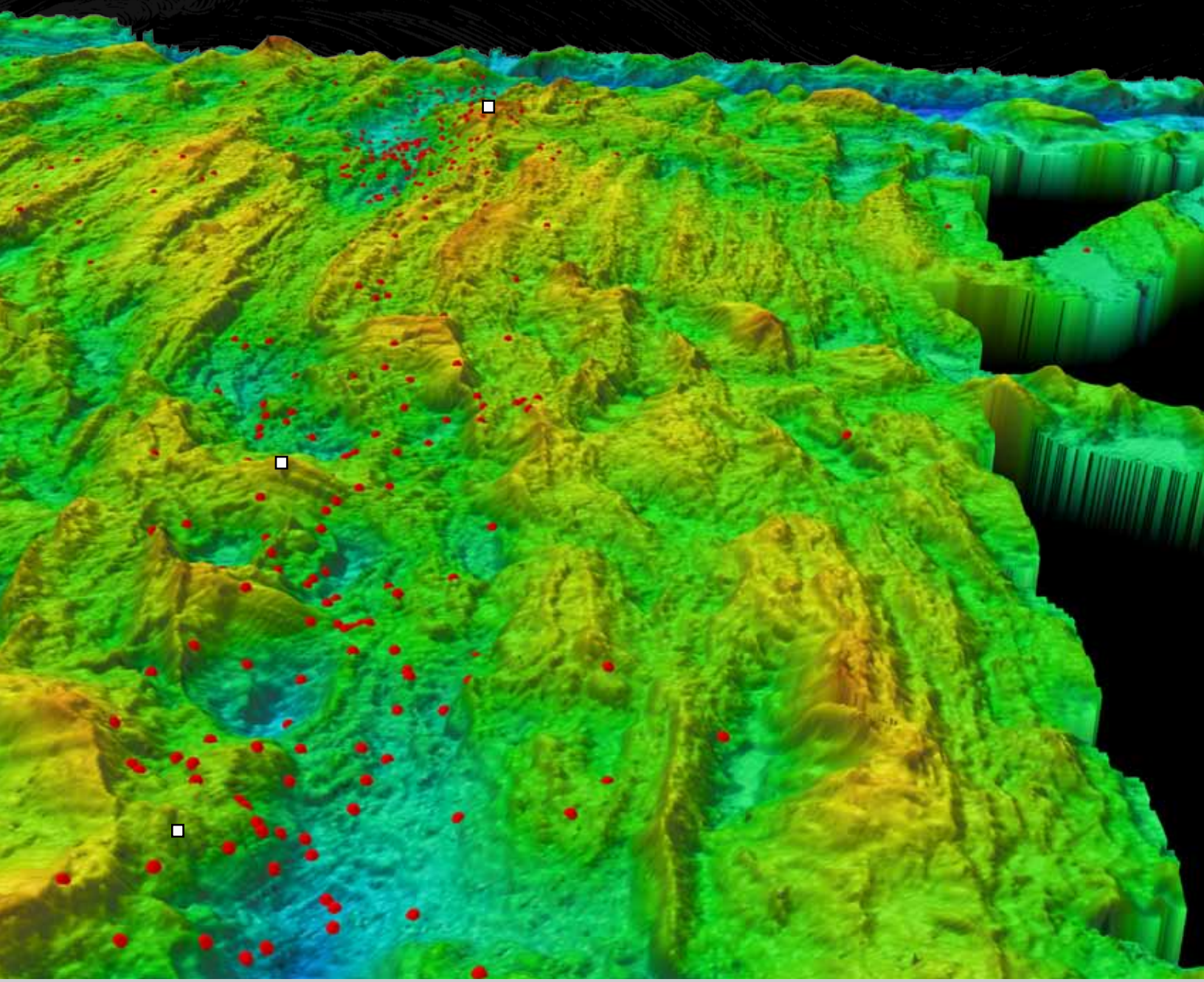
InterRidge News

Promoting international cooperation in ridge-crest studies



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InterRidge News

Vol. 18, November 2009

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Stace Beaulieu and Katherine Joyce

For Contributors
Please send all items for publication via email to the InterRidge Coordinator.

Text should be in Microsoft Word format. Figures should be sent in high resolution, preferrably eps or tif format for optimal printing, although other formats are accepted.

Deadline for InterRidge News Vol. 19 Contributions
15 September 2010

Letter from the Chairs

Jian Lin and Chris German

2009 has been a remarkable year of progress by the InterRidge science community as reflected in articles reported in this annual Newsletter. This is also the final year of the three-year rotation of the IR Office in Woods Hole. All of us who worked in the IR Office in Woods Hole felt privileged and a tremendous sense of honor to serve this remarkably vibrant community.

Exciting news from the IR community

2009 witnessed many exciting "firsts" in the thriving international, deep-ocean research community, despite the worst worldwide economic slowdown in decades. The U.S. hybrid remotely operated vehicle (HROV) *Nereus* successfully dove to the deepest part of the world's ocean at the Challenger Deep in the Pacific and explored the Caribbean's Cayman Trough, one of the deepest ocean ridges. Korea launched its first icebreaker R/V *Araon* – this state-of-the-art vehicle will be a major platform for carrying out exciting research in high latitude oceans, including an ambitious multi-year initiative to explore geological, hydrothermal, and biological processes of the little-studied Pacific-Antarctic Ridge. Also for the first time Chinese scientists successfully used a new ROV *Hailong 2* to image hydrothermal chimneys and sample sulfides at the equatorial East Pacific Rise. And after many years of dedicated efforts, NEPTUNE Canada, which has a key node on the Endeavour segment of the Juan de Fuca Ridge, is live!

New developments in the regional and national research programs of the IR community, including Bulgaria, Canada, China, France, Germany, India, Japan, Korea, Norway, Portugal, Russia, SOPAC, Switzerland, UK, and USA, are reported in the International Research and National News sections of this Newsletter.

Working groups fully active

Five new IR working groups (Hydrothermal Energy and Ocean Carbon Cycles, Long-Range Exploration, Mantle Imaging, Seafloor Mineralization, and Vent Ecology) held their inaugural group meetings in 2009. The Seafloor Mineralization WG successfully convened an international workshop and policy colloquium on "Deep-Sea Mining of Seafloor Massive Sulfides" with recommendations provided to the 15th General Session of the International Seabed Authority. The Deep Earth Sampling WG organized a workshop on "Melting, Magma, Fluids and Life," which generated a timely white paper to the IODP INVEST workshop to define the future of the international ocean drilling program beyond 2013. These and many other WG activities are summarized in the Working Group Updates and Workshops and Conferences sections of this Newsletter.

The Long-Range Exploration WG and Hydrothermal Energy and Ocean Carbon Cycles WG are planning international workshops in 2010 and 2012, respectively, while the Mantle Imaging WG is organizing an IR Theoretical Institute in 2011. Stay tuned for news on these and other community-wide events.

New opportunities for international collaborations

IR continued to encourage and expand opportunities for young scientists to participate in international collaborations through the 2009 IR Student and Postdoctoral Fellowships, IR Student Awards at the 4th International Symposium on Chemosynthesis-Based Ecosystems, and partial travel funding for students and young scientists for attending the IR workshops. This and other news on the IR education and outreach activities are reported in the Education and Outreach Update and InterRidge Fellows sections of this Newsletter.

IR Office moving to Southampton, UK

We are delighted that Dr. Bramley Murton and Dr. Jon Copley at the National Oceanography Centre, Southampton, UK, will serve as Chair and Co-Chair, respectively, of InterRidge for 2010-2012. Bram is a researcher specializing in geological and geochemical evolution of oceanic crust. He has been a member of IR working groups, convened IR meetings, and sits on several research program panels (e.g., UK-IODP and NOAA Ocean Exploration). Jon is an ecologist specializing in chemosynthetic ecosystems. He coordinated a national research program for the use of AUV technology to investigate challenging polar environments. He also holds several awards for science communication and teaching and has been a news editor of *New Scientist* magazine. The next few years will be an exciting time for the UK to host the IR Office, with UK researchers engaged in several major programs on mid-ocean ridge systems. Over to you, Bram and Jon!

Goodbye from the IR Office in Woods Hole: (from back to front): Jian Lin (Chair), Chris German (Co-Chair), Stace Beaulieu (Coordinator 2008-2009), Kristin Kusek (Education and Outreach 2007), Rhian Waller (Coordinator 2007).

Coordinator Update

Stace Beaulieu

The InterRidge (IR) program office is now in its third and final year at Woods Hole Oceanographic Institution. The IR office will move to the National Oceanography Centre, Southampton, UK, for the next three years of the IR Next Decade Plan for 2004-2013 (http://www.interridge.org/science/nextdecade).

Membership

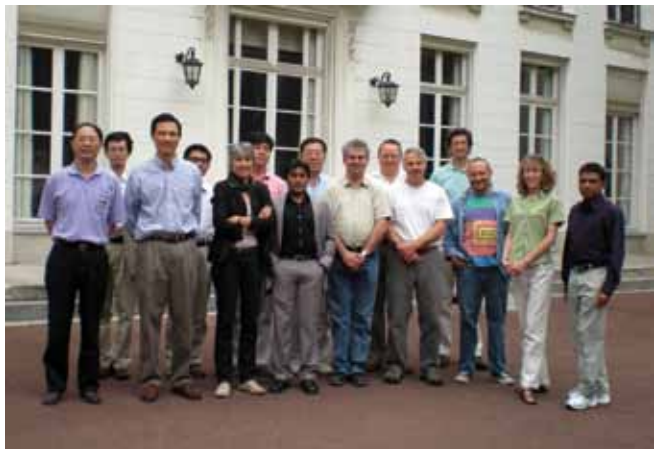
In the past year, IR expanded from 30 to 31 regional and national memberships with the addition of Bulgaria as a Corresponding Member. The total number of regions and nations represented by the ~2,500 individual IR members remains at 62 with this year's addition of Myanmar and subtraction of French West Indies. China is now ranked 7th in number of IR members, surpassing Canada this year. The biweekly "interridge-mail" e-news is sent to over 1,600 IR members, and our e-mailing list for job postings ("interridge-classifieds") has over 160 IR members. We regularly update the IR membership list; please email the IR office or log onto your online member account if you have changed your email or postal mail address.

Steering Committee

In July 2009 the IR Steering Committee (StCOM) meeting was held at CNRS, Paris, France (photo below). The StCOM meeting report is posted at: http://www.interridge.org/stcom/reports. We welcome Pedro Ferreira, our new StCOM member from Portugal. For our Members rotating off the StCOM, we thank Jérôme Dyment (France) and Chris German (USA) for their years of leadership and service. Jian Lin (current IR Chair) will stay on as a non-voting ad hoc member of the StCOM in 2010 to assist the transition of the IR office to the UK.

National Correspondents

We are pleased to welcome Vesselin Dekov and Akuila Tawake as our new Correspondents in 2009, to Bulgaria and to the Pacific Islands Applied Geoscience Commission (SOPAC), respectively. Please feel free to contact the IR office at any time to update us with news related to ridge-crest research and education/outreach activities. If you would like to be considered as a National Correspondent, we request a letter from you, on the official letterhead of your research organization, that briefly describes your current research as it applies to the study of oceanic spreading centers (i.e., ridge-crest research). We also ask you to comment on how your research program fits into the mission and/or next decade plan of InterRidge.



IR Steering Committee in Paris, France, July 2009: (left to right): J. Li, H. Kumagai, J. Lin, J. Ishibashi, N. Le Bris, S.-H. Park, D. Bissessur, Y.J. Chen, J. Dyment, C. German, D. Fornari, P. Ferreira, B. Ildefonse, S. Beaulieu, K. Kamesh Raju.

Working Groups

The IR Working Groups (WGs) play an essential role in promoting, facilitating, and coordinating new research that follows a focused theme of emerging scientific promise, or is conducted in a unique geographic setting where advances in science will benefit significantly from IR coordination. Two of our WGs completed their efforts in 2009: Biogeochemical Interactions at Deep-Sea Vents and Monitoring and Observatories. Our new WG in 2009 is the IR-SCOR co-sponsored WG on Hydrothermal Energy and Ocean Carbon Cycles. The other five WGs continuing into next year are: Deep Earth Sampling, Long-Range Exploration, Mantle Imaging, Seafloor Mineralization, and Vent Ecology. Please read about the latest WG achievements in the Working Group Updates section of this volume.

Workshops and Conferences

Two of the IR WGs convened workshops in 2009. The Seafloor Mineralization WG held an international workshop on Deep-Sea Mining of Seafloor Massive Sulfides in April in Woods Hole, USA. The Deep Earth Sampling WG held an international workshop titled, "Melting, Magma, Fluids, and Life" in July in Southampton, UK. The Vent Ecology WG met at the 4th International Chemosynthesis-Based Ecosystems (CBE) Symposium, co-sponsored by InterRidge and held in July in Okinawa, Japan. The IR office participated at the Korea Polar Research Institute's 16th Symposium on Polar Sciences in June in Incheon, Korea. For more information on these workshops and conferences, please see the respective articles in the Workshops and Conferences section of this volume.

Hydrothermal Vents Database

By the end of this year, the revised InterRidge Global Database of Active Hydrothermal Vent Fields will be posted to the InterRidge website: http://www.interridge.org/IRvents.

This list of active hydrothermal vent fields is the most comprehensive in the world, thanks to communications with researchers all over the world who have been independently maintaining their own regional and global lists of hydrothermal sites. I would like to give special thanks to Ed Baker (USA), Mark Hannington (Canada), and Sven Petersen (Germany) for sharing their spreadsheets. I have teamed with Ed Baker and Chris German to submit a manuscript for the revised database.

Newsletter

For this year's Newsletter, we chose to highlight new developments in research of oceanic core complexes (OCCs), the uplifted footwalls of detachment faults at slow-spreading ridges. Images of these seafloor features are shown on the front and back cover. The article by Henig et al. highlights work at the Atlantis Massif, an OCC at 30°N on the Mid-Atlantic Ridge (MAR), and the hydrothermal deposits detailed in the article by Beltenev et al. are in proximity to the 13°30'N OCC on the MAR. InterRidge is co-sponsoring a conference on OCCs in May 2010 (see advertisement in the Upcoming Events section).

Goodbye

I would like to give special thanks to Jian, Chris, the IR Steering Committee, and Working Group Chairs for the very enriching experience of serving as InterRidge Coordinator. This job has been a very exciting mix of science, administration, communications, and international relations. Two decades ago, through my involvement with the International Science and Engineering Fair student competition, I was given the opportunity to participate in the London International Youth Science Fortnight (http://www.liysf.org.uk). This experience in particular motivated me towards a career in the sciences that would also involve international relations. As InterRidge Coordinator, I have been able to fulfill this dream. Thank you all. Best wishes, Stace

InterRidge to sign Letter of Agreement with UNEP/GRID-Arendal

InterRidge is pleased to announce a Letter of Agreement (LoA) to be signed with GRID-Arendal, a collaborating center of the United Nations Environment Programme (UNEP). The GRID (Global Resource Information Database) center, recognized worldwide for its role in bridging the gap between science and policy, is based in Arendal, Norway (http://www.grida.no/). The objective of the LoA is to establish a framework for cooperation between UNEP/GRID-Arendal and InterRidge. This will be the first LoA in which InterRidge is a signatory. LoA's are routinely used at UNEP/GRID-Arendal for non-binding expressions of cooperation.

The mission of UNEP/GRID-Arendal is "to provide environmental information, communications and capacity building services for information management and assessment," with a vision that includes being "a leading centre for marine environment issues and global environmental information." As explained by Yannick Beaudoin, Geoscientist at UNEP/GRID-Arendal, "Through a formal Memorandum of Understanding involving UNEP and the Government of Norway, UNEP/GRID-Arendal is an Official Collaborating Center of UNEP. This essentially means that our program of work is dedicated to supporting the activities and priorities of UNEP, but we remain an administratively independent organization." Their Marine Programme is working on the UNEP Shelf Programme, marine protected areas of the high seas, a global assessment of methane gas hydrates, and a proposed assessment of Pacific deep-sea minerals. The Marine Programme's interests align well with several of the InterRidge Working Groups, including Seafloor Mineralization and Vent Ecology.

The LoA will promote cooperation in the form of information exchange, workshops, and collaborative ventures. Both parties will benefit from increased communication and interaction in activities of mutual interest such as providing scientific information to international organizations and decision makers (e.g., UNESCO, International Seabed Authority, NGOs). InterRidge will benefit from the access to UNEP/GRID-Arendal's outreach capacity and involvement with their University of the Sea programme to implement a new cruise berth program proposed by the incoming InterRidge Chairs. Jon Copley, incoming InterRidge Co-Chair, said that the LoA "fits well with how we see InterRidge continuing to develop in the next office term (particularly our goals for reaching out to policymakers)."

Education and Outreach Update

Stace Beaulieu

Student awards at 4th CBE Symposium

At the 4th International Symposium on Chemosynthesis-Based Ecosystems (see article in Workshops and Conferences section of this volume), InterRidge presented two awards to students:

- **Dennis Fink**, from Max Planck Institute for Marine Microbiology, received the "hottest" poster award, for his work titled, "Symbiont response to changes in vent fluid flow." Dennis is a second year graduate student, supervised by Nicole Dubilier and Christian Borowski. He will continue his work on a cruise in 2010 to Menez Gwen hydrothermal vent on the Mid-Atlantic Ridge; and
- **Daphne Cuvelier**, from University of the Azores, received the "hottest" oral presentation award, for her talk titled, "A first decadal study (1994-2008) of community dynamics on an Atlantic hydrothermal edifice as revealed by high-resolution video image analysis." Daphne is in her last year as a Ph.D. student, supervised by Ricardo Serrão Santos and Ana Colaço, and with additional supervisors at Ifremer (D. Desbruyères, J. Sarrazin), NOCS (P. Tyler, J. Copley) and NHM (A. Glover).

Stephane Hourdez, Vent Ecology Working Group Co-Chair, and Stace Beaulieu, InterRidge Coordinator, served as judges for the competition, and they had a very difficult time choosing among the approximately 60 student presentations. Yoshi Fujiwara, newly-elected Vent Ecology Working Group Co-Chair, helped in the final decision, serving as a "tie breaker."

Summer school on "Geodynamics of Mid-Ocean Ridges"

IR co-sponsored a summer school on "Geodynamics of Mid-Ocean Ridges" in Sept. 2009 (more details are in the Deep Earth Sampling WG update in this volume).

FLEXE cruise featured on GLOBE website

InterRidge is continuing to partner with the FLEXE (From Local to Extreme Environments) Project, a GLOBE Earth System Science Project (http://www.globe.gov/projects/flexe). GLOBE (Global Learning and Observations to Benefit the Environment) is a web-based international science education program that joins scientists, students, and teachers in 110 countries in studying Earth Systems Science. Approximately 1500 students in four countries (USA, Thailand, Australia, and Germany) were involved in this year's FLEXE Pilot, tuning in to follow a cruise to the Lau Basin in May - June 2009. The cruise was led by USA PI Chuck Fisher, and participating scientists were from the USA, France, and Austria.

Other public outreach activities in 2009

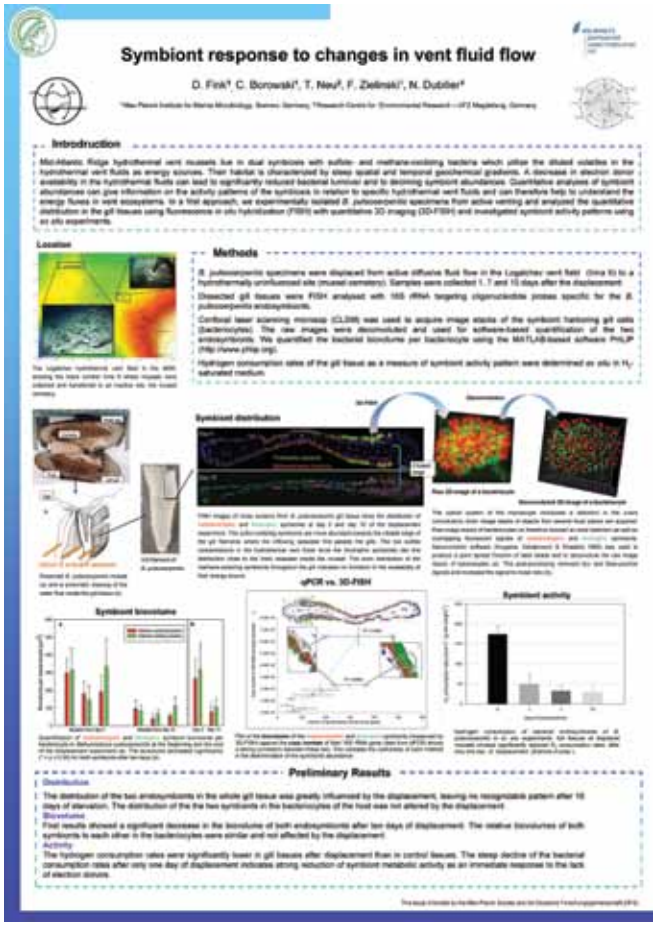
IR contributed to two museum exhibits in 2009:

- "Creatures of the Abyss" exhibit at Science North, Canada, opened in May 2009 (open through Jan. 2010),
- Extreme Deep exhibit at the Museon, in the Netherlands, Oct. 2008 - May 2009.

Two radio interviews were associated with the IR co-sponsored Deep-Sea Mining Workshop in April 2009: Deutsche Welle (Germany) and National Public Radio (USA). The latter interview, which included Maurice Tivey, Chair of the Seafloor Mineralization WG, and Stace Beaulieu, InterRidge Coordinator, may be listened to at: http://www.wgbh.org/cainan/article/?item_id=480593 (March 26, 2009).

Students who received awards at 4th CBE:
(left) Dennis Fink
(right) Daphne Cuvelier

Student poster award at 4th CBE: Poster by Dennis Fink



2009 InterRidge Student and Postdoctoral Fellows

As part of InterRidge's mission to promote international, collaborative, and interdisciplinary studies of oceanic spreading centers, we invite proposals for InterRidge Student and Postdoctoral Fellowships of up to $5000 USD each. These Fellowships are designed to encourage international collaboration on any aspect of ridge-crest science by graduate students or postdoctoral researchers, fostering long-standing partnerships for their future careers. In 2009 the Fellowship Program expanded with funding from the International Seabed Authority (ISA) Endowment Fund to enhance the training opportunities for young researchers in developing countries.

The InterRidge Steering Committee is very pleased to announce the awards for the 2009 InterRidge Student and Postdoctoral Fellowship Program. The awards go to **Susan Lang**, a postdoctoral researcher at Scripps Institution of Oceanography (SIO), USA, to work at a laboratory in Switzerland, and to **Surya Prakash**, a Ph.D. candidate at the National Institute of Oceanography (NIO), India, to conduct research in the USA.

We would like to extend special thanks to the reviewers for the fellowship proposals. All proposals were reviewed by two topical science reviewers (one a native and the other a non-native English speaker). We would also like to thank the Advisory Panel to the ISA Endowment Fund. For more information about the ISA Endowment Fund, please see: http://www.isa.org.jm/en/efund/fund. For more information on the InterRidge Student and Postdoctoral Fellowship Program, please see: http://www.interridge.org/fellowship.

Susan Lang - The title of Lang's project is "Investigating the formation mechanisms and inorganic precursors of formate and acetate in Lost City hydrothermal fluids." Lang will determine the stable carbon isotopes of formate and acetate and the radiocarbon isotopes of formate in Lost City fluids with the objective to: (1) constrain the formation mechanisms of formate and acetate (biological vs. abiological), and (2) determine the inorganic precursor to these species (mantle CO_2 vs. seawater bicarbonate). Lang is advised by Dr. Lihini Aluwihare at SIO, and the fellowship will be conducted with Dr. Gretchen Früh-Green at ETH Zürich, Institute for Mineralogy and Petrology. Lang received her Ph.D. in Chemical Oceanography in 2006 from University of Washington. As an undergraduate, she studied chemistry at Massachusetts Institute of Technology.

In describing her career goals, Lang writes, "My career goal is to become a research scientist at a university or governmental agency. My primary research interests are in using organic geochemistry techniques to investigate where, why and how organisms interact with their environment and in investigating how the quality and quantity of organic matter affects biological species. The use of radiocarbon isotopes is a fundamental organic geochemical technique that I do not yet have experience with. This opportunity would allow me to master this type of analysis in one of the world's preeminent accelerator mass spectrometer laboratories."

Surya Prakash - Prakash is our first fellow to be supported through the International Seabed Authority Endowment Fund. The title of Prakash's proposal is "Helium isotope studies of hydrothermal plume over slow spreading Carlsberg Ridge, Indian Ocean." Prakash will analyze helium isotopes in water samples collected in a systematic survey of the Carlsberg Ridge to confirm the existence and source of a hydrothermal plume in this region. Prakash is advised by Dr. K. A. Kamesh Raju at NIO, and the fellowship will be conducted with Dr. John E. Lupton at NOAA Pacific Marine Environmental Laboratory. Prakash graduated in chemistry from Jiwaji University, Gwalior, India.

As explained by Prakash, "This fellowship will give me an opportunity to learn the analytical techniques for estimation of dissolved helium isotopes in sea water, using a noble gas mass-spectrometer. The technique and facilities are not available in India, and are present in only a few laboratories in the world." As a side note, Prakash mentioned that he was inspired by the movie "Aliens of the Deep" to explore hydrothermal vents in his graduate student research.

2009 InterRidge Fellows

Surya Prakash: (above) operating an Isotope Ratio Mass Spectrometer at NIO to analyze sulfur isotopes.

Susan Lang: (left) helping recover an in situ pump during a recent cruise in the North Pacific.

InterRidge Student and Postdoctoral Fellowship Program
http://www.interridge.org/fellowship

The Call for Proposals for the 2010 Fellowships will be released in January 2010.
Deadline: **31 March 2010**

2008 InterRidge Student Fellow

Michelle Harris
National Oceanography Centre, University of Southampton, UK

I visited the University of Western Ontario, Canada, in June - July 2009 to undertake the stable isotope analyses proposed in my InterRidge student fellowship project, "An oxygen isotope investigation of an intact section of upper oceanic crust." This project is in collaboration with Prof. Neil Banerjee. The project aimed to investigate the conditions of hydrothermal circulation at Ocean Drilling Program (ODP) Hole 1256D by integrating new oxygen isotope data with my existing strontium isotope study and petrological observations of hydrothermal alteration for my Ph.D. project supervised by Prof. Damon Teagle.

During my visit I was trained at the Laboratory for Stable Isotope Science to use the silicate line to produce oxygen isotope data. The procedure involves initially extracting the oxygen from the silicate samples by reaction with ClF_3 at high temperatures, and then converting the oxygen to CO_2 to be measured on the mass spectrometer. This process allows the oxygen isotope ratio of the sample to be determined. I analysed a selection of whole rock samples and mineral separates from ODP Hole 1256D, focussing on samples from the sheeted dike and plutonic complexes. This included detailed sampling across dike margins to investigate the role of focussed fluid flow in the hydrothermal system, and quartz-epidote mineral separates to estimate the temperatures of the fluids.

Fully understanding hydrothermal processes in oceanic crust

is important for testing crustal accretion processes and quantifying hydrothermal inputs to global geochemical cycles. The oxygen isotope results from mineral separates collected during my visit have provided key constraints on the temperature of hydrothermal fluids in the lower sheeted dikes and plutonic rocks in ODP Hole 1256D. This is particularly important as the samples come from the first intact sampling of the dike-gabbro boundary, and understanding these processes from in situ samples is critical. These new results demonstrate that high temperature fluids circulated through the sheeted dike complex and down into the plutonic complex and, that significant focussing of the fluids has occurred along dike margins and intrusive contacts in the plutonic complex. The combination of the new oxygen isotopes with my existing strontium isotopes will allow me to further constrain the magnitude of the fluid flux through Site 1256.

I was also fortunate to spend a short, but very interesting time in the field with Prof. Banerjee and his research students looking at hydrothermal systems in Archean rocks from the Abitibi Greenstone Belt in northern Canada (Fig. 1). My visit was a very productive and enjoyable experience, and I would like to thank Prof. Banerjee for hosting me, and in particular Kim Law in the Stable Isotope Lab at the University of Western Ontario for accommodating my project and introducing me to stable isotope geochemistry. In addition, I would like to thank InterRidge for providing this unique opportunity for me to develop my career in mid-ocean ridge science.

Figure 1: Pillow lavas exposed at the Abitibi Greenstone Belt in northern Canada.

2008 InterRidge Student Fellow

Kerry Howard
Cardiff University, UK

Hess Deep in the eastern Pacific Ocean is a rift valley formed by the westward propagation of the Cocos-Nazca spreading centre into the Galapagos microplate. At this unique location a complete, albeit dismembered, section of oceanic crust that formed ~1Myr ago at the East Pacific Rise (EPR) is exposed in the valley walls and floor. The purpose of research cruise JC21 aboard the RRS *James Cook* in 2008 (PI Chris MacLeod, Cardiff University) was to obtain site survey information in support of proposed IODP drilling into the lower crustal section in Hess Deep. Using the UK's *Isis* ROV, high-resolution bathymetry and seabed video was acquired from the proposed drill sites. In addition, samples were collected from all levels of the ocean crust and uppermost mantle, though concentrating on the plutonic section. Since the focus of my Ph.D. project is the mechanism(s) by which the lower crust accretes at fast spreading ridges, my principal interest is in the geochemistry and petrofabrics of the 76 lower crustal gabbroic samples we collected with *Isis*. The aim is to use my results to test current accretion models and provide new constraints on the mechanisms involved in the formation of lower oceanic crust.

Being awarded an InterRidge Fellowship has enabled me to greatly expand the scope of my project by giving me the opportunity to conduct a systematic study of stratigraphic changes in crystallographic fabrics through the EPR lower crust using electron backscatter diffraction (EBSD) analysis. This is a fast and accurate method for quantifying lattice preferred orientations (LPOs) of crystals in a sample. At Hess Deep these LPOs have been imparted by magmatic flow in the magma chamber beneath the EPR. EBSD utilises the omnidirectional scattering of electrons that results when a narrow SEM electron beam is focused onto the surface of a sample oriented at 70° to the incident beam. The diffraction of the electrons by the lattice planes in a crystal produces a spatial pattern, called a "Kikuchi" pattern, which consists of a series of bands that vary with phase and crystal orientation. Comparison of these bands with a library of calculated patterns enables identification of both the mineral and its orientation. Further processing can

provide phase maps of the sample and pole figures highlighting the orientations of specific crystallographic features.

My Fellowship allowed me to conduct this study by funding two trips to Université Montpellier II, where, in collaboration with Dr. Benoît Ildefonse, I analysed 34 of the lower crustal samples from Hess Deep. My first visit to Montpellier, in August 2008, enabled me to familiarise myself with the EBSD technique and provided me with insight into the data it produced and its applications. Dr. Ildefonse instructed me in the use of the EBSD-dedicated SEM at Montpellier, and in the processing steps and different software necessary to convert the raw analyses to usable output. This first batch of eight analyses provided a tantalising glimpse into the range of magmatic fabrics that were present in the samples, and allowed for various combinations of phase images to be produced. A further 26 samples were analysed during my second trip, early in 2009, and I also had the opportunity to meet several other key workers in the field of EBSD analysis, including Dr. David Mainprice, the author of the software used to produce the pole figures.

The 34 samples now analysed represent the full range of lithologies present in the lower crust at Hess Deep – troctolites, olivine gabbros, gabbros, gabbronorites and oxide-rich gabbros. No correlation between lithology and fabric strength has yet been identified, though full comparison with modal analyses is not yet complete. The fragmentation of the section makes reconstructing the stratigraphy somewhat complex, and until this is done it is difficult to comment on whether there is any systematic variation in fabric strength up section.

Preliminary macroscopic observations revealed a large range in intensity of magmatic fabrics, with rocks ranging from apparently undeformed to strongly foliated. This wide range of fabric strengths has been confirmed by the EBSD analyses, with foliations and lineations present to various degrees, either separately or in combination. This suggests that different crystallisation conditions occurred throughout the lower crust. By quantifying these fabrics in the context of their reconstructed stratigraphic positions, I will be able to determine changes of deformation and crystallisation conditions throughout the lower crust and hence test the accretion models.

As magmatic fabrics are generally defined by alignment of elongate tabular crystals, much of my early focus was on plagioclase grains, however I have recently begun investigating the fabrics exhibited by the clinopyroxene (cpx) grains. Comparison of the two sets of fabric data has shown that for most samples with strong fabrics there is a good correlation between the orientation of plagioclase and cpx foliations, but that such correlations are much less apparent in the samples with weak to moderate fabric intensities.

In addition to the study of plagioclase and cpx LPOs I am also carrying out a comparison of the silicate fabrics revealed by EBSD with magnetic fabrics identified by anisotropy of magnetic susceptibility (AMS) analysis. By doing this I hope to discover whether there is a correlation between the two, and to investigate the mineralogical and process-related reasons responsible for the results. Early findings show a clear relationship in some of the samples but not in all, so further study is required.

I am also shortly to conduct a pilot study in which I will compare the EBSD LPOs with shape-preferred orientations of grains. The latter I shall be acquiring via detailed image analysis of thin sections of a small sub-group of samples cut from orthogonal blocks oriented according to fabrics identified by the EBSD analyses. This should enable me to carry out an evaluation of the primary processes of cumulate formation within the lower crustal mush beneath a fast-spreading mid-ocean ridge.

I gratefully acknowledge the InterRidge Fellowship for giving me the opportunity to greatly extend the original goal of my Ph.D. project, for allowing me to learn new skills, and to forge strong links with key workers in an exciting field.

On watch in the *Isis* control room: Kerry Howard records events in the log while Masako Tominaga watches a sample being retrieved on the video display wall.

International Research:
MID-ATLANTIC RIDGE

Seismic velocity variation within the footwall of an oceanic core complex – Atlantis Massif, Mid-Atlantic Ridge, 30°N

Ashlee S. Henig[1], Donna K. Blackman[1], Alistair J. Harding[1], Graham M. Kent[1], and Juan-Pablo Canales[2]

Abstract

The Atlantis Massif, an oceanic core complex (OCC) at 30°N on the Mid-Atlantic Ridge, is hypothesized to have formed via long-lived slip on a detachment fault. Due to unroofing that results from this sustained slip, the domal core of the OCC is predicted to comprise lower crustal and/or upper mantle rock. Seafloor mapping and deep drilling confirm that this is the case in local areas, and regional geophysical mapping allows us to extend these groundtruth data to infer the broader lithospheric architecture. New results for a multichannel seismic (MCS) line across the Southern Ridge of the massif motivate this report. Our findings require an important update to previously-published interpretations of the structure of this domal core: seismic velocity models indicate that a gabbroic body similar to that drilled in the Central Dome likely also exists in at least the eastern portion of the Southern Ridge.

Introduction

The formation of oceanic core complexes represents a style of rifting and accretion that occurs episodically at a variety of spreading centers (ranging from intermediate to ultra-slow spreading rates) as changes in the balance of magmatic and tectonic activity take place along the ridge. Recent models predict that a threshold percentage of 30-50% magmatic accretion versus tectonic extension is conducive to the development of long-lived detachment faults and the formation of OCCs during the exhumation of the footwall (Tucholke et al., 2008). The seismic structure of the footwall to the detachment fault controlling the formation of an OCC can document variability associated with the distribution of mafic (magmatic) versus altered ultramafic (tectonically extended, fractured) lithosphere within the OCC structure.

The domal core of the Atlantis Massif at 30°N on the Mid-Atlantic Ridge is comprised of two main structural components, the Southern Ridge and the Central Dome (Figure 1). The Southern Ridge of the massif, located adjacent to the Atlantis transform fault, rises to a topographic peak about 760 meters below the sea surface, just below which occurs the serpentinite-hosted Lost City Hydrothermal vent field (Kelley et al., 2001; 2005; Früh-Green et al., 2003). Mapping and sampling of bedrock exposed along mass wasting scars at the Southern Ridge have returned a combination of serpentinites, gabbros, and few basalts (Blackman et al., 2002; Karson et al., 2006). The deeper Central Dome is adjacent and morphologically continuous with the north side of the Southern Ridge. Spreading-parallel corrugations are visible on the surface of both domal highs and juxtaposed to the Central Dome, a narrow block of volcanics sits atop the eastern portion and is probably a remnant of the detachment fault hanging wall or rider blocks to the footwall (Blackman et al., 1998; 2002). Drilling at Integrated Ocean Drilling Program (IODP) Hole U1309D on the southern Central Dome recovered a 1.4 km, nearly continuous gabbroic sequence (Blackman et al., 2006). This OCC is similar to others with comparable data coverage, with seafloor samples returning a ratio of about 70% serpentinized peridotite and 30% gabbro whereas deep drilling recovers dominantly gabbro (Ildefonse et al., 2007; Dick et al., 2008).

Seismic refraction analyses of the domal core of Atlantis Massif (Canales et al., 2008; Collins et al., 2009) reveal a heterogeneous structure in the upper 0.5-1.5 km, with large P-wave velocity gradients at lateral scales of less than 1 km. Canales et al. (2008) use refracted arrivals picked from standard MCS shot gathers along Line 10 and invert these data to obtain a velocity model where shallow, high-velocity material (> 4.2 km/s) and large vertical velocity gradients (> 3 s^{-1}, Figure 2) occur beneath the eastern slope of the Central Dome. Shallow velocity less than 3.4 km/s and low vertical gradients (~1 s^{-1}) occur immediately beneath the western slope of the Central Dome. Similar analysis of Line 4 shows intermediate P-wave velocities and vertical gradients where this alongstrike profile crossed the Southern Ridge, in the vicinity of its central peak (Figure 1). Velocity structure for Line 9 crossing the Southern Ridge in the dip direction was not considered in prior studies.

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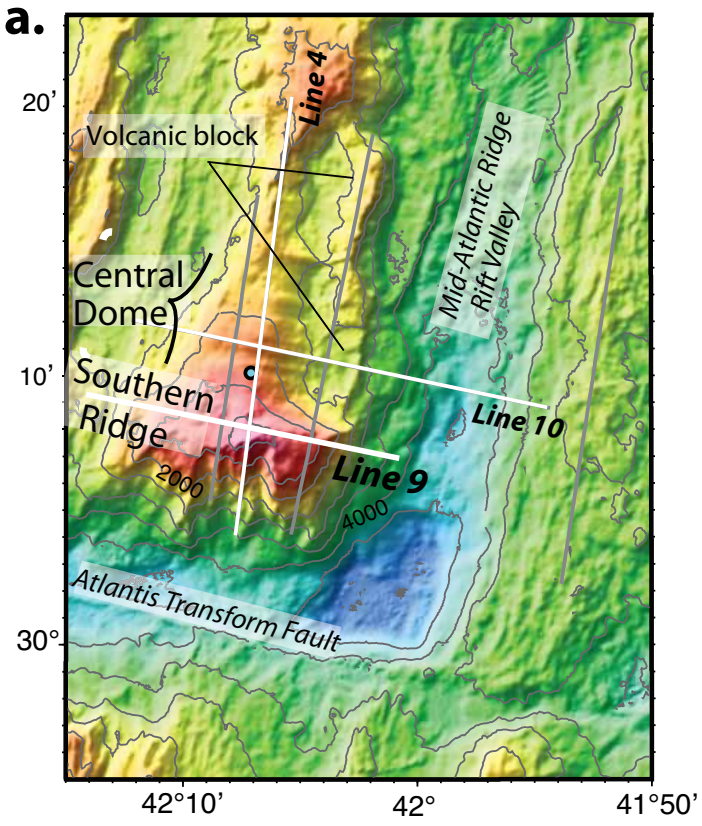
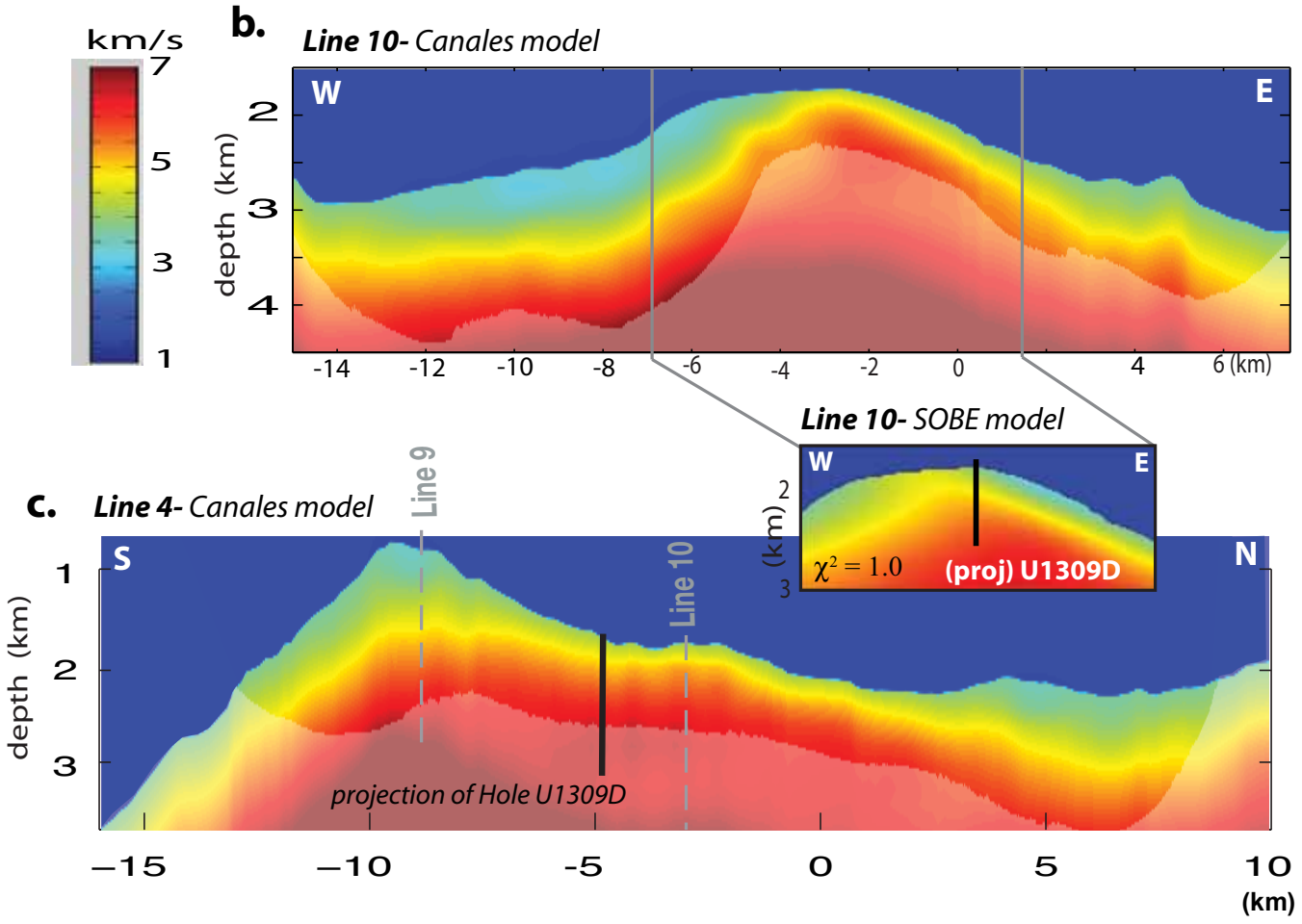


Figure 1: Morphology and previously-published seismic results for the Atlantis Massif OCC.
a: Bathymetry of the ridge-transform intersection, 500 m contour interval, with major structural components of the OCC labeled. MCS lines are shown as white (discussed herein, line numbers labeled) or gray (for which refraction processing remains to be done). IODP Hole U1309D is located by the circle on Central Dome.
b: Velocity models for Line 10 obtained by Canales et al. (2008; upper panel) and the result for a portion obtained by the SOBE method (Harding et al., 2007; Blackman et al., 2009; lower panel).
c: Velocity model for Line 4 (Canales et al., 2008). Gray dashed lines indicate where Lines 9 and 10 cross this line.
For **b** and **c**, heavy black line shows the projection of Hole U1309D onto the model; transparent white indicates where there is no ray coverage and hence no constraint; velocity color scale is the same for all panels.



Data analysis

MCS data collected in 2001 (Canales et al., 2004) are again employed in our study, but here we emphasize more detailed structure in the uppermost approximately one kilometer of structure. MCS data is advantageous over more conventional on-bottom seismic (OBS) datasets due to the multiplicity and even spatial distribution of the ray coverage. The Synthetic On-Bottom Experiment (SOBE) method used to process the data downward continues the shots and receivers to a depth just above the seafloor (Harding et al., 2007; Henig et al., 2008). The SOBE method overcomes one of the disadvantages of surface sources and receivers characteristic of MCS data by unmasking the shallowest turning rays covered by the water wave in areas of deep topography. This exposes more of the first refracted arrival in the shot gathers, allowing for the picking of refracted arrivals recorded on the streamer at very-near offset (300-2000 m range). The SOBE method provides constraints from rays turning in the upper few hundred meters, which were unavailable when standard shot gathers were analyzed by Canales et al. (2008). Improved models of the upper few hundred meters of the section enables greater confidence in the deeper (400-1500 m) structure obtained in the velocity model inversion.

Following the method of Van Avendonk (Van Avendonk et al., 2004), velocity structure of the massif is modeled by inverting the first refracted arrival time picks. The models are updated by minimizing the misfit between the predicted times and the picked times in a least squares sense. The initial result shown here for Line 9 (Figure 2a) represents both a good overall fit to the data, with χ^2 close to 1, and a good fit within each por-

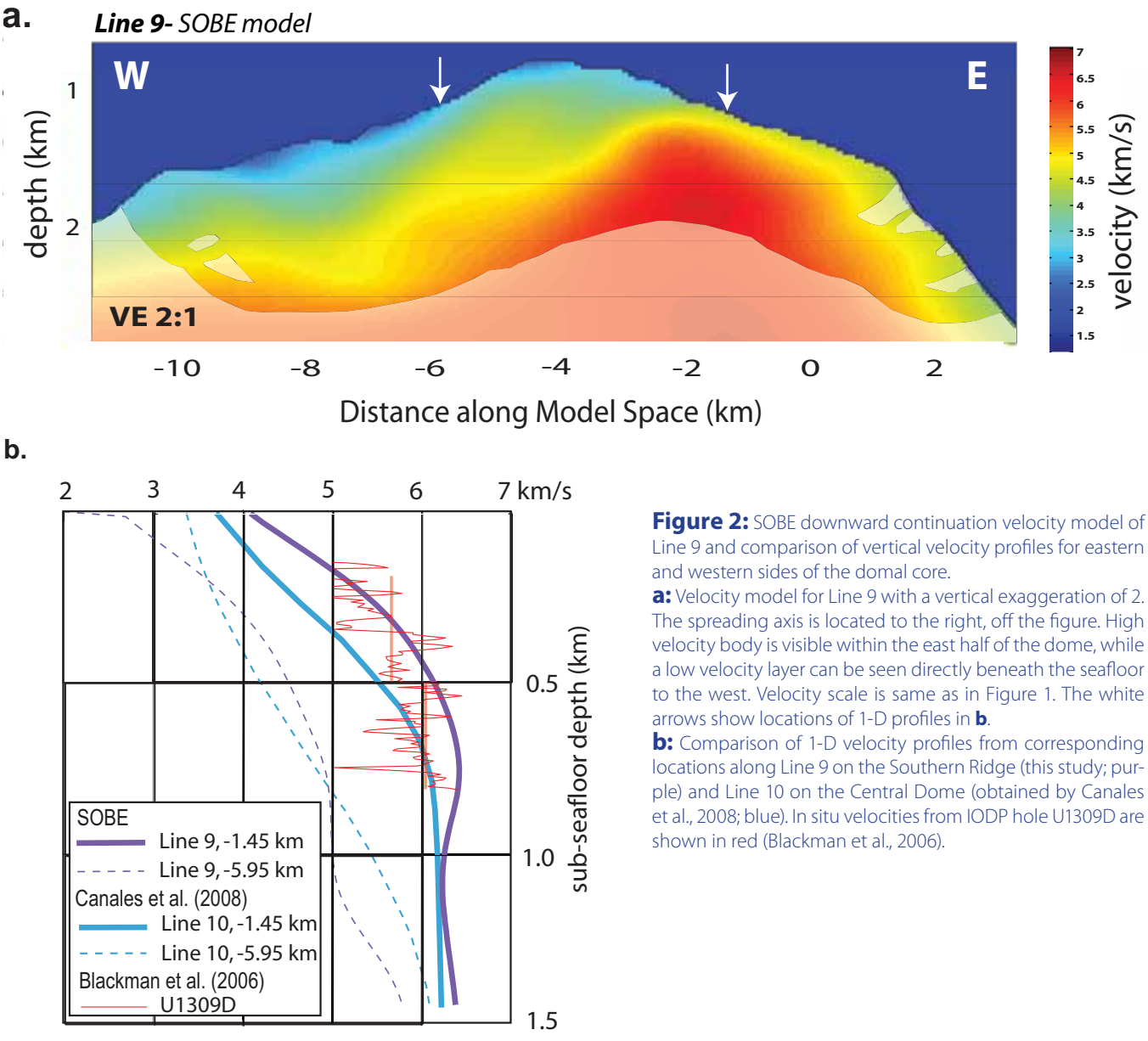


Figure 2: SOBE downward continuation velocity model of Line 9 and comparison of vertical velocity profiles for eastern and western sides of the domal core.
a: Velocity model for Line 9 with a vertical exaggeration of 2. The spreading axis is located to the right, off the figure. High velocity body is visible within the east half of the dome, while a low velocity layer can be seen directly beneath the seafloor to the west. Velocity scale is same as in Figure 1. The white arrows show locations of 1-D profiles in **b**.
b: Comparison of 1-D velocity profiles from corresponding locations along Line 9 on the Southern Ridge (this study; purple) and Line 10 on the Central Dome (obtained by Canales et al., 2008; blue). In situ velocities from IODP hole U1309D are shown in red (Blackman et al., 2006).

tion of the Line (i.e., western slope, central area, and eastern slope). While additional tests of the effect of specific inversion parameters will affect details, the main result for Line 9 that we emphasize here is robust. Application of this method to Lines 10 (Blackman et al., 2009) and 4 (Henig et al., 2008) produce results that are in general agreement with the results of Canales et al. (2008; Figure 1) indicating that our implementation of downward continuation and inversion is robust.

The most obvious feature in our results for Line 9 (Figure 2a) is a large high-velocity body beneath the eastern half of the Southern Ridge. Velocities greater than 5 km/s occur within the upper 200 meters and values greater than 6.2 km/s are reached within 500 meters of the seafloor (Figure 2b). Figure 2b shows that the velocities in this region are similar to the in situ velocities recorded in the drill hole U1309D on the Central Dome. This structure extends about 5 km in the ridge-perpendicular direction (1 to -4 km in model, Figure 2a). In contrast to the east, a noticeable thin low-velocity layer caps the western two-thirds of the Southern Ridge along Line 9. This layer extends laterally about 9 km (-2 to -11 km, Figure 2a) and has velocities of 2-3 km/s extending 100-400 meters below the surface (Figure 2b). Away from the high-velocity body and the low-velocity cap layer, model velocities are generally between 4 and 5.5 km/s.

With such a large range of velocities modeled in such a shallow depth range, there are high vertical velocity gradients and strong lateral heterogeneities along Line 9. The eastern high-velocity body has vertical gradients greater than 3.33 s^{-1}. The western portion has shallow gradients as high as 3 s^{-1} in the transition from the low-velocity cap to velocities >5 km/s at 1 km depth. Whereas the coverage of Canales et al. (2008) highlighted heterogeneity between the central and southern domes of Atlantis Massif, here we find additional heterogeneity within the Southern Ridge that is of comparable scale. The eastern portion of Line 9 is similar in velocity structure to that beneath the eastern slope of Line 10 and beneath the Central Dome where Line 4 crosses it.

Discussion

The velocity structure within the Atlantis Massif supports previous hypotheses regarding the formation of OCCs and their internal structure. The high-velocity body(ies) in Lines 4, 9, and 10 is(are) interpreted as a large mafic intrusion(s) surrounded by lower density material that is composed of shallower crustal rocks or highly serpentinized peridotite. This is consistent with gravity analysis that shows a positive gravity anomaly in the central/southeastern region of Line 9 (Blackman et al., 2008). If the rock surrounding the body is serpentinized peridotite, this velocity distribution supports the plum-pudding model of OCC formation (Escartin et al., 2003; Ildefonse et al., 2007) where mafic material is episodically injected into serpentinized mantle material that is exposed and altered by the exhumation of the footwall. The location of this intrusive body at the flank of the OCC closest to the ridge and the termination of the detachment also supports the increased-melt OCC extinction model previously proposed by Tucholke et al. (2008).

The low velocities in the upper few hundred meters of structure on the western side of the massif probably represent strongly fractured, permeable, and serpentinized peridotite. The observed velocity structure is indicative of prolonged weathering with increased distance from the ridge. Differences in the mechanical properties of rocks between the western and eastern portion of Line 9 such as crustal versus mantle composition, permeability versus impermeability, or susceptibility versus resistance to chemical alteration, might lead to such a velocity distribution within the OCC.

Ongoing work

Downward continued MCS refraction velocity models in the upper ~1.5 km of the Atlantis Massif continue to reveal new seismic structure that indicate important geologic features of this oceanic core complex. Our ongoing work includes processing and analysis of the complete set of MCS lines (Figure 1a) at this OCC using the SOBE downward continuation technique. Velocity models along all of the along- and across-strike profiles will document the scale of variability within the upper lithosphere, providing for the first time a more comprehensive, 3-dimensional view into the OCC.

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New data about hydrothermal fields on the Mid-Atlantic Ridge between 11° - 14°N: 32nd Cruise of R/V *Professor Logatchev*

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Introduction

Integrated geological-geophysical studies were carried out by the Polar Marine Geosurvey Expedition (PMGE) together with VNIIOkeangeologia (St. Petersburg, Russia) on the 32nd cruise of R/V *Professor Logatchev* during December 2008 to July 2009. The first objective of the expedition was to search for indicators of hydrothermal activity and related sulfide mineralization within the Mid-Atlantic Ridge (MAR) rift valley by means of reconnaissance studies between 11° to 12°30´N. The second objective was to perform detailed studies of the sulfide district (cluster of hydrothermal deposits) Semyenov discovered on a previous cruise at 13° 31´N (Beltenev et al., 2007).

Methods used on the cruise

- Hydro-physical sounding using CTD SBE-9ll Plus and water sampling by SBE-32 Carousel system
- Side-scan sonar profiling of the sea floor using MAK-1M system (Yuzhmorgeologia)
- Profiling by means of deep-towed Rift-3 system (Sevmorgeo) recording electric potential (EP) of the near-bottom waters
- Underwater photo-TV profiling
- Geological sampling by means of dredge, rectangular corer, and TV-controlled grab system.

A previous multi-beam survey carried out by Yuzhmorgeologia at a scale of 1: 200 000 was used for bathymetry.

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Results: New discoveries between 11°00´ - 12°30´N

The reconnaissance studies yielded two areas with indicators of hydrothermal activity at the MAR section between 11°00´ - 12°30´N (Fig. 1). The first area is located at the axial volcanic ridge between 11°24' - 11°27'N. Anomalies of turbidity, salinity, potential temperature, and density were detected in the interval 3500-3600 m at the hydrocast station 125 (11°26.89'N, 43°42.21'W, water depth 3835 m; Fig. 2). Four additional hydrocasts confirmed the distribution of these anomalies at the distance of 1000 meters along the ridge summit. The second area is related to the eastern slope of the rift valley, where hydrological anomalies were recorded at the st. 132 (11°02.28'N, 43°38.90'W, 4010 m) at 200 m above the sea floor (Fig. 2).

Investigation of Semyenov sulfide district

The studies of the second part of the cruise were concentrated at the cluster of hydrothermal deposits named Semyenov. As established in the 30th cruise of R/V *Professor Logatchev* all of the discovered hydrothermal sites are related to the latitudinally elongated, uplifted seamount-like massif of about 10 km length, 4.5 km width, and 850 m elevation above the surrounding seafloor (Fig. 3A). The seamount has a complex geological structure: serpentinized peridotites, gabbroids, basalts, metabasalts, and plagiogranites were recovered from its summit and slopes.

The detailed studies of the Semyenov deposits started with the profiling by the deep-towed geo-electrical system Rift-3. The profiling identified numerous EP anomalies of variable intensity along the northern slope of the seamount (Fig. 3B). These anomalies confirmed the location of hydrothermal sites 1-4 discovered earlier in the 30th cruise of R/V *Professor Logatchev*. High-amplitude EP anomalies covering the area of several square kilometers were also found in the central part of the seamount (new hydrothermal site with number 5) and to the East and North of the site 4.

Further studies included underwater TV profiling and geological sampling by means of dredging and TV-controlled grab system within the hydrothermal sites discovered in the 30th cruise of R/V *Professor Logatchev*. Detailed studies were also performed within the mapped EP anomalies. Results of these investigations provided new data on the structure of the known hydrothermal fields (1-4) and the location of the new site 5 (central coordinates 13°30.7'N, 44°56.2'W; Fig. 3A).

The TV profiling grid differs considerably between the five investigated hydrothermal sites due to the fairly large dimensions of some of the discovered deposits. Distance between the profiles was between 50-100 m in the sites 1 and 2, 200-250 m in the site 5, and 400-450 m in the sites 3 and 4.

The dimension, type of hosting rocks, characteristics of hydrothermal activity and composition of deposits at sites 1-5 are described briefly below.

Site 1 with the dimensions of 200x175 m is located between 2570-2620 m water depths and is spatially related to serpentinitized peridotites. The deposit constitutes an ore mound or a group of closely spaced structures covered by metalliferous sediments and hydrothermal crusts. This site has been sampled by three TV-controlled grabs and six dredges, only one of which recovered sulfide material. Hydrothermal mineralization is mostly represented by iron sulfides - pyrite and marcasite (15-30%). Copper sulfides (-5%) are found in chimneys and consist of approximately even amounts of chalcopyrite and

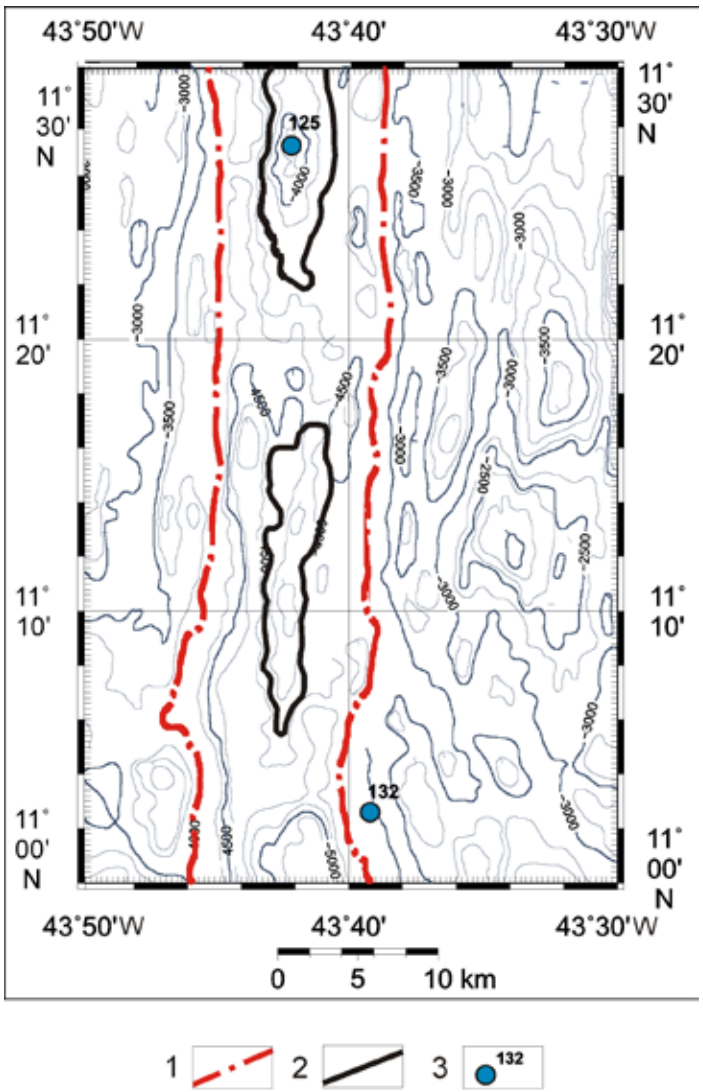
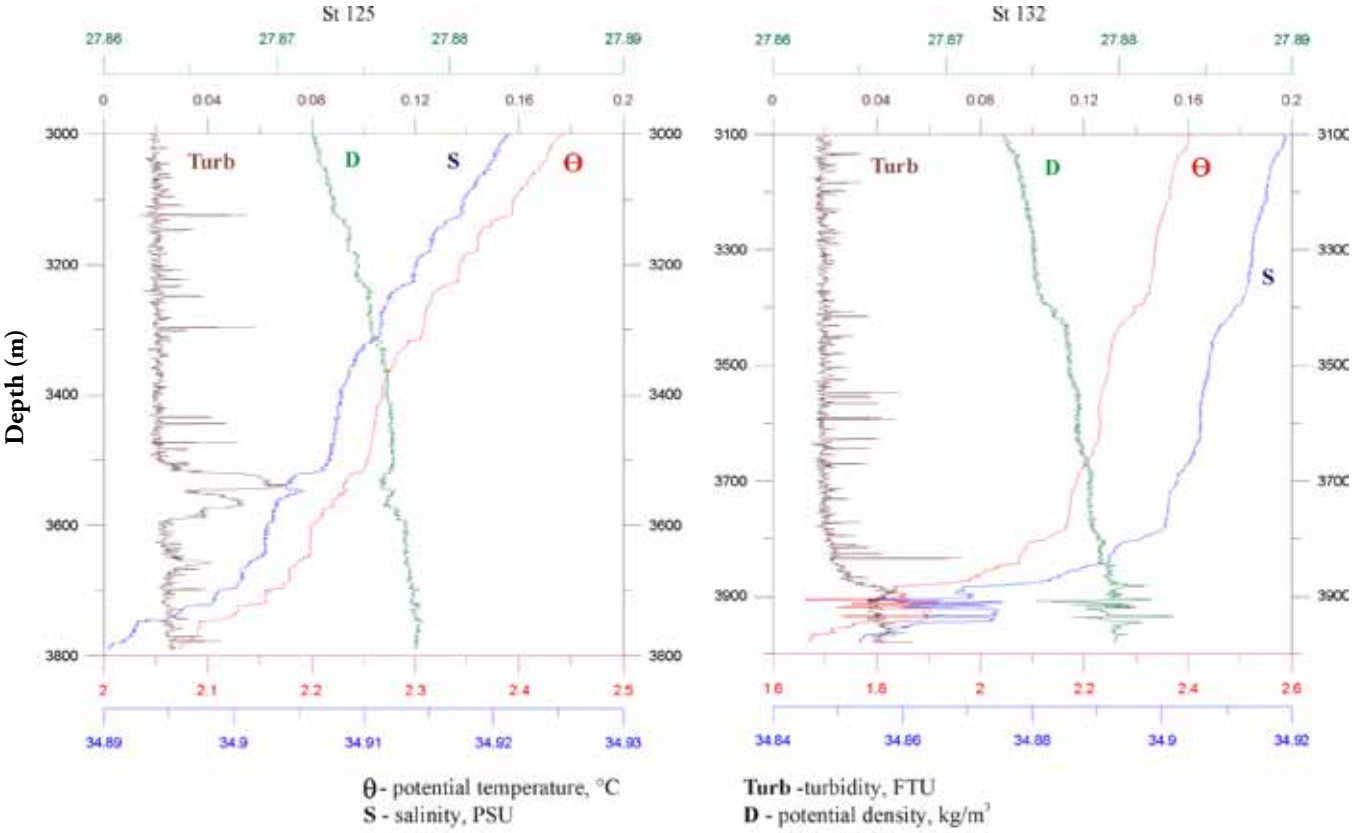


Figure 1: Locations of hydrocast stations 125 and 132 with hydrothermal plume anomalies. 1 – Rift valley floor; 2 – Axial volcanic ridge; 3 – Hydrocast stations.

Figure 2: Anomalies in the vertical distributions of turbidity, salinity, potential temperature, and density at hydrocast stations 125 and 132.



secondary copper sulfides. These chimneys are characterized by a strong opalization. Hydrothermal activity was not recorded at this site.

Site 2 is located between 2360-2580 m water depths and is spatially related to basalts. This site consists of two deposits (sulfide mounds and products of their disintegration). The dimensions of the deposits are 600x400 m and 200x175 m respectively. Site 2 was sampled by 1 dredge and 13 TV-controlled grabs. Massive sulfides recovered from 10 stations are represented by fairly rich copper sulfides in chimneys, relics in atacamite-aragonite crusts, and clasts in breccias with an opaline cement.

Chimneys recovered from 8 stations consist of chalcopyrite (40-80%) and secondary sulfides (20-60%). Pyrite, marcasite, and barite are present in small amounts. Copper sulfide relics in atacamite-aragonite crusts were recovered from 6 stations. Primary chalcopyrite (10-45%) as well as the secondary copper sulfides, sulfates and hydrochlorides (atacamite) with the total amount of up to 70% are the major minerals for this type of hydrothermal precipitate.

Site 2 is the only one in the cluster of the Semyenov deposits where hydrothermal activity was detected. Two vent zones similar to white smokers were recorded during the TV-profiling. However, no plumes in near-bottom waters were observed in 7 hydrocasts conducted at this site. A sample taken at St. 275 (13°30.82'N, 44°57.78'W, depth 2441 m) contained biota. At least 12 taxa were preliminary identified in this sample, including the mussel *Bathymodiolus puteoserpentis*, the gastropod *Phymorhynchus ovatus*, polychaetes *Amathys lutzi* and *Levensteiniella* sp., the pycnogonid *Sericosura heteroscela*, shrimps *Alvinocaris markensis* and *Opaepele susannae*, the crab *Segonzacia mesatlantica*, and the brittle-star *Ophioctenella acies*. In a wash-off from mussels, several species of nematodes, copepods and acarids were recorded. The composition of species in the sample at St. 275 is typical of fauna associated with mussel beds at hydrothermal fields on the northern MAR.

Of special interest is the record of the shrimp *O. susannae* (six specimens in the sample). This species has been described recently from two locations on the MAR south of equator: Lilliput (9°32'S, 1500 m) and Sisters Peak (4°48'S, 2986 m) (Komai et al., 2007). The new record of *O. susannae* north of equator is important for understanding relationships of hydrothermal vent fauna north and south of equator on the MAR. Several other species known from both sides of equator in the Atlantic include *Rimicaris exoculata* and *Bathymodiolus puteoserpentis* (Van der Heijden et al., 2009). Such a pattern of distribution indicates that equatorial fracture zones in the Atlantic Ocean (Romanche and Chain) are not a major physical barrier for

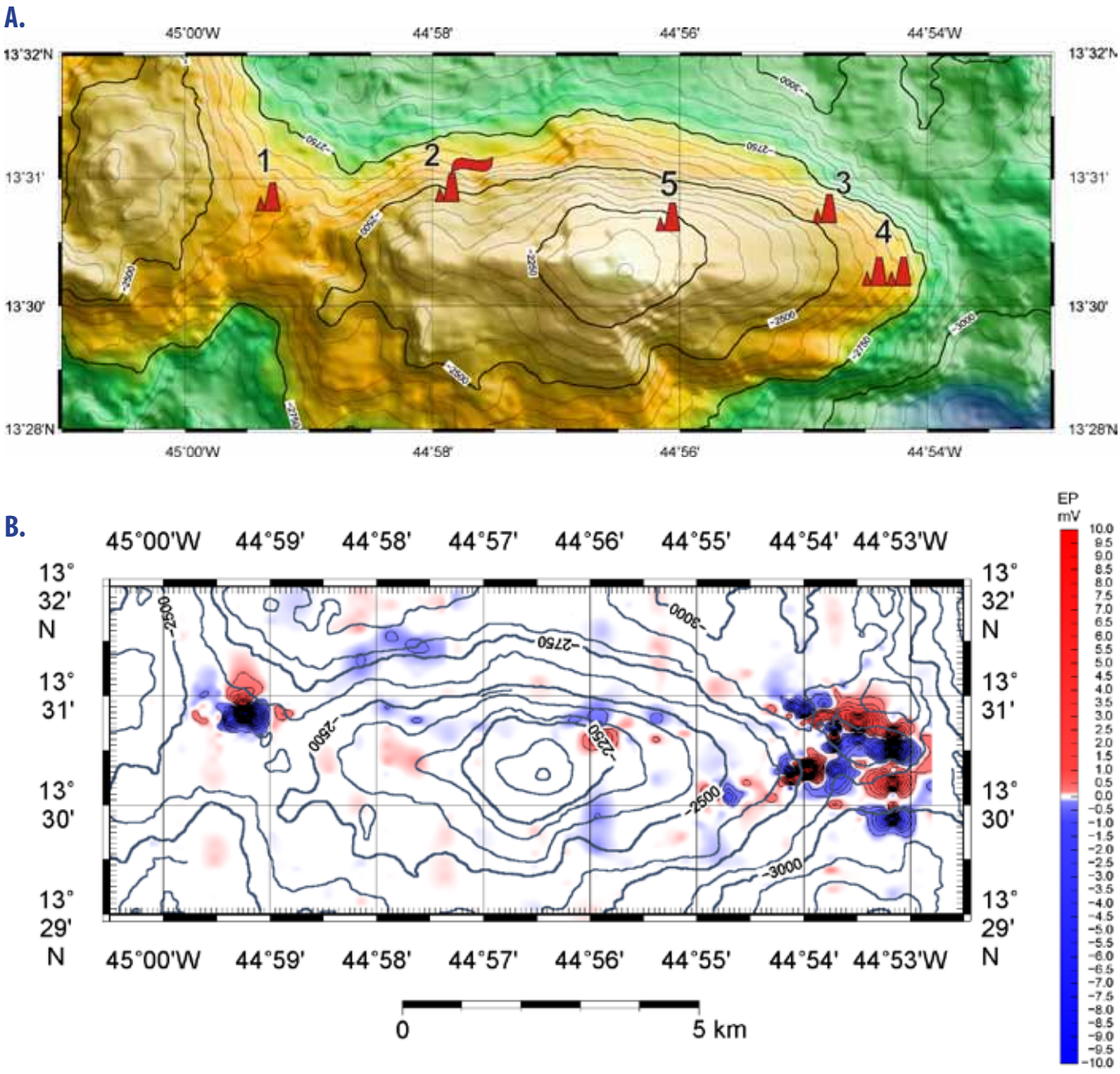
dispersal of hydrothermal vent fauna along the MAR. There is evidence to believe that this dispersal is a recent process and its direction is from south to north (Gebruk and Mironov, 2006).

Site 3 is located at 2300-2640 m water depth. This site has not yet been thoroughly investigated. A massive sulfide deposit is hosted here by both basalts and serpentinitized peridotites. The dimension of the deposit is 1200x650 m. Massive sulfides were recovered from one grab sample only. Iron sulfides (pyrite and marcasite) are the major minerals (up to 60 %) in this sample. Altered rocks with quartz and stockwork sulfides were reported as well. No indications of hydrothermal activity were detected at site 3.

Site 4 is located deeper than others at the depths of 2560-3020 m. The dimensions of this deposit are also the largest in the Semyenov sulfide district: ~2700x1600 m (!). The northern border of the deposit has not yet been determined, and the EP anomalies detected further north still need to be groundtruthed.

Site 4 was sampled by 15 grabs and 3 rectangular corers. Prevalent iron sulfide mineralization is represented by pyrite and pyrite-marcasite (with the mean value of 43%), but copper sul-

Figure 3: Semyenov sulfide district. **A.** Location of hydrothermal sites. The symbol at Site 2 indicates current hydrothermal activity, and the symbol at Site 4 indicates the relatively large size of the deposit. **B.** Electric potential (EP) anomalies.



fides (chalcopyrite and secondary copper sulfide minerals) are also abundant and have been recovered from 6 stations (mean value 17%).

The following N-S trending zones in the distribution of geochemical types of the sulfide mineralization were reported for deposit 4:

1. Hydrothermal deposits enriched in copper sulfides (50-80%) are located in the NE area of site 4. Copper mineralization is represented by chalcopyrite and secondary copper sulfides (7-15%). Sulfide chimneys consist of chalcopyrite-pyrite and chalcopyrite-marcasite-pyrite associations. Massive chalcopyrite-pyrite ores as well as chalcopyrite-marcasite-pyrite breccias are also reported.
2. Iron sulfides (pyrite and melnikovite-pyrite with barite) predominate in the western and eastern areas of deposit 4.
3. Basalts with quartz and sulfide stockwork as well as iron sulfides have been recovered from the SW part of deposit 4.

The association of iron sulfides (major minerals) and copper sulfides (minor minerals) characterize the remainder of deposit 4. No indications of hydrothermal activity were detected at site 4.

Site 5 is located at 2160-2340 m water depth. This site has not yet been thoroughly investigated. A massive sulfide deposit is hosted here by both basalts and serpentinitized peridotites. The dimension of the deposit is 700x500 m. Massive sulfides were recovered from two grab samples and one dredge. Copper-iron sulfides (chalcopyrite-pyrite assemblage) are the major type of mineralization. Chimneys are mainly associated with peridotites. Disintegrating iron sulfides with a high degree of oxidation were recovered further to the east of site 5. No indications of hydrothermal activity were detected at this site.

Summary

The following results are reported for the 32nd cruise of R/V *Professor Logatchev*:

1. Two areas with indications of hydrothermal activity were detected at the MAR segment between 11° - 12°30'N.
2. The existence of four earlier discovered hydrothermal sites was confirmed at the sulfide district Semyenov (13°31'N). New data about their setting, size, and composition were collected.
3. The new hydrothermal site (Semyenov-5) was discovered at the summit of the seamount.
4. Modern hydrothermal activity was detected at Semyenov site 2.
5. The sulfide deposit Semyenov-4 is the largest known in the MAR. Its resources are at least three times bigger than those of the Krasnov deposit.
6. The composition of sulfide mineralization at all Semyenov sites is represented by iron and copper sulfides in considerable variety.

Acknowledgements

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To access the InterRidge Cruise Database,
our online "News from the Ridge Crest,"
and daily logs from cruise websites, please see:
http://www.interridge.org/cruise

First record of *Pachycara thermophilum* (Pisces, Zoarcidae) from Ashadze Hydrothermal Vent Field (Mid-Atlantic Ridge, 13°N)

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Introduction

The genus *Pachycara* is represented in the Atlantic Ocean by eight species (Anderson and Fedorov, 2004; Biscoito and Almeida, 2004; Anderson and Mincarone, 2006), two of which are restricted to deep-sea hydrothermal vents on the Mid-Atlantic Ridge: *P. thermophilum* Geistdoerfer, 1994, from Broken Spur (29°10'N, 43°10.3'W, 3020 m), TAG (26°08'N, 44°49' W, 3600 m), Snake Pit (23°22'N, 44°57'W, 3480 m) and Logatchev (14°45'N, 44°58.7'W, 3000 m), and *P. saldanhai* Biscoito & Almeida, 2004, from Rainbow (36°13.1'N, 33°54.35'W, 2300 m) (Biscoito *et al.*, 2002; Biscoito and Almeida, 2004).

In 2007 the French-Russian Serpentine cruise took place at the northern Mid-Atlantic Ridge (NMAR) on board the French R/V *Pourquoi Pas?* (Fouquet *et al.,* 2008). The objective was to determine the geological, geochemical, biological and microbiological variability of hydrothermal systems at two recently discovered sites, Ashadze and Krasnov, that were not yet studied and sampled with submersibles. Additional sampling was also planned on the Logatchev hydrothermal field.

Ashadze-1 hydrothermal vent field (12°58'N, 44°51'W, 4080m, southernmost confirmed active vent on the NMAR; Fig. 1), is the deepest known black smoker field, located on serpentinized peridotites (mantle rock altered by sea water). After its discovery in 2003 (Beltenev *et al.*, 2003), Ashadze-1 was revisited in 2005 (Beltenev *et al.*, 2005), but no remarks on the fish fauna were made.

In the course of the Serpentine cruise three new specimens of *P. thermophilum* were collected, two at Logatchev and one at Ashadze hydrothermal vent field, the latter being the southernmost and deepest record of this species. The confirmation of the specimens' identities and their counts and measurements are reported herein.

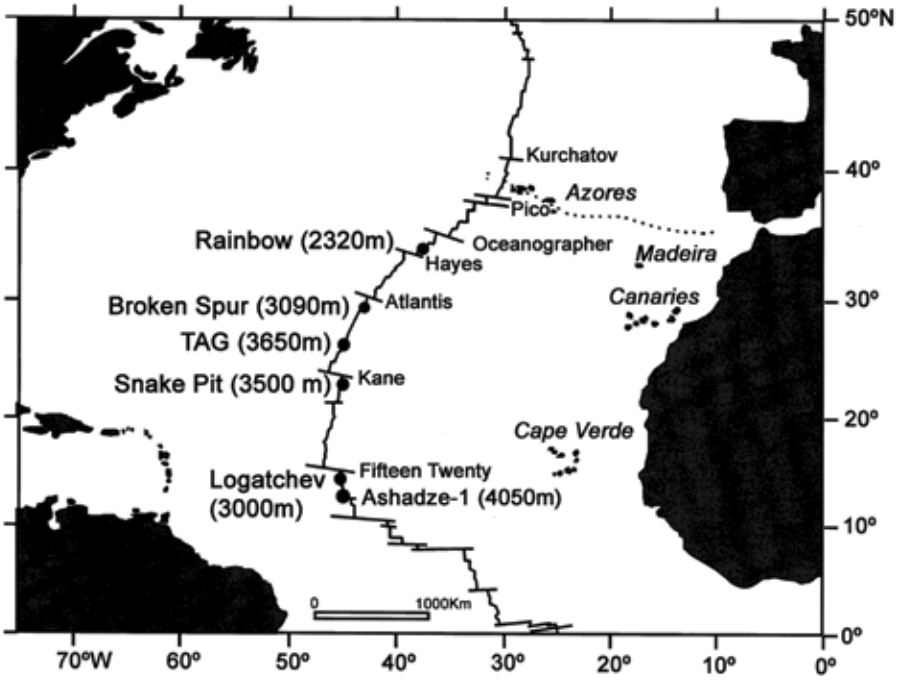

Figure 1: Hydrothermal vent fields on NMAR where *Pachycara* spp. occur.

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Materials and methods

All specimens were collected with the suction sampler of the Remotely Operated Vehicle (ROV) *Victor 6000* during three dives, one (312-03) at Ashadze-1 and two (315-06 and 316-07) at Logatchev.

Measurements were taken on ethanol preserved specimens to the nearest 0.5 mm. Definition of characters and measurements follow those of Anderson (1982, 1994). Vertebrae and fin ray counts were made from x-rays.

Abbreviations used: HL, head length; SL, standard length; IFREMER, Institut Français de Recherche pour l'Exploitation de la Mer; MMF, Museu Municipal do Funchal (História Natural); MNHN, Museum national d'Histoire naturelle.

The specimens will be deposited in the collections of the MNHN and MMF.

Results:

***Pachycara thermophilum* Geistdoerfer, 1994**

(Figs. 2 - 4 and Tab. 1)

Material examined

Specimen 312-03, 124 mm SL, Ashadze-1 hydrothermal vent field, Mid-Atlantic Ridge, 12°58'N, 44°51'W, 4080 m; R/V *Pourquoi Pas?*, Serpentine cruise, ROV *Victor 6000*, dive 312-03, suction sampler; Specimen 315-06, 312 mm SL, Logatchev hydrothermal vent field, Mid-Atlantic Ridge, site Irina-2, 14°45'N, 44°58'W, 3023 m, R/V *Pourquoi Pas?*, Serpentine cruise, ROV *Victor 6000*, dive 315-06, suction sampler; Specimen 316-07 (specimen damaged), 50 mm HL, Logatchev hydrothermal vent field, Mid-Atlantic Ridge, site Irina-2, 14°45'N, 44°58'W, 3022 m, R/V *Pourquoi Pas?*, Serpentine cruise, ROV *Victor 6000*, dive 316-07, suction sampler.

The specimens observed cover a size range from 124 mm to 312 mm SL, the former (Fig. 2) being the smallest specimen of this species ever measured completely. The specimens are well preserved, with the exception of 316-07, which is broken at mid-body. Counts and measurements of all specimens studied are given in Table 1.

Remarks

Up to the present, *P. thermophilum* seems to be the only zoarcid considered endemic to the hydrothermal vents found in the Mid-Atlantic Ridge vent fields south of Rainbow. At Rainbow, this species is substituted by *P. saldanhai* (Biscoito *et al.*, 2002).

Figure 2: (upper) Detail of *Pachycara thermophilum* from Ashadze-1 vent field.

Figure 3: (lower) Ecological setting of ***P. thermophilum*** (centre of image) at Ashadze-1 vent field.

The specimens studied agree well with the re-description of *P. thermophilum* by Anderson and Bluhm (1996) with little discrepancies, which will be discussed elsewhere. The specimen from Ashadze is of particular relevance, as it is the smallest and the deepest of this species collected to date, as well as the southernmost record for the species.

Ecological information

The ecological setting of the Ashadze-1 hydrothermal vent site, where the specimen of *P. thermophilum* was collected, will be described in detail elsewhere (Fabri *et al.*, in prep). As in all other vent fields where this species has been observed, the indi-

Table 1: Measurements and counts of the specimens of *P. thermophilum* studied.

	Ashadze-1	Logatchev	Logatchev
Collection No.	312-03	315-06	316-07
Standard length (mm)	124	312	-
Head length (mm)	19,5	56	50
Measurements, in percent SL			
Head length	16,9	17,9	-
Head width	6,5	7,7	-
Head depth	8,1	8,7	-
Pectoral length	9,7	8,7	-
Predorsal length	21,8	23,7	-
Preanal length	39,5	43,9	-
Body height	9,3	13,8	-
Gill slit length	4,4	4,8	-
Caudal fin length	2,8	1,9	-
Measurements, in percent HL			
Head width	38,1	42,9	54,0
Head depth	47,6	48,2	54,0
Upper jaw length	33,3	48,2	46,0
Pectoral length	57,1	48,2	48,0
Snout length	23,8	25,9	30,0
Eye diameter	14,3	10,7	13,0
Gill slit length	26,2	26,8	38,0
Interorbital width	10,3	16,1	16,0
Interpupillary width	33,3	23,2	30,0
Pelvic fin length	11,9	7,1	8,0
Counts			
Vertebrae	29+82	32+80	30+82
Dorsal fin rays	105	106	104
Anal fin rays	86	86	86
Caudal fin rays	-	-	-
Pectoral fin rays	18	-	18
Pelvic fin rays			
Gill-rakers	2+13	2+12	3+13
Pseudobranchs	4	-	5
Vomerine teeth	5	6	5
Palatine teeth	5	7-6	5-4
Teeth rows on dentary	3-4	4	3
Teeth rows on pre-maxillary	2	2	2
Sub-orbital pores	6	6	6
Post-orbital pores	2	2	2
Preoperculomandibular pores	8	8	8
Nasal pores	2	2	2

Figure 4: *P. thermophilum* at Irina-2 site, Logatchev vent field.

viduals are quite inactive, sitting on the bottom over sulphide deposits or over mussel beds not far away from active chimneys. Although not uncommon, they are not as numerous as the Zoarcid *Thermarces cerberus* at the Pacific Ocean vents. At Ashadze-1 the site is dominated by the actinian *Maractis rimicarivora* and the chaetopterid polychaete *Phyllochaetopterus* n. sp. (Fig. 3). A small baited fish trap was used to try to catch these fish, with no results at all, demonstrating that these fish do not seem to be attracted to conventional baits. A similar behaviour was already observed at Rainbow vent field with *P. saldanhai*.

One specimen (315-06) collected at Logatchev was sitting together with another one amongst the mussels, *Bathymodiolus puteoserpentis* (Fig. 4), close to gastropods *Phymorhynchus* sp. and together with numerous ophiuroids and shrimps *Mirocaris fortunata*. Diffuse venting was present, with a maximum temperature of 16.36°C. The other (316-07) was also near another fish of the same species, sitting together over a *B. puteoserpentis* bed, close to small active black smokers on which a dense population of *Rimicaris exoculata* was present. All of the above four specimens showed a languid behaviour when chased by the suction sampler, not giving the impression that they would be fast swimmers, even when disturbed.

Other fish observations at Ashadze revealed only an unidentified macrourid, swimming near dead or less active chimneys. Macrourids occur quite often at those depths and have been regularly seen in the periphery of active vents (Biscoito *et al.*, 2002).

Acknowledgements

The authors are indebted to the Serpentine Cruise chief scientist, captain and crew of the R/V *Pourquoi Pas?*, and the team of the ROV *Victor 6000* for all the help on board that allowed the collection of the specimens. Thanks are also due to Stace Beaulieu for useful comments on the manuscript and revision of the English.

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Detailed investigation of hydrothermal site Rainbow, Mid-Atlantic Ridge, 36°13'N: Cruise MoMARDream

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Hydrothermal site Rainbow, located on the Mid-Atlantic Ridge (MAR) at 36°13'N, is one of the first hydrothermal sites discovered on an ultramafic basement (Fouquet et al., 1997). The sulfide mineralization exhibits high concentrations of copper, zinc, gold, nickel and cobalt (Marques et al., 2006), and the hydrothermal fluid is remarkably abundant in natural hydrogen, methane, and iron (Charlou et al., 2002). Indeed, at Rainbow, iron plays an essential role in producing the strong magnetic anomalies discovered in 2001 (Dyment et al., 2005), and a symbiosis with bacteria based on iron oxidation is proposed for the shrimp *Rimicaris exoculata* (Zbinden et al., 2004).

In Aug. - Sept. 2008, cruise MoMARDream (MoMAR'08, Leg 2) of R/V *L'Atalante* with ROV *Victor* revisited site Rainbow to achieve: (1) a multidisciplinary, multi-scale study of the hydrothermal processes on an ultramafic basement, with a special focus on the role of iron; and (2) a systematic mapping and inventory of the site to (a) provide a reference state for future repeated observations and/or a permanent observatory in the framework of the MoMAR project (http://www.momar.org), and (b) help to define possible drilling sites to support a revised IODP proposal. To fulfill these objectives, ROV *Victor* was used in both the "survey" and "sampling" modes. During maintenance periods, we carried out 15 dredges which add to the already important sample collection from the Rainbow Massif.

ROV *Victor* in "survey" mode realized a full bathymetric and magnetic coverage of site Rainbow and its vicinity at an altitude ~50 m above the seafloor on a 4000 x 2500 m box, with profile interval of ~120 m. In addition, higher resolution bathymetric and magnetic surveys as well as complete vertical photographic coverage were achieved at an altitude ~10 m above the seafloor, with ~10 m profile interval, on three boxes: a 500 x 500 m box over site Rainbow, and two boxes, respectively 300 x 300 m and 100 x 100 m, east of site Rainbow, on the crest of the Rainbow Massif. Temperature and nephelometry data were also acquired on parts of these surveys.

ROV *Victor* in "sampling" mode devoted a full dive and part of another dive to the geological exploration of areas located south and north of the site, as possible signs for other active or fossil hydrothermal fields had been observed on the magnetic data. No active site was found, although evidence for fossil low-temperature hydrothermal activity was widespread. Sulfide and serpentinite samples were collected for mineralogical and magnetic property analyses. Seven dives were devoted to chemical and biological experiments, including the collection of shrimps, mussels (Figure 1), and a broken chimney fragment, and the deposition and recovery of biological colonization modules. Measurement of chemical parameters and collection of diffused fluid samples were carried out at a number of points around Thermitière, on the most active part of the site, for a detailed study of the bio-geochemical interactions. Samples of pure hot fluids were also collected for inorganic and organic geochemical analyses. Such samples have been collected during most of the cruises visiting the site since its discovery for geochemical data compilation and time-series study.

The large harvest of data and samples obtained during the cruise is currently being analyzed. An excerpt of the bathymet-

Figure 1: ROV *Victor* collects mussels at Rainbow – a difficult task requiring highly specialized devices!

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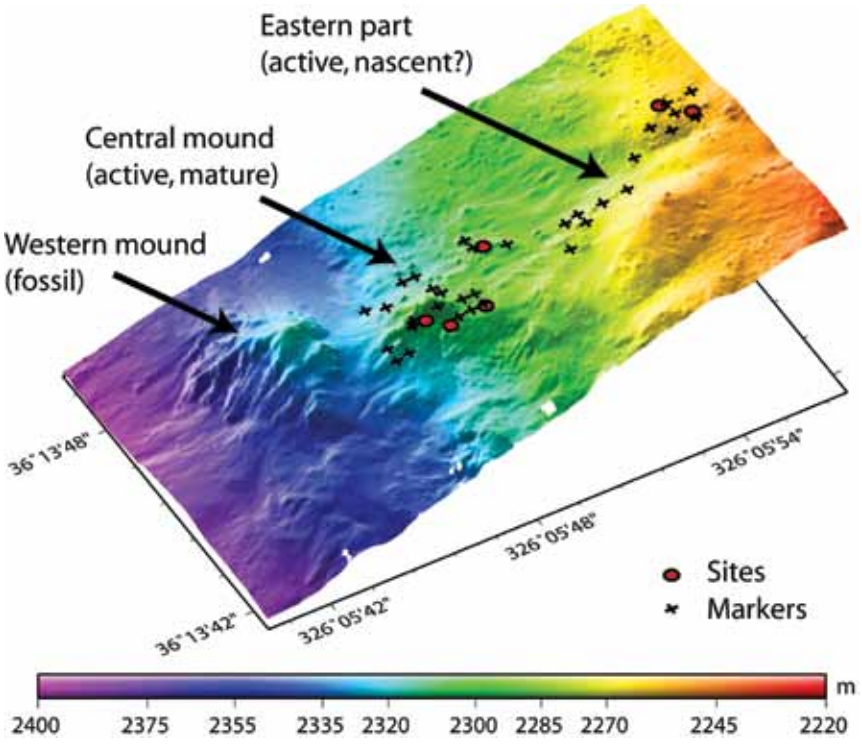

Figure 2: (upper, right) 3D view of the multibeam bathymetry collected by ROV *Victor* at altitude ~50 m (processed by R. Thibaud and P. Gente). Crosses and red circles show the relocated markers and some hydrothermal sites.

Figure 3: (lower, right) Hydrothermal chimney at Rainbow, in the vicinity of site Magali. Note the broken chimney on the right and marker Flores 09 in the background (see Table 1 on next page for location).

ric map acquired at ~50 m altitude shows the overall structure of the site, made of three parts (Figure 2). The western mound, now hydrothermally inactive, displays an accumulation of iron sulfide and represents a fossil, partly dismantled, hydrothermal site. The central mound exhibits chimney groups and strong hydrothermal and biological activity – it is considered as a mature hydrothermal site. The eastern part of the site is made of isolated active chimneys, without any large mound, and may represent a nascent hydrothermal site. The systematic survey allowed us to revisit and relocate many markers set up during previous cruises (Figure 3). Table 1 on the next page gives the relocated position of known markers at Rainbow.

For a summary of the previous cruise MoMARDream-Naut, please refer to the article by Gaill et al. in the 2007 InterRidge News.

Acknowledgements

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Table 1: Relocated sites and markers at site Rainbow (prepared by J. Renard).

SITES	Latitude (Decimal °)	Longitude (Decimal °)	Latitude	Longitude	Depth (m)[1]
Jean-Luc	36.229100	-33.903367	36 ° 13 ' 44.76 " N	33 ° 54 ' 12.12 " W	2307
Caroline	36.229489	-33.901141	36 ° 13 ' 46.16 " N	33 ° 54 ' 4.11 " W	2249
Thermitiere	36.229482	-33.902832	36 ° 13 ' 46.14 " N	33 ° 54 ' 10.20 " W	2297
Magali	36.229217	-33.903483	36 ° 13 ' 45.18 " N	33 ° 54 ' 12.54 " W	2309
Hisako	36.229100	-33.903083	36 ° 13 ' 44.76 " N	33 ° 54 ' 11.10 " W	2302
Thin Chimney	36.229700	-33.901258	36 ° 13 ' 46.92 " N	33 ° 54 ' 4.53 " W	2260

MARKERS	Latitude (Decimal °)	Longitude (Decimal °)	Latitude	Longitude	Depth (m)[1]	Cruise & Year	Valid. / Comp.[2]
Flores 01 / F1	36.229165	-33.902219	36 ° 13 ' 44.99 " N	33 ° 54 ' 7.99 " W		Flores 1997	Comp.
Flores 02 / F2	36.229115	-33.902402	36 ° 13 ' 44.81 " N	33 ° 54 ' 8.65 " W		Flores 1997	Comp.
Flores 03 / F3	36.229132	-33.903126	36 ° 13 ' 44.88 " N	33 ° 54 ' 11.25 " W		Flores 1997	Comp.
Flores 04 / F4	36.229692	-33.901036	36 ° 13 ' 46.89 " N	33 ° 54 ' 3.73 " W		Flores 1997	Valid.
Flores 05 / F5	36.229537	-33.901553	36 ° 13 ' 46.33 " N	33 ° 54 ' 5.59 " W		Flores 1997	Comp.
Flores 06 / F6	36.229115	-33.903693	36 ° 13 ' 44.81 " N	33 ° 54 ' 13.29 " W		Flores 1997	Comp.
Flores 07 / F7	36.229199	-33.903610	36 ° 13 ' 45.12 " N	33 ° 54 ' 13.00 " W		Flores 1997	Comp.
Flores 08 / F8	36.229382	-33.902736	36 ° 13 ' 45.78 " N	33 ° 54 ' 9.85 " W		Flores 1997	Comp.
Flores 09 / F9	36.229154	-33.903825	36 ° 13 ' 44.95 " N	33 ° 54 ' 13.77 " W	2321	Flores 1997	Valid.
Flores 10 / F10	36.229548	-33.901255	36 ° 13 ' 46.37 " N	33 ° 54 ' 4.52 " W	2259	Flores 1997	Valid.
PP27	36.229566	-33.902856	36 ° 13 ' 46.44 " N	33 ° 54 ' 10.28 " W	2290	French before 2001	Valid.
PP37	36.229273	-33.902221	36 ° 13 ' 45.38 " N	33 ° 54 ' 8.00 " W	2281	French, before 2001	Valid.
Iris 3	36.229500	-33.903650	36 ° 13 ' 46.20 " N	33 ° 54 ' 13.14 " W		Iris 2001	Comp.
Iris 4	36.229584	-33.903384	36 ° 13 ' 46.50 " N	33 ° 54 ' 12.18 " W	2320	Iris 2001	Valid.
Iris 5	36.229400	-33.903267	36 ° 13 ' 45.84 " N	33 ° 54 ' 11.76 " W		Iris 2001	Comp.
Iris 6	36.229650	-33.903283	36 ° 13 ' 46.74 " N	33 ° 54 ' 11.82 " W		Iris 2001	Comp.
Iris 7	36.229283	-33.902283	36 ° 13 ' 45.42 " N	33 ° 54 ' 8.22 " W	2276	Iris 2001	Comp.
Iris 9	36.229281	-33.901842	36 ° 13 ' 45.41 " N	33 ° 54 ' 6.63 " W	2255	Iris 2001	Valid.
Iris 11	36.229217	-33.903650	36 ° 13 ' 45.18 " N	33 ° 54 ' 13.14 " W		Iris 2001	Comp.
Iris 13	36.229261	-33.903299	36 ° 13 ' 45.34 " N	33 ° 54 ' 11.88 " W	2292	Iris 2001	Valid.
EXO1	36.229508	-33.901083	36 ° 13 ' 46.23 " N	33 ° 54 ' 3.90 " W	2248	Exomar 2005	Valid.
EXO2	36.229485	-33.902878	36 ° 13 ' 46.15 " N	33 ° 54 ' 10.36 " W	2295	Exomar 2005	Valid.
EXO3	36.229245	-33.903577	36 ° 13 ' 45.28 " N	33 ° 54 ' 12.88 " W	2311	Exomar 2005	Comp.
JL	36.229125	-33.903249	36 ° 13 ' 44.85 " N	33 ° 54 ' 11.70 " W		Revelle 2008	Valid.
US B	36.229597	-33.901379	36 ° 13 ' 46.55 " N	33 ° 54 ' 4.96 " W	2265	Revelle MAR 2008	Valid.
US C	36.229183	-33.903350	36 ° 13 ' 45.06 " N	33 ° 54 ' 12.06 " W	2309	Revelle MAR 2008	Valid.
US E	36.229306	-33.901982	36 ° 13 ' 45.50 " N	33 ° 54 ' 7.14 " W	2271	Revelle MAR 2008	Valid.
X3	36.229153	-33.903171	36 ° 13 ' 44.95 " N	33 ° 54 ' 11.42 " W		Revelle MAR 2008	Valid.
X6	36.229126	-33.903343	36 ° 13 ' 44.85 " N	33 ° 54 ' 12.03 " W		Revelle MAR 2008	Valid.
X7	36.229207	-33.903126	36 ° 13 ' 45.15 " N	33 ° 54 ' 11.25 " W	2300	Revelle MAR 2008	Valid.
X11	36.229611	-33.901202	36 ° 13 ' 46.60 " N	33 ° 54 ' 4.33 " W	2258	Revelle MAR 2008	Valid.
TIC	36.220833	-33.894841	36 ° 13 ' 15.00 " N	33 ° 53 ' 41.43 " W	2081	MomarDream 2008	Valid.
TAC	36.229655	-33.901250	36 ° 13 ' 46.76 " N	33 ° 54 ' 4.50 " W	2258	MomarDream 2008	Valid.
Soliton	36.229259	-33.902182	36 ° 13 ' 45.33 " N	33 ° 54 ' 7.86 " W	2275	MomarDream 2008	Valid.
Russian marker	36.229617	-33.903733	36 ° 13 ' 46.62 " N	33 ° 54 ' 13.44 " W		??	Comp.
Cylinder	36.229107	-33.903759	36 ° 13 ' 44.79 " N	33 ° 54 ' 13.53 " W	2320	??	Valid.

[1] Depth is the reported depth from cruise.
[2] Valid means that the location has been validated during cruise MomarDream, Comp means that the location has been modified taking into account the average shift, determined for each previous cruises, between the original and relocated coordinates for all validated location.

OSPAR to protect the Alps of the undersea: Progress and drawbacks on the Charlie-Gibbs Marine Protected Area

Stephan Lutter[1]

It was a groundbreaking and milestone achievement when the OSPAR Commission for the Protection of the Marine Environment of the North-East Atlantic (http://www.ospar.org) agreed in principle to pursue the establishment of the first Marine Protected Area (MPA) in Areas Beyond National Jurisdiction (ABNJ). The proposal and scientific rationale to nominate, to the OSPAR network of MPAs, a 320,000 square km section of the Mid-Atlantic Ridge (MAR) including the Charlie-Gibbs Fracture Zone (Fig. 1) had been developed by World Wide Fund for Nature (WWF), reviewed by the International Council for the Exploration of the Sea and independent scientists, co-sponsored by France, Germany, the Netherlands, and Portugal, and finally accepted unanimously by the 15 Contracting Parties (pending a reservation by Denmark on behalf of the Faroe Islands) in June 2008. In parallel, further candidate sites in ABNJ were identified including two smaller sections of the

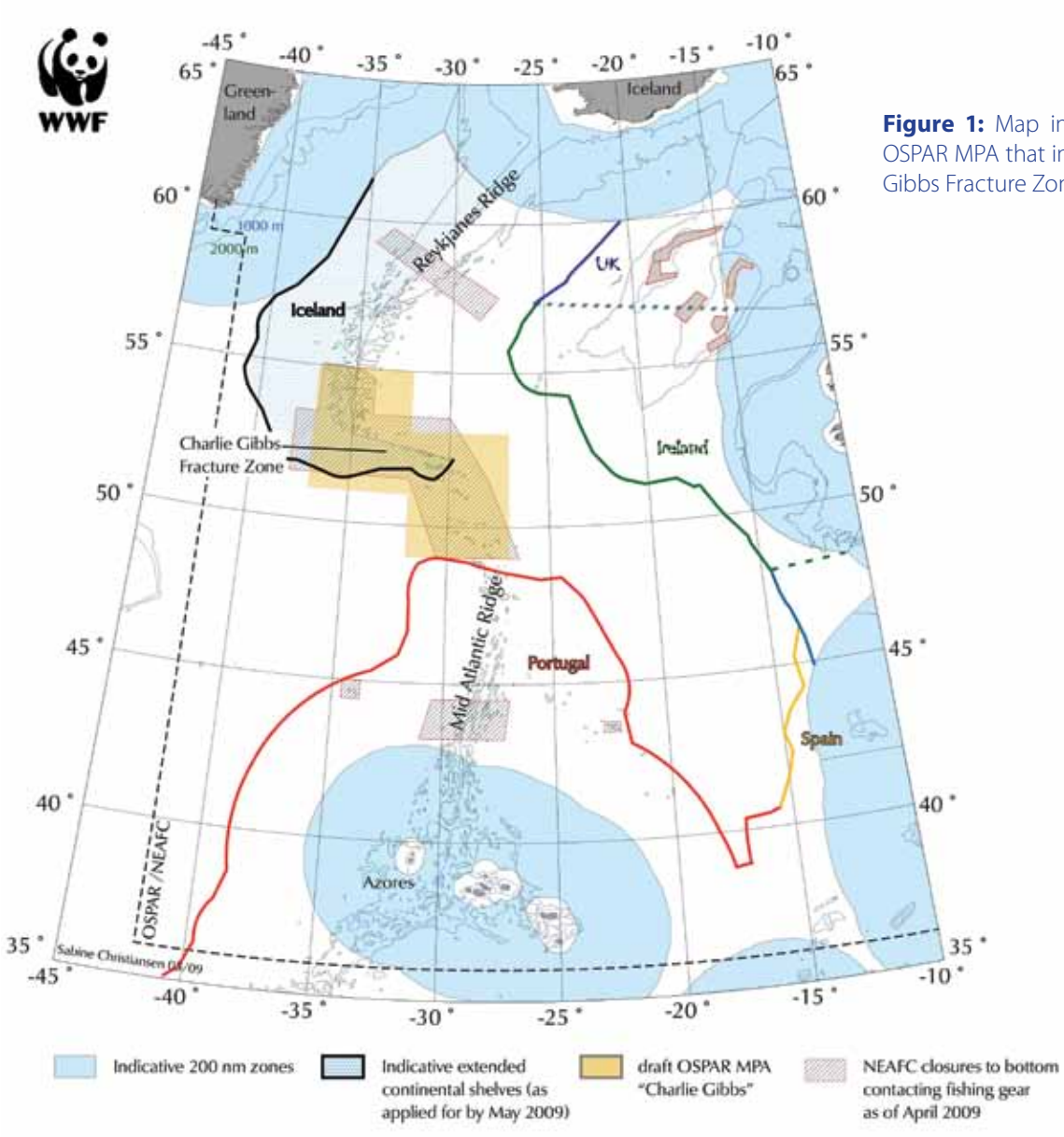

Figure 1: Map indicating proposed OSPAR MPA that includes the Charlie-Gibbs Fracture Zone.

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MAR to the north and south. The OSPAR Commission also agreed on a roadmap to designate the Charlie-Gibbs MPA and make it operational for sign-off by its Ministerial Meeting in Bergen, Norway, September 2010.

The proposed High Seas MPA (Fig. 1) includes the eponymous fracture zone connecting two parts of the North Atlantic abyssal plain and the giant mountain range of the MAR rising up to 3,500 metres above it. The MPA also includes the overlying water column, teeming with life in the meandering sub-polar front. As one of the projects of the Census of Marine Life, MAR-ECO (http://www.mar-eco.no/) has brought a tremendous amount of new information about deep-sea biodiversity to light from the area. It is assumed that Vulnerable Marine Ecosystems such as cold-water coral and sponge aggregations occur (Fig. 2). Deep-water fish stocks, e.g., sharks, roundnose grenadier (Fig. 3), and orange roughy often associated with seamount communities, belong to the proposed MPA's characteristic benthic and bathypelagic features. These species all deserve strict protection according to the OSPAR list of threatened and declining species and habitats which has also been addressed by the 2006 UN General Assembly resolution on sustainable fishing. Consequently, in April 2009 the North-East Atlantic Fisheries Commission (NEAFC) decided to close off most of the prospective Charlie-Gibbs MPA and two other sections of the MAR to the use of fishing gear in contact with the seafloor.

While such cooperation between OSPAR and NEAFC, meanwhile carved in stone by a Memorandum of Understanding, is the most logical step to implement the Charlie-Gibbs MPA roadmap at regional seas level, there is more work ahead with regard to other regulatory authorities that are competent to put the necessary management measures in place. Again, OSPAR is currently pioneering in mapping out and consulting such managing needs and options with the bodies concerned, including the International Maritime Organisation, International Seabed Authority, and International Whaling Commission (whose stakeholders will meet at a workshop in April 2010 to discuss further action). Once again, WWF is informing this process with ideas and suggestions for managing and monitoring human activities in a future High Seas MPA, as well as advocating to make use of existing Codes of Conduct for responsible deep-sea research (such as the InterRidge statement of commitment: http://www.interridge.org/IRstatement).

Recently, however, a big stumbling block slipped into the "road to Charlie-Gibbs" as several North-East Atlantic Coastal States had made their submissions to the UN Commission on the Limits of the Continental Shelf with Iceland claiming a considerable portion of the ridge's seabed between the fracture zone and the northern boundary of the proposed MPA (for reference, see OSPAR Commission Meeting, June 2009, Summary Record, §§ 6.9-6.16, http://www.ospar.org). It is therefore suggested to postpone further efforts to designate and implement the MPA in its current shape until the boundaries of the outer continental shelf are sorted out at the UN. While legal experts are now seeking solutions and testing scenarios including modifica-

Figure 2: (upper) Deep-sea corals and sponges observed on dive with submersible ***Mir*** on a MAR-ECO cruise (photo credit: Yuri Shcherbachev).

Figure 3: (lower) The roundnose grenadier, ***Coryphaenoides rupestris***, a commercially exploited deep-sea macrourid (photo credit: O.A. Bergstad).

tion of the site's boundaries, WWF stays in favour of keeping the momentum and concerted action by international and national authorities in order not to jeopardise an important international precedent in High Seas and deep-water ecosystem conservation.

Additional information

WWF news story:
http://www.panda.org/about_our_earth/blue_planet/deep_sea/seamounts/alps_of_the_undersea/

WWF fact sheet:
http://www.ngo.grida.no/wwfneap/Publication/briefings/MAR_factsheet.pdf

WWF scoping of management measures:
http://www.ngo.grida.no/wwfneap/Publication/Submissions/OSPAR2009/WWF_OSPAR09_CHarlie_Gibbs_Annex.pdf

OSPAR information:
http://www.ospar.org/content/content.asp?menu=00120000000011_000000_000000

MAR-ECO / NEAFC information:
http://www.mar-eco.no/mareco_news/2009/areas_on_the_mid-atlantic_ridge_closed_to_fisheries

http://www.neafc.org/

Additional regions of mid-ocean ridges that are currently designated or formally nominated as MPAs

Endeavour Hydrothermal Vents, Juan de Fuca Ridge (Canada)

Status: MPA as of 2003
For more information: http://www.pac.dfo-mpo.gc.ca/oceans/mpa/Endeavour_e.htm

Guaymas Basin and 21°N East Pacific Rise (Mexico)

Status: MPA as of 2009
Official announcement (in Spanish):
http://dof.gob.mx/nota_detalle.php?codigo=5093568&fecha=05/06/2009

Lucky Strike, Menez Gwen, and Rainbow Hydrothermal Vents, Mid-Atlantic Ridge (Portugal)

Current status: These three vent fields are reported by Portugal to the OSPAR Network of MPAs.

Deep-sea hydrothermal vents are also protected along the Mariana Arc

Marianas Trench Marine National Monument (USA)

Status: MPA as of 2009
For more information: http://www.fws.gov/marianastrenchmarinemonument/

National News

Bulgaria

Vesselin Dekov

Ridge research in Bulgaria includes international collaboration on studies of the Mid-Atlantic Ridge. IR's national correspondent of Bulgaria, Vesselin Dekov, and collaborators from IFM-GEOMAR (Sven Petersen) and University of Kiel (Dieter Garbe-Schönberg) have been funded by Alexander von Humboldt Foundation (Germany) for a lab-based study of the hydrothermal deposits and fluids from the Lilliput hydrothermal field on the southern Mid-Atlantic Ridge. Mineralogy and geochemistry of deposits and fluids sampled at four vent sites from this field during three cruises of the R/V *Meteor* were studied, and the results are going to be submitted for publication soon. Additionally, alteration products of primary sulfides at the Logatchev 1 and 2 fields on the northern Mid-Atlantic Ridge were investigated. This is a development of a study funded by SYNTHESYS (an EU-funded Integrated Infrastructure Initiative grant) in collaboration with the Royal Museum of Natural History, Stockholm.

Figure 1: The IR Office welcomes our new Correspondent to Bulgaria, Vesselin Dekov, shown here working in Sven Petersen's lab of seafloor hydrothermal deposits at IFM-GEOMAR.

NEPTUNE Canada

Adapted from press release, 24 Sep. 2009
For more information, please see: http://www.neptunecanada.ca

Installation cruise success

After a busy summer of operations, our 2009 installation cruises have drawn to a close.

The first part of the summer focused on infrastructure installation, as the C/S *Lodbrog* and the R/V *Atlantis*, working with ROV *ROPOS*, installed 1 Trawl-Resistant Frame, 4 science nodes and 2 fixed instrument platforms.

Next, an instrument installation cruise commenced aboard the R/V *Thompson* (Figure 1). Over the course of 4 intense and amazing weeks, we installed 1 science node and 7 fixed and 2 mobile instrument platforms (mobile platforms are the Vertical Profiler System and the Benthic Crawler, "Wally"). Connected to these platforms are 3 broadband seismometers, 5 bottom pressure recorders, and over 60 other devices. As of this press release, NEPTUNE Canada's Data Management and Archive System (DMAS) has successfully powered up all junction boxes and confirmed communication to over 90% of instruments installed.

The first leg of the cruise onboard R/V *Thompson* (22 August - 7 September) took us to all five node locations, starting

at Endeavour on the Juan de Fuca Ridge (for a map of the proposed system layout at Endeavour, including the Main Endeavour and Mothra hydrothermal vent fields, please refer to: http://www.neptunecanada.ca/sensors-instruments/locations/endeavour.dot). During this leg, we made 10 *ROPOS* installation dives during two very busy weeks.

The second leg (8-20 September) included 16 *ROPOS* dives at four locations, first to Barkley Canyon to install a broadband seismometer and 3 instrument platforms. While there, we also installed temperature probes and retrieved Wally the Crawler from the Barkley Canyon hydrates field. Next, we installed an extension cable in Folger Passage. From Folger Passage we transited 115nm to ODP 1027 to install a second broadband seismometer, then steamed to ODP 889 for installation of the third broadband seismometer and the Controlled-Source Electro-Magnetic (CSEM) and Seafloor Compliance experiments. Finally, before returning to Victoria, we revisited the Barkley Canyon hydrates field to redeploy Wally the Crawler.

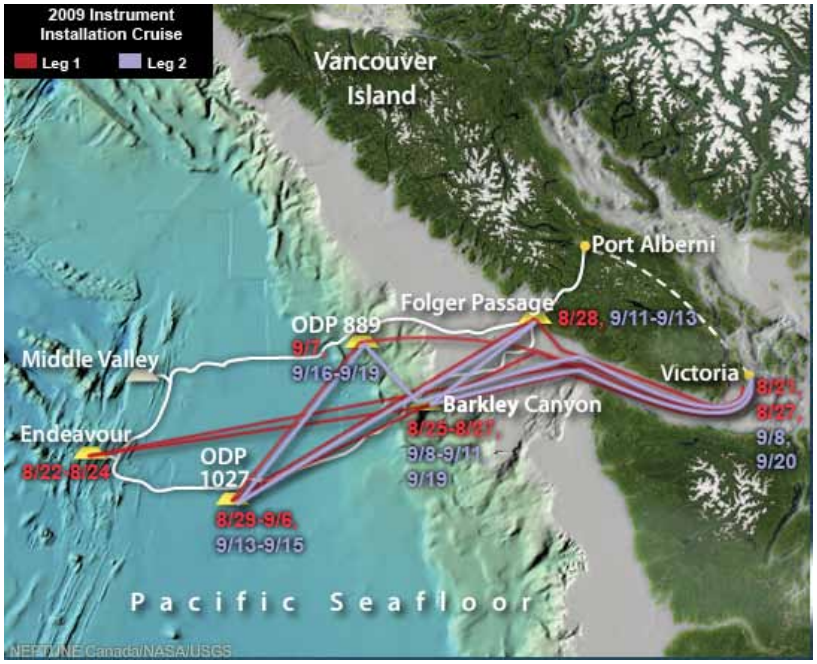


Figure 1: NEPTUNE Canada instrument installation cruise on R/V *Thompson*.

The R/V *Thompson* cruise was successful due to the expertise and hard work of many people. Sincere thanks to the *ROPOS* team and to the R/V *Thompson* team who were instrumental in staging our equipment for deployment, holding some difficult ship positions in challenging seas, and keeping the 24-hour operation going for the cruise duration. We are also highly appreciative of the tremendous efforts put forth by a team of technicians, working for NEPTUNE Canada and Highland Tech, who made sure everything was "fit for deployment."

Additional critical support was provided by the NEPTUNE Canada DMAS team who powered up platforms and instruments from shore to enable live testing. Finally, the shipboard dive logging and communications team helped connect scientists on land with activities on ship, engaging scores of virtual participants in this eventful cruise.

Hot news: Live data from NEPTUNE Canada will begin flowing on 8 December 2009!

China

Y. John Chen and Jiabiao Li

InterRidge-China has been busy with several field research programs in the past year, an international ocean economy forum, and development of deep submergence vehicles.

Field research

R/V *Dayang Yihao* completed a several-leg expedition to the ultraslow-spreading Southwest Indian Ridge (SWIR) in Oct. 2008 - March 2009. In particular, the 5th leg of the DY115-20 expedition discovered an inactive hydrothermal vent field at 50.4671°E, 37.6579°S. Two areas of sulfide deposits within this inactive hydrothermal field were confirmed tentatively by video system and nine TV-grabber samples. This inactive field is located on the shallowest portion of Segment 27 of the SWIR west of the Gallieni Transform Fault, about 49 miles east of the active hydrothermal vent field on Segment 28. Dead bi-

valve and gastropod shells were collected, suggestive of recent hydrothermal activity. More details on the discovery of seafloor massive sulfides in this region are posted at the IR website in an article by Chunhui Tao and the science party of cruise DY115-20 Leg 5 (http://www.interridge.org/node/5706).

Other field research included the first Chinese OBS experiment in the South China Sea, conducted in Apr. - June 2009 (PI Jiabiao Li; 37 OBS deployed, 34 OBS recovered). The current expedition of R/V *Dayang Yihao* started in July 2009 and will repeat the track of the 2005 voyage. Chief Scientist for this expedition, Chunhui Tao, was interviewed by China View prior to the cruise (video posted at: http://news.xinhuanet.com/english/2009-07/20/content_11744215.htm).

In terms of upcoming research, the first Chinese OBS experiment at the Southwest Indian Ridge at 50°W is planned for Jan. - Feb. 2010 (expect to deploy 24 OBS). Future plans include a COMRA SWIR Observatory and a potential proposal for drilling of Indian Ocean hydrothermal vents. We encourage scientists of other countries to collaborate and join in using R/V *Dayang Yihao* for ridge studies.

International ocean economy forum

The inaugural Qingdao International Blue Economy Summit Forum (http://oceanforum.qingdao.gov.cn/) was held in Qingdao in August 2009. This summit forum is designed as a platform for high-level international exchange on major issues of ocean economy and development, science and technology, and protection. The 2009 summit forum was attended by more than 500 participants with guests and representatives from UN organizations and various nations. Invited speakers included InterRidge Chair Jian Lin.

Deep submergence vehicles

In June 2009 the Chinese ROV *Hailong 2* (*Sea Dragon 2*) was tested in the South China Sea. A press release of the ROV *Hailong 2* collecting sulfides at the equatorial East Pacific Rise in October 2009 can be seen at: http://news.xinhuanet.com/english/2009-11/03/content_12377302.htm. China is also developing a submersible capable of working to 7000-m depth. A test of the 7000-m human-occupied vehicle is planned for late 2009 or early 2010. R/V *Xiangyanghong #9* is currently hosting this vehicle.

France

Jérôme Dyment

The French representatives to InterRidge were happy to welcome the IR Steering Committee Meeting which took place in Paris on July 10th and 11th at Centre National de la Recherche Scientifique (CNRS) headquarters, Paris. The meeting was hosted by Françoise Gaill, Director of the new Institute for Ecology and Environment (INEE), and Jérôme Dyment, Chargé de Mission of the National Institute for Earth Science and Astronomy (INSU).

MOMAR

A large part of French efforts on ridge studies has focused on the MOMAR project, initiated by InterRidge a decade ago and now part of the ESONET-EMSO (European Multidisciplinary Seafloor Observatory) initiative for deep-sea observatories in the European seas (http://www.esonet-emso.org/).

After several postponements – the latest due to the requisition of the ship and submersibles for the search of the black boxes and aircraft remains of the lost Rio-Paris flight, cruise BATHYLUCK (PI J. Escartin) finally took place in September 2009 on R/V *Pourquoi pas?* with ROV *Victor* and AUV *ASTER*^{X}. The cruise, an integrated, multi-scale study of the Lucky Strike area (Mid-Atlantic Ridge, 37°N), was designed to understand the interplay between tectonics and volcanism along the zone of crustal accretion, constrain the physical and chemical characteristics and temporal evolution of hydrothermal activity, and investigate their effect on geo-microbiological interactions. More information on the cruise can be found (in French) at: http://www.insu.cnrs.fr/co/bathyluck09/blog.

Plans for 2010 include: (1) cruise MOMARSAT (PIs M. Cannat, J. Blandin and P.M. Sarradin), a demonstration mission supported by ESONET which will deploy an acoustically-linked multidisciplinary observing system at the Lucky Strike vent field with satellite connection to shore; and (2) cruise HYDROBS-MOMAR (PI J. Perrot) aimed to continue the experiment of hydrophones in the SOFAR channel around the MOMAR area.

Indian Ridges

In Jan. - Feb. 2009, cruise GEISEIR (PI C. Hémond) on R/V *Marion Dufresne* explored the Southeast Indian Ridge (SEIR) between 86° and 99°E and achieved a dense collection of dredged and wax-core samples (about one sample per 8 km) over ~1200 km in order to investigate the isotopic heterogeneities observed along this ridge and, in fine, the dynamics of the underlying mantle. The deployment of MAPRs during sampling (collaboration with Ed Baker, NOAA, USA) allowed the detection of several hydrothermal plumes.

Plans for 2010 in the Indian Ocean include: (1) cruise GEISEIR 2 (PI C. Hémond), to extend further west the area studied during GEISEIR; (2) cruise OHA-SIS-BIO (PI J.-Y. Royer) to continue and expand the hydrophone experiment designed to monitor the seismicity of the three Indian ridges and the deformation zone of the Central Indian Ocean, as well as the vocal activity of marine mammals; and possibly (3) cruise SMOOTHSEAFLOOR (PIs D. Sauter and M. Cannat) aimed to better constrain the composition, structure, magnetic signature and mode of formation of the "smooth seafloor" domains described during a previous cruise on the Southwest Indian Ridge (Cannat et al., *Geology*, 2006).

Pacific Ridges

The three cruises planned in the northeastern Pacific Ocean onboard newly refurbished R/V *L'Atalante* with deep-sea submersible *Nautile* and AUV *ASTER*^{X} have been re-scheduled to spring 2010. Cruise PARISUB (PI P. Gente) will investigate the East Pacific Rise (EPR) at 16°N, in the area of interaction between the Mathematicians hotspot and the spreading axis. Cruise MESCAL (PIs F. Lallier and N. Le Bris), on EPR at 9, 11, and 13°N, will focus on the colonization strategies and the adaptation of *Alvinella pompejana* to thermal and chemical stresses, as well as the integrative biology of thiotrophic endosymbiosis. Cruise BIG (PI A. Godfroy), in the Guaymas Basin, will characterize the physicochemical gradients and the associated microbial and animal communities in the hydrothermal vents and cold seeps observed in this basin, to evaluate the taxonomical and functional similarities/differences between these habitats.

Germany

Colin Devey

The German Ridge program entered its final phase of operations in 2009, with the last two cruises to the Mid-Atlantic Ridge: one to the Logatchev hydrothermal vent field (MSM10/3) and one to the south equatorial area 4-11°S (M78/2). Highlights of these cruises were extensive in situ biological work at Logatchev and the first successful deployments of the new 6000 m-capable ridge research AUV "*ABYSS*" (Figure 1). "*ABYSS*" is equipped with Eh and turbidity sensors specifically for hydrothermal prospecting as well as a multibeam echosounder (Reson 7125), side-scan sonar, sediment-penetrating echosounder, and camera/flash system. The first mapping work in the region around the Lilliput hydrothermal area at 9°30′S in 1500-m water depth has returned maps in unprecedented detail which will greatly help with volcanological interpretations (see Haase et al., 2009, Diking, young volcanism and diffuse hydrothermal activity on the southern Mid-Atlantic Ridge: The Lilliput field at 9°33'S. Marine Geology 266: 52-64). The Turtle Pits vent site near 5°S is still at 407°C.

Ridge work in Germany will not finish of course with the German Ridge program. Already cruises to the Woodlark Basin are planned for Nov. 2009 (PI C. Devey) to study ocean basin formation. Also, the German Research Foundation funded a Cluster of Excellence at MARUM, Bremen, for the years 2008-2012 that includes a large research program for geological, chemical and biological research on hydrothermal vents.

Figure 1: Thumbs up for the deployment of the AUV "*ABYSS*."

The following cruises are funded through this program: a) MomarMap, RV *Poseidon* P402; 30 Jul. - 10 Aug. 2010; Menez Gwen, Azores; AUV and ROV *Cherokee* Bremen; Chief Scientist: Christian Borowski; b) MenezMar, RV *Meteor* M82/3; 30 Aug. - 8 Oct. 2010; Menez Gwen, Azores; ROV *Quest* Bremen; Chief Scientist: Nicole Dubilier; c) Bambus, RV *Sonne*, June 2011; Manus Basin; ROV *Quest* Bremen; Chief Scientist: Wolfgang Bach. For both cruises to Menez Gwen, scientists from other nations, including Portugal, have been invited.

The German Ridge group, together with colleagues from other InterRidge nations, encourages articles for a new themed volume of G-cubed: "Life, energy and material cycles at slow-spreading ridges" (theme editors: Colin Devey, Nicole Dubilier, Jian Lin, Nadine Le Bris and Doug Connelly). Because of the complex interplay between magmatism, tectonism and hydrothermalism, determining fundamental principles of how slow-spreading ridges and their associated ecosystems work has required time-consuming and costly studies of relatively large areas of the seafloor, often with remotely-operated or autonomous vehicles. The first fruits of a new generation of such studies are now becoming available. This theme is intended to provide a focus for results of recent studies on slow-spreading ridges. Visit the G-cubed theme: http://www.agu.org/journals/gc/themes.shtml?collectionCode=MANTLE1&journalCode=GC.

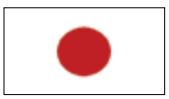
India

K.A. Kamesh Raju

The Indian Ministry of Earth Sciences (MoES) is funding "Studies on Hydrothermal Sulphides" for 2008-2013 with target areas: Carlsberg Ridge, Central Indian Ridge, and Andaman Backarc Spreading Center. The National Institute of Oceanography, Dona Paula, Goa, is the nodal lab, and participating labs are National Geophysical Research Institute (NGRI, Hyderabad), Delhi University (DU, New Delhi), and Inter-University Accelerator Centre (IUAC, New Delhi). The program encourages participation of graduate students from all over India. Plans include deploying AUVs and ROVs during this phase of exploration of slow spreading ridges in the Indian Ocean. India is eager to locate new active vent sites in the Indian Ocean and to initiate vent-specific multidisciplinary experiments. Two cruises to the Carlsberg Ridge in May (completed) and Nov. 2009 were planned under the new program to investigate hydrothermal plumes and to locate the active vent site.

Indian ridge scientists also have been active in InterRidge Working Groups. For example, Kamesh Raju attended the first meeting of the Seafloor Mineralization WG in Apr. 2009, and P.A. Loka Bharathi will attend the first meeting of the IR-SCOR Hydrothermal Energy and Ocean Carbon Cycles WG in Nov. 2009.

Japan



Kyoko Okino

The InterRidge-Japan program continues efforts to promote ridge-related studies in Japan. In FY2008, we launched the new project, TAIGA, for interdisciplinary research among microbiology, geochemistry, geology, and geophysics, focusing on Trans-crustal Advection and In-situ biogeochemical processes of Global sub-seafloor Aquifer. We would like to promote seagoing and onshore hydrothermal-related studies and expand our community under this project. The outline of the new project and other activities are described on the following pages.

Domestic meetings

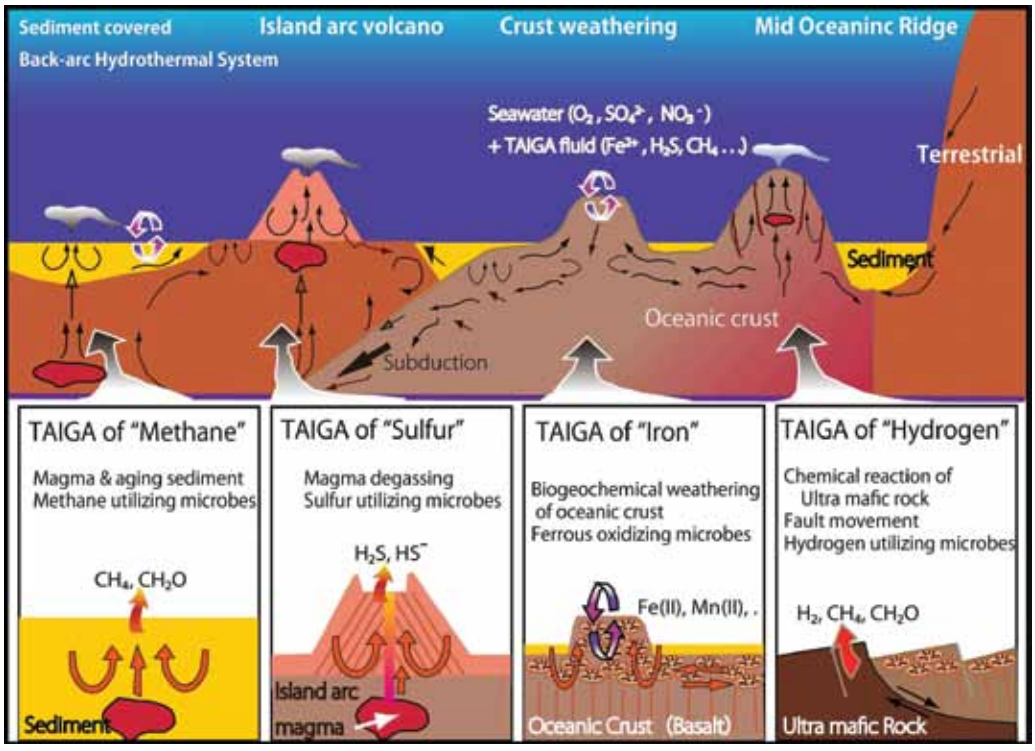
An InterRidge-Japan symposium was held on October 30-31, 2008, at Ocean Research Institute, University of Tokyo. About sixty scientists participated in the symposium to share recent research activities. We encouraged graduate students to present their studies in this symposium, and 14 students gave talks. We plan a similar symposium in October 2009. We also had a business meeting on May 18, 2009, at the Japan Geosci-

ence Union Meeting, where we shared information on budget, cruise, workshops and international affairs, and discussed the InterRidge-Japan annual activity plan. We agreed that the annual contribution to InterRidge will be shared by the TAIGA project and JAMSTEC.

New project "TAIGA"

The new interdisciplinary research project TAIGA, Trans-crustal Advection and In-situ biogeochemical processes of Global sub-seafloor Aquifer, was launched last year. The project is funded by MEXT (Ministry of Education, Culture, Sports Science and Technology) from FY2008 to FY2012. We focus on subseafloor fluid advection which carries huge heat and chemical fluxes from the interior of the earth and supports growth of biosphere (beneath and on the seafloor). We call this advection system as "TAIGA," which is a Japanese word meaning "big river flow." We hypothesize that the world's hydrothermal systems can be categorized into four types according to the reducing substances used in primary production of their derived ecosystems: sulfur, hydrogen, iron, and methane (Figure 1). Three integrated study sites are selected: the southern Mariana Trough as TAIGA of sulfur, the Indian Triple Junction as TAIGA of hydrogen, and the Okinawa Trough as TAIGA of methane. More than fifty scientists joined the project, and many seagoing studies are planned, mainly in the integrated study sites. The project leader is Prof. T. Urabe, University of Tokyo, and further information can be found at the project website (http://www-gbs.eps.s.u-tokyo.ac.jp/~taiga/en/index.html).

Figure 1: Diagram from TAIGA project website.



Cruises in FY2008

In FY2008, nine ridge-related and/or hydrothermalism-related cruises were funded, mainly in the northwestern Pacific. Two cruises using submersible *Shinkai 6500* targeted the lower crustal section of backarc lithosphere along the Mariana Trench (YK08-8-1: PI Y. Ohara) and the backarc spreading axis of the central Mariana Trough (YK08-8-2: PI T. Fujiwara). Five cruises on R/V *Natsushima* with ROV *Hyper-Dolphin* were conducted for hydrothermal vent biological research: NT08-07 to Myojinsho Caldera (PI K. Inoue), NT08-12 to Kagoshima Bay (PI Y. Fujiwara), NT08-13 to the Okinawa Trough (PIs T. Toki and T. Nunoura), NT08-15 to the Okinawa Trough (PI H. Yamazaki), and NT08-17 to Kagoshima Bay (PIs K. Inoue and T. Yamanaka). For the remaining cruise that was conducted, R/V *Mirai* crossed the Pacific Ocean and visited the Chile Triple Junction in early 2009 (MR08-06-1). Geophysical mapping, rock sampling, and OBS deployment were planned to reveal the geophysical and geological process of ridge subduction (PI N. Abe). A planned R/V *Hakuho-maru* cruise along the Southwest Indian Ridge near the Marion Hotspot, where we conducted the survey and deployed OBEMs in FY2007, was postponed to FY2009, January 2010, due to the rapid increase of fuel cost. Fortunately the deployed OBEMs were all successfully recovered by a Japanese fisheries training vessel in December 2008.

Cruises in FY2009

Including the postponed R/V *Hakuho-maru* cruise, a total of eight cruises were funded in FY2009. Four cruises were conducted in summer 2009. Three-dimensional, high-resolution, multi-sensor mapping of three hydrothermal sites in the southern Mariana Trough was done by AUV *Urashima* (YK09-08: PI K. Okino). The chemical and microbiological mapping of hydrothermal plume was successful as well as the detailed bathymetry and seafloor images of the vent sites. The AUV was equipped with a Niskin-type water sampler, and we collected some of the world's first water samples by AUV in the deep sea. Three cruises mainly focusing on geochemistry and microbiology of hydrothermal sites were conducted in

the Okinawa Trough area, using ROV *Hyper-Dolphin* (NT09-10-2: PI T. Yamanaka, NT09-11: PI M. Yamamoto) and R/V *Tansei-Maru* (KT09-16: PI M. Sunamura). R/V *Yokosuka* with *Shinkai 6500* will leave for the Indian Ocean in October 2009 for two legs of submersible dives. YK09-13-1 (PI K. Tamaki) aims to discover a new hydrothermal site along the Central Indian Ridge, where we detected a plume anomaly by AUV *r2D4* in 2006. The target of the second leg (YK09-13-2: PIs S. Nunoura and K. Nakamura) is the known hydrothermal site at the Indian Ridge Triple Junction, where the fluid is hydrogen-rich. A geophysical study in the Lau Basin involves USA-Japan collaboration; a cruise using R/V *Roger Revelle* is planned in Nov. - Dec. 2009 to deploy OBS, OBM and OBEMs (PI D. Wiens, Japanese Scientist: N. Seama).

InterRidge-Japan web site (in Japanese): http://ofgs.ori.u-tokyo.ac.jp/~intridgej/

Korea

Sung-Hyun Park

Ridge-related research activities in Korea extend from the equator to polar regions. Korea Ocean Research & Development Institute (KORDI) used R/V *Onnuri* to conduct seismic, magnetic, camera tow, and MAPR surveys in the Tonga Arc to explore for mineral resources and hydrothermal plumes. KORDI also plan to go to the Central Indian Ridge (CIR) north of the triple junction (8°-17°S) to find mineral resources. The CIR survey will be divided into two cruises. The objective of the first cruise (16 Dec. 2009 - 3 Jan. 2010) is to obtain multi-beam bathymetry and magnetic data on an un-surveyed ridge segment. On the second cruise, they will conduct dredges for rock and chimney sampling, and water column surveys for hydrothermal plumes. Korea Polar Research Institute (KOPRI) is continuing a collaborative project with NOAA (USA) for hydroacoustic monitoring in the Bransfield Strait, with a cruise scheduled for 2-14 Jan. 2010 (R/V *James Clark Ross*). These recordings are expected to help better understand tectonic events, volcanic activities, and ice breakup in the region.

The 16th International Symposium on Polar Sciences was held at KOPRI in June 2009 (see article in Workshops and Conferences). The Symposium highlighted the research opportunities soon to be provided by the new icebreaker R/V *Araon*. *Araon* was delivered in Nov. 2009, and a test cruise will be conducted in Nov. - Dec. 2009. The mission of *Araon* is to conduct comprehensive scientific surveys in the polar oceans and logistics to the Korean stations in the Antarctic (King Sejong station in King George Islands and a new station on the Antarctic continent). Proposed scientific programs with *Araon* include: Response of the biogeochemistry and ecosystem in the Southern Ocean and the Arctic Ocean to climate change; Multi-disciplinary exploration of polar ridges such as the Pacific-Antarctic and Gakkel Ridges; Hydroacoustic monitoring of the Antarctic Ocean; and Paleoceanography in Arctic and Antarctic Oceans. Of particular interest to the IR community is the proposed KOPRIDGE Program for the Pacific-Antarctic Ridge, with phase I proposed for 2010-2014 and phase II for 2014-2019.

Portugal

Pedro Ferreira

In the past year, Portugal purchased an ROV, "*LUSO*," that is planned for work related to Portugal's extended continental shelf. As described in an abstract submitted to the 2008 AGU Fall Meeting, *LUSO* is a work class Bathysaurus XL, capable to 6000-m depth. The ROV has undergone two sea trials, including dives in the Azores region of the Mid-Atlantic Ridge. Portugal's government operates two research vessels - one, R/V *Gago Coutinho*, hosts the ROV and the other will host a TV grab.

A group of Portuguese scientists is aiming to conduct a multi-disciplinary cruise (geology/biology) at Menez Gwen on the Mid-Atlantic Ridge in June 2010.

Russia

Sergei Silantyev

Russian ridge cruises in spring-summer 2009 included: R/V "*Professor Logachev*" at the Mid-Atlantic Ridge (MAR), near the recently discovered hydrothermal ore deposit "Zenith-Victory" (20°07.75'N, 45°37.35'W) and R/V "*Akademik Boris Petrov*" for multidisciplinary investigations of the ridge systems of the Indian Ocean, under an agreement between Vernadsky Institute RAS and Ministry of Earth Sciences, India.

The biennial workshop of Russian-Ridge was held in St. Petersburg on 6-7 June 2009. The topic of this workshop was "Magmatic and Hydrothermal Systems Interaction in the Mid-Ocean Ridges." Scientists from different scientific centers of Russia participated in this meeting, as well as colleagues from the First Institute of Oceanography, SOA, China.

Among the most important results of investigations of ridge processes carried out by Russian scientists in 2009, we would like to highlight the following:

Petrology and geochemistry

A set of basalt samples from the Krasnov hydrothermal field, MAR, 16°38'N, was studied for isotopic composition of Nd and Sr. The sample set comprises several fresh pillow-basalt and dolerite-basalts. In general, the samples examined are supposed to be the derivatives of the depleted mantle source without any input from the enriched source – K.N. Shatagin, A.N. Pertsev (*anpertsev@rambler.ru*), A.Yu. Kramchaninov (IGEM RAS).

More than 300 zircon grains extracted from gabbro samples dredged in the Ashadze hydrothermal field area, MAR, 13°N, were examined for their composition and isotope chemistry. The study of the zircon grains was carried out using local analytic methods (SEM CamScan 2500S, SIMS SHRIMP II, LA-MC-ICPMS). Two distinct Zr groups were established by this study: 1) Zr originated from contemporary magmatic system related with depleted oceanic mantle source; and 2) Zr characterized by very old age (no younger than 260 Ma) not related with lithosphere of contemporary oceanic basins – B.V. Belyatsky (*bbelyatsky@mail.ru*), O.G. Shulyatin, E.N. Lepekhina, S.A. Sergeev (VNIIOkeangeologiya, VSEGEI, CIR).

Study of peridotites from the Gorringe Ridge (North Atlantic) showed the principal similarity of the dredged and drilled rocks in terms of their mineralogical and petrographical features. These peridotites are almost completely serpentinized; preserved relicts of primary minerals are spinel and clinopyroxene only. These rocks by their mineralogy and geochemistry are different than spinel peridotites of mid-ocean ridges and similar to peridotites of the adjacent Iberian continental margin and the Galicia Bank that represent the subcontinental lithospheric mantle – B.A. Bazylev (*bazylev@geokhi.ru*), K.V. Popov (Vernadsky Institute RAS, Shirshov Institute of Oceanology RAS).

Hydrothermalism

A hydrothermal plume signal was discovered at MAR, 11°23'N during the 32nd cruise of R/V "*Professor Logachev*" (for details, see Beltenev at al., this volume).

Sulphide ore samples from the French-Russian Serpentine cruise on the Ashadze-1 hydrothermal field, MAR, 13°N, were selected for laboratory analyses. The Serpentine expedition was in 2007 on board the R/V *Pourquoi Pas?* equipped with ROV *VICTOR*. Physical-chemical parameters of hydrothermal ore-forming processes have been defined by means of the analysis of fluid inclusions in anhydrite from samples of two active sulphide chimneys, named "Long Chimney" and "Big Chimney." The analyses of fluid inclusions have shown that sulphide ores of the Ashadze-1 field were formed from solutions with temperatures from 210-355°C and salinity 5-7 wt. %. These data considerably expand an interval of physical and chemical conditions of deposition of sulphide ores that was established by means of direct measurements – N. S. Bortnikov (*bns@igem.ru*), V.A. Simonov (IGEM RAS, IGM SB RAS).

A study of relationships between chemistry of hydrothermal fluid and serpentinization process of host peridotites at the Lost City hydrothermal field was carried out (Fig. 1). New data for isotopic composition of Sr (determined by MC-ICPMS with Neptune-Finnigan) and O and C (determined by IRMS method with DELTA^{plus}-Finnigan) were obtained. Samples examined are composed of brucite, aragonite and calcite. Thin needles of serpentine (chrysotile) are present also in inner part of hydrother-

Figure 1: Sampling with Submersible "*Mir*" on the Lost City hydrothermal field during 50th cruise of R/V "*Akademik Mstislav Keldysh*," 2005.

mal spires. These new data provide evidence for the participation of dissolved inorganic carbonate phases in formation of hydrothermal edifices at Lost City. It was also established that carbonate phases from host serpentinites could be considered as one of the end members in the Lost City hydrothermal system – E.O. Dubinina (*elenadelta@gmail.com*), A.Yu. Kramchaninov, K.N. Shatagin, I.V. Chernyshev, N.S. Bortnikov, S.A. Silantyev (IGEM RAS, Vernadsky Institute RAS).

Thermodynamic simulations were carried out for chemical and mineralogical effects associated with transport of hydrothermal fluid along upwelling limb of serpentinite hosted hydrothermal systems. Chemical transformations in fluid at change of pressure and temperature parameters and during its mixing with sea water have been modeled as series of isobaric-isothermal equilibriums. A 14-component system was examined: O - H - Si - Al - Mg - Fe - Ca - Na - Cl - S - C - Zn - Pb - Cu. Six components were taken into account for calculations: CH_4, CO, H_2, H_2O, CO_2, O_2. Ore forming minerals were presented by pyrrhotite, sphalerite, chalcopyrite, chalcosine, bornite, galenite, pyrite, covellite, and native copper. Modeling results showed that ore matter accumulation in discharge zones of serpentinite hosted hydrothermal systems takes place only at high temperature fluid venting – S.A. Silantyev (*silantyev@geokhi.ru*), M.V. Mironenko, A.A. Novoselov (Vernadsky Institute RAS).

Fluid inclusions in minerals from gabbro samples collected near the Logatchev hydrothermal field, MAR, just south of the 15°20' Fracture Zone, were studied, in particular, fluid inclusions in quartz from gabbro-dolerites and dolerites. These inclusions were analyzed by thermobarogeochemical methods and by LA-ICPMS in Australia (University of Tasmania, Hobart, Australia). Two-phase (gas + liquid) and multiphase (gas + liquid + crystal salt phases) inclusions representing high concentration fluid systems were recognized. Homogenization temperatures of two-phase fluid inclusions in quartz differ according to the composition of solutions: 302°-356°C (NaCl-$MgCl_2$-H_2O), 294°-302°C (NaCl-$FeCl_2$-H_2O) and 310°-320°C (NaCl-$CaCl_2$-H_2O). Introducing a pressure correction, it was possible to compute real temperatures of hydrothermal processes: 340°-395°C, 335°-345°C and 345°-355°C. Thermometric studies of multiphase inclusions have shown that partial homogenization (gas + liquid) occurs at 205°-310°C and complete homogenization at 297°-405°C. Thus, concentration of salts in solutions of these inclusions reach 38-48 wt. %, and pressure varies in the range of 510-960 bar, that testifies to quartz crystallization in the magmatic conditions under the surface of the ocean bottom – V.A. Simonov (*simonov@nsc.ru*), V.V. Maslennikov (IGM SB RAS, IM UrO RAS).

Geodynamics and geophysics

A joint Russian-German geophysical survey (IPY 2007-2008 Project) was conducted in the Cooperation Sea and Southern Kerguelen Plateau, East Antarctica, using two research vessels "*Akademik Alexander Karpinsky*" and "*Polarstern.*" 5000 km of MCS, gravity and magnetic profiles, 37 OBS records and about 8000 km of detailed helicopter magnetic lines have been acquired. Additionally, a two-ship (long aperture) seismic experiment was carried out. These investigations provide new important information about crustal construction and evolution in the region, including early break-up between India and Antarctica – G. Leitchenkov (VNIIOkeangeologiya, 1 Angliysky Ave., 190121 St. Petersburg, Russia), Ju. Guseva, V. Gandyukhin, A. Kazankov, K. Gohl, D. Damaske, A. Golynsky (VNIIOkeangeologiya, PMGE, AWI, P.O.B., BGR).

A non-steady thermal model of spreading with periodic axial intrusions was developed to explain some specific features in the formation of magma chambers of various scales as a function of seafloor spreading conditions. The model takes into account the following parameters of spreading and mantle processes: periodic character of tectonic-magma cycles (spreading episodes), hydrothermal cooling of the crust, mantle temperature and heating, latent heat of rock fusion, change in the solidus and liquidus temperatures according to the crust and mantle rock composition, depth and width of intrusions and others. This model allows a rather satisfactory explanation of location, size and shape of the crust and mantle magma chambers and to analyze how the changes in these parameters depend on the spreading rate, temperature and composition of the mantle and crust rocks – E.P. Dubinin (*dubinin@mes.msu.ru*), Y.I. Galushkin, A.L. Grokholsky, A.A. Sveshnikov (Earth Science Museum, Lomonosov Moscow State University).

A comparative study of the character of some geophysical and geomorphologic parameters along the MAR between 50°S and 70°N was conducted. Profiles of the distribution of the anomalies in the ridge-axis earthquake focal mechanisms, localities of stress and strain activation zones, and localities of the MAR ridge-transform intersections were prepared. Along the MAR strong seismic events having typical ridge-axis focal mechanisms (normal faulting and strike-slip faulting) comprised 90% of the database. The remaining 10% contains events with mechanisms showing the presence of tension and compression along the directions that are not perpendicular to the MAR. Comparison of the listed parameters shows that earthquakes of anomalous mechanisms are distributed along the ridge axis at the spacing that is not random. Their concentration is attributed to the concept of zoning, as detected in the Atlantic Ocean lithosphere from contrast combination of Bouguer anomaly maximums and isostatic anomalies minimums and also from increased values of P-wave tomography. The neotectonic features of the Atlantic lithosphere, including the MAR, are being activated along sublateral zones with movement vector having mainly north-south direction, which leads to the formation of compression and tension zones with corresponding orientation of stress axis and focal mechanisms - S.Y. Sokolov (sysokolov@yandex.ru) (Institute of Geology RAS - GIN).

SOPAC (Pacific Islands Applied Geoscience Commission):

Deep-sea minerals in the Pacific Islands region: a legal and fiscal framework for sustainable resource management

Akuila Tawake

Rationale

There has been a recent upsurge in activity related to exploration for mineral resources on the seabed within the territorial seas and Exclusive Economic Zones (EEZs) of Pacific Island Countries (PICs). Whilst exploration and research into these deposits have been underway for several decades, the current work is being conducted for commercial purposes, with numerous mining entities raising public funds for resource quantification, feasibility studies and eventual mining. The recent discovery of 'high grade' sulphide deposits in PNG's territorial waters has led to a rush for applications within other EEZs previously identified as having deep-sea mineral potential (Tonga, Fiji, Federated States of Micronesia, New Zealand, Solomon Islands and Vanuatu). The targets for much of this interest are polymetallic Seafloor Massive Sulphide (SMS) deposits which can be localized concentrations of copper, lead and zinc with significant enrichments in gold and silver.

Despite this surge in interest and activity around the Pacific, specific policy, legislation and regulations necessary for the governance of deep-sea mineral resources are lacking. Also lacking is the specific technical and human resource capacity essential to ensure that PICs are able to effectively manage these newfound ocean resources that offer significant economic potential.

Project development

In an endeavour to address these issues, a regional approach for the management of marine minerals in the Pacific Islands was endorsed during a project conception meeting in Suva, Fiji, in August 2008. The meeting was attended by representatives from SOPAC, the World Bank and the Pacific Islands Forum Secretariat (PIFS). The support of the SOPAC Governing Council was also successfully sought in Funafuti, Tuvalu, during the 37th SOPAC Annual Session, October 2008, and given the regional interest in deep-sea minerals potential and regional support for such a Project, SOPAC has over the last 12 months developed a proposal document and pursued potential funding opportunities.

SOPAC in consultation with other technical partners prepared and submitted the Deep Sea Minerals (DSM) Project Proposal to the European Union during the call for papers for the European Development Programme EDF10 Regional Indicative Programme in late 2008. This proposal has been through various assessment stages (Concept Notes, Identification Fiche and Action Fiche) and approval was gained in August 2009. It is expected that a Contribution Agreement with

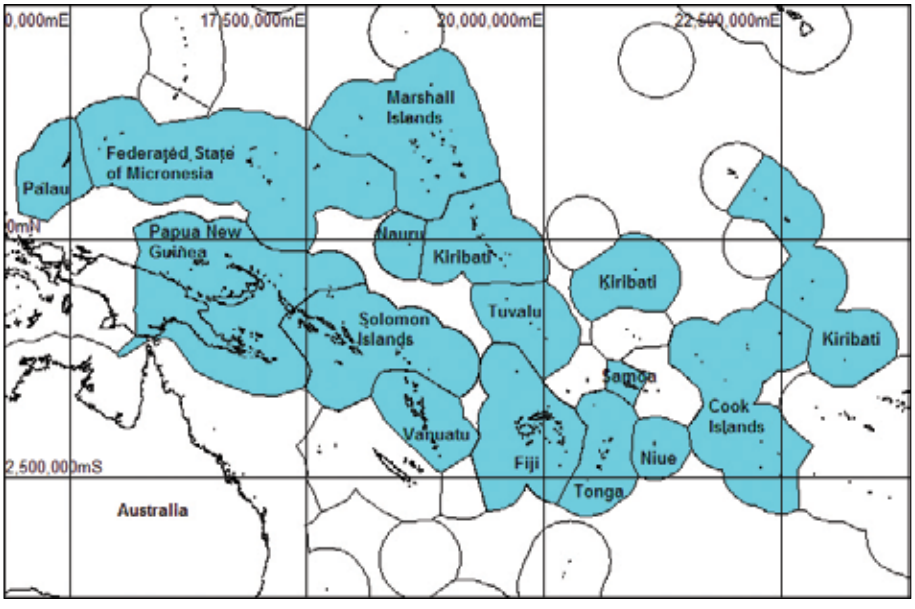


Figure 1: (left) Map of SOPAC member countries and the extent of their respective EEZs (in blue).

Figure 2: (below) IR welcomes new correspondent Akuila Tawake, shown here at the STAR Conference in Port Vila, Vanuatu, Oct. 2009.

the EU will be signed in early 2010 providing €4.7 Million to support regional deep-sea minerals policy, legislation and regulations development in the Pacific Islands region. The Project which will run for 4 years, is expected to begin in 2010 and initial discussions between SOPAC and other potential implementing partners are already underway.

Brief project description

The overall objective of the Project is to expand the economic resource base of Pacific States in the ACP (African, Caribbean and Pacific Group of States) by facilitating the development of a viable and sustainable marine minerals industry. The specific objective is to strengthen the system of governance and capacity of Pacific ACP States in the management of deep-sea minerals through the development and implementation of sound and regionally integrated legal frameworks, improved human and technical capacity and effective monitoring systems.

The Project will have four Key Result Areas: (1) Development of Regional Legislative and Regulatory Framework(s) (RLRF) for offshore minerals exploration and mining; (2) Formulation of national policy, legislation and regulations; (3) Building national capacities; and (4) Effective management and monitoring of offshore exploration and mining operations.

With the Project assistance, the RLRF will be used by individual PICs to develop their national frameworks for the management of their marine mineral resources. The work is of critical importance if PICs are to have effective environmental, fiscal and social management instruments in place for the exploration and exploitation of deep-sea minerals.

Ongoing activities

In recognising the potential of deep-sea minerals for economic development in the region, the organisers of the 2009 STAR (Science, Technology and Resources) Network and Conference held in Port Vila, Vanuatu, October 2009, selected the theme: *"Exploiting and managing resources to enhance economic development, with special focus on deep-sea minerals, water and renewable energy, and reducing disaster risk."* A total of six deep-sea minerals-related papers were presented during STAR, encompassing deep-sea minerals potential, exploration and exploitation in the Pacific region, providing environmental information for sustainable offshore minerals development, proposed implementation strategy for the Project, maritime boundaries, and economic potential of extended Continental Shelf.

In addition, the STAR Conference enabled opportunities for the deep-sea minerals stakeholders within the region and beyond to meet and discuss relevant issues. Consequently, a stakeholder network was established with significant membership potential for sustainable mineral resources development and management in the region. A deep-sea minerals "Working Group" was also convened during STAR and produced the following summary recommendations:

- A longer-term regional program for the management of marine minerals in the Pacific Islands region should be devised, and the Project can be seen as an excellent starting point. This initiative should also encompass coastal and terrestrial minerals (i.e., industrial and metalliferous minerals).
- A strategic plan for the overall management of offshore mineral resources in the region should be developed and be considered during the upcoming review of the SOPAC strategic plan.
- A marine minerals stakeholder network should be set up in the PI region including the establishment of an ad hoc STAR Advisory Group that can be consulted on a regular basis on issues pertaining to all aspects of the offshore minerals industry in PICs.
- A regional mineral database should be established within SOPAC and regularly backed up elsewhere to ensure the safety of the data/information.

Switzerland

Gretchen Früh-Green

Switzerland has no formal oceanographic program, and active participation in oceanographic research and cruises depends greatly on international collaborations and participation in international programs, such as ODP and IODP. We are particularly pleased that a number of young scientists and early career alumni from Swiss universities have been able to participate on IODP expeditions on all three platforms over the past few years. A number of research groups are also indirectly involved in ridge-related research through field, experimental, and analytical studies. As in recent years, active ridge research is primarily concentrated at the Department of Earth Sciences of the ETH Zurich.

Mid-ocean ridge hydrothermal systems

The group Marine Geology and Geochemistry at the ETH Zurich (http://www.imp.ethz.ch/research/marine) is involved

in studies of hydrothermal alteration and geochemical fluxes in the oceanic lithosphere. One project involves collaboration with the Centre of Geobiology at the University of Bergen as part of the ESF EuroMARC Programme. This interdisciplinary, international project is aimed at studying geodynamic and hydrothermal processes and their links to the deep biosphere along the southern Knipovich Ridge, one of the slowest spreading segments of the global ridge system. We have participated in the past three multidisciplinary, Norwegian-led cruises (2007-2009) on board the R/V *G.O. Sars* to the Mohns-Knipovich ridges. The cruise in 2008 led to the discovery of "Loki's Castle," the most northerly black smoker vent field at 73°N and ~2400-m water depth. Our individual project focuses on characterizing water-rock interactions and the links between chemical and microbiological processes in ultra-slow spreading environments.

One of our Ph.D. students, Tamara Baumberger, was also able to participate on two NOAA cruises on board the R/V *Thomas G. Thompson* investigating arc volcanism and hydrothermal activity in the NE Lau Basin. The aim of the first expedition in November 2008 was to search for hydrothermal activity by conducting water-column plume surveys, which led to the discovery of two major eruptions at the NE Lau Spreading Centre and the submarine volcano West Mata. These discoveries led to the follow-up expedition in May 2009, which was jointly funded by NOAA, Ridge 2000 and Margins. The remotely operated vehicle *Jason II* was aboard the research vessel and recorded spectacular video coverage of ongoing eruptions at two different sites on West Mata (http://www.pmel.noaa.gov/vents/laubasin.html).

Past studies have focused to a large degree on understanding the peridotite-hosted Lost City hydrothermal system. Two Ph.D. theses have been completed and much of this research is now published. On-going, follow-up studies involve boron isotope, phosphorous, and organic geochemical analyses of the Lost City hydrothermal deposits. In addition we are conducting comparative land-based studies on ancient serpentinite-carbonate deposits (so-called ophicalcites) in the Ligurian ophiolites (Italy) and on present-day alkaline springs associated with serpentinization near Genoa. This project focuses on understanding the links between inorganic reactions that produce hydrocarbons, biogeochemical cycling of carbon and sulfur, and microbial activity in high pH systems associated with serpentinization.

We are also happy to be able to welcome Susan Lang to our group. Susan won the 2009 InterRidge Postdoctoral Fellow award to work on a project entitled "Investigating the formation mechanisms and inorganic precursors of formate and acetate in Lost City hydrothermal fluids."

Modelling hydrothermal processes

Christoph Heinrich and part of his Fluids and Mineral Deposits group at the ETH continue to be active in modeling hydrothermal processes. This group has generated an advanced set of simulation tools. This integrated collection of tools is called the Complex System Modelling Platform (CSMP++) and is written as an object-oriented C++ library with interfaces to many in- and output formats. The core of the simulation package combines finite-element and finite-volume algorithms that deal with diffusive and advective parts of governing equations. Recent modeling projects have particularly focused on new models for H_2O-NaCl fluid properties, finite element-finite volume algorithms for multiphase fluid flow, and chemical reaction modelling. Some of the newer results include new models of the 3D-structure of hydrothermal convection cells. For more information, please see: http://www.igmr.ethz.ch/research/fluids/modelling.

Figure 1: (upper) Rita Fonseca and Tamara Baumberger processing sediment cores from the Knipovich Ridge.

Figure 2: (lower) The R/V ***G.O. Sars*** coming into port at Tromso, Norway.

UK

Tim Henstock

The ChEsSo cruise (JR224) on RRS *James Clark Ross* in Jan.-Feb. 2009 explored deep Antarctic waters for hydrothermal vents and cold seeps (http://www.classroomatsea.net/JR224/index.html). Cruise PIs included R. Larter (Chief Sci.), A. Rogers (IR StCOM), and P. Tyler (Co-Chair, ChEss). Scientists from Portugal and Spain also participated in this multidisciplinary expedition.

Several cruises are planned for 2010, including a second expedition to the East Scotia Ridge and a cruise to the Mid-Cayman Spreading Center (MCSC) with AUV *Autosub 6000* and TOBI (D. Connelly, Chief Sci.). These two cruises and an interview with J. Copley (IR Co-Chair for 2010-12) are highlighted in a recent article in The Times (UK): http://www.timesonline.co.uk/tol/news/environment/article6863801.ece. Copley will lead an expedition to the MCSC with ROV *Isis* in 2011.

A follow-up cruise to collect multichannel seismic data over V-shaped ridges south of Iceland will be led by N. White with other PIs including J. Maclennan, B. Murton (IR Chair for 2010-12) and T. Henstock (IR StCOM). This cruise has been funded as a site survey for an IODP drilling proposal (see article for previous cruise in 2008 IR News).

USA

Breea Govenar and Dan Fornari, Ridge 2000 Program, Woods Hole Oceanographic Institution

Office rotation

The Ridge 2000 (R2K) Program is a 12-year initiative to foster integrated, multi-disciplinary research of geological, chemical, and biological processes at oceanic spreading centers, funded by the U.S. National Science Foundation (NSF). The R2K office rotates every 3-4 years and moved in Nov. 2008 for the final rotation to the Woods Hole Oceanographic Institution (WHOI), with Dan Fornari (Senior Scientist, Geology and Geophysics Department) as the new Program Chair. Also at WHOI are Breea Govenar (Postdoctoral Investigator, Biology Department), the new Science Coordinator, and Janet Moore, the new Administrative Specialist. Liz Goehring (Pennsylvania State University) continues as the Education and Public Outreach Coordinator. Vicki Ferrini at Lamont-Doherty Earth Observatory (LDEO) is the R2K Data Portal liaison.

Program announcement

To reflect the current focus of the R2K Program and recent program manager rotations at NSF, the R2K Program Announcement was revised with a new annual proposal deadline of April 8 (http://nsf.gov/funding/pgm_summ.jsp?pims_id=5513). In 2009, R2K received 40 proposals. A major emphasis of funded proposals was related to data integration and synthesis efforts and developing empirical models for oceanic spreading center and hydrothermal system evolution.

Compliance with NSF data policies

To facilitate data integration and synthesis, and with the encouragement of NSF to improve transparency of federal funding for scientific research to the U.S. Congress and for the benefit of the lay public, the R2K Program developed a Data Compliance Plan outlining the necessary steps to achieve compliance with R2K and NSF Data Policies (http://www.ridge2000.org/science/data/index.php). As a result, many PIs submitted derived data and Shore-Based Analysis Plans, which are and will continue to be available on the R2K Data Portal.

Website

Following the office rotation, the R2K website (http://www.ridge2000.org) was migrated to a commercial server by the Marine Geoscience Data System (MGDS) staff at LDEO. The R2K website is now managed by the MGDS, where it will be archived after the Program ends in 2012. The website was reorganized to improve navigation, and additional materials are being added regularly. Please visit the website for recent news, publications, updates on research, resources for education and public outreach, and more.

Research updates: Ridge 2000 Integration and Synthesis Workshop

Following the success of Integrated Study Site (ISS)-specific Integration and Synthesis Workshops in Sep. 2008, R2K held a cross-ISS Integration and Synthesis Workshop, titled "Developing a holistic view of oceanic spreading center processes," Oct. 1-3, 2009, in St. Louis, MO. Nearly 80 participants registered and submitted abstracts of their current research, and half of the participants presented posters with a focus on multidisciplinary, integrated research, models, and comparisons to

other hydrothermal systems. The workshop opened with three invited talks that outlined comparisons among the ISSs, followed by a poster session. The remaining day and a half were dedicated to discussions in Disciplinary, Interdisciplinary, ISS-specific, and self-organized groups. A wiki-based website for the workshop was constructed to facilitate discussions among the breakout groups before, during, and after the workshop. The contents of the wiki, along with summaries of the cross-ISS talks and breakout groups, will be available on the R2K website.

Cruises

Seismic cruises on R/V *Langseth* were conducted at the Eastern Lau Spreading Center (ELSC; D. Wiens, Chief Sci.) and the Endeavour Segment on the Juan de Fuca Ridge (D. Toomey, Chief Sci.), following a similar program at the 8-11° segment of the East Pacific Rise last year (S. Carbotte, Chief Sci.), completing detailed geophysical surveys at the three R2K ISSs.

Interdisciplinary field programs continued on the ELSC [PIs C. Fisher (16 May- 8 June 2009); A.L. Reysenbach and M.K. Tivey (12 June- 8 July 2009)] and the Endeavour Segment of the Juan de Fuca Ridge [PIs J. Holden, M. Lilley, R. Embley (13-27 June 2009); A. Fisher and R. Lee (20 Aug.- 6 Sep. 2009)], where the first cable of the NEPTUNE-Canada/ NSF-OOI seafloor observatory was deployed in June 2009. There is also an upcoming cruise to the East Pacific Rise, 9°50'N (PIs M. Cormier and S. Nooner, 16 Dec.- 1 Jan. 2010), as well as three cruises to Guaymas Basin [PIs D. Lizzarralde (19 Oct.- 3 Nov. 2009); A.L. Reysenbach and M.K. Tivey (7-17 Nov. 2009); A. Teske and A. Bowen (22 Nov.- 6 Dec. 2009)].

NSF-NOAA-funded rapid response cruise

An active boninitic eruption was observed at West Mata submarine volcano in the NE Lau Basin in May 2009 (Fig. 1). West Mata volcano is the largest in a series of en echelon volcanoes lying between the magmatic arc front and the NE Lau Spreading Center (NELSC). The eruption was witnessed during an eruption-response cruise, funded by NSF (R2K and Margins Programs) and NOAA, to examine the sites of two eruptions in the NE Lau Basin that were discovered in Nov. 2008 during a previous expedition on the R/V *Thompson*. The second of the two eruptions was along the NELSC and was not actively erupting during the response cruise. During the response cruise five ROV dives were conducted at West Mata volcano and two at the NELSC to characterize the volcanic deposits and associated phenomena. For a pdf copy of the cruise report: http://www.ridge2000.org/science/tcs/NELRC-CruiseReport-final.pdf.

Technological advances

The WHOI Hybrid Remotely Operated Vehicle (HROV) *Nereus* recently dove to the Mariana Trench and to the Cayman Trough to carry out its initial science programs. Results of the engineering tests and field programs can be found at: Mariana Trench cruise: http://www.whoi.edu/page.do?pid=7545&tid=282&cid=57586&ct=162, and Cayman Trough cruise: http://oases-expedition.blogspot.com/.

Education and Outreach: FLEXE-GLOBE

From Local to Extreme Environments (FLEXE) is part of the international GLOBE education program and presents R2K science to K-12 students worldwide. FLEXE students study Earth System processes through data analysis of local environmental data and data from the deep-sea (extreme) environment. R2K scientists guide students in their analyses of deep-sea data through the online FLEXE Forum. FLEXE (http://flexe.psu.edu) is funded by NSF.

Distinguished Lecturer Series

The R2K Distinguished Lecturer Series (DLS) in 2009 featured Rob Reves-Sohn, Dana Yoerger, and Breea Govenar. The 2010 DLS features Suzanne Carbotte, Bill Seyfried, Matt Schrenk, and Adam Soule. R2K Each speaker is paired with three or four host institutions around the country, presenting general-public and scientific-audience lectures at each host site based on the schedules and curriculum interests of the host departments.

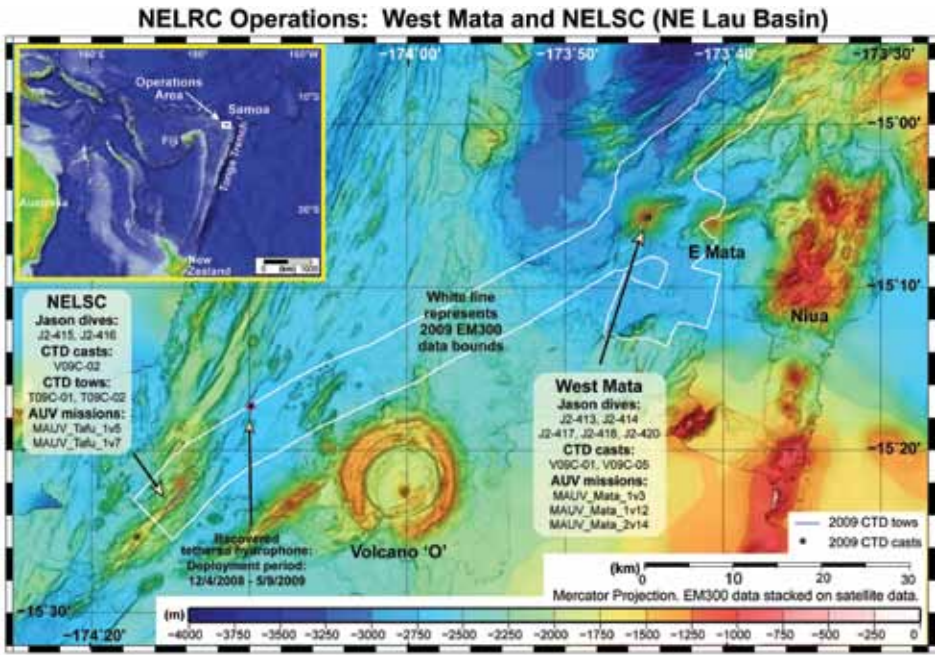


Figure 1: Study sites during Northeast Lau Response Cruise (from J. Resing, R. Embley, S. Merle - NOAA).

Working Group Updates

Deep Earth Sampling

Chair - Benoit Ildefonse (Univ. Montpellier II, France)

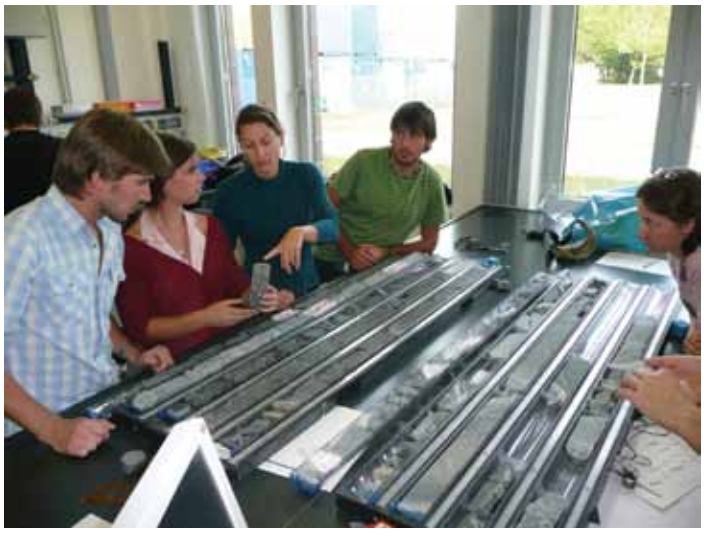
The Deep Earth Sampling (DES) WG was very active in the past year, starting with a meeting in Dec. 2008 prior to the AGU Fall Meeting. This gathering of WG members and other interested scientists had three main outcomes: 1) a request was sent to the IODP Engineering Development Panel (EDP) to set up a technology and science planning group for very deep drilling, 2) members decided to organize a scientific planning workshop prior to the IODP INVEST workshop, and 3) a motion was sent to the IODP Science Planning Committee (SPC) Chair to re-state the importance of returning to 1256D as a short-term community priority. As a follow-up to this meeting, and to serve as an InterRidge liaison to IODP, WG Chair B. Ildefonse participated at the March 2009 IODP SPC meeting in Miami, FL, USA.

In 2009 the WG convened 1) an international workshop and 2) an international summer school, and 3) participated in the IODP's INVEST workshop as follows:

Melting, Magma, Fluids and Life (MMFL) Workshop

With InterRidge serving as a co-sponsor, the DES WG convened the Melting, Magma, Fluids and Life (MMFL) Workshop for Scientific Ocean Drilling at the National Oceanography Centre, Southampton, UK in July 2009. For a workshop summary, please see the article in the Workshops and Conferences section of this volume. The workshop report and a list of participants can be viewed at: http://www.interridge.org/WG/DeepEarthSampling/workshop2009. As one key outcome of this workshop, the workshop conveners submitted a white paper to the IODP INVEST workshop, titled "The Ocean Lithosphere: A Fundamental Component of the Earth System," which can also be downloaded from the workshop web page.

Figure 1: Students examine core samples at the 2009 ECORD Summer School on "Geodynamics of Mid-Ocean Ridges."



ECORD Summer School: "Geodynamics of Mid-Ocean Ridges"

InterRidge also served as a co-sponsor of the ECORD Summer School: "Geodynamics of Mid-Ocean Ridges," organized by members of the DES WG. This summer school was held in Bremen, Germany, 31 Aug. - 11 Sep. 2009, and trained approximately 30 early-career scientists including our 2008 InterRidge Fellow Michelle Harris (http://www.glomar.uni-bremen.de/ECORD_Summer_School_2009_2.html).

IODP INVEST Workshop

The IODP New Ventures in Exploring Scientific Targets (INVEST) workshop was held in Bremen, Germany, in Sept. 2009 (http://www.marum.de/iodp-invest.html). INVEST was organized as a large, multidisciplinary, international community meeting, with focus to define the scientific research goals of a new ocean drilling program, expected to replace IODP in 2013. The workshop was extremely well attended, with more than 550 participants, including most members of the DES WG.

Also, we note that an IODP Thematic Review on "Oceanic Crustal Structure and Formation: IODP and ODP Achievements November 2002 - December 2005" can be accessed from the DES WG webpage: http://www.interridge.org/WG/DeepEarthSampling.

The InterRidge Steering Committee suggested that the DES WG should continue into 2010, to follow-up on the 2009 MMFL and INVEST workshops. In 2010 the StCOM will decide whether it is time for this WG to disband; however, the StCOM wants IR to maintain a liaison with IODP.

Visit the InterRidge website
for more about our Working Groups:
http://www.interridge.org/WGlist

Hydrothermal Energy and Ocean Carbon Cycles

Chairs - Nadine Le Bris (UPMC-Paris 6, France) and Chris German (WHOI, USA)

In Oct. 2008, the Scientific Committee on Oceanic Research (SCOR) approved a new Working Group (WG 135) on "Hydrothermal Energy Transfer and its Impact on the Ocean Carbon Cycles" for 2009-2013 (http://www.scor-int.org/Working_Groups/wg135.htm). This is the first SCOR WG in over ten years to derive from InterRidge activities. The WG developed from discussions at the 2007 InterRidge Theoretical Institute. IR is co-sponsoring this WG (http://www.interridge.org/WG/carboncycles), which effectively replaces the pre-existing WG on Biogeochemical Interactions at Deep-Sea Vents.

The WG mission is to consider the diverse pathways of biomass generation driven by hydrothermal processes on MOR and the potential contribution that they may make to the global ocean carbon cycle. Three key objectives are: 1) to synthesize current knowledge of mechanisms and rates of chemosynthetic carbon fixation and the transfer of phytoplankton-limiting micronutrients to the open ocean, 2) to integrate these findings into conceptual models of energy transfer and carbon cycling through hydrothermal systems in view of a future assessment of the contribution of these systems to the global ocean carbon cycle, and 3) to identify critical gaps in quantification of the impact of deep-sea hydrothermal systems on ocean carbon cycles and to propose a strategy for future field, laboratory, experimental and/or theoretical studies to bridge these gaps.

Membership

The WG membership list has been completed with 8 full and 8 associate members, including 7 members of the former IR WG. We are also particularly grateful to Dr. Toshi Gamo (ORI, Tokyo, Japan), who is also a member of the GEOTRACES International Scientific Steering Committee, for accepting to help us to develop links between our WG and that particular SCOR programme. Extension of the representation of southern hemisphere countries has not been achieved yet, despite various contacts we have made and invitations extended to colleagues in New Zealand, Chile and South Africa. Actions are pending to further develop interactions with these countries.

Sessions in international conferences

In 2009, WG-related sessions were held at two international conferences: the ASLO Aquatic Sciences Meeting, 25-30 Jan. (Nice, France) and the Goldschmidt Conference, 22-26 June (Davos, Switzerland). Both had similar topics but were directed to different scientific communities (oceanography and geochemistry, respectively). The ASLO session "From molecules to organisms: Chemoautotrophic pathways and mechanisms of energy transfer in extreme marine environments" gathered 18 presentations. Most of these contributions were related to hydrothermal vent systems or chemoautotrophy. The Goldschmidt session "Pathways and regulation of energy and carbon transfer in extreme deep-sea environments" participated to the Theme 16 "Life on the edge: extreme environments." A total of 14 contributed presentations were dedicated to hydrothermal systems and to chemoautotrophy. Several hot topics in relation to our WG objectives were identified through these sessions. Additionally, these sessions helped us start to establish a core group of experts around whom we can prepare for the community-wide workshop we have planned for 2012.

First working group meeting

The first meeting of the WG will take place 23-24 November 2009 in Woods Hole (USA). Main points to be discussed will be the strategies to address our terms of reference and the definition of a preliminary agenda for the next 3 years. This will include the definition of sub-groups (water column, deep-biosphere, seafloor ecosystems) and the links with initiatives like GEOTRACES, IODP, and any future programmes emerging from CoML beyond 2010. We expect to reach preliminary agreement on the 2012 workshop organisation committee and place of the venue during the course of our November meeting.

Figure 1: Chemical measurements conducted during a biological colonization experiment at 9°50'N East Pacific Rise (photo courtesy Ledwell/Mullineaux LADDER 2 cruise, 2007).

Long-Range Ridge Exploration

Chair - Colin Devey (IFM-GEOMAR, Germany)

The Long-Range Exploration Working Group (LRE WG; http://www.interridge.org/WG/Exploration) held its first meeting on 14-16 Sep. 2009 at Woods Hole Oceanographic Institution, USA. The main purpose of the meeting was to plan for an international workshop on long-range exploration of oceanic spreading centers, including mid-ocean ridges and back-arc basin systems. The purpose of this workshop will be to bring together scientists and technologists to plan international field research programs for hypothesis-driven exploration of large regions of the ocean ridge crests and flanks. The workshop is tentatively planned for 28-30 June 2010 in Southampton, UK, and Colin Devey (IFM-GEOMAR, Germany) and Chris German (WHOI, USA) will serve as the co-conveners with the LRE WG members forming the bulk of the organizing committee.

A total of eight different nations, from North and South America, Europe, Asia, and Africa, were represented at the LRE WG meeting. The first afternoon of the WG meeting involved a series of brief presentations of technical capabilities in the represented countries, mainly involving autonomous underwater vehicles (AUVs). The WG members discussed the many definitions of "long-range," which included the use of AUVs to survey on the order of 100-1000 km of ridge crest on a single deployment and the use of AUVs on smaller spatial scales but from remote land bases or ships of opportunity. The second day of the WG meeting was mainly devoted to identifying the science drivers for long-range exploration. Although scientific questions were listed under the following four disciplines: geophysics, petrology, hydrothermal chemistry, and biology, attention was given to the interdisciplinary nature of each science question. Relevant vehicle and sensor technologies were identified along with each science question. The WG members started a list of geographic areas of the ridge crest which may be of interest to multiple disciplines for exploration. The second day concluded with a tour of facilities at Hydroid, Inc., an AUV manufacturer. The final morning of the WG meeting involved planning for the workshop in 2010. Please contact Colin Devey (cdevey@ifm-geomar.de) or Chris German (cgerman@whoi.edu) if you are interested in attending the workshop.

Mantle Imaging

Chair - Nobukazu Seama (Kobe Univ., Japan)

Several members of the Mantle Imaging WG (http://www.interridge.org/WG/MantleImaging) met informally in Feb. 2009 during the Stagnant Slab Project meeting in Japan and drafted a plan for the WG. After the meeting, Chair Nobukazu (Nobi) Seama and colleagues at InterRidge-Japan discussed the possibility of hosting an IR Theoretical Institute (or symposium) with a workshop. Such an event may be feasible in 2011FY, with help from InterRidge-Japan for organizing the meeting and some funding from project TAIGA (for more information on TAIGA, see Japan's National News in this volume). The WG plan is as follows:

2010 EGU General Assembly

The WG is convening a special session at the 2010 EGU General Assembly: "GD4.1/GMPV52: Melt generation to crustal formation beneath mid-ocean ridges." The purpose of this session is: 1) exchanging the latest mantle structure results and laboratory experiments on mantle rocks, 2) addressing variability of crustal formation through investigations of structural, geophysical, petrological and geochemical characteristics of the crust, and 3) linking investigations from numerical simulations to identify the parameters controlling crustal formation and mantle structure.

2011 IRTI

The WG is planning to organize an IRTI (or symposium) with a workshop in Japan in summer or fall 2011. The WG will submit a JSPS (Japan Society for the Promotion of Science) proposal in April 2010 for the majority of funding for the IRTI. Also, each WG member will make an effort to recruit sponsorship for the meeting from their respective countries. The WG would like to invite keynote speakers and provide support for

graduate student travel. Potential participants at the IRTI include those who work on: results from large-scale experiments, rock laboratory experiments, petrology, and numerical modeling.

OBS-OBEM webpage: http://www.interridge.org/OBS-OBEM

One way to promote large-scale seismic/EM experiments to image the mantle structure at ridge systems is to enlarge a pre-scheduled single nation seismic/EM experiment by adding instruments with an international team. A first step in enlarging a pre-scheduled experiment is to share the information on long-term OBS and/or OBEM observations planned by individual scientists. The InterRidge website now includes a list of long term OBS and/or OBEM observations (at the URL above). The list includes whether bunks are available on these cruises for graduate students. The WG would like to encourage graduate students to join a cruise of different country, which could result in new connections for the future. Please feel free to add your cruise or experiment to the list.

Monitoring and Observatories

Chairs - Javier Escartin (IPGP, France) and Ana Colaço (Univ. Azores, Portugal)

The Monitoring and Observatories (MoMAR) WG completed its work in 2009; the main goal of the WG has been achieved, as there is an international and multidisciplinary program in Europe, ESONET-EMSO (European Multidisciplinary Seafloor Observatory; http://www.esonet-emso.org/), that includes the development and installation of a seafloor observatory at the Lucky Strike vent field in the MoMAR area. The first step of this effort is the ESONET MoMAR-D demonstration mission in 2010, which will provide an autonomous seafloor observatory with direct communication to and from land for 2010-2011 (http://www.esonet-noe.org/main_activities/demonstration_missions/momar). A workshop specific to ESONET MoMAR was held in Oct. 2009, followed by an ESONET best practices workshop on "Instrumentation - Infrastructure - Interoperability."

Recent MoMAR field activities include the Bathyluck'09 Cruise onboard N/O *Pourquoi Pas?* (PIs J. Escartin and M. Cannat), that carried out extensive near-bottom geophysical surveying of the Lucky Strike segment and vent field using ROV *Victor* and AUV *Aster*^{X} (IFREMER), sampling (basalt, hydrothermal deposits, fluids, biological and microbiological samples) and installation of instrumentation (temperature sensors, pressure gauges, current meters, seismometers) to be recovered and redeployed in 2010 during the installation of the seafloor observatory. A GIS database of the MoMAR area is under development. An online (http://www.momar.org) version and a more complete version (upon request, contact: J. Escartin) of the GIS database is available for cruise planning purposes.

Although this WG is now disbanded after achieving its main goals, IR will maintain an active role to help foster collaborations among the various international seafloor observatory programs, an important development for IR's third decade plan.

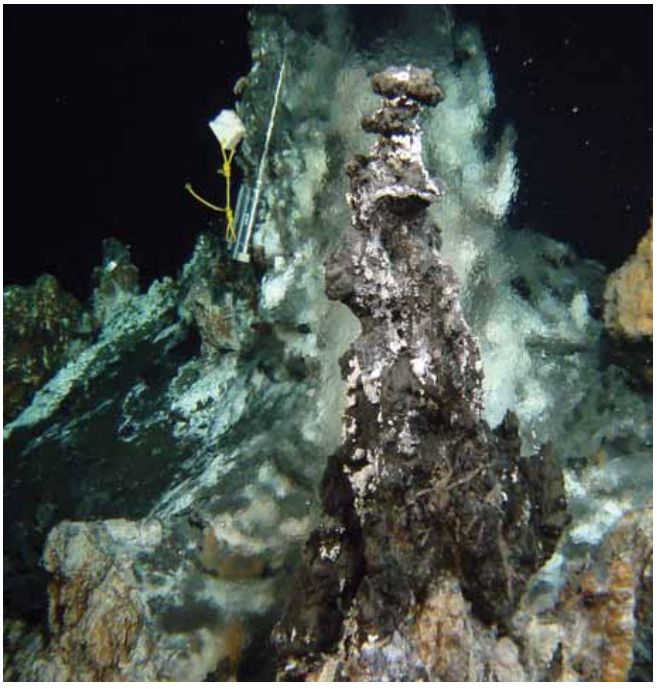


Figure 1: Autonomous temperature sensor installed at the White Castle Vent (Lucky Strike field). Bathyluck'09 Cruise (PIs J. Escartin and M. Cannat). Copyright: CNRS(INSU)/IFREMER.

Seafloor Mineralization

Chair - Maurice Tivey (WHOI, USA)

The Seafloor Mineralization Working Group (SM WG; http://www.interridge.org/WG/Mineral) was very active in the past year, convening an international workshop on deep-sea mining of seafloor massive sulfides (SMS) that was held in April 2009 at Woods Hole Oceanographic Institution (WHOI). For more details about this workshop and the associated WHOI-Morss public colloquium, please see the article in the Workshops and Conferences section of this volume and the workshop website (http://www.whoi.edu/workshops/deepseamining/).

The SM WG met on the day following this workshop to discuss the main themes/topics and issues that arose in the previous two days and to identify gaps in scientific knowledge of SMS deposits. One new member joined the SM WG for this meeting (Fernando Barriga, Portugal). A central charge of the SM WG is to assess the current knowledge of seafloor hydrothermal/SMS deposits and to identify and classify what we know and don't know about both active vent systems and the relatively poorly studied inactive systems. Science has focused on active systems for obvious reasons: they are the locus of visually dynamic processes, they host unique fauna, they are easier to locate. There has been markedly less focus on the inactive or extinct deposits. Part of the reason for this has been because inactive deposits are hard to locate except in the vicinity of active systems, they do not host the spectacular and abundant fauna found at active vents, and the processes that are occurring at these inactive sites are likely occurring subsurface within the deposits or mounds and possibly occur over long timescales. Taken together however, both active and inactive/extinct SMS deposits provide modern analogs to ancient ore deposits presently being mined on land.

The major outcome of the SM WG meeting was providing scientific recommendations to the International Seabed Authority (ISA) to advance the scientific knowledge of SMS deposits. A sound scientific base of knowledge would both advance science but also inform the commercial and political world of the importance of these multi-faceted resources and encourage responsible development. These questions and recommendations were provided to the ISA for the 15th Session (25 May - 5 June 2009). The WG developed three groups of questions and recommendations:

1) What are the spatial controls on hydrothermal activity and SMS deposition?
2) What are the timescales for the evolution of SMS deposits?
3) What are the changes in biological communities that occur during the evolution of an SMS deposit?

Recommendations range from developing a list of criteria to quantify the extent of activity at a hydrothermal vent site, to using cutting-edge technology to locate and characterize inactive deposits, to encouraging biological studies of inactive and extinct SMS deposits. For the full WG meeting report sent to the ISA, please see: http://www.interridge.org/files/interridge/SMWG_meeting_report_2009_final_rev.pdf.

Other outcomes of the SM WG meeting include the planning for a workshop on "Design of Marine Protected Areas for Chemosynthetic Ecosystems Potentially Threatened by Human Activities in the Deep Sea," with lead conveners Cindy Van Dover (SM WG member) and Craig Smith. The workshop, which will be co-sponsored by InterRidge, is being planned for summer or fall 2010 (venue to be determined). The goals of this workshop are to: 1) Formulate a general approach, with specific examples, for the design of networks of areas for environmental protection for hydrothermal-vent and cold-seep ecosystems; and 2) Outline research needs to allow better application of spatially based ecosystem management of human impacts in deep-sea chemosynthetic ecosystems. This will be an international workshop, with ~20 invited experts drawn from all parts of the world. Please contact Cindy (clv3@duke.edu) if you are interested in participating at the workshop.

Figure 1: Georgy Cherkashov, SM WG Member, gave a talk about SMS deposits on the northern Mid-Atlantic Ridge at the April 2009 workshop on deep-sea mining.

Vent Ecology

Chairs - Stéphane Hourdez (Sta. Biol. Roscoff, France) and Yoshihiro Fujiwara (JAMSTEC, Japan)

The Vent Ecology WG (http://www.interridge.org/WG/VentEcology) took advantage of the 4th Chemosynthesis-Based Ecosystems (CBE) Symposium to meet on July 2, 2009. Topics of discussion during the WG meeting were: choice of a new WG co-chair, the high throughput project list on the InterRidge website, a proposed new webpage on biological sample sharing, the future of the ChEss database after 2010, and discussions on the location of the 5th CBE Symposium (tentatively planned for summer 2013 in Victoria, Canada).

New co-chair for the working group

As announced at the 2008 Steering Committee meeting, Chuck Fisher stepped down as WG co-chair. At the 4th CBE Symposium, several WG members recommended Yoshihiro Fujiwara (Secretary of the Organizing Committee for the 4th CBE Symposium). Yoshi kindly accepted to serve in the capacity. Chuck Fisher will continue as a regular WG member.

High-throughput list

When the WG group was created, one of the goals was to encourage international collaboration, in particular for costly approaches such as transcriptomics (ESTs, microarray), genomics, and proteomics. Thanks to Stace Beaulieu (InterRidge Coordinator), an interactive list of these projects has been made available to all on the InterRidge website (http://www.interridge.org/highthroughput). A screen grab is shown in the Online Resources section of this volume. The goals are to avoid duplicating efforts, encourage common projects, and facilitate communication between groups interested in such approaches. This is only starting and we encourage people to add their projects to the list (http:// www.interridge.org/node/add/highthroughput).

Biological sample sharing

Another goal of the WG is to enhance the distribution and use of specimens collected at vents (one of the tenets of the InterRidge "Code of Conduct") – basically, to link people with samples. The goal here is to minimize the impact of biological sampling by sharing the samples already collected. This would also enhance international collaboration and perhaps enable scientists in countries without deep submergence assets to gain access to such samples. The WG is looking into having a code of conduct or transfer agreement for sample sharing to try to alleviate possible concerns of some researchers about sharing their samples. Our ultimate goal is to also have an interactive webpage with list of samples available and sample requests. These listings and requests would be announced periodically in the IR biweekly e-news.

Future of the ChEss database

ChEss is part of the Census of Marine Life program that will end in 2010. Although the ChEss database "ChEssBase" is integrated to the Ocean Biogeographic Information System (OBIS), there are concerns as to whether ChEssBase will be kept updated. As we discover new vent sites, and describe new species, there will be a need for updates by our community. Various options are being considered and we should know more about this in a few months.

Meetings

4th Chemosynthesis-Based Ecosystems Symposium (29 June - 3 July 2009, Okinawa, Japan)

This Symposium is traditionally sponsored by InterRidge and the working group dealing with the biology of vent organisms. The 4th CBE Symposium gathered about 200 researchers studying vent and seep biology and demonstrated the very dynamic character of the community. Young researchers were noticeably active, with about 1/3 of all communications (posters and talks) by Ph.D. or Master's students. For more details, please see the article in the Workshops and Conferences section of this volume.

CAREX workshop on model organisms (16-18 June 2009, Sasbachwalden, Germany)

This was the last of a series of three workshops on Life in Extreme Environments (Model ecosystems, Technology and infrastructure, and Identification of model organisms), sponsored by the European Science Foundation. The goal of this series of workshops was to come up with a document for governments and funding agencies to depict a clear picture of the current research and future needs. As far as hydrothermal vent invertebrates are concerned, the chosen models were: Alvinellids, *Bathymodiolus*, and *Rimicaris*.

ASLO meeting (25-30 January 2009, Nice, France)

During this meeting, two special sessions were dedicated to hydrothermal vents. One session was co-organized by WG member C. Fisher and F. Lallier (Life in extreme environments: deep-sea chemosynthetic ecosystems), and the other by ex-officio WG member N. Le Bris (From molecules to organisms: Chemoautotrophic pathways and mechanisms of energy transfer in extreme marine environments).

Workshops and Conferences

Workshop on Deep-Sea Mining of Seafloor Massive Sulfides

Stace Beaulieu and Maurice Tivey

Hydrothermal vent systems host seafloor massive sulfide (SMS) deposits that are typically rich in copper, zinc, gold, and silver. In recent years, these systems have attracted considerable interest from commercial mining companies, and in 2007 the International Seabed Authority (ISA) released the first "Draft regulations on prospecting and exploration for polymetallic sulphides in the Area." On April 1-2, 2009, the InterRidge Office and Seafloor Mineralization Working Group coordinated a science and policy workshop on "Deep-Sea Mining of Seafloor Massive Sulfides: A Reality for Science and Society in the 21st Century." A total of 98 participants from more than 20 nations attended the workshop in Woods Hole, USA. Participants included scientists, lawyers, economists, government representatives, the International Seabed Authority (ISA), mining companies, and NGOs. Students from countries around the globe including Papua New Guinea, Mauritius, and Djibouti, also were among the participants. A number of media representatives also attended, and the Associated Press bulletin was broadcast on over 3000 webpages (news media and blogs) around the globe. For a full list of participants, videos of the public presentations, media coverage, and background information, see the workshop webpage: http://www.whoi.edu/workshops/deepseamining.

The workshop began with a full day of science presentations, from the full spectrum of disciplines, including geology, geophysics, geochemistry, macro- and microbiology, and marine conservation. Studies were reported from all ocean basins and a full range of hydrothermal systems, including mid-ocean ridges, back-arc basins, and submarine arc volcanoes. The abstract booklet is available at the InterRidge website: http://www.interridge.org/science/IRmeetings/reports. The second day of the workshop was devoted to a policy discussion, with presentations from the ISA, the International Marine Minerals Society, Nautilus Minerals, Teck, Anglo American, and the Marine Conservation Biology Institute.

The workshop concluded with a public colloquium, "Precious Metals from Deep-Sea Vents." This event was sponsored by the Morss Colloquium endowed program at WHOI, which supports public colloquia on issues of global importance that connect science and society. Keynote speakers and panelists were

Figure 1: (upper) Audience for the public presentations that concluded the deep-sea mining workshop. Center, left to right: Jian Lin (InterRidge Chair), Nii Odunton (Secretary-General, International Seabed Authority), Chris German (InterRidge Co-Chair).

Figure 2: (lower) Panelists for the Morss Colloquium were (seated), from left: Caitlyn Antrim, Sabine Christiansen, Rod Eggert, Chris German, Nii Allotey Odunton, Samantha Smith, and Maurice Tivey. The panel was moderated by Mindy Todd (standing), host of the U.S. National Public Radio program "The Point."

Caitlyn Antrim (Rule of Law Committee for the Oceans), Sabine Christiansen (World Wildlife Fund), Rod Eggert (Colorado School of Mines), Chris German (WHOI, ChEss Co-Chair and InterRidge Co-Chair), Nii Allotey Odunton (ISA Secretary-General), Samantha Smith (Nautilus Minerals), and Maurice Tivey (WHOI, and Chair of the InterRidge Working Group on Seafloor Mineralization). The public colloquium was simulcast on the internet and viewed by people across the USA and in Jamaica, the UK, Bulgaria, and South Africa.

Following the workshop and colloquium, the InterRidge Working Group (WG) on Seafloor Mineralization met on April 3rd to discuss the gaps in scientific knowledge that were identified by the various stakeholders during the workshop. Please see the Working Group Updates section of this volume for the WG's questions and recommendations that were provided to the ISA in time for the 2009 Annual Session at which the draft regulations for polymetallic sulfides were discussed.

Another outcome of the workshop was the interaction between InterRidge and scientists at UNEP/GRID-Arendal, a collaborating center of UNEP (United Nations Environment Programme). Please find more information about the new Letter of Agreement between InterRidge and UNEP/GRID-Arendal in the "From the Office" section of this Newsletter.

We received many positive comments on the unique blend of disciplines and diversity at the workshop, and the workshop was successful in establishing a dialogue between the broad range of stakeholders. We would like to extend many thanks to our sponsors: the Woods Hole Oceanographic Institution, the ChEss project of the Census of Marine Life, InterRidge, and the U.S. Ridge 2000 program.

Figure 3: Jelena Puzic (Teck) and Roger Amato (U.S. Minerals Management Service), examining a seafloor sulfide sample collected by Meg Tivey (WHOI).

(Photo credits: Tom Kleindinst, WHOI)

KOPRI's 16th International Symposium on Polar Sciences

Stace Beaulieu

The Korea Polar Research Institute (KOPRI) hosted the 16th International Symposium on Polar Sciences: "Polar Exploration with *ARAON*" in Incheon, Korea, on 10-12 June 2009. The symposium brought together 144 scientists from the broad fields of both ridge and climate research, representing 11 countries around the globe. The meeting was timely, with the delivery in Nov. 2009 of the new Korean research icebreaker R/V *Araon*, with sea trials planned for Nov. - Dec. 2009. The energy in anticipation of the opportunities for expanding Korea's ocean science programs and collaborating with other nations was palpable immediately in the opening address and throughout the two days of presentations and workshop discussions.

The workshop program on ridge research was organized by Sung-Hyun Park, Korea's Steering Committee member in In-

Figure 1: New Korean research icebreaker ***Araon***.

terRidge. An objective of this program was to forge collaborations for the Korean Polar Ridge program (KOPRIDGE) which is proposed to explore for hydrothermal activity at the Pacific-Antarctic Ridge over the next several years. Presentations were also given for other ridge and submarine volcanic systems from the Bransfield Strait in the Southern Ocean to the Gakkel Ridge in the Arctic.

InterRidge contributions included:

- Jian Lin, InterRidge Chair, gave a keynote presentation on "Major opportunities for international multi-disciplinary research and exploration of the global mid-ocean ridge system;"
- Y. John Chen, InterRidge StCOM member, provided a presentation entitled "Recent progress in mid-ocean ridge research in China;"
- Sang-Mook Lee, former InterRidge StCOM member, spoke on "Comparisons between back-arc basin and mid-ocean ridges;"
- Stace Beaulieu, InterRidge Coordinator, gave an overview of hydrothermal vent faunal biogeography and presented "Larval supply, colonization, and faunal community development at hydrothermal vents on the East Pacific Rise;"

Talks and posters from InterRidge members from France and USA:

- Anne Briais gave presentations on "The Pacific-Antarctic Ridge: Geophysical and geochemical results from the French expeditions obtained with R/V *L'Atalante* (1996 and 2002)" and "The tectonic evolution of the Pacific Antarctic Ridge, recent changes in plate motion, intraplate tectonics and axial morphology;"
- Dana Yoerger gave an invited lecture on "Autonomous discovery, mapping, and sampling of deep-sea hydrothermal vents;"
- Robert (Bob) Dziak, presented "Tectono-magmatic activity and ice dynamics in the Bransfield Strait Back-arc Basin, Antarctica;"
- Ed Baker showed a poster on "Exploration strategies for polar environments: High-resolution mapping of hydrothermal discharge using an autonomous underwater vehicle."

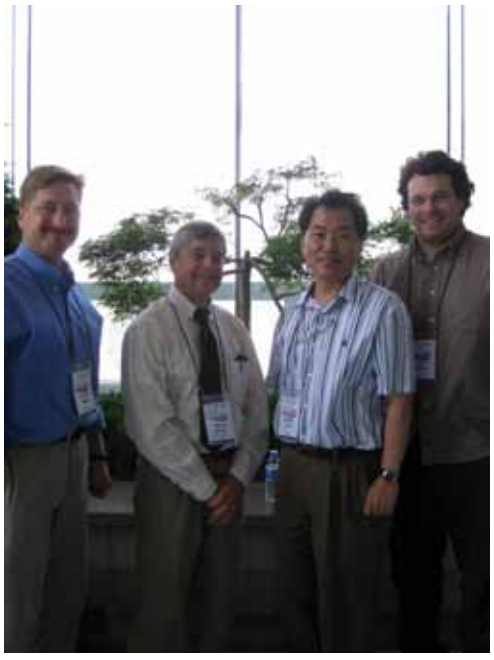
Additional ridge studies were presented from the international community, including:

- From Korea – Won-Sang Lee presented "Hydroacoustic monitoring in the Scotia Sea, Antactica" and Sukyoung Yun presented "Southeast Indian Ocean Ridge earthquake sequences from cross-correlation analysis of hydroacoustic data;"
- From Japan – Yoshikumi Nogi presented "Japanese marine geophysical and geological research activities in the Antarctic Ocean;"
- From USA – Ken Sims gave presentations on "Application of U- and Th decay series disequilibria to dating submarine basalts" and "Generation of 231Pa, 226Ra, 238U, and 230Th excesses in Arctic mid-ocean ridge basalts from the Kolbeinsey, Mohns, Knipovich, and Gakkel Ridges" and Joe Haxel presented a poster on "Regional comparisons of deep-ocean sound from the Bransfield Strait and Scotia Sea."

We thank Dr. Park and KOPRI for inviting InterRidge to participate in the Symposium, and we look forward to many years ahead of international collaboration in ridge research enabled by the R/V *Araon*.

Figure 2: (below) Participants at the 2009 Symposium at KOPRI in Incheon, Korea.

Figure 3: (right) Bob Dziak, Ed Baker, Minkyu Park, and Joe Haxel at the 2009 KOPRI Symposium.



4th International Symposium on Chemosynthesis-Based Ecosystems

Stace Beaulieu

Specialists in the biology of hydrothermal vents gathered June 29 - July 3, 2009, in Okinawa, Japan, for the 4th International Symposium on Chemosynthesis-Based Ecosystems (CBE). The CBE Symposium, sponsored in part by InterRidge, brought together approximately 200 scientists from 20 countries/regions. Studies of hydrothermal vent macro- and microbiology were presented for ridge-crest sites across the globe including the eastern Pacific (e.g., Juan de Fuca Ridge and East Pacific Rise), the western Pacific (e.g., Manus and Lau Basins and Okinawa Trough), the southern and northern Mid-Atlantic Ridge, and Indian Ocean (e.g., Rodrigues Triple Junction).

Members of the InterRidge Vent Ecology Working Group held a meeting during the Symposium, and Yoshihiro (Yoshi) Fujiwara (JAMSTEC) was chosen as a new Co-Chair to serve alongside Co-Chair Stephane Hourdez. The WG discussion is summarized in the Working Group Updates section of this volume.

Presentations by Members of the Vent Ecology WG included:
- Stephane Hourdez, Working Group Chair, "Adaptations to chronic hypoxia in hydrothermal vent and cold-seep invertebrates;"
- Monika Bright, "Succession of hydrothermal vent meiobenthos after a recent volcanic eruption at the 9 50'N East Pacific Rise region;"
- Ana Colaço, "Trophic structure of colonization modules at chemosynthetic environments: a comparative approach;"
- Nicole Dubilier, "Understanding diversity in chemosynthetic symbioses;"
- Charles (Chuck) Fisher, "Stable isotopes and chemoautotrophic ecosystems;"
- Katsunori Fujikura, "Turrid gastropod *Phymorhynchus buccinoides* relies on mytilid mussel *Bathymodiolus* in Sagami Bay, Japan;"
- Sergey Galkin, "Concentration function of the deep-sea vent benthic organisms" and "Bioaccumulation of some trace elements in the biota of the Guaymas Basin hydrothermal vent fields;"
- Crispin Little, "Fossilization processes at hydrothermal vents;"
- Anna Metaxas, "The role of larval dispersal and colonization in the biogeography of chemosynthetic habitats of the deep sea;" and
- Xiang Xiao, "Metagenomic assisted investigation of microbial communities at the Juan de Fuca Ridge hydrothermal vent."

Additional presentations by Members of the InterRidge Steering Committee and other Working Groups, and the InterRidge Coordinator included:
- Nadine Le Bris, "In situ continuous monitoring using autonomous electrochemical sensors: insights to the temporal variability

Figure 1: (upper) Participants at the 4th CBE Symposium in Okinawa, Japan.

Figure 2: (lower) Wonderful conference room faciltiies at the Bankoku Shinryokan.

of various chemosynthetic habitats;"
- Lisa Levin, "Colonization patterns offer a window into metacommunity structure of seeps and vents in the NE Pacific Ocean."
- Stace Beaulieu presented the InterRidge "Code of Conduct" as well as the "Photographic identification guide to hydrothermal vent larvae: http://www.whoi.edu/vent-larval-id."

InterRidge presented two awards ($700 USD each) to students Dennis Fink, from Max Planck Institute for Marine Microbiology, and Daphne Cuvelier, from University of the Azores, as detailed in the Education and Outreach section of this volume.

We would like to thank the CBE Organizing Committee, including Chair Tadashi Maruyama (JAMSTEC) and Secretary Yoshi Fujiwara, and the Scientific Committee, chaired by Shigeaki Kojima (ORI, Univ. Tokyo). To view the Symposium program, please see: http://www.jamstec.go.jp/xbr/4th_CBE/. Proceedings of the Symposium will be published in Cahiers de Biologie Marine.

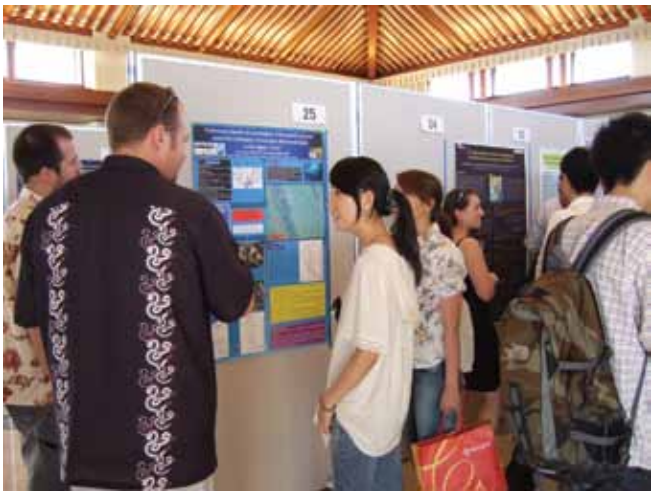


Figure 3: (upper) Poster session and close-up of the beautiful tubeworm artwork on the Kariyushi-style conference shirt. Kariyushi is a word made up of "kari" and "yushi" in Okinawan (Ryukyu) dialect and means auspicious or happiness.

Figure 4: (lower) Exciting drumming and dancing at the conference dinner at Ufuya, or Big House, restaurant.

Melting, Magma, Fluids and Life Workshop:
Challenges for the next generation of scientific ocean drilling into the oceanic lithosphere

Stace Beaulieu and Benoit Ildefonse

The Melting, Magma, Fluids and Life (MMFL) Workshop brought together more than 70 scientists from 9 countries to discuss and explore new ideas for ocean drilling studies to improve our knowledge of mid-ocean ridge processes and the chemical and biological exchanges between the oceanic lithosphere and the wider Earth system. It was not the aim of the workshop to design future drilling proposals, but to build community momentum along new and established research avenues that will shape the future priorities of scientific ocean drilling and guide innovative experiments by the broader earth science community. InterRidge co-sponsored the workshop as part of the activities of the Deep Earth Sampling Working Group. Other sponsors included {in order of Contribution}, the UK-IODP, the U.S. Consortium for Ocean Leadership, NOCS, JAMSTEC, JSPS, the Integrated Ocean Drilling Program (IODP), as well as national agencies. The workshop was held at the National Oceanographic Centre, Southampton (NOCS), UK, 27-29 July 2009. Lead conveners were Damon

Teagle (host) and Rosalind Coggon (UK), Natsue Abe (Japan), Wolfgang Bach (Germany), Donna Blackman, Henry Dick, and Katrina Edwards (USA), and Benoit Ildefonse (France).

A major outcome of the workshop was a white paper submitted to the INVEST (IODP New Ventures in Exploring Scientific Targets) Workshop that was held in Sept. 2009. The objective of the INVEST Workshop was to define the scientific research goals for the next decade of ocean drilling research, beginning in 2013 after the conclusion of the current IODP. The MMFL white paper, titled "The Ocean Lithosphere: A Fundamental Component of the Earth System," develops three main themes, each comprising geological, hydrological, chemical, and biological processes that are closely interdependent:

• Understanding the accretion of ocean crust. This goal requires (a) full section characterization of minimally-disrupted ocean crust and a sufficient portion of underlying uppermost mantle, and (b) detailed understanding of active processes within the axial zone;

• Understanding lithospheric heterogeneity in slow- and ultra-slow spread crust, in particular the impact of serpentinization on global biogeochemical cycles and plate rheology. The latter is likely a controlling factor in regional tectonic behavior;

• Following the maturation process of lithosphere from the axis to the ridge flanks and investigating the hydrological-geochemical-microbiological feedbacks during the aging of the oceanic basement.

The full MMFL workshop report, copies of presentations, and white paper for INVEST are all available at the InterRidge website: http://www.interridge.org/WG/DeepEarthSampling/workshop2009.

Below are the concluding remarks from the MMFL workshop report:

"A general framework for ocean lithosphere efforts within a new ocean drilling program

The compositional and structural heterogeneity of the oceanic lithosphere arises from temporal and spatial variations in mantle composition and thermal structure, magma supply, efficiency of melt extraction, tectonic extension, or a combination of any of these factors. Drilling is a fundamental and critical tool for understanding the origin, scales, and implications of such heterogeneity. For many fundamental Earth science questions drilling is the only possible approach to recover samples, on which analyses and observations can be conducted to test competing hypotheses of how our planet works. However, the global relevance of the geological processes inferred from the one-dimensional view that deep drilling provides must be tightly integrated with other regional observations to fully understanding the complex, three-dimensional nature of the context where drilling takes places. This is particularly true when considering drilling a full crustal penetration to the Moho and well into the underlying upper mantle, which, if as planned, will be initially attempted in a single site. Improved understanding of the ocean lithosphere can only be achieved by integrating and ground-truthing drilling observations in different geologic settings with detailed morphological and seafloor geological mapping, and with geophysical imaging of the sub-seafloor heterogeneity at spatial scales that are comparable to those of seafloor observations.

The ocean lithosphere community has a strong record of science-driven technology development (e.g., CORKS). The fundamental and challenging science questions outlined in this report will be a major incentive for continued technological development and innovation. It is hoped that the full suite of available and next-generation technological capabilities will be used to optimize scientific return in ocean lithosphere drilling efforts. This includes, for example, D/V *Chikyu*, seabed rock drills, CORKS, the capacity to drill fractured basalts, the monitoring of and fluid/gas sampling in boreholes in high-temperature environments, borehole experiments (e.g., cross-hole experiments, VSP), borehole-hosted laboratories and instruments (e.g., microbe culturing), improved wireline tools, mud logging (cuttings analysis, fluid/gas monitoring), sidewall coring. As the need to drill and core a full intact section of ocean crust to the Moho and into the upper mantle is reaffirmed, we strongly endorse development and continuation of efforts to assess and design coring and borehole characterization capability that enable coring, measurement and sampling at high temperatures, in very deep holes and in great water depths."

Visit the InterRidge website for reports from IR-sponsored workshops:
http://www.interridge.org/science/IRmeetings

Online Resources and Publications

Resources available at the InterRidge website:

InterRidge Global Database
of Active Hydrothermal Vent Fields

http://www.interridge.org/IRvents

Please note: this webpage may not be activated until Jan. 2010

Screen grab: of hydrothermal vent field positions displayed in Google Earth, centered on the first deep-sea vent field discovered at the Galapagos Rift.

InterRidge Working Group for Mantle Imaging

List of OBS and OBEM field research projects
http://www.interridge.org/OBS-OBEM

InterRidge Working Group for Vent Ecology

List of high-throughput projects
http://www.interridge.org/highthroughput

Screen grab: of the high throughput project list as of Nov. 2009.

GODAC 国際海洋環境情報センター
Global Oceanographic DAta Center

http://www.godac.jp/top/en/index.html
(in English)

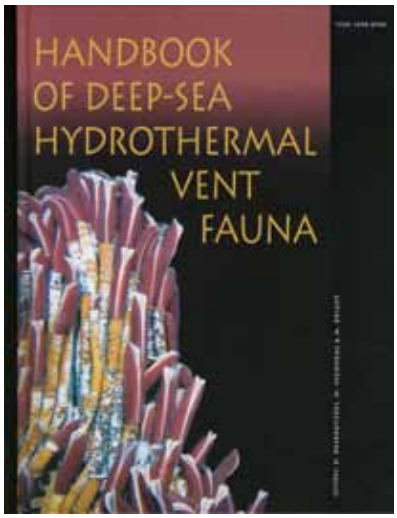
In 2009 JAMSTEC launched a new database, Biological Information System for Marine Life (BISMaL), online at the Global Oceanographic Data Center (GODAC):

http://www.godac.jp/bismal/searchSpecies.jsf

You can search marine species including those from deep-sea vents and seeps around the Japan Islands and browse photographs, descriptions on morphology/ecology, videos, sample records, and references of each species.

In addition, the GODAC website links to:

- JAMSTEC cruise reports,
- GANSEKI: Deep Sea Floor Rock Sample Database, and
- Deep-sea Video Database featuring video from vehicles including *Shinkai 6500* and ROV *HYPER-DOLPHIN*.



"Handbook of Deep-Sea Hydrothermal Vent Fauna,"

D. Desbruyères, M. Segonzac and M. Bright (Eds.), 2nd ed., 2006

Now available online:
http://www.biologiezentrum.at/biophp/de/band_det.php?litnr=23702

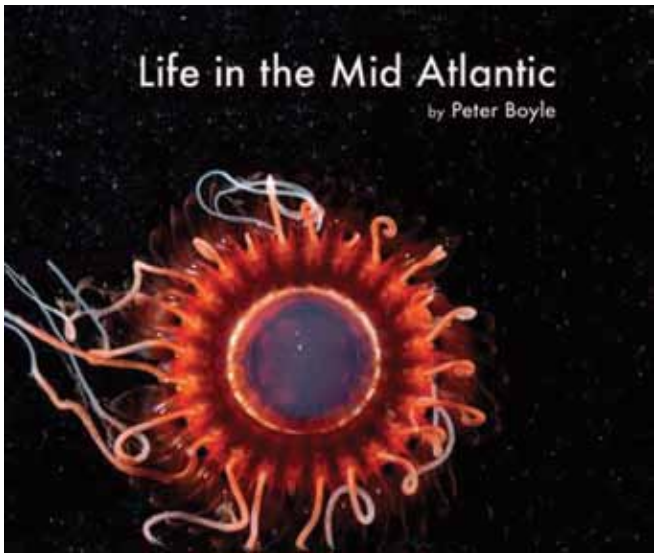
Geochemistry Geophysics Geosystems G3
An Electronic Journal of the Earth Sciences

Submissions encouraged for new themed volume of G-cubed:

"Life, energy and material cycles at slow-spreading ridges"

Theme Editors: Colin Devey, Nicole Dubilier, Jian Lin, Nadine Le Bris and Doug Connelly
http://www.agu.org/journals/gc/themes.shtml?collectionCode=MANTLE1&journalCode=GC

This theme is intended to provide a focus for results of recent studies on slow-spreading ridges globally. Because of their complex interplay between magmatism, tectonism and hydrothermalism, determining fundamental principles of how slow-spreading ridges and their associated ecosystems work has required time-consuming and costly studies of relatively large areas of the seafloor, often with remotely-operated or autonomous vehicles. The first fruits of a new generation of such studies are now becoming available. This theme should showcase and assemble these results.



"Life in the Mid Atlantic,"

by Peter Boyle (Univ. Aberdeen), 2009

Now available at: http://amazon.co.uk

The well-illustrated text provides background information, accounts of goals, plans, and technologies, and a final summary of results to date of the Census of Marine Life project MAR-ECO (2001-2010). By adopting novel technology and the best research vessels, the international MAR-ECO team significantly enhanced the knowledge of biodiversity of the Atlantic mid-ocean ridge system.

Upcoming Events

Dec. 14-18, 2009	AGU Fall Meeting 2009, San Francisco, CA, USA
Feb. 11-12, 2010	British Geophysical Association 2010, London, UK
Feb. 22-26, 2010	Ocean Sciences Meeting 2010, Portland, Oregon, USA
May 2-7, 2010	European Geosciences Union (EGU) General Assembly 2010, Vienna, Austria
May 8-16, 2010	AGU Chapman Conference on "Detachments in Oceanic Lithosphere: Deformation, Magmatism, Fluid Flow, and Ecosystems," Cyprus *(see advertisement next page)*
May 24-27, 2010	OCEANS '10 IEEE, Sydney, Australia
Jun. 14-18, 2009	Goldschmidt Conference 2010, Davos, Switzerland
June 21-25, 2010	Joint "Minerals of the Ocean - 5" and "Deep-Sea Minerals and Mining -2 (DSMM-2)," St.Petersburg, Russia
Jun. 22-25, 2010	Western Pacific Geophysics Meeting 2010, Taipei, Taiwan
Jun. 28-30, 2010	Long-Range Exploration Workshop, Southampton, UK
July 5-9, 2010	Asia Oceania Geosciences Society (AOGS) 2010, Hyderabad, India
August 8-13, 2010	AGU Joint Assembly 2010 - The Meeting of the Americas, Foz do Iguaçu, Brazil
October 4-9, 2010	Underwater Mining Institute (UMI) 2010, Gelendzhik, Russia

Also in 2010:	12th Deep-Sea Biology Symposium, Iceland
	Workshop: "Design of Marine Protected Areas for Chemosynthetic Ecosystems Potentially Threatened by Human Activities in the Deep Sea," *date and venue to be determined*
	Conference: "Ridges and Hotspots around the Mascarene Islands: present activity, past evolution," *date and venue to be determined*
	InterRidge Steering Committee meeting, Southampton, UK

Visit the InterRidge website for Upcoming Event listings:
http://www.interridge.org/events

AGU Chapman Conference "Detachments in Oceanic Lithosphere: Deformation, Magmatism, Fluid Flow and Ecosystems"

8-16 May 2010, Cyprus

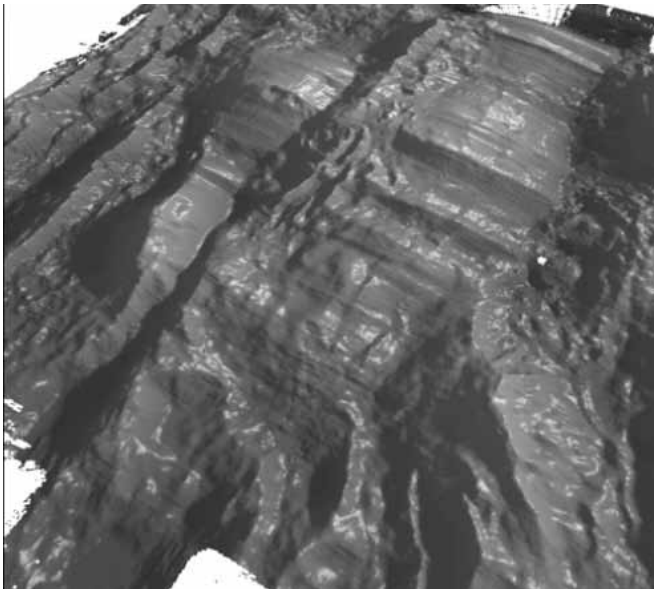
http://www.agu.org/meetings/chapman/2010/dcall/

Abstract submission deadline: **15 January 2010**

Oceanic core complexes (OCCs) are deep sections of the oceanic lithosphere exhumed to the seafloor by long-lived detachment faults formed along the flanks of ultra-slow to intermediate-spreading mid-ocean ridges. These structures have attracted interest because: (1) provide windows into the oceanic lithosphere, (2) are an important component of lithospheric accretion along ridges, (3) host a large variety of high- and low-temperature hydrothermal fields and associated ecosystems, (4) represent an extreme case of strain localization and tectonic deformation, and (5) may provide insights into the origin and nature of continental metamorphic core complexes and detachment faulting in extensional continental margins.

The goals of the conference are:

- To share results and synthesize our current knowledge of OCCs, oceanic detachment faulting, and associated geological, chemical, and biological phenomena
- To identify relevant scientific questions that remain unanswered, put forward new questions, and define both scientific experiments and an approach strategy to address them.



Kane OCC at the Mid-Atlantic Ridge: Image courtesy of J.P. Canales & H. Dick

This will require the community to address the following science questions:

1. How and under which conditions does detachment-faulting lead to the formation and development of OCCs? What are the mechanisms and conditions that promote and sustain strain localization over long periods of time, and the development of an OCC?
2. What is the lithological structure of OCCs and its variability at scales of meters to tens of kilometers? What is the link between deformation and magmatic emplacement?
3. What drives hydrothermal circulation in OCCs and detachment faults? What are the feedbacks between fluid circulation, deformation, and magmatic processes?
4. What is the biodiversity and characteristics of ecosystems associated with OCCs, and how are they related to the style of hydrothermal circulation within OCCs and along detachment faults?
5. What are the similarities and differences between oceanic and continental detachment faulting (including extensional margins)? How can current knowledge on continental core complex formation, continental breakup and initiation of seafloor spreading inform and contribute to advance research on OCCs?

Conveners:
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Country	Dates	PI	Ship	Cruise ID / Location	Research Objectives
China	Oct - Nov 2009	C. Tao	R/V DayangYihao, ROV Sea Dragon 2	EPR, 2°S	Investigate hydrothermal vents and recover samples at the equatorial EPR
China	Nov - Dec 2009	C. Tao	R/V DayangYihao	SMAR	Investigation of hydrothermal plumes along the southern Mid-Atlantic Ridge
China	Dec 2009 - Jan 2010	H. Zhou	R/V DayangYihao	SWIR	Investigation of hydrothermal vents along the Southwest Indian Ridge
China	Jan - Mar 2010	J. Li	R/V DayangYihao	SWIR, 50°W	Chinese OBS experiment at the Southwest Indian Ridge with possible French collaboration
China	Mar - Apr 2010	COMRA	R/V DayangYihao	SWIR and CIR	Investigation of hydrothermal vents along the Southwest Indian Ridge and Central Indian Ridge
France	Mar - Apr 2010	P. Gente	R/V L'Atalante, submersible Nautile, AUV ASTERx	PARISUB / EPR, 16°N	Investigation of the interaction between a plume, the Mathematicians hotspot, and the EPR spreading axis
France	Apr - May 2010	F. Lallier; N. Le Bris	R/V L'Atalante, submersible Nautile	MESCAL / EPR, 9°N, 11°N, 13°N	(a) Colonization strategies and adaptation of *Alvinella pompejana* to thermal and chemical stresses, and (b) integrative biology of thiotrophic endosymbiosis
France	Jun - Jul 2010	A. Godfroy	R/V L'Atalante, submersible Nautile, AUV ASTERx	BIG / Guaymas Basin	Characterize physicochemical gradients and microbial and animal communities to evaluate the taxonomical and functional similarities within the vent and cold seep habitats
France	Aug 2010	M. Cannat; J. Blandin; P.-M. Sarradin	N/O Pourquoi Pas?, ROV Victor	MOMARSAT / NMAR, Lucky Strike	Deploy acoustically-linked, multidisciplinary observing system at the Lucky Strike vent field, with satellite connection to shore; installation of an ESONET observatory in the MOMAR area
France	2010	J. Perrot	NRP Don Carlos	HYDROBS-MOMAR / NMAR	To continue the experiment of hydrophones in the SOFAR channel around the MOMAR area
France	2010	J.-Y. Royer	R/V Marion Dufresne	OHA-SIS-BIO / Indian Ocean	To continue and expand the hydrophone experiment to monitor the seismicity of the three Indian ridges and the deformation zone of the Central Indian Ocean, as well as the vocal activity of marine mammals
France	2010	C. Hémond	R/V Marion Dufresne	GEISEIR 2 / SEIR	To extend further west the area studied during GEISEIR
France	2010	D. Sauter; M. Cannat	R/V Marion Dufresne	SMOOTHSEAFLOOR / SWIR	To better constrain the composition, structure, magnetic signature and mode of formation of the "smooth seafloor" domains described during a previous cruise on the Southwest Indian Ridge
Germany	30 Jul - 10 Aug 2010	C. Borowski	R/V Poseidon, AUV, ROV Cherokee	MoMARMap, P402 / NMAR, Menez Gwen	AUV mapping
Germany	30 Aug - 8 Oct 2010	N. Dubilier	RV Meteor, ROV Quest	MenezMAR, M82/3 / NMAR, Menez Gwen	
Germany	Jun 2011	W. Bach	RV Sonne, ROV Quest	Bambus / Manus Basin	
Japan	14-27 Jan 2010	K. Okino	R/V Hakuho-maru	KH09-5-4 / SWIR, near Marion hotspot, 26-39°E	Geophysical mapping and dredging
Japan	May 2010	T. Urabe	R/V Daini Hakurei-maru	S. Mariana BSC	BMS drilling for TAIGA project
Japan	Aug 2010	N. Seama		S. Mariana BSC	OBS and OBEM deployments
Japan	Sep 2010	S. Kojima; J.-I. Ishibashi	R/V Yokosuka, subm. Shinkai 6500	S. Mariana BSC	Biology and geochemistry of hydrothermal vents
Japan	Nov - Dec 2010	K. Okino	R/V Hakuho-maru, AUV or deep-tow	KH10-5 / Indian RTJ	Integrated survey around Kairei hydrothermal site for TAIGA project
Korea	16 Dec 2009 - 3 Jan 2010	KORDI	R/V Onnuri	CIR, north of the triple junction, 8-17°S	The objective of the first cruise is to obtain multi-beam bathymetry and magnetic data on an un-surveyed ridge segment. The second cruise will conduct dredges for rock and chimney sampling, and water column surveys for hydrothermal plumes.
Korea / USA	2-14 Jan 2010	KOPRI; NOAA	R/V James Clark Ross	Bransfield Strait	Collaborative project for hydroacoustic monitoring in the Bransfield Strait; these recordings are expected to help better understand tectonic events, volcanic activities, and ice breakup in the region.

Korea / Canada / USA	2011	KOPRI	proposed with ROV ROPOS	Bransfield Strait	Collaboration between KOPRI, Univ. Victoria, and NOAA
Portugal	Jun 2010	P. Ferreira; A. Colaço	NRP Almirante Gago Coutinho	NMAR, Menez Gwen	Multidisciplinary cruise (geology/biology)
UK	7 Jan - 24 Feb 2010	P. Tyler	RRS James Cook, ROV Isis	ChEsSo 2 / ESR	Detailed analysis of East Scotia Ridge vents
UK	20 Mar - 24 Apr 2010	D. Connelly	RRS James Cook, AUV Autosub 6000, TOBI	Mid-Cayman Rise Leg 1 / Mid-Cayman Spreading Center	Geochemistry and biology of hydrothermal vents
UK	2010	N. White	RRS James Cook	Reykjanes Ridge	A follow-up cruise to collect multichannel seismic data over V-shaped ridges south of Iceland; site survey for an IODP drilling proposal
UK	Jan 2011	A. Rogers	RRS James Cook, ROV Isis	Bransfield Strait	Vents and seeps in Bransfield Strait
UK	2011	J. Copley	with ROV Isis	Mid-Cayman Rise Leg 2 / Mid-Cayman Spreading Center	Geochemistry and biology of hydrothermal vents
USA / Japan	21 Nov - 6 Dec 2009	D. Wiens; N. Seama	R/V Revelle	Lau Basin, ELSC	Crustal accretion and mantle processes along the subduction-influenced Eastern Lau Spreading Center; includes seismic survey of ELSC and deployment of OBSs
USA	22 Nov - 6 Dec 2009	A. Teske; M.K. Tivey	R/V Atlantis, submersible Alvin	AT 15-56 / Guaymas Basin	Microbial carbon and sulfur cycling in the hydrothermally altered sediments of Guaymas Basin; Using thermocouple arrays to investigate temporal and spatial microbial colonization in actively forming hydrothermal vent deposits
USA	9-17 Dec 2009	D. Bohnenstiehl; R. Embley	R/V Revelle	Lau Basin, ELSC	Assessment of T-wave processes and hydroacoustic monitoring capabilities in the Lau Basin; NOAA VENTS
USA / Austria	16 Dec 2009 - 1 Jan 2010	S. Nooner; M. Cormier; M. Bright	R/V Atlantis, ROV Jason II	AT 15-58 / EPR, 9°N	Establishing a long-term geodetic network at the East Pacific Rise, Ridge 2000 Integrated Studies Site; Testing models of magma movement along the East Pacific Rise using combined geodetic and numerical experiments; Succession of deep sea hydrothermal vent meiofauna after a recent eruption
USA / Chile	24 Feb - 17 Mar 2010	A. Thurber; J. Sellanes; C. German	R/V Melville, AUV Sentry	Chile Triple Junction	Preliminary detection, location, mapping and photography of the seafloor at new seep and vent sites along the Chile margin including the adjacent Chile Rise
USA	15 Mar - 14 Apr 2010	J. Sinton	R/V Atlantis, submersible Alvin, AUV Sentry	Galapagos Spreading Center	Volcanic Eruptions on the Galapagos Spreading Center: Effect of Variable Magma Supply on Eruption and Magma Chamber Processes on Mid-Ocean Ridges
USA	16-30 Mar 2010	W. Chadwick	R/V Kilo Moana, ROV Jason II	Mariana Arc	Strombolian volcanism, magma degassing, and hydrothermal discharge at an active submarine arc volcano
USA	17 Apr - 10 May 2010	D. Bohnenstiehl	R/V Kilo Moana	Lau Basin	Assessment of T-wave Processes and Hydroacoustic Monitoring Capabilities in the Lau Basin
USA	17 May - 18 Jun 2010	K. Harpp	R/V Melville, TowCam	Galapagos Spreading Center	Plume-Ridge Interaction in the Northern Galápagos: Understanding mantle-lithosphere dynamics through geochemistry, geophysical mapping, and gravity modeling
USA	6-26 Jul 2010	J. Cowen; R. Lee; M. Tivey; M. Lilley	R/V Atlantis, submersible Alvin	Juan de Fuca, Endeavour	CORK Optical Telemetry System; Thermal biology of hydrothermal vent paralvinellid worms; Resistivity probe deployments at the Endeavour ISS
USA	24 Jul - 21 Aug 2010	J. Delaney; R. McDuff	R/V Thompson, ROV Jason II	Enlighten'10 / Juan de Fuca	Regional Scale Nodes Detailed Site Characterization; Student Instruction
USA	25 Aug - 6 Sep 2010	W. Chadwick; J. Huber	R/V Thompson, ROV Jason II	Juan de Fuca, Axial Seamount	Monitoring inflation at Axial Seamount; Function, activity, and adaptation of microbial communities in geochemically diverse subseafloor habitats
USA	27 Oct - 10 Nov 2010	D. Wiens	R/V Kilo Moana	Lau Basin, ELSC	Crustal accretion and mantle processes along the subduction-influenced Eastern Lau Spreading Center; includes recovery of OBSs

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* Rotating off Committee at end of 2009.

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Cover: Perspective image of active oceanic detachments at the Mid-Atlantic Ridge near 13°N (image width ~50 km in foreground). The deep valley at the top of the image is the Fifteen Twenty Fracture Zone. Red dots indicate seismic activity detected hydroacoustically. White squares indicate active hydrothermal vent fields as listed in the InterRidge Vents Database (from N to S: Logatchev, Semyenov, and Ashadze). Data acquired during MODE (Japan), Ridelente, Faranaut, Sigma (France) and Knorr'05 (NSF, USA) cruises. Courtesy of J. Escartin, IPGP, France & D. K. Smith, WHOI, USA.

Back cover: Mafic-ultramafic contact on the seafloor at Atlantis Bank OCC, Southwest Indian Ridge. This image mosaic was made by JAMSTEC from still camera images taken by submersible *Shinkai 6500* in 2002. The uppermost part of the outcrop is isotropic/ massive gabbro sitting on layered gabbro (center of the image). Below these gabbro lithologies, ultramafic rocks were observed. Image courtesy of H. Kumagai, JAMSTEC.