December., 2004	**AGU 2004 Fall Meeting,** San Francisco, USA

Upcoming Meetings and Workshops

EGS-AGU-EUG Joint Assembly

07 - 11 April 2003

Nice, France

Full session details at:

http://www.copernicus.org/EGS/egsga/nice03/programme/overview.htm

Ridge related sessions

TS5.07 "High resolution acoustic imaging and geological sampling studies of young ocean floor". **Convenors:** Roger Searle (*r.c.searle@durham.ac.uk*) and Jian Lin, (*jlin@whoi.edu*)

VGP1.02 "Magma generation and evolution in the Earth and other terrestrial planets - a 21st Century perspective" - a symposium to celebrate the 70th birthday of Mike O'Hara. **Convenors:** Yaoling Niu (*NiuY@Cardiff.ac.uk*), Marjorie Wilson (*M. Wilson@earth.leeds.ac.uk*), Claude Herzberg (*herzberg@rci.rutgers.edu*) and Ed Stolper (ems@gps.caltech.edu)

VGP3.05 "Fluid flow and transport in oceanic and continental volcano-hydrothermal systems". **Convenors:** Shaul Hurwitz (*shaulh@usgs.gov*), Sebastian Geiger (*geiger@erdw.ethz.ch*) and Tim Jupp (*tim@bpi.cam.ac.uk*)

InterRidge Workshop:

Opportunities and Contributions of Asian Countries to the InterRidge Next Decade Initiative

Beijing, China, June 23-25, 2003

http://www.intridge.org/

ORGANIZING COMMITTEE

John Chen (co-chair), Peking University, Beijing, China (*johnyc@pku.edu.cn*)
Jian Lin (co-chair), Woods Hole Oceanographic Institution, USA (*jlin@whoi.edu*)
Kensaku Tamaki, University of Tokyo, Japan
Sang-Mook Lee, Korea Ocean Research & Development Institute, Korea
Catherine Mevel, Universite Pierre et Marie Curie, France

OBJECTIVES

1) To promote active participation of Asian countries in the InterRidge program and to improve coordination of InterRidge research activities among Asian countries;

2) To bring together scientists from different disciplines to discuss unique contributions that Asian countries can make to the InterRidge Next Decade Initiative; and

3) To provide a forum for exchange of ideas and research results on a variety of subjects including oceanic crustal processes, back arc spreading ridges, hydrothermal systems, vent biology, and sub-seafloor biosphere.

WORKSHOP AGENDA

Available from the IR website: *http://www.intridge.org/*

InterRidge Symposium and Workshop:

Ridge-Hotspot Interaction: Recent Progress and Prospects for Enhanced International Collaboration

September 8-10, 2003 (Monday–Wednesday)

Institut Universitaire Européen de la Mer
Université de Bretagne Occidentale, Brest, France

http://www.intridge.org/rhi03.htm

ORGANISNG COMMITTEE

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Agnieszka Adamczewska, InterRidge Office, University of Tokyo, Japan

OBJECTIVES

(1) To review recent progress in geological, geophysical, geochemical, and theoretical studies of hotspot mantle plumes and their interaction with mid-ocean ridges on global ocean basins;

(2) To identify key scientific issues that could be addressed in the coming years; and

(3) To discuss a general plan for more focused international collaboration in this important research field, especially multi-disciplinary experiments that can not be achieved by single nations alone.

MEETING AGENDA

The meeting has two components :

- The first one and half days is a symposium to review the latest progress in international community on various ridge-hotspot systems global wide (including oral and poster presentations); and
- The second one and half days is a workshop to identify pressing major issues on ridge-hotspot interaction and to discuss unique international, multi-disciplinary experiments to address these questions which otherwise can not be done by single nations alone.

A more detailed agenda is now available from the IR website. The latest information workshop and registration details will be posted as they become available on the IR home page: *http://www.intridge.org*

Questions about the meeting can be directed to the IR office: *intridge@ori.u-tokyo.ac.jp*

Upcoming Meetings and Workshops

Biogeography and Biodiversity of Chemosynthetic Ecosystems: What do we need to understand?

Southampton Oceanography Centre, UK,
16 - 18 June 2003

Co-organised by Ridge 2000, ChEss (Census of Marine Life), Ocean Exploration and InterRidge.

This workshop will focus on the biogeography and biodiversity of hydrothermal vent and cold seep communities. It will include patterns and processes in geochemistry and physical oceanography as well as biogeography and biology. The workshop aims are to define what is known and unknown about chemosynthetic ecosystems and to develop a new international phase for exploration of hydrothermal vents and cold seeps at the global scale.

A key motivation of the workshop will be to target specific areas of research requiring future investigations. Break-out groups will be focussed upon developing specific research prorities, that will facilitate international cooperation in pursuit of these goals.

An organising committee is being formed.

For futher information contact: Dr Eva Ramirez Llodra (*ezr@soc.soton.ac.uk*)

The latest information will be posted on the IR website as it becomes available.

7th International Conference on Gas Geochemistry (ICGG 7)

Freiberg, Germany,
22 - 26 September 2003

http://www.copernicus.org/ICGG7/

Organising Committee Chairman: J. Heinicke (SAW/TU-BA Freiberg)

Deadlines
- Notification of Interest: ***15 February 2003***
- Receipt of abstract: ***30 April 2003***
- Pre-registration and pre-reservation of accommodation: ***1 June 2003***

Aims & Scope
- Gas migration in terrestrial and marine environments
- Earth degassing (geogas) and its relation to seismicity and volcanic eruptions
- Rare gas application in hydrogeology and geothermal systems
- Application of isotope techniques for geogas/fluid transport processes
- Measurement and analytical techniques

Upcoming Meetings and Workshops

Joint R2K-IR Theoretical Institute: Backarc Basins and Spreading Systems

Cheju Island, Korea
24 - 28 May, 2004

The second IR theoretical Institute will take place on the Jeju (Cheju) Island, a shield volcanic island, located at the southern end of Korean peninsular.

The IRTI will consist of 2 days of invited lectures and short courses, a one day field excursion, and then a 2 day workshop devoted to discussions by subgroups.

Further information about this R2K-IRTI will be posted on the IR website as it becomes available.

Please contact the IR office (*intridge@ori.u-tokyo.ac.jp*) to pre-register your interest in attending.

3rd International Workshop on Scientific Use of Submarine Cables and Related Technologies

Komaba Campus - University of Tokyo, Japan
June 24-27, 2003,

http://wwweprc.eri.u-tokyo.ac.jp/KAIIKI/SSC03.html

Co-Chairs:
Junzo Kasahara, Earthquake Research Institute, University of Tokyo, Japan
Alan Chave, Woods Hole Oceanographic Institution, USA

Abstract Deadline: 31st January, 2003

Ridge related Scientific Topics will include:
- Mid-ocean ridge process studies
- Global geophysics

Technical Topics will include:
- Communication technologies
- Data management and archival technologies
- AUV/ROV
- Sensors

Full topic details can also be obtained from the link on "Meetings" page on the IR website.

Your requests

The InterRidge *Wishhhhhh List...*

On suggestion of the IR Steering Committee, we have opened the InterRidge Wishhhhhhh list to facilitate and poromote sample exchange between ridge scientists. Please submit requests for samples, to the IR Office. Iwould like to encourage all ridge scientist to check the Wishhhh list and share samples with your international colleagues. The success of this initiative is dependent on YOU! Below are three requests for samples. If you have such samples to share, please contact the appropriate scientists.

I wish I could get my hands on ....

Requested samples.....

Request for:
CHIMINEY SAMPLES

Samples of manganese encrusted chimneys as well as hydrothermal or hydrogenous ferromanganese samples and associated sediments collected from any other midoceanic ridge system".
Contact: Ranadip Banerjee
<banerjee@darya.nio.org> or
<banerjee@csnio.ren.nic.in>

SEARCH FOR GRAPHITE

Sediment trap deposits collected nearby vents, and/or grab samples of particulates from vents (0.0X to 1 gram quantities). Old collections are OK.
If such materials are available in your drawers, please contact: Jacques Jedwab
<jjedwab@ulb.ac.be>

ROCK SAMPLES
Rock samples from Laxmi Basin, Laxmi continental block or any protruding seamounts in eastern Arabian sea for physical/chemical studies
Contact: A. Shivaji (ashivaji@hotmail.com)

Wishhhhhh list ....

I wish I could get my hands on .....

Would you like to get your hands on certain samples; be they rocks, crabs or tubeworms!
Send your 'wish list' to the InterRidge office and we will post it on the IR website and print it in the next issue of IR news.
Cooperation is the key to good science!

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