Vol. 8 (2) Fall 1999

InterRidge News

Initiative for international cooperation in ridge-crest studies

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InterRidge Office Updates

Coordinator Update

InterRidge/BRIDGE Troodos Ophiolite Field Course

InterRidge and BRIDGE co-sponsored a field trip to the Troodos Ophiolite July 11-17, 1999. An international group of 37 scientists from 13 countries (Brazil, Canada, France, Germany, Israel, Italy, Japan, Portugal, Russia, Spain, Switzerland, UK and USA) participated in the field trip which was led by Joe Cann (UK), Kathy Gillis (Canada), Costas Xenophontos (Cyprus) and John Malpas (Hong Kong). For more details see the report on page 8.

Upcoming meetings

Workshop on the Management of Hydrothermal Vent Ecosystems

The workshop is motivated by the realization that impacts of scientific researchers, mining consortia and tour groups on vent habitats may be substantial, and the activities of one group are likely to have a negative effect on others. Its main objective will be to provide guidelines and recommendations for wise and sustainable use of these unique habitats. A summary of some of the legal issues involved with vent protection is given in the article on page 45 of this issue. Planning of the workshop has been undertaken by an international organizing committee composed of scientists and policy makers. The workshop is tentatively scheduled for September 2000.

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

This IRTI is being jointly organized by the 4D-Architecture of the Oceanic Lithosphere working group and the Global Distribution of Hydrothermal Venting working group. It will have a short course component which will focus on the modeling aspects of the dynamics of hydrothermal circulation in the crust, and a workshop component to synthesize the current models, debate controversies, and outline the future directions for collaborative research. The IRTI is tentatively scheduled to be in the Spring of 2001.

The Nature & Tectonic Significance of Fault Zone Weakening

InterRidge is one of the co-sponsors of this meeting which will take place March 8-9, 2000 in London, UK. There will be a special session devoted to the detachment fault problem in both continental and oceanic regions.

WWW Pages

Recent additions to the InterRidge web page include a new page on "Ridge-Hot Spot Interactions" which was developed under the auspices of the 4D-Architecture working group and summaries of major collections of hydrothermal vent biology samples. We are also trying to renew interest in the biological samples database. This database was developed at the request of participants at the First International Symposium on Hydrothermal Vent Biology in 1997 in order to facilitate the exchange of biological samples between researchers. To encourage submissions to it we are offering a free copy of the *Handbook of Hydrothermal Vent Fauna* to the next five people who submit relevant data to it before Dec. 31, 1999.

SCOR and India

The annual SCOR (Scientific Committee on Oceanic Research) meeting was held in Goa, India Oct. 25-28, 1999 and I attended as an InterRidge representative. This meeting offered us the chance to strengthen our connections with SCOR, and at the same time develop stronger contacts with the Indian ridge community. India has expressed interest in becoming an Associate member of InterRidge and we hope to welcome them as a new Associate member in 2000.

Steering Committee

The 1999 InterRidge Steering Committee Meeting was held June 25-26 in Bergen, Norway. Eirik Sundvor will be leaving the Steering Committee in 2000 and will be replaced by Rolf Pederson. The next steering committee meeting will be held June 16-17, 2000 in Woods Hole, MA, USA.

InterRidge Office Transfer

In January 2000 Kensaku Tamaki will take over as the Chair of InterRidge and the office will move to Tokyo, Japan. At the beginning of December I will be moving back to the states to start a research position with NASA in Maryland (my new coordinates are listed on the InterRidge electronic directory on the web). At that time Agnieszka M. Adamczewska, a biologist who just finished a post-doc at the Oregon Institute of Marine Biology center at the University of Oregon, will take over as the next InterRidge Coordinator. Both Mathilde and I have greatly enjoyed our interactions with the InterRidge community these last several years, and we would like to express our best wishes to Kensaku and Agnieszka for the rotation of the InterRidge Office to Japan.

Cara Wilson
InterRidge Coordinator
10 November 1999

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InterRidge Mailing List Sign up Form

Or sign up on the web at: http://www.lgs.jussieu.fr/~intridge/signup.htm

You can use this form to join are regular mailing list to receive *InterRidge News*, to be placed on our electronic mailing list or to be put on the electronic directory on the web (**http://www.lgs.jussieu.fr/~intridge**). Currently there are more than 350 people who are active in mid-ocean ridge research listed on this electronic directory. The directory contains a listing of each researcher's field of interest and expertise as well as their full address information. Links are also provided to personal or departmental web pages.

Indicate whether you would like your name to appear on:

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

Name____________________
Department/Institute____________________
Address____________________
____
City__________ **State/County**__________
Post Code__________ **Country**__________
Phone:__________ **Fax:**__________
country code area code number country code area code number
E-mail:____________________
WWW:____________________

What are your fields of interest/expertise?

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

Send to (address also on the reverse side): InterRidge Office, Laboratoire de Pétrologie, Tour 26, 3ème étage, Université Pierre et Marie Curie, 4 Place Jussieu, 75252 Paris Cédex 05, France (before Jan. 1, 2000)
InterRidge Office, Ocean Research Institute, University of Tokyo, 1-15-1 Minamidai, Nakano, Tokyo 164-8639, Japan (after Jan. 1, 2000)

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InterRidge Office Updates

InterRidge Publications

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

InterRidge News:

InterRidge News, 1999, 8 (2) pp. 72
InterRidge News, 1999, 8 (1) pp. 72
InterRidge News, 1998, 7 (2) pp. 68
InterRidge News, 1998, 7 (1) pp. 72
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InterRidge News, 1996, 5 (1) pp. 52
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InterRidge News, 1995, 4 (1) pp. 72
InterRidge News, 1994, 3 (2) pp. 44
InterRidge News, 1994, 3 (1) pp. 28
InterRidge News, 1993, 2 (2) pp. 4
InterRidge News, 1993, 2 (1) pp. 32
InterRidge News, 1992, 1 (1) pp. 26

Workshop and Working Group Reports:

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

Workshop and Symposium Abstract Volumes:

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

Steering Committee and Program Plan Reports:

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

InterRidge Office Updates

InterRidge Website

http://www.lgs.jussieu.fr/~intridge (until Dec. 15, 1999)
http://triton.ori.u-tokyo.ac.jp/~intridge (after Dec. 15, 1999)

Some of the features found on the InterRidge website include:

Ridge-Hot Spot Interactions
This new page was developed under the umbrella of the "4-D Architecture of the Oceanic Lithosphere" working group. It lists all the hot spots which interact with the mid-ocean ridge system, and cites relevant cruises and references for each.

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

International Vessel & Vehicle Database
A database of the vessels and vehicles (submersibles etc) capable for use in mid-ocean ridge science. Links are provided to that ship's homepage, for access to up-to-date scheduling information.

Hydrothermal Vent Faunal Database
A database of almost 500 species of faunal found at hydrothermal vents listing the general geographic range of the species and references.

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

Hydrothermal Vent Database
A database listing the known (i.e. ground-truthed) and suspected (i.e. plumes observed, vents not yet ground-truthed) vents, including the location, general description, and references.

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

Hydrothermal Ecological Reserves
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 Publication List
A list and on-line order form for all the InterRidge publications.

InterRidge Electronic Directory
A database of over 350 researchers active in mid-ocean ridge science, with their complete address, phone and fax numbers, e-mail addresses, and links to their web pages.

InterRidge Mailing List Sign-up Form
One can sign up on-line to be on our postal mailing list (to receive *InterRidge News*), our electronic mailing list or our web electronic directory, or you change your address if you are already in our records.

Updates on InterRidge Projects

Overview of InterRidge Working Groups

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

Arctic Oceans

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

Current Activities: Coordination of international cruise to the Gakkel Ridge in 2001.

Chair: Colin Devey (Germany)

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

Back-Arc Basins

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

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

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

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

Biological Studies

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

Current Activities: See page 10.

Chair: L.S. Mullineaux (USA).

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

Global Digital Database

Objective: Establish a database of global multibeam bathymetry and other data for mid-ocean ridges and back-arc basins.

Current Activities: Compiling data.

Chair: Philippe Blondel (UK)

WG members: J. S. Cervantes (Spain), C. Deplus (France), M. Jakobsson (Sweden), K. Okino (Japan), M. Ligi (Italy), R. Macnab (Canada), T. Matsumoto (Japan), K. A. K. Raju (India), W. Ryan (USA), and W. Weinrebe (Germany).

Global Distribution of Hydrothermal Venting

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

Current Activities: Organizing the InterRidge Theoretical Institute on the Thermal regime of Ocean Ridges and the Dynamics of Hydrothermal Circulation to be held in the Spring of 2001.

Chair: Chris R. German (UK)

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

4-D Architecture

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

Current Activities: Organizing the InterRidge Theoretical Institute on the Thermal regime of Ocean Ridges and the Dynamics of Hydrothermal Circulation to be held in the Spring of 2001.

Chair: Jian Lin (USA)

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

Event Detection and Response & Observ

Objectives: Develop detection methods of transient ridge-crest seismic, volcanic and hydrothermal events, and the logistical responses to them.

Current Activites: Development of MOMAR project.

Chair: Chris Fox (USA)

WG member: K. Mitsuzawa (Japan)

SWIR

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

Current Activities: Coordinating upcoming cruises.

Chair: Catherine Mével (France)

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

Undersea Technology

Objective: Foster the development of undersea technology and disseminate information about it.

Current Activities: Development of MOMAR project.

Chair: Alan Chave (USA)

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

Updates on InterRidge Projects

Report on the InterRidge/BRIDGE Field Trip to the Troodos Ophiolite, Cyprus, July 11-17, 1999

An international group of 37 scientists from 13 countries (Brazil, Canada, France, Germany, Israel, Italy, Japan, Portugal, Russia, Spain, Switzerland, UK and USA) participated in the InterRidge/BRIDGE field trip to the Troodos Ophiolite (Cyprus) in July. Joe Cann (UK), Kathy Gillis (Canada), Costas Xenophontos (Cyprus) and John Malpas (Hong Kong) were the field trip leaders. The field course concentrated on the upper part of the crustal section, including the volcanics, sheeted dykes, and all elements of the hydrothermal systems. The plutonic crust, upper mantle and a major transform fault terrane were also studied. Below are some of the participant's comments and perceptions on the experience.

"Troodos, past, present and future, remains an essential location for any self respecting scientist interested in oceanic lithosphere. The InterRidge field trip this summer provided an excellent opportunity to be familiarized with some of the latest thinking on the ophiolite. Despite the 40°C heat, discussion was excellent, largely as a result of the variety of disciplines represented by the party. Some of the more surreal experiences included a "Mary Whithead-style" virtual exposure of hydrothermal mounds... or the incredibly large hole where the sulphide deposit had been before being mined! Standing beside Joe Cann at the bottom of a 500 m deep pit as he waved his arms above his head and explained that the "roughly circular sulphide mound of breccia and volcaniclastics above us was similar in size and shape to TAG, and below us, beneath that brown lake of sulphuric acid, is a well developed stockwork" was an inspirational act of imagination that left us all spell-bound. Other awesome experiences included sticking ones head into the electrolyte shed where 20,000 amps were being pumped through a solution of copper sulphate at a copper processing plant. That and the fact the mine had been operating since 2000 BC, albeit with different technologies, made for some sobering thinking. For those who consider imaging the ridge floor amazing, a walk down Akaki Canyon and seeing a cross-section through a pile of syntectonic volcanics was an excellent insight into the complexities of the eruptive section. Similarly, to listen to some eminent geophysicsts discuss Moho definitions while strolling the upper mantle (petrologically speaking, of course) was somewhat ironic. Of course, the highlight of the trip, for me at least, was to jumble the ophiolite up and throw the entire party at the mixture. This is the Limassol Forest/Arakapas Transform area. A source of great controversy, perhaps, but after ten years since doing my PhD in the area, it is with some pride that I find the ideas and interpretations still in the scientific forum. In fact, for me, the Limassol Forest/Arakapas Transform problem sums up the attraction of Troodos; what ever we think now the ophiolite will continue to give us greater insights in to the subject so dear to us, the ocean crust."

Bramley J. Murton (UK)

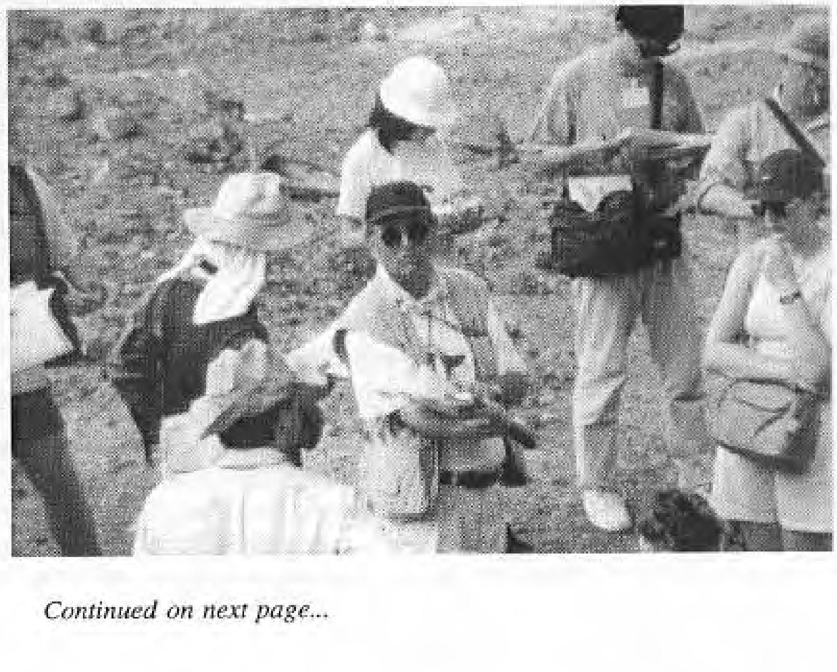
"Memories of days in Cyprus

Leaving the air-conditioned bedroom for the heat of the bathroom. Fresh orange juice for breakfast. The road to Nicosia. The road to hell across scorched fields. Sulphide mine waste so hot it burnt your fingers. Lakes of sulphuric acid. Olive bread. Jasper-bearing conglomerates. Sheeted dykes of indescribable monotony. Ultramafics of indescribable complexity. Walking on the seafloor. Learning about quantitative alteration studies. Mezes with Costas (what was that schnaps?). Scientific discussion at the highest intellectual levels ("Shut ya gob Bramley!")

The rocks

In terms of the science, I found the alteration details very exciting, the pillows, seafloor exposures and umbers were very good. I found it less easy to get a real sense for the ultramafics (they seemed very complicated and their relationships in space to one another and to the other units was difficult to imagine). The sheeted dykes were the least spectacular part of the whole trip, they were as I expected them to be and therefore not particularly exciting."

Colin W. Devey (Germany)



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Updates on InterRidge Projects

"The Cyprus Field Trip was excellent. There was a very good blend of people, some with sea floor experience, others with on-land and/or laboratory expertise, very good and comprehensive guidance, with contributions from many, a useful guidebook and finally, Joe Cann's in-field pad drafting, upside down, from left to right, was a major hit!"

Fernando Barriga (Portugal)

"As a non geologist I had a great trip, the leaders (and others) were very helpful in pointing out areas of interest and at clarifying what was probably obvious to most people. I learnt a great deal about specific rocks and also about the geological story of Troodos on a large scale, and areas which I knew nothing about, such as hydrothermal stuff, were made very clear."

Abigal Bralee (UK)

"The exposures of the upper crustal lavas and sheeted dike sections in the Akaki Valley were spectacular. The abruptness of the transition from lavas to sheeted dikes was clear and is a really important constraint on the construction of the upper crust. I was also impressed by the difficulty and ambiguity of the interpretation of faulting in this terrain. Are they listric faults or rotated, originally steeply dipping normal faults? Are the graben structures extinct spreading axes or did they form another way? Perhaps a good argument for the need for (seismic) studies of the interaction of magmatism and faulting along an active spreading center!!

I was also very impressed by the extensive hydrothermal deposits in Cyprus. The lava subsidence model now burned into my brain provided a very nice conceptual model for the variable stratigraphic position of these deposits in the lava section exposed in Cyprus. The size of some of the ore deposits was striking, and the fact that some have been mined since ancient times provided an interesting cultural angle to the geology we were seeing. Indeed, my only disappointment of the trip was that there was so much spectacular geology to see that we didn't have time to see many of the Greek and Roman sites on the island. But it is always good to leave a few things undone so as to justify another visit!"

Bob Detrick (USA)

"A remarkable aspect of the Troodos ophiolite is the freshness of preservation of features as if the whole slice of ocean lithosphere was gently uplifted and carefully placed in a museum of geology. The quality and scientific value of this preservation is exemplified by a hydrothermal chimney segment that I sampled during our stop at the Red Hill Kokkino-vounaros Mine. The deposit at this mine has been interpreted as supergene enrichment of gold by subaerial weathering of a seafloor massive sulfide deposit. On the day of our visit to the site the chimney segment lying in the hot sun was almost too hot to pick up. It is about 25 cm long and 10 cm in diameter with the inside silicified with jasper around a central opening and the outside covered with a bright yellow alteration mineral (jarosite?) that appears to preserve the original surface detail of the chimney. The chimney segment will be studied to test the hypothesis that the gold was enriched by low-temperature processes in place on the seafloor rather than after uplift on land."

Peter A. Rona (USA)

"What I liked most, was that people of all ages and of all status interacted in a very friendly manner. People were eager to learn from each other and to share their knowledge. The ophiolite let me put under my eyes what I usually see as a sonar image. It is not the same to speak about a 100 m deep graben and to be in it with forbidding, surrounding walls that you know you'll have to climb sooner or later. The same is true for hydrothermal deposits, pillow lavas, faults and talus. What was the most interesting to me was the chance to put a real scale to a mid-ocean ridge (all right, an ophiolite is not exactly a mid-ocean ridge, but it has once been, hasn't it?). Another interesting aspect was the alteration. I knew rocks could change their shape and their color when eroded, but I never dreamed it could be so spectacular! I will not forget this yellowish stone which was black inside and turned out to be a dunite. Quite a strange change...."

Olga Gomez (France)

"As hydrothermal systems and the rocks associated with them are strongly related to ancient hydrothermal deposits, it was interesting for me

Continued on next page...

to see "in situ" some of these ancient deposits. The Troodos ophiolite is one of the best examples in the world, as all the sequence of the oceanic crust is exposed, and it is possible to observe almost all the units. It's also the one where the upper layers - upper oceanic crust and its associated hydrothermal alteration (with massive sulphide deposits) - are best exposed. Nevertheless, I thought that it was better understood than it is. There are still many questions to be answered, which was understandable viewing the ophiolite in the field and many interesting discussions took place in front of the outcrop. It was very enriching to hear and to discuss with specialists, in particular when some of them know very well the modern and the ancient mid-ocean ridges systems.

It was very valuable to me to be able to observe the third dimension of the oceanic crust, as in the present day the possibilities to see it are restricted to its surface (ocean floor) or the first few meters in depth, using submersibles or studying some of the drill holes."

Isabel Costa (Portugal)

"I thoroughly enjoyed the fieldtrip. As I was only in my first year of my PhD it was my first opportunity, not only to take part in a group excursion, but also to integrate with others interested in similar topics as myself. The fieldtrip was well thought out with each day leading on clearly from the previous, and integrating these separate observations into the bigger picture of the ophiolite as a whole - an impressive feat seeing that the trip lasted less than a week! The information was pitched at many different levels to accommodate those with little previous knowledge right up to the dizzy heights of the experts.

From a personal point of view I benefited greatly from the trip. I was able to see how just how different ophiolite sequences can be by comparing Cyprus to what I had just seen on Oman. Just as importantly was that I had my first opportunity to meet others interested in ophiolite-related processes, and to discuss ongoing research on a personal level, a gratifying and exciting experience when innocent conversations can lead to new research ideas - and to new contacts."

Rich Thomas (UK)

"I really wanted to see the underneath of the seafloor, to feel as if I was in the *Voyage au Centre de la Terre* novel by Jules Verne. As a geophysicist my knowledge of geological terms was restricted to pillow lavas, sheeted dykes, basalts, gabbros, and peridotites. The introductary talks by Joe were helpful, as he pointed out what to see and how to see, giving meaning to what would otherwise have been just walls and rocks. To see the vertical section of a high temperature hydrothermal system was very impressive, and was especially important to me as a new big project is starting in Japan, "Archaean Park", which will explore the deep sub-seafloor biosphere in hydrothermal systems.

The field course was great, mainly because of the efforts of the field trip organizers, but also due to the diverse participants from different countries with different specialties and interests."

Nobukazu Seama (Japan)

Biology Working Group Update

Lauren Mullineaux (Working Group Chair) and Cara Wilson (InterRidge Coordinator)

An unusual event caught the attention of the Biology Working Group this year: the announcement in April that tourist visits to the Rainbow vent site were being scheduled for October 1999. The cruise organization was being done by Zegrahm DeepSea Voyages, a tour company that has previously conducted tour groups to the Titanic. The platform for the cruises was the *Akademik Keldysh* with the MIR submersibles.

This announcement instigated a spirited discussion of what InterRidge's response should be. On one hand, tourism could be used as a valuable education outreach program, by raising the visibility of mid-ocean ridge science to the general public, and by heightening awareness of the sensitivity of hydrothermal vent environments to anthropogenic impact. On the other hand, uncontrolled visits to vents have the potential to disrupt scientific research and have a negative impact on the vent organisms and their habitat.

As InterRidge representatives, we contacted both the tour operators and the chief of submersible operations, Professor Anatoly Sagalevitch of the P. P. Shirshov Institute, to get more information. Prof. Sagalevitch described the cruise as a scientific expedition with some tourists included to help cover costs and thus InterRidge elected to treat the *Keldysh* expedition as any other scientific cruise. The principal scientists involved in the *Keldysh* effort were put in contact with scientists currently working at Rainbow vents. Information was exchanged about the objectives of the MIR dives and the locations of ongoing observations at Rainbow. This information is posted on the InterRidge Hydrothermal Vent Ecological Reserves web site.

The Biology Working Group plans to follow up on this issue to help guide InterRidge policy and responses in the future to tourism at vents.

In addition, progress has been made on numerous biological projects:

Contributions from the First International Symposium on Deep-Sea Hydrothermal Vent Biology

The Contributions Volume from the First International Symposium on Deep-Sea Hydrothermal Vent Biology (Madeira, Portugal, October 1997) was published as volume 39(3/4) of *Cahiers de Biologie Marine*. The volume, with 43 papers, came out in February 1999 and can be purchased from Manual Biscoito in Madeira. InterRidge sent copies as gifts to selected libraries that do not subscribe to the journal, including 6 to Russia, 15 to Japan and 1 to Canada.

Database of Hydrothermal Vent Biology Samples

InterRidge established a database of hydrothermal biology samples (http://www.lgs.jussieu.fr/~intridge/samp-db.htm) at the request of participants at the 1997 International Symposium on Deep-Sea Hydrothermal Vent Biology. But despite energetic attempts to solicit contributions to this database only one set of samples from a single cruise has been submitted. Thus an alternative approach was devised, and summaries were solicited from major individual collections. Such summaries, including the approximate size of the collection, the geographical and taxonomical emphasis, and a contact person, have been submitted by: The Field Museum, Chicago, IL, USA; The Smithsonian, Washington, DC, USA; the P.P.Shirshov Institute of Oceanology, Russian Academy of Sciences; and the Mullineaux lab., Woods Hole Oceanographic Institution, USA.

There has been renewed interest in the database in the past 6 months and we expect at least some of these summaries to be expanded into on-line sample listings. Meanwhile, we continue to encourage other major collectors to submit summaries, and cruise PI's to submit sample listings.

Hydrothermal Vent Fauna web page

Andrew McArthur has supplied a compilation of data on known hydrothermal vent fauna, and this information is available on the InterRidge web page in database format (http://www.lgs.jussieu.fr/~intridge/fauna/). Much of the information displayed in this data base was published in Tunnicliffe, et al. 1998 (*Adv. Mar. Biol.*, 34, 355-442, 1998), but information is also being added as it becomes available. The database lists almost 500 species that have been identified as hydrothermal vent fauna. It also contains the geographical range of each species and relevant references. We encourage additional contributions to this database, and thank Andrew for his generous efforts.

Hydrothermal Vent Ecological Reserves web page.

Since 1997, InterRidge has maintained the Hydrothermal Vent Ecological Reserves web page (http://www.lgs.jussieu.fr/~intridge/reser-db.htm) in order to allow scientists to post the location of vent sites that they request remain undisturbed for a specified length of time. To date, ecological reserves have been proposed at the Mid-Atlantic Ridge, East Pacific Rise and Juan de Fuca Ridge. In addition, a request has been made to delay mining operations at western Pacific vents in order to allow for scientific study. The reserve postings 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 the reserves at the other areas consist of requests from individual scientists conducting experiments at those areas.

Workshop on Management of Hydrothermal Vent Ecosystems (Fall 2000).

The motivation for this workshop is the realization that the increasing interest in vent habitats from different interests can lead to incompatible activities at individual vent sites. InterRidge has been concerned with the issue of how to regulate scientific activities at vents (see the EOS article at: http://www.lgs.jussieu.fr/~intridge/reserve.htm), and that concern has broadened with the new prospect of vent tourism and mining. In particular, the interest of some companies in mining deep vent habitats raises the possibility of large-scale damage or destruction of little-known vent communities in the Western Pacific, with its consequent reduction in biodiversity and loss of critical biogeographic and evolutionary information.

The main workshop objective will be to develop mechanisms for managing multinational activities at vents, in international and EEZ waters. The effects of various uses of vent ecosystems (i.e., what damage occurs) will be discussed, and a rationale derived for why it is important to preserved these systems. Specific, uniquely sensitive vent sites will be identified and plans drafted for sites currently exposed to multiple users, including Endeavour, 9°N East Pacific Rise, Rainbow, and Lucky Strike. Finally, recommendations will be made for future conservation research.

The workshop will be convened by Drs. Kim Juniper and Paul Dando. An organizing committee is being assembled of scientists and policy makers from InterRidge nations and international policy and conservation organizations. An announcement describing the workshop in more detail will be issued by InterRidge.

Hydrothermal Vent Biology Symposium (Fall 2001)

Daniel Desbruyères is organizing a hydrothermal vent biology symposium in Brest in September 2001. This meeting will provide an opportunity for international hydrothermal biologists to review the objectives of the InterRidge biology working group and to generate a new plan for the next 5 years.

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

Hydrothermal vent communities in the Manus Basin, Papua New Guinea: Results of the BIOACCESS cruises '96 and '98

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Introduction

Hydrothermal vent communities in the northwestern Pacific have been reported from the Okinawa Trough (Ohta, 1990; Hashimoto et al., 1995), Kagoshima Bay (Hashimoto et al., 1993; Miura et al., 1997) and Izu-Bonin area (Hashimoto and Ohta, 1997). In the southwestern Pacific, vent communities have been reported from the Mariana Trough (Okutani and Ohta, 1988; Hessler and Lonsdale, 1991), the North Fiji Basin (Jollivet et al., 1989), and the Lau Basin (Desbruyères et al, 1994). Several areas of hydrothermal activity and vent-associated biological communities have also been reported in the Manus Basin (Tufar, 1990; Beck, 1991; Binns and Scott, 1993; Lisitsin et al., 1993; Auzende et al., 1996; Auzende et al., 1997; Gamo et al., 1997; Galkin, 1997). However, studies on the ecology and distribution of fauna in the Manus Basin have been limited despite the availability of topographical, geological and geochemical information. The Manus Basin lies halfway between the Mariana Trough and the North Fiji Basin and the vent communities in the Manus Basin are important from a biogeographical point of view.

The **BIOACCESS** (**B**iological **I**nvestigation **O**f **A** **C**hemosynthetic **C**ommunity: **E**cological and **S**ystematical **S**urvey) cruises in 1996 and 1998 with the *Natsushima/Shinkai 2000* included biologists (physiologists and microbiologists), geochemists and geologists. Thirty dives with the submersible *Shinkai 2000* were undertaken during the two cruises. This paper describes the results of the BIOACCESS cruises '96 and '98 and summarizes the biogeographical knowledge on the chemosynthetic communities of the Western Pacific.

Hydrothermal vent fields and vent-associated biological communities in the Manus Basin

In the Manus Basin (Fig. 1), hydrothermal activities and vent-associated biological communities have been reported from the PACMANUS, DESMOS and Vienna Woods sites between depths of 1600 m and 2500 m (Auzende et al., 1996; Auzende et al., 1997; Gamo et al., 1997; Galkin, 1997). During the BIO-

ACCESS cruises '96 and '98 the hydrothermal vent communities at the PACMANUS and DESMOS sites on the southeastern Ridge (SER) in the eastern Manus Back-arc Basin were studied in detail.

PACMANUS site

Three hydrothermal vent fields, Field D, Field E and Field F, were previously located in the PACMANUS site with a deep-tow system (Binns et al., 1991). In 1995, the ManusFlux cruise with the *Yokosuka/Shinkai 6500* was conducted at this site as part of the Japan-France cooperative program New STARMER, and the three vent fields were surveyed by the *Shinkai 6500*. Active chimneys venting out high-temperature black or gray vent fluids (268°C maximum) were found in all three fields. Low-temperature diffuse vents (approximately 45°C) were found in Fields D and F (Auzende et al., 1996). The PACMANUS vent fluids are rich in potassium and deficient in calcium, reflecting the interactions between the fluids and the dacite host rock (Gamo et al., 1997). Chimneys, several tens of meters in height, lie on top of sulfide mounds (Auzende et al., 1996).

During the BIOACCESS cruise '96 a new active vent site was discovered by the *Shinkai 2000*. This new site was named the Tsukusi (cat-tail in Japanese) site after the shape of the chimneys. The site, in Field G, is located located about 350 m southwest of Field D. During the BIOACCESS cruises '96 and '98 eighteen dives by the *Shinkai 2000* were conducted to study the hydrothermal activity and the vent communities in all four fields (D-G). The distribution of hydrothermal activity and the vent communities at the PACMANUS site is shown in Fig. 2.

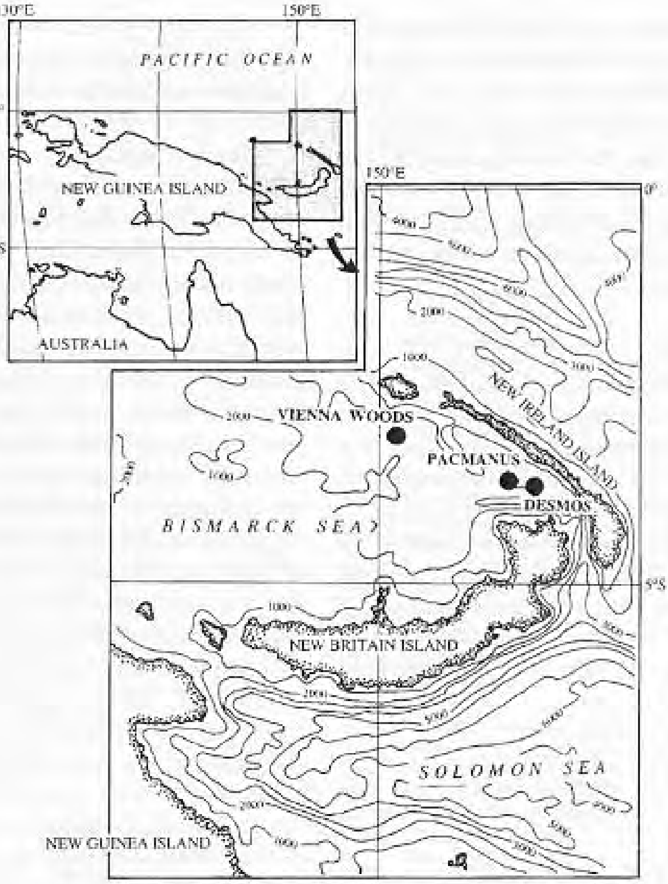

Figure 1. Location of the survey sites in the Manus Basin.

Field D

A group of large chimneys was found in the northwestern part of Field D with chimney walls more than 20 m high. Two large diffuse vent sites, the Mont Blanc and Kai-Kai sites, were also found in this field.

Strong shimmering was observed around cracks at the base of the active chimneys, where there was a large population of *Ifremeria nautilei* and *Alviniconcha* cf. *hessleri*, together with individuals of buccinid gastropod (*Eosipho desbruyeresi*), limpets, barnacle (*Neolepas* sp.), bresiliid shrimps, bythograeid crab (*Austino-graea alayseae*), galatheid (*Munidopsis lauensis*) and zoarcid fishes.

The Mont Blanc site is located about 50-60 m east of the active chimney wall. The seafloor bottom at the Mont Blanc site is relatively flat and covered with thick sediment. Blackish rocks (andecite or dacite) dusted with sediments and pillow lava formations were scattered on the bottom. To the north of the Mont Blanc site there is a small ridge running roughly northeast to southwest. On the western slope of this ridge repetitions of sedimented bottom, lobate lava, a depression and pillow lava were observed. Many dead shells of deep-sea mussels and conid gastropods were distributed on the upper part of the ridge slope. Along the ridgeline there was many active diffuse vents, color alterations, bacterial mats, live mussel beds, small actinians, galatheids, two species of vestimentiferans (*Lamellibrachia* sp. and *Alaysia* sp.), stalked barnacles and zoarcid fishes. Some mussels were burrowed into the sediments among the sulfide slabs. Many limpets, including *Olgasolaris tollmani* and *Lepetodrilus schrolli*, were attached to the shell surfaces of the mussels.

The Kai Kai (food market in the Papua New Guinean language) site is located about 100 m southeast of the chimney wall. Abundant bacterial mats, galatheids, mussels, limpets, conid gastropods, vestimentiferans (*Alaysia* sp., *Escarpia* sp. and *Lamellibrachia* sp.), stalked barnacles, bresiliid shrimp (*Alvino-*

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caris longirostris) and zoarcid fish were seen around the low-temperature diffuse vents of this site. Many stalked barnacles were swaying in the weak bottom current in and around the mussel bed. Several specimens of the barnacles were also observed attached to vestimentiferan tubes.

Field E

The Black Smoker site (160 m ×90 m), an area with active chimneys and several diffuse vent sites, was found in Field E. The largest diffuse vent site, the Juvenile site, is located about 200 m east-northeast of the Black Smoker site. Several small diffuse vent sites were also found about 250 m south of the Black Smoker site. Presumably more low-temperature diffuse vents similar to the Juvenile site are scattered at the eastern part of the Black Smoker site.

At the Black Smoker site, many veritable forests of small active and dead chimneys were found at the base of 10-15 m high chimneys. Active black, gray and clear smokers venting out high-temperature vent fluids were observed. The temperature of the clear smokers was approximately 103°C. Many scale worms (Branchinotogluminae gen. sp.) and paralvinellid polychaetes were found on the top of the chimneys. Active black smokers occurred among large groups of dead chimneys which had white and yellow patches on the chimney tops. The densest vent populations at the base of the active chimneys were two species of provannid gastropods (*Ifremeria nautilei* and *Alviniconcha* cf. *hessleri*). The temperature of the habitat of the gastropods was between 5-40°C. Bresiliid shrimp, bythograeid crab, galatheids and zoarcid fishes were observed in and around the vent site.

Co-dominant species at the Juvenile site were a deep-sea mussel (*Bathymodiolus* sp.), and a vestimentiferan (*Arcovestia ivanovi*) which inhabited the shimmering water (temperature between 22-29°C). Numerous limpets, barnacles attached to mussels, bresillid shrimp, galatheid, bythograeid crab, synaptid holothurian and zoarcid were observed in and around the shimmering water.

Five species of limpets (*Lepetodrilus schrolli, Olgasolaris tollmanii, Shinkailepas tufari, Shinkailepas* sp., *Symmetromphalus hageni* and *Bathyacmaea jonassoni*), two species of mussels (*Bathymodiolus brevior* and *Bathymodiolus* sp.) and four species of barnacles (*Eochinonelasmus ohtai manusensis, Neoverruca* sp. and *Neolepas* spp.) were also observed and sampled in this field.

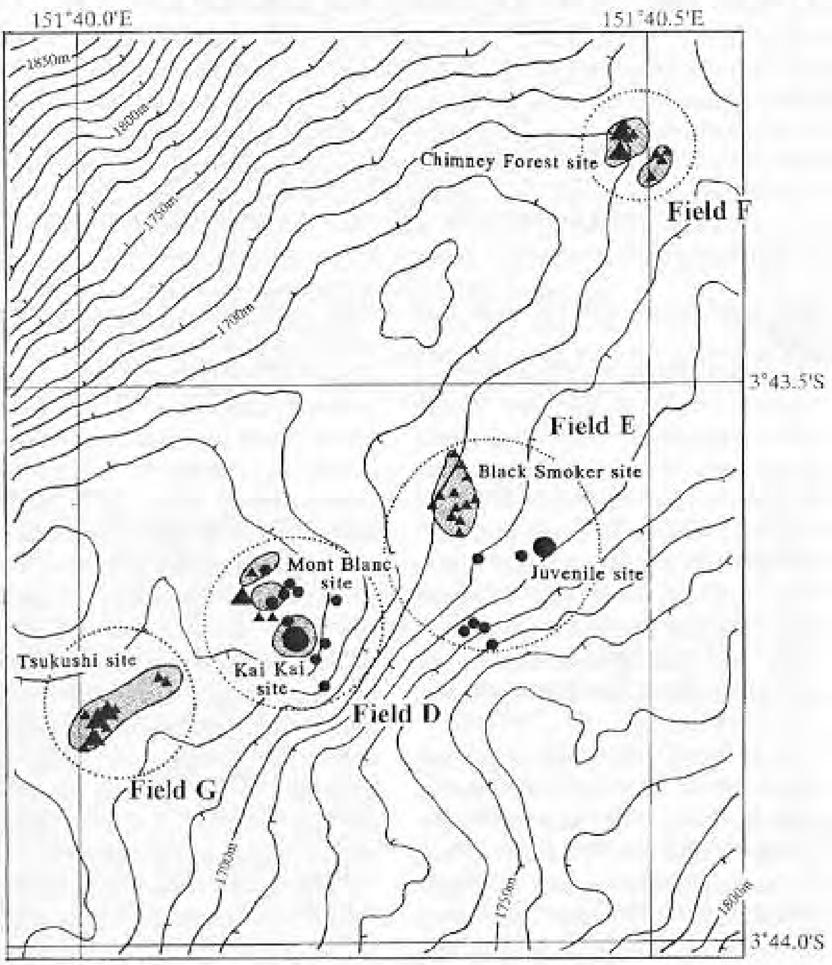

Figure 2. Distribution of active hydrothermal sites and biological communities at the PACMANUS site. Gray parts: active hydrothermal areas, solid triangles: chimneys with vent communities, solid circles: diffuse vents with vent communities.

Field F

The Chimney Forest site was found in Field F. This area consists of many active and dead chimneys, 15 m in height, and much broken chimney debris. Another vent site composed of a bunch of small (5-6 m) chimneys was found several tens of meters southeast of the Chimney Forest site.

The Chimney Forest site is situated on the slope of a valley, the substrate of which was formed by very old volcanic flows. The tops of the chimneys are white and covered with numerous scale worms (Branchinotogluminae gen. sp.) and paralvinellid polychaetes. Shimmering water was observed in most of the chimneys and whitish-gray fluids were also observed exiting from some of them. The maximum temperature of the diffuse vent fluid at the base of an active large chimney was 238°C. The usual vent animals, including actinians, provannid gastropods, limpets, bresiliid shrimps, bythograeid crabs, galatheids and zoarcids, were scattered in and around the shimmering water like at the other active fields.

Field G

The Tsukushi site is composed of a series of turreted gothic towers. Each tower is composed of multiple auxiliary chimneys or pinnacles supporting the main tower, the largest of which was over 20 m high and several meters across at the base. Clear and/or white vent fluids were emitted from the top of the cat-tail shaped chimneys with a maximum temperature of 262°C. The general architecture of the tower at the Tsukushi site is similar to that of the Black Smoker site in Field F.

Black and gray smokers were also observed around the huge towers. Dacite covered with thin sediments and a fresh glassy pillow were observed at the base of a huge chimney. Pillow lavas covered with thin sediments were observed about 100 m north and 100 m south of the Tsukushi site. The area extending out to 150 m northeast of the Tsukushi site had abundant bacterial mats, deposits of altered grayish-white sediments, and multiple low-temperature diffuse vents.

Many gills of paralvinellid polychaetes and large-sized polynoids (Branchinotogluminae gen. sp.) were observed on the surface of the white (mainly barite) chimney tops. Shimmering water and venting from fissures and/or small chimneys at the base of the huge chimneys was also observed. The maximum temperature was 233°C. Provannid gastropods (*Ifremeria nautilei* and *Alviniconcha* cf. *hessleri*) inhabited the center of the vents. Limpets, bresiliid shrimp, bythograeid crab, galatheids and zoarcid fish were crawling or swimming in and around the active vents.

DESMOS site

Hydrothermal activity and vent-associated biological communities were discovered at the DESMOS site by a deep tow survey during the Aquarius Expedition of the *Hakuho Maru* (Cruise KH-90-3). The most active hydrothermal activity was found on a small terrace on the northwestern inner wall of the DESMOS Cauldron (3°41.75'S, 151°52.30'E) at ~2000 m (Ohta et al., 1997). During the ManusFlux cruise by the *Shinkai 6500*, high- and low- temperature vent sites were found on the northwestern wall of the DESMOS Cauldron, including the Onsen site, an extremely active white smoker site (Gamo et al., 1997; Auzende et al., 1996; Auzende et al., 1997).

During the BIOACCESS cruises '96 and '98, twelve dives of the *Shinkai 2000* were carried out at the DESMOS site. The most striking ecological feature of the Onsen site is that in the midst of the milky smokers, the vent-associated fauna is very poor both in species richness and in the number of individuals present. Numerous galatheid crabs (*Munidopsis lauensis*) and vestimentiferan tube-worms (*Arcovestia ivanovi*) characterize this vent site. This site is devoid of organisms with large amount of calcium carbonate, such as vesicomyid clams, mussels, barnacles, bythograeid crabs and shrimps.

Swarms of galatheids and zoarcid fish were also found on a small terrace between 1860-1890 m depth. This zone is just above the Onsen site and is separated horizontally only by a few tens of meters. This site was preliminarily named the Genge-ba (zoarcid's habitat in Japanese) site. The most prominent members of this habitat were four species of vestimentiferan tubeworms (*Arcovestia ivanovi*, *Escarpia* sp., *Lamellibrachia* sp. and *Ridgeia* sp.), among which many galatheids (mostly *Munidopsis lauensis*), shrimp (*Alvinocaris longirostris*), zoarcid fish and small gas-

Table 1. Collected and observed species at the PACMANUS site.

CNIDARIA
Anthozoa? type-1
Anthozoa? type-2
Anthozoa? type-3
POLYCHAETA
Paralvinella sp.
Iheyomytilidicola sp.
Lepidonotopodus sp.
Opisthotrochopodus sp.
Protomystides sp.
Ampharetidae gen. sp.
Nereididae gen. sp.
Capitellidae gen. sp.
Trochochaetidae gen. sp.
Hesionidae gen. sp.
Harmothoinae gen. sp.
Spionidae gen. sp.
Branchinotogluminae gen. sp.
Branchipolynoe sp
Polynoidae gen. sp. type-1
Polynoidae gen. sp. type-2
VESTIMENTIFERA
Arcovestia ivanovi
Escarpia sp.
Lamellibrachia sp.
Ridgeia sp.
Alaysia sp.
MOLLUSCA
Gastropoda
Bathyacmaea jonassoni
Olgasolaris tollmanii
Lepetodrilus schrolli
Lepetodrilus sp.
Shinkailepas tufari
Shinkailepas sp.
Symmetromphalus hageni
Alviniconcha cf. *hessleri*
Provanna buccinoides
Provanna nassariaeformis
Provanna sp.
Ifremeria nautilei
Eosipho desbruyeresi
Desbruyeresia melanoides
Phymorhynchus starmeri
Margarites sp.
Bivalvia
Bathymodiolus brevior
Bathymodiolus sp.
Malletia sp.
Thyasiridae gen. sp.
ARTHROPODA
Cirripedia
Eochionelasmus ohtai manusensis
Neoverruca sp.
Neolepas sp. type-1
Neolepas sp. type-2
Macrura
Bresiliidae gen. sp.
Alvinocaris longirostris
Lebbeus washingtonianus
Brachiura
Austinograea alayseae
Anomura
Munidopsis lauensis
Munidposis starmer
ECHINODERMATA
Branchipolynoe sp
Echinoidea type-1
Echinoidea type-2
Ophiuroidea type-1
Ophiuroidea type-2
Synaptidae gen. sp.
Holothroidea type-1
PISCES
Zoarcidae gen. sp.

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tropod (probably belonging to the family Provannidae) occurred. Numerous limpets, including *Lepetodrilus schrolli*, were attached to the tubes of the vestimentiferans. Small individuals of the mussel *Bathymodiolus* sp. were discovered next to a clump of fresh vestimentiferan tubes, almost all of which were empty. Close observation of the dense biological communities suggested that they are situated among diffuse, clear vents, and are not nourished directly by the milky smokers. It appears that the organisms avoid areas under the direct influence of the milky smokers.

No shimmering water was observed at the *Calyptogena* field located to the east of the Onsen site, although a vast extension of white precipitates was visible on the sandy sediment. The *Calyptogena* patch is not a gregarious one, and clams occurred solely, or in twos and threes. The lack of a black sulfate reduction layer beneath the sediment suggests that the hydrogen sulfide which supports the symbiotic nourishment of the clams is magmatic in origin and not formed via the "fermentation bed" of seawater sulfate reduction as observed in the cold seep zone. Vestimentiferans belonging to the genus *Ridgea* were confined to the basement of outcropping rocks. *Alvinocaris longirostris* sat around or perched directly on the posterior extremities of *Calyptogena* clams. A schematic topographic map showing the active vents and vent communities at the Onsen site at DESMOS is shown in Fig. 3.

Table 2. Collected and observed species at the DESMOS site

CNIDARIA
Anthozoa? type-4
POLYCHAETA
Opisthotrochopodus sp.
Shinkai sp.
Nereididae gen. sp.
Serpulidae gen. sp.
VESTIMENTIFERA
Arcovestia ivanovi
*Lamellibrachia*sp.
Escarpia sp.
Ridgeia sp.
MOLLUSCA
Gastropoda
Bathyacmaea jonassoni
Lepetodrilus schrolli
Lepetodrilus sp.
unidentified limpet
Phymorhynchus starmeri
Provanna sp.
Margarites sp.
Bivalvia
Bathymodiolus sp.
Calyptogena sp.
Malletia sp.
Thyasiridae gen. sp.
ARTHROPODA
Cirripedia
Eochionelasmus ohtai manusensis
Neolepas sp. type-2
Macrura
Alvinocaris longirostris
Nematocarcinus sp.
Anomura
Munidopsis lauensis
Munidopsis sp.
PISCES
Zoarcidae gen. sp.

Discussion

During the BIOACCESS cruises '96 and '98 at least 68 species of deep-sea animals were collected from the Manus Basin (Table 1 and Table 2). Taxonomic and phylogenetic studies of the vent communities revealed the following:

1. Two populations of *Ifremeria nautilei* from the Manus Basin and from North-Fiji Basin are probably the same species (Kojima et al., 1998).
2. All individuals of *Alviniconcha* from the Manus and North-Fiji Basins are genetically different from *A. hessleri* from the Mariana Trough (Kojima et al., 1998).
3. *Eosipho desbruyeresi* was reported from the Mariana Trough, North-Fiji Basin and Lau Basin (Okutani and Ohta, 1993).
4. The deep-sea mussel, *Bathymodiolus brevior*, is distributed in the North-Fiji and Lau Basins (Cosel et al., 1994).
5. The galatheid, *Munidopsis starmer*, is distributed in the North-Fiji Basin (Baba and de Saint Laurent, 1992).
6. *Lebbeus washingtonianus* has been reported from off British Columbia and off California in the eastern Pacific, and from the Iheya Ridge of the Okinawa Trough in the western Pacific (Kikuchi and Ohta, 1995).
7. The type locality of *Alvinocaris longirostris* is the Iheya Ridge in the Okinawa Trough (Kikuchi and Ohta, 1995).
8. The type locality of *Desbruyeresia melanoides*, *Austinograea alayseae* and *Munidopsis lauensis* is in the Lau Basin (Warén and Bouchet, 1993; Guinot, 1989; Baba and de Saint Laurent, 1992).
9. Undescribed vestimentiferan tubeworms belonging to the genus *Escrapia* from the Manus Basin, Okinawa Trough and the Nankai Trough were thought to be conspecific based on the comparison of nucleotide sequences of mitochondria genes for COI (Kojima et al., 1998).

The new biogeographical results from vent organisms from the Manus Basin reveal that there is faunal exchange among chemosynthetic communities of the Manus Basin, the North-Fiji Basin, the Lau Basin, the Mariana Trough and the Okinawa Trough.

The biological communities at the Vienna Woods and the PACMANUS sites are different from those at the DESMOS site. Gastropods symbiotic with chemosynthetic bacteria such as *Alviniconcha* cf. *hessleri* and *Ifremeria nautilei* are the major constituents at the Vienna Woods and PACMANUS sites, whereas *Calyptogena* and four species of vestimentiferans are thought to be the co-dominant members of the hydrothermal communities at the DESMOS site. Both the PACMANUS site and DESMOS site are located on the same segment of the SER, and the distance between the two sites is less than a hundred kilometers. Here we have the opportunity to evaluate the differences and similarities (especially in terms of gene flow) between biological communities that are separated by only a hundred kilometers. We have already explored many hydrothermal vent fields in the Western Pacific, such as several sites in the Okinawa Trough (Ohta, 1990; Hashimoto *et al.*, 1995), along the Bonin island chains (Hashimoto and Ohta, 1997), several sites in the Mariana Basin (Okutani and Ohta, 1988; Hessler and Lonsdale, 1991), the Manus Basin (Auzende et al., 1996; Auzende et al., 1997; Gamo et al., 1997; Galkin, 1997), the North Fiji Basin (Jollivet et al., 1989), the Lau Basin (Desbruyères et al., 1994) and the Kagoshima Bay (Hashimoto et al., 1993; Miura et al., 1997). They are separated from each other by distances ranging between several tens of kilometers to a few thousand kilometers, and the bathymetry ranges from less than a hundred meters to deeper than 3600 m. Such high concentrations of hydrothermal vent communities are rare, and they provide a great opportunity in advancing the research of these biological communities.

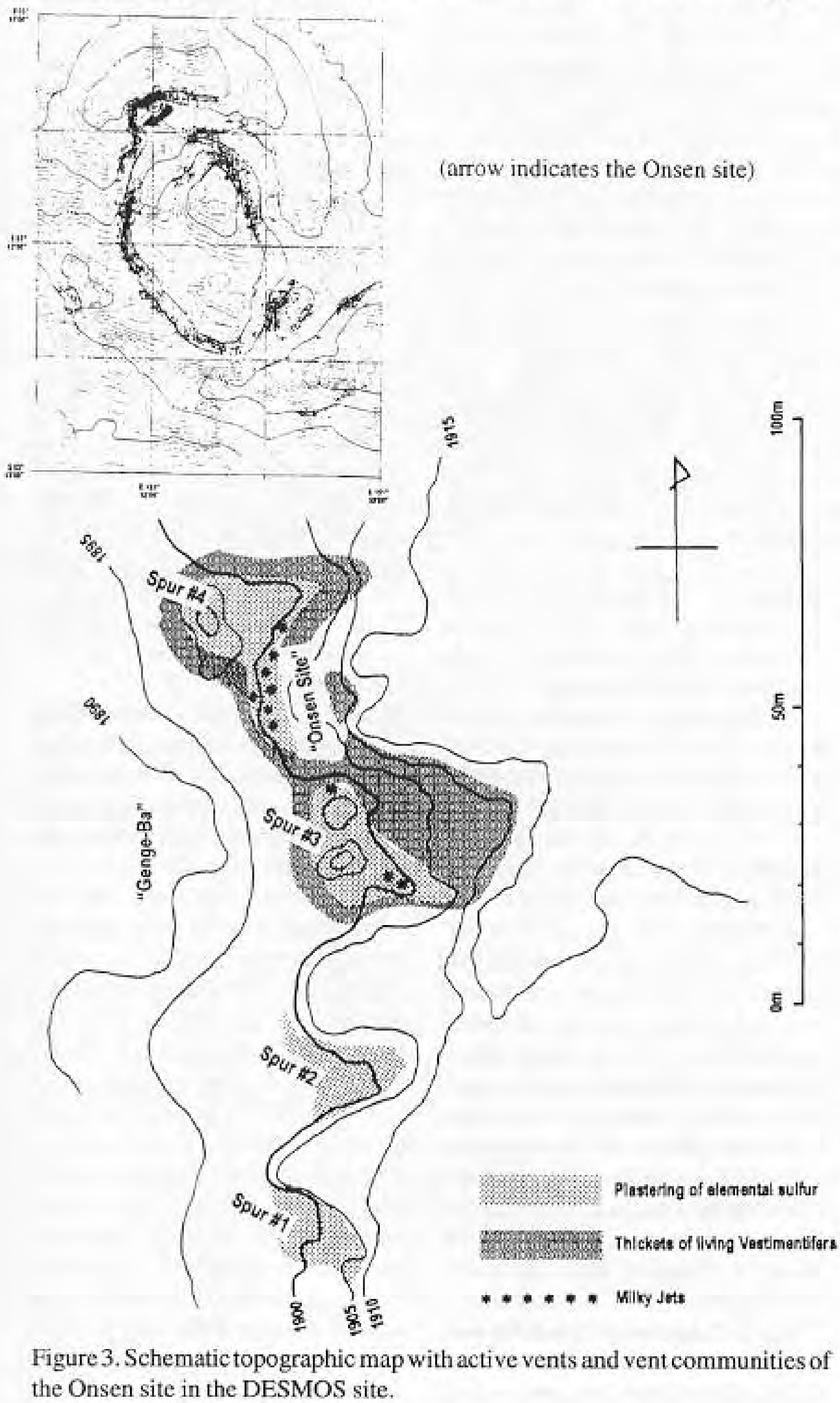

Figure 3. Schematic topographic map with active vents and vent communities of the Onsen site in the DESMOS site.

Acknowledgments

We are deeply indebted to the government of Papua New Guinea for granting us special permission for the cruise. Our thanks are also extended to captain and crew of the R/V *Natsushima* and the submersible *Shinkai 2000* operation for their enthusiastic cooperation during the BIOACCESS cruises '96 and '98 in the Manus Basin.

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

The HOPE 99 cruise: back to 13°N EPR

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The HOPE 99 (**H**ydrothermalisme **O**céanique: **P**hysiologie et **E**cologie) cruise took place at the East Pacific Rise vent sites from April 9 to May 22, 1999 with the N/O *L'Atalante* and the submersible *Nautile*. The cruise was conducted in two legs, the first one was centered around the 13°N segment, with off-axis incursions to nearby seamounts, with ecology and population genetics as the key objectives, the second leg was oriented towards biochemical and physiological studies on vent model species found at 13°N and at 9°50'N.

The first leg (12 dives) was truly multi-disciplinary with specialists in the geology, chemistry, ecology and genetics of vents. A new set of bathymetric data acquired with the multibeam EM12 echo sounder allowed us to finely position active and inactive sites during subsequent dives. Using a newly developed software package, ADELIE (**A**ide au **DE**pouiLlement des **I**nformations des **E**ngins submersibles), based on a GIS synchronized to dive data and video, we were able to replay previous dives to prepare the next ones.

In a global sense the 13°N segment is still active but differences could be noted along the axis (see map on Fig. 1 and photos in Fig. 2). The northern part (A on map) showed numerous black smokers, often appearing as recent outgrowth from ancient chimneys, with dense populations of *Alvinella* and accompanying fauna (e.g. *Cyanagraea, Hesiolyra*...). In the central part (B) well known sites such as Genesis, Elsa or Parigo were still active with dense populations of *Riftia* and nice hot spots with *Alvinella* communities. However, the faunal composition seems to have evolved since 1996, with higher densities of octopusses and serpulid worms and virtually no mussels or clams. In the southern part (C) numerous inactive sites were spotted but their precise identification must await careful examination of previous cruises video recordings. Two active sites were spotted off-axis: the Caldera (F) with *Riftia* and *Alvinella* communities developing, a site previously described by Fouquet in 1991, and the NE seamount (D) with several black smokers colonized by *Alvinella*. No active sites were found on the SE seamount (E).

In addition to the submersible dives, deep trawling along and across the axis was conducted at night with the RMT (Remotely Monitored Trawl) 1+8 net system, with successful trawls as close as 50 m above the axis. Except for some *Nematocarcinus* shrimps, juveniles of bythograeid crabs and cirrotheutid octopusses very few familiar vent species were recovered

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form the catches.

Faunal sampling during the first leg was specially designed for segment-scale population genetics studies, focusing on a limited number of species living in either high-temperature zones (*Alvinella pompejana*, *Hesiolyra bergi*, *Nodopelta* spp. and *Peltospira* spp), low-temperature zones (*Amphisamytha galapagensis*, *Lepetodrilus pustulosus* and *Cyathermia naticoides*)or both areas(*Paralvinella grasslei* and *Lepetodrilus elevatus*). Subsequent studies on these samples will hopefully improve our understanding of the site colonization and dispersal strategies of vent endemic species.

During the second leg (21 dives) emphasis was put on *in situ* experiments and moorings, and on on-board experimental work with model species. Several kinds of moorings were deployed and recovered after a few days or weeks (thanks to the help of the AMISTAD cruise following ours). All the moorings were aimed at collecting particles near the vents, these included: sediment traps, PLASMA (**PLA**ncton **S**ampler for **M**oleular **A**nalysis), TRAC (**T**itanium**R**ing for **A**lvinellid **C**olonization) and SMAC (**S**ampling**M**odule for**A**nimal**C**olonization) modules (see Fig. 3).

Nautile was equipped for the first time with ALCHIMIST (**A**na**L**yseur **CHIM**ique**I**n**S**i**T**u, developed by IFREMER) an *in situ* chemical analyzer monitored from within the sphere of the submersible. Sulfide, nitrate, temperature and pH were measured and several continuous series of data (20 to 40 minutes) were acquired close to the vent fauna, e.g. within*Riftia* bushes, mussel beds or close to alvinellid tubes. Discrete water samples were taken during these *in situ* measurements for in-depth analysis of chemical composition around animal communities. A few dives were devoted to tube painting using the Dome Stainer (generously provided by C.R Fisher) for growth studies on *Riftia*.

Work on-board was centered around the new pressure vessel IPOCAMP (**I**ncubateur **P**ressurisé pour l'**O**bservation et la**C**ulture d'**A**nimaux **M**arins**P**rofonds), largely inspired by the work of J.J. Childress but improved with video monitoring capacities. The behavior of some species under different temperatures could thus be observed. As expected, working on re-pressurised animals gave more reliable results. Experiments included heavy metal accumulation by mussels, hypercapnia tolerance on crabs, induced mutagenesis on worms, tube growth on*Riftia* and more. Additional experiments and samplings were done on for a variety of biochemical and molecular studies which will be completed in the near future.

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We wish to express our deep gratitude to the captain and crew of the NO *L'Atalante* and to the *Nautile* team. Many thanks also to C.R. Fisher and P. Hickey for the "fresh" information they provided on the 9°50'N sites. And a big "merci" to the chief scientists of the AMISTAD cruise, C. Jeanthon and D. Prieur, for their help in recovering moorings. This cruise was supported by the DORSALES program, IFREMER and CNRS/ INSU.

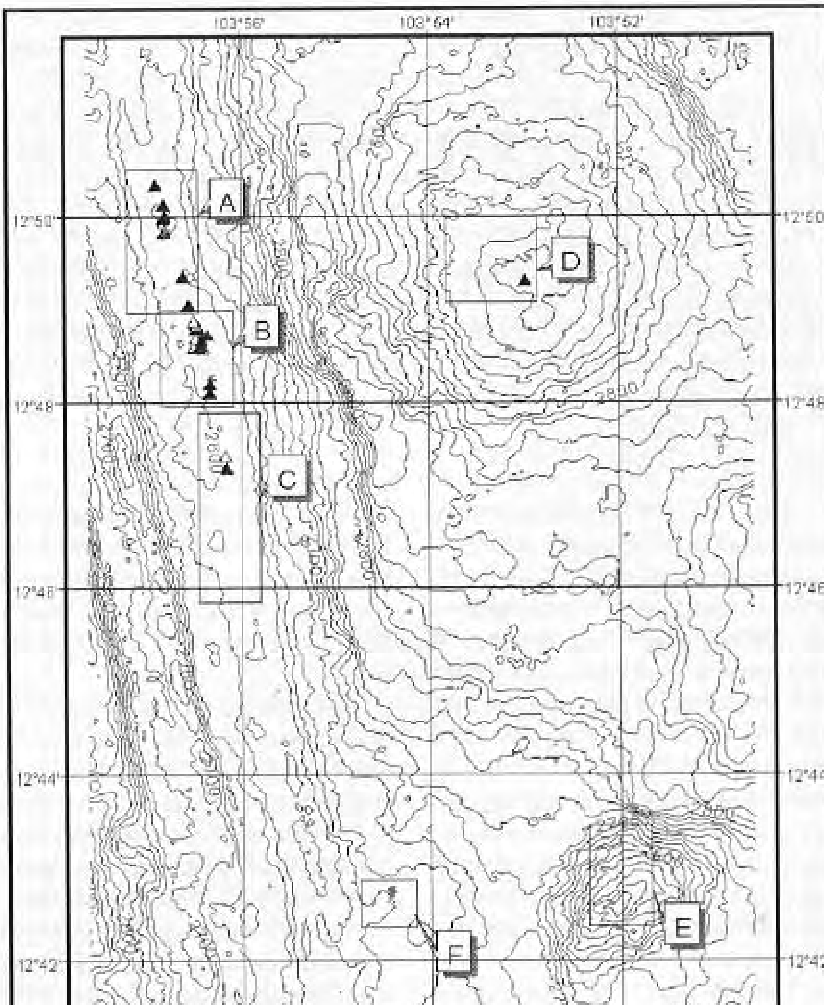
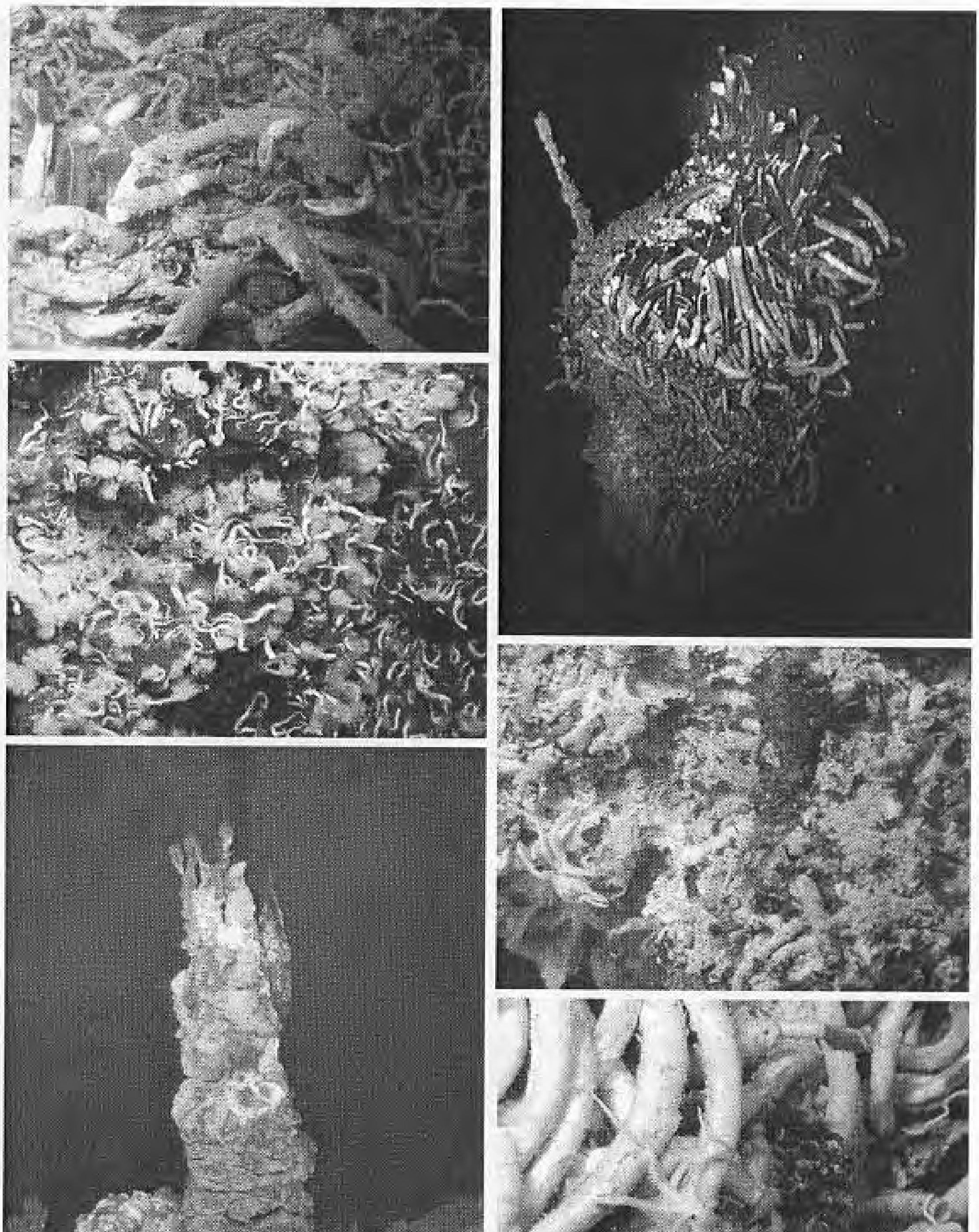


Figure 1. Bathymetric map of the 13°N segment of the East Pacific Rise, including the two east-side seamounts. Data acquisition was with the EM12 multibeam echosounder, data processing by CARAIBES and layout by ADELIE, the software was developed by IFREMER.



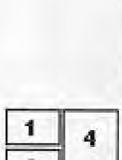


Figure 2. Associated fauna at the EPR 13°N sites. 1. Caldera site, an off-axis site with a rich assemblage of endemic species, visible here are *Riftia*, *Tevnia* and *Bythograea*. 2. Genesis site. This well-studied site showed an important evolution in species distribution, like this high density of serpulid (*Laminatubus*) worms close to the *Riftia* bushes. 3. The Annivella site is located off-axis on the NE seamount. It is colonized by Pompei worms (*Alvinella*) and smoker crabs (*Cyanagraea*). 4. The Grandbonum site is a 25 m high active chimney which has not previously been observed. 5. The Elsa site was thought to be dying in 1996 but very active sites were found with the typical species assemblage of *Alvinella, Paralvinella* and *Bythograea*. 6. Changes in the composition of fauna associated with *Riftia* bushes have been noticed, with an increasing number of the vent octupus *Vulcanoctopus hydrothermalis*.
Photos ©IFREMER (HOPE'99 Cruise)

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Figure 3. *In situ* instruments used during the HOPE'99 Cruise. 1. TRAC module fitted with two HOPO probes to study *Alvinella* colonization. 2. Thermal siphon and SMAC module for collection of larvae and juveniles around active sites. 3. Dome stainer to study the growth of *Riftia* tubes. 4. ALCHEMIST probe for continuous *in situ* measurements of sulfide and nitrate. 5. Water multisampler with a population of *Bathymodiolus*. 6. Particle trap positioned on the seafloor.
Photos ©IFREMER (HOPE'99 Cruise)

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

Brief description of biological communities at 7°S on the East Pacific Rise

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Considerable time and effort has been expended studying the ridge crest spreading centers of the eastern Pacific Ocean north of the equator. Deep-sea hydrothermal vents along the East Pacific Rise (EPR), Guaymas Basin, Juan de Fuca, Explorer and Gorda spreading centers have been the focus of numerous cruises. Only more recently, however, has the EPR south of the equator (SEPR) been explored using deep-submergence vehicles and relatively few biological descriptions have been published (Geistdoerfer et al., 1995; Auzende et al., 1996; Embley et al., 1998). The purpose of this paper is to describe the biological character of communities inhabiting newly discovered vents at 7°22.1'S and 7°25.2'S on the SEPR.

Descriptions of biological communities along the SEPR between 17°S and 19°S (Geistdoerfer et al., 1995) revealed notable differences from the Galapagos, northern EPR (NEPR), and Juan de Fuca communities (Grassle, 1986; Shank et al., 1998; Tunnicliffe, 1991). Although numerous species are shared between the NEPR and 17°-19°S on the SEPR, their composition and abundances are markedly different within a given vent field. Most notably, lush tubeworm (vestimentiferan) fields appear to be more restricted or absent along the SEPR. Due to their geographic location between studied NEPR and SEPR vent communities, the hydrothermal vent ecosystems at 7°S EPR may provide insight as to how and why biological vent communities differ over the length of the EPR axis.

Images of mussels, enteropnuests (spaghetti worms), and sea anemones from towed camera surveys in 1991 by German researchers (Holler, 1993) presented evidence of hydrothermal activity in the 7°S area. On-bottom observations of hydrothermal activity in this region were conducted during the "SEPR '98" cruise which visited sites from 5°S to 32°S along the SEPR. The 7°S region of the EPR consists of a typical axial summit trough (AST) at approximately 2700-2750 meters below sea level. In this region, the AST is approximately 500-700 meters wide near 7°25'S and is broader and less well-defined to the north at 7°21'S (Cochran et al., 1993). We report on several different diffuse flow sites in the 7°S area which have similar species composition to vent sites along the NEPR, but markedly different abundances. This report will focus on the largest two biological sites (Sarah's Spring and White Christmas) observed because they were the best characterized. Our observations suggest that variability exists among local communities. For example, although both sites contain the vestimentiferan tubeworms *Tevnia* (cf. *jerichonana*) and *Riftia* (cf. *pachyptila*), Sarah's Spring hosts numerous stauromedusae whereas White Christmas has a high density of bythograeid crabs.

Material and Methods

The vent sites were visited in three successive dives (3320 – 3322) with the submersible *DSV Alvin* with the support vessel *R/V ATLANTIS* on Dec. 23-25, 1998. The observations here are compiled from two scientific observers per dive, Hi-8 video footage, and sampled organisms. Video footage was collected with *Alvin's* Sony SXC-107 pan and tilt camera and 3-chip Sony DXC-930 which record to a Sony Hi 8 computer video deck (CVD-1000). Selected footage was also recorded to a Beta formatted tape. A hand held Sony DCR-VX1000 digital camera was also used from inside *Alvin*. Organismal collections were made with *Alvin's* manipulator claws or by a five chambered hydraulic-powered suction "slurp" sampler. Once on deck organisms were identified to "genera". Before complete species designations can be made in confidence, the morphology must be confirmed by taxonomic experts and genetic analyses need to be undertaken. Therefore, this report will adopt a conservative stance of referring to organisms only by their generic name.

Results

Fig. 1 shows a multibeam map (Cochran et al., 1993) of the AST around 7°S with the localities of the biological sites highlighted. A broad-scale geological description of the ridge crest can be found in Cochran et al. (1993). A list of the organisms observed and collected at 7°S is given in Table 1.

Sarah's Spring

The field of diffuse flow approximately 20 m × 10 m located at 7°25.23'S, 107°47.72'W has been named Sarah's Spring (*Alvin* dives 3320 and 3321). The biological component of this site (Fig. 2a) occurred on a fairly level talus terrain at 2747 m depth. The north end of the talus field gently sloped down into a fissure approximately 5 m deep. The average talus size was ~20 – 30 cm. A maximum temperature of 7°C was recorded from the center of this diffuse field. A piece of orange syntactic foam (15 cm x 15 cm) labeled "Bio Marker" was deployed on the edge of the level talus.

The dominant organisms of the field were small white anemones (~3-6 cm in diameter) and stauromedusae (Fig. 2b), but tubeworms (*Tevnia* and *Riftia*) were present in isolated patches. When present, *Riftia* coexisted with the *Tevnia*. Filamentous bacteria were evident as a "white fuzz" on and around organisms, but no well-defined mats were observed on the terrain. The diffuse venting area was dominated by the small white anemones interspersed with tubeworms. Clumps of *Tevnia* tubeworms (with some *Riftia*) were observed on the southern edge of the fissure in higher densities. Closer inspection revealed ~60% of the *Tevnia* did not extend their plumes and may have been dead. In contrast, most (if not all) of the *Riftia* tubes appeared occupied. Throughout the anemones and tubeworms, numerous limpets (*Eulepetosus*) and crabs (bythograeids with some galatheids) were present. Although no bivalve fauna was directly observed from *Alvin*, several small mussels (*Bathymodiolus*) were obtained among the tubeworm collections.

The immediate periphery of the diffuse flow area was covered by stauromedusae that were usually orange but occasionally white in color. (This color was associated with internal organs that were presumed to be gonadal tissue based on gross morphology.) Ophiuroids appeared to be in high density under the surrounding talus (they may have been present but not visible in the diffuse flow region). Serpulid polychaetes were also abundant on the peripheral basalt. Typical of

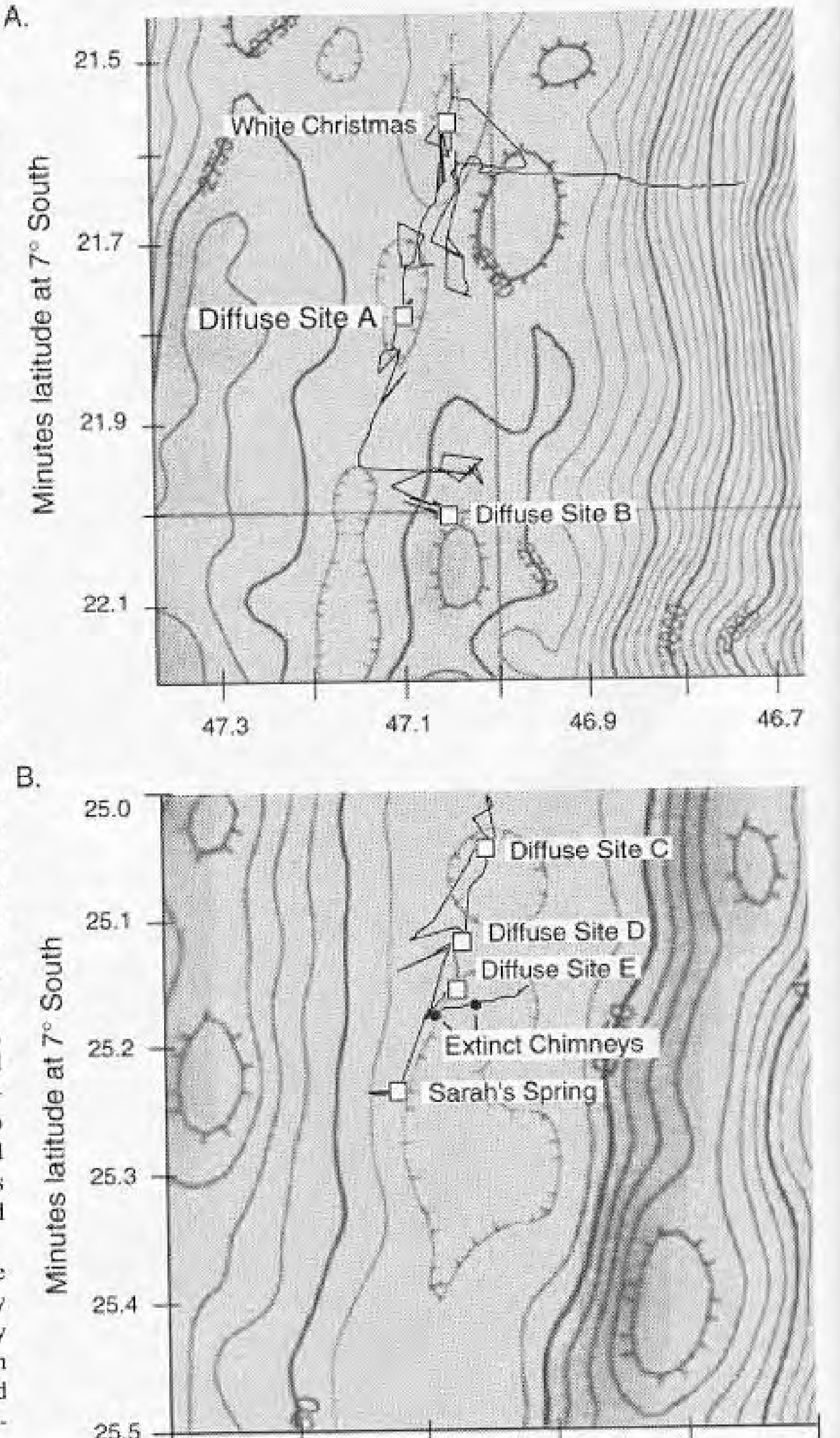

Figure 1. Bathymetric maps of axial crest (derived from hydrosweep multibeam data, Cochran et al., 1993) showing submersible track-lines. Notable biological communities and extinct sulfide chimneys are highlighted.

NEPR hydrothermal vent localities, the densities of crabs (both galatheid and bythograeid) and anemones increased proportionally with proximity to the venting fluids. Fish life at the vent site was primarily zoarcids with a few unidentified species. Also, several types of smaller planktonic organisms were observed (amphipods, polychaetes, ctenophores, and several swimming crinoids).

Sarah Spring's peripheral environment

Regions of the AST region immediately south (Dive 3320) and north (Dive 3321) of Sarah's Spring were explored. In both areas, fields of extinct sulfide chimneys were discovered (Fig. 1), but no venting water or abundance of organisms was observed at these chimneys. Unfortunately, navigation on Dive 3320 was problematic, and thus the exact location of the southern extinct chimneys was ambiguous. To the north of Sarah's Spring, three areas of increased biological abundance that contained stauromedusae were noted. The localities at 7°25.15'S, 107°47.67'W and 7°25.11'S, 107°47.67'W were covered by the same white anemone as at Sarah's Spring. The other site (7°25.04'S, 107°47.65'W) also had some diffuse flow, but only ophiuroids and *Tevnia* tubes were seen. No vestimentiferan plumes were extending from the *Tevnia* tubes and they were assumed to be dead. The ophiuroids were in high number crawling in and around the tubeworms (Fig 2c). Other typical vent fauna (crabs, limpets, alvinellids) were not obvious.

Table 1. Organism list from 7°S EPR. Abundances of collected taxa (identified to "genus") are given, in several cases taxa were observed (obs.) but not collected. The abundance values given represent what was collected sorted and identified on the ship. These values are highly biased by collection methods and do not represent abundances in the ecosystem.

Clade	Specimen	Sarah's Spring area 3320	3321	White Christmas viciniy 3322
Cnidaria	Stauromedusae	44	obs.	Obs.
	Anemone	12	64	10
	Thermopalia sp.		obs.	1
Ctenophora	Unknown Ctenophore	obs.		
Platyhelminthes	flatworm		4	
Echinodermata	stalked crinoid	obs.	obs.	obs.
	swimming crinoid	obs.	obs.	obs.
	Ophiuroid	2	19	
Chordata	*Thermaces* sp.	1	obs.	obs.
Arthropoda	*Dahlella* sp.	1	13	15
	Ventiella sp.	~230	~460	~500
	Neolepas sp.		1	
	shrimp	obs.	obs.	obs.
	Munidopsis sp.	obs.	2	obs.
	Bythograea sp.	obs.	8	4
Annelida	*Amphisamytha* sp.	2	21	15
	Unknown worm #1	1	2	6
	Eulalia sp. (green)	5	17	
	Eulalia sp. (yellow)	13	18	9
	Galapagomystides sp.	90	190	68
	Laminitubus sp.			44
	Nereis sp.		1	
	Orbiniidae	3		
	Paralvinella sp.	21	16	
	Lepidonotopodium sp.			2
	Branchiplicatus sp.	1	3	
	Branchinotogluma sp.		1	
	Ophryotrocha sp.	1		
	Juvenile Vestimentifera	obs.	12	2
	Riftia (cf. pachyptila)	6	22	1
	Tevnia (cf. jerichonana)	5	45	31
Mollusca	*Eulepetopsis* (cf. vitrea).	1	8	
	Cyatherma sp.		1	32
	Neolepetopsis sp.			1
	Lepetodrilus (cf. pustulosus)		34	153
	Lepetrodrilus (cf. elevatus)		20	111
	Ctenopelta sp.		1	
	Bathymodiolus (cf.thermophilus)	18	27	2
	Octopus	obs.	obs.	obs.
Bacteria	white filamentous bacteria	obs.	obs.	obs.

White Christmas

A diffuse flow site (7°21.59' S, 107°47.06'W) named White Christmas (Dive 3322 on Dec. 25, 1998) consisted of ~10-30 cm talus. The most conspicuous biologically active area was 5 m × 6 m covering the east-facing slope of a north-south running talus mound (~3 m in height), and was dominated by *Tevnia* and *Riftia* (Fig. 2d). There was one other small (3 m by 4 m) area characterized by shimmering flow, tubeworms, and white anemones in close proximity (~10 m south-southwest of White Christmas). At the southern community, the tubeworms were brown in color, suggestive of high iron concentration. Increased iron concentration and decreased H_2S have been correlated with the death of a similar vent community at 9°50'N on the EPR (Shank et al., 1998). In addition to the two localized pockets, diffuse venting influenced the biological community over an area of at least 500 m². A notable amount of white particulate material was in the water column, but a point source(s) of this material was not observed. The maximum temperature observed over the main diffuse flow area was 12.2°C. A white syntactic foam marker (8 cm × 25 cm) labeled "42" was deployed by the larger of the tubeworm communities.

In addition to the tubeworms, White Christmas had a large abundance of bythograeid crabs that seemed to swarm in and around the tubeworm mats. Observing 5-8 crabs clinging to one *Riftia* tube was common. Collection from this site revealed limpets (dominated by *Lepetodrilus*) and abundant amphipods. The basalt talus surrounding the tubeworm mats was covered with serpulids, anemones, and bythograeid crabs. Although galatheid crabs were common in the vicinity of Sarah's Spring, they were not observed at White Christmas. The immediate periphery of the tubeworm mats was dominated by the same white anemones found at Sarah's Spring. A different anemone, orange in color, was scattered around the most peripheral regions of the field (these were also observed occasionally in non-venting areas during all three dives). Serpulids were found on basalt over the 500 m² area.

Two additional biological sites to the south of White Christmas are noteworthy. A small site at 7°21.81'S, 107°47.15'W consisted of diffuse flow with serpulids, anemones, a few stauromedusae and crabs (galatheid and bythograeid). ,The second site (7°22.02'S, 107°47.06'W) had diffuse flow with isolated *Tevnia* and *Riftia* growing out of a vertical face. Other observed organisms included serpulids, anemones, stauromedusae, bythograeids, galatheids and several "dandelion" siphonophores. Because both of these sites were more limited in size and abundance, extensive collecting and surveying was not done.

Discussion

The venting fields observed at 7°S on the EPR have marked differences in community structure despite their close proximity. The organismal densities and species abundances for stauromedusae, bythograeid crabs, white anemones, and tubeworms varied considerably at different venting sites that were separated by tens to hundreds of meters. Visual inspection of the two communities (separated by less than 20 m) at the White Christmas site suggests substantial differences in aqueous iron content which may be correlated to successional stage of the venting region (see Shank et al., 1998). The high turnover, fast-spreading nature of the southern EPR (Cochran et al., 1993) may create significant variation in the dynamics of venting fluid over small spatial scales creating localized microhabitats that differ in faunal assemblages. A locality such as 7°S may provide an excellent opportunity to determine whether biotic or abiotic factors are more influential in shaping vent communities.

Whereas Geistdoerfer et al. (1995) concluded that some SEPR

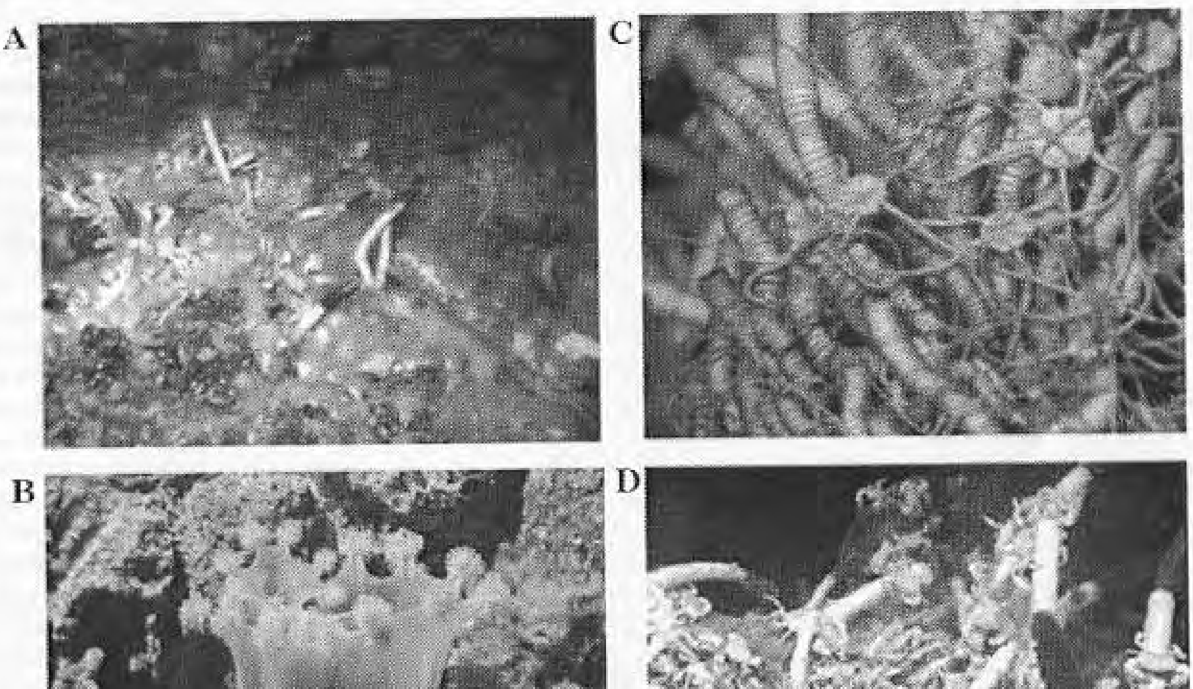

Figure 2. Video images from the 7°S area. a) The main diffuse flow locality of Sarah's Spring (7°25.23' S, 107°47.72'W). b) Close-up view of stauromedusae from a diffuse flow site north of Sarah's Spring. c) Ophiuroids covering *Tevnia* tubes in high density at 7°25.04'S, 107°47.65' W. d) Primary diffuse flow region at White Christmas (7°21.59'S, 107°47.06'W).

communities are considerably different from sites north of the equator, we feel that a similar conclusion about White Christmas or Sarah's Spring would be premature. Although some differences exist between EPR vents sites, an accurate understanding of the temporal factors and magnitude the geochemical and biological processes is wanting. Perhaps the 7°S site is, in fact, similar to northern EPR sites but just at a different stage of succession or on a much smaller scale. The position of the 7°S vents between the traditionally studied northern EPR fields (i.e., Galapagos (Grassle 1986), and 9°N EPR (Shank et al. 1998) sites) and the sites at 17°S–19°S (Geistdoerfer et al., 1995) can provide interesting clues as to how and why similarities or differences are maintained between the northern and southern EPR. Clearly only future studies will elucidate the relationship between the 7°S communities and other venting habitats along the EPR.

Prior to our cruise, stauromedusae had only been reported by Lutz et al. (1998) from 21°N on the EPR. Unfortunately the 21°N observation was made at the end of a dive and no samples were obtained. The stauromedusae obtained at 7°S are the first hydrothermal vent stauromedusae that have been sampled and they will allow the hypothesis of Lutz et al., that they are closely related to members of the genus *Lucernaria*, to be tested.

The purpose of this short communication is to relay initial information about the biology of the vent communities at 7° S. Although biological communities were observed, a sizable portion of the AST at 7°S remains unexplored. The region between White Christmas and Sarah's Spring was not surveyed, and the western face of the AST was not observed near White Christmas. The extensive diffuse field and the presence of large amounts of particulate matter (without an observable point source) suggest that more extensive communities may be found around White Christmas.

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Hydrothermal Vent Biology Samples Database

Data on existing hydrothermal vent biology samples are presented in two ways: (1) short summaries of the major collections of hydrothermal vent biology samples and (2) a database of existing samples (still under development). Both are designed to facilitate the exchange of biological samples between researchers. Scientists with hydrothermal biology samples are strongly encouraged to submit information to either forum.

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

Hydrothermal activity along the Tjoernes Fracture Zone, north of Iceland: Initial results of *R/V Poseidon* cruises 252 and 253

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Introduction

The active neovolcanic zone on Iceland, including the giant Krafla volcano, is an area where the spreading axis of the Mid-Atlantic Ridge intersects the Iceland plateau. North of Iceland the spreading axis continues along the Kolbeinsey Ridge which is located about 75 km to the west. The jump of the spreading axis between Iceland and the Kolbeinsey Ridge is facilitated by the Tjoernes Fracture Zone which consists of transform faults and associated small pull-apart basins.

First reports of hydrothermal activity in this region came from a fishing trawler that observed gas bubbles at the sea surface at the Kolbeinsey Ridge in 1974. Diving campaigns with *Geo* in 1988 and *Jago* in 1997 (Stoffers et al., 1997) discovered active vents with temperatures up to 131°C in water 100-110 m deep. Boiling and near-boiling fluids and gas bubbles were emanated and discharged from fissures or crater-like pits. Hydrothermal precipitates consisted of orange-reddish mud or yellow-reddish iron-hydroxide staining on highly altered basalts. Further surveying along the Tjoernes Fracture Zone during *Poseidon* cruise 229 in 1997 (Stoffers et al., 1997) discovered an active hydrothermal vent field mainly consisting of anhydrite chimneys and mounds with fluid temperatures up to 250°C in 400 m water depth near Grimsey Island. This field is located in the Grimsey graben which is about 10 km wide and 30-40 km long and filled with glacial sediments from ice-fed rivers draining the north coast of Iceland.

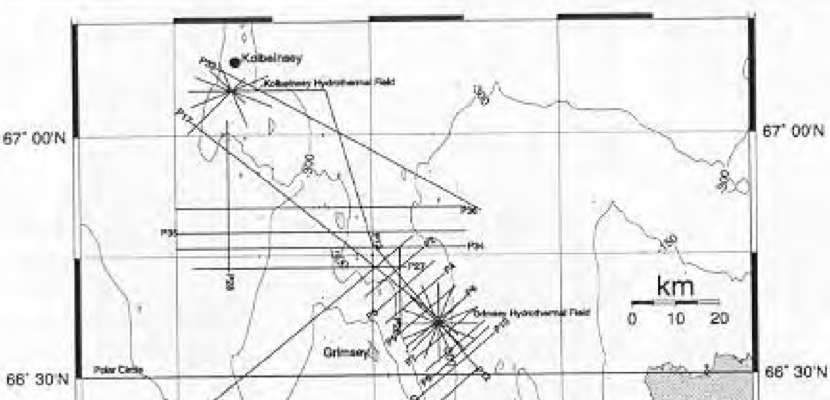

Figure 1. Map of the survey area showing the seismic profiles.

During the *Poseidon* 252 and 253 cruises in 1999 the region of the Tjoernes Fracture Zone was revisited by an international team of researchers from Germany, Iceland, and Canada. The scientific objectives included:

- High resolution geophysical profiling by multichannel seismic reflection in the southern Kolbeinsey Ridge area and the Tjoernes Fracture Zone.
- Identification of hydrothermally active areas by on-board interpretation of seismic reflection records (sub-bottom fault systems, gas pockets and gas-charged sediments)
- Hydrothermal plume mapping by water-column sampling.
- Detailed investigation of the Grimsey vent field including: (i) Sampling of gases and vent fluids using the manned submersible *Jago* (ii) Investigation of the type and extent of hydrothermal mineralisation (iii) Estimating the biodiversity of anaerobic and aerobic bacterial communities.

Reflection seismology

Thirty-six multichannel reflection seismic profiles were conducted in the Kolbeinsey and Grimsey hydrothermal fields on the southern Kolbeinsey Ridge (Fig. 1). The seismic data was analysed on-board for negative amplitudes of the first reflections of the seismic signal penetrating the seafloor. This phase reversal was previously described in areas where hydrothermal activity occurs (Neben, 1992).

The Grimsey hydrothermal field was surveyed by a sequence of seismic lines centering the estimated area of 300 m x 1000 m and a negative amplitude trend was observed (seismic lines 20 and 25 in Fig. 2). Mapping of this trend showed a distorted, nearly elliptical sphere above the vent field. However, a closer inspection of the amplitudes showed an ambiguous trend in detail. Although the phase reversal was clearly visible when observing the maximum amplitudes, positive precursors appeared on the negative wavelet and the phase reversal was smaller than 90°.

The Kolbeinsey hydrothermal field was detected by echo-sounding and showed the typical dotted, bubble-like structures of vent-fields, which is probably due to the difference between the acoustic qualities of normal seawater and that of the brine or gases above the hydrothermal area. A negative amplitude trend at the bottom reflector similar to the one detected at the Grimsey vent field was observed. Further interpretation of the seismic reflection signals by modeling the amplitude variation with offset (e.g. Andreassen et al., 1997) will reveal more information about the physical properties of the seafloor and the distribution of free gas in the Grimsey and Kolbeinsey hydrothermal fields.

A new hydrothermally active area (66°58'N, 18°43'W) south of Kolbeinsey was crossed during acquisition of lines 17 and 28, and was predicted by reflection seismology. The multiple of the seismic signal vanished beneath the strongly scattering seafloor reflection, which was probably produced by an anhydrite body. We observed, however, two strong reflectors at 1.6 s and at 2.1 s made up from a cluster of diffraction hyperbolae, which are typical for magma chambers (Collier and Sinha, 1990; Calvert, 1995). Initial velocity analyses supported the idea of a magma chamber (3300 m/s) and suggested the presence of a classical heating system underneath a hydrothermal vent field.

The reflection lines acquired suggest that the sedimentation rate in the study area is low. A maximum sediment thickness of about 100 m was observed on line 28. Strong multiples throughout the registration suggest high reflectivities, thus it is more likely that most of the imaged seafloor is formed by basalts rather than sediments. This hypothesis is also supported by the diffraction hyperbolae in the seismic profiles.

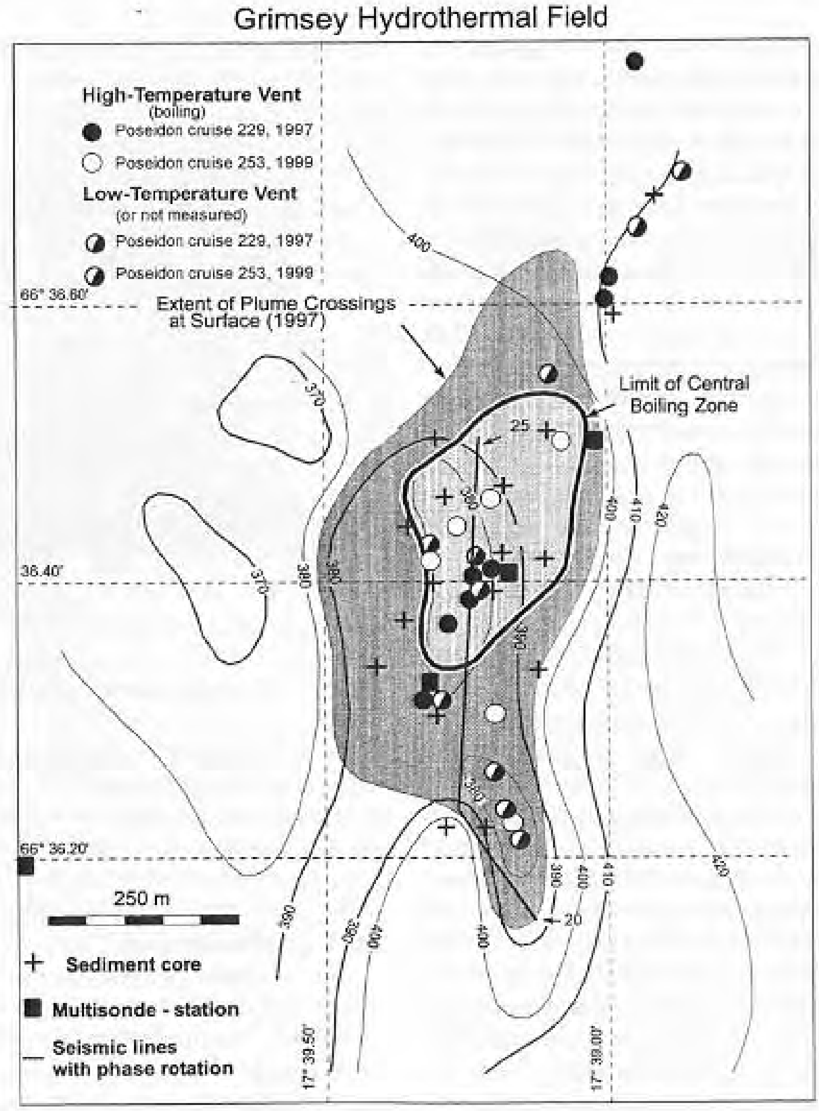

Figure 2. Map of the Grimsey hydrothermal field observations.

Mapping of gas distributions in the southern Kolbeinsey Ridge area

Five hydrocast ("multisonde" MS) stations were performed in the southern Kolbeinsey Ridge area to sample the vertical water column. Water samples were taken down to 7 m above the seafloor for further hydrothermal tracer studies (e.g. CH_4, He). Methane concentrations were were determined with an onboard gaschromatography. The methane concentrations were low, usually <30 nl/l, and they probably represented the background methane concentration. Only a slight methane increase, of about twice the background value, was detected near the seafloor in water samples from station MS383 near the Kolbeinsey hydrothermal field. Large water mass exchange and/or methane oxidation in oxygen-rich seawater is probably responsible for the lack of significant methane anomalies. Therefore, the existence of a new hydrothermal field as suggested by on board interpretation of seismic reflection patterns could not be confirmed. He-isotope measurements are expected to give more information about the distribution of hydrothermal plumes in the southern Kolbeinsey ridge area.

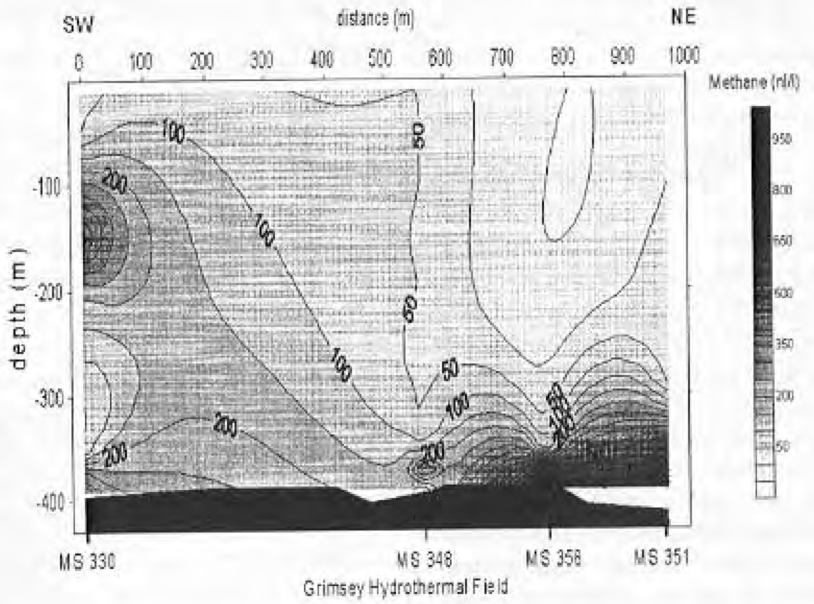

Figure 3. Methane plume distribution in the Grimsey hydrothermal vent area.

Detailed investigation of the Grimsey hydrothermal field

JAGO Dives

The Grimsey hydrothermal vent field (66°36.4 N, 17°39.3 W) was located at 400 m water depth and was mapped during *Poseidon* cruise 229 (Stoffers et al., 1997) on the basis of a strong acoustic signal in the water column produced by a bubble plume rising from the boiling vents. A two-manned research submersible operated by the Max-Planck Institute (*Jago*) was used for detailed investigation of the area and to sample vent waters, gases and anhydrite chimneys. Bacteria traps were deployed at the vent sites and recovered after 48-72 hours.

The Grimsey hydrothermal vent field is characterised by various anhydrite mounds covered with a thin layer of sediment. On top of these mounds several actively venting chimneys, up to three meter high, were observed which were usually surrounded by collapsed chimneys. Most of the active vents were found at the top of the central rise in the southern field (Fig. 2). All of the measured vent temperatures ranged between 248-251°C, the boiling temperature of seawater at the given depth, and visible phase separation was noted at the vent outlets. The vent sites at the southernmost ridge are probably in a waning state of hydrothermal activity as suggested by (i) only small chimneys with relatively low discharge rate, (ii) one apparently inactive (or totally sealed off) anhydrite mound without any chimneys, and (iii) one old and almost completely dissolved and extinct vent site. No typical macrofauna associated with the hydrothermal vents was found.

The chimneys sampled by *Jago* consisted mainly of soft and friable anhydrite. The fluid channels in the chimneys were lined with pinkish-brown to pale-yellow botryoidal talc. Some black material (pyrite, pyrolized bacteria?) was dispersed in the outer walls of the chimneys. One piece recovered from an inactive chimney consisted of strongly oxidised relics of a fluid conduit composed of pyrite and anhydrite.

Gas and water samples collected during the *Jago* dives indicate significant enrichments in methane and higher hydrocarbons. The gas sampling rate was approximately 10-280 ml (1 atm) per minute. The highest methane concentrations collected during the cruise are only half of the concentrations recorded two years ago at the same site (Botz et al., 1999). The methane/ethane-ratio has increased (up to 250), possibly reflecting different fluid migration pathways or sub-bottom conditions.

"Multisonde" investigations

The hydrothermal plume distribution above the Grimsey hydrothermal vent field was investigated by four "Multisonde" stations which were conducted across the vent field from SW to NE (Fig. 2). Large methane anomalies of about 1000 nl/l occurred near the sea floor but directly above the vent field only background concentrations of methane could be detected above 300 m water depths . The CH_4 distribution plotted in Fig. 3 shows the hydrothermal plume above the vent field at stations MS348, MS358 and MS351. A further methane anomaly was detected at station MS330 at 150 m water depth probably indicating a southward plume drift due to a strong current in this region.

Sediment Coring

In the area of the Grimsey vent field sediments were sampled by 3 - 5 m long gravity cores (17 stations in total). In some cores boiling seawater trapped in the sediments was observed as the cores arrived on the ship's deck. Except from one core, the temperatures of the sediments measured at the end of the core barrel were all above 25°C (ambient seawater temperature was approximately 2.5°C) with a maximum of about 106°C. The "hot cores" originate from an area of extremely high heat-flow up to 1 km off the main hydrothermal mounds and presumably delineate the extent of a subseafloor hydrothermal aquifer (Fig. 2). The areas of active venting is underlain by pelagic, clastic and hydrothermally altered sediments. Multiple sulfate debris flows (anhydrite clasts, gravel and sand-like talc), separated by hemipelagic and turbiditic sediments, indicate several stages of anhydrite chimney formation, collapse and resedimentation. Mineralizations in the form of vein and disseminated pyrite within altered layers of clays and mud was seen in the sediment cores at depths between 2-3 m deep.

Conclusions

Hydrothermally active areas on the southern Kolbeinsey Ridge and the Tjoernes Fracture Zone were revisited during *Poseidon* cruises 252 and 253. Hydrothermal activity was detected and investigated by multichannel reflection seismics, geochemical sampling and several dives with the manned submersible *JAGO*.

Our observations suggest that the Grimsey hydrothermal field consists of several mounds which are composed of anhydrite and talc. Actively venting chimneys occur on top of the mounds surrounded by abundant chimney debris. Less intensive fluid venting and almost completely sealed hydrothermal mounds as well as extinct vents indicate a recent waning of hydrothermal activity in the southern field.

The Grimsey hydrothermal field provides the unique opportunity to study an extensive subseafloor boiling system as well as fluid-sediment interaction in a shallow-marine setting. The mineral deposits and the hydrology of the system have important similarities to sites such as Middle Valley at the Juan De Fuca Ridge, with potential for significant sediment-hosted sulfide mineralization at greater depths.

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.

Cara Wilson
InterRidge News Editor

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

ROV exploration of the Kolbeinsey Ridge: Preliminary results of the SUBMAR-99 cruise

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The SUBMAR-99 cruise to the Kolbeinsey Ridge was the first of a series of five cruises planned to take place during a new Norwegian project aimed at exploring the Arctic spreading ridges. The SUBMAR program (**Sub**surface Biosphere, hydrothermal activity and **Ma**gmatism along the **A**rctic **R**idges) is a five-year project (1999-2003) that is financed by the Norwegian Research Council and operated by the University of Bergen. The program is interdisciplinary and includes geologists, microbiologists, marine biologists, and chemical oceanographers, and the principal aim is to gain more knowledge about:

- Magma generation and magma transport below slow- and ultra slow-spreading ridges.
- Magmatic and tectonic segmentation of the oblique spreading Mohns and Knipovich ridges.
- Sub-seafloor biosphere and biodegradation of oceanic crust.
- Hydrothermal activity and hydrothermal ecosystems along the Arctic Ridges.

The Arctic ridges will be explored using the University of Bergen research vessel *R/V Håkon Mosby* and a new remotely operated vehicle (ROV) named *Aglantha*. *Aglantha* is equipped with 4 black and white cameras and one color video camera. The vehicle is also fitted with a 5-function arm for sampling and manipulation of equipment, a CTD for continuous monitoring of temperature, salinity, particulates, and depth during dive operations, and two top-mounted Niskin bottles for water sampling. *Aglantha* has a present depth range of 2000 meters which allows operation along the Kolbeinsey Ridge, the southern part of the Mohns Ridge and the flank regions of the Mohns and the Knipovich Ridges.

SUBMAR-99 cruise to the Kolbeinsey Ridge

The Kolbeinsey Ridge is a slow spreading center that extends from Iceland to the Jan Mayen Fracture Zone to the north (Fig. 1). The water depth along the Knipovich Ridge is generally less then 1200 meters, making it the shallowest ridge in the world. The Kolbeinsey Ridge is a slow spreading center with a half-rate of 1 cm/yr (Vogt et al., 1980), but it exhibits some morphologic features of fast spreading environments - e.g. it lacks a rift valley along some segments.

Deep water hydrothermal systems have not yet been studied north of Iceland, and the nature of the vent biota north of this barrier on the Mid-Atlantic Ridge is therefore an open question. At such a shallow ridge the hydrothermal plumes may reach the surface waters, which also makes this ridge an interesting target for more detailed studies.

The aim of this first SUBMAR-

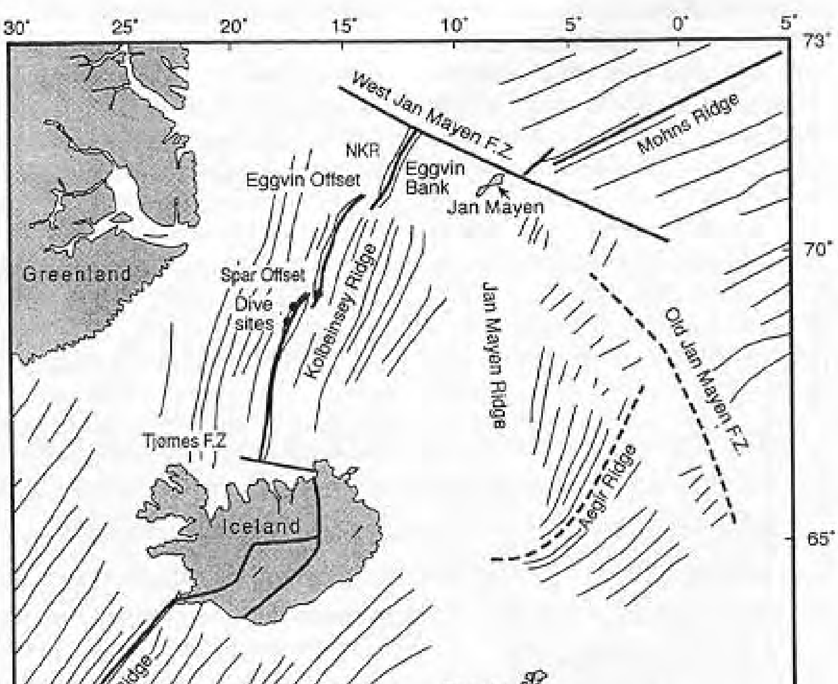

Figure 1. Map showing the dive locations on the Kolbeinsey Ridge.

cruise was to test the new ROV in deep open water and to explore for hydrothermal deposits and venting. We successfully completed seven dive operations with a total bottom time of 20 hours. Dives lasted from 1.5 to 8 hours and were variably successful in the completion of dive objectives. There was remarkably little downtime on deck and the ROV operated extremely well mechanically reaching maximum working depths of just over 1325 m. Dive operations were completed under often difficult working conditions due to steep, highly irregular slopes and strong currents. This coupled with tether management problems hampered ROV maneuverability and therefore many dives were of limited aerial extent. Future operations will include a clump weight and a 100 meter neutrally to partially buoyant cable leading from the ROV. Despite tether management problems, the initial dive operations with this new vehicle were successful, and resulted in high quality imaging of sections of the ridge never before explored.

Geologic observations

Dive operations successful imaged the rifted and faulted axial valley and bounding walls, unfaulted axial highs, and a flat-topped seamount. In these areas, massive, immense pillow flows, hackly to ropy sheet flows, lobate flows, and talus were imaged as well as their associated biological communities.

Side-scan images of the Kolbeinsey Ridge demonstrate that the small-scale ridge morphology is dominated by individual volcanic edifices. Similar ridge morphology has been observed at the MAR between 24° and 30°N (Smith and Cann, 1990; Smith et al., 1995; Lawson et al. 1996) and at the Reykjanes Ridge (Murton and Parson, 1993). Based on side-scan sonar images showing radial symmetry and central depressions, Smith and Cann (1990) and Lawson et al. (1996) have suggested that flat-topped volcanoes, such as those observed during this program, are fed from a central pipe conduit or conduits.

Three dives were carried out on a flat-topped volcano at 68.57°N and 11.08°W that we named "Full Gale Volcano". The volcano is about 200 meters high and 2 km in diameter. The southern side of the volcano is dominated by pillow flows that have streamed down the side of the edifice. Pillow lavas are, however, rare on the flat top. The top of the volcano is instead dominated by smooth surfaced swales defined by massive uniform to lobate flows with a dusting of sediment and some hyaloclastite deposits. Some areas of intense fissuring were observed, and the fissuring varied from single fissures to formation of extensive mud crack like fractures. Very large isolated pillows were locally present along fissures in the massive flows. Several minor collapse basins were found in the central parts of the volcano. Our observations suggest that the volcano is made up of a stack of massive flows that transition into pillow lava flows at the volcano rim.

Discovery of an extinct hydrothermal field in the central parts of a flat-topped volcano

Of particular interest was the discovery of an extinct hydrothermal field in the central part of Full Gale Volcano. Old sulfide chimneys were found in a 4-6 m deep collapse basin. The single to coalesced pinnacles reached up to 2-3 m in height, but larger slender sulfide columns were observed that had toppled over. There are multiple spires within the field, some surrounded by a thick layer of oxidized hydrothermal sediment. All pinnacles were extinct. Three other sites of venting were found in the same region. They were characterized by a few composite, small sulfide structures with multiple narrow spires. One of the fields appeared to be located within a small collapse basin. There was an abundance of squid between the pinnacles, and so the field was named "Squid Forest".

The half meter top of a 2-3 meter high chimney was sampled using the manipulator arm of the ROV. Preliminary investigation of this sample shows that the central part is composed of silica, sphalerite, and pyrite, suggesting that it formed by relative low-temperature venting. The hydrothermal fields are likely small, reaching only tens of meters in length, and may have resulted from cooling of a single eruption.

Water Column Studies

Investigation of water column properties was done using a Sea

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International Ridge-Crest Research: **Arctic Ridges:** Pedersen et al. continued...

Bird 911 instrument package with sensors to measure conductivity, depth, temperature, and water column particulates (i.e. a CTD). The CTD was used either in a vertical mode in which it was lowered within 10-15 m of the bottom, and brought straight back up to the deck, or in tow-yo mode for efficient surveying of large areas of the ridge. These tows covered an estimated distance along the Southern and Middle Kolbeinsey Ridge Segments of 60 km. The CTD casts and tows were used to explore for temperature-salinity-particulate anomalies indicating sites of hydrothermal venting. During many of these operations deviations in temperature were measured with respect to background ocean water values. These deviations occurred both as positive and negative thermal anomalies. Particularly at depths 200-300 m above the bottom thermal anomalies correlated with salinity anomalies. Particulate anomalies were rare. Thermal and salinity anomalies exhibited extremely complex patterns and were difficult to interpret and await shore-based analyses for further interpretation.

Microbiological Studies

An important aim of the SUBMAR project is to assess the overall microbial diversity at the ridge, in particular that of specific microbial groups important in biodegradation of basalts. Samples of basalt from pillow lava and sheet flows, rock samples from one of the fossil hydrothermal vents and ocean water samples were analyzed for the presence of microbes. Subsamples were transferred to bottles with sea water medium to which various carbon and energy sources were added. These samples were incubated either aerobially or anaerobically. Hydrogen, methane, low molecular weight fatty acids, alcohol, methyl amines and carbon dioxide were used as energy and/or carbon sources. The aim was to enrich (under aerobic conditions) for iron and maganese oxidizing bacteria, methane- and methylotropic bacteria, sulfur oxidizers, and general aerobic bacteria. Anaerobic enrichment cultures were made for iron- and sulphate reducing bacteria and for methanogenic Archaeae. Cultures were incubated at 4°C. Subsamples were also fixed in formaldehyde or ethanol for further analyses (electron microscopy, epifluorescence microscopy and DNA/RNA extraction and sequencing).

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

First Systematic Survey of Submarine Hydrothermal Plumes Associated with Active Volcanoes of the Southern Kermadec Arc, New Zealand: Initial Results from the NZAPLUME Cruise

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Introduction

Most of the world's currently exploited massive sulfide deposits were probably once formed in island arc/back-arc environments, yet most studies of active vent fields have concentrated on sites situated at mid-ocean ridges (MOR's), such as those along the East Pacific Rise. The Kermadec arc - Havre Trough provides us with a unique opportunity to study the tectonic setting and geochemistry of ore deposits formed in this 'transition zone' between subaerial geothermal systems/epithermal deposits of the Taupo Volcanic Zone, and massive sulfide deposits of MOR's.

Evidence for vigorous submarine hydrothermal activity has been, until recently, noticeably absent along the entire 1200 km of the Kermadec arc-Havre Trough system that extends northeastwards from New Zealand, towards Tonga (Fig. 1). Previously, the only known active high-temperature vent fields were those on the Valu Fa ridge of the southern Lau Basin (Fouquet et al., 1993). Reconnaissance studies of Havre Trough sediment geochemistry (Cronan et al., 1984) and water-column CH_4 concentrations (Craig et al., 1987) did not show any significant hydrothermal signatures, although sites containing Fe-Mn crusts of inferred hydrothermal origin have been reported (Howard et al., 1991).

The recovery (by dredging) in 1996 of gold-bearing massive sulfides from the calderas of Brothers and Rumble II West volcanoes produced, for the first time, direct evidence for deep water (>1000 m), high-temperature venting within the southern Kermadec arc (Wright et al., 1998). Moreover, the recent (Sept-Oct. '98) research cruise by the *R/V Sonne* to this area provided the first evidence of active hydrothermal venting at Brothers volcano, with several venting black smoker chimneys seen during towed camera surveys (Stoffers et al., 1999).

Kermadec arc - Havre Trough

The southern Kermadec arc - Havre Trough form part of the 2700 km long, southward propagating, actively widening, Lau-Havre-Taupo backarc complex associated with Pacific-Australian plate convergence. This complex is evolving from full oceanic speading in the central and southern Lau Basins, through rifting of arc crust along the southernmost Lau and entire Havre Trough, to rifting within New Zealand continental crust (e.g., Gamble and Wright, 1995; Parson and Wright, 1996; Wright et al., 1996). Rates of extension and age of opening for the southern Havre Trough are estimated to be 15-20 mm yr^{-1} and 5 Myr, respectively (Wright et al., 1996). Flanking the Havre Trough, the remnant Colville and active Kermadec arc margins form longitudinally continuous ridges. The presently active volcanic front lies west of the Kermadec Ridge, as marked by a series of submarine stratovolcanoes (Fig. 1).

NZAPLUME cruise

The first systematic survey of submarine hydrothermal plumes associated with an active frontal arc was conducted NE of New Zealand during the NZAPLUME (**N**ew **Z**ealand**A**merican**PLU**me**M**apping**E**xpedition) cruise of March 4-19, 1999.

The cruise objectives included:

- Conduct a series of vertical-cast and tow-yo water column surveys over known seafloor hydrothermal sites adjacent to White Island (centred at ~37°41'S, 177°06'E) and then along a SW-NE line over various Kermadec frontal arc volcanoes, including; Whakatane, Clark, Tangaroa, Rumble IV, Rumble V, Rumble III, Rumble II West, Rumble II East, Silent II, Cotton, Healy and Brothers (n = 12 sites),
- Collect hydrographic and optical data using continuous data logging tools including conductivity-temperature-depth (CTD), transmissometer and nephelometer sen-

sors thereby providing (1) real-time information for plume sampling by monitoring the optical (light-scattering) and hydrographic characteristics of the water column at each station, (2) a sampling platform for the collection of water samples, and (3) a tool to map the distribution of hydrothermal plumes throughout the survey area in terms of light-scattering, a measure of particle mass concentration, and hydrothermal temperature anomaly.

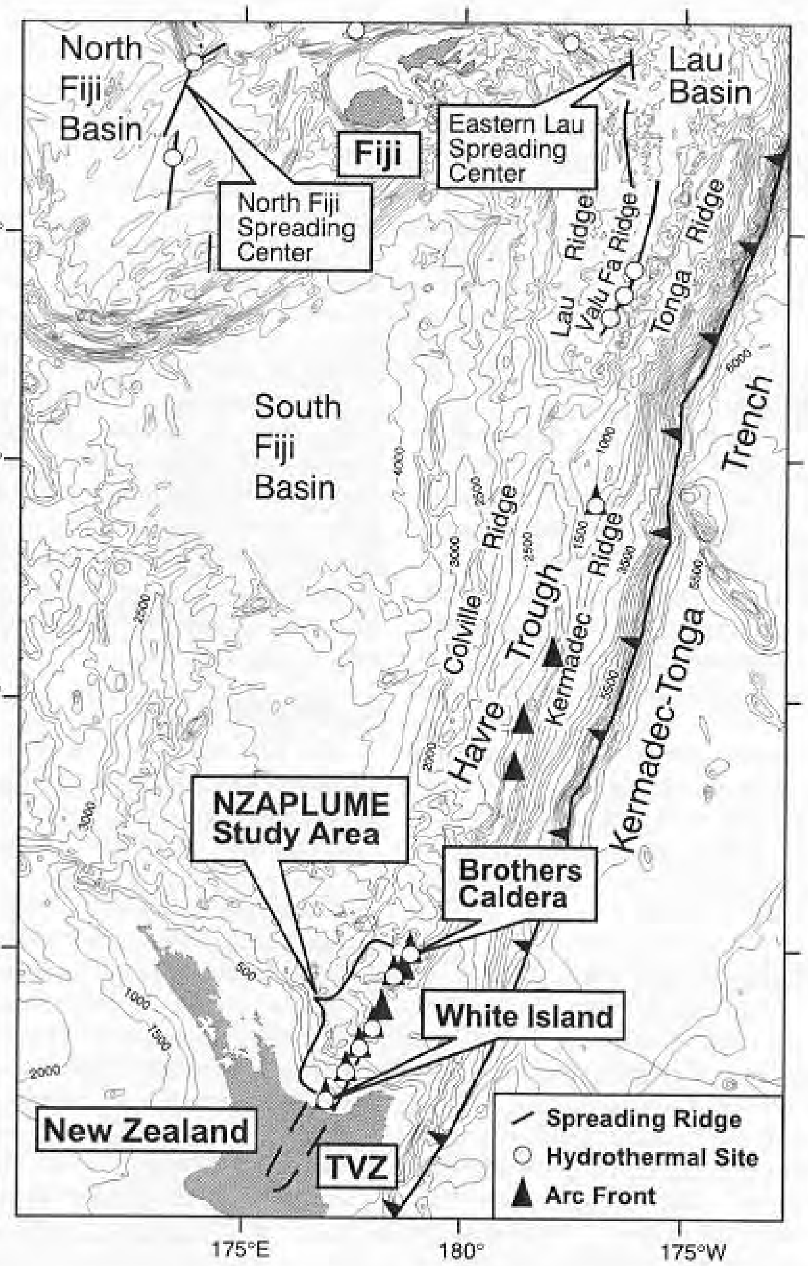

Figure 1. Location diagram for the NZAPLUME study area conducted along the southern Kermadec arc, NE of New Zealand. Subaerial geothermal systems occur within the Taupo Volcanic Zone (TVZ) of continental New Zealand, immediately offshore on White Island, and also on Raoul and Curtis Islands of the Kermadec group, near 30°S. Submarine hydrothermal activity is now known to occur at 6 different sites associated with frontal arc volcanoes. For clarity, not all the southern Kermadec vent sites are shown in the figure.

- Collect continuos chemical (Fe, Mn, H_2S) data using the SUAVE *in situ* chemical analyser,
- Sample discrete seawater samples for pH, total and dissolved metals, salinity, dissolved He and particulate (e.g., by filtration) hydrothermal species, and
- Conduct dredge operations over newly discovered hydrothermal sites.

A total of 76 CTD stations were occupied during the cruise, including 64 vertical casts and 13 deep 'tow-yo' lines; 404 bottle trips were taken during these casts and tows. The most detailed part of the survey includes 13 submarine arc volcanoes, between Whakatane (36.83°S; 177.47°E) to the SW and Brothers (34.86°S; 179.06°E) to the NE (Fig. 2). Two profiles were also surveyed normal to the arc, extending from the Kermadec Ridge westwards into the Havre Trough.

CTD results

During the initial part of the cruise vertical casts and some tow-yos were made over the summits of the volcanoes along the Kermadec arc front, later followed by casts in between these same volcanoes. Several further tows were then undertaken over known, and suspected, venting volcanoes. Optical anomalies indicative of active hydrothermal venting were difficult to discern for the Calypso vent field, offshore White Island, due to high ambient concentrations of particles from local re-suspension in these shallow (180-200 m) waters.

The distribution of suspended particles along a 260 km long transect between Whakatane and Brothers describes a thin (~300 m) surface layer with high particle concentrations, a broad mid-depth minimum centered between ~800 m and 1500 m, and a thick bottom nepheloid layer extending to the maximum depth sampled (3000 m). Superimposed on this background are distinct hydrothermal plumes from six volcanoes,

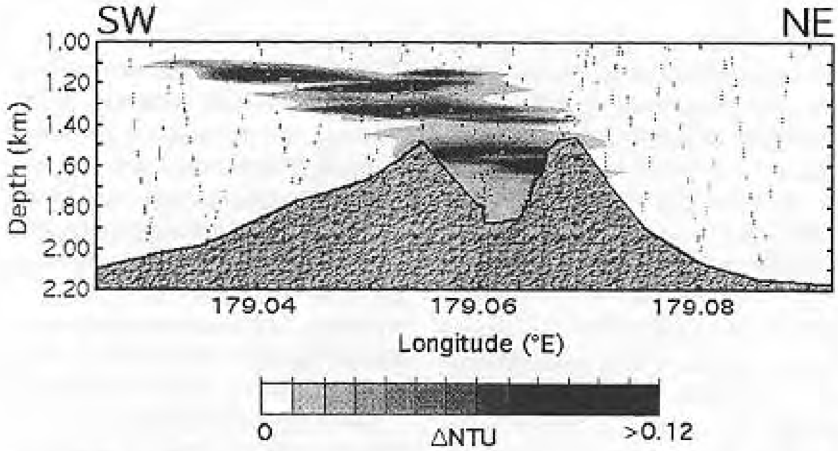

Figure 2. Compilation of two tow-yo profiles across Brothers caldera (see Fig. 1 for location). Tracks of the CTD tow package given by dashed lines. Plot shows concentration of nephels (note that NTU units are a nondimensional optical standard). Two obvious vent sources occur within Brothers volcano; one at ~1600 m on the NW wall of the caldera and the other at ~1150 m on the dome near the southern part of the caldera (not discernable in Figure).

including (from south to north): Tangaroa, Rumble IV, Rumble V, and Rumble III, which are volcanic edifices, and Healy and Brothers, which have calderas. At least four of the remaining volcanos—Whakatane, Clark, Rumble III south, and Cotton—were unable to be surveyed in sufficient detail to be certain that no hydrothermal activity presently exists. The depths of the vents range from 1850 m at Brothers (the most active site) to 250 m at Rumble III; some of the volcanoes have multiple sources.

Light scattering measurements proved to be a simple and reliable indicator of hydrothermal activity over these forearc volcanoes. Nevertheless, it is possible that some volcanoes host activity that emits plumes of negligible particle content, such as intensely phase-separated, gas-rich fluids. Because of the complex hydrography of this region (a prominent salinity minimum in midwater depths) we were unable to routinely calculate hydrothermal temperature anomalies.

SUAVE operations

SUAVE (**S**ubmersible System **U**sed to **A**ssess **V**ented **E**missions) is a state-of-the-art in situ chemical analyzer based on the principals of flow analysis and colorimetric detection. SUAVE was deployed as an integral part of the profiling package and was operated in autonomous mode. Four chemical channels (Mn low sensitivity, Mn high sensitivity, Fe, and H_2S) were run in parallel with a single determination made once every 5 seconds on each channel. Thus, pseudo-continuous vertical profiles and two-dimensional tow-yo sections were obtained for each of the targeted analytes.

SUAVE was deployed on 13 tows and 51 casts for a composite 115 hours of *in situ* analysis time. Volcanoes in which anomalous levels of Fe, Mn and/or H_2S were detected include: Tangaroa, Rumble V, Rumble III, Healy, and Brothers. Volcanoes without chemical plumes are: Whakatane, Clark, Rumble IV, Rumble II East, Rumble II West, Silent II, and Cotton.

Water sampling

Discrete water samples were collected in custom-built 19L PVC bottles attached to a towable profiling package. The bottles were closed using silastic springs actuated by remote control while monitoring hydrographic data (light scattering or depth/altitude) telemetered shipboard in real-time. The water sampling rosette was configured to hold twelve Niskin bottles, the SUAVE in-situ chemical analyser, and the CTD instrumentation.

He

A total of 397 He samples were collected in duplicate from sites covering the entire study area and is the most comprehensive of all the water sample data sets. Preliminary results show a deep helium signal of $\delta^3He = 20\%$ around 2000 m and deeper which is the general background expected for this region, and is considered to originate from the East Pacific Rise and other sources. Local injections of ^3He (up to $\delta^3He = 116\%$) related to the hydrothermal plumes were noted over Brothers, Rumble III, Rumble V and Tangaroa volcanoes, in particular, and to a lesser degree Clark. The latter site was not detected by light scattering measurements, highlighting the effectiveness of a multi-component approach to water sampling.

Total and dissolved metals

A total of 319 samples were collected for determination of total dissolved Mn and total dissolved Fe, and 106 samples for dissolved Mn and dissolved Fe. Of the total 425 discrete samples collected, 220 were analyzed shipboard (440 determinations), with the remainder to be analyzed ashore. Both these analyses are designed to also calibrate the SUAVE Fe and Mn analyses. Dissolved metal samples were largely collected from plume samples whereas the total dissolved samples were also collected from background stations. Onboard determinations of plume-level concentrations of Mn and Fe were performed simultaneously using an automated flow-injection-analysis-colorimetric detection system.

Total dissolved metal data from the plumes show that, relative to mid-ocean ridge (MOR) plumes, concentrations of Fe are enriched up to 5 times, H_2S maxima are almost two orders-of-magnitude higher, and Fe/Mn values are commonly double those reported for even brine-rich venting systems on MOR's. Marked variations in venting chemistry are also noted between volcanoes (e.g., Rumble V and Brothers) and also between vent sites at the same volcano (e.g., NW caldera wall and dome sites at Brothers), illustrative that a diversity of venting environments exists within the frontal arc environment.

pH

A total of 277 determinations of pH were made by potentiometry before the sensing electrode failed near the conclusion of the cruise. Departures greater than -0.25 pH from the regional depth trend were noted at four volcanoes (Brothers, Rumble III, Rumble IV, and Tangaroa). This is likely a function of the total amount of CO_2 dissolved in the water column above the vent sites.

Particulates

Particulate samples (130) were collected from all the active venting sites where noticeable light scattering anomalies were recorded as well as from background casts. Analysis was performed by thin-film energy-dispersive XRF. Preliminary results show elevated concentrations of Fe, Cu and Zn occur within particulates recovered from plumes above Brothers, Rumble III and Tangaroa. SEM analyses of these same particulates show pyrite, anhydrite and colloidal-Fe minerals are present together with large concentrations of bacterial matter; the latter consistent with intense light scattering anomalies for these plumes.

Dredge operations

Thirty four dredge stations were completed at the end of the cruise, 10 at Tangaroa, 11 at Rumble V, 5 at Healy, and 8 at the Brothers dome site.

Most of the rock samples recovered at Tangaroa were weakly vesiculated basalts, or basaltic andesites with plagioclase phenocrysts apparent. Minor (mm thick) Fe-oxide crusts were seen on some of the rock specimens.

At Rumble V the rocks were basalts and possibly andesites, locally glassy with flow banding on their outer surface, vesicular (scoriaceous), and hydrothermally altered by clay in places with minor associated Fe-oxide staining. At one dredge site abundant, recently deposited, elemental sulfur was seen infilling vesicles in the rocks. In another dredge, several large (~15 cm long) mussel shells were recovered.

At Healy volcano the dredges recovered largely pumiceous, and less commonly, vesiculated rhyodacite. One dredge recovered a red shrimp.

At the Brothers dome site, numerous samples of relatively fresh, glassy, vesicular andesite/dacite were sampled. Highly clay ± disseminated pyrite-altered rock samples, a large piece of elemental sulfur, barnacles, and a second shrimp were also recovered from different dredges. A strong smell of H_2S emanated from several of these samples.

The 34 dredge sites were all sited over, or thereabouts, known areas of active venting. However, the actual black smoker chimneys proved elusive, with no massive sulfides samples recovered during dredging operations. This highlights the necessity of follow-up submersible/ ROV dives to sample the vents. The results from the dredges do suggest, however, that elemental sulfur is being expelled into the water column at Rumble V and Brothers, consistent with the high light scattering values, high H_2S recorded by SUAVE, and preliminary XRF/SEM results of particulates recovered from plumes over these sites. The recovery of mussel shells at Rumble V, shrimps at Healy, and shrimps, barnacles and a strong smell of H_2S at Brothers, is also consistent with active venting.

Summary

The NZAPLUME cruise was highly successful in achieving its main aim, i.e, to locate and delineate, both physically and chemically, hydrothermal plumes associated with southern Kermadec arc front volcanoes. Some of the more obvious outcomes of this cruise include:

- The first, systematic, detailed plume mapping cruise to be conducted along an active frontal arc system anywhere in the world.
- Almost 60% (7 of the 12) volcanoes surveyed along the southern Kermadec arc are hydrothermally active. The remainder of the Kermadec-Tonga arc complex north of the study area is believed to contain at least 60 more submarine volcanoes (Worthington et al., submitted). If the southern Kermadec arc is representative of this population, ~35 will be found to be hydrothermally active, and thus a rich source of hydrothermal fluids and minerals.
- This study shows how a multitude of vent sources along the arc are supplying various elements into the oceans at depths ranging from (excluding offshore White Island) 250 m at Rumble III to around 1600 m for the NW site in the Brothers caldera. The shallow nature of some of the Kermadec arc vent sites has connotations for the exploitation of their associated massive sulfide deposits and the natural "Fe-fertilization" of the oceans.
- The concentration of some elements within the Kermadec forearc plumes, such as Fe and H_2S, together with and Fe/Mn values, are high relative to values typical of MOR plumes. Extremely high nephel readings recorded in some of the plumes likely reflect high concentrations of microbes (as determined by SEM) and/or elemental sulfur in the water column.
- Marked variations in venting chemistry among volcanoes and between sites at Rumble V and Brothers indicate that a diversity of venting environments exists within the

frontal arc environment.

- The two most active vent sites occur in the northern part of the study area (e.g., Healy and Brothers) and are the deepest at 1100-1600 m. They are also hosted by calderas. Vents further south are found associated with shallower (250-700 m) sites associated with volcanic cones. The plumes in Healy are mostly contained within the caldera walls, as are the plumes originating from the deep (1600 m) NW caldera site at Brothers; plumes originating from the resurgent dome site at Brothers clearly escape the caldera (see Fig. 2).
- Delineation of plume dispersals suggest mid-water (400-1150 m) current directions in the Havre Trough are to the south (e.g., Fig. 2).
- The intensity and nature of the chemical signals detected differ significantly from historical results for mid-ocean ridge and intra-plate volcanoes, suggesting that the island arc setting may constitute a unique and volumetrically important 'end-member' relative to the transfer of heat and mass to the oceans via submarine hydrothermal venting.

Acknowledgments

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International Ridge-Crest Research: **Hotspot-ridge interactions**

Hotspot-ridge interactions near Ascension Island, equatorial Atlantic?

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Introduction

In 1998 we undertook a detailed sampling of the Atlantic spreading axis between 6° and 11°S close to Ascension Island with the following aims:

- Establish in detail the extent and intensity of the geochemical anomaly (previously outlined at a coarse scale by Fontignie and Schilling, 1996; Graham et al., 1992 and Hanan et al., 1986) associated with the already known bathymetric (see Fig. 1 and Brozena and White (1990)) and geophysical (Minshull et al., 1998) anomalies in this region.
- Try and find evidence either for or against a hotspot origin for the Ascension volcanism.
- Characterise the geochemistry of other near-ridge volcanoes known in the area (see Fig. 1 and Brozena (1986)).

Ultimately the data from the samples gathered during the cruise will be used to model the magmatic processes occurring on this anomalous ridge segment.

Here we present an initial report of the sampling we undertook and the geochemical data available at present together with some preliminary interpretations. These data will also be presented at the Fall 1999 AGU (Möller et al., 1999).

General Geology and Sampling

The topography of the seafloor and our sampling stations are shown in Fig. 1. The area is characterised by two large transform fault systems in the north and south (the Ascension and Bode Verde Transforms), both of which are marked by two large faults separated by a small intratransform spreading axis. The spreading axis between the Ascension and Bode Verde Fracture Zones is dissected by several non-transform offsets, creating a series of ridge segments. For ease of description we numbered the segments consecutively from north to south (ASC1 to ASC6). Detailed bathymetric information extended only as far as ca. 10°10'S (southern end of segment ASC5). South of segment ASC5 we had to rely on bathymetry predicted from satellite altimetry to guide the sampling, and due to the low resolution of this data we have no clear idea of how many ridge discontinuities there may be in this area. For this reason, the whole southern part of the ridge was grouped under the segment name ASC6 (see Fig. 1).

Details of all samples collected by the dredges and the exact sampling locations are available in the cruise report (Devey et al., 1999). Sampling began with four dredges on the axis north of the Ascension Fracture Zone to characterise the mantle composition away from any influence of an Ascension anomaly. A dredge taken on the inside corner high north of the Ascension Fracture Zone in an attempt to recover peridotites yielded only basalts. Within the fracture zone itself east of 11° 40'W the inter-transform crust is a typical rough terraine of ridge-parallel abyssal hills, but west of this the bathymetry shows a smoother surface with transform-parallel crenulations. Such crenulated surfaces have recently been interpreted as possible detachment faults, similar to those in core-complexes on continents (Cann et al., 1997). If this is a detachment fault surface, it is one of the largest such structures found so far – crenulations can be traced over a length of ~50 km at around 12° W. We made three attempts to recover peridotite within the transform zone and were successful in two locations on the crenulation surface, the third location somewhat further west yielded gabbros. Attempts to dredge the small intra fracture zone axis yielded old pillow lavas in only one case, two attempts to recover peridotites from the inside corner high south of the Ascension Fracture Zone yielded only gabbros.

Sampling of the Ascension spreading axis at a sample spacing of 3 locations per 10 minutes of latitude was then begun. The exact location of the active spreading axis for segment ASC4 was in some doubt before the cruise – several authors (Brozena and White, 1990; Minshull et al., 1998) were in favour of the axis lying at 13°15'W based on magnetic anomalies, bathymetric considerations suggested that the axis could recently have been active at 13°35'W. In order to investigate these possibilities we dredged both locations at ca. 8°20'S (see Fig. 1).

Figure 1: Sample stations and axial segment locations superimposed on seafloor bathymetry (data from Brozena and White, 1990).

The station on the more easterly of the proposed axes yielded only calcareous sediments, whilst samples from the more westerly ridge (at 13°35´W) were all relatively fresh. This ground-truthing gives relatively strong evidence that the present ASC4 axis is located well in the west and not in the east as previously proposed.

Segment ASC5 is characterised by very shallow water depths (in places < 1400m) and a poorly-defined or in places non-existent axial valley. Previous geophysical work (Minshull et al., 1998) has shown that this segment is characterised by abnormally thick (10 km) crust. In total we took 12 dredge hauls along the crest of this segment, most of which yielded very fresh basalt. East of the shallowest portion of ASC5 is a chain of three seamounts running E-W. Of these seamounts, the most westerly yielded paradoxically the oldest-looking samples, the samples from Grattan were reasonably fresh, whilst those from the easternmost Seamount D (name taken from the figures in Brozena (1986)) were amongst the freshest. These samples and ash layers recovered from sediment corers taken close to the seamounts are presently being dated by P. v.d. Bogaart, Geomar, Kiel.

The morphology of the spreading axis changes dramatically from ASC5 to ASC6. The rift axis becomes once more deep and there is a pronounced axial valley. Thirteen dredge positions were occupied along this axis. The final dredge was taken on the intra fracture zone inside corner high in the Bode Verde Fracture Zone.

Geochemistry

Fresh glass was recovered from almost all dredge sites and major and trace element analyses have been carried out on these glasses wherever possible. Some diagrams of variation of composition with latitude are shown in Fig. 2. Incompatible trace element enriched magmas occur on the shallow spreading segment 5 and the near-ridge seamounts, and also on segment 1 at 7°52´S, directly east of Ascension Island. The rest of the MORB between 6 and 11°S are trace-element depleted. The presence of incompatible element-enriched basalts close to intraplate volcanoes erupting enriched magmas suggests that young intraplate volcanism both west (Ascension) and east (seamounts at 9°30'S) of the MAR influences the magmatism of the spreading axis. There is no sign of any variations in Na_8, implying that the influence is either not associated with a thermal anomaly or that the competing efffects of source enrichment and increasing degrees of melting on Na_8 exactly cancel each other out. We prefer the former interpretation as it does not appeal to a fortuitous coincidence of enrichment and depletion factors. Several other observations support this interpretation: constant along-axis Al_8 and Ca_8 concentrations, parameters which are also sensitive to changes in the degree of partial melting, and only low MgO magmas are found on segment 5.

Particularly the MgO observation seems important for reasons which are shown diagrammaitcally in Fig. 3. To produce thicker-than-normal crust excess magmatism is required, i.e. more magma must be

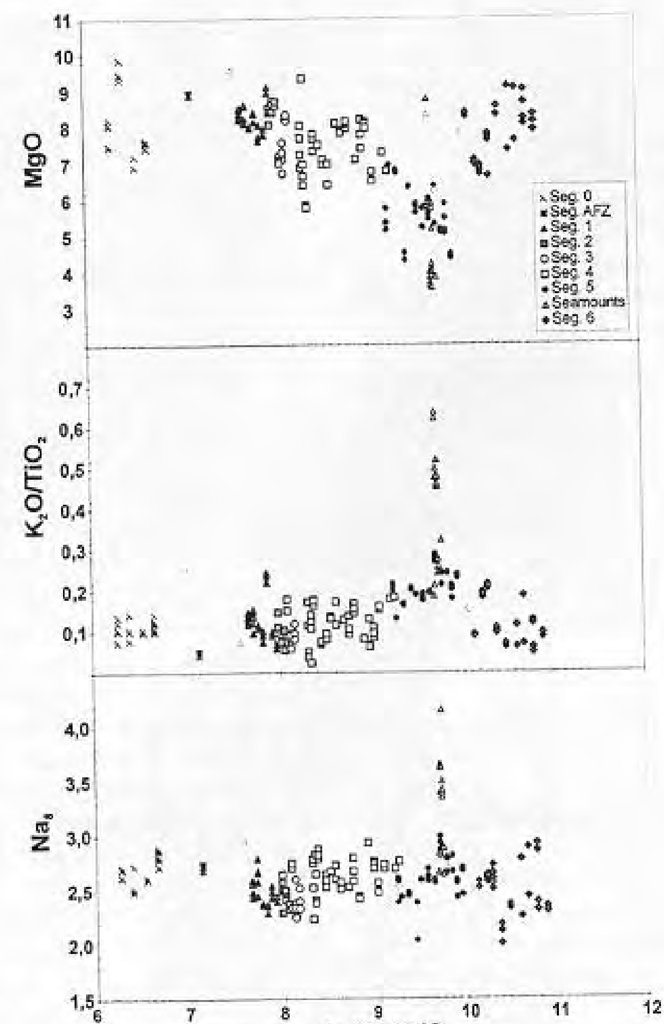

Figure 2: Major element data from samples from the active spreading axis. All data measured on glass separates, each data point is the average of 9 individual measurements with the electron microprobe.

supplied to the ridge than would normally be supplied if only passive upwelling of asthenosphere with average temperature was occurring. In part A of Fig. 3 we show what happens if this excess magmatism results from upwelling of overly warm mantle, the maximum and average degrees of melting in the melting column are both elevated compared to the normal MORB situation and relatively mafic magmas should be produced. In Fig. 3B we show how a contribution of magmas from an off-ridge source can, when added to the products of a normal axial upwelling, also lead to excess magmatism, in this case neither melting column should produce abnormally Mg-rich magmas (the passive upwelling column because it is essentially a normal MORB column, the off-axis column because it is capped by the lithosphere), the resulting magmas should then have lower average MgO than those produced by a system such as shown in Fig. 3A. The occurrence of low MgO on segment 5 suggests that a situation similar to Fig. 3B exists there.

The seamount magmas show increasing fractionation and enrichment with increasing distance from the spreading axis. This, combined with decreasing SiO_2 concentrations and increasing $(Tb/Yb)_N$ ratios with distance, indicates that the average depth of melting beneath the volcanoes is increasing as the age of the overlying plate increases.

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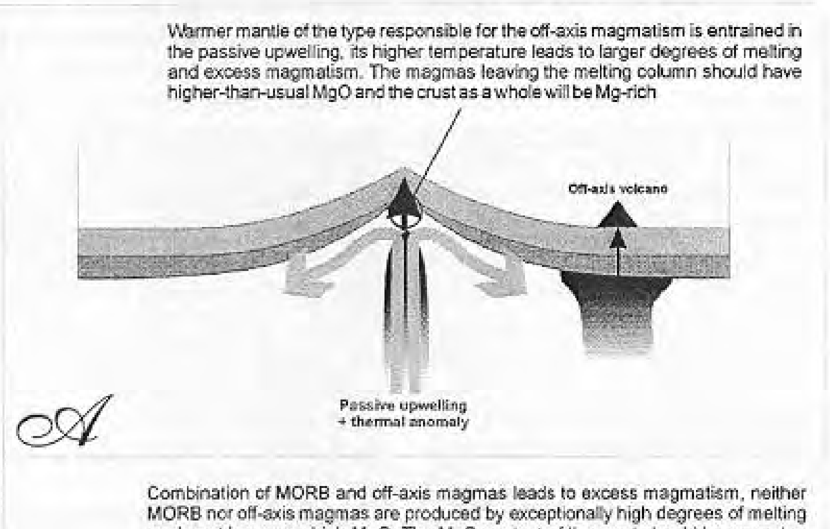

Figure 3: Models of possible mantle configurations beneath Segment 5 which could account for the thickened crust and geochemical anomalies.

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International Ridge-Crest Research: **International Policy**

Why Oceanographers Should be Concerned about Submarine Telephone Cable Protection

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Submarine telegraph cables were first laid over transoceanic distances in 1857, and proliferated globally over the next century. The first transoceanic submarine telephone cable was installed across the Atlantic in 1957, and ushered in an era of rapid submarine telecommunications infrastructure expansion over the subsequent 30 years. This trend accelerated substantially in the 1990's, driven by both the development of high data rate fiber optic technology and the enormous and ongoing expansion of the Internet. With data rates that approach 100 Gbit/s or more on a single cable, the revenue loss caused by disruption of service is measured in millions of dollars per day, and hence international telecommunications companies are taking the issue of protecting their seafloor assets very seriously. This is manifest in the International Cable Protection Commission (ICPC; http://www.iscpc.org), an organization of cable owners whose purpose is to share information on cable protection and facilitate cable protection activities.

Historically, cable protection efforts by both individual telecommunications companies and the ICPC have focussed primarily on waters shallower than about 1000 m since the primary threats to submarine cables have always been human-induced, and especially due to fishing activity. Cable protection has three major thrusts: burial and armoring of cables to a depth beyond which there is a perceived threat (now approaching 2000 m), communication about the issue through outreach activities and the distribution of charts marking cable locations, and follow-up activities after incidents, increasingly via recourse to the legal system. The first of these has been standard practice for 20 years, and new cables are typically armored and buried 1-2 m below the seafloor out to water depths of 2000 m. Outreach and charting activities are ongoing, although the primary focus is on the continental shelves. Deep water charts typically show only approximate location informtion. Post-break litigation is certainly on the rise as the cost of repairs and service restoration increases.

Comparatively little effort has been expended on cable protection in the deep ocean because cable faults in the abyss have been both rare and typically due to natural phenomena like submarine landslides. This largely reflects much more limited human seabed activities as the water depth increases. In fact, the principal users of the seabed at depths beyond 2000 m or so are the submarine telephone industry itself and the oceanographic community. The former already has well-defined and widely used procedures to prevent damage to existing systems during either repair operations or new lays. By contrast, oceanographers are rarely aware of the risk of cable damage during research activities that interact with the bottom, especially dredging, coring, and drilling. To date, no cable faults attributable to oceanographic activities have occurred, but the financial and public relations consequences if they do are considerable.

International law clearly places the burden for cable protection on ship owners or operators, and hence indirectly on oceanographers themselves. There are two key international treaties that pertain to this. The first is the International Convention of March 14, 1884 for the Protection of Submarine Cables, to which all of the major nations operating oceanographic ships (except Japan) are signatories. This states that outside of territorial waters, breaking or injuring (either willfully or negligently) a submarine cable shall be a punishable offense with no bar to further civil action except in situations involving the safety of persons or vessels. It also states that infractions are subject to the courts in the country of registry of the offending vessel. The Law of the Sea Treaties of 1958 and 1982, which have been signed and ratified by all major countries operating oceanographic research vessels (except the US, which has only signed the 1982 convention), reaffirm these principles. Most nations have implemented these treaties in national law, although in some instances (e.g., the US), legislation is so old that criminal penalties are almost negligible. For this reason, telecommunication companies are more likely to seek damages through US civil than criminal actions when cable faults are caused by US vessels. It is probable that comparable situations exist in other countries, although the author is not familiar with all of the details.

Some telecommunication companies are aware of the potential risks associated with oceanographic research cruises. For example, AT&T attempts to monitor the UNOLS ship schedule, contacting chief scientists when they will be working in areas containing cables and providing cable location information when appropriate. ODP also maintains regular communication about drilling activity with telecommunications companies. Other telecommunication companies may be taking similar actions to those of AT&T. However, this approach is *ad hoc* at best, and cannot reach either all oceanographic ship operators worldwide or all cable owners with any certainty.

For this reason, it is incumbent on both ship operators and chief scientists to be aware of the cable protection issue and be proactive in dealing with it prior to research cruises. This is an especially important concern for Mid-Atlantic Ridge research due to the high density of cables crossing that feature. For cruises which do not involve dredging, coring, or other bottom-interactive methods, cable protection is obviously not an issue. When these activities are planned, a good starting point for cable protection information is the ICPC home page. Detailed information about cable tracks is not always available at this site, and follow-up contact with the cable owners is necessary. All of the major cable operators have cable protection managers, and these can also serve as a point of contact. Good starting points are the cable protection representatives from either AT&T (R. Wargo, +1-973-326-3445, rwargo@ems.att.com), France Telecom (J. Genoux, 33-1-43-42-62-93, jacques.genoux@francetelecom.fr), BT (C. Fenn, 44-181-315-3176, fenncp@boat.bt.com), or KDD (I. Hiratsuka, 81-33-347-5676, it-hiratsuka@kdd.co.jp), depending on the area of operations.

Testing the Waters: Establishing the Legal Basis to Conserve and Sustainably Use Hydrothermal Vents and Their Biological Communities

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Introduction

Marine scientific researchers studying hydrothermal vent systems and their associated biological communities are at the cutting edge of some of the most exciting research undertaken this century. But the focus of their work is increasingly under threat from sea bed mining and marine scientific research, including biological sampling. In addition bioprospecting activities involving the genetic resources from hydrothermal vents are coming under increasing scrutiny nationally and internationally.

The purpose of this article is to provide marine scientific researchers, both geologists and biologists, with a better understanding of the international legal framework that can guide their activities and potentially provide the legal basis to conserve and sustainably use hydrothermal vents and their biological communities.

Marine scientific researchers may not realise that such international treaties as the United Nations Convention on the Law of the Sea (1982) (UNCLOS) and the Convention on Biological Diversity (1992) (CBD) may apply to hydrothermal vents, their associated biological communities and marine scientific research activities. Each treaty's scope of application depends primarily on the nature of the activity and its geographical location. Activities can take place in areas within national jurisdiction (the territorial sea, the EEZ and the continental shelf).

They can also take place beyond the limits of any national jurisdiction, in other words beyond the EEZ and the continental shelf. This part of the seabed has been designated by UNCLOS as "the Area". The Area and its mineral resources (e.g., polymetallic nodules, sulphide crusts and methane hydrates) have a special legal designation as the "common heritage of mankind". As a result, the right to explore and exploit them rests solely with the international community.

The greatest impact of UNCLOS and the CBD will likely occur in areas of national jurisdiction, as both treaties have the most detailed provisions covering this geographical area. Relatedly, States may already have in place laws implementing these treaties as well as unrelated but potentially applicable environmental laws. The very last point may be especially important for States, such as the USA, which are not party to either treaty, and therefore have no obligation to implement them.

In the Area there are no definitive or clear cut applications of either treaty, especially in terms of conservation and sustainable use

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of the biological communities associated with vents. From a practical standpoint, hydrothermal vents, their associated biological communities and the activities involving them fall into an international legal crack; neither UNCLOS nor the CBD specifically reference them and their application can only be inferred.

This is not surprising given the fact that it has only been about twenty years since deep seabed hydrothermal vents were first observed directly. Still, the situation is not direly problematic if States party to the conventions are willing to creatively interpret the treaties and other non-party States, such as the USA, apply their spirit. Barring this "the users" of hydrothermal vents in the Area – marine scientific researchers in particular – can act voluntarily to apply the spirit of the treaties to their own activities. The initiative researchers voluntary take themselves might actually catalyse subsequent State action.

The activities most likely to involve hydrothermal vents and their biological communities are sea-bed mining, marine scientific research, biological sampling and bioprospecting.

Seabed Mining

Mining hydrothermal vents for polymetallic sulphide crusts poses perhaps the greatest potential physical threat to them and their biological communities. Threats include not only direct physical damage and destruction, but indirectly the possibility of sedimentation and upsetting water circulation systems.

The most immediate threat is mining in areas of national jurisdiction, where vents with potentially valuable associated minerals lie close to shore. Potentially rich in gold and other valuable metals, these vents offer the possibility of reasonable extraction and processing costs because of their accessibility.

The best example of this are the plans of a mining consortium to explore the feasibility of mining polymetallic sulphide crusts from a vent system located in the Manus Basin of the Bismarck Sea within the EEZ of Papua New Guinea, a Contracting Party to UNCLOS and the CBD.

The international legal basis for conserving and sustainably using hydrothermal vent areas within areas of national jurisdiction is fairly clear, with the added benefit that national environmental regulatory processes may already exist. As a principle of international environmental law a State has the sovereign right to exploit its natural resources provided it does not damage the environment of other States and areas beyond national jurisdiction. The extent to which it must account for the environmental impacts of actions within its own territory depends on its other international environmental obligations and its national environmental laws.

As a Contracting Party to UNCLOS, Papua New Guinea has the very general obligation "to protect and preserve rare or fragile ecosystems as well as the habitat of depleted, threatened or endangered species and other forms of marine life" (article 194(5)). Furthermore, as a Contracting Party to the CBD it has a range of explicit obligations to conserve biological diversity and use its components sustainably.

Fulfilling these obligations should entail at minimum (1) identifying any biological communities associated with the target vent system and (2) regulating or managing the activity to eliminate or minimize impacts on biodiversity. Therefore, an environmental impact assessment should be required.

Provided that public participation is allowed in Papua New Guinea's regulatory oversight and environmental impact assessment processes, marine scientific researchers could have an important role to play. For example, they could offer the best available information on the particular sites under review to help determine what the proposal's potential impacts would be. They might also be able to steer proposed activities away from rare or fragile sites or those of particular scientific interest.

Beyond the limits of national jurisdiction, in the Area, sulphide crusts are not currently economically exploitable because of the great expense involved in recovering and processing them. Some estimates place mining as emerging in 10-15 years.

In this time and, pursuant to UNCLOS, prior to any mining takes place, the International Seabed Authority (ISA), the UN body that oversees mining in the Area, needs to develop a mining code for sulphide crusts. An initiative within the ISA, instigated recently by the Russian Federation delegation, seeks to do just that.

While it is still too early to determine the scope of the code, it will likely be modelled on the draft code for manganese nodule mining that the ISA has been working on. Strong environmental impact assessment procedures, presently not well developed in the draft nodule code, should be developed for the crusts code to fulfil the stipulation in UNCLOS that the code protect and conserve the Area's natural resources and prevent damage to the flora and fauna of the marine environment (article 145).

It should be kept in mind that the intergovernmental process to develop such a code would surely benefit from and could be influenced by available marine scientific research. In other words, the process could provide marine scientific researchers working on hydrothermal vents and concerned with their conservation and sustainable use with a good opportunity to influence their governments' technical, scientific and negotiating positions.

Marine Scientific Research

Ironically, perhaps the most immediate threat to hydrothermal vent systems and their associated biological communities may be marine scientific research itself. As a "use", marine scientific research needs to be sustainable just like any other natural resource-based activity.

The CBD defines "sustainable use" as using the "components of biological diversity in a way and at a rate that does not lead to the long term decline of biological diversity, thereby maintaining its potential to meet the needs and aspirations of future generations" (article 2). This definition recognises that biological diversity conservation cannot be separated from the sustainable use of its components – genomes, populations of species and ecosystems. In other words to conserve biological diversity – the variety of life on Earth – its tangible manifestations must be conserved and sustainably used (Glowka et al., 1994).

Commentators have noted that one aspect of the threat marine scientific research poses originates from a shift in research priorities from exploration and discovery to those emphasizing temporal processes (Mullineaux et al., 1998). According to Mullineaux et al., the resulting "concentration of sampling, observation and instrumentation at a small number of well known hydrothermal sites" has led to the discovery "that certain activities are incompatible, and that even more cooperation and coordination will be required to resolve potential conflict".

The main problem is a conflict between observational monitoring activities that depend upon an undisturbed state and those activities that involve manipulating or collecting biological or geological samples from a particular area. Mullineaux et al. (1998) assert that "disturbance by researchers can have a substantial impact on vent systems" and that "anthropogenic changes in distribution and occurrence of vent fluid flows and of associated vent communities have been well documented at vents along the East Pacific Rise, on the Juan de Fuca Ridge and at the TAG field on the Mid-Atlantic Ridge."

In areas of national jurisdiction managing physical access to sites of scientific interest or important for biodiversity conservation may be a viable solution to the problem. At a minimum, the oversight agency that provides consent to undertake marine scientific research within the EEZ and on the continental shelf, could provide a screening or clearing-house-type function. It could identify potential conflicts and make prospective researchers aware of them before they occur when a permit application to undertake research is first submitted.

If the country is particularly advanced, granting permission to undertake activities in an area might be informed by a management plan and an environmental impact assessment, especially if the hydrothermal vent area has been established as a protected area. This seems to be the approach Canada will ultimately take with the Endeavour Hot Vents site, a designated "pilot marine protected area" located on the Juan de Fuca Ridge within Canada's EEZ (Canadian Ministry of Fisheries and Oceans, 1998).

Even though Canada has not ratified UNCLOS and is therefore not a Contracting Party that accepts to implement the treaty's obligations, such a step implements the spirit of the UNCLOS provision to protect rare and fragile ecosystems. It also implements the various conservation obligations Canada has accepted as a Party to the CBD. Provided there is a multi-stakeholder consultation process to inform the development of a management plan, and a transparent regulatory system that guarantees public participation, Canada's approach should minimize threats to this heavily used site and not negatively impact marine scientific research.

In this or other areas, "zoning" a vent system according to the UNESCO Biosphere Reserve approach could be envisioned. This approach is used terrestrially and in some marine areas such as Australia's Great Barrier Reef. It is characterised by delineating an area into zones to be managed to achieve particular objectives. These might include a (1) a core area or areas devoted to strict protection where the possibility might exist for non-invasive observational research, (2) a delineated buffer zone where only research and other activities compatible with specified objectives could take place and, possibly, (3) a transition zone where more invasive activities such as sea bed mining could take place.

Such an approach would certainly be in keeping with the single UNCLOS provision on protecting fragile or unique ecosystems. Furthermore, it would also support the CBD objectives to conserve biodiversity and sustainably use its components by among other things, identifying and managing threats to biodiversity (articles 7(c) and 8(l)) and creating protected areas (article 8(a)).

As one might guess the situation is a lot less structured in areas beyond the limits of national jurisdiction because at this time there is no oversight agency for the seabed with a mandate to oversee marine scientific research activities or biological resources.

The mandate of the ISA is limited to the Area's mineral resources. It only addresses marine scientific research and the Area's biological communities when seabed mining is involved. Therefore, without (1) direct measures taken by researching States to regulate the conduct of their marine scientific researchers in the Area, (2) a new international treaty or (3) voluntary oversight by the scientific community itself, there is very little that international law can directly offer at present to minimize the potential use conflicts and the threats marine scientific research may pose to a hydrothermal system.

While a new international treaty is unlikely, direct measures by individual or a group of researching

States are possible, especially if they act pursuant to their treaty obligations under the UNCLOS and CBD. The outstanding problem is motivating States to act in the first place. A related problem may involve coordinating and harmonising disparate approaches States may take if they act individually.

Both issues could perhaps be taken up by UNESCO's Intergovernmental Oceanographic Commission (IOC) whose mandate, among other things, includes marine scientific research. But intergovernmental processes tend to be time consuming and potentially political.

Voluntary approaches, possibly involving self-policing, may be the most expeditious way to minimize the conflicts and environmental impacts that marine scientific research activities may pose. Voluntary actions by researchers have been proposed by Mullineaux et al. (1998).

This would require greater coordination and collaboration between marine scientific researchers themselves, which will depend upon information sharing, awareness and good will. In addition, a coordinating body, such as InterRidge, will likely be required.

A step towards voluntary action is already being taken as a result of a 1995 recommendation of the InterRidge Biological Studies *Ad Hoc* Committee to demarcate seabed sanctuaries (Desbruyères and Lutz, 1995). This was subsequently elaborated upon further in a position paper put forth by Mullineaux et al., whereby a "research reserve system" was proposed that would be "regulated entirely by consensus".

InterRidge would disseminate information and summarise controversies. To alleviate collecting pressure at the most popular sites researchers would be encouraged to devote dive time to explore new sites for collecting. Thus far two sites in the Area have been proposed; one on the East Pacific Rise; the other on the Mid-Atlantic Ridge.

Interestingly, in the absence of State action, voluntary actions by marine researchers would be in keeping with the spirit of UNCLOS since it applies to marine scientific research beyond the areas of national jurisdiction. When undertaken beyond the limits of any national jurisdiction the legal status of marine scientific research is determined by where it takes place.

On the high seas and in the Area, all States and competent international organizations have the right to conduct marine scientific research (article 256). But unlike the situation with the high seas, all marine scientific research within the Area "shall be carried out for the benefit of [hu]mankind as a whole" (article 143(1)). Unfortunately, UNCLOS neither defines "marine scientific research" nor "benefit of [hu]mankind as a whole".

Still, one could argue that the scientific community's voluntary actions would contribute to the conservation and sustainable use of hydrothermal vents and their associated biodiversity and thereby benefit humankind as a whole. This also would be in keeping with the spirit of the CBD's international cooperation provisions and its declaration that biodiversity conservation is a "common concern of humankind" (preambular para. 3).

With any voluntary system the principles upon which it is based must be known to the participants. In lieu of regulatory oversight, the scientific community could undertake to develop a professional code of conduct for activities involving hydrothermal vents to guide researchers and to provide a reference point against which they can judge their own conduct and the conduct their peers.

Furthermore, the ultimate success of any voluntary system or instrument such as a professional code of conduct is intimately related to the process by which it is developed. It is a well established principle in modern conservation circles that the key stakeholders must be involved in any process whose result may impact upon their activities.

In addition, incentives may need to be provided to encourage application. For example, national funding institutions could agree to condition grant money upon the demonstrable application of code of conduct by the grantee. Peer pressure may also play a role in the ultimate success of any voluntary system.

To fully ensure the codes' application, and give it added weight, it ultimately may need to be concretized further by an intergovernmental body such UNESCO's IOC. This would ensure oversight of its implementation at the global level and may encourage its voluntary application by States.

Biological Sampling

Biological sampling of macro- and micro-organisms is a primary goal of many marine scientific research activities both within and beyond the limits of national jurisdiction. Depending on the circumstances, sampling activities may put pressure on hydrothermal biological communities causing adverse impacts. Consequently, sampling may not be sustainable. This may be especially true for sampling involving invertebrates.

Direct impacts associated with sampling a limited population of organisms are clearly possible. Possible indirect impacts are less predictable. For example, sampling in unique environments may be an unsustainable use without precautions to minimize the introduction of alien or non-indigenous species from site to another.

For micro-organisms the situation is less clear cut. It appears that the use of a micro-organism may not diminish a fixed stock of that organism, especially if the micro-organism is readily culturable and the means of collection are sustainable. However, there may be instances where a micro-organism's use is unsustainable because of the impact on the micro-organism's habitat or other mutualistic or non-mutualistic organisms it is associated with it.

For example, sustainability may need to be considered where bio-prospectors need large quantities of a macro-organism to obtain useful quantities of a secondary metabolite produced by a mutualistic micro-organism. If the secondary metabolite is not readily synthesizable and the micro-organism is not culturable, then harvesting the macro-organism at unsustainable levels could threaten both it, the micro-organism as well as the particular ecosystem (Glowka, 1996).

For these reasons, in areas of national jurisdiction, there are clear intersections between these activities and the CBD's sustainable use provisions, especially where activities take place in a coastal State party to the convention.

As with seabed mining, a Party is to identify actual or potential threats to biodiversity (article 7(c)), and subsequently regulate or manage them to minimise those threats (article 8(l)). A complementary provision, requires the coastal State to adopt measures relating to the use of biological resources to avoid or minimize adverse impacts on biological diversity (article 10(b)). Intersections with environmental impact assessment (article 14) are also apparent. Finally, a Contracting Party is required to regulate and manage biological resources collecting from natural habitats for ex-situ conservation purposes so as not to threaten ecosystems and in-situ populations of species (article 9(d)).

Beyond national jurisdiction, in the Area, the situation is similar to that for general marine scientific research. Unsustainable collecting for research purposes could be interpreted as being inconsistent with the requirement that marine scientific research be undertaken for the benefit of humankind as a whole.

As already suggested, voluntary action by the marine scientific research community could fill the gap left by the unlikelihood of a new treaty or until other State action takes place. In 1995 the InterRidge Biological Studies *Ad Hoc* Committee recommended that the member States of InterRidge establish a voluntary international sample exchange agreement whose "aim is to avoid duplication of sampling which is costly not only in monetary terms but also in terms of environmental impact" (Desbruyères and Lutz, 1995).

The idea was further elaborated upon by a group of scientists at the First International Symposium on Deep-Sea Hydrothermal Vent Biology in Madeira in 1997 as a means to augment existing international exchanges, and subsequently InterRidge established a WWW-based database with information on existing biological samples. In addition, non-biology research cruises are provided with "bio-boxes" for collecting and preserving biological samples collected and making them available for exchange. The draft agreement has not been officially endorsed by InterRidge member States, but national corresponding curators are asked to draw on its terms and conditions, including prohibitions on redistribution of exchanged samples and using the samples for commercially oriented research. This initiative could contribute to one aspect of the sustainable use of vent organisms.

Bioprospecting

It is becoming more common for marine scientific research activities, especially those related to biological and geological sampling, to have links to onshore commercial bioprospecting activities. While it is doubtful that such activities pose an immediate threat to biological communities associated with hydrothermal vents, at least in areas of national jurisdiction, especially where a coastal State is a party to the CBD, there may implications for the marine scientific researcher.

The third objective of the Convention on Biological Diversity – the fair and equitable sharing of benefits derived from the utilization of genetic resources – provides the conceptual basis for later CBD articles, notably articles 15 (Access to Genetic Resources), 16 (Access to and Transfer of Technology) and 19 (Handling of Biotechnology and Distribution of its Benefits). These obligations seek to establish a new equity relationship between Contracting Parties providing genetic resources and the Contracting Parties with users of genetic resources (Glowka, 1994; Glowka, 1998).

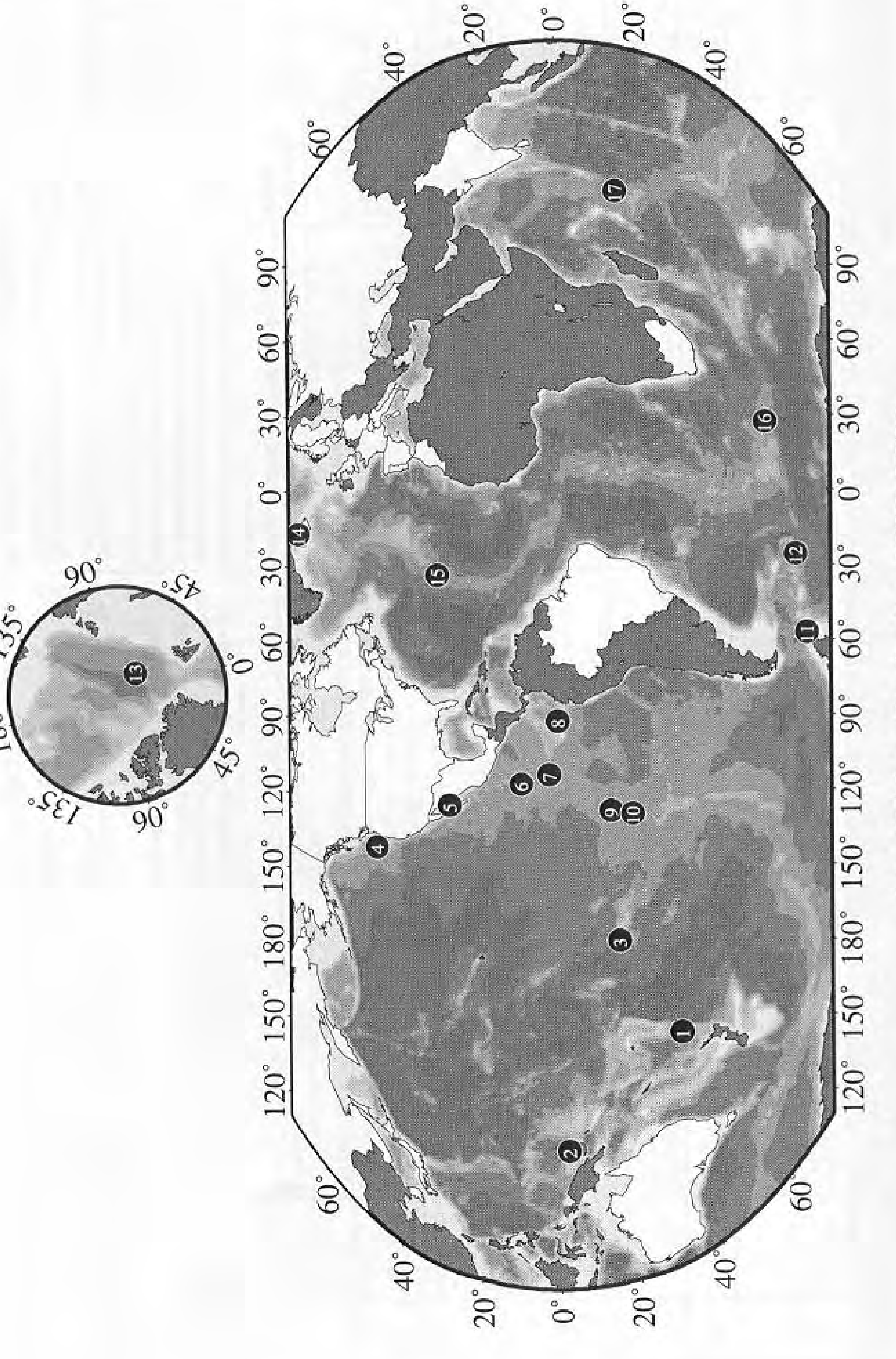
Essentially a *quid pro quo* is established: access to genetic resources in exchange for sharing of benefits derived from their use. Benefits may include: participation in scientific research; the fair and equitable sharing of research results; commercial and other benefits derived from the genetic resources; access to, and transfer of, technology making use of the genetic resources provided; participation in biotechnological research activities based on genetic resources provided; and priority access to results and benefits arising from biotechnological use of genetic resources provided.

One goal of benefit sharing is to create greater incentives for conserving biological diversity and sustainably using biological resources under the jurisdiction of a Party provider.

The CBD's genetic resources provisions only apply to marine areas within the areas of national jurisdiction and approximately 40 countries, many of them coastal states, are developing policies and legislation on access to genetic resources. These provisions may require marine scientific researchers to obtain the government's prior informed consent prior to access. Prior informed consent will be subject to mutually agreed terms, including benefit sharing.

Similarly, under UNCLOS, con-

World Ridge Cruise Map, 1999-2000



InterRidge Projects, 1999-2000

World Ridge Cruise Schedule, 1999-2000

Map No.	Country	PI	Institution	Name/Location	Research Objectives	Ship	Dates
2	Australia	Dekker, Binns	CSIRO	Manus Basin, Bismarck Sea, Papua New Guinea	Microbe collection for minerals bioprocessing; trials of bottom-tow instruments for exploration and mineral resource assessment; searching for new hydrothermal sites	Franklin	April 14 - May 4 '00
2	Australia	McInnes	CSIRO	New Ireland and Solomon and Forearc Basins	Investigation of hydrothermically active submarine arc volcanoes	Franklin	May 5-24 '00
4	Canada, USA	Juniper, Embley	UQAM, NOAA-PMEL	**NeMO '99**, Axial, Juan de Fuca Ridge (VENTS program) See Canadian update on page ??	Interdisciplinary investigation using ROPOS to continue a time series/mapping program over the 1998 eruption site in Axial Caldera. Several instruments will be recovered and redeployed.	Thompson, ROPOS	Jun. 17 - Jul. 14 '99
4	Canada, USA	Juniper, Sternberg	UQAM, U. Wash.	**HiRise '99**, Endeavour Segment - See Canadian update on page ??	Evaluate Endeavour Segment as a Canadian Marine Protected Area and revisit Mothra hydrothermal vent field.	Thompson, ROPOS	Jul 15 - 23 '99
6	France	Lallier	CNRS, IFREMER, UPMC	East Pacific Rise 13°N, 9-10°N - **HOPE'99** (Hydrothermalisme Océanique: Physiologie et Ecologie) see article on pg. 19	Ecology and physiology of vent organisms.	L'Atalante, Nautile	April 7 - May 22 '99
6	France	Prieur	UBO, Roscoff	East Pacific Rise 13°N - **AMISTAD** (Advanced **Mi**crobiological **St**udies on Thermophiles: **A**daptations and **D**iversity) .	Microbiology cruise to study procaryotic thermophiles and hyperthermophilic communities	L'Atalante, Nautile	May 23 to 15 June '99
3	France	Cheminée	IPGP	**POLYNAUT**: Tahiti hot spot	Origins, emplacement and evolution of hotspot volcanoes and associated hydrothermalism	L'Atalante, Nautile	Aug.-Sept. 1999
2	France, Japan	Auzende, Urabe	IFREMER, Geological Survey of Japan	**MANAUT** cruise, Manus Basin in Papua New Guinea, part of the New STARMER (1994-1999) French-Japanese bilateral joint program	Study spreading processes characterising the three axes in terms of tectonic and magmatic manifestation and study the processes associated with the spreading such as active hydrothermal venting, fossil and active deposits and fauna colonization	L'Atalante, Nautile	22 Dec. '99 - 27 Jan. '00
17	France	Dyment	IUEM-UBO	**GIMNAUT:** Central Indian Ocean	intercalibration of magnetic and radiometric dating of young basalt	L'Atalante, Nautile	2000
14	Germany	Theilen	Univ. Kiel	PO 252: Kolbeinsey Ridge 66.5-68°N See article on pg. 28	Detecting the overall geological structure surrounding vent-fields by airgun seismics	Poseidon	Jun 26-July 7, '99

World Ridge Cruise Schedule, 1999-2000, continued...

14	Germany	Scholten	Univ. Kiel	PO 253: Kolbeinsey Ridge 66.5-68°N See article on pg. 28	Sampling of vent-fields	Poseidon, JAGO	July 80-22, '99
9	Germany	Devey, Villinger	U. Bremen	EXCOII Leg 1 and 2, EPR at ca. 13°S	Geophysics (mapping, simple seismics and heat flow) and rock, sediment, and pore water sampling on the EXCO corridor from 0-8 Ma	Sonne	Dec. 29 '99 Jan. 27 '00; Jan. 28 - Feb 29' 00
2	Japan	Hashimoto	JAMSTEC	BIOACCESS cruise '99 in the Manus Basin (PACMANUS and DESMOS sites) See article on pg. 12.	Biogeography and Ecology of vent organisms	Natsshima, Shinkai 2000	Oct. 30 - Nov. 13, '99
1	New Zealand, USA	De Ronde, Massoth, Wright	IGNS, NOAA, NIWA	southern Kermadec arc - Wright Island see article on pg. 35	CTD and SUAVE mapping and sampling of hydrothermal plumes along the southern Kermadec and around White Island	Tangaroa	Mar '99
14	Norway	Pedersen	U. Bergen	SUBMAR-99, Kolbeinsey Ridge See article on page 32	Investigate the subsurface biosphere, hydrothermal activity and magmatism along the Arctic Ridges	Håkon Mosby, Aglantha	July '99
12	UK	Livermore	British Antarctic Survey	JR39 - East Scotia Ridge article in *InterRidge News* 8.1	Locate hydrothermal vents. Map selected segments with TOBI. Geochemical sampling.	James Clark Ross	Feb 12 - Mar, 11 '99
15	UK	Sinha	U. Cambridge	MADRIGALS: **M**id-**A**tlantic **D**eep-towed **R**esistivity and **I**nduction **G**eophysics **a**t **L**ucky **S**trike (CD-120)	Crustal scale controlled-source EM experiment of the Lucky Strike segment median valley and deployed a small array of recording current meters with temperature and conductivity sensors	Charles Darwin	October '99
9, 10	USA	Vrijenhoek, Lupton	Rutgers, NOAA	SEPR, 13°-21°S See article on pg. 23	Test hypothesis that dispersal of vent-endemic fauna is unimpeded between the NEPR and the SEPR; extend previous studies of hydrothermal venting rates	Atlantis, Alvin	Dec. 16 '98- Jan. 21 '99
10	USA	Sinton, Van Dover	U. Hawaii, College William & Mary	SEPR, near 17°26'S, 18°10'-18°20'S, and 18°37'S	Conduct volcanological investigations of single eruptive sequences using deep towed 120 KHz surveys, ALVIN dives, rock dredging and wax coring.	Atlantis, Alvin	Jan. 25 - Mar. 6 '99
15	USA	Smith, Tolstoy, Fox	WHOI, LDEO, NOAA	MAR, 10°-40°N article in *InterRidge News* 8.1	install six autonomous underwater hydrophone moorings to monitor the MAR from 10°-40°N for two years	Ewing	Jan. 30 - Feb 24. '99

World Ridge Cruise Schedule, 1999-2000, continued...

Map No.	Country	PI	Institution	Name/Location	Research Objectives	Ship	Dates
7	USA	Karson, Klein, Hurst	Duke, U. Illinois	Northern wall of the Hess Deep Rift	Focus on a section of the uppermost oceanic crust using AMS-120 side-looking sonar; ARGO II imaging of selected areas; Alvin sampling and observations	Atlantis, Alvin, ARGO (15 dives)	Mar 12- Apr. 12 '99
13	USA	Edwards	U. Hawaii	SCICEX- Gakkel Ridge, Arctic Ocean article in *InterRidge News* 8.1 http://www.ldeo.columbia.edu/SCICEX	Oceanography and geophysical mapping with SCAMP	USS Hawkbill	Mar. 15- Apr. 25 '99
11	USA	Klinkhammer	Oregon State Univ.	Deception Island & Bransfield Strait, Antarctica	Search for hydrothermal vents using ZAPS sled	N. B. Palmer	Apr. 14 - May 10 '99
6	USA	Mullineaux, Cavanaugh	WHOI, Harvard	EPR, 9-10°N	Community development and structure at Hydrothermal Vents: Life After Recruitment: final in a series of five cruises investigating biological interactions during colonization of hydrothermal vents.	Atlantis, Alvin	Apr. 17 - May 4 '99
4	USA	Menke, Webb	LDEO, SIO	Juan de Fuca Ridge	Active-source imaging of the crustal magma system of Axial Volcano, using airgun sources to already-deployed Scripps OBS's.	Ewing	Apr. 17- May 3 '99
4	USA	Cary, Luther, Lutz	U. Delaware, Rutgers	EPR, 9-10°N (LEXEN)		Atlantis, Alvin	May 8- Jun 6 '99
4	USA	Spiess, Chadwell	SIO	Cleft segment, Juan de Fuca Ridge	GPS/Acoustic data, CTD, USGS transponder interrogation	New Horizon	Jun 25- Jul. 12 '99
4	USA	Baker	NOAA	Axial caldera, Cleft segment, Juan de Fuca Ridge	CTD work and mooring deployment	Wecoma	Jul 16-29 '99
2	USA	Mutter, Silver, Taylor	LDEO, USCB, HIG	Woodlark Basin	Study late stage continental rifting in the Woodlark basin using airguns, OBS	Ewing	Aug 30 - Sept 16 '99
2	USA	Martinez	HIG	Woodlark Basin	Study lithospheric deformation at different stages of rifting and possible dynamic mantle effects via a series of marine heat flow measurements in continental basement areas in different stages from rifting to incipient seafloor spreading to young conjugate margins.	Ewing	Sept. 19 - Oct. 22 '99
4	USA	Cowen, Johnson	U. Hawaii, UW	Juan de Fuca Ridge		Thompson, JASON	Aug 25- Sept 6 '99

World Ridge Cruise Schedule, 1999-2000, continued...

4	USA	Chadwick, Embley	OSU, PMEL/NOAA	Juan de Fuca Ridge	Deploy an array of acoustic extensometers to measure seafloor spreading events. Part of the south Cleft observatory effort.	Thompson, JASON	
4	USA	Fisher, Cavanaugh	U. Penn., Harvard	Endeavour Segment of the Juan de Fuca Ridge	Long term studies of vestimentiferan growth and nutritional interactions; examining the molecular and biochemical basis for the tissue stable C isotope signature of vesicomyid clams.	Atlantis, Alvin	Aug. 23 - Sep 7. 1999
4	USA	Seyfried, Becker, Kastner, Wheat	U. Minnesota, U. Miami	Juan de Fuca Ridge (LEXEN)	Test performance of solid state chemical sensors to measure pH and the dissolved concentration of H_2 and H_2S in vent fluids; monitor of vent fluid chemistry over a time period from hours to days	Atlantis, Alvin	Sept. 12 - Oct. 1 '99
1	USA	Harding	SIO	Lau Basin - all the major seafloor spreading centers of the Lau Basin from the Central Lau Spreading Center to the Valu Fa Ridge.	Collect reflection data to determine how the style of crustal accretion varies within the Basin and to compare it with mid-ocean settings	Ewing	Dec 3-29 '99
6	USA	Lutz, Van Dover	Rutgers, College William & Mary	EPR, 9-10°N	Continue time-series analyses of biological and geological changes; Replicate mussel sampling for a regional and global comparison of biodiversity at hydrothermal vents; sample for phototrophs	Atlantis, Alvin	Nov 10 - Dec. 3 '99
6	USA	Manahan, Deming	USC, UW	EPR, 9-10°N, LARVE Project and LEXEN	Collect for studies of the biology of their larvae and to collect larvae from the field ear vent sites.	Atlantis, Alvin	Dec. 7-28 '99
5	USA	Cary, Luther, Reysenbach	Delaware, PSU	EXTREME 2000, Guaymas Basin LEXEN	microbiology centered on diffuse flow chimney environments	Atlantis, Alvin	Jan. 12-23 '00
6	USA	Cochran, Fornari	LDEO, WHOI	9°35'-38'N EPR	Conduct near bottom geophysical data collection on closely spaced E-W lines using near bottom continuous gravity, maggie and EM2000 mb	Atlantis, Alvin	Jan 27 - Feb. 9 '00
6	USA	Webb, Evans	SIO,WHOI	9°50'N EPR	Hydrothermal Structure: A Magnetometric Resistivity Survey	Melville	Feb. 17 -Mar. 11 '00
15	USA	Smith	WHOI	Mid-Atlantic Ridge	Recover North Atlantic Hydrophone Acoustic Array	Knorr	Feb. 23- Mar. 20 '00

World Ridge Cruise Schedule, 1999-2000, continued...

Map No.	Country	PI	Institution	Name/Location	Research Objectives	Ship	Dates
6,7, 9,10	USA	Fornari	WHOI	**AHA** cruise (Autonomous Hydrophone Array), East Pacific Rise, 20°N-26°S	Carry out near-bottom investigations using Seabeam, DSL-120 sonar, Argo-II, dredging, rock coring, and CTDs over 4 -5 areas suspected of having recent volcanic eruptions based on NOAA Autonomous Hydrophone Array	Melville	Mar 24 - May 10 '00
11	USA	Christeson, Dalziel, Nakamura	UTIG	Bransfield Strait, Antarctica	Ocean Bottom Seismograph refraction profiling for crustal structure in Bransfield Strait, West Antarctica	N.B. Palmer	April '00
6	USA	Lutz	Rutgers	EPR		Atlantis, Alvin	April 9-27, '00
8	USA	Sinton, Detrick	U. Hawaii, WHOI	Galapagos	Ocean bottom Seismograph refraction profiling, multi-channel seismics and petrological dredging of the Galapagos spreading center to study its interactions with the Galapagos hotspot	Ewing	April-May, '00
6	USA	Manahan, Cary, Felbeck	USC, Delaware, SIO	9°N EPR	Dispersal mechanisms and reproductive strategies of vent crabs; Recover live Alvinalla pompejana and perform physiological experiments on board ship using a recently developed pressurized and heated collection device.	Atlantis, Alvin	May 2 -28 '00
4	USA	Delaney	UW	Juan de Fuca		Atlantis, Alvin, JASON	Jun 10 - Jul. 11 '00
4	USA	Trehu	OSU	Juan de Fuca	MCS and OBS	Thompson, JASON	Jun 23 - Jul 7 '00

World Ridge Cruise Schedule, 1999-2000, continued...

4	USA	Plumley, Van Dover, Seewald	U. Alaska, William & Mary, WHOI	Juan de Fuca	Search for photosynthetic bacteria at vents using a variety of methods to test the hypothesis that ambient light at vents ma support geothermally driven photosynthesis or photo-assisted energy transfer, including pigment extractions and analysis, characterization of fluorescence spectra of microbial cells associated with hydrothermal substrates and fluids, as well as molecular and culture techniques.	Atlantis, Alvin	Jul 16 - 28 '00
4	USA	McDuff	UW	Juan de Fuca	Heat Flux	Thompson, ABE	Jul 10-28, '00
4	USA	Carson, Kastner	Lehigh, SIO	Juan de Fuca		Atlantis, Alvin	Aug. 2-11 '00
4	USA	Fisher	UCSC	Juan de Fuca	SCS & Heat Flow	Thompson, JASON	Aug. 21 - Sep. 20 '00
4	USA	Delaney	UW	Juan de Fuca		Atlantis, Alvin, JASON	Jun. 10 - Jul. 11, '00
4	USA	Levin	SIO, NOAA	Juan de Fuca, Methane Seep		Thompson, JASON	Sep. 23- Oct. 1 '00
4	USA	Rona	Rutgers	Juan de Fuca	acoustic imaging of hydrothermal flow regimes (buoyant plumes and diffuse flow) in coordination with in-situ flux measurements	Thompson, JASON	Oct 2-10, '00
15	USA	Blackman	SIO	Mid-Atlantic Ridge - 30°N	Use submersible, sonar & video mapping, deep-tow gravity profiles and oriented samples to determine the structure and evolution of the oceanic core complex on the inside corner of the RTI	Atlantis, Alvin, Argo-II, DSL-120	Nov 10- Dec. 15'00
16	USA	Dick, Lin	WHOI	Western part of the South West Indian Ridge	Rock dredging and geophysical survey of an oblique section and adjacent segments of the SWIR	Knorr	Dec. 8 '00 - Jan. 21 '01

If you have a ridge-related scheduled or proposed cruise that is not listed here, please inform the InterRidge Office.

National News....

Canada: CanRidge

Canadian researchers participated in two submersible cruises to the Juan de Fuca Ridge during the summer of 1999.

NeMO 1999

The Canadian participants were Kim Juniper (Université du Québec à Montréal (UQAM) - co-chief scientist), Christian Levesque (UQAM), Marlène Le Bel (UQAM), Catherine Charpentier, (UQAM), Steve Scott (U. Toronto), Naaznin Pastakia (U. Toronto), Maia Tsurumi (U. Victoria) and Jean Marcus (U. Victoria)

Oceanographic Platform: *ROPOS* submersible and the *R/V Thomas G. Thompson*

This multidisciplinary cruise was jointly financed by NSERC Canada and two American agencies, the National Oceanic and Atmospheric Administration (NOAA) and the Washington Sea Grant program. The cruise represented the second year of a multi-year program aimed at understanding the interaction of volcanic, hydrothermal and ecological processes on Axial Volcano on the Juan de Fuca Ridge (northeast Pacific). As in 1998, the field program used the Canadian submersible *ROPOS* for observation, sampling and experimentation on the seafloor. *ROPOS* was deployed from the *R/V Thomas G. Thompson*.

A January 1998 seafloor eruption at our field site provided an unusual opportunity to begin studying the aftermath of a volcanic event during the first field season in 1998. The objectives of the 1999 cruise were primarily determined by our discoveries in summer 1998 where we documented the destruction of extensive areas of hydrothermal vent habitat by lava flows in the eastern portion of the Axial Volcano caldera (crater), the creation and early colonization of new vents, and little apparent affect in the ASHES vent field located in the southwestern sector. The primary objectives of the Canadian group were:

1) Continued sampling of faunal communities and particulate organic matter at the new hydrothermal vents to examine de novo colonization, community succession and food web development.
2) Extension of regional sampling to vent faunal communities in the caldera to advance a study of metapopulation.
3) Sampling of hydrothermal iron oxyhydroxide deposits and fluids forming such deposits for a study of biomineralization.
4) Sampling of sulfide edifice structures for a study of mineralogy, particularly gold content.
5) Recovery and redeployment of a time-lapse camera deployed at a new vent in summer 1998.
6) Further sampling of sites in the ASHES vent field to complete a study of food web structure at these 'steady-state' vents.

A summary of work completed is given below:

1) New vent sampling – all new hydrothermal vent communities sampled in 1998 were resampled in 1999, along with several new vents not found or sampled in 1998.
2) Regional sampling – regional sampling was extended to several new sites in the caldera, in particular to a series of new and old vents discovered during 1999 geological mapping dives that were aimed at defining the southern limits of the 1998 lava flow.
3) Iron oxyhydroxide sampling – a series of iron oxyhyoxide samples was collected from the new lava flow (freshly deposited) and from older lavas near the ASHES vent field. Several collections were coordinated with water sampling, permitting later determination of bioconcentration of trace metals from hydrothermal fluids.
4) Sulfide sampling – mineralogical samples were collected from both active and inactive sulfide mineral edifices. The samples record the variation in fluid temperature and its variation through time. Of particular interest is the gold content of the Axial Volcano samples which, from limited previous sampling, is known to be unusually high (about 5 ppm compared to <1 ppm at typical ocean spreading centres).
5) Time lapse camera – the UVic time-lapse camera system was successfully recovered by *ROPOS* after a one-year deployment at a new hydrothermal vent site, where it was positioned to record colonization by vent organisms. The camera system was then serviced on board ship and redeployed by *ROPOS* for a second year at the same site.
6) ASHES vent field sampling – Only one of two scheduled dives for Canadian participant research was completed at the ASHES vent site. The second dive was cancelled because of bad weather that came at the end of the cruise. Sampling was limited to collections made with the *ROPOS* suction sampler. Planned faunal grab samples will be included in the summer 2000 NeMO cruise.

Canada's Marine Protected Area at Endeavour vent field
http://www.er.uqam.ca/nobel/oasis

National News....

HiRise '99

A submersible expedition visited the Endeavour Hot Vents Area MPA July 15-23, 1999. The expedition, jointly funded by the University of Washington and the Department of Fisheries and Oceans, deployed the Canadian remotely-operated submersible *ROPOS* from the University of Washington Research Vessel *Thomas G. Thompson*. The primary goal of the Canadian component of the mission was to acquire samples, imagery and sonar data for an assessment of the distribution of hydrothermal vent habitat and vent species. This work focused on the High Rise vent field, one of 4 known hydrothermal fields on the Endeavour Segment.

Canadian cruise participants were Kim Juniper (UQAM - Co-chief scientist), Mark Fox (UQAM), Christian Levesque (UQAM), Steve Scott (U. Toronto), Yannick Beaudoin (U. Toronto), Kaihui Yang (U. Toronto), Verena Tunnicliffe (U. Victoria), Jean Marcus (U. Victoria), Jamie McLaughlin (U. Victoria), Brian Smiley (Institute of Ocean Sciences), Simone Kuklinski (St. Michaels School, Victoria, B.C.), Danny Mauro (Sport Diver Television) and John Madden (Private Consultant)

Major accomplishments of the Canadian component of the cruise include:

1) High-resolution sonar mapping of a 60,000 square metre area of the seafloor that encompasses approximately 90% of the known area of venting in the High Rise field. A preliminary sonar map and 3D visualization were produced on-board by the University of New Brunswick Ocean Mapping Group, and further post-processesing and refinement of the maps is on-going.
2) A video survey of water column organisms over the High Rise vent field was conducted during the sonar survey. The precise navigational information available for this survey will permit systematic study of the relationship of near-bottom (25 m altitude) organisms to the location of hydrothermal vents. Previous work by Drs. Thomson and Burd of IOS has shown unusual concentrations of zooplankton, apparently feeding in hydrothermal plumes about 200 m off bottom on Endeavour Segment, but little is known of the near-bottom environment. Video recordings from this survey are being analyzed at the University of Victoria.
3) Acquisition of approximately 60 hours of video recording from two submersible cameras and > 500 colour photographs from a deep-sea film camera mounted on the *ROPOS* vehicle. Some imagery recorded sampling and experimental operations but most was collected in a systematic effort to document different types of faunal habitat and individual species in their natural environment. For the latter, extensive use was made of the remote-controlled zoom lens on the *ROPOS* 3-CCD colour video camera. Sampled species were further documented on shipboard with hand-held still cameras and two laboratory video cameras mounted on dissecting microscopes. Several hundred digitized video frames and digital still photos were archived onto CD-ROMs in the final days of the cruise. A more elaborate digital photo data base is presently being designed by DFO and university scientists involved in the cruise.
4) Deployment of a free-vehicle elevator in the High Rise vent field for collection of biological and geological samples. Portable sample boxes mounted in the elevator enabled the submersible to collect multiple samples during individual sampling dives. Biological samples were collected from portions of sulphide edifices in various stages of succession, and samples of mature and senescent tube worm bushes at sites where venting occurs directly through cracks in the seafloor. Smaller organisms and biofilms were collected with the *ROPOS* 8-jar suction sampler during 3 dives on the High Rise field. Species identification and biodiversity determination for all biological samples will be carried out at the University of Victoria. Five samples of the High Rise sulphide minerals were collected for mineralogical analyses at the University of Toronto.
5) A public outreach effort, organized by the University of Washington, that included the participation of secondary school teachers, including one Canadian from St. Michaels School in Victoria, British Columbia, in the mission at sea. Teachers attended shipboard lectures by scientists, and participated in dive operations and scientific meetings. All teachers will be developing curriculum material from the cruise, to integrate into their individual teaching programs. Another major outreach project, a mission web site (www.ocean.washington.edu/outreach/revel), was updated daily via satellite with images, personal impressions and scientific summaries prepared by on-board teachers and scientists.

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National News....

India: InRidge

The Indian Ridge Initiative, InRidge, was formed in 1997 to undertake complete petrological and tectonic mapping of the Indian Ridge system and to examine tectonic and magmatic segmentations. Threeareas have been identified for immediate investigation: (1) the slow-spreading Carlsberg Ridge (2) the intermediate-spreading Central Indian Ridge, and (3) the Andaman back-arc basin. Detailed studies from these three strikingly different tectono-magmatic environment will serve to increase our understanding of mantle dynamics. The National Institute of Oceanography, Goa, and the Geological Survey of India, Calcutta, are the organisations spearheading the Indian ridge programmes. Brief results from these activities are summarized below.

Carlsberg Ridge

Recent multibeam bathymetry survey over this ridge shows a ridge axial discontinuity, with a broad axial valley and depths varying from 2200 - 4500 m. Backscatter amplitude data indicates a sedimented rift valley, although the presence of mantle rocks such as lherzolites, gabbros and serpentinites, from the inner rift valley wall suggests a shallow mantle depth (Mudholkar et al., 1996). The presence of well-preserved pteropods in the southern part of the Carlsberg Ridge below the aragonite compensation depth (between 2000-2500 m) suggests that there could local hydrothermal activity, as this would increase the alkalinity in seabed sediments (Bhattacharjee, 1996).

Central Indian Ridge

Research on the CIR is focussing on the four major intersection points between the long and prominent NE-SW trending fracture zones and the NNW-SSW oriented CIR between 5°S and 18°S. The morphological segmentation along the northern part of CIR occurs at a spacing of 30-80 km. Magnetic anomalies up to chron 5 have been identified. The evolutionary history of the CIR since 10 Ma has been traced and it shows that the spreading across the ridge has been asymmetric, and coupled with the presence of several second-order discontinuities. The difference in spreading rate along the CIR suggests that the northern part, in continuation with the Carlsberg Ridge, forms the slow accretionary boundary of the Indian plate, while the southern CIR is evolving as the intermediate spreading western boundary of the Australian plate. They converge in the region between 6°-9°S on the CIR, where the wide boundary zone of intraplate deformation separating the Indian and Australian plates intersects the CIR. The region is probably evolving as a RRTc type triple junction (Drolia et al., 1999).

Rocks dredged from the ridge axis valley and walls are largely typical normal basalt (N-MORB), and are rarely transitional or enriched in large ion lithophile elements (T/E-MORBs). Geochemical and isotopic analyses of the rocks show discreet magmatic provinces. The depth, pressure and extent of magma melting in this area are characteristically different from those of ridge systems in other oceans. The magma is inferred to have surfaced from several, small, shallow-seated chambers, where melt accumulates through diapirs (Mukhopadhyay et al., 1998; Mukhopadhyay et al., in preparation). Recent results confirm a slow but hot spreading centre at 19°S along the CIR, and morphological, geochemical and geophysical characters suggest ridge–hotspot interaction forming two underwater ridges (Dyment et al, 1999). Manganese nodules recovered from the Vityaz fracture zone area (Mn/Fe <1) are hydrogenetic with significant influence of hydrothermal components that probably throw interesting light on the bottom water movement in the recent past (Banerjee et al., in preparation).

Andaman Back-Arc

Within the complex morphotectonic fabric of the Andaman back-arc basin, a spreading ridge, cratered volcanic seamounts and apparently active faults have been identified. The 80 km long spreading ridge trends north-south and is active in the southern part. The axial valley and the seamount crater appear to contain broken parts of chimney structures and both disseminated and vein type metal sulphides (Rao et al., 1996). The Nicobar rift valley, the deepest part of this area, has recently been studied in detail. Late release of stress through this rift valley (via faults) seems to have adjusted the basement, which is overburdened with a huge pile of sediment in the form of an hour-glass structure which is oriented normal to the principal strain axis. The present configuration of the basin seems to be the result of a continuous dilational stress, with younger tensional structures reorienting the geomorphic regime (Bandyopadhyay et al., 1999). Studies on the pteropod assemblage in the surrounding area successfully drew the boundary between the top warmer Holocene and cooler Pleistocene at about 90 - 110 cm (Bhattacharjee, 1996).

Future Research

Some of the research directions of InRidge during the early years of the next century could be:

- Studying the creation and propagation of the triple junction, as one such unique feature is suspected to be in the making at around 6°-10°S along the CIR, where the Indo-Arabian, Australian and African plates meet.
- Generation and growth of new faults, their episodicity, and the mechanism for the exposure of ultramafics at the magma-starved ridges.
- Effect of mantle temperature on formation, migration, budget, and upwelling of magma, and on the rate of crustal accretion.

- Do near-uniform condition in structure and petrology exists at two points of a ridge-transform intersection along a fracture zone?
- Withdrawal and recharge of magma, and the related deflation and inflation of the ocean floor.
- The nature of mixing of ridge and hotspot melts; and the formation, eruption style and conduit geometry of near-axis seamount.
- The evolution of fluid composition with time, and the mechanism of phase separation and differential discharge of these fluids.

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Korea

In May 1999, Korea Ocean Research and Development Institute (KORDI) conducted a hydrothermal survey of the East Manus Basin using R/V *Onnuri*. The survey comprised of 3-day multibeam bathymetric mapping of the Planet Deep sector of the New Britain Trench, followed by 4 days of investigation around the three known hydrothermal vent sites within the basin, PACMANUS, DESMOS and Susu Knolls. The latter part of the survey included multibeam mapping, sea-surface magnetic field measurements, underwater camera deployments, and numerous hydrocasts and dredge rock samplings. A number of observations suggest that the tectomagmatic and hydrothermal activity in the East Manus spreading does not fit with the classical model of back-arc spreading associated with the subduction of the New Britain Trench. The aim of our mapping in areas outside the basin was to test the hypothesis that the tectonic and magmatic processes in the Manus Basin is driven by the sharp inflection of the New Britain Trench near the Planet Deep. In particular, we were interested in examining whether the sharp inflection is actually a transform-trench-trench type triple junction. The results of the Manus Basin study will be presented at the 1999 Fall AGU Meeting.

Starting in late October 1999, KORDI will embark on a new program that will take R/V *Onnuri* half way around the globe to Antarctic and back. KORDI maintains a permanent station at King George Island on the Antarctic Peninsula. The ship is set to leave Korea on Oct. 31, 1999 and will not return till April 2000. During this 5-month period, scientists will conduct physical oceanographic survey along the equator near the Galapagos Islands, and geological/geophysical surveys in the Drake Passage and Bransfield Strait. International hydrothermal and geophysical cruises also are scheduled in the north Lau Basin and in the western Pacific. Experiments and sampling will be carried out by biologists during transits.

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National News....

France: Dorsales

1999 Projects

With its limited budget, the Dorsales Committee funds a few shore-based projects each year. In 1999, the 13 research projects funded covered three major themes:

- Geophysical imagery of the lithosphere and mantle
- Experimental petrology
- Symbiosis

A new call for proposal will be issued at the end of this year. The Dorsales Committee also contributed to help young French scientists attend the InterRidge field trip to the Troodos Ophiolite in Cyprus.

IPOCAMP

In 1998, the Dorsales program funded the development of a pressured container (IPOCAMP), designed to maintain the biological samples under in-situ pressure conditions, once they have been recovered on board. This equipment has been successfully tested on the HOPE Nautile cruise in the spring of 1999. It has a volume capacity of 20 liter, the pressure can reach up to 340 bars, and it is equipped with a video system which allows to follow the experiments in real time. It was used for a number of experiments, and over 300 biological samples (mussels, crabs, tube worms, etc...) went through it.

IPOCAMP is now operational and is considered as a national equipment that will be available to the community. The next step is now to develop a system to regulate the chemistry of the circulating fluid. Funds for further developments have been requested from the European Community.

Contact: Bruce Shillito (Bruce.Shillito@snv.jussieu.fr)

Geophysical Database

The French geophysical data base is in progress and a group has met twice to define the formats. A website will be opened at the end of this year at the SISMER, IFREMER. The data base will then be progressively filled. The aim is to complete the transfer of the data collected with French Research vessels by the end of 2001.

Contact: Christine Deplus (deplus@ipgp.jussieu.fr)

Upcoming cruises : year 2000

Two *Nautile* cruises are presently scheduled in 2000:

MANAUTE (P.I.: J.M. Auzende): geological and biological investigations of hydrothermal activity in the Manus Basin

GIMNAUT (co-P.I.s: C. Hémond and J. Dyment): intercalibration of magnetic and radiogenic dating of young basalts on the Central Indian Ridge.

For technical reasons, a second call for proposals was issued for the *R/V Marion Dufresne*, and 3 proposals are still pending. Their objectives are the mapping and sampling of portions of the Indian Ocean Ridge system, on the South West Indian Ridge, the Carlsberg Ridge and the Sheba Ridge respectively.

Journées Dorsales 2000: 20-22 Sept 2000, Roscoff

The Dorsales Program is organizing a scientific meeting in September 2000. Invited presentations on selected topics will alternate with poster sessions. The objective is to emphasize the major results obtained by the French teams in ridge studies.

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InterRidge - Japan

Arctic ridge research plan in 2000

University researchers have been funded by InterRidge Japan to conduct research cruises to the Arctic ridge. The current plan is to conduct a research cruise to the Knipovich Ridge in the summer 2000 using the *R/V Logachev* (Russia) under contract with InterRidge Japan. The research program is planned as a collaboration between Japanese and Russian ridge research scientists, but also with involvement of US, UK, Norwegian, and Italian scientists. InterRidge Japan also plans to invite scientists from Korea, Taiwan, China and other Asian countries.

The principal objective of this program is to understand the tectonics of this highly oblique and ultra-slow spreading system and to search for hydrothermal activity. The basic research operation currently planned is a deep-tow sidescan sonar survey using an ORE system (30-100 kHz) along the axis of the Knipovich Ridge. The deep-tow system will be installed with a self-recording proton magnetometer, a self-recording CTD, and other geochemical sensors (MAPR and/or METS). Other operations will include bottom rock sampling by TV grab sampler and dredges, CTD hydrocasts, heat flow measurements and an OBS deployment.

In an effort to foster multinational collaboration US and UK research groups are trying to get additional funds to add more shiptime to our current (30 day) cruise plan.

***R/V Hakuho-maru* cruise in the Gulf of Aden** (duration 17 work days)

Researchers at the Ocean Research Institute, University of Tokyo have a cruise to the Gulf of Aden (Dec. 2000 - Jan. 2001) with the *R/V Hakuho-maru* PI of the cruise is H. Fujimoto (http://www.ori.u-tokyo.ac.jp/ori/3_1he.html). The cruise objectives are to investigate the tectonics and geochemistry of the central rift system of the Gulf of Aden and to survey a site for an ODP proposal

Since the inception of the oceanic crust in the Gulf of Aden 20 Ma by the breakup of Africa and Arabia, the spreading system in the gulf has been spreading at 2.0 cm/yr in an oblique (NE-SW) manner and appears to be highly sedimented. Swath mapping was achieved only at the western end of the spreading system (west of 46°E) by a French research cruise in 1995 (PI: Ph. Huchon). We plan to do swath mapping with a new SeaBeam system 2120 with 20 kHz and 1 degree narrow beam, gravity and magnetics mapping, MCS seismics, deep mantle structure by Ocean Bottom Magnetometer, observation of seismicity by Ocean Bottom Seismometers, bottom rock sampling, and CTD hydrocasts to search for hydrothermal activity.

SWIR cruise in 2000 with ROV Kaiko

JAMSTEC has a cruise to the Indian Ocean in the summer 2000 with the *R/V Kairei*. (PIs J. Hashimoto and E. Kikawa). *Kaiko*, a new ROV capable of operating to a depth of 11,000 m (http://www.jamstec.go.jp/jamstec-e/rov/index.html), will be used to observe outcrops of the lower crust at the Atlantis II Fracture Zone of the Southwest Indian Ridge. The cruise will also search for active hydrothermal systems on ridges around the Rodriguez Triple Junction.

New program "Archean Park"

The "Ridge Flux" Program (PI: T. Urabe) has completed its 6 year monitoring program (1993-1998). The first results will appear at the 1999 AGU Fall Meeting. The principal objective of this program is to understand the tectonics of this highly oblique and ultra-slow spreading system and to search for hydrothermal activity. This research group is currently devising a new program "Archean Park" to sample subsurface biota at the back-arc basin rift system and the submarine arc volcanoes of the Western Pacific.

Millennium InterRidge Office in Japan

As it has been rare for Japan and any Asian countries to host a large international program, it is a great honour for Japan to host the InterRidge Office from the beginning of the new millennium – year 2000. The Ocean Research Institute, University of Tokyo, will host the office for three years, with Kensaku Tamaki as the chair. Dr. Agnieszka Adamczewska will be the coordinator. She is a Polish Australian, with a background in animal physiology.

The Japan Office of InterRidge plans to continue the present activities of InterRidge but will be responsible for devising the new science plan beyond 2003. Also, the office plans to further enhance the InterRidge webpage and to improve the interdisciplinary coordination of InterRidge by increasing the involvement of Asian countries. We will present a more detailed outline of our plan in the first issue of *InterRidge News* from Japan in the year 2000.

Kensaku Tamaki and Hiromi Fujimoto
Ocean Research Institute,
University of Tokyo

National News...

Morocco

Morocco joined InterRidge as a corresponding member in 1998. Research related to ridge processes has traditionally involved comparative field, geochemical and petrologic studies of ophiolites and marine sediments with their modern anlogues. Few scientists in Morocco are directly involved into ridge processes. This fact is due to the relatively low level of available funding, and of recent, a major swing in government policy emphasising funding of research more directly relevant to the Morocco population. At present, the only ridge related research being undertaken is confined to a very small group at the University of Marrakech. Most Moroccan research related to mid-ocean ridges has concentrated on two zones in the Anti Atlas domain in southern Morocco: the Bou Azzer and the Siroua Massif . A large number of earth scientists have been interested by the study of the Moroccan Ophiolitic complexes at the Bou Azzer zone (Leblanc and Lancelot, 1980; Bodinier et al., 1984; Sequasque 1992) the Tazenakht zone (Brabes and Vogel, 1985), the Siroua zone (Brabes and Vogel, 1985; Schermerhorn et al., 1986; El Boukhari, 1991 and Châabane, 1991). Past episodes of continental rifting can also be studied in the Middle and High Atlas.

In view of the lack of access to their own research vessel, future work by Moroccan scientists on ridge related matters will rely heavily on collaborative projects with their international colleagues, offering in return excellent facilities for geochemical analysis of MORB samples. Currently there is no hydrothermal or biological research being undertaken in Morocco.

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UK: BRIDGE

Celebrating the breakthroughs of BRIDGE

The £13 million Natural Environment Research Council (NERC) funded British Mid-Ocean Ridge Initiative (BRIDGE) comes to an end this year, after six years. During its lifetime, BRIDGE supported 20 expeditions to the deep oceans, purchased new instruments for the NERC research fleet, and funded 44 research projects involving some 200 scientists at UK universities and NERC institutes. BRIDGE was a fully interdisciplinary programme, supporting science ranging from deep earth geophysics through seafloor volcanology and chemical oceanography to the marine biology of organisms thriving around deep-sea hot springs. The end of the programme will be marked in several ways. A special colour issue of the BRIDGE Newsletter is in production and this will also be made available on the web at www.nerc.ac.uk/bridge (after 16 November 1999). We hope to hold a final BRIDGE science meeting next year and there will certainly be a BRIDGE symposium at Geoscience 2000 in Manchester, UK in April 2000. A celebration day will be held at the Natural History Museum on 16th November 1999. Here BRIDGE achievements will be presented to the press and to an audience of opinion formers. This event, and the special newsletter, will be unified under the title "The Fiery Deep - Exploring a New Earth", emphasising the extraordinary environment in which new ocean floor is created and the pioneering nature of research at this frontier. For further information about this event or a copy of the special issue of the BRIDGE newsletter, please contact Dr Neville Hollingworth, Natural Environment Research Council, Room 133, Polaris House, North Star Avenue, Swindon, SN2 1EU. Tel. +44 1793 411527. E-mail nth@nerc.ac.uk.

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National News...

USA: RIDGE

RIDGE Troodos Field School Report

40 participants and 10 instructors spent an invigorating and very intense 10 days in Cyprus. Six day-long field trips provided us with a thorough overview of this complex and fascinating terrain, while intervening lecture and discussion days were equally illuminating. Discussion sessions, led and managed solely by the graduate students and post-doctoral scholars in the group thoroughly dissected both the appointed subjects and the brains of the speakers. All participants report that the Field School was a very valuable learning experience, with some ranking it as a "trip of a lifetime". Sincerest thanks are due to Joe Cann and Kathy Gillis for organization and leadership and to Costas Xenophontas for introducing us to Cyprus' spectacular hospitality. The trip was funded by a special grant from the US National Science Foundation.

Beyond RIDGE

More than 130 US ridge scientists (plus one each from Japan, India and France) met at the RIDGE 2000 Conference in Newport Oregon from September 23-25 to discuss how to reinvent or replace the RIDGE Program.

The meeting was very successful. There was strong and apparently unanimous recognition that the numerous achievements of ridge science in the last decade have been greatly enhanced by the RIDGE Program and by the diverse, powerful, national and international scientific community that it has fostered.

Speaker after speaker emphasized the need to maintain the RIDGE Office and community support (Theoretical Institutes, workshops, newsletter, web page, etc.) with an increased emphasis on formal outreach/education activities and on the development and maintenance of database, sample storage, and other infrastructure activities. There was also remarkably strong support (perhaps reinforced by a sense of inevitability) for a new, more strongly focused scientific program with clearly assigned priorities. In a way that we have not seen before, the great majority of participants in the various working groups were able to set aside their individual interests in order to forge a focused program that can potentially involve a wide spectrum of investigators.

Although details are not final, the new program will have a strong focus on integrated studies that will bring a broad range of tools and approaches to a small number of key sites in order to understand the array of processes and linkages "from mantle to microbes and beyond". The program will have two main themes. The first and larger theme will concentrate on phased, integrated programs covering everything from melting and mantle dynamics, to crustal growth, hydrothermal studies, macro- and micro-biology, and the water column at each of a small number of sites. Site selection will be on the basis of competing "Site Proposals" prepared by interested groups. Following appropriate workshops and a public comment period, final site selection and prioritization will be the responsibility of the steering committee (or its designated special committee). The second theme will focus on "exploratory" and/or "rapid response" studies which cannot be done at the chosen sites, and on a specific problems in biogeography/biodiversity that require a different geographic approach. Details are still being worked out at the time this is being written but should be available soon. Reports from the meeting and recommendations to NSF will be posted on the RIDGE website as soon as they become available.

New RIDGE Postdoctoral Fellow

CONGRATULATIONS to the newest RIDGE Postdoctoral Fellow -- Alberto Saal. Alberto received his Ph.D. at Woods Hole Oceanographic Institution, and will be working with Charles Langmuir at Lamont-Doherty Earth Observatory.

Upcoming RIDGE-sponsored meetings

RIDGE Smoker
13 December 1999 (Monday)
Brasserie Savoy,
San Francisco, California

2nd MELT Workshop
26-28 March 2000
Providence, Rhode Island

Plume-Ridge Interaction Workshop
26-28 June 2000
Troutdale, Oregon

Subsurface Biosphere RIDGE Theoretical Institute
28 July - 1 August 2000
Big Sky, Montana

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Upcoming Meetings and Workshops

Calendar

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

Dec. 13-17, 1999	**AGU 1999 Fall Meeting** San Francisco, CA, USA
Jan. 24-28, 2000	**Ocean Sciences 2000 Meeting** San Antonio, TX, USA
Mar. 8-9, 2000	**The Nature and Tectonic Significance of Fault Zone Weakening** **A joint Geological Society of London/Geological Society of America/InterRidge meeting** Geological Society, London, UK
Mar. 26-28, 2000	**2nd RIDGE MELT Workshop** Providence, Rhode Island
Mar. 27-30, 2000	**Penrose Conference: Volcanic Rifted Margins** London, UK
Apr. 16-19, 2000	**8th International Symposium on Experimental Mineralogy, Petrology, and Geochemistry** Bergamo, Italy
Apr. 17-20, 2000	**GEOSCIENCE 2000** University of Manchester, UK
Apr. 24-29, 2000	**European Geophysical Society** Nice, France
May 23-26, 2000	**Underwater Technology 2000 (UT'00)** Tokyo, Japan
May 30 - Jun, 3, 2000	**AGU Spring Meeting** Washington, DC, USA
Jun. 16-17, 2000	**InterRidge Steering Committee Meeting** Woods Hole, MA, USA
Jun. 26-28, 2000	**RIDGE Plume-Ridge Interaction Workshop** Portland, OR, USA
Jun. 27-30, 2000	**Western Pacific Geophysics AGU Meeting** Tokyo, Japan
Jul. 28 - Aug. 1, 2000	**RIDGE Theoretical Institute: Subsurface Biosphere** Big Sky, MT, USA
Aug. 6-17, 2000	**31st International Geological Congress** Rio de Janeiro, Brazil
Aug. 28-Sep. 2, 2000	**The XVIIIth (New) International Congress of Zoology** Athens, Greece
September, 2000	**InterRidge Workshop on Management of Hydrothermal Vent Ecosystems** Canada
Sep. 20-22, 2000	**Journées DORSALE 2000** Paris, France
Dec. 15-19, 2000	**AGU 2000 Fall Meeting** San Francisco, CA, USA
Jun. 10-15, 2001	**10th Water-Rock Interaction Symposium** Sardinia, Italy
Oct. 8-13, 2001	**Second International Symposium on Deep-Sea Hydrothermal Vent Biology** Brest, France

Upcoming Meetings and Workshops

American Geophysical Union Fall Meeting

Mid-ocean ridge related sessions

13-17 December 1999, San Francisco, CA, USA

http://www.agu.org/meetings/fm99top.html

- Mid-Atlantic Ridge vs. Indian Ridge-Characterization: Comparison of the slow spreading ridges by submersible dives, surface ship operation and ODP drilling (T11A, T21D)
- Heat Flow and the Thermal Evolution of Oceanic Lithosphere: A Session Honoring Richard P. Von Herzen (T11D, T12A)
- MORB (V11E)
- MORBs, Seamounts, and Ophiolites (V12B)
- Volcanic, Tectonic, and Hydrothermal Activity Along the Southern East Pacific Rise (V11A, V12D)
- Advances in Marine Geosciences: A session in honor of Donald F. Heinrichs (OS21A, OS22C)
- Phase Relations and Element Partitioning on the Mantle Solidus (V21D, V22D)
- Internal Structure and Composition of Fast Spreading Crust Exposed at the Hess Deep Rift (T31B, T32A)
- Arctic Basin Geophysics: New Data, New Theories, and Future Opportunities (T31F, T32B)
- Magmatic, Hydrothermal, and Tectonic Processes of the Kermadec Subduction and Arc - Havre Trough Back-Arc System (V31B, V32E)
- Deep Biospheres: Where and How? (B41C, B42B)
- Mid-Ocean Ridges (T51D, T52F)

European Geophysical Society XXV General Assembly

Mid-ocean ridge related sessions

25-29 April 2000, Nice, France

http://www.copernicus.org/EGS/egsga/nice00/nice00.htm

SE41 Open session in Marine Geophysics

Convener: M. Torné (Spain); Co-convener: K. Gohl (Australia)

This session aims at assessing the state-of-the-art methods and progress made in characterization of the and mapping the oceanic crust to address questions on ocean dynamics at different scales (preferably at crustal scale) in terms of spatial and temporal variability. We encourage presentations dealing with new techniques to explore the oceanic crust, results from recent and current research projects, as well as planned projects dealing with regional scale studies mapping unexplored parts of the oceanic crust. Characterizing and assessing the oceans, and in particular, their margins is of crucial importance for both academia and industry.

SE42.01 Mid-ocean ridge processes and structure of the oceanic lithosphere

Convener: M. Cannat (France); Co-convener: A. Schultz (UK)

This session will welcome talks and posters presenting the results of recent cruises and of modeling work on all aspects of mid-ocean ridge dynamics: the physical and chemical aspects of mantle melting, melt extraction, melt transport and the mode of emplacement and crystallization of magmatic rocks at fast and slow spreading ridges; ridge tectonics and the mechanisms of unroofing of lower crustal and mantle-derived rocks at mid-ocean ridges; hydrothermal processes, the characteristics of crustal aquifers, the heat and chemical budget of crust-seawater interactions at the ridge axis and in ridge flank environment, as well as the biochemical processes associated with the development of life within the crust and deep biosphere, at hydrothermal vent sites, and analogous systems conjectured to exist elsewhere in the solar system.

Upcoming Meetings and Workshops

The Nature and Tectonic Significance of Fault Zone Weakening

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

7-9 March 2000, The Geological Society, Burlington House, London

http://www.dur.ac.uk/~dgl0www1/weak2.htm

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

Possible thematic sessions include:

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

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Second RIDGE Workshop on Mantle Flow and Melt Generation Beneath Mid-Ocean Ridges: Constraints From MELT and Other Experiments and Observations

26-28 March 2000, Providence, Rhode Island

http://ridge.oce.orst.edu/meetings/MELT2/

Conveners

Alan Chave (WHOI), Don Forsyth (Brown University), Roger Buck (LDEO), Jill Karsten, (University of Hawaii)

Since the first MELT workshop held in October 1997, there has been substantial progress toward finalizing the two components (seismic and EM) of the MELT experiment. The initial seismic results were published as a collection of papers in *Science* in May 1998. A second generation of interpretations will have been completed by the time of the second workshop. The EM data have now been analyzed and modeled, and results have been presented at a variety of national and international meetings. The initial EM results were published in the 22 October 1999 issue of *Science*.

The physiochemical implications of the seismic and EM data are in some ways different, reflecting the distinct properties that each method is especially sensitive to. The first part of the workshop will be structured to emphasize these differences with the objective of reconciling them.

The chief goal of the meeting will be to encourage collaborations between the seismic, EM and geochemistry communities who collected and interpreted the MELT data and the modeling community who needs to incorporate these and other experimental constraints into their models.

The Workshop will have three primary purposes:

- To critically examine new observational constraints on mantle flow and melt production beneath mid-ocean ridges in the light of recent experimental advances, especially the MELT experiment
- To promote interaction between geochemists and geophysicists, and between observationalists and theoreticians
- To stimulate collaborative work towards theoretical models of the melt generation and migration processes that incorporate constraints from a variety of disciplines.

Upcoming Meetings and Workshops

Underwater Technology 2000 (UT'00)

"Advanced Underwater Technologies for the 21st Century"

23-26 May 2000, New Sanno Hotel, Tokyo, Japan

Sessions will cover various technologies and applications in the underwater environment. Topics may include, but are not limited to, the following areas:

Underwater Acoustics
- Global Acoustics, Tomography
- Acoustical Oceanography
- Sound Propagation & Scattering
- Transducers & Arrays

Underwater Construction
- Harbor & Tunnel Construction
- Deep Sea Construction
- Diving Operations
- Saturation Diving

Underwater Vehicles & Robotics
- ROVs
- AUVs
- Manned Submersibles
- Underwater Robotics

Underwater Observation
- Imaging Systems
- Sensors
- Instrumentation Systems
- Underwater Cable Systems

Underwater Positioning
- Mapping & Guidance Systems
- Navigation & Tracking Systems
- Geodetic Measurement Systems
- Underwater Telemetry

Signal & Information Processing
- Detection & Estimation
- High Resolution Processing
- Image & Signal Compression
- Neural & Fuzzy Systems

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The XVIIIth (New) International Congress of Zoology

28 August - 2 September 2000, Athens, Greece

Special Symposium B7:

Zoological implications of the discovery of geothermally-driven commmunities

Convener: Françoise Gaill, Université Pierre et Marie Curie, francoise.gaill@snv.jussieu.fr

The discovery of deep-sea vent fauna has given new insights into several important zoological aspects. These hydrothermal vents are one of the most unusual habitats found on earth. Vents are surrounded by a dense community which is supported by primary production through chemoautotrophic bacteria. Most of this fauna is composed of sessile animals that harbor these bacteria as intracellular symbionts. Such geothermally-driven commmunities are dependant on the reduced sulfur compounds found in the emerging hot hydrothermal fluid (up to 400°C) which are the main energy source for free-living and symbiotic bacteria.

Since the primary food source of the vent community is locally produced in the deep sea, it has been suggested that these communities are largely independant of environmental changes at the surface and not subject to the same evolutionary pressures as other organisms. Supporting this hypothesis is the fact that most of the organisms found at the vents are endemic. This observation raises the question of how old these ecosystems are and when animals first started to be associated with vents. These communities may have escaped the mass extinctions affecting surface dwelling organisms. Even though our knowledge about the zoology of this fauna is increasing, we still do not know what are the life cycles of these animals, what their larvae look like and where they are found. Understanding the dispersal, colonisation and succession of species in vent and cold seep habitats is a great challenge for the future and will shed light about major questions such as the origin of life, evolution of symbiotrophy, diversity of physiological adaptations and molecular phylogeny.

For more details see: http://www.ims.usm.edu/~musweb/icz_xviii/icz_home.html

Upcoming Meetings and Workshops

Physical and Chemical Effects of Mantle Plume - Spreading Ridge Interaction

RIDGE

26-28 June 2000, Edgefield Lodge, Troutdale, Oregon
http://ridge.oce.orst.edu/meetings/PRIworkshop/

Convenors

David Graham (COAS, Oregon State University), **Garrett Ito** (SOEST, University of Hawaii), **Y. John Chen** (COAS, Oregon State University)

Motivation

Structural and geochemical anomalies related to mantle plumes affect more than 20% of the global mid-ocean ridge system, indicating a fundamental role for mantle plumes in the creation and evolution of oceanic lithosphere. Previous geophysical and geochemical studies have established a general framework for understanding the processes along plume-influenced ridges, but we have only recently begun to integrate the disciplines.

A number of important problems pertaining to mantle flow, tectonic evolution, crustal accretion and hydrothermal activity are now particularly amenable to investigation, due to the improved resolution of new geophysical and geochemical data sets, and to the increased sophistication of analytical techniques and numerical modeling capabilities. The scientific community is now well equipped to address these questions through new field and laboratory-based studies, and through coordinated efforts among geophysicists, geochemists, and geodynamicists. Due to the complexity of plume-ridge interaction, a substantial gain in our understanding requires us to attack the above problems with integrated, multi-disciplinary investigations that are cost-effective. A RIDGE workshop that aims to facilitate such a coordination is both a timely and necessary first step.

The workshop has three primary purposes:
- provide a forum for discussing recent and ongoing research
- assess our current understanding of mantle plume-spreading ridge systems
- identify the most important outstanding problems and establish a coordinated strategy to address them

Keynote talks and discussion sessions of the workshop will be organized around three inter-linked themes:
- geodynamics and mantle flow
- plate tectonic evolution
- magma genesis, crustal accretion and hydrothermal activity

InterRidge

Workshop on Management of Hydrothermal Vent Ecosystems

September 2000, Canada

The workshop is motivated by the realization that impacts of scientific researchers, mining consortia and tour groups on vent habitats may be substantial, and the activities of one group are likely to have a negative effect on others. Its main objective will be to provide guidelines and recommendations for wise and sustainable use of these unique habitats.

Co-convenors: **Paul Dando**, UK (p.dando@bangor.ac.uk)
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sent for marine scientific research must first be acquired. when it will be undertaken within the limits of national jurisdiction. Consent is presumed unless the coastal State has reason to be believe the proposed research is "directly significant" to commercial exploration and exploitation of natural resources, whether living or non-living (article 246(3)).

Where the marine scientific research is for non-commercial purposes, the researching State (i.e., its researchers) is to: ensure the participation of the scientists from the coastal State; provide preliminary reports and final results upon request; provide access to samples and data collected upon request; provide sample and data assessment and research results upon request; and ensure international availability of the research results.

The true extent of marine bioprospecting at hydrothermal vent sites within areas of national jurisdiction is unknown. But biotechnology companies are increasingly aware of the CBD's access and benefit-sharing provisions. The more responsible companies are beginning to request collectors to demonstrate that biological and environmental samples have been collected subject to prior informed consent.

Beyond the limits of national jurisdiction, in the Area, the CBD's provisions on genetic resources access and benefit-sharing are not applicable. This is because genetic resources are a component of biological diversity and according the CBD's scope of application, and international law, a State only has jurisdiction over biological resources within its territory. Furthermore, there is no entity with which to share benefits. Therefore, although it is being considered within the CBD Conference of Parties and is seen as an area to study by the UN Secretary General and the Independent World Commission on Oceans, (Glowka, 1999), at this time there are no obligations for benefit-sharing for genetic resources removed from the Area.

Conclusion

Even though hydrothermal vents are not squarely addressed by UNCLOS and the CBD, with creative interpretation, they can still be used as the legal basis to ensure conservation and sustainable use. Working amongst themselves and with their respective governments marine scientific researchers can have a significant hand in ensuring that in those countries party to both treaties, and in those that are not, the spirit if not the letter of the law is applied.

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