InterRidge News

Promoting international cooperation in ridge-crest studies

Volume 19 • 2010

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Contents

InterRidge News

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Layout
Kate Davis

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 (minimum width of 1000 pixels, 2000 is preferable), in eps or tif format for optimal printing, although other formats are accepted.

Deadline for InterRidge News Vol. 20 Contributions
12 September 2011

Letter from the Chairs

Bramley Murton and Jon Copley

On January 1st 2010, the InterRidge Office moved from Woods Hole Oceanographic Institute (USA) to the National Oceanography Centre in Southampton (UK). We would like to take this opportunity to thank the previous InterRidge Office team, Jian Lin (Chair), Chris German (Co-Chair) and Stace Beaulieu (Coordinator), for their enormously successful efforts to further InterRidge activities over the past three years.

InterRidge activities

This has been a remarkably successful and busy year for InterRidge science with forty cruises carried out by InterRidge member countries. In March, the Chinese ridge community made a major effort on the SWIR during which new evidence for active hydrothermal sites was found and a 3D seismic cube over a 50x50 km^2 area of the ridge crest was acquired. The new Chinese human-occupied submersible "*Harmony 7000*" and ROV "*Ocean Dragon 2*" were also successfully deployed. The French Ridge community has had three cruises in the NE Pacific Ocean, as well as conducting back-arc basin exploration in the SW Pacific, the completion of geochemical exploration along the South East Indian Ridge, and a cruise devoted to the South West Indian Ridge crustal architecture in the Indian Ocean. The 6000 m rated German AUV "*ABYSS*" is now fully operational and has already conducted some exciting mapping of seamounts in the SW Pacific. In Japan, the major ridge-related effort is the interdisciplinary research project TAIGA (Trans-crustal Advection and In-situ biogeochemical processes of Global sub-seafloor Aquifer). Three integrated study sites have been selected: the southern Mariana Trough, the Indian Ocean Triple Junction, and the Okinawa Trough. Along the East Chile Rise close to the Chile Triple Junction, scientists from the USA have been searching for sites of hydrothermal activity using a combination of AUV surveys and TV-guided coring. UK scientists from Southampton, working in collaboration with those from the USA, successfully completed the search for the deepest-known hydrothermal sites. Using the AUV *Autosub6000* and ROTV *HyBIS* they located active high-temperature vents down to ~5000 m on the floor of the Mid-Cayman Rise, Caribbean. This successful example of InterRidge collaboration has opened up the possibility for further collaborative studies in this exciting area.

Emerging technology

An emerging area of activity has been the use of AUV (autonomous underwater vehicles), especially when combined with ROV and HOV (remotely operated and human occupied vehicles). But AUV technology is not without its dangers and sadly, during this year's US cruise to the Chile Triple Junction, the Woods Hole Oceanographic Institute's AUV *ABE* suffered a catastrophic failure and was lost. *ABE* has served the science community well during the years and both pioneered and set the pace for using AUV technology at the ridge crest.

Working Groups

The working groups continue to be one of the most important mechanisms for InterRidge scientists to identify emerging areas for collaboration. We currently have five working groups: Mantle Imaging, Long-range Exploration, Seafloor Mineralization, Vent Ecology, and Hydrothermal Energy and Ocean Carbon Cycles - their reports are in this volume. The Deep Earth Sampling Working Group declared its work done and has now been disbanded. We would like to extend our thanks to the chair, Benoit Ildefonse, and the Working Group Members for their hard work.

Engaging the IR community and policy makers

With its migration to the National Oceanography Centre, the InterRidge Office has redefined its priorities with an emphasis on engaging the community and building capacity. The InterRidge Student and Postdoctoral Fellowships are becoming better known within the ridge community and we have also announced the first phase of cruise travel bursaries. These are to enable early career, ridge-crest scientists to participate in mid-ocean ridge research cruises and thereby encourage new collaborative networks and partnerships.

The "InterRidge Vents Database" has been completed and is now available on the InterRidge website. The database was put together largely through the efforts of Stace Beaulieu, to whom InterRidge extends its enormous gratitude. The database is a maintained resource and new discoveries are added to it as they are reported.

Building on the USA Office's liaison with UNEP/GRID-Arendal to initiate outreach and information services for InterRidge science, we aim to begin populating Google Ocean with InterRidge sites of special interest. We intend to develop our relationship with GRID-Arendal to include information resources for policy makers and governments, to inform them of the value of the ridge-crest environment and the importance of ridge-crest research.

With the recent licence application to the UN's International Seabed Authority by the Chinese, for exploration of a 1000 km-long section of the Southwest Indian Ridge for polymetallic sulphides, there is a growing need for InterRidge to consider issues around sustainability and the protection of valuable and fragile ecosystems. Protection of chemosynthetic habitats was the topic of an InterRidge sponsored meeting in Dinard, France this year. An outcome from that meeting was a call to the InterRidge community to nominate sites of special interest to inform the International Seabed Authority (ISA) prior to future exploration licensing rounds.

It is likely that InterRidge will become increasingly involved in informing policy makers about the value of ridge-crest environments. Having partnerships with GRID-Arendal and the ISA is essential for our voice to be heard.

Coordinator Update

Debbie Milton

January 2010 marked the move of the InterRidge (IR) Office from WHOI to the National Oceanography Centre, Southampton, UK. We would like to thank the USA office, and those involved at NOC, for the very efficient changeover of the website – in particular, Andy Maffei and Dan Perry. Also, Stace Beaulieu (IR Coordinator 2007-9) has provided invaluable advice and support to the new office during this first year – thank you!

Membership

Individual membership is currently ~ 2600, representing 62 nations and regions. The new office took the opportunity of refreshing the mailing list of members but found many undeliverable addresses. Please check the details we have for you by logging in at: http://www.interridge.org and going to "My Account". From here, apart from changing any details, you can sign up to support the Statement of Responsible Research and also request a hard copy of the annual Newsletter (under "Edit/Other Info").

The "interridge-mail" e-news is sent to >1200 members on a bi-weekly basis and disseminates news pertinent to the ridge community. Nearly 180 IR members receive "interridge-classifieds" - our mailing list for job postings.

DO WE HAVE YOUR CORRECT DETAILS?
Have you moved institution or changed your email?

Update your details - log on to your online member account at http://www.interridge.org

Any members with undeliverable emails will be removed by March 2011

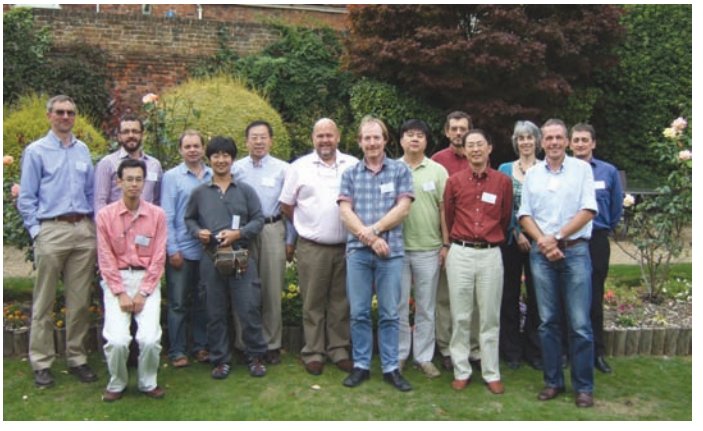
Steering Committee

The IR Steering Committee (StComm) meeting was held in Winchester, UK in September 2010 (see photo). The report of this meeting is posted at: http://www.interridge.org/stcom/reports. Three members will rotate off the StComm this year: we thank Jian Lin for his support during the transition, as well as Jun-ichiro Ishibashi, for his service to IR. He will be replaced by Michinari Sunamura, who attended as his alternate this year. Jérôme Dyment has served an extra year but expects to stand down in 2011 - thank you! Three invited guests made valuable contributions to the meeting - Hans Christian Larsen from IODP, Adam Cook representing the ISA and Yannick Beaudoin, who invited collaboration on outreach between IR and UNEP/GRID-Arendal. A special act of commitment should be mentioned - Dan Fornari attended via Skype for the whole meeting, despite the time difference meaning a 04:00 start each day - thanks Dan!

National Correspondents

In InterRidge News each year, we report on ridge-related activity around the world, through the National News section of this volume. This is the chance to tell the IR community about cruises, conferences and workshops that have been organised or attended by your national members, as well as reporting on general scientific achievements and technologies. Currently we have 31 Correspondents (see back page), but many more nations and regions are represented by individual members for whom there is no Correspondent and so we have not heard their news!

Could you be a National Correspondent?	Countries needing a Correspondent	
What's involved? The IR Office will contact you once or twice a year asking for updates and a short annual report for the InterRidge News.You will be sent a list of emails of IR members in your country/ region to help network with colleagues and whom you can ask for current information.	Argentina	Malaysia
	Bangladesh	Maldives
	Belgium	Mexico
	Canada	Monaco
	Colombia	Myanmar
	Cuba	Nepal
	Cyprus	Netherlands
	Czech Republic	New Caledonia
What's in it for you? You get to liaise not only with your national colleagues, but also become an important link in the global network of ridge researchers. You are first to hear of news disseminated by the IR Office.	Denmark	Pakistan
	Ecuador	Papua New Guinea
	Egypt	Peru
	Greece	Poland
	Indonesia	Slovenia
	Iran	Turkey
How do you become one? Write in to the IR Office expressing your interest (coordinator@interridge.org)	Ireland	Ukraine
	Israel	Venezuela
	Jamaica	Vietnam



IR Steering Committee in Winchester, UK, Sept 2010:
From left to right: Tim Henstock, Adam Cook, Hide Kumagai, Yannick Beaudoin, Michinari Sunamura, John Chen, Christophe Hémond, Bramley Murton, Sung-Hyun Park, Hans Christian Larsen, Jiabiao Li, Debbie Milton, Colin Devey, Jon Copley.

Welcome to two new Correspondents

Jo Whittaker (Australia) is currently a postdoctoral fellow in the EarthByte Group in the School of Geosciences at the University of Sydney, Australia. She is currently investigating Indian Ocean plate reconstructions and continental break-up. Jo's research interests are in the field of plate tectonics, geophysics and geology and she is especially interested in the formation and evolution of oceanic crust, particularly the interplay between tectonics and mantle dynamics. She completed her PhD at the University of Sydney in 2008 on the tectonic consequences of mid-ocean ridge formation, evolution and subduction, before moving to Leeds, UK to work as a Geodynamicist for Getech.

Jo takes over from Dietmar Müller, whom we thank for his years of service to IR-Australia.

Richard Wysoczanski (New Zealand) joined the National Institute of Water and Atmospheric Research (NIWA), New Zealand, at the end of January replacing Ian Wright as the Ocean Geology group's submarine volcanologist. Richard comes to NIWA after extensive experience, completing his PhD at Victoria University of Wellington, fulfilling full-time and postdoctoral positions at the Australian National University, Smithsonian Institute and JAMSTEC. Most recently, Richard returned to New Zealand as Laboratory Manager for the new Geochemistry Laboratory at Victoria University of Wellington before moving to NIWA in early 2009. His research interests include the geochemistry and structure of volcanic arcs and the growth of crust. Currently this work is centred on the Kermadec arc and Havre Trough back arc volcanoes and hydrothermal systems.

Working Groups

IR Working Groups (WG) have been described as the engine room of InterRidge. A WG is formed when new scientific questions arise, and where coordination from IR can benefit in promoting and advancing research in new areas. Each WG exists for about five years until it has served its purpose and is wound up, allowing other initiatives to develop. In 2010, the Deep Earth Sampling WG completed its work and the Chair, Benoit Ildefonse, and the Group Members, were thanked for their efforts. Continuing into next year are: Hydrothermal Energy and Ocean Carbon Cycles, Long Range Exploration, Mantle Imaging, Seafloor Mineralisation and Vent Ecology. Updates on the progress of these WG can be found in the "Working Group Updates" section of this volume.

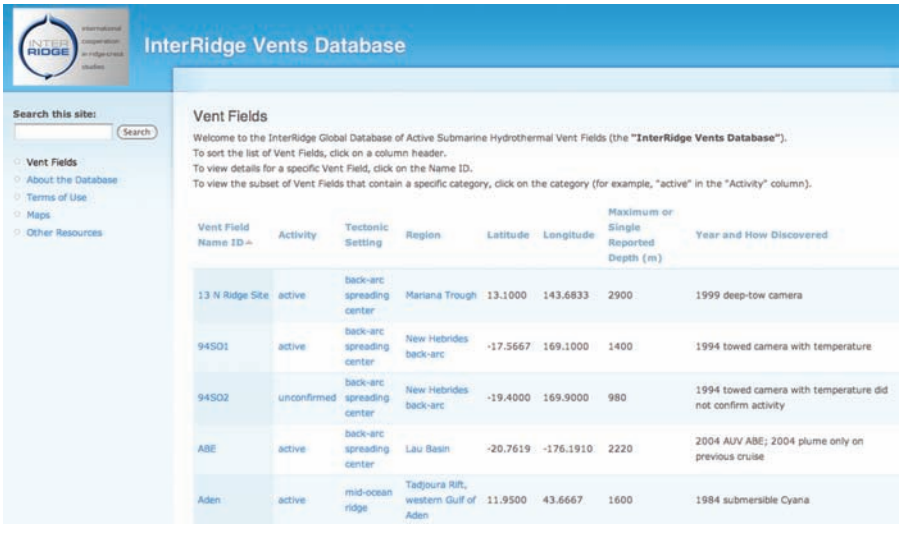
Workshops and Conferences

The Long-Range Exploration workshop held an international workshop at the National Oceanography Centre, Southampton, UK in June 2010, entitled "Long-Range Exploration of the Ridge Crests". Following a meeting in 2009 of the Seafloor Mineralisation WG, Cindy Van Dover, along with Craig Smith, convened a workshop in Dinard, France on "Design of Marine Protected Areas for Hydrothermal-Vent and Cold-Seep Ecosystems Potentially Threatened by Human Activities in the Deep Sea". Financial support was given to "The Mohole: a Crustal Journey and Mantle Quest" in June 2010 in Kanazawa, Japan, as well as to the AGU Chapman Conference on "Detachments in Oceanic Lithosphere: Deformation, Magmatism, Fluid Flow and Ecosystems", held in Cyprus, in May 2010. Further information can be found in the "Working Group Updates" and "Workshops and Conferences" sections of this volume.

Hydrothermal Vents database

We are pleased to announce that, in August 2010, the InterRidge Global Database of Active Hydrothermal Vents was posted to the IR website: http://www.interridge.org/IRvents. This represents a major achievement by Stace Beaulieu and there has been much interest shown since its publication. Updates can be sent to the IR Office, fulfilling a vision expressed in 2000: "The idea of this database is that it should become the international standard for all known sites of submarine hydrothermal activity which can be updated simply by submitting an electronic message to the InterRidge Office." (InterRidge News 9.1, April 2000).

Below: Screen grab of the InterRidge Global Database of Active Hydrothermal Vents.



Education and Outreach Update

Debbie Milton

InterRidge forges links with UNEP/GRID-Arendal

http://www.grida.no

A Letter Of Agreement was signed in January 2010, establishing a framework for cooperation between UNEP/GRID-Arendal and InterRidge. To further this liaison, Yannick Beaudoin, Head of Marine Programme, attended the InterRidge Steering Committee in September 2010. After explaining the mission of GRID-Arendal, he invited IR StComm members to think of topics and materials that could be used to highlight issues within InterRidge science. Over the next two years, InterRidge will aim to develop an outreach strategy in collaboration with GRID-Arendal. IR members will be consulted when devising a priority list of issues, which will be promoted using the most appropriate outreach tools.

The challenge is to make data available to non-specialists - international organisations, policy makers and the public - in an engaging and enabling format. The deep ocean is an alien environment to most people, so the lack of direct observation and experience means all outreach materials need to be highly visual and delivered as small messages, which over time can bring about massive positive changes in society's valuation of the marine environment. Many examples, including video clips on Google Oceans, podcasts and interactive e-books and games, can be accessed from the website: http://www.grida.no. Underlying all these approaches is the question: "Why should society value these natural systems?" Raising awareness of issues and supplying data helps to ensure that policy makers are able to ask the right questions when dealing with complex subjects.

Code of Conduct survey

In 2006 InterRidge developed a "Statement of Commitment to Responsible Research Practices at Deep-Sea Hydrothermal Vents" (http://www.interridge.org/IRStatement). Four years on, InterRidge was pleased to support the work of Cindy Van Dover, Kevin Zelnio and Laurent Godet, who conducted a survey to evaluate the potential awareness, relevance and efficiency of this code of conduct. 164 responses were received from 26 countries, representing 23 disciplines. Results will be placed on the InterRidge website when available.

Cruise travel bursaries – new awards

InterRidge has introduced a cruise travel bursary scheme to enable early career ridge-crest scientists to participate in mid-ocean ridge research cruises. It is designed to initiate new collaborations and new research directions across the InterRidge member nations. Up to $2000 USD will be awarded for travel and subsistence costs to facilitate cruise participation.

InterRidge will facilitate contact between host scientists with planned cruises and early career scientists from outside the host nation. There are two routes to obtain a cruise travel bursary. A student can identify a collaborator on a particular cruise and negotiate a place, subject to berth availability. Alternatively, a host scientist, with the consent of the cruise Chief Scientist, can post details of the cruise opportunity on the InterRidge website. Interested applicants will be invited to contact the host partner. Only with full agreement between student, host scientist and cruise Chief Scientist, will a cruise place be offered.

Preference will be given to applicants from InterRidge member countries who are at an early stage in their career, who have a clear role on the research cruise and who are not part of the original research team. We especially favour applicants from countries other than those of the host scientist. Full details and application form at: http://www.interridge.org/cruisebursary.

InterRidge Fellows

2010 InterRidge Student and Postdoctoral Fellows

In accordance with InterRidge's mission to encourage and support young ridge researchers in international, collaborative and interdisciplinary studies, annual Fellowships of $5000 USD are awarded to students or postdoctoral researchers, allowing them the opportunity to work overseas in established laboratories and to develop partnerships with key scientists in their field of interest. Since 2009, this project has been supported by funding from the International Seabed Authority (ISA) Endowment Fund, which assists young researchers from developing countries.

There has been a significant increase in applications this year, which suggests that these awards are becoming better known in the wider ridge community. The IR Steering Committee would like to thank the large cohort of reviewers - each proposal is reviewed twice, once by a native and also a non-native English-speaking scientist. We would also like to acknowledge the continuing support of the ISA Endowment Fund, for which more information is available at http://www.isa.org.jm/en/efund/fund. Further information on the InterRidge Student and Fellowship Programme can be found at: http://www.interridge.org/fellowship.

The IR Steering Committee is pleased to announce the awards for the 2010 InterRidge Student and Postdoctoral Fellowship Programme. The InterRidge Fellowship goes to Shinsuke Kawagucci, a postdoctoral researcher at JAMSTEC, Japan, who will work with Dr. Jeff Seewald, at WHOI, USA. Two awards from the ISA Endowment Fund were made. Baby Divya, a PhD student at NIO, India, will also travel to the USA to develop her research with Dr. Robert Morris at the Center for Environmental Genomics, University of Washington. Akumbom Vishiti, a graduate student at University of Buea, Cameroon, will build on the collaboration between Kiel and Buea by participating on a cruise led by Colin Devey, IFM-GEOMAR, Germany, as well as gaining laboratory experience. Our congratulations go to all three award winners!

Shinsuke Kawagucci

From an early age, Kawagucci has always been attracted to science, in particular seafloor hydrothermal ecosystems. The InterRidge Fellowship will enable him to develop international links, as well as giving him opportunities to expand the interdisciplinary nature of his research. As he explains: "The project will promote future international collaborative interpretations on the world's sediment-covered hydrothermal sites".

Shinsuke Kawagucci is a postdoctoral researcher at JAMSTEC, Japan, advised by Dr. Ken Takai. His proposal title is: "An experimental study for characterizing thermogenic methane at sediment-covered hydrothermal systems". The hydrothermally active ridge close to continents (Okinawa, JdFR, etc.) has sediments on the seafloor. The sedimentation settings are often linked to fluid geochemistry (e.g. high CH_4 content at sediment-covered sites). However, it has been poorly investigated how and where the fluid-sediment interaction occurs during hydrothermal fluid circulation. In order to elucidate the thermal fluid-sediment interactions under hydrothermal conditions, sediment-heating experiments will be carried out in close collaboration with Dr. Jeff Seewald at WHOI, USA. Here, Kawagucci will conduct an experiment handling thermal decomposition of sedimentary organic matter under hydrothermal conditions (pressure, temperature, and natural water-sediment ratio). The results obtained from the experiments will provide detailed information about "thermogenic methane" characteristics, which will clearly differentiate between thermogenic and biogenic "sediment-derived" characteristics.

Akumbom Vishiti

Explaining her research interests, Vishiti writes: "I got interested in science in my secondary school days. What attracted my attention were the experiments in the Chemistry and Biology classes! The University of Buea sits on the flanks of the active Mount Cameroon volcano. My interest in hydrothermal systems was driven by the observation of fumaroles on Mount Cameroon and the possibility of drawing parallels with ancient hydrothermal systems that led to ore deposits". She anticipates that this opportunity will have a very positive impact on her career development: "Considering that there are few female scientists in Cameroon, my vision is to become a senior academic in the Cameroon university system. The skills and networks I will set up during this Fellowship will be very useful in my career path".

Akumbom Vishiti, of the University of Buea, Cameroon, is a graduate student who will use the ISA Endowment Fund award to support a collaboration with IFM-GEOMAR and its international deep ocean systems programme. The title of Vishiti's project is: "Melt inclusions, fluid composition and sulphide microchemistry at the Red Sea ridge". She will participate on a cruise to the Atlantis II Deep in January 2011, focusing on sampling the crustal rocks both in and around the brine pool, looking at fluid sources. Vishiti is advised by Prof. Cheo Emmanuel Suh, University of Buea, and the fellowship will be conducted with Prof. Colin Devey, IFM-GEOMAR.

Ancient hydrothermal activity in continental settings led to the formation of mineral deposits through fluid-rock interaction as evidenced from wall-rock alterations associated with these deposits. Typically, pyrite formed in such deposits through the process of wall- rock sulphidation involving the interaction between iron from the host rock and bisulphide from the fluid. The exact temperatures at which these alterations occurred and the nature of the hydrothermal fluid are of broad scientific interest. Hydrothermal venting at mid ocean ridges allows scientists to observe in real time how these ancient hydrothermal circuits on the continents functioned. This study aims at studying basaltic rocks from the Red Sea area that have experienced sulphidation. In addition, melt inclusions from phenocrysts in the basaltic rocks will be studied as well as fluid inclusions. The composition of these fluids and microchemistry of the sulphides will then be compared to those of hydrothermal gold deposits in Cameroon.

Baby Divya

Divya states: "This Fellowship will give me an opportunity to work on the microbiological aspects of the hydrothermal vent fauna which only very few people have access to, due to the heterogeneity of these ecosystems and the difficulty of sample acquisition. It will also help me in acquiring knowledge and training in proteomics from a premier research institute. Interacting with senior researchers and peers will be a great boost for my career in science."

The title of Divya's proposal is: "Chemosynthetic microbial communities drive specificity of the hydrothermal vent's fauna: analysis using combined genomics and proteomic approaches". Divya is supported through the ISA Endowment Fund and is advised by Dr Shanta Achuthankutty, National Institute of Oceanography (NIO), India. She will be working with Dr. Robert Morris, University of Washington, whose laboratory uses similar approaches to study marine bacterial communities. During her visit to the USA, Divya will aim to:

(1) determine the abundantly active bacterial population of the sulphide-rich sediments of hydrothermal vents using molecular probes;
(2) examine the abundantly expressed proteins in the vent communities using metaproteome profiles;
(3) explore the occurrence of chemo-signals responsible for the dominance of particular fauna in the vents.

Divya obtained her M.Sc. in Marine Biology from the Cochin University of Science and Technology, Kerala, India. She is currently studying for her PhD at the National Institute of Oceanography, Goa, India. As she has always been fascinated by microbial life of extreme environments, Divya has been working on the bacterial diversity of the Oxygen Minimum Zone (OMZ) in the Arabian Sea, which is an extreme ecosystem. The title of her thesis is: "Delineation of the phylogenetic and functional diversity of the sediment-associated bacteria of the Arabian Sea Oxygen Minimum Zone".

Hydrothermal vents are extreme, dynamic and reducing ecosystems, but what captivated her interest were the strategies that macrobial life employ to survive in this unique ecosystem. The talks at the InterRidge Workshop held at NIO, in 2005, inspired her to learn and understand more about the different aspects of hydrothermal vents.

Update on 2009 IR Fellows – where are they now?

Susan Lang - 2009 InterRidge Student Fellow
ETH Zürich, Switzerland

Fluids from the Lost City Hydrothermal Field are rich in hydrogen and methane, with high pH values (9 - 11), as a result of serpentinization reactions at moderate temperatures of approximately 120-200°C. It has been predicted that organic carbon compounds would form abiologically under these chemical and thermal conditions from inorganic precursors, in the form of hydrocarbons and organic acids. Previous work has demonstrated the presence of high concentrations of both formate and acetate in Lost City fluids, but their origins are as yet unknown. Formate is the second most prevalent carbon species in the fluids and may provide local microbial communities with a necessary carbon source in the face of low dissolved inorganic carbon concentrations. The objective of the InterRidge Fellowship research was to constrain the formation mechanisms of formate and acetate in Lost City fluids (abiotic vs. biotic), and identify their inorganic carbon precursors. This objective is being pursued through the use of stable and radiocarbon isotopes which have proven to be useful diagnostic tools at Lost City and other hydrothermal environments. For example, methane and short-chain n-alkanes have similar ^{13}C compositions at Lost City, which has been used as one line of evidence for an abiogenic origin to these compounds. Radiocarbon measurements can be used to distinguish between carbon that is ultimately sourced either from the mantle (radiocarbon dead) or seawater bicarbonate (with a modern radiocarbon signature).

The InterRidge Fellowship provided funding to visit the laboratories of Dr. Gretchen Früh-Green, a participant on the expedition that discovered Lost City, and Dr. Stefano Bernasconi, head of the Stable Isotope Facility, at ETH in Switzerland. These groups have unique instrumentation and collaborate with the Ion Beam Physics group of the ETH Zurich, which has recently developed a gas-source accelerator mass spectrometer that is capable of determining the radiocarbon content of very small amounts of carbon (3 to 20 micrograms).

With the funding I was able to develop a method to isolate the individual organic acids for isotopic analysis. Formate and acetate have been isolated from multiple fluid samples by preparative high-

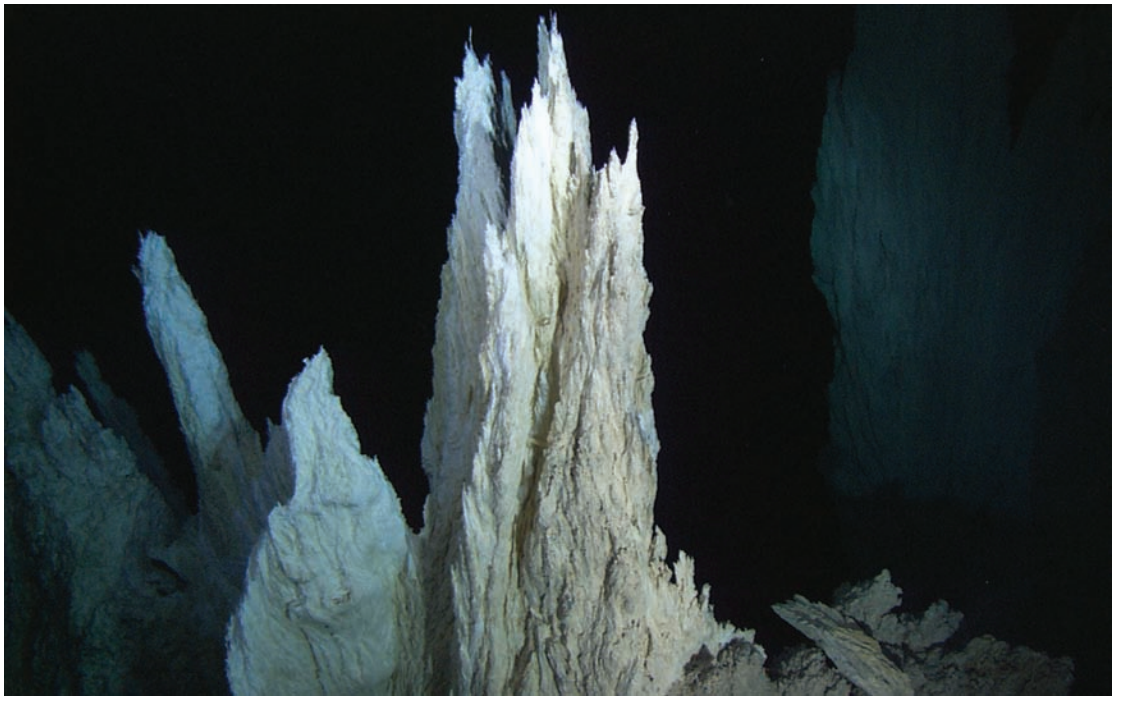


Figure 1:
A Lost City carbonate tower. Courtesy of University of Washington, IFE-URI, and NOAA-OE; Lost City Expedition 2005.

performance liquid chromatography. The preliminary stable carbon analyses indicate that the results will allow us to distinguish between biological and abiological formation mechanisms. Additionally, formate from several samples has also been isolated for radiocarbon analysis and these measurements will proceed soon.

I am very grateful to InterRidge for providing me with the opportunity to pursue these measurements, and to develop valuable relationships with international colleagues. As a result of these collaborations, I was able to apply for a post-doctoral position at ETH, which has recently been funded by the Swiss National Science Foundation. Over the next two years I will build on the organic acid isotopic analysis by comparing the biogeochemistry of the Lost City system to that of another serpentinite-carbonate system: the alkaline springs in the Voltri Massif (Liguria, Italy). The ultimate goal is to link inorganic reactions in the ultramafic basement rocks (i.e. serpentinization reactions) to microbial activity by characterizing the cycling of carbon and nitrogen in these high pH systems.

Surya Prakash - 2009 InterRidge/ISA Student Fellow
National Institute of Oceanography (CSIR), Goa, India

In September 2010 I visited the NOAA Pacific Marine Environmental Laboratory, Oregon, USA to carry out my project "Helium isotope studies of the hydrothermal plume over the slow spreading Carlsberg Ridge, Indian Ocean", under the guidance of Dr. John E. Lupton. I submitted this proposal to InterRidge during 2009 and requested support under the InterRidge Student Fellowship program. The objective of my proposal is to track the plume signal using the study of helium isotopes in the water column. A hydrothermal plume was identified at the Carlsberg Ridge, Indian Ocean during a cruise onboard R/V *Sonne* in 2007. Water samples were collected for helium isotopes and other trace metal analysis from the plume layer. Onboard analysis of CTD, MAPR (Miniature Autonomous Plume Recorders) data and onshore analysis of trace metals such as dissolved manganese showed prominent features of hydrothermal activity in the surrounding area.

During my stay at NOAA/PMEL, I learnt methods for extracting dissolved gases from the seawater samples, as well as analyzing the same for helium isotopes by mass spectrometry. The gas extraction and mass spectrometer analyses both use high vacuum technology.

The water samples were collected in copper tubes and sealed using a hydraulic crimper at sea without exposing the sample to the atmosphere and without any leaks. The sealed copper tubes were opened in the vacuum system and dissolved gases were extracted from the water and sealed into specially designed glass tubes called "ampoules". On the mass spectrometer inlet system the ampoule is opened with a small metal block, and different gases such as hydrogen and neon are removed and only helium passes into the mass spectrometer for isotopic analysis. The results of this project will provide new information to the Ridge community about the hydrothermal activity on the Carlsberg Ridge, north Indian Ocean. I also propose to carry out helium isotope analysis of a few rock samples (basalt glass) from the Carlsberg Ridge.

I have been very fortunate to work with Dr. John E. Lupton and his team. I would like to thank Dr. Lupton for giving his valuable time and hosting me. I would like to thank Ron Greene and L. J. Evans for providing guidance in extraction and mass spectrometer analysis. I have had a good time and this opportunity has allowed me to learn many things here in this laboratory. I also thank my Project Leader

Dr. K. A. Kamesh Raju and my senior colleague Mr. Durbar Ray for their continuous support.

Finally, I gratefully acknowledge the InterRidge Program, through the ISA Endowment Fund, for providing me with this opportunity to work at NOAA/PMEL by means of their fellowship. I also acknowledge the support received from the Council of Scientific and Industrial Research (CSIR), New Delhi and the Ministry of Earth Science (MoES), Government of India.

From left: Ron Greene, Surya Prakash, John Lupton and L. J. Evans at the Helium Isotope Laboratory, NOAA/PMEL, Newport, OR, USA.

Beyond the Edge of the Sea – Diversity of Life in the Deep-Ocean Wilderness

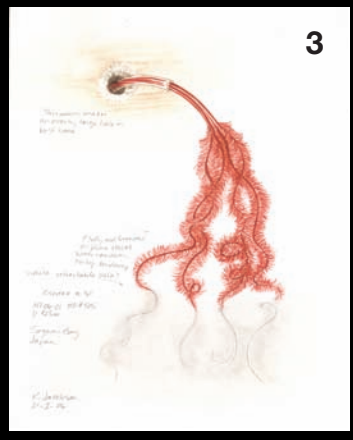
An exhibition by Karen Jacobsen

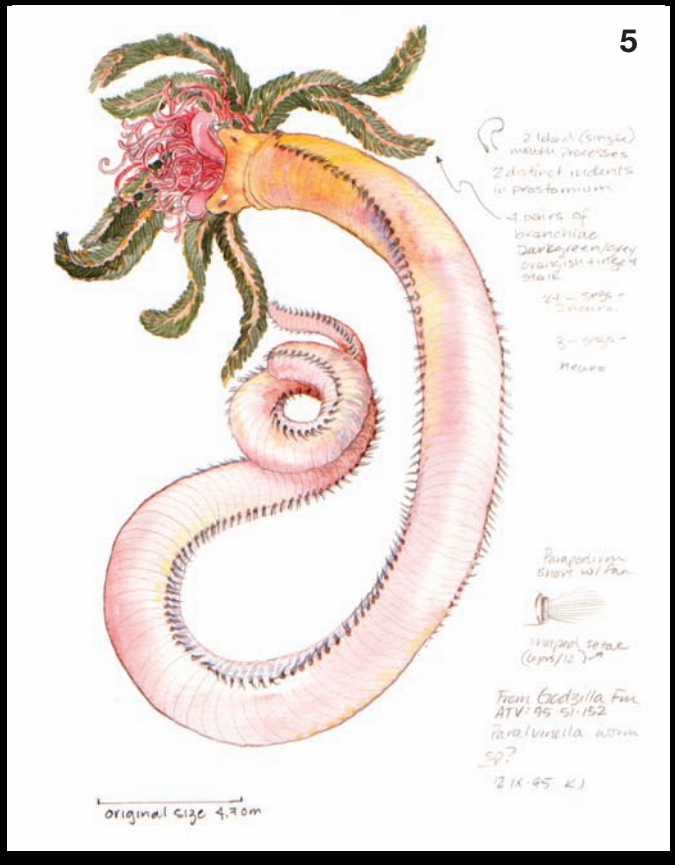
The illustrations here, and overleaf, are part of an exhibition by natural science illustrator, Karen Jacobsen. It represents the culmination of a collaboration between artist and deep-sea scientist and explorer, Dr. Cindy Lee Van Dover. Both seek to reach out to educate the public about the existence of extreme deep-ocean environments and the need for ocean conservation. Go online to see more illustrations and background information:
http://web.wm.edu/muscarelle/exhibitions/traveling/beyond/index.html

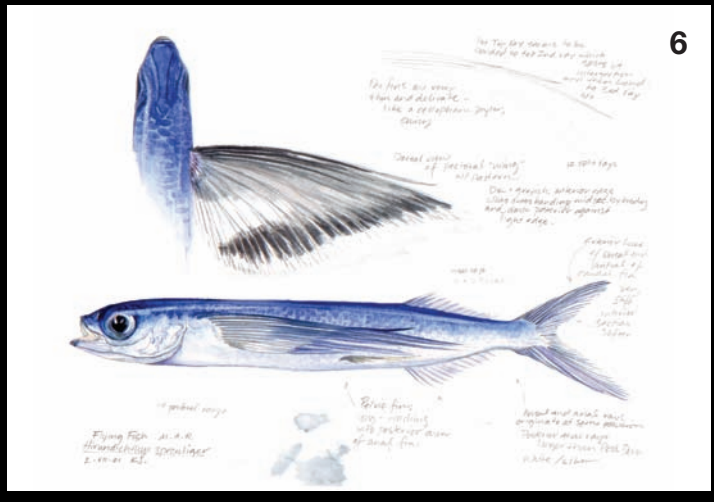
Left: Clam Alley, Juan de Fuca vents, 1995. **Centre:** Sperm whale *in situ*, Sagami Bay, Japan, 2006.
Right: Majid crab, Clam Alley, Juan de Fuca vents, 1995

Left: Painting of tube worms.
Right: Collapsed area with fauna from 9ºN East Pacific Rise, Alvin Dive # 2474, 1991.

An exhibition by Karen Jacobsen







1: *Ifremeria* snail, Lau back-arc basin, 2005.

2: Mussel bed community, Florida Escarpment, Alvin Dive #3635, 2000.

3: *Osedax*, Sagami Bay, Japan, 2006.

4: Cluster of *Oasisia* worms, from Pacific-Antarctic Ridge, Alvin Dive #4093, 2005.

5: *Paralvinella* worm, from Godzilla formation, Juan de Fuca vents, 1995.

6: Mirror-wing flying fish, *Hirundichthys speculiger* Mid-Atlantic.

Existence of several fossil oceanic lithospheres and terrane configuration in northwestern Mindoro Island, central Philippines: Geological, geochemical and paleomagnetic constraints

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The spatio-temporal distribution of numerous fossil oceanic lithospheres in the Philippines has been increasingly recognized as potent tools for geodynamic reconstructions as they are primary proxies of lost ocean basins (Tamayo et al., 2004; Pubellier et al., 2004; Encarnacion, 2004). In a comprehensive geological and geochemical review of Philippine ophiolites, Yumul (2007) concluded that the westward younging disposition of most ophiolites is a consequence of the clockwise rotation of the Philippine island arc system during its northwestward translation. However, this younging trend is not true for the central Philippines, particularly in the island of Mindoro. This anomaly can be attributed to the unique tectonic history of the region. Central Philippines is the site of the collision between the Philippine Mobile Belt (PMB) and the North Palawan Block (NPB) which consists of micro-continents derived from the Eurasian margin. Thus the geology of the NPB differs significantly from the PMB because its Cenozoic history is imprinted on a Mesozoic one.

We report here the preliminary results from ongoing investigations on the ophiolites of Mindoro. This forms part of a project under the Philippines-Taiwan Collaboration on Geosciences (Phase I of the Integrated Geodynamics Project), focusing on arc-continent collision processes. Research initiatives under this collaborative effort are supported by the Department of Science and Technology of the Philippines and by the National Science Council of Taiwan.

The Amnay Ophiolite in western Mindoro is the most studied upper mantle-crust sequence in the island. Together with the East Taiwan Ophiolite, it remains the best analogue for the oceanic crust generated during the spreading of the South China Sea basin. Recent field mapping campaigns identified the layered ultramafic sequence and sheeted dike complex of the Amnay Ophiolite at Igsuso Point. New exposures of pillow basalts were mapped between the towns of Mamburao and Sta. Cruz. Based on petrographic analysis of the least serpentinized harzburgites from Sta. Cruz, the samples exhibit porphyroclastic texture with coarse grained, elongated and strained orthopyroxenes (kink banding present in some samples) in fine-grained polygonal olivine neoblasts. Present as a minor phase is chromian spinel that is parallel with the orthopyroxene and exhibits a teardrop texture. In contrast, peridotites from Ambil Island offshore northwest Mindoro are characteristically porphyroblastic with coarse-grained annealed olivine with orthopyroxene and are distinctively less serpentinized than Amnay and Mangyan.

Northeast of Mamburao additional gabbro and basalt exposures were found that correspond to the Late Cretaceous Mangyan Ophiolitic Complex (Hashimoto, 1968; Karig, 1983). The isolated and sporadic distribution of the oceanic fragments is in stark contrast with the NW-SE trending, west dipping Amnay Ophiolite. Coupled with a close spatial and structural association with the metamorphic units, there is a possibility that these pervasively altered meta-ophiolitic blocks are megaclasts in nature. The late Eocene - early Oligocene turbiditic Lasala Formation unconformably overlies the metamorphic unit and meta-ophiolitic fragments. The sedimentary sequence is composed of sublitharenites, arkoses and quartz arenites that are characterized by a high polycrystalline-monocrystalline quartz ratio with small amounts of lithic fragments that are predominantly basaltic in composition. On discriminant function and geochemical diagrams, the samples plot within the quartzose sedimentary to felsic igneous provenance fields and in the passive to active continental margin fields respectively.

Data from newly identified outcrops of the volcanic section of the Amnay Ophiolite reveals a suite of basalts that is geochemically distinct from previous units reported by Yumul et al. (2009). Preliminary peridotite mineral chemistry data from the Amnay Ophiolite and Ambil Island suggests ocean floor and supra-subduction affinities, respectively. Peridotites from the Mangyan Ophiolitic Complex however exhibit overlapping ocean floor and supra-subduction characteristics.

Samples for paleomagnetic analyses were also collected from the volcanic sections of the Amnay Ophiolite and Mangyan Ophiolitic Complex and from the overlying sedimentary Lasala Formation. Laboratory analyses, conducted at the Department of Earth Sciences, University of Hong Kong, showed the basalts to possess strong enough natural remanent magnetizations (NRM) for analysis using a JR-6 spinner magnetometer. However, the sedimentary specimens have NRM several orders weaker and are thus being reserved for future studies using more sensitive equipment. Data

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processing for the isolation of the specimens' characteristic remanant magnetization is currently underway.

Studies on upper mantle-crust sequences on Mindoro Island coupled with geochemical provenance studies of juxtaposed sedimentary sequences shed light on the nature of the terranes comprising the island and the extent of the North Palawan Block. These relationships provide new information and offer additional perspectives to the evolution of the southeastern margin of Asia during the Mesozoic to early Cenozoic.

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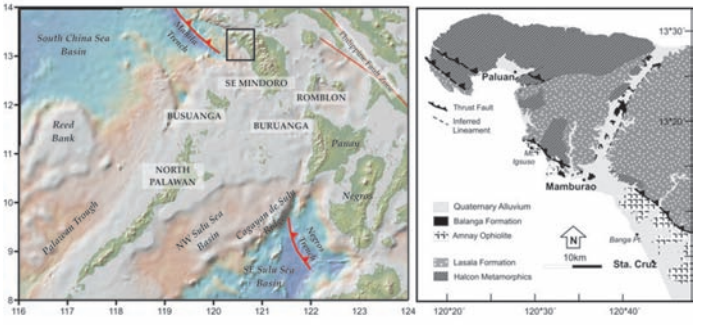

Figure 1: Ongoing research initiatives in central Philippines seek to elucidate the extent of the North Palawan Block. Recent investigations in Buruanga Peninsula (NW Panay) and the Romblon Island Group coupled with well-established stratigraphic and paleontologic data from SE Mindoro, North Palawan and Busuanga have all indicated a continental nature to these areas. Recent mapping in NW Mindoro was designed to complement existing information on the North Palawan Block and it is hoped that results of continuing investigations will shed more light on the extent of this continental fragment. (Image generated using GeoMapApp).

Figure 2: New features from the Amnay Ophiolite recognized during recent fieldwork: **(a)** pillow basalts south of Mamburao, and in **(b)** Banga Point; **(c)** dike complex along the coast of Igsuso and **(d)** layered ultramafics in Mount Igsuso.

Some observations on the magmatism in relation to hydrothermal activity on the rapidly diverging Nazca and Pacific Plates

Ganpat S. Roonwal[1]

The following observations are based on OFOS TV survey and colour slide film. Each of the OFOS / TV / slide traverse generally covered about 3-4 miles of length, and was conducted at pre-selected locations on the EPR axis, between 17ºS and 7ºS latitudes (R/V *Sonne* cruise SO40; Leg 2).

The magmatism on the EPR axis is represented by basaltic flows of different types, shapes and patterns. No rocks of acidic or even an intermediate composition have been recovered. Also no rock of ultramafic composition has been recovered. The plutohic equivalents of basalts are also absent. However, at a few locations (343G) the basalts contained coarse-grained aggregate - an agglomeration of ortho-clyno pyroxenes, calcic plagioclases and (perhaps) olivine, forming a core in a few pieces of basalts recovered through TV grabs.

The basalts show a glassy crust, with a fine-grained, fresh, black-grey colour, occasionally with minor vesicles, but often platy in nature. Weathering is absent. However, in several places in a large number of sampled locations, clear signs of alteration of basalts (lavas) due to hydrothermal solutions are observed. Such hydrothermal ichors penetrate the rock through minor cracks and fissures, thus producing the "soak" effect on them. Hand-specimen examinations of some samples have shown that such alteration has resulted also in the formation of several new minerals, at places even resulting in the development of unusual minerals within the basalts. For example AlOOH, Boehmite, has been observed as a suracia1 feature in basalt at location 347G. Kaolioe and other clay minerals like chlorite and mixed layered clay minerals have also been identified. At one location, such minerals as needles of actinolite have been seen, while at one location even garnet was observed (386G). This indeed shows the activity of hydrothermalism in the EPR region, which has also of course resulted in the formation of high temperature vents and chimneys or "black smokers", with which are associated the precipitation of massive sulfides. Several evidences of biological fauna and chemical activities (methane gas anomaly) indicate and confirm the occurrence of "black smoker" chimneys.

Based on the OFOS observations it is possible to define and conclude at least four major basaltic phases in the area.
1. The earliest and in fact the lowest in EPR profile phase is represented by sheet lava where the flows are thick, massive and flow gradually to produce their own cooling patterns, with curtain falls and ripple structures. Such flows now no longer show glassy reflections, and certainly suggest an "old age" relationship.

2. The next phase of magmatism is represented by pillow lavas, so clear by their shape, and ornamented by shrinkage striations. They rest clearly over the sheet lava.

3. The third phase of lava activity is represented by located sheets, where a lava flow represents a mixture of sheet - pillow. These flows are characterized by varying proportions of surface protuberances of a black, glassy nature. They roughly resemble the common desert cactus with several bulbs on its body.

4. The fourth and the last phase of magmatism is represented by glassy lava, generally forming thin sheets, which flows rapidly due to its viscosity, its cooling due to quenching, and resulting in a shining glassy crust surface of about 1 cm thickness. This glassy crust is very friable and its typical surface has a convex structure (Figures 1 and 2).

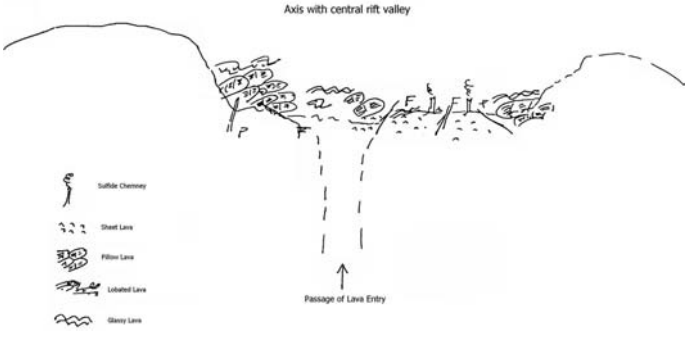

Figure 1: Axis with central rift valley.

Figure 2: Overlapping spreading centre.

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The EPR lavas are also covered at places by sediments, which indicates that after the period of igneous flows, there was a time gap permitting the flow of some sediments through the water currents. At chimneys, and where a methane anomaly was later confirmed but a high density of fauna could be seen, the typical yellow sediment of a hydrothermal source was observed. Such sediments also contain volcanic dust in them.

The OFOS survey shows that this EPR axial zone is magmatically active. There is clear evidence of large scale faulting and fissuring, as well as minor dislocations. It is difficult to clearly delineate them to magmatic or tectonomagmatic origins because some of them show syn- and post-magmatic evolution. Frozen lava lakes are often features of interest observed in the area.

On-board chemical analyses indicated the basalts to be tholeitic in nature, but it is to be expected that there would be a clear variation in their H_20+ and volatile contents. Amorphous silica has been observed at a few locations, and even smectite "white lines" are clear. The mineralogical observation of the hard specimens have indicated variation as well as alteration of them - the sort of features commonly found either in the wall-rock alteration, or retrograde metamorphism of the host basalts. It is to be considered if such features are representing the process of ophiolitization in the EPR axial zone. The evidence in my opinion calls for further petrological investigations.

In this area the sulfide chimneys were clearly seen only in a few places, though sulfide occurrence was indicated by fauna and a methane anomaly. The reason could be that, as we have observed, sulfide chimneys were confined to thick sheet lava areas, and it seems that in this northern (equatorial) part of the transect, the newer lava flows have covered them. Only at places where new activity took place and the hydrothermal plumes were forceful enough that the vents would penetrate through the overlying cover of lava. Such features have been observed at a couple of places. Does it mean that sulfide chimneys are to be searched in old "sheet lava" only? May be it is here that due to their massive nature and thickness, the hydrothermal solutions are able to derive the necessary heavy metals for eventual precipitation through the chimneys. A support for this idea is seen by the near absence of hydrothermal chimneys in areas of "new" lavas.

In conclusion, it is possible to produce a set of two profiles to show the mutual relationship of the lavas, both in the area of "main rift valley" and in the equatorial areas of "overlapping spreading centre", of McDonald et al., (1973), and Backer et al., (1985).

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Application of deep sea in-situ electrochemical sensors to investigate modern seafloor hydrothermal activities

Wu guanghai[1], Ye ying[2], Qin huawei[3] and Li xuefu[1]

Abstract

Different chemical properties between hydrothermal plumes and surrounding seawater provide a means of detecting hydrothermal activity. Therefore, a deep-sea, in-situ electrochemical sensor integrating three types of electrochemical electrodes, including an Eh electrode, Ag/Ag_2S electrode and pH electrode, was designed to take deep-sea measurements during DY115-20 cruise, on the R/V *Dayang Yihao*. This sensor successfully recorded valid data of 56 groups (total 58 survey lines) in the EPR and the SWIR, of which 12 records indicated obvious hydrothermal anomalies, which proved the system to be an effective tool in detecting hydrothermal activity.

Introduction

A deep-sea, in-situ electrochemical sensor integrating three types of electrochemical electrodes, including an Eh electrode, Ag/Ag_2S electrode and pH electrode, obtained deep-sea measurements during DY115-20 cruise, R/V *Dayang Yihao*. The sensor exhibited good sensitivity, stability and longevity. The design of external housing proved to be solid while the electronic circuit was designed with low-power consumption. A hydrothermal plume characteristically has high H_2S and low Eh values compared with the surrounding seawater. The sensor (Fig. 1) was designed to measure the water column's Eh, H_2S and pH, in order to discover hydrothermal anomalies that would lead to finding seafloor hydrothermal activity.

Investigated regions

The two investigated regions (Fig. 2) were located at the East Pacific Ridge (EPR) and the Southwest Indian Ridge (SWIR), with the former being a fast spreading ridge and the latter one having an ultraslow spreading rate.

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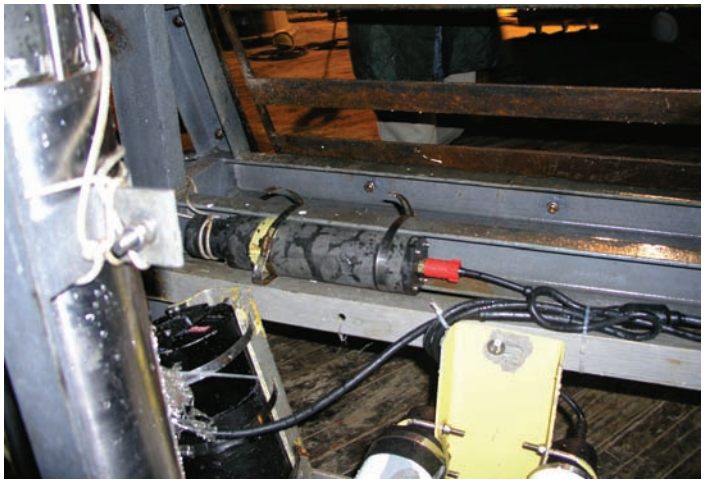

Figure 1: Deep-sea, in-situ electrochemical sensor on the hydrothermal deep-tow.

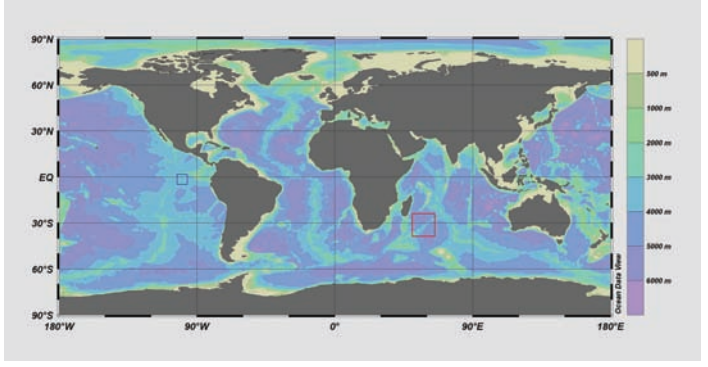

Figure 2: Map of investigated regions.

Results

Data from 58 survey lines were obtained, 12 of which indicated obvious hydrothermal anomalies. In the 11 EPR survey lines, there were five survey lines with clear hydrothermal anomalies, compared with the 47 SWIR survey lines, where there were 7 such lines. Results are presented for two of these lines (one EPR, one SWIR; Figs. 3 and 4) showing typical hydrothermal anomalies. In all cases, Eh and H_2S were found to have abrupt changes, which occurred simultaneously.

In contrast to the Eh and H_2S data, the pH data had no corresponding anomalies at all. So the pH cannot be used for the detection of the hydrothermal anomaly, and is only able to provide environmental information.

Conclusions

This deep-sea, in-situ electrochemical sensor is small in size and lightweight, so it can be fixed onto a variety of deep-sea equipment, such as deep-tow, CTD and ROV. The H_2S, Eh, and pH data, combined with pressure, temperature and turbidity measurements by other equipment during the investigation of hydrothermal activities, can accurately determine the hydrothermal anomalies. The anomalies of Eh and H_2S measured by electrochemical sensors could also be effective in finding an inactive hydrothermal vent, although there were no obvious turbidity and temperature anomalies around this kind of vent.

On the Chinese DY115-20 cruise, some hydrothermal anomalies were found within 11 hydrothermal activity areas, and most of them have been further verified. Some of them correspond with the temperature and turbidity anomalies measured by the MARP sensors and the methane anomalies measured by the METS instrument, whereas others correspond with the sampling and the seafloor video information. In summary, the deep-sea, in-situ electrochemical sensors made a great contribution to the discovery of hydrothermally active areas.

Acknowledgements

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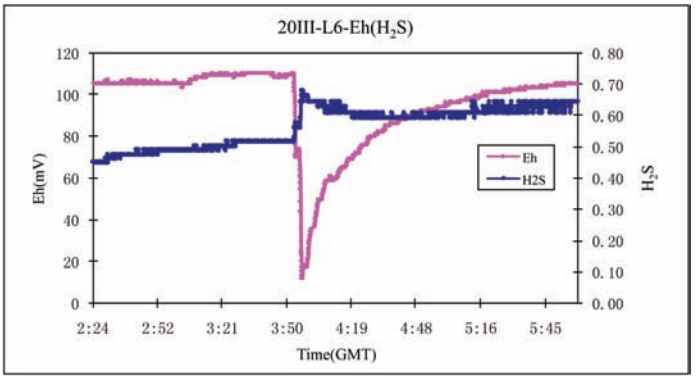

Figure 3: . Eh and H_2S anomalies in the 20III-L6 (EPR) survey line.

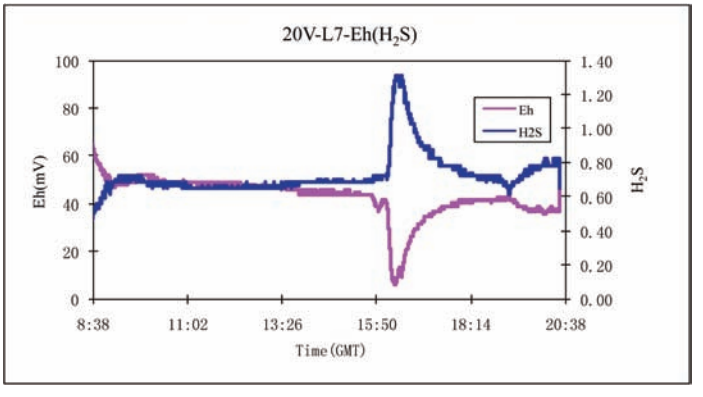

Figure 4: . Eh and H_2S anomalies in the 20V-L7 (SWIR) survey line.

First Chinese OBS experiment at Southwest Indian Ridge

Jiabiao Li[1] and Y. John Chen[2]

An active source, 3-D seismic (refraction/wide angle reflection) experiment was completed at the ultra-slow spreading Southwest Indian Ridge during the 6th leg of the CHINA RIDGE cruise (DY115-21) on board R/V *Dayang Yihao* from January 31, 2010 to March 7, 2010, led by Dr. Jiabiao Li as the Chief Scientist and Dr. Y. John Chen and Dr. Jianyu Ni as the Co-PIs. We had deployed 40 Ocean Bottom Seismographs (OBS) within two 50 km by 50 km areas during this 36 day OBS cruise (Fig. 1). One study area is at the western end of the ridge segment at 50ºE, where an active hydrothermal vent field was discovered by Chinese scientists on R/V *Dayang Yihao* from various observations including the observations by WHOI's *ABE* vehicle in March 2007. The other study area is located at the center of this segment where the axial rift valley was replaced by an axial high (as shallow as 1700 m water depth), which is similar to the Lucky Strike segment at the North Mid-Atlantic Ridge. Among the 40 OBSs, seventeen were provided by Institute de Physique du Globe de Paris (IPGP) as the first Sino-French collaboration on mid-ocean ridge studies, and also as a consequence of a MOU signed by InterRidge China and IPGP at Hangzhou, China in October 2009. Three French OBS engineers - Romuald Daniel, Alexander Blin, and Christopher Courrier from IPGP - were also onboard, along with 32 scientists from 12 institutions of China.

An array of four air guns (1500 cubic inch each) was shot along a total of 40 near east-west and north-south lines at an interval of 100-120 seconds with a ship speed of 4.5-4.9 knots. The total of 10,832 shots within the 13 days of air gun shooting should provide enough seismic source and path coverage for a 3-D tomographic inversion of these two study areas to a depth of 20 km.

We successfully recovered 38 OBSs out of the 40 deployed. The weather was very cooperative during the 20 days of the seismic experiment with a calm sea condition that is quite unusual at this latitude of the Indian Ocean. The most important scientific questions this 3-D active source seismic experiment will address are the crustal structure at this ridge segment, with a strong focus on imaging a potential magma chamber in the crust. Also, it will look for any slow velocity anomalies beneath the Moho, an indication of melt body in the uppermost mantle. Preliminary results are expected to be presented at the 2010 Fall AGU Meeting in San Francisco, in December 2010.

This is the first Chinese OBS experiment at mid-ocean ridges and as a matter of fact, the large number of OBS used makes it a large OBS experiment conducted at global mid-ocean ridges. This is also the first seismic experiment at the ultra-slow spreading Southwest Indian Ridge and therefore, the three-dimensional seismic structure of the ridge imaged by this experiment will add important information at the ultra-slow spreading end of the global mid-ocean ridges. Finally, this OBS cruise was organized by the Second Institute of Oceanography, SOA and funded by the China Ocean Mineral Resources R & D Association (COMRA), which is the organization responsible for organizing and conducting deep-sea resources research and development for China.

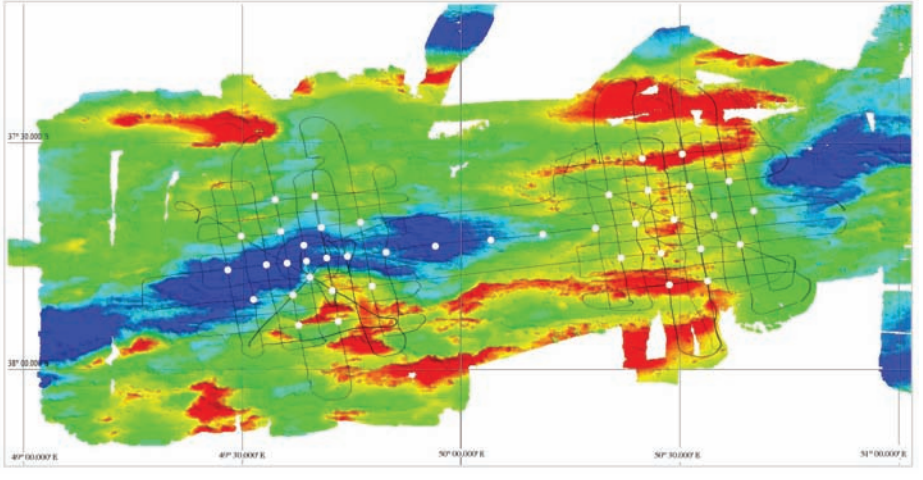

Figure 1: Cruise tracks and OBS deploying sites (white circles).

The Second Institute of Oceanography (SIO), State Oceanic Administration of China (SOA), is a key institute of Chinese deep ocean scientific expedition and research, which is mainly engaged in the multi-disciplinary investigation and research of marine environments and resources on China's marginal seas, oceans and polar region. Peking University is one of the top universities in China, which leads the national research in many areas including marine geophysics. The Institute de Physique du Globe de Paris (IPGP) is the largest institute of Earth Sciences in France and also one of the largest in Europe. The Institute conducts research and education in geology, geophysics, geochemistry and the environmental sciences.

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Cruise PARISUB on EPR 16°N: magmatism and hydrothermalism over a ridge-hotspot interaction

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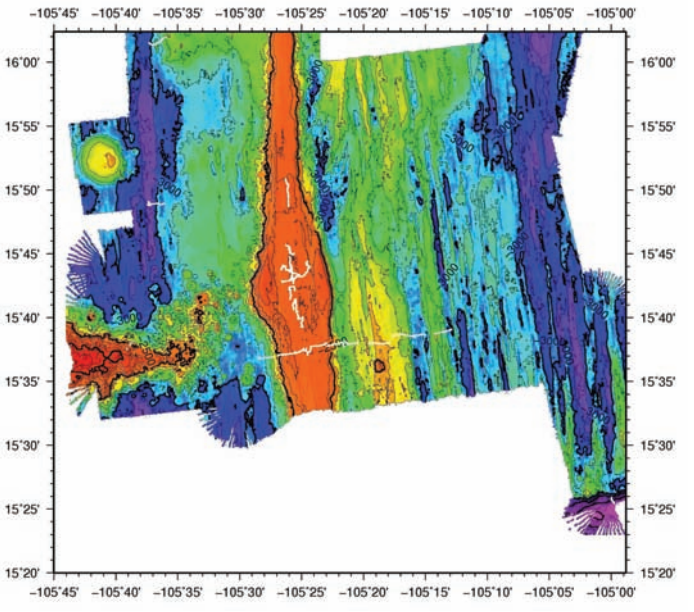

Figure 1: New bathymetric map of the investigated area from R/V *L'Atalante*. Major isobaths every 1000 m, minor isobaths every 250 m; orange areas are shallower than 2000 m, dark blue and purple are deeper than 3000 m. White lines represent the *Nautile* dives: a long cross section intersecting the ridge axis at 15°37'N (10 dives), a cluster on the axial dome between 15°37'N and 15°52'N (13 dives) and three isolated dives (two on the scarp at 105°37'W and one on the Orozco Fracture Zone).

In March-April 2010, cruise PARISUB (Plume And Ridge Interaction by Submersible) of R/V *L'Atalante* investigated the East Pacific Rise (EPR) between 15°22'N and 16°15'N where the spreading axis meets the Mathematician seamount chain. This international (French-Mexican) multidisciplinary research expedition used the facilities of R/V *L'Atalante*, Deep-Sea Submersible (DSS) *Nautile*, and Autonomous Underwater Vehicle (AUV) *Aster-X* operated by IFREMER in order to collect a unique set of bathymetric and geophysical data, direct observations, biological and geological samples over a ridge-hotspot interaction area characterised by an over-inflated ridge segment (Langmuir et al., 1998), a peculiar geochemical signature (Donnelly, 2002), and the suspected presence of hydrothermalism (Baker et al., 2001). The cruise involved both on- and off-axis experiments and sampling, to decipher the present characters of the interaction in terms of axis stability, hydrothermalism, and associated fauna as well as the recent history of the interaction.

Geosciences

In terms of general mapping of the area, the new SIMRAD EM 122 multibeam echo sounder of R/V *L'Atalante* enabled us to achieve a full bathymetric (and reflectivity) coverage of the study area, between 15°35'N and 16°N, 105°40'W and 105°05'W (Figure 1). In addition, sea surface gravity and magnetic profiles along spreading flow lines have been acquired during this survey. A slower pass along the axis has permitted the collection of a higher resolution profile, which was useful to plan DSS *Nautile* and AUV *Aster-X* dives (Figure 2).

The first objective of the cruise was the completion of a 25 km-long section of the ridge across oceanic crust created during the last 300 kyrs (Figure 1). This section, which intersects the axis at 15°37'N, has been investigated thoroughly during 10 *Nautile* dives with direct observation (i.e. videos and photos), continuous acquisition of magnetic data, gravity measurement at selected stations, and sampling an important collection of rock samples. A continuous magnetic profile was acquired by AUV *Aster-X* at an altitude of 70 m to 200 m above the seafloor along the same section. This material, being currently processed and analyzed, will enable high resolution dating of the seafloor to examine the hypotheses of (1) discrete ridge jumps reflecting episodic ridge axis relocation in a closer vicinity of the hotspot, and (2) related variations of the geochemical influence and flux of hotspot material in the ridge plumbing.

The second objective was a detailed study of the up-to-13 km-wide, 700 m-high, axial dome which characterizes the ridge axis in the over-inflated area, in order to locate the axial graben(s), and find active and fossil hydrothermal sites whose presence has been detected in the water column more than a decade earlier (Baker et

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al., 2001). To do so, we achieved a 30 km-long by 4 km-wide AUV survey along the rather flat submittal part of the dome, collecting multibeam bathymetry and imagery (Figure 3), magnetics and nephelometry at an altitude of 70 m above the seafloor. The axial graben was identified along the whole surveyed area (Figure 3) and in some places, two grabens co-exist at the same latitude, with hot material (dykes) inferred on both from the observed magnetic low (thermal demagnetization). This strongly suggests that the segment is so magmatic that dykes intrude in more than one location, in agreement with the two distinct seismic reflections, attributed to axial magma chambers, observed locally by Carbotte et al. (2000) in the same area.

A total of 13 *Nautile* dives were devoted to the detailed exploration of the axial area and the search for hydrothermal sites. Many fossil sites have been found, in most cases with standing chimneys, which suggest that these sites are recent. An active hydrothermal area has been discovered, among which two diffuse flow vents and two active vents have been explored and sampled thoroughly. This hydrothermal area has been named "Teotihuacan". There appears to be a linear arrangement parallel to the axis: the active and fossil smokers are found along the western wall of the axial graben, while sulphide deposits, then diffuse flow vents are observed eastward. Such an arrangement may be related to a thermal gradient linked to the presence of the hotspot west of the area.

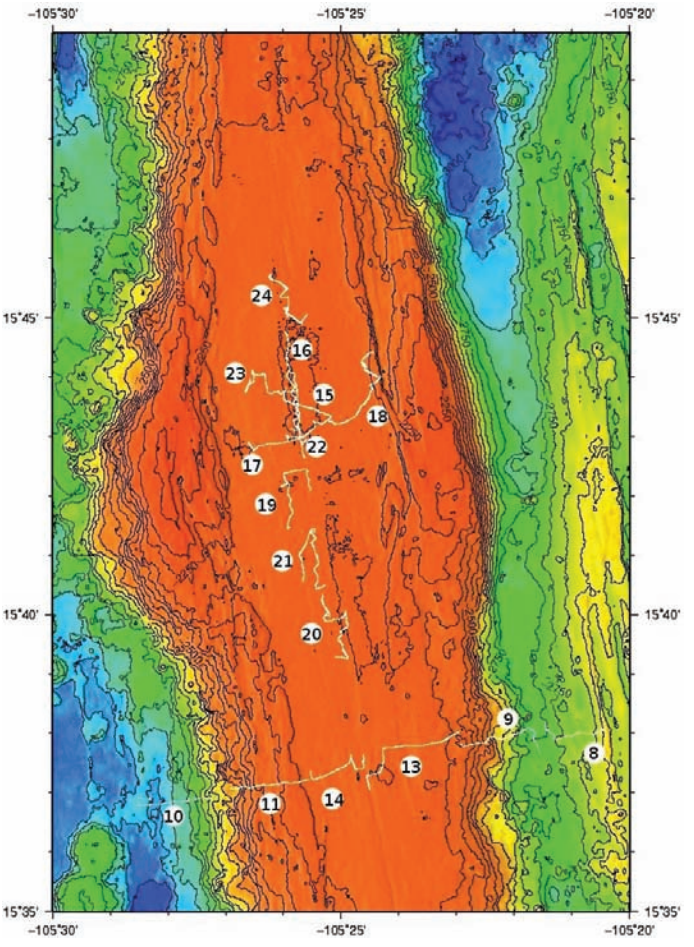

Figure 2: New bathymetric map of the EPR axis from R/V *L'Atalante*. Isobaths every 50 m; same colors as in Figure 1. Labelled white lines represent the *Nautile* dives: dives 8 to 14 are part of the long cross section intersecting the ridge axis at 15°37'N, whereas dives 13 to 24 are part of the cluster exploring the axial dome.

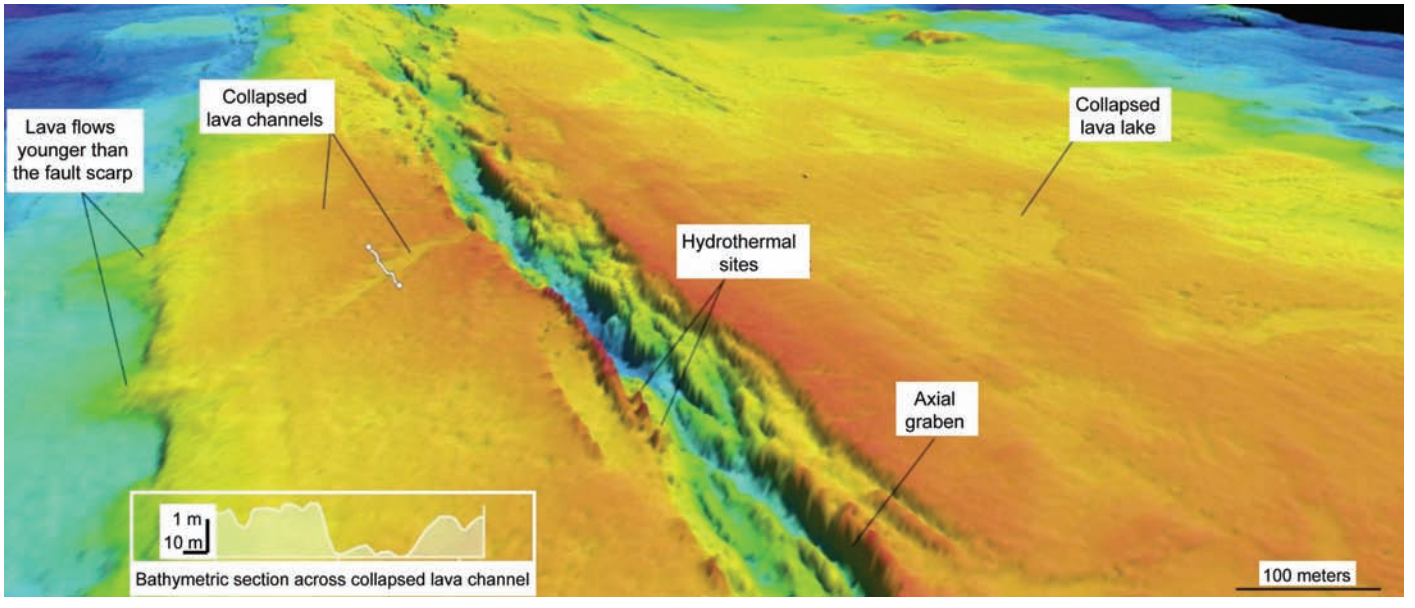

Figure 3: Perspective view of high resolution bathymetry of the EPR axis from AUV *Aster-X*. Volcano-tectonic features such as the axial graben, collapsed lava channels (also shown in section along the white line) and collapsed lava lakes, lava flows covering partially a fault scarp, and hydrothermal mounds (Teotihuacan hydrothermal area) are clearly depicted.

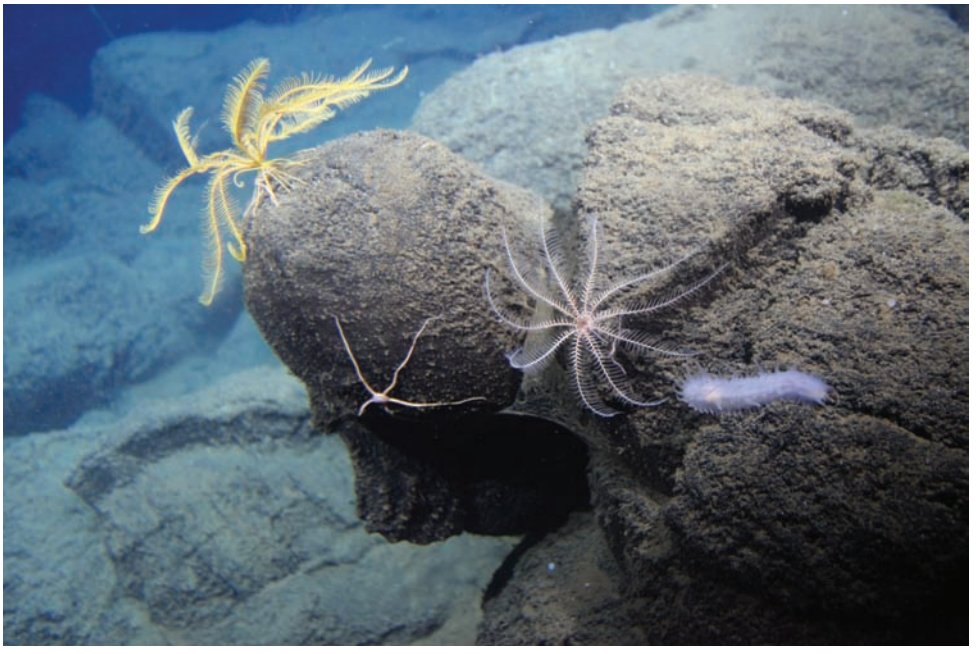

Figure 4: Fauna on pillow lava: brittle star, crinoid, holothurian, brisingid asteroid and sponge. © Cruise PARISUB - UMR6538 (UBO-CNRS) - IFREMER 2010/Nautile.

Figure 5: Diffuse flow vents at the Teotihuacan hydrothermal area: large colony of vestimentifera worms *Oasisia sp*. with Bythograeidae crabs, hydrothermal shrimps, and squat lobsters *Munidopsis sp*. and remains of tubes of *Ridgeia sp*.worms. © Cruise PARISUB - UMR6538 (UBO-CNRS) - IFREMER 2010/Nautile.

Faunal communities

During cruise PARISUB, DSS *Nautile* explored the seafloor between 4500 m and 2300 m depth, revealing abyssal and bathyal faunal communities on pillow lava covered by variable amounts of sediment. Off-axis, the more distant from the axis, the more encrusted by manganese is the basalt, on which biological communities show a higher abundance and biodiversity (Figure 4). The more sedimented areas are highly populated by meiofauna and macrofauna. On the axial dome slopes and their pillow lava, faunal communities are often represented by suspension feeders with a mixture of abyssal species (octopods, e.g. *Grimpoteuthis sp*., holothurians e.g. *Enypniastes eximia*, *Peniagone leander*) (Gage and Tyler, 1992; Tilot, 2006) and bathyal species (e.g. Echinothurioida urchins, rays) (Wilson et al., 2003). On the axial dome and its fresh basalt, the faunal abundance and taxonomic richness is much lower, with a dominance of carnivorous feeders (Bythitidae fishes, holothurians Synallactids, shrimps *Nematocarcinus sp*., cerianthid anemones, carnivorous sponges, e.g. *Caulophacus sp*.). Such an observation implies a shift of trophic and functional guilds related to the physico-chemical, environmental and trophic conditions on the axis, in particular the lack of what would appear as "the biota-attractive manganese crust" on the lava.

The newly discovered active hydrothermal area, Teotihuacan, displays a mosaic of conspicuous faunal communities adapted to the specific environmental, thermal and geochemical conditions of diffuse flow vents and black smokers. These communities are quite different from the rest of the fauna on the EPR and would have similar characteristics to the fauna of Lau basin. (1) The diffuse flow vents are located on sulphide mounds swarming with small amphipods and polynoids. Faunal communities are dominated by Siblogonids *Oasisia sp*. and squat lobsters Galathea *Munidopsis sp*.

(Figure 5). Some *Riftia pachyptila*, Zoarcid fish *Thermaces cerberus*, crabs Bythograeidae, transparent shrimps *Alvinocaris sp*., gastropods Phenacolepadidae, Lepetodrilidae, bivalves Vesicomyidae coexist in the thickets of these Vestimentifera. Further, bivalves *Calyptogena magnifica* dwell along fissures. Serpulidae *Laminatubus sp*. are found away from the active sites. Bivalves Pectnids *Bathypecten vulcani* aggregate elsewhere (Desbruyeres *et al*., 2006). (2) Inactive sulphid mounds host Brisingid asteroids, hydroids, sponges (*Caulophacus sp*.), annelids, hydrozoa, squat lobsters *Munidopsis sp*., actinians. Fossil chimneys host Nereididae worms, e.g. *Nereis sp*. or cirripeds *Neolepas sp*.. (3) In the vicinity of tall active chimneys (Figures 6 and 7) cohabit Zoarcid fishes *Thermarces sp*., squat lobsters Galathea *Munidopsis sp*., crabs Bythograeidae, Vestimentifera *Riftia pachyptila*, cerianthid anemones, octopus *Vulcanoctopus hydrothermalis,* polynoides

Lepidonotopodium sp., polychaetes *Alvinella pompeiana*. Faunal communities appear to follow the linear arrangement of geological events parallel to the axis described previously.

Acknowledgements

We thank Captain Jean-René Gléhen, crew and officers of R/V *L'Atalante*, as well as engineers, pilots and divers operating DSS *Nautile* and AUV *Aster-X* for their excellent work. Support by IFREMER, GENAVIR, and CNRS-INSU is gratefully acknowledged.

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Figure 6: Active black smokers at the Teotihuacan hydrothermal area. © Cruise PARISUB - UMR6538 (UBO-CNRS) - IFREMER 2010/Nautile.

Figure 7: Faunal communities on active black smokers at the Teotihuacan hydrothermal area vestimentiferan worms *Riftia pachyptila*, Zoarcidae fish *Thermarces sp.*, squat lobsters *Munidopsis sp.* crabs Bythograeidae, polychaete worms *Alvinella pompeiana* … © Cruise PARISUB - UMR6538 (UBO-CNRS) - IFREMER 2010/Nautile.

INSPIRE: International South-East Pacific Investigation of Reducing Environments

*Andrew J.Thurber[1]; Christopher R.German[2] & the INSPIRE Cruise Team**

Introduction

With a coastline stretching more than 4,300 km (>2,700 miles), the geology and biology of Chile provides an incredible natural laboratory to study how life on our earth functions and has evolved. One specific setting, the Chile Triple Junction, of particular interest to two intersecting international programs – InterRidge and the Census of Marine Life - exemplifies this. The Chile Triple Junction (CTJ) area represents the intersection of three tectonic plates and the only place on Earth where a mid ocean ridge spreading center is being actively subducted beneath a continental margin. Yet the processes active at the CTJ today have likely recurred around the perimeter of the Pacific basin throughout that ocean's history.

In February-March 2010 we conducted the first systematic exploration for hydrothermal vents and adjacent cold seeps at the Triple Junction as part of a larger cruise aboard R/V *Melville* that also sought to investigate a wider range of habitats extending north from the CTJ along the Chile Trench and Margin. Shiptime for the project was funded through the State of California to Andrew Thurber and co-PI PhD students from UCSD and UCSB, while additional funding for water column and AUV-based exploration was provided by NOAA's Ocean Exploration program. Additional funds from CoML, via both the CoMarge and ChEss projects, provided support for a range of activities including a live web-cast from the ship that was broadcast in both English and Spanish to a range of destinations in South America, North America and Europe.

Rationale

While it is now established that hydrothermal activity occurs in all ocean basins and along ridges of all spreading rates, the vast majority of the global ridge crest remains to be explored. With limited resources to conduct such activity, however, and with the wealth of ridges awaiting exploration resting at high latitudes, choosing exactly where to explore deserves particular attention. Over the past decade, the Census of Marine Life field program ChEss (Biogeography and Biodiversity of Deepwater Chemosynthetic Ecosystems) has been actively investigating what controls and causes the wide variety of fauna that are known to exist worldwide at vent sites (~600 species new to science at ~200 total vent-sites that have been studied in sufficient density for the fauna to have been revealed). That work has continued to demonstrate that at least 5 and probably more distinct biogeographic provinces can be discerned despite the fact that vents appear to be rather common (~1 site, at least, every 100 km) along the entire and continuous global ridge crest and, further, that thermohaline circulation of the entire ocean volume (along trajectories that follow the path of the global ridge crest) takes place on time scales of just 1-2,000 years. Hence, the question arises: if the oceans are so thoroughly mixed, how is such apparent genetic isolation between different ridge/vent fauna populations maintained? Also, given that some chemosynthetic fauna are able to exist at cold seep and large organic fall chemosynthetic sites as well as at vents, can vent-fauna also treat seeps and organic-fall sites as additional "oases" or stopping-off points as they migrate from one vent-site to another if they disperse widely through the ocean?

In January 2003, at the opening meeting of the ChEss Steering Committee at the Scripps Institution of Oceanography, the Chile Triple Junction was identified as a particularly important site for future exploration because this is the only place on Earth where every known form of chemosynthetic ecosystem has the opportunity to co-exist: hydrothermal vents on the Mid Ocean Ridge, cold seeps along the Ocean Margin, large organic falls (temperate forest wood falls, whale falls along coast-hugging migration routes) and, immediately to the north, the East Pacific oxygen minimum zone. Only here, the argument has been made, might we be able to find the extent to which vent-fauna can also colonize other chemosynthetic "oases" at the same locale and, from that, one could begin to hypothesize what factors (ocean temperature, chemical anomalies, substrate, ocean currents, other) might dictate which chemosynthetic fauna colonize each of these different systems. Using the CTJ as a "control" station, one might then begin to understand much more clearly how the patterns of biogeography and biodiversity seen at other hydrothermal fields worldwide have become established.

But first, somebody had to (a) prove that hydrothermal activity occurred anywhere along the East Chile Rise (it was already known that extensive cold seeps occur off Concepción, further north along the Chile margin) and then (b) locate hydrothermal vents and cold seeps as close as possible to one another – i.e. as close as possible to the Chile Triple Junction itself.

*[1]Scripps Institution of Oceanography; [2]Woods Hole Oceanographic Institution; *INSPIRE Scientific Party: Eleonora Barroso, Tamara Baumberger, Karen Belmar, Donna Blackman, Kate Buckman, Ximena Contardo Berríos, Al Duester, Fernando Gajardo Rojas, Christopher German, Ron Greene, Benjamin Grupe, Monica Heintz, Ashlee Henig, Rosa León-Zayas, Lisa Levin , Marvin Lilley, Benjamin Maurer, Mauricio Mella Barra, Stephanie Mendes, Alexis Pasulka, Eduardo Quiroga Jamett, Danny Richter, Francisco Valdés Robledo, Ives Sanchez, Nicolás Segovia Cortes, Javier Sellanes, Tim Shank, Jordan Stanway, Christina Tanner, Andrew Thurber & Dana Yoerger.*

Preliminary Results

To start our work we first tow-yo'd a CTD-rosette along the length of the first two segments of the East Chile Rise, using in situ sensing (temperature, salinity, depth, optical back scatter and oxidation/reduction potential) to prospect for tell-tale hydrothermal signals in the water column and also tripping bottles to collect sub-vertical mini-profiles (typically 4-5 depths at a time) of water samples that could be used for shipboard (methane) and shorebased (δ^3He, TDMn/TDFe) geochemical analyses (Fig.1).

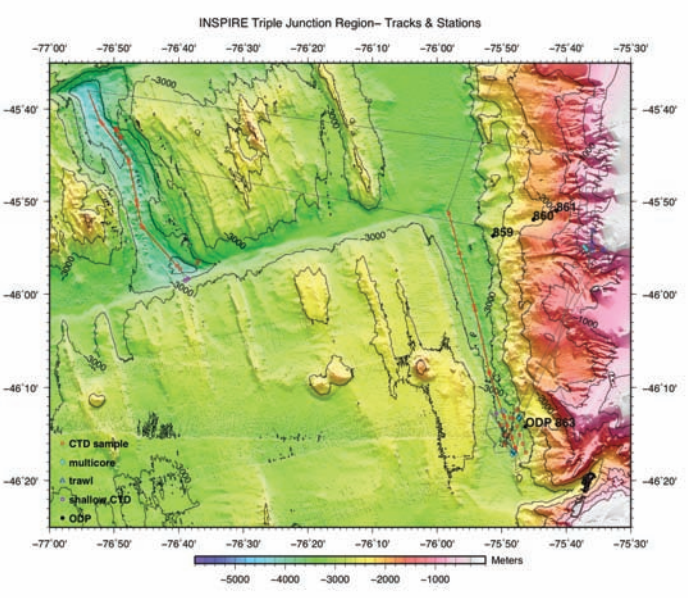

Figure 1: Map of the Chile Triple Junction showing tracks followed by CTD tow-yos along the axis of the East Chile Rise segments I and II extending NW away from the CTJ at ~46°20'S, 75°40-50'W.

While most of the work-up of the samples is ongoing, at sea data revealed strong plume signals, including methane concentrations up to 50nmol/L at the southern end of segment 1 close to the Triple Junction itself. Further, a combination of shipboard echo-sounder, TV-guided multi-corer and shipboard methane analyses of samples collected by CTD rosette also provided strong evidence for active cold seep activity close by along the adjacent margin near 46°S. At the CTJ proper, we then conducted a series of CTD stations (vertical casts, pogos) that were occupied at sufficiently high resolution that they appear to reveal evidence for two separate sources of hydrothermal venting present.

Farewell to an old friend

Having narrowed down our search so well, from ≥200 km to ≤20 km, we were faced with a dilemma: we had anticipated that we might find evidence for one hydrothermal field so close to the CTJ and so had no time to use our *ABE* AUV to track down both, following the 3-phase strategy that had previously helped us find first vents along (a) much of the Lau Basin, (b) the southern Mid-Atlantic Ridge and (c) the SW Indian Ridge. For *ABE* dive 221 we decided that we already had sufficient CTD Tow-Yo data to launch a "Phase 2" dive that would follow closely-spaced multibeam track-lines (~30km apart) to map a ~1 km x 2 km length of the neovolcanic ridge axis where we were confident that the first of the detected hydrothermal sources should exist. Sadly, after just a few minutes on-bottom a technical error caused *ABE* to abort its mission and return to the surface – although even on its down-cast, the vehicle had already collected additional in-situ plume-sensor data to confirm we WERE on the right track. Next day we were ready to launch *ABE* again, this time to conduct both mapping and bottom-photography missions, as well as carrying in situ sensors. Again, all began well. The vehicle descended to the seafloor and after releasing its descent weight it began to track across the seafloor from its landing site to the beginning of the track lines for its pre-programmed survey. And then nothing. All of a sudden, in the small hours of the morning, all three independent sets of acoustic communications between the AUV and the ship went silent. *ABE* was never heard from again. After a further 12 hours of patrolling the surface of the ocean, searching, and repeatedly sending a series of acoustic commands to return to the surface, we eventually had to break off and move north to pursue our other cruise objectives.

Figure 2: *ABE* being prepared for launch for its final dive: *ABE* 222.

After some days, weeks and months of further consideration the most likely cause of error is as follows. *ABE* contained 9 separate glass spheres that contained a range of electronic circuitry but also provided essential buoyancy to the vehicle. While the *ABE* team maintained a vigorous and routine schedule of inspection and maintenance of these spheres it is widely accepted that once in a while one of these spheres might implode. And when that happens at deep pressure, the energy released can often trigger the implosion of any other spheres in the vicinity. This is what we believed happened to *ABE* and, according to the calculations of Jordan Stanway, a WHOI/MIT joint program PhD student on the cruise, the energy released aboard *ABE* should all 9 spheres have failed, would have been close to the force of detonating 3 sticks of dynamite on the vehicle.

Conclusion

While losing *ABE* presented a setback for our scientific program, its significance was dwarfed by the impact suffered on-shore while we were at sea as a result of the Magntiude 9 Earthquake that struck near Concepción while we were on station at the CTJ and the resulting tsunami that caused damage all along the adjacent coastline. Also, while *ABE* may not have completed all that we had wished, its legacy endures as a pioneer of deep-water hydrothermal exploration. By then end of 2010, AUVs of multiple nations have begun to follow in *ABE*'s wake, searching for and investigating new hydrothermal fields in previously unexplored sections of mid-ocean ridge crest world-wide (see report from the IR Long Range Exploration WG workshop elsewhere in this volume). And of course, our endeavours at the Chile Triple Junction have already achieved their preliminary and highest priority goal - to demonstrate that hydrothermal activity near the CTJ most definitely exists. It is now only a matter of time until those sites can be dived upon and investigated in detail and we will be working with our colleagues in Chile – and ideally with other international partners throughout the InterRidge community, to return to the Chile Triple Junction soon. It may have taken 7 years of planning and the demise of a pioneering AUV to conduct these first explorations – but the site is extremely interesting and merits a return visit, soon!

New Hydrothermal Vents Located on the Mid-Cayman Spreading Centre: Cruise RRS James Cook 44, March-April 2010

D. Connelly[1] and the JC44 scientific party

In March and April this year scientists from the National Oceanography Centre (NOC), and the universities of Southampton, Durham, North Carolina and Texas located, imaged and sampled two vent sites on the Mid-Cayman Rise, in the Caribbean Sea. The NOC cruise, aboard the RRS *James Cook*, was led by Doug Connelly with Jon Copley, Bramley Murton, Paul Tyler and Kate Stansfield. It was part of a collaborative programme with Chris German from Woods Hole Oceanographic Institution and Cindy Van Dover from Duke University Marine Lab and followed an earlier cruise aboard the R/V *Cape Hatteras* during October 2009. That earlier cruise, as reported in InterRidge News last year, discovered plumes in three locations indicating the potential presence of both high and low temperature venting on the sea floor. The results from that survey were also published this year in Proceedings of the National Academy of Sciences (German et al., 2010).

Our cruise (JC44) started with a high resolution multibeam survey (Simrad EM120 bathymetry with 50 m resolution) and TOBI survey (30kHz deep-towed sidescan sonar with 3 m resolution) of the entire Mid-Cayman Rise. We followed this with a plume survey using CTD casts and fine scale mapping using the new AUV, *Autosub6000*. The target areas were initially based on the earlier R/V *Cape Hatteras* plume data but were quickly modified following the results from our new surveys.

Carrying a CTD (with light scattering sensors), an Eh sensor (for proximal plume location), and a Simrad EM2000 multibeam sonar for high resolution bathymetric and acoustic mapping, *Autosub6000* proved extremely efficient at locating the seabed sources of the plumes. Operating down to 5000 m, the AUV was able to make 24 hour dives at altitudes as low as 5 m and at speeds of 4 kts covering large areas in great detail. These AUV surveys produced overwhelming evidence for the presence of two separate vent sites on the floor of the Mid-Cayman Rise, which is an outstanding scientific and engineering success for the *Autosub6000* on its first scientific mission.

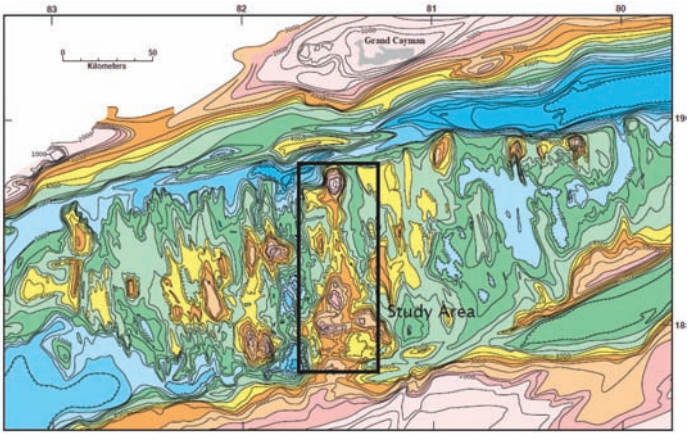

Figure 1: Bathymetry of the Cayman Trough with the study area (black rectangle) showing the crest of the ultra-slow spreading Mid-Cayman Rise.

Also on its first scientific mission was NOC's new, cost-effective, remotely operated tethered vehicle (ROTV) *HyBIS* commissioned

[1]*National Oceanography Centre, Southampton, UK*

from the UK company Hydro-Lek (www.hydro-lek.co.uk). Using this 6000 m-rated, manoeuverable vehicle allowed us to explore the two sites and take reconnaissance samples of plume particulates, vent fluids, vent fauna, microbiota and mineral deposits. Using an HD camera on the vehicle, we were able to video the worlds deepest vent site, at 4960 m, in exceptional clarity, revealing abundant chimney structures of polymetalic sulphides from which dense clouds of particulate-rich fluid were gushing. We have named this ultra-deep vent site Beebe (in memory of William Beebe, the first person to observe deep sea life in situ).

The second vent site was found at shallower depths and also revealed actively venting sulphide chimneys with an abundance of vent life. Our scientific team have named this site Von Damm (in honour of Karen Von Damm, who passed away in 2008 after making a uniquely valuable contribution to our understanding of hydrothermal processes).

We also investigated a third area of the spreading centre where the previous R/V *Cape Hatteras* survey detected LSS signals and elevated concentrations of dissolved Fe and Mn in a single CTD profile (German et al., 2010). Despite occupying 27 km of new CTD tow-yo survey lines, 130 km of closely spaced *Autosub6000* survey lines, and 12 hours of seafloor exploration by *HyBIS*, no further evidence was found for any seafloor hydrothermal venting.

The combination of using both an AUV and ROTV together proved exceptionally powerful as a method for locating and investigating new hydrothermal sites. We were impressed by the capabilities and versatility of both NOC's new vehicles. This novel

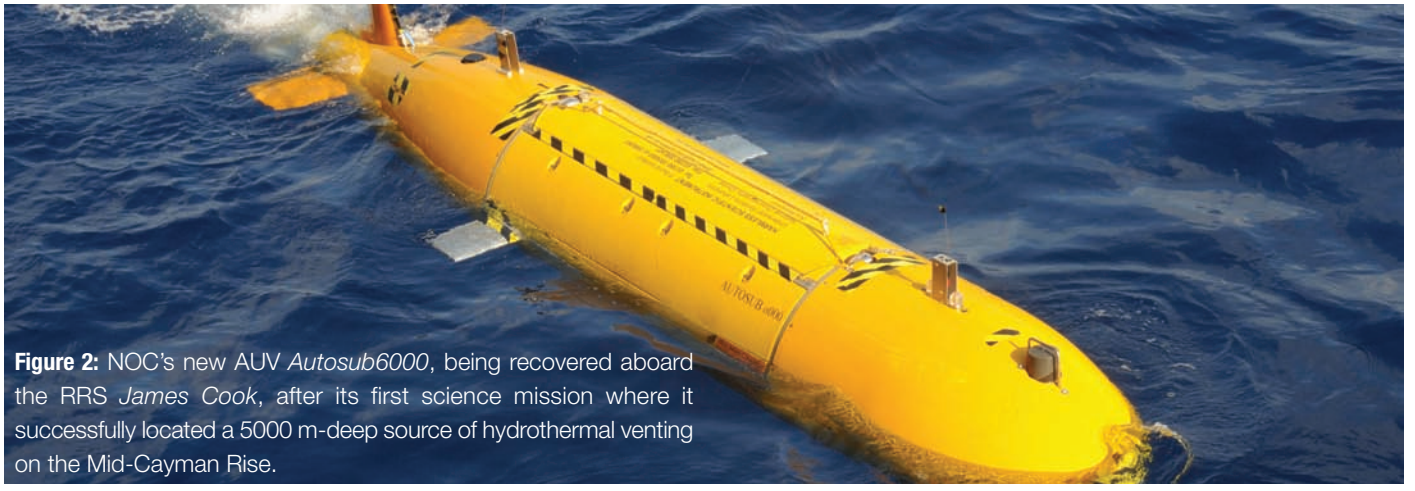

Figure 2: NOC's new AUV *Autosub6000*, being recovered aboard the RRS *James Cook*, after its first science mission where it successfully located a 5000 m-deep source of hydrothermal venting on the Mid-Cayman Rise.

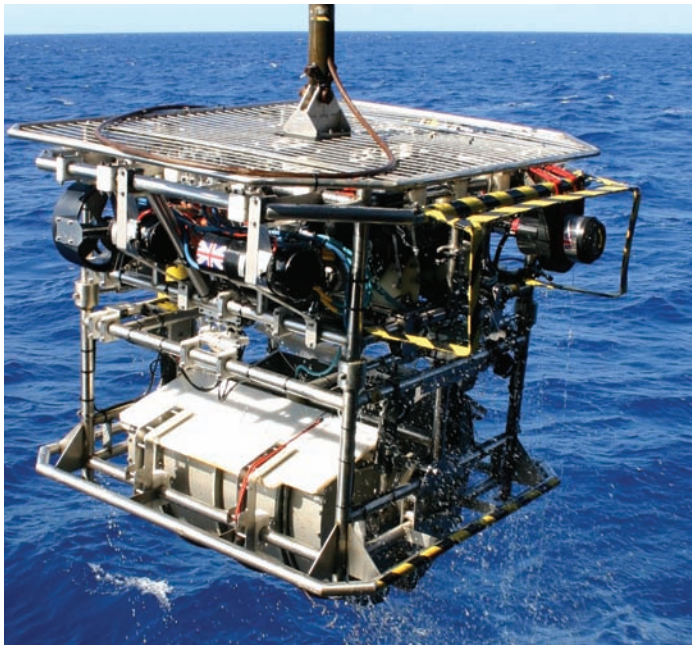

Figure 3: The *HyBIS* ROTV being deployed from the RRS *James Cook.*

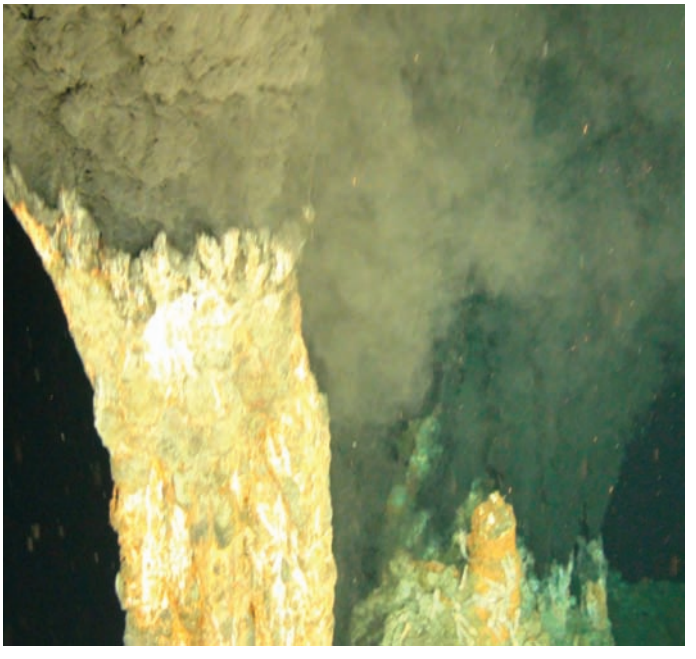

Figure 4: Sulphide chimneys and black vent fluids at the ~5000m deep vent site, Mid-Cayman Rise (photo from the *HyBIS* ROTV).

approach to searching for hydrothermal vents is becoming established as the preferred mode of operation and is likely to become commonplace in the future. The success of the Cayman work is also testimony to the benefits of close collaboration; the initial plume survey by our US partners followed by our AUV/ROTV survey exemplifies the spirit of InterRidge by being able to achieve far more together than separately.

We would like to thank the captain, officers and crew, and the UK's National Marine Facilities' engineers, on the RRS *James Cook* cruise JC44 for their enthusiasm and professionalism throughout this exciting and demanding cruise.

The *James Cook* will be returning to the two vent sites in early 2012, with the UK ROV *ISIS*, for a more thorough mapping and sampling programme.

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New deep-sea hot springs discovered in the Atlantic

Press release, 7th October 2010
Max Planck Society

Hydrothermal vents may contribute more to the thermal budget of the oceans than previously assumed.

Scientists from the MARUM Center for Marine Environmental Sciences and the Max Planck Institute for Marine Microbiology in Bremen on board the German R/V *Meteor* have discovered a new hydrothermal vent 500 km south-west of the Azores. The vent with chimneys as high as one meter and fluids with temperatures up to 300ºC was found at 1000 m water depth in the middle of the Atlantic Ocean. The discovery of the new deep-sea vent is remarkable because the area in which it was found has been intensively studied during previous research cruises.

The Bremen scientists were able to find the hydrothermal vent by using the new, latest-generation multibeam echosounder on board the research vessel *Meteor* that allows the imaging of the water column above the ocean floor with previously unattained precision. The scientists saw a plume of gas bubbles in the water column at a site about 5 km away from the known large vent field *Menez Gwen* that they were working on. A dive with the remote-controlled submarine MARUM-*QUEST* revealed the new hydrothermal site with smokers and animals typically found at vents on the Mid-Atlantic Ridge.

Since the discovery of the new vent, the scientists have been intensively searching the water column with the multibeam echosounder. To their astonishment, they have already found at least five other sites with gas plumes. Some even lie outside the volcanically active spreading zone in areas where hydrothermal activity was previously not assumed to occur.

"Our results indicate that many more of these small active sites exist along the Mid-Atlantic Ridge than previously assumed," said Dr. Nicole Dubilier, the chief scientist of the expedition. "This could change our understanding of the contribution of hydrothermal activity to the thermal budget of the oceans. Our discovery is also exciting because it could provide the answer to a long standing mystery: we do not know how animals travel between the large hydrothermal vents, which are often separated by hundreds to thousands of kilometres from each other. They may be using these smaller sites as stepping stones for their dispersal."

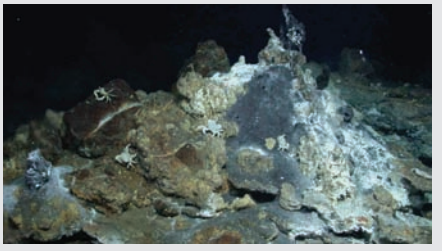


Figure 1: Chimney-like structures spew hot fluids of up to 300ºC that contain large amounts of methane and hydrogen sulfide.

Research on deep-sea hydrothermal vents in the Atlantic is the objective of the 30 marine scientists from Hamburg, Bremen, Kiel, Portugal, and France who have been on board the German research vessel *Meteor* since September 6th. The expedition to the submarine volcano *Menez Gwen* near the Azores is financed by MARUM, the Center for Marine Environmental Sciences in Bremen. "One of the questions that the team would like to answer is why the hydrothermal sources in this area emit so much methane - a very potent greenhouse gas," says chief scientist Nicole Dubilier, who is also a member of the Steering Committee of the Census of Marine Life Vents and Seeps project ChEss (Chemosynthetic Ecosystem Science). "Another important focus of the research is the deep-sea mussels that live at the hydrothermal vents and host symbiotic bacteria in their gills. The mussels obtain their nutrition from these bacteria."

http://www.mpg.de/english/illustrationsDocumentation/documentation/pressReleases/2010/pressRelease201010071/

National News

Australia

Jo Whittaker

Australian researchers have been busy over the past twelve months, having been involved in a number of national and international expeditions to investigate mid-ocean ridges.

Leonid Danyushevski from the University of Tasmania led a highly successful cruise aboard the Australian Marine National Facility, the *Southern Surveyor*, in 2009 to the Fiji back-arc region. The aim of this cruise was to undertake fundamental petrological and geochemical research into how magma is generated at the active transition between continental and oceanic crust. The focus of the expedition was the submarine Hunter Ridge, located between Fiji and Vanuatu, which contains unusual magmatic assemblages containing rocks that are not normally associated in time and space.

Richard Arculus from the Australian National University also led a successful *Southern Surveyor* cruise to the Fiji/Tonga backarc region, which is the most rapidly spreading mid-ocean ridge on Earth, located close to the boundary of the Australian and Pacific plate. This expedition gathered valuable multibeam bathymetry data and refined techniques for locating hydrothermal plumes.

In November 2011, a *Southern Surveyor* expedition is planned to investigate the extinct mid-ocean ridge in the Perth Abyssal Plain, located in the Mesozoic ocean floor offshore from southwestern Australia. Led by Joanne Whittaker from the University of Sydney, this cruise aims to understand the formation history of the Perth Abyssal Plain and the crustal nature and tectonic history of a number of surrounding submerged plateaus.

More information about *Southern Surveyor* cruises at: http://www.marine.csiro.au/nationalfacility/features/vessel.htm

IODP mid-ocean ridge related expeditions

Chris Yeats, CSIRO expert on seafloor hydrothermal systems, spent the month of September 2010 on the Deep Hot Biosphere *Chikyu* Expedition 331 in the Okinawa Trough. He was working as a sulfide petrologist on this expedition designed to drill backarc spreading centre hydrothermal activity, similar to the role he had on ODP Leg 193 in the Manus Basin in 2000. The first Expedition 331 hole drilled very hot material that melted the plastic core liners, but some sulfides were recovered.

Graham Baines, University of Adelaide, has been selected to join the Superfast Spreading Rate Crust 4 *JOIDES Resolution* Expedition 335, in the eastern Pacific in April 2011 as a physical properties specialist. In this expedition, Graham's primary interests are geophysical, in particular the analysis of potential field data, with the objectives of helping determine the geological nature of layer 3 and the layer 2/3 boundary, and constraining the magnetic contribution of the lower crust to marine magnetic anomalies.

John Moreau, University of Melbourne microbiologist, will join the Mid-Atlantic Ridge Microbiology *JOIDES Resolution* Expedition 336 in September 2011. John aims to understand the distribution, activity and involvement of anaerobic sulfide-oxidizing bacteria in the weathering of seafloor basalt and nitrogen cycling at North Pond on the Mid-Atlantic Ridge. He says that anaerobic sulfide-oxidizing bacteria are an important (but under-studied) group of environmental microbes with significant geochemical impacts and play a vital role in the biogeochemically ancient microbial sulfur cycle.

Brazil

Susanna E. Sichel

Ridge research in Brazil includes international collaboration on studies of the abyssal peridotites from the St Peter-St Paul massif (Equatorial Atlantic Ocean 29°25'W) sampled in 1997-1998 by the *Nautile* submersible (<3700 m depth) during the St Paul cruise (IFREMER). InterRidge's national correspondent Susanna E. Sichel and collaborators from Woods Hole Oceanographic Institution (Mark D. Kurz and Jersey S. Blutsztajn) have initiated a project dealing with the behaviour of noble gases (He, Ne, Ar) and Sr, Pb isotopes during deformation and serpentinization in granular peridotites and peridotitic mylonites. The analyses were performed using facilities at WHOI. The results are part of the MSc. dissertation of graduate student Jennifer Angel Amaya at the Federal Fluminense University, Brazil. Additionally, alteration processes relating to phosphatization of the peridotites at the St Peter-St Paul Archipelago are being studied in collaboration with Bernard Smith from the School of Geography, Queen's University, Belfast.

Structural Studies

Recent research, including results from the fracture analysis in the emergent islands, and earthquake focal mechanisms, reveal that local NNW compressional forces may be responsible for the tectonic uplift of the massif. ^{14}C dating in calcareous bioclasts indicates emergence during the last 6600 a at a minimum average rate of ~1.5 mm/a (Campos et al., 2010. Marine Geology, Vol. 271, Issues 1-2, pp. 177-186). These results were part of a collaboration with researchers from Brazilian universities in Rio de Janeiro UERJ (Akihisa Motoki) and Natal UFRN (Thomas F.C. Campos). Other results related to the petrography and structural interpretation have been published in a special review commemorating 10 years of the scientific station on the St Peter-St Paul Archipelago edited and funded by the Brazilian navy program PROARQUIPELAGO, https://www.mar.mil.br/secirm/publicacao/arquipe.pdf. This special book also contains results from other ongoing researches in hydrology, physical oceanography and biology in surrounding areas.

Future work

A follow-up Brazilian-French project COLMEIA – COLd Mantle Exhumation and Intra-transform Accretion – has been submitted in order to fund a future cruise as well as developments on a seismic survey with autonomous hydrophones over the St Paul Transform System and its intersection with the Mid-Atlantic Ridge. This project will be led by Marcia Maia (CNRS-INSU, France) with other PIs including Susanna E. Sichel and Kaiser De Souza (National Geological Service CPRM, Brazil).

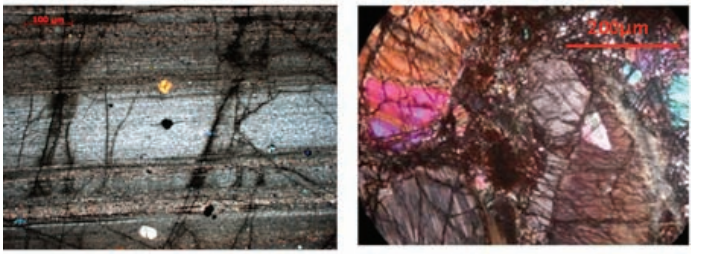


Figure 1: Microphotographs of peridotite mylonite and serpentinized peridotite (1351 m depth).

NEPTUNE Canada

Media release, University of Victoria, Oct. 15, 2010

TEAM COMPLETES WORLD-FIRST OCEAN OBSERVATORY

More than two kilometres down in the inky depths of the Pacific Ocean and 300 km off the coast of Vancouver Island, Canada has just made scientific and technological history. The installation of NEPTUNE Canada—the world's largest and most advanced cabled ocean observatory—has been completed. Most of the voyage was spent at volcanically active Endeavour Ridge, where the team installed two six-kilometre cables and 29 instruments on the seafloor and connected them to the main NEPTUNE Canada network.

"High-pressure work in harsh environments sounds like a recipe for disaster, but the excitement carried us through storms, equipment failure and long shifts. There was a pervasive feeling of being part of a significant achievement," says Dr. Mairi Best, NEPTUNE Canada's associate director (science) and co-leader of the expedition.

NEPTUNE Canada is managed by Ocean Networks Canada for a consortium led by the University of Victoria. Along with its coastal sister, VENUS, it pioneers a new generation of ocean observation systems that, using power and the Internet, provides continuous, long-term monitoring of ocean processes and events, as they happen. The entire observatory—which features an 800-km loop of powered fibre-optic cable, and power and communication nodes

at five key scientific sites—has taken almost 10 years to plan, develop and install.

Endeavour Ridge proved to be the team's most challenging installation site. Before laying several kilometres of cable through a subsea mountain range pocked with deep chasms, jagged rocks and belching hot vents, ROPOS "flew" slowly along the route, surveying the bottom with high-resolution sonar.

Every year for the next 25 years, NEPTUNE Canada will amass more than 60 terabytes of scientific data - equivalent to the text in about 60 million books - on biological, physical, chemical and geological processes in the Pacific Ocean. The data will have policy applications in the areas of climate change, hazard mitigation (earthquakes and tsunamis), ocean pollution, port security and shipping, resource development, sovereignty and security, and ocean management.

The development of NEPTUNE Canada has been funded by more than $100 million from the Government of Canada through CFI, the Natural Sciences and Engineering Research Council and CANARIE, and the Government of British Columbia through the British Columbia Knowledge Development Fund.

To see live data streaming from NEPTUNE Canada instruments or for more information on the observatory, visit www.neptunecanada.ca. Downloadable images available at: http://www.flickr.com/photos/neptunecanada/sets/

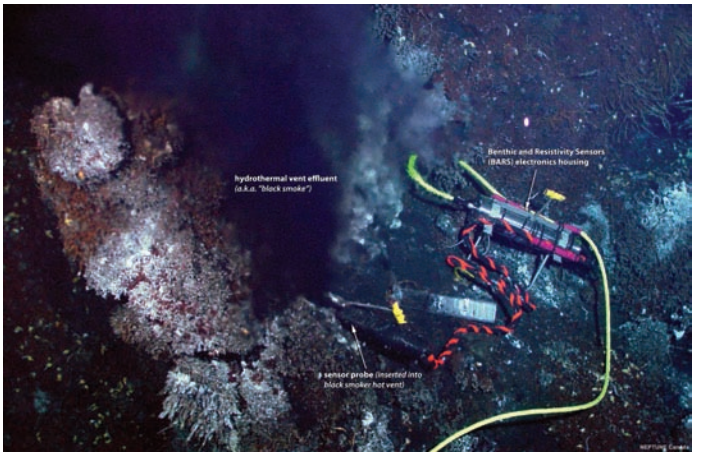


Figure 1: The Benthic and Resistivity Probe after deployment atop Grotto hydrothermal vent edifice, 28 September 2010. (N47° 56.9551′, W129° 5.8912′; depth: 2187.879m).

China

Y. John Chen and Jiabiao Li

2010 has been another fruitful year of mid-ocean ridge research in China, with several important areas of progress.

Cruise research

Chinese scientists completed 6 consecutive ridge cruises onboard the R/V *Dayang Yihao* and collected evidence for active hydrothermal vents on the equatorial East Pacific Rise, South Mid-Atlantic Ridges, and the Southwest Indian Ridges.

The first active source OBS array experiment at the ultraslow spreading Southwest Indian Ridge at 50°W was successfully conducted. A total of 40 OBSs were deployed and an array of 4 air-guns (1,500 cbf each) was shot for 14 continuous days covering two 50-km by 50-km areas for a 3-D OBS study: one at the active hydrothermal vent site found in 2007 and the other at the axial high nearby along the ridge segment mid-point. These OBSs also included 17 instruments from the IPGP, France, and a team of 3 French engineers were also on board, conducting deployment/recovery of the French OBSs as part of the collaboration between IPGP (Dr. Satish Singh) and InterRidge China (Dr. Jiabiao Li at the Second Institute of Oceanography and Dr. John Chen at Peking University). For further reporting of this, see the "International Research" section in this volume.

Deep submergence vehicles

During the cruise to the equatorial East Pacific Rise, the Chinese ROV, "*Ocean Dragon 2*" was successfully deployed for the first time for seafloor observation and direct collection of seafloor samples. Chinese Deep Tow System with sidescan and profile was also used in seabed observation of a 4,500 m deep manganese nodule area. Four test dives to a depth of 3,759 m by the Chinese manned underwater submersible "*Harmony 7000*" were successfully completed in the South China Sea.

Education and outreach

Shanghai Ocean Sciences Summer School, "Evolution and Dynamics of Oceanic Lithosphere", was held in Shanghai, China, August 2-6, 2010. Three scientists (Jian Lin, Yaoling Niu, and Kelin Wang) from US, UK and Canada, gave lectures including the evolution in scientific concepts leading to plate tectonics, the mantle plume debates, mid-ocean ridges and transform systems, subduction processes, cycling of Earth's geochemical elements, deep-sea hydrothermal vents, and the deep-biosphere. The summer school attracted over 140 participants from institutions all over China, and mostly students who are a major research force and future leaders in deep-sea research in China.

The first national conference focused on Deep Sea Research and Earth System Sciences was held at Tongji University on June 28-30, 2010. Over 450 scientists and students participated in this conference (see "China Outlines deep-sea ambitions", Nature, 466, 166, 2010;

http://www.nature.com/news/2010/100706/full/466166a.html?s=news_rss).

Finally, the China Ocean Mineral Resources Research and Development Association (COMRA) has submitted an application to the International Seabed Authority for approval of a plan of work to explore for polymetallic sulphides on the Southwest Indian Ocean Ridge.

Figure 1: Successful completion of a test dive for *Jiaolong* (*Harmony*) *7000.*

France

Jérôme Dyment, Nadine Le Bris, and Christophe Hémond

Year 2010 has been a good vintage for the French Ridge community, with nine ridge-related cruises completed or scheduled before the end of the year! Among these are three long-awaited cruises in the NE Pacific Ocean; the renewal of back-arc basin exploration in the SW Pacific as part of EEZ mineral resource exploration; the completion of a geochemical exploration project on the SEIR and a cruise devoted to the SWIR crustal architecture in the Indian Ocean; and two MoMAR follow-up cruises, the first one devoted to the replacement of large scale hydrophone recording network around the Azores, and the second one to the instalment of an observatory demonstrator as part of the ESONET project.

Pacific Ocean

R/V *L'Atalante* has been in the NE Pacific Ocean with deep-sea submersible *Nautile* and AUV *ASTER-X* in Spring and early Summer 2010 for the following three cruises.

Cruise PARISUB (PI P. Gente) investigated the East Pacific Rise (EPR) at 16°N, an area of interaction between the Mathematicians hotspot and the spreading axis. The main data collected included 25 *Nautile* dives and a 30x4 km wide AUV survey of the hyper-inflated spreading axis with multibeam bathymetry and imagery, magnetics, and nephelometry. Previously unknown active hydrothermal vents have been directly observed, and fauna has been sampled as well.

Cruise MESCAL (PI N. Le Bris, 1st leg and F. Lallier, 2nd leg) was dedicated to biological and ecological studies of model organisms of the EPR (9°N and 13°N vent fields). Its objectives focussed on colonisation dynamics of unstable vent habitats and adaptation to extreme environmental conditions. The first leg (5 *Nautile* dives) prioritized the most extreme habitats on black smokers, namely Alvinella pompejana and associated communities, while the second (13 *Nautile* dives) was dedicated to symbioses from diffuse vents (*Riftia pachyptila* and *Bathymodiolus thermophilus*). A new isobaric system for data collection, *BALIST*, was successfully implemented during the cruise.

Cruise BIG (PI A. Godfroy) aimed to compare the diversity of ecosystems associated with cold seeps and hydrothermal vents in the Guaymas Basin. This microbiology and ecology cruise involved multiscale approaches, including the use of AUV *ASTER-X* for the exploration and mapping of vent and seep biological assemblages and 14 *Nautile* dives. The operations allowed the sampling of both hard substrate and sediment communities, combined with the characterisation of physico-chemical conditions in their habitats.

Cruises FUTUNA 1 and FUTUNA 2 of R/V *L'Atalante* (PI Y. Fouquet) are devoted to the exploration of the Futuna Ridge, one of the small ridge segments connecting the Lau and North Fiji back arc basins. This spreading centre is located in the EEZ of the French territory of Wallis and Futuna, and cruise FUTUNA 1 has improved the sea-surface mapping by acquiring swath bathymetry and imagery using R/V *L'Atalante* new generation multibeam echo sounder, magnetics and gravity data. This improved accuracy has paved the way for the ongoing cruise FUTUNA 2, devoted to the search for hydrothermal sites – active or fossil – with deep-sea submersible Nautile and AUV *ASTER-X*. These cruises are part of the French national effort to explore the French EEZ for mineral resources, supported by the industry and several government agencies.

Indian Ocean

In Jan-Feb 2010, cruise GEISEIR 2 (PI C. Hémond) on R/V *Marion*

Dufresne continued the dense collection of samples along the SEIR, initiated a year ago to investigate the small scale geochemical heterogeneity of the mantle. Bathymetric and geophysical data have been acquired as well, and the dense wax core sampling has also permitted the acquisition of a unique set of nephelometric data (MAPRs, collab. Ed Baker). Cruise GEISEIR 1 and 2 have achieved the mapping and dense sampling of a 1400 km long section (4 segments) of the SEIR, with 175 locations successfully sampled.

Cruise SMOOTHSEAFLOOR (PIs D. Sauter and M. Cannat) on the SWIR is scheduled onboard R/V *Marion Dufresne* in October 2010. As part of the European exchange of marine facilities, the cruise will use the British TOBI to collect deep towed side scan and magnetic data. The objective is to understand the crustal architecture of the peculiar "smooth seafloor" observed in this area and to search for hydrothermal activity.

Cruise OHASISBIO (PI J.-Y. Royer) should take place at the end of 2010 or beginning of 2011 on R/V *Marion Dufresne* to redeploy a hydrophone network 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.

Finally, following the visit of Chinese colleagues in Paris aside of the InterRidge Steering Committee in 2009, a Sino-French collaboration has started to investigate the seismic structure of the SWIR. Three French engineers joined the seismic cruise of R/V *Dayang Yihao* in February 2010 (French PI collab. S. Singh).

Atlantic Ocean – MoMAR

French efforts are continuing to promote the MOMAR project, initiated by InterRidge and now part of the ESONET–EMSO European initiative for implementing deep sea observatories around Europe.

Cruise HYDROBS-MOMAR (PI J. Perrot) on R/V *Le Suroît* has redeployed the five hydrophones of the network centred on Lucky Strike hydrothermal site near the Azores, continuing time series covering almost a decade now.

Cruise MOMARSAT (PIs M. Cannat, J. Blandin and P.M. Sarradin), is 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; this cruise is expected in October on R/V *Pourquoi pas?*, after the refurbishment of ROV *Victor*.

Instrumentation and methods

ROV *Victor* is currently in the final phases of a year-long refurbishment. For this reason, deep-sea manned submersible *Nautile* has been used for cruises PARISUB, MESCAL, BIG, and FUTUNA 2. In three of these four cruises, *Nautile* has been used in conjunction with AUV *ASTER-X*, Nautile diving on day time to focus on specific targets and *ASTER-X* on night time to map larger areas. This configuration offers an efficient alternative to the use of the two modules of ROV *Victor* – the "mapping" module with multibeam and geophysical measurement capabilities for surveys, and the "sampling" module for more focused geological, physico-chemical, and biological site exploration.

It is also worth mentioning that the efficient and dense sampling achieved using wax core on GEISEIR 1 and 2 cruises along the SEIR allowed a similarly dense MAPR data set. The use of such an easy and promising tool for geochemical studies and hydrothermal plume detection should probably be applied to other parts of the world's mid-ocean ridges.

Mineral resource exploration

Following industrial requests to investigate parts of the French EEZ for this purpose, French officials have realized the general interest for deep sea mineral resources and more specifically massive sulfide deposits at mid-ocean ridges. A prospective working group composed of scientists, industrialists, and decision-makers was established in Fall 2009 and has completed its task in less than 9 months, resulting in the implementation of an industry-supported exploration program around Wallis and Futuna (see above). Several scientists active in InterRidge, including the National Correspondent, participated in these meetings and made the non-scientific audience aware of InterRidge and its role in the community and beyond. Further discussions are presently being held at Ministry level to define future actions in response to the new ISA policy on seafloor massive sulfide deposits.

Germany

Nicole Dubilier and Colin Devey

Ridge research in Germany continues to thrive through research programs and a number of cruises that took place during the last year or are planned in the near future. The German Priority Program 'Ridge' coordinated by Colin Devey and funded by the German Research Foundation is now no longer financially active (funding ran from 2003-2009) but papers are still appearing or are in submission as a result of this program (http://www.ifm-geomar.de/index.php?id=1448&L=1). Colin Devey was the chief

scientist of a cruise to the Woodlark Basin in the West Pacific to study ocean basin formation, aboard the RV *Sonne*, with the IFM-GEOMAR AUV *ABYSS*.

The German Research Foundation has funded a Cluster of Excellence at MARUM, Bremen, for 2008-2012 which includes a large research program for geological, chemical and biological research on hydrothermal vents. Two cruises funded through this program to the Menez Gwen vent field on the Mid-Atlantic Ridge have already taken place: a) MomarMap, RV *Poseidon* P402; 30 Jul-10 Aug 2010; AUV and ROV *Cherokee* Bremen; PI Christian Borowski; and b) MenezMar, RV *Meteor* M82/3; 3 Sep-11 Oct 2010; ROV *QUEST* Bremen; PI Nicole Dubilier. With the aid of CTD information gained from the MomarMap cruise, the German, Portuguese, and French scientists on the MenezMar cruise were able to quickly localize and discover a new hydrothermal vent site, named Bubbylon, 5 km to the south of Menez Gwen (further details in the "International Research" section of this volume). A third cruise funded through the MARUM Cluster of Excellence program heads to the Manus Basin on the RV *Sonne* with the ROV *QUEST* (Bambus, Jun-Jul 2011; PI Wolfgang Bach, MARUM).

German ridge research in the polar regions will start taking shape in early 2012 thanks to the Alfred-Wegener-Institute for Polar and Marine Research (AWI) funding of several cruises with the RV *Polarstern*: a) Vera Schlindwein from the AWI will be the chief scientist on the cruise SWEAP to the ultra-slow spreading Southwest Indian Ridge planned for Dec 2012-Jan 2013, b) Gerhard Bohrmann is the chief scientist of a cruise with the MARUM AUV and ROV to vents and seeps on the Sandwich Plate in March 2013, and c) Antje Boetius (AWI and MPI-Bremen) will head the AURORA cruise to 83°N on the Gakkel Ridge in June 2014 using

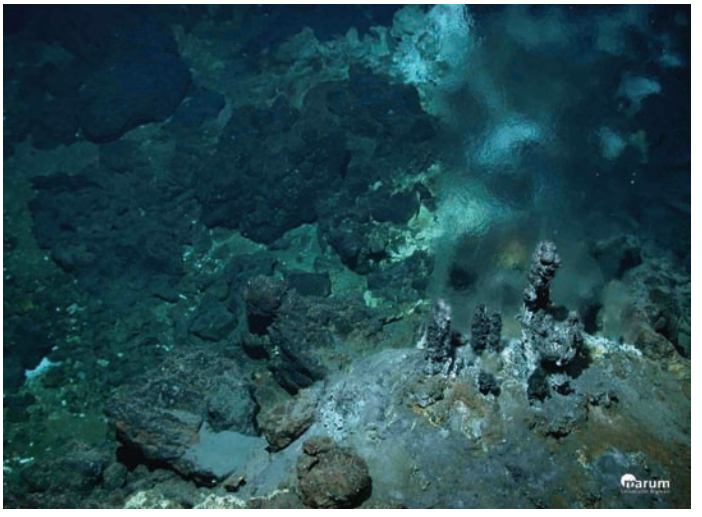


Figure 1: The hydrothermal vent crab Segonzacia on a mound that is covered with white bacteria and mineral precipitates. (Image taken on RV *Meteor* cruise, Menez Gwen, Oct 2010)

a new hybrid ROV/AUV system developed by WHOI for under-ice diving in a collaboration with Chris German from WHOI.

German ridge research has profited immensely during the last five years from the IFM-GEOMAR and MARUM ROVs (*Kiel6000* and *QUEST*) and AUVs (*ABYSS* and *SEAL*). Technical advances in underwater vehicles needed for ridge research will continue in Germany with plans to build a hybrid-ROV at MARUM, and a new under-ice deep submergence vehicle within a European research project between AWI, MARUM and IFREMER in collaboration with WHOI.

India

Kamesh Raju

We had one cruise to the Carlsberg Ridge during the last year, on a chartered Russian vessel RV *Boris Petrov*. The objectives of the cruise were to carry out systematic sampling along the rift valley from the Owen fracture zone to 62ºE and to make repeat observations at the HT plume region that was discovered during the RV *Sonne* cruise in December 2007. Systematic sampling was carried out as planned. Repeat observations at the plume region were conducted with MAPRs; these observations have reconfirmed the plume. We have also initiated a process to hire a suitable AUV (due to non availability of *Sentry*) to conduct detailed investigation of the HT plume region and the *ABYSS* AUV of IFM-GEOMAR has been selected. An AUV cruise to the Carlsberg Ridge is planned for Oct-Nov 2010 onboard the Indian research vessel RV *Sagar Nidhi*. Besides the scientists from NIO, Goa, scientists from the National

Figure 1: RV *Sagar Nidhi*

Geophysical Research Institute (NGRI), Hyderabad, Delhi University and IUAC (Inter-University Accelerator Centre) New Delhi are actively participating in the MoES funded Ridge program.

Italy

P. Tartarotti

Ridge research in Italy includes international collaborations on studies on the superfast ocean crust created at the 6°N EPR segment (IODP Site 1256) and on core complex formations (MAR). Researchers from the University of Milano and Modena have been involved in recent IODP cruises. One was to the Guatemala Basin (Eastern Pacific; IODP Exp. 309) where the focus was on the structure of upper ocean crust and its relation to hydrothermal alteration. Another was to the Atlantis oceanic core complex (IODP Exp. 305), which studied mantle melting processes.

Italy is very active in research on ophiolites which simulate the comparison between modern ocean crust and its fossil analogues. An international journal on ophiolites and related topics has been published in Italy since 1976 (http://www.edizioniets.com/ofioliti/).

Italian scientists linked to the Working Group on Mediterranean Ophiolites are still actively involved in multidisciplinary research on ophiolites of the peri-Mediterranean belt. In particular, recent studies on the Ligurian and Western Alps ophiolites by research groups from the universities of Genova, Parma, Pavia and Pisa have focused on lithosphere evolution during the extensional processes leading to the formation of an oceanic basin. These studies demonstrated that the structural and compositional features of the marginal ophiolitic sequences recall those of the modern non-volcanic continental margins, whereas the ophiolites from the inner domains display structural and compositional similarities to modern slow- and ultraslow-spreading ridges.

Figure 1: Shearing foliation at low angle with respect to the igneous layering of the gabbro (Ligurian ophiolite).

Both mantle and magmatic rocks from these ophiolites are currently the subject of field-based geochemical studies developed in cooperation with Lamont-Doherty Earth Observatory, (New York, USA), Okayama University (Japan) and Royal Holloway (University of London, UK). Recent and ongoing studies have shown that interaction of old, veined subcontinental lithosphere and convective mantle during rifting and ocean formation resulted in deeply modified and refertilized mantle sequences. In particular, great efforts have been devoted to understanding the structural and compositional evolution of the peridotites percolated by MORB melts and the mechanisms of melt/peridotite interaction. The problem of melt-source isotopic equilibrium vs. disequilibrium in abyssal peridotites has been also addressed through the study of depleted peridotites considered to be representative of a mid-ocean setting. In addition, the widespread occurrence of different generations of pyroxenite layers in a MORB-type mantle setting provides unique insights on the chemical and isotopic variability of pyroxenite components and on small-scale isotopic heterogeneity. The studies of the magmatic rocks from the ophiolites of the Alpine-Apennine belt are mainly focused on the origin of the gabbroic plutons, to yield information about the tectonic and magmatic processes leading to the building of oceanic gabbroic crust.

Ocean-floor and high-pressure orogenic metamorphism in ophiolitic units from the Western Alps and Southern Apennines are being investigated by groups from Cosenza, Genova, Milano, Pavia, Potenza and Torino universities, through combined field, structural, geochronological and petrological approaches.

Mesozoic ophiolitic sequences from the Dinaride-Hellenide belts, which include both mid-ocean ridge and supra-subduction zone ophiolites, have been extensively studied by research groups from Ferrara, Firenze and Pisa universities, with the aim of achieving detailed stratigraphic and geodynamic reconstructions coupled with identification of mantle components and magma sources in the different ophiolitic units (e.g. Mirdita, Guevgueli, Pindos, Othrys, Vourinos). This study has been recently extended to selected ophiolitic sutures of Paleotethys and Neotethys in Turkey.

For a report of the 2009 international workshop on ophiolites, see the section "Workshops and Conferences" in this volume.

Japan

K. Okino

The InterRidge-Japan program continues efforts to promote ridge-related studies in Japan and to expand our community. The outline of the ongoing project and other activities are described below.

Domestic and International Meetings

An InterRidge-Japan symposium was held on October 29-30, 2009, at Ocean Research Institute, University of Tokyo. About sixty scientists participated in the symposium to share recent research activities. We plan a similar symposium in November 2010, including a one-day international session under the collaboration with a Japan-New Zealand workshop on marine resources. We also had a business meeting on May 25, 2010, at the Japan Geoscience 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.

Ongoing project "TAIGA"

The interdisciplinary research project TAIGA, Trans-crustal Advection and In-situ biogeochemical processes of Global subseafloor Aquifer, was launched in 2008. The project is funded by MEXT (Ministry of Education, Culture, Sports Science and Technology) from FY2008 to FY2012 and we will have a mid-term external evaluation this year.

As we outlined in the last IR News, we focus on subseafloor fluid advection which carries huge heat and chemical fluxes from the interior of the earth and supports growth of the biosphere (beneath and on the seafloor). Three integrated study sites have been selected:

1. Southern Mariana Trough as TAIGA of sulfur

Here, the detailed seafloor mapping and plume detection were carried out using AUV *Urashima* in 2009. We also conducted a cruise with benthic multi-coring system (BMS) and succeeded in obtaining 12 contamination-free core samples (0.4-4.5 m) in the same area. These core samples will be used for various analyses including rock-magnetism, bulk petro-chemistry, alteration mineralogy, ore mineralogy, isotopic geochemistry, age determination, redox-state analysis, organic chemistry, amino-acid analysis, microbiology and microbial ecology. The deep crust / upper mantle imaging using OBSs and OBEMs, and the geological, geochemical, microbiological, and biological submersible surveys are also planned later in 2010.

2. Indian Triple Junction as TAIGA of hydrogen

A short submersible dive cruise was done in 2009 and the exposure of mantle peridotite was discovered, which may be a key to understanding the hydrogen-rich Kairei hydrothermal field. More surveys in the Indian Ocean are planned in 2010 and 2011.

3. Okinawa Trough as TAIGA of methane

We also have several cruises in the Okinawa Trough as TAIGA of methane and the *Chikyu* deep drilling is scheduled in September 2010.

More than fifty scientists joined the project, and many seagoing studies are planned, mainly in the integrated study sites. Further information can be checked at the project website (http://www-gbs.eps.s.u-tokyo.ac.jp/~taiga/en/index.html).

Cruises in FY2010

Including the OBEM recovery cruise in the Lau Basin under the collaboration with the US team, a total of nine cruises were funded in FY2010. In the southern Mariana backarc area, nine BMS (Benthic Multi-coring System) drillings were conducted during the *Hakurei-Maru* No.2 cruise in June 2010 (PI T. Urabe) and 12 holes were drilled with a total hole depth of 42 m. Two cruises with submersible *Shinkai 6500* were planned in the same hydrothermal area this summer (YK10-10: PI J. Miyazaki and YK10-11: PI S. Kojima), when an in-situ microbiological incubation system using BMS drill holes was settled. To investigate the deep crust and upper mantle structure beneath the Mariana hydrothermal area, 20 OBSs and 11 OBEMs were deployed in August (YK10-10) and then will be recovered in November (YK10-15: PI N. Seama). In the Okinawa Trough area, two cruises using R/V *Tansei-maru* are scheduled in October: KT10-22 (PI T. Yamanaka) and KT10-23 (H. Yamamoto). Both cruises will target the microbiological and geochemical studies in sediment-rich hydrothermal sites. R/V *Hakuho-maru* will visit the Indian Ocean triple junction (KH-10-6: PI K. Okino) with AUV r2D4 in November 2010. Integrated AUV survey, rock dredge, water and plankton sampling in hydrothermal plumes are planned.

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

Figure 1: Japan's AUV *Urashima*

Korea

Sung-Hyun Park

Korea Polar Research Institute (KOPRI) will conduct a survey of the 160E segment of Southeast Indian Ridge from 25th Feb - 12th March 2011. The ports of embarkation and disembarkation will be Christchurch, New Zealand. The 160E segment in SEIR remained unsurveyed, but is scientifically interesting because it is very shallow (2200 m) but may be not influenced by any mantle plume. During the cruise we will be mapping, sampling and hydrothermal surveying. This survey is historic because it will be the first mid-ocean ridge survey using the new Icebreaker R/V *Araon* of KOPRI. It will also be a pilot cruise to prepare for a major survey of the entire Pacific-Antarctic Ridge. Participation on the cruise will be open to international MOR scientists who propose new ideas for collaboration.

In addition to the SEIR cruise, the Korea Ocean Research and Development Institute (KORDI) have continued surveying the Tonga arc area and Central Indian Ridge.

Tonga Arc survey

KORDI performed a 25-day cruise in Tongan waters with 18 KORDI and University of Hawaii (HMRG) scientists and one Tongan observer (27 January - 20 February 2010, onboard RV *Sonne*). A deep tow side scan sonar survey, using IMI-120 of HMRG, was performed over 5 volcanoes which were selected from the results of previous KORDI cruises. Precise seafloor observation and sampling were also performed using OFOS (Ocean Floor Observation System) and GTV (TV-guided Grab) with an acoustic underwater positioning system. The results identified four hydrothermal vents and related mineralized sites on three volcanoes. KORDI plans to make an ROV survey of the newly identified vents and mineralized areas in March 2011.

Indian Ridge Survey

Hydrothermal exploration aboard the R/V *Onnuri* was performed along the northern Central Indian Ridge (CIR) between 8°S - 17°S in January 2010. The main objectives of the cruise were (1) to understand the nature of spreading segments of the northern CIR area, where no systematic surveys have been before, by mapping and sampling volcanic rocks and (2) to discover new hydrothermal venting along the spreading center of northern CIR. Our initial bathymetric survey located and imaged the structure of the axial rift valley. The bathymetric data also revealed several ocean core complexes (OCC) which are indentified by their topographic-shape and elevated corrugated surfaces. Mantle peridotite and gabbroic rocks were recovered from these OCC sites. Rock sampling, CTD casts and tows were also performed in the northern half of the survey area. The sampled lavas are typical mid-ocean ridge basalt (MORB) with glassy chilled margin. The analyzed basaltic glasses show geographical variations in incompatible element concentrations that are possibly an effect of interaction between the ridge and the Reunion hot spot. Hydrothermal plume signatures were also observed at all 5 surveyed segments, indicating the location of several hydrothermal vents along the northern CIR. KORDI plans to revisit the northern CIR area in November 2010. The upcoming cruise will be focused on the southern half of the surveyed area but where sampling was absent during the previous cruise.

New Zealand

Richard Wysoczanski, Matthew Leybourne and Malcolm Clark

InterRidge research in New Zealand has continued to focus on hydrothermal vent activity in the Kermadec arc. Since the last report in 2007, several cruises have targeted these deposits as well as New Zealand researchers participating in international voyages. There have also been changes in research staff involved in InterRidge activities.

Research voyages

In November 2007, GNS scientists, along with a team from NOAA/PMEL participated on an Italian-led cruise on the R/V *Urania* to survey the entire Aeolian arc in the Tyrrhenian Sea. The cruise was focused on CTDO work and hydrothermal plume mapping. Several submarine volcanoes along the arc were found to be hydrothermally active.

In March 2009, GNS scientists joined the R/V *Thomas G. Thompson*, which included scientists and a student oceanography class from the University of Washington and scientists from WHOI. The cruise collected multi-beam bathymetry, sea-floor imagery, and CTDO data from Brothers, Rumble II West and Rumble III volcanoes. Mapping

of Rumble III revealed that the summit had collapsed since the last major bathymetric survey of the volcano. Follow-up multi-beam mapping by the R/V *Tangaroa* KARMA voyage in 2010 confirmed the collapse.

The KARMA (Kermadec Arc MinerAls) voyage was held over two legs in May to conduct geophysical (leg 1) and biological (leg 2) surveys of hydrothermal vents in the Kermadec Arc. Hydrothermal fields on Brothers and Rumble II West volcanoes were targeted as well as the inactive Rumble II East volcano. The voyage included researchers from NIWA, Auckland University, GNS, Woods Hole Oceanographic Institute and Census of Marine Life on Seamounts (CenSeam).

Leg 1 resulted in the acquisition of ~830 km (460 NM) of Multichannel Seismic Data (MCS), ~3000 km^2 of multi-beam bathymetry, and 23 sample sites. There was an additional 1250 km of magnetic data recorded using either a gradiometer or a single magnetometer, and 1450 km of gravity data recorded. The multichannel lines included regional lines over all three volcanoes as well as several lines that together provide a transect from the Kermadec Ridge, across the Havre Trough back arc basin, and to the Colville Ridge. A pseudo-3D experiment was also conducted over Brothers caldera, initially planned to consist of 111 lines spaced just 25 m apart. Only 62 lines were acquired (see Figure 1) due to weather conditions preventing sufficient navigation precision. Leg 2 focused on surveying a range of habitat types on the three volcanoes to describe the benthic fauna. A total of 100 sampling stations were completed, most using a deep camera system which was towed just above the seafloor running both video and still cameras. Transect lines with the camera covered the summit areas of the volcanoes, the outer flanks, caldera floor, inner caldera wall, and chimney and vent fields. This gives us the ability to determine the variability of the fauna with habitat type, and relate it to geological and geophysical properties of the volcanoes. The biological survey was very successful, with the camera returning high quality images of the seafloor substrate, benthic invertebrates, and fish. The direct sampling during both legs captured almost 3000 invertebrate and fish specimens. Sponges, anemones, crabs, feather stars, corals, brittle stars and polychaetes were the most common invertebrate groups.

Over the past couple of years several GNS scientists have also participated in various cruises in the Lau basin and the Mariana arc with colleagues from NOAA, JAMSTEC, the University of Texas at Dallas and the USGS.

Upcoming events

Japan - New Zealand Workshop on Seafloor Resources

Japan and New Zealand share a common tectonic setting, that of a continental subduction zone that extends offshore to an oceanic arc: the Izu Bonin Mariana (IBM) arc for Japan and the Kermadec arc (KA) for New Zealand. Associated with this tectonic setting are untapped resources on the ocean floor, particularly seafloor massive sulphide (SMS) deposits and gas hydrates, both of which have a vast economic potential. For both nations, the exploration and understanding of these deposits, and the environmental implications of future extraction of the resources, is in an infant stage. A workshop to discuss the future direction of SMS research in Japan and New Zealand will be held over three days at the University of Tokyo in November 2010. The workshop will include researchers from NIWA, GNS and Victoria University of Wellington. It is funded by the Japan Society for the Promotion of Science and the Royal Society of New Zealand.

Special Issue of Economic Geology

Cornel de Ronde (GNS), Dave Butterfield (NOAA/PMEL) and Matt Leybourne (GNS) are guest editing a special issue of the journal Economic Geology. The special issue will concentrate on the metallogeny/ore deposits of intraoceanic arcs. Deadline for manuscript submission is the end of December 2010, with publication anticipated for later in 2011. To date, around 26 manuscripts have been "promised", with studies from the Kermadec arc, the IBM and the Aeolian arc, among others.

Oceans 2020 voyage

GNS, along with colleagues from NOAA, WHOI and NIWA have a cruise planned to the southern Kermadec arc for February-March of 2011. This cruise will be around 3 weeks in duration and will involve mapping of several massive sulfide hosting submarine caldera and cone volcanoes using the AUV *Sentry*. Complimentary

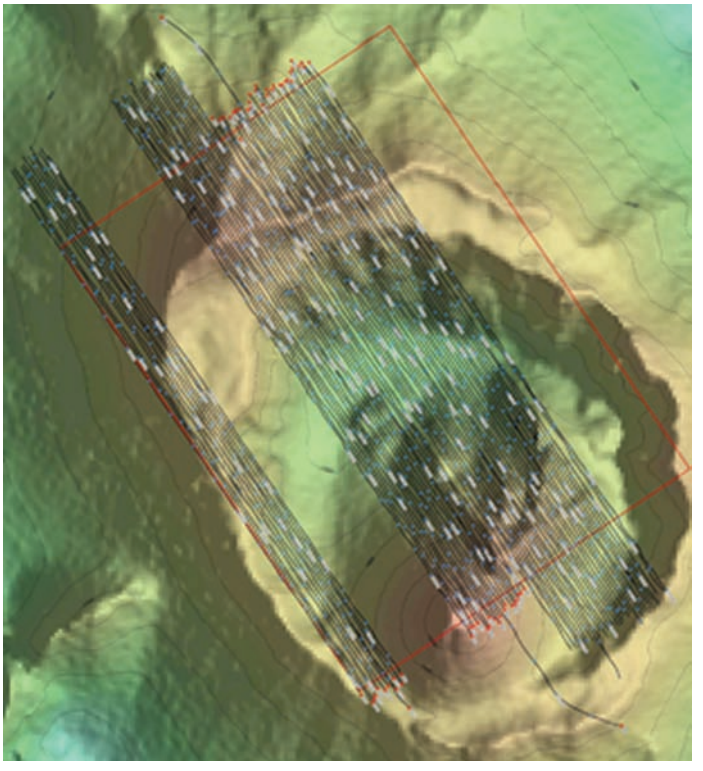


Figure 1: Pseudo 3D seismic experiment ship tracks over Brothers Volcano spaced at 25 m intervals.

studies will include video and still imagery collection of known vent sites with Tow-Cam and CTDO time-series plume studies at Brothers, Healy and Rumble II West volcanoes.

Research institute news

The Off-Shore Minerals group at GNS has expanded over the last year or so with the addition of Marine Geophysicist Fabio Caratori Tontini, Petrologist Christian Timm, and Marine Technician Tineke Berthelsen. During this time, GNS has also upgraded its marine geophysics capability with the purchase of a new gradiometer, and is in the process of upgrading a gravimeter recently obtained from the NZ Navy.

Richard Wysoczanski joined NIWA in 2009, replacing Prof. Ian Wright, who left to take up a position at NOC, Southampton, UK.

Norway

Rolf Pedersen

Ridge research in Norway continues primarily at the University of Bergen where it is a research theme at the Centre for Geobiology (http://www.uib.no/geobio/en). In summer 2010, researchers returned to the Mohns-Knipovich Ridge, and the cruise employed an AUV in addition to an ROV. A *Hugin* AUV (Kongsberg Maritime) that is operated by FFI was deployed from RV *G.O.Sars* to acquire micro-bathymetry of the Loki's Castle vent field and to search for new venting areas. The cruise had several research foci:

1. Returning to the Loki's Castle hydrothermal vent field for renewed measurements and sampling (both geological and biological);

2. Taking of several Calypso cores in the Mohn-Knipovich rift valleys to assess the sedimentation and geological history in this area;

3. Undertaking more detailed mapping and water column studies of the southern Knipovich Ridge region, searching for new hydrothermal sites.

The Loki's Castle hydrothermal field is located on the crest of an axial volcanic ridge and is associated with an unusually large hydrothermal deposit. This sizeable field provides clear evidence that extensive venting and long-lived hydrothermal systems exist at ultraslow spreading ridges. In addition, the field hosts vent fauna that is distinct from that found to the south along the Mid-Atlantic Ridge. Successive cruises these past summers to the Loki's Castle area have enabled researchers to build up significant data sets and sample collections that are being analysed by Norwegian and international collaborators.

Philippines

Graciano P Yumul, Jr. and Dr. C.B. Dimalanta

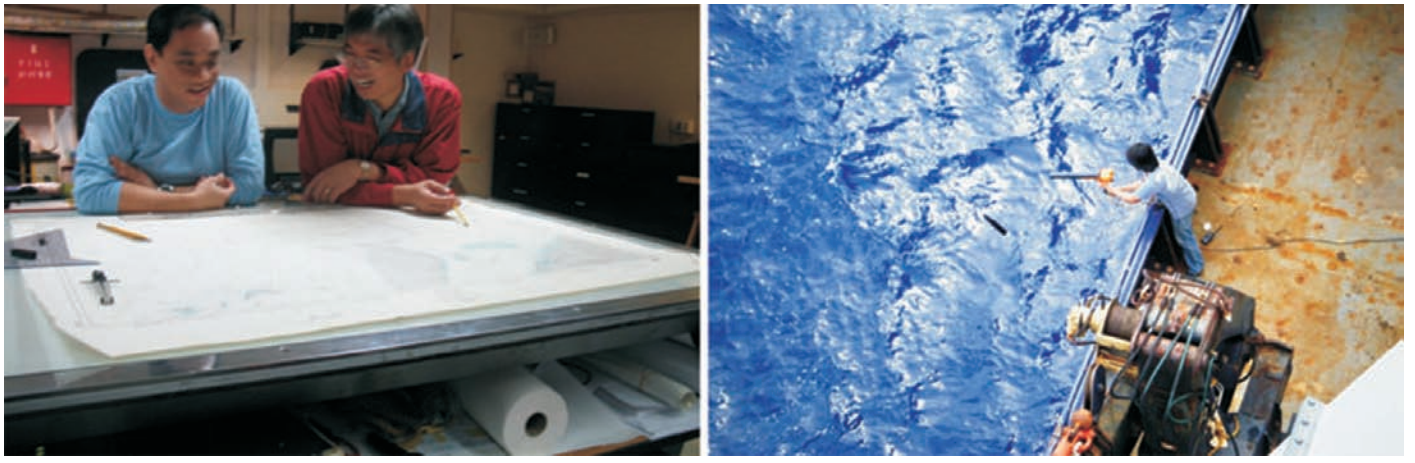


Figure 1: The Philippines-Taiwan Collaboration on Geosciences allowed for several researchers from the Philippines to participate in offshore studies that investigated the extension of the Philippine Fault Zone between the Philippine archipelago and Taiwan.

Filipino scientists participate in the TAiwan Integrated GEodynamics Research cruise

As part of the Taiwan-Philippines Geodynamics Project, researchers from the National Institute of Geological Sciences, University of the Philippines, joined their Taiwanese counterparts aboard the R/V Marcus Langseth on the 4th leg of the TAIGER (TAiwan Integrated GEodynamics Research) cruise. Multi-channel seismic reflection and bathymetric data were collected during the marine survey. Portions of the survey were conducted off the coast of northern Luzon. The offshore extension of the Philippine Fault Zone (PFZ) is one topic focused on by the current research collaboration. Preliminary results of the processed seismic data indicate active deformation (i.e. folding, thrust faulting, general uplift) that may be attributed to an oceanic prolongation of the PFZ. Future surveys are planned to gather additional data to resolve the crustal structure and deformation in this region.

For further information on research carried out in central Philippines, see the "International Research" section in this volume.

Portugal

Pedro Ferreira

Ridge-related research activities in Portugal during the last year were performed by two scientific groups: 1) EMEPC (Portuguese Task Group for the Extension of the Continental Shelf); 2) DOP (Department of Oceanography and Fisheries, University of the Azores).

EMEPC - Missions 2010

Swath Bathymetry Surveys

To improve and complement the Portuguese Continental Shelf Extension submission in the scope of UNCLOS (1982 United Nations Convention on the Law Of the Sea), the EMEPC has been carrying out systematic seafloor mapping of a significant area of the North Atlantic. During 2010, 22 effective days of survey have been performed with the Portuguese Navy vessel NRP *Almirante Gago Coutinho*. Since the beginning of the project in mid-2005, more than 1.8 million km^2 of the seafloor have been continuously mapped, corresponding to a total of 900 effective surveying days.

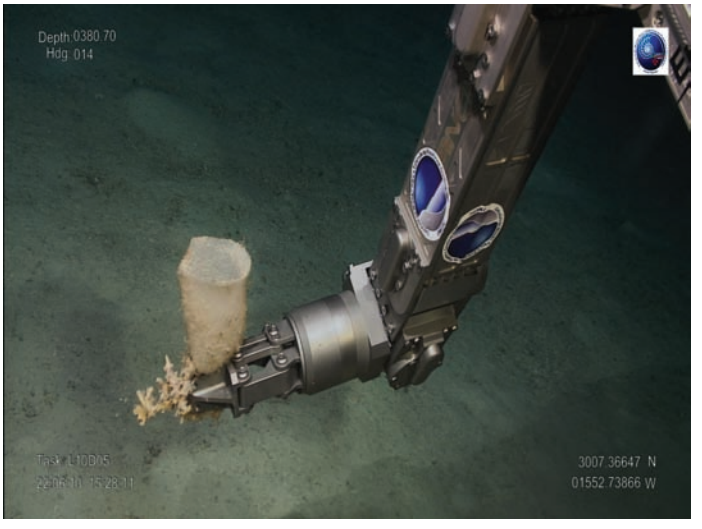


Figure 1: *LUSO* ROV image depicting a Porifera specimen sampling.

EMEPC/M@rBis/Selvagens2010

The objectives of EMEPC/M@rBis/Selvagens2010 scientific expedition were to map the marine biodiversity and to produce an annotated checklist of all the marine flora and fauna present in the Selvagens Islands. With the results thus obtained the M@rBis (Marine Biodiversity Information System) data model was tested along with all the designed outputs – a crucial step in the development of decision support systems. Moreover, the collected data will constitute the basis for future biodiversity monitoring and conservation measures. The cruise involved the participation of over 70 researchers from 35 national and international institutions and three vessels, the NRP *Almirante Gago Coutinho* (centralized ROV operations and oceanographic surveys), the NTM *Creoula*, a motor-sail vessel where all scuba-diving logistics were based to address the sub-tidal areas around the islands, and the *Vera Cruz* caravel, a 24 m long replica of the Portuguese caravels from the Maritime Discovery period. This latter vessel had a crew mainly composed of undergraduate students and teachers who were also involved in the fieldwork. To address the intertidal areas, during the expedition a base was installed on land on both Islands. As preliminary results, more than 8000 specimens were recorded corresponding to more than 1000 taxa (Figure 1). Three threatened species (*Caretta caretta*, *Megabalanus azoricus* and *Patella ulysiponensis*) and habitats (Maerl, Coral gardens and Sponge gardens) referred to in the OSPAR Convention were recorded. In addition, species considered of Community interest in the "Habitat Directive-92/43/EEC of 21 May 1992" were also found (*Lithothamnion corallioides*, *Scyllarides latus*, *Bulweria bulwerii*, *Calonectris diomedea*, *Oceanodroma castro*, *Pelagodroma marina*, *Sterna hirundo* and *Cetacea*).

EMEPC/LUSO/2010

The EMEPC/LUSO/2010 cruise was held by the EMEPC with the Navy vessel NRP *Almirante Gago Coutinho* from the 9th July-3rd August. It comprised three legs. During the first leg, *LUSO* ROV

dives were performed on the top and flanks of a seafloor high located south of the Azores, dubbed as "Fried Egg" due to its peculiar shape (Figure 2). Additionally, systematic bathymetric, gravimetric and magnetic surveys were performed over this structure and in its vicinities. Two additional structures with the same morphology were imaged during these surveys.

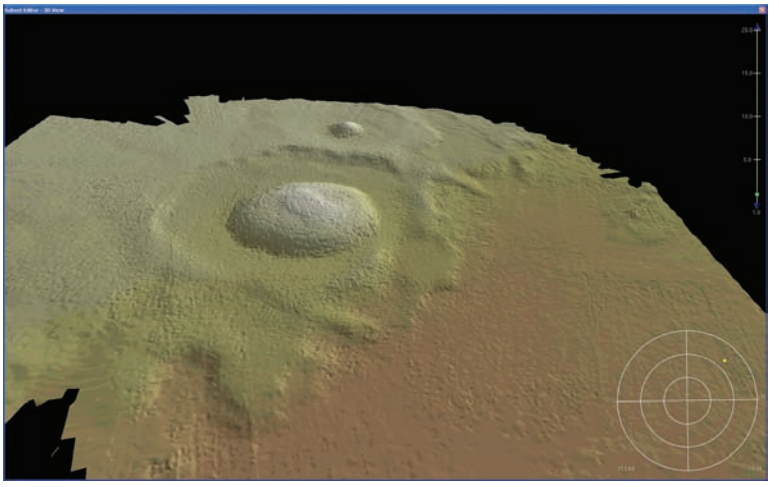


Figure 2: Shaded perspective view of the Fried Egg structure.

Leg 2 started on 19th July and lasted for 15 days, at the area comprising the Milne and Altair seamounts, both located to the west of the Mid-Atlantic Ridge, and aimed to collect geologic, biologic and water samples with the *LUSO* ROV, as well as bathymetric, magnetic and gravimetric data. Technical problems rendered the use of the *LUSO* ROV impossible during this leg. Vertical casts using a rosette system (General Oceanics 1018, coupled with an Ocean Seven 316Plus CTD multiparameter probe) were performed. High quality bathymetric data was gathered from the multibeam survey (Kongsberg, EM120), covering a navigation line with more than 1500 NM, extending from Terceira Island to the Altair and western Milne seamounts and back again to the Azores Archipelago.

Leg 3 was performed in collaboration between EMEPC, DOP and LNEG (National Laboratory for Energy and Geology), lasting from 4-14 August, on board of NRP *Almirante Gago Coutinho*. Leg 3 objectives were to map and sample benthonic communities of the seamounts southwest of the Azores Central group and to perform systematic bathymetric surveys of those areas. During this leg a total of 7 ROV dives were performed in depths ranging from 1500 m to 200 m which yielded the collection of a significant batch of geological and biological samples. A DOP mooring deployed one year ago at a water depth of 200 m was searched and its ADCP recovered as a piggyback operation.

DOP - Missions 2010

Scientific expedition DOP/UA-EMEPC-LNEG to the Condor seamount at the Azores Triple Junction took place from 5-8 August 2010, operated by the Hydrographic Institute and the ROV *LUSO*. It revealed exuberant coral gardens. The sandy areas of the seamount flanks were characterized by the presence of large aggregations of sponges and sea-urchins. An interesting observation during the deepest dives was the occurrence of the protozoa Xenophyophores, unicellular organisms that can reach 10 cm in diameter. In addition to the visual surveys, the ROV collected samples of animals, rocks, sediments and water for laboratory analyses.

Scientific cruise on N/I *Noruega* (INRB, National Institute of Biological Resources, Portugal) was undertaken on the Condor seamount at the Azores Triple Junction, from 25 Jul - 1 Aug 2010. During this cruise, organisms living on the seamount Condor have been sampled using different equipment. Fish, crustaceans and other small organisms living in the water column have been collected with an Isaacs-Kids mid water trawl net. These animals make daily vertical migrations and are visible as reflective layers using echosounders. Hydroacoustic surveys have been conducted simultaneously with net collection, to monitor the scattering layer.

The DOP research activities also included the participation of some of their scientists in the following missions:

- Mission MenezKArt To Menez Gwen with RV *Poseidon* and ROV *Cherokee*. PI Christian Borowski; 1-10 August 2010.

- Mission MenezMAR to Menes Gwen with RV *Meteor* and ROV *QUEST*. PI Nicole Dubilier; 5 Sept-11 Oct 2010.

- Mission MoMARSAT to Lucky Strike with RV *PourQuoi pas?* and ROV *Victor*. PI Pierre Marie Sarradin; 1-16 Oct 2010.

For the next year, the Group will participate in the MoMARSAT Cruise.

News has also come in about investigations led by Portuguese scientists from the University of the Azores and from the Advanced Service Unit (DNA sequencing) at Biocant (www.biocant.pt). These have been focusing on the sequence and analysis of the gill transcriptome from the deep-sea vent mussel *Bathymodiolus azoricus* and have now been reported in a recently published article in the BMC Genomics journal. The article entitled "High-throughput sequencing and analysis of the gill tissue transcriptome from the deep-sea hydrothermal vent mussel *Bathymodiolus azoricus*" describes the establishment of the **DeepSeaVent** database (http://www.biomedcentral.com/1471-2164/11/559/abstract), a fully searchable and sequence-retrievable collection of more than 75000 cDNAs from *B. azoricus*. The article also discusses the efficacy of using 454 sequencing technology to analyze the transcriptome of *B. azoricus* and to put in evidence genes involved in stress and immunity, focal research topics involving deep-sea vent mussels, at the IMAR institute in the Azores.

Russia

Sergei Silantyev

Russian ridge cruises in 2010

1. In May-August the R/V *Professor Logachev* went to the Mid-Atlantic Ridge Axial Zone, (19º15´- 20º05´N) where two new ore deposits were discovered on the hydrothermal field "Zenith-Victory" (20º07.75´N, 45º37.35´W). A new, previously unknown hydrothermal field has been discovered at MAR, 19°52´N, 45°52´ W, where dredging yielded ore samples characterized by copper mineralization. R/V *Professor Logachev* will operate during 2011 in the MAR area near the recently discovered hydrothermal field "Semenov" (13º31´N).

2. R/V *Akademik Nikolai* led continued investigations of the North Barents Sea and adjacent Arctic Basins, including the western continental slope of the Arctic Ocean.

3. R/V *Akademik Boris Petrov* carried out multidisciplinary investigations of the central part of the Indian Ocean under an agreement between the Vernadsky Institute RAS and Ministry of Earth Sciences, India.

Conferences and workshops

The joint international conference "Minerals of the Ocean-5" and "Deep-Sea Minerals and Mining-2" organized by VNIIOkeangeologia (Russia), RWTH-Aachen and Berlin Free University (both Germany) was held on 28 June-01 July, 2010 in VNIIOkeangeologia (St.Petersburg, Russia). 50 participants from Russia, Germany, Brazil, Great Britain, China, Korea, Taiwan, Norway and Jamaica made presentations at four sessions: Ferromanganese nodules and crusts, Hydrothermal deposits, Gas hydrates and Sea technology.

The biennial workshop of Russian-Ridge will be held in Moscow during summer 2011, the topic being: "Main Results in Russian Study of the Mid-Oceanic Ridge Processes in First Decade of XXI."

UK

Tim Henstock

2010 has seen a relatively large number of ridge-related cruises from the UK, with much of the programme of the RRS *James Cook* being dedicated to these projects.

In January and February JC042 (PI A. Rogers) carried out sampling around hydrothermal vent sites in the East Scotia Sea using the *ISIS* ROV; this was the second of three cruises funded within the ChEsSo consortium programme, with the final cruise of the series due to go to the Bransfield Strait in early 2011.

JC044 (PI D. Connelly) to the Mid-Cayman Rise spreading centre collected swath, deep-towed sidescan data using TOBI, and water column measurements using *Autosub6000* and CTD casts. These enabled the use of *HyBIS* to locate and sample hydrothermal vent systems at depths of up to 4960 m (http://www.thesearethevoyages.net/). A later cruise will use the *ISIS* ROV to further characterise these systems.

JC048 (PI M. Priede) which ran throughout June, was the last of four cruises funded as part of the ECOMAR consortium programme which used the *ISIS* ROV to sample the ecosystems

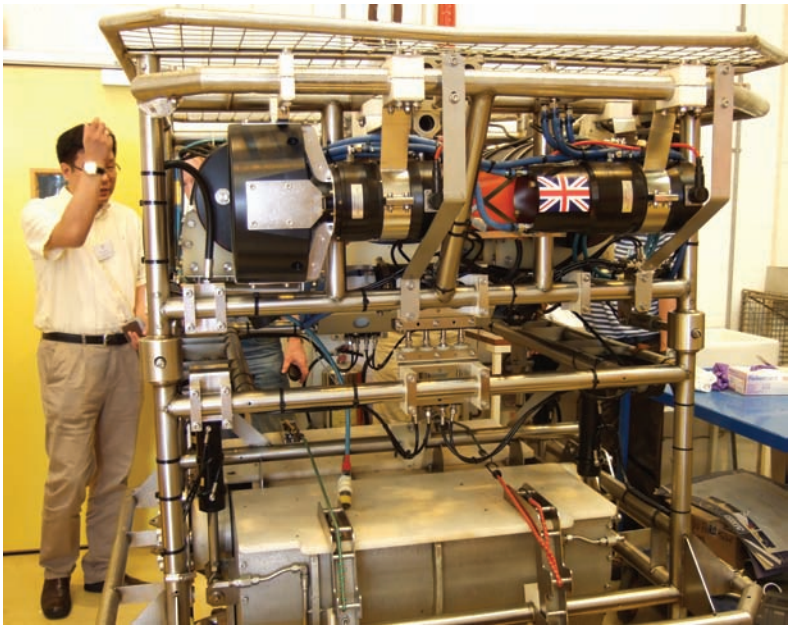


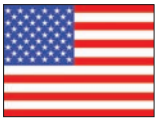
Figure 1: *HyBIS* (Hydraulic Benthic Interactive Sampler) designed for targeted sampling of the seabed, at depths down to 6000 m.

around Charlie Gibbs Fracture Zone. This feeds into the Census of Marine Life MAR-ECO study of ecological systems along the Mid-Atlantic Ridge.

JC050 (PI N.White) was a four-week cruise which collected seismic reflection and underway geophysics transects running along flow lines between the Hatton Bank and East Greenland continental margins to study the V-shaped ridges south of Iceland. The data from this cruise will be used to support an IODP drilling proposal focused on studying fluctuations in the effect of the Iceland plume both on the ridge axis and ocean circulation.

There have also been some longer-term developments. The AUV *Autosub6000* has been proved in depths of more than 5600 m, with enhancements including the ability to carry out surveys at altitudes of as little as 3 m above the seabed. Its scientific potential was demonstrated during JC044. In addition, the programme to replace RRS *Discovery* has survived the first round of expenditure review of the new government, and the new ship (also to be called *Discovery*) is projected to enter service in 2014.

USA



Dan Fornari

Introduction

The U.S. Ridge 2000 (R2K) program aims to answer key questions pertaining to fundamental processes that control biological, chemical and geological phenomena at oceanic spreading centers using observational, experimental and modeling data derived from the past few decades of research on mid-ocean ridges (MORs). The program has completed many successful coordinated field campaigns and shore-based research projects, resulting in the publication of a large volume of scientific papers spanning many subjects (see below for reference database). The program focus now is to synthesize the accumulated knowledge and data from the past decade of field and laboratory efforts, and decades of allied research, into widely accessible published products that highlight the progress in understanding questions pertaining to earth/ocean phenomena associated with crustal generation and the linkages between physical, chemical and biological processes at MORs. Synthesis of these multidisciplinary data sets yields new insights into oceanic spreading center processes, impacts multiple related research fields, and paves the way for new scientific directions that will extend our knowledge of fundamental earth-ocean processes.

R2K Community Meetings and Commitment to Achieving Program Goals

The role of community meetings, such as the 2010 R2K Meeting held in Portland, OR (Oct 29-31, 2010), is to bring the PIs of all disciplines together face-to-face after they have had a chance to begin interactions, to give them the opportunity to have focused, multi-day discussions, set strategies and schedules for producing their group products, and to learn about the work of other groups, including topics they are addressing, and to explore successful collaboration modes. The community meeting is a means to an end, rather than a specific, fixed time frame to accomplish this synthesis effort. The meetings serve as an impetus for the community to continue on the path that will lead to fully capitalizing on R2K research to date; synthesizing and integrating information to achieve a more complete knowledge of MOR processes.

R2K and Related Cruises

U.S.-led MOR cruises in the past year included several related cruises to the Galapagos Spreading Center (Sinton et al. – RV *Atlantis* – April 2010; GRUVEE cruise website: http://www.gruveecruise.org/GRUVEEducation/Home.html) and Northern Galapagos area (Harpp et al. – RV *Melville* – May-June, 2010). Four cruises went to the Juan de Fuca Ridge between July and October (PIs R. Lee, M. Tivey, M. Lilley – 6-26 July; J. Delaney, R. McDuff – 26 Jul-23 Aug; W. Chadwick, J. Huber – 26 Aug-07 Sept; M. Best, R. Light – 11 Sept-3 Oct). U.S. scientists also participated on cruises led by other InterRidge Member nations, such as Japan (YK10-11 in the southern Mariana back-arc region; cruise blog: http://ventlarvae.blogspot.com/) and France (MESCAL cruise to the East Pacific Rise).

Distinguished Lecturer Series

The R2K Distinguished Lecturer Series (DLS) in 2010 featured Suzanne Carbotte, Matt Schrenk, Bill Seyfried and Adam Soule. In 2011 the invited speakers are Anna-Louise Reysenbach, Ken Rubin, William Strickrott and Brandy Toner. For venues and titles of lectures, visit: http://www.ridge2000.org/dls/speaker_list.php.

Reference database at R2K data portal launched in July 2010

A significant effort was made this year to consolidate R2K references and integrate them within the primary database maintained by the R2K Data Management Office (DMO). This effort included the development of a script by Lamont-Doherty Earth Observatory (LDEO) staff (Ferrini) to harvest reference information off the R2K website, so the information could be

standardized and reformatted by WHOI staff (Govenar, Beaulieu, Moore). Where possible, WHOI staff also gathered award, cruise, and focus site information for each reference. Modifications were then made to the Marine Geoscience Data System (MGDS) database backend, and reference information was integrated into the data system. A new searchable reference page (http://www.marine-geo.org/portals/ridge2000/references.php) was then developed by LDEO staff (Leung, Ferrini) and launched on the R2K Data Portal page to provide access to the new reference database. This page also provides direct access to data sets and cruise information, as well as options to save references in EndNote format. Updating the reference database is an ongoing project, and a new webform developed by LDEO staff (Ferrini) to facilitate this process will be launched in the coming weeks.

Ridge 2000 Education & Outreach

FLEXE (From Local to Extreme Environments) is part of the GLOBE (Global Learning and Observations to Benefit the Environment) program, which aims to promote understanding of local and deep-sea environments, the interconnectivity of the Earth system, and scientific methods. Access to a range of exciting educational materials, including interactive projects, is at: http://globe.gov and http://flexe.psu.edu.

Working Group Updates

Deep Earth Sampling

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

After a rather active year in 2009, the Deep Earth Sampling (DES) WG continued into 2010, to follow-up on the 2009 MMFL and INVEST workshops. Several key objectives were common to both reports, including:

- the MoHole, i.e. a full crustal penetration to the Moho and into the uppermost mantle,
- addressing crustal ageing and lithosphere/hydrosphere exchanges through drilling transects,
- ultramafic seafloor, including serpentinite-hosted hydrothermal systems, and CO_2 capture and storage through carbonation,
- subseafloor resources (including deep seafloor volcanogenic hosted massive sulfide deposits).

The Scientific Plan for the next phase of the scientific drilling program, to follow IODP in 2013, is currently being written by an international group of experts chaired by Michael Bickle (Cambridge University, UK).

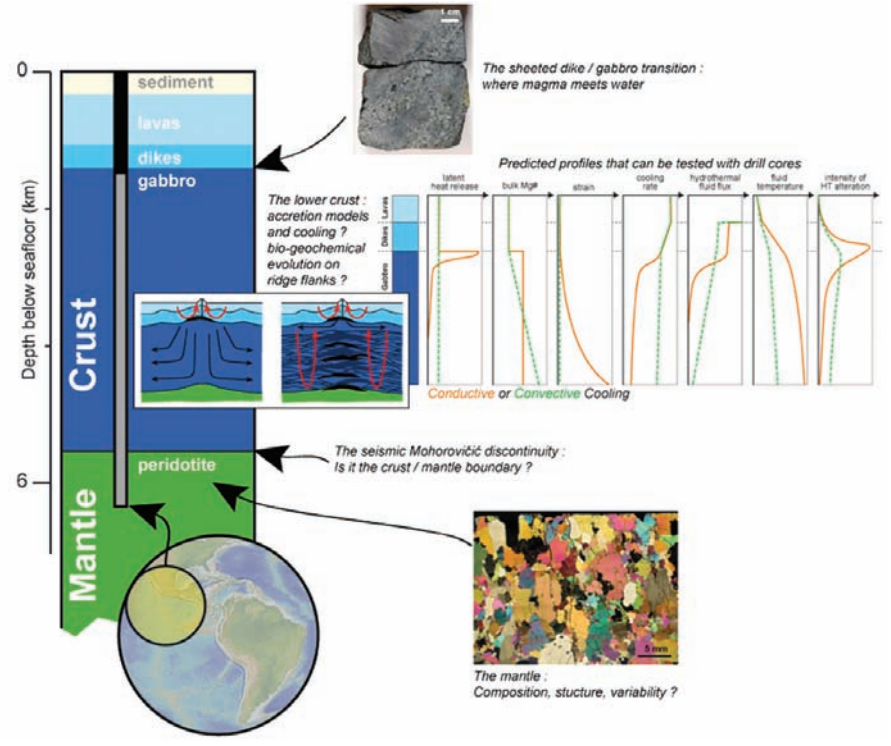


Figure 1: The mantle/crust boundary (Image courtesy of B. Ildefonse).

The MoHole: a Crustal Journey and Mantle Quest

In 2010, InterRidge co-funded the MoHole workshop organised in June in Kanazawa, Japan : http://earth.s.kanazawa-u.ac.jp/~Mohole/index.html, in continuation of the science planning discussions that took place in 2009 and during the earlier Mission Moho workshop in 2006 (http://www.iodp.org/mission-moho-workshop/). The 2010 MoHole workshop had two interconnected objectives, which have been discussed jointly between ocean lithosphere specialists, marine geophysicists and engineers:

• to initiate a roadmap for technology development, and the project implementation plan, which are necessary to achieve the deep drilling objectives of the MoHole project;

• to identify potential MoHole sites in the Pacific (i.e., in fast-spread crust), where the scientific community will focus geophysical site survey efforts over the next few years. Selecting drilling sites is essential to identify the anticipated range of water depths, drilling target depths, and temperatures, and better define the technology required to be developed and implemented to drill, sample and geophysically log the MoHole. The full workshop report is available at: http://mohole.org

In 2009, following a meeting of the working group in December 2008 in San Francisco, a motion was sent to the IODP Science Planning Committee (SPC) Chair to re-state the importance of returning to IODP Hole 1256D as a short-term community priority. The bottom of Hole 1256D currently resides in the vari-textured gabbros of the transition zone between the sheeted dyke complex and the underlying cumulate gabbros. The next IODP expedition to Site 1256, to deepen Hole 1256D and penetrate into the cumulate gabbros, is now scheduled for Apr 14 - June 4 2011 (http://iodp.tamu.edu/scienceops/expeditions/superfast_rate_crust.html).

As a manifestation of the increased interest of the geomarine community for the ultramafic seafloor, aka "serpentinite sea", it is worth noting the recent submission in 2009 of a

drilling proposal that presents a plan to drill and core the Atlantis Massif using a seabed, shallow drilling/coring device. Objectives of this proposal (IODP proposal #758, by G. Früh-Green et al.; http://www.iodp.org/index.php?option=com_docman&task=doc_download&gid=2837) are to:

• quantify the role of serpentinization in generating H_2- and hydrocarbon-rich fluids, in driving hydrothermal systems, and in sustaining microbiological communities, and the potential for carbon sequestration in ultramafic rocks,

• understand the linkages among detachment faulting, abiotic and biotic processes, and hydrothermal circulation in young mafic and ultramafic seafloor, and determine how these change with age and rock type,

• characterize tectono-magmatic processes that lead to lithospheric heterogeneities and the evolution of hydrothermal activity associated with detachment faulting.

The InterRidge Steering Committee in 2010 recognised the work that has been achieved by this Working Group and thanked Members for their efforts. The WG will now be disbanded.

Hydrothermal Energy and Ocean Carbon Cycles

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

First meeting: where are we, and where are we going?

Hydrothermal systems have been studied for 35 years now, but the issue of their impact on global-scale ocean biogeochemistry remains to be adequately addressed. Rather, vent ecosystems are often described as being largely independent of the rest of the biosphere, but the extent to which they are inter-connected with the photosynthetic world still needs to be assessed. One way of considering this question is to consider the service that is provided by hydrothermal systems to the ocean as a whole. The aim of our first Working Group meeting was to discuss the most relevant strategies to address this objective and to clarify the expected outcomes, while discussing science plans and opportunities arising in partnership with various other initiatives such as GEOTRACES (SCOR), IODP and the Japanese programme TAIGA.

The first meeting of our Working Group, which is co-sponsored by SCOR as their WG 135, was held in Woods Hole 23-24 Nov 2009. Among WG members, Wolfgang Bach, Loka Bharathi, Nicole Dubilier, Katrina Edwards, Chris German, Peter R. Girguis, Xiqiu Han, Julie Huber, Nadine Le Bris, Louis Legendre, Stefan Sievert and Andreas Thurnherr were present. George Luther and William Seyfried joined the discussion via teleconference on Nov. 24th. Ken Takai, Françoise Gaill, Toshitaka Gamo & Meg Tivey were not able to attend but Jian Lin (as InterRidge Chair) and Stace Beaulieu (as InterRidge Coordinator) both attended the meeting and Ed Urban (SCOR Executive Director) also joined us via Skype on Nov. 23rd.

Discussions at the meeting led us to identify the following key questions that still need to be answered:

- Can we estimate the fraction and nature of carbon exported from vent-sites to oceanic ecosystems (inorganic and organic carbon, including methane)?
- How much microbial biomass is trapped in the subseafloor?
- How do the microbes that live within the crust affect the carbon balance of the overlying ocean?
- Beyond carbon, what other hydrothermally affected elements are likely to have a significant impact on ocean biogeochemistry?
- Recent estimates have suggested that 10-25% of all dissolved Fe in the deep ocean may be hydrothermally sourced, but how much impact do vents have on other trace metals that can also act as micronutrients – e.g. nickel, which is known to be important in enzymes?
- Conversely, the link between hydrothermal biogeochemical systems and the photosynthetic world can also be addressed by asking questions that consider the reverse order. For example: how much of the life at vents depends on a well-oxygenated ocean to function?

Our aim is to engage a broad community in this work and, concurrently, to help shape the future direction of submarine hydrothermal research. Key goals identified include:

1. To constrain micronutrient hydrothermal fluxes and their influence on ocean productivity.
2. To assess the productivity of seafloor and subseafloor vent ecosystems and their dependence on oceanic processes.
3. To estimate the extent of methane export, and of new DOC and POC production and export from seafloor hydrothermal systems and how these fluxes may influence deep water ecosystems.

Future plans

We have extant data in hand, although they are patchy. Consensus was met that the first aim of the Working Group should be to draft several review papers, together with a shorter paper that will capture key concepts and present them in an accessible form for a broad ocean science community, in advance of – and to set the scene for - an international community workshop in 2012. The main goal of these papers will be (i) to provide a basis from which to explain why

we think these systems are important to study in a broader oceanographic context and (ii) to help establish what new approaches are needed to progress in this field. Starting with the best-studied hydrothermal sites known, our framework will be to summarize existing knowledge on these three questions:

- What are the important processes active in the system?
- What missing information do we need to determine mechanisms and rates?
- Where are the gaps and what new measurements are needed?

Other relevant and related activities in 2010

- At the June 2010 Goldschmidt conference, WG members Bill Seyfried and Wolfgang Bach organized the session: Theme 5: Evolution of Oceanic Crust and its Hydrothermal Systems; Brandy Toner organized: Theme 15 Geomicrobiology of Mid-Ocean Ridge Systems.
- In early June, the Steering Committee of the US GEOTRACES Program identified a pan-SE Pacific section as their next highest priority after completion of this year's Trans-Atlantic section.
- Also in June 2010, Colin Devey and Chris German convened a complementary community-wide meeting based upon their IR Long-Range Exploration WG (see following report in this section).

Agenda for 2011-2012

The most important date for 2011 will be the second Working Group Meeting. Xiqiu Han has offered to host this meeting at the 2nd Institute for Oceanography, in Hangzhou, China. This meeting will be important to allow us to plan more thoroughly for the community-wide workshop for this WG that will be held in Europe in May/June 2012.

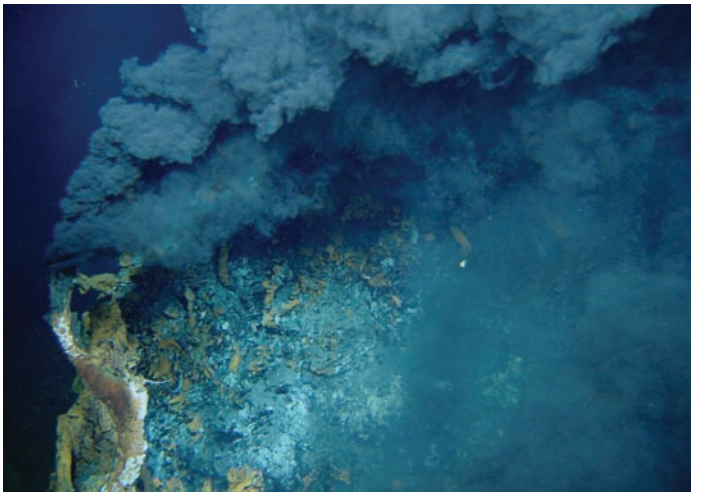


Figure 1: Hydrothermal venting and chemosynthetic communities on the East Pacific Rise. Copyright Ifremer/PHARE2002.

In the USA it is also anticipated that a community meeting to prepare proposals for the US GEOTRACES Cruise to investigate the SE Pacific Hydrothermal Plume will be held in June 2011 for a cruise to be targeted for Austral Summer 2012-13.

To sustain momentum between now and 2012, we also propose related special sessions at one or more major international conferences in the interim. For example, the WG Co-Chairs are currently proposing a dedicated special session for the next Goldschmidt Conference to be held in Prague, 2011.

Long Range Exploration

Chair - Colin Devey (IFM-GEOMAR, Germany)

The Long Range Exploration Working Group (LRE WG) held an international workshop on 28-30 June 2010 at the National Oceanography Centre, Southampton, UK. Approximately thirty ocean scientists and engineers met to discuss how to make significant advances in ridge exploration in the near future. One initial driver for this was the recent advances that have been achieved in AUV technology and the extent to which these could enable new modes of ridge-crest exploration. The meeting started with presentations on the state of knowledge in the various scientific and technological fields. This was followed by disciplinary breakout groups (Geology; Biology/Hydrothermal fluids/Oceanography; Geotectonics) to identify the most important science drivers. The definition of "long-range" was unclear - for questions of species genetics, for example, separations of 2-4 km might allow total genetic exchange and mixing while separations of 2500 km lead to genetic isolation. Seafloor geology, on the other hand, sees length scales longer than a ROV dive as being essentially "long-range" and as yielding important new insights. The result of this mismatch in definitions led to a primary division in the workshop outcome - the seafloor geologists (with the support of a subset of biologists, hydrothermal fluid scientists and geophysicists) felt that the most compelling science could come from a comprehensive visual survey of a first order ridge segment. Another group concentrated on the more long-range exploration on a global scale.

On the final day, the workshop participants met in plenary to reach a consensus on those areas of the global ridge-crest that should be rated as of highest priority, across multiple disciplines, for future

global exploration. From a list of 20 sites nominated by at least one disciplinary group, a list of the top 5 sites was compiled. The matrix is shown in Figure 1.

	Geotectonics	Hydothermal	Phys Oc	Biology	Geology	Astrobio.	Off-Áxis Volc.	Hits
Gakkel Ridge			√	√		√		2
Knipovich Ridge	(√)	√	√	√				1
Reykjanes Ridge		√		√	(√)			
Chralie Gibbs FZ	√	√	√	√	√	√		1
MAR N.Az				√				
EqAtl Fracture Zones	√	√	√	√		√		5
Sth MAR 15-35S	√	√	√	√	√			3
Sth MAR 35-55S	√√	√	√	√	√			1
Oblique SWIR (0-10E)		√	√	√				1
SWIR (20-30E)	√	(√)	(√)	√	√			1
SWIR (60E)		√		√				1
Central Indian Ridge	√	√	√	√	√		√	2
Carlsberg Ridge		√	√	√				1
Red Sea		√	√	√		√		1
Andaman Sea	√	√		√√				1
SEIR (80-130E)			(√)	√				
AAD*	√	√		√√				2
Macquarie TJ*	√	√	√	√	√	√		1
Sth Marianas Trough	√ (S3)	√		√				
PacAntRidge (Nth of Polar Front)				√				
Pac-Ant Ridge (Sth of Polar Front)			√	√				
Southern EPR (14S and below)		√		(√)	√		√	1
Bransfield Strait	√ (S3)	√	√	√	√			
East Chile Rise	√ (S3)	√		√	√			2

Figure 1: Matrix of geographic areas of interest to 7 sub-disciplines represented among the workshop participants. Areas of interest to any sub-discipline were first captured by ticks and each disciplinary group was then asked to assign highest prioritisation to 5 key areas (yellow higher, pink lower). Double ticks were used by some disciplines to mark those areas which were also deemed highly interesting although not in that group's "Top 5".

Summary outcomes of the workshop

Segment Scale Studies (S3): It quickly became clear that the technology (especially AUV) is now available to consider conducting total coverage studies of the seafloor at the first-order segment scale (length n x 100km). The science drivers for this type of study are very strong across a range of disciplines but the resources it will require are significant, confirming that there is a need for InterRidge involvement, coordinating the resources of more than one nation to conduct the work and meaning that the area to be studied needs to be picked with care. Because this is beyond the scope of the current "Long-Range Exploration" working group, we recommend to the InterRidge Office and Steering Committee that the possibility of establishing a new working group focusing on this problem and running a workshop specifically to address segment-scale studies (photographic mapping of axial valley and flanks) be investigated.

Global Exploration (GE): Main science drivers for global exploration are questions of vent biogeography, variations in fluid compositions in different or novel tectonic and geological situations and questions of tectonic evolution and functioning of the spreading axes. Our workshop identified 20 future targets for GE activities and prioritized the first 5 of these. These highest-priority targets have a global distribution and will attract multi-disciplinary scientific interest. It is clear that continuing international coordination will be required to bring the envisaged research to fruition.

Technological readiness: A range of autonomous underwater vehicles is now available at academic institutions around the world - these vehicles will play a key role in many LRE endeavours. Other key equipment is also required, however, including ship-based multibeam mapping, CTD, ROV & HOV capabilities. The most technologically challenging aspect of the work, multi-AUV deployments, is judged to be possible and vehicle reliability, although still an issue, is no longer seen as an insurmountable barrier.

The full report is available at:
http://www.interridge.org/files/interridge/LREWG_Report_Final_web_0.pdf

Figure 2: Discussion during the LRE workshop.

Mantle Imaging

Chair – Nobukazu Seama (Kobe University, Japan)

In 2010, we convened a session at the EGU meeting, the title being: "Melt generation to crustal formation beneath mid-ocean ridges" and we had 12 abstracts. However, we merged to make an oral session entitled: "Two-phase dynamics of mid-ocean ridges and other systems: theory and observation". Whilst there were not many abstracts, the session itself attracted a lot of interest. Activities for 2011 are currently under discussion.

Seafloor Mineralisation

Chair – Maurice Tivey (WHOI, USA)

Following the first meeting of the Seafloor Mineralisation Working Group in Spring 2009 at WHOI, USA (reported in InterRidge News 2009), three recommendations have been developed this year.

i) Mark Hannington submitted a proposal to International Seabed Authority (ISA) to update a technical database on seafloor vent deposits. That proposal was funded by ISA and submitted to ISA in December 2009. A portion of the database was ported to the InterRidge database by Stace Beaulieu. It was considered advantageous to have ISA work with InterRidge to maintain updates to the database. New discoveries are made all the time (e.g. Cayman) and it behoves the ISA to have the latest information when making decisions on seafloor leases.

(ii)The SMWG recommended that a workshop be convened to determine guidelines for the design of Marine Protected Areas and Reserves for hydrothermal settings. This workshop – "Design of Marine Protected Areas for Chemosynthetic Ecosystems Potentially Threatened by Human Activities in the Deep Sea" – chaired by Cindy van Dover and Craig Smith took place in Dinard, France, during June 2010. For more details about this workshop, please see the article in the "Workshops and Conferences" section of this volume.

iii) The SMWG recommended that more formal ties be initiated between United Nations environmental program (UNEP) and InterRidge in terms of outreach to small nations lacking scientific infrastructure to gauge their seafloor resources. Yannick Beaudoin of UNEP/GRID-Arendal has initiated this connection. For more details about this liaison, see the article in the "Education and Outreach" section of this volume.

Other activities included hosting two visits to Woods Hole by Ian Stevenson of Nautilus Minerals. Maurice Tivey was an invited keynote speaker at: The New Gold Rush: Seafloor Hydrothermal Research and Marine Mining, Geological Assoc. Canada Spring meeting, St John's, Newfoundland, Canada, Feb 22, 2010. An article stemming from the 2009 workshop and colloquium was published in Marine Policy. Ref: Hoagland, P., S.E. Beaulieu, M.A. Tivey, R.G. Eggert, C.R. German, L. Glowka and J. Lin, Deep sea mining of seafloor massive sulfides, Marine Policy, 34, 728-732, doi:10.1016/j.marpol. 2009.12.001, 2010.

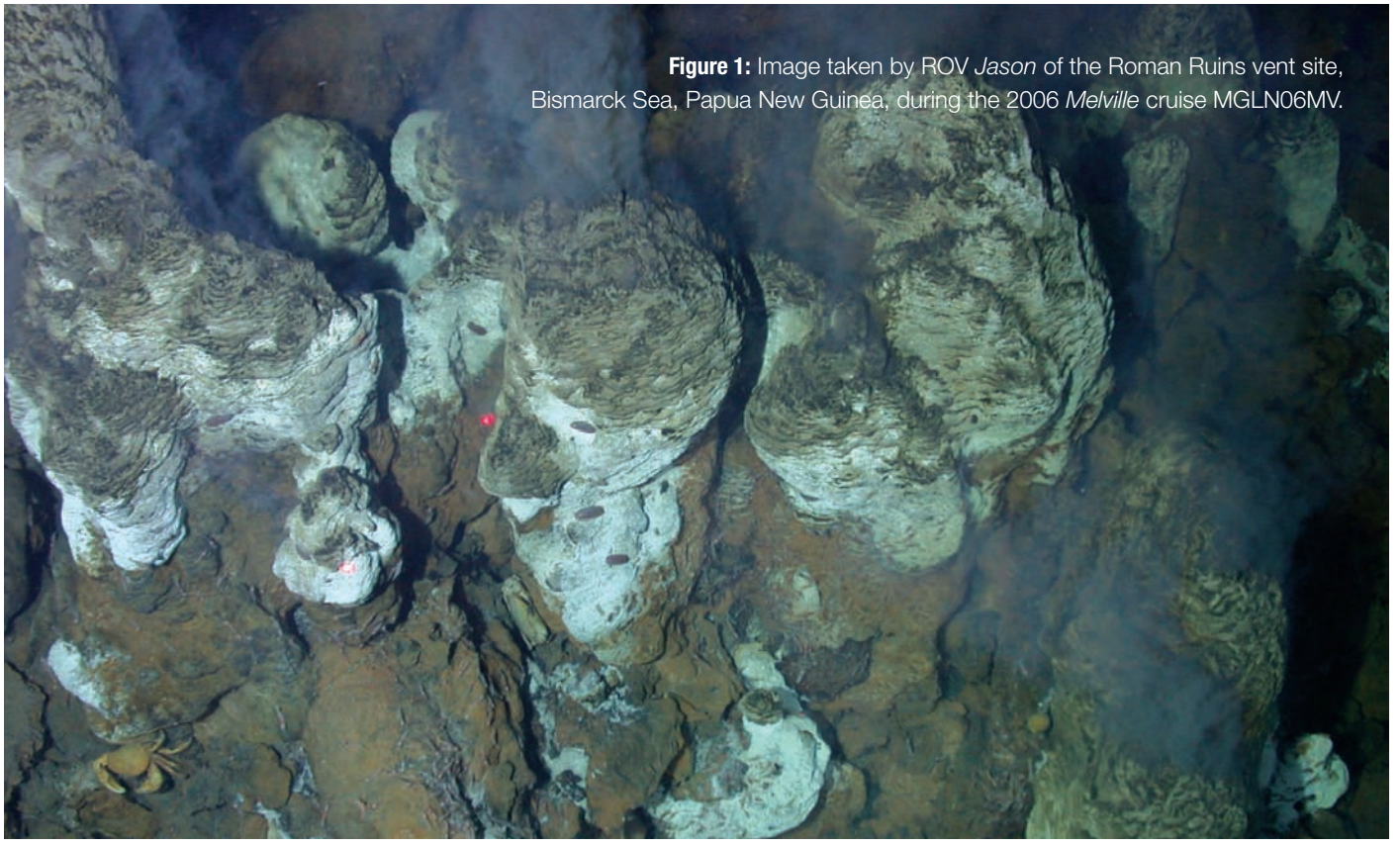


Figure 1: Image taken by ROV *Jason* of the Roman Ruins vent site, Bismarck Sea, Papua New Guinea, during the 2006 *Melville* cruise MGLN06MV.

Vent Ecology

Chairs – Stephane Hourdez (Sta.Biol. Roscoff, France) and Yoshihiro Fujiwara (JAMSTEC, Japan)

As no major meeting of general interest to the deep-sea hydrothermal vent ecology and biology community was organized this year, the Vent Ecology WG has mainly been interacting at distance, through the internet.

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. The initial interactive list of these projects has been made available to all on the InterRidge website (http://www.interridge.org/highthroughput) that was originally set up by Stace Beaulieu (InterRidge Coordinator in Woods Hole). The goals are to avoid duplicating efforts, encourage common projects, and facilitate communication between groups interested in such approaches. This has been going on for nearly two years now, a good number of projects have been posted and we encourage people to add their projects to the list (http://www.interridge.org/node/add/highthrough put).

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"). The goal here is to minimize the impact of biological sampling by sharing the samples already collected. We hope this will 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. The WG will be working on this in the upcoming year.

Future of the ChEss database

ChEss is part of the Census of Marine Life program that ends in 2010. ChEss and the biology/ecology scientific community working at hydrothermal vents have been actively participating in ChEss activities. Although the ChEss database "ChEssBase" is integrated with the Ocean Biogeographic Information System (OBIS), there were concerns as to whether ChEssBase will be kept updated. ChEss coordinators are actively working on this subject.

Meetings

CAREX Strategic Roadmap Workshop (18-20 November 2009, Ostende, Belgium).

The EU-funded Coordination Action for Research Activities on life in Extreme Environments (CAREX) has held a series of workshops over the past two years. Although this deals with research at the European level, representatives from the US were invited. The biology and ecology of hydrothermal vents occupies an important place in the CAREX program. The CAREX Strategic Roadmap workshop aimed to develop a synthesis of the outcomes from three previous workshops (Identification of model ecosystems, of the necessary technology platforms and infrastructures, and of model organisms in extreme environments) and produce a strategic report addressing both future European research priorities in extreme environments and the technological developments needed to facilitate the research. The outcomes from this meeting will be published and distributed to national and European level funding bodies, including the European Research Council. This will be an important document in advancing the development of a coordinated European capability in extreme environment research.

The 8th International Congress on Extremophiles was held in Sao Miguel, Azores, Portugal, September 12-16 2010.

Figure 1: Eelpout (*Thermarces cerberus*), amongst tubeworms (*Riftia pachyptila* - the larger of the two - and Tevnia jerichonana), with crabs (*Bythograea thermydron*) and limpets (*Lepetodrilus elevatus*) on the *Riftia* tubes in the background. Image courtesy of Emory Kristof – National Geographic Photographer, Richard A. Lutz and Woods Hole Oceanographic Institution.

Workshops and Conferences

Alpine Ophiolites and Modern Analogues (AOMA)

Parma, Italy; September 30-October 2, 2009

Conveners: Alessandra Montanini[1], Giovanni B. Piccardo[2], Riccardo Tribuzio[3]

The ophiolitic bodies from the Western Alpine belt are lithosphere remnants of the Western Tethys basin which developed in Middle to Late Jurassic, in conjunction with the opening of the Central Atlantic Ocean. Structural and compositional features of the ophiolitic sequences attributed to marginal domains of the Western Tethys basin are similar to those of the non-volcanic continental margin of Western Iberia, whereas the Alpine ophiolitic bodies from the inner domains display structural and compositional similarities to modern slow- and ultraslow-spreading ridges. The Western Tethys ophiolites therefore represent an excellent laboratory for the study of rift and accretion processes which led to inception and evolution of slow-ultraslow spreading ridges.

The AOMA workshop aimed to collect multidisciplinary contributions on continental rifting and formation/evolution of oceanic basins recorded by ophiolites and modern oceanic lithosphere, bringing together scientists from the ophiolite, slow and ultra-slow spreading ridge and margin communities.

The workshop, co-sponsored by the Italian universities of Genova, Parma, Pavia and by the Working Group on Mediterranean Ophiolites, Italian Groups of Petrology (GNP) and Structural Geology (GIGS), was held in Parma (Italy), from September 30 to October 2, 2009.

A total of 85 participants from nine European countries, USA, Canada, Japan and New Zealand attended the workshop. The meeting consisted of three days of oral/poster presentations and two field excursions to the Ligurian ophiolites (Northern Apennines) and Lanzo Peridotite Massif (Western Alps). Keynote talks were given by Enrico Bonatti, Henry J.B. Dick, Benoit Ildefonse, Gianreto Manatschal, Othmar Müntener, Giorgio Ranalli and Brian Tucholke. The main topics included:

- evolution and modification of continental lithosphere during rifting,
- depletion/refertilisation events and melt trapping in the oceanic peridotites,
- mechanisms and timing of melt emplacement.

Paired investigations on Alpine ophiolitic sequences and on modern slow, ultraslow and amagmatic ridge segments have offered a novel and stimulating approach to increasing knowledge of these processes.

The two-day excursion on Ligurian ophiolites illustrated the relationships among mantle peridotites, gabbroic intrusives, basalt flows and sedimentary material in an intraoceanic domain of the Western Tethys basin. These ophiolites include morphological highs made of gabbroic plutons intruded into mantle peridotites, bearing close compositional and structural resemblance to modern oceanic core complexes (e.g. Atlantis Massif and Kane Megamullion), as well as sequences similar to some magma-starved sections of the Mid-Atlantic Ridge.

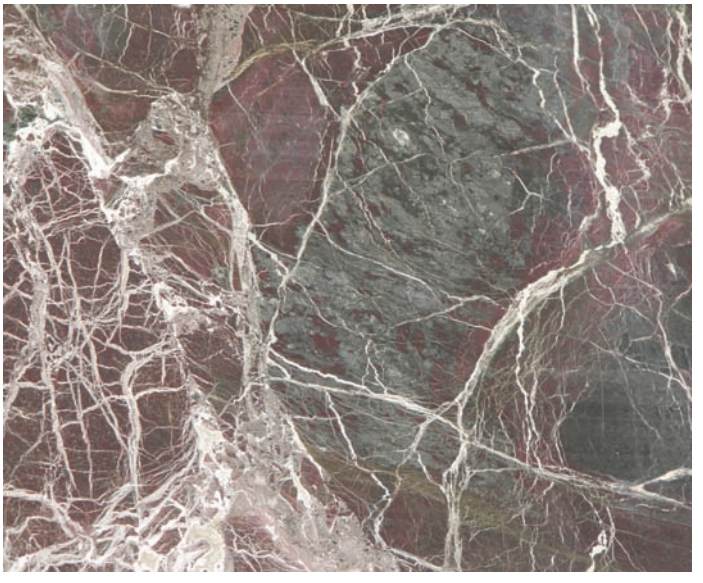


Figure 1: Mantle "ophicalcites" from Ligurian ophiolites. (Image courtesy of Riccardo Tribuzio, Dipartimento di Scienze della Terra, Università di Pavia, Italy).

[1]Dipartimento di Scienze della Terra, Università di Parma, Italy; [2]DIPTERIS, Università di Genova, Italy;
[3]Dipartimento di Scienze della Terra, Università di Pavia, Italy.

Field, petrologic and geochemical heterogeneities in fresh mantle rocks exposed at the sea-floor of the basin have been shown during the post-meeting field trip on the Lanzo massif, where the peridotites record a complex history of melt-rock interaction induced by porous flow percolation of asthenospheric melts related to rifting and oceanisation stages.

Abstract volume and field trip guides are available at: http://www.alpineophiolite2009.org

Publication of a Lithos thematic issue on the topics discussed at the workshop is planned for the end of 2010.

Figure 2: Shearing foliation at low angle with respect to the igneous layering of the gabbro (Ligurian ophiolite).

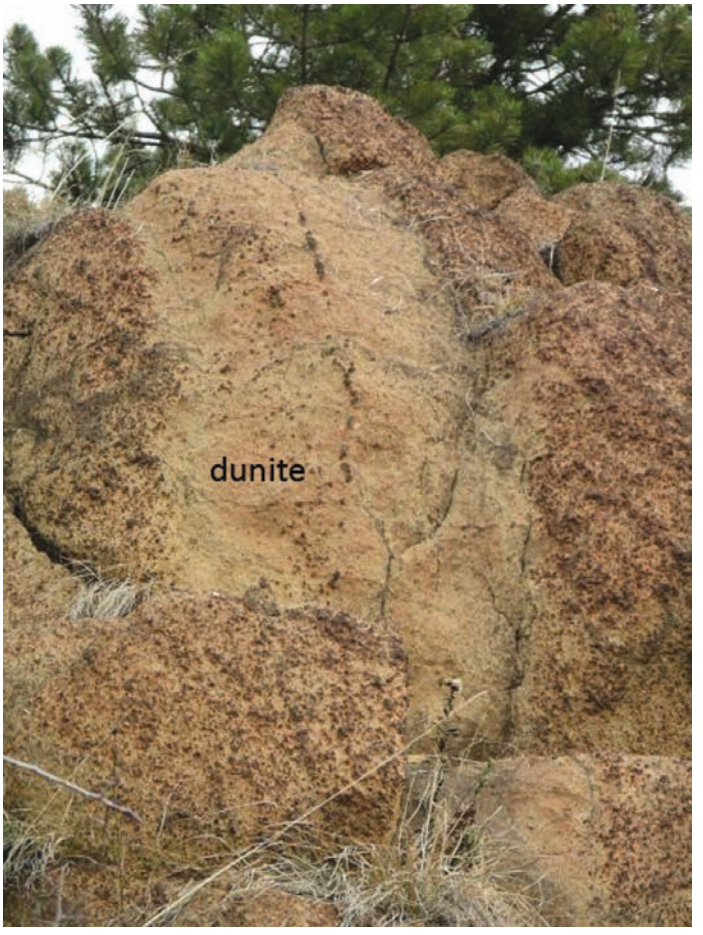


Figure 3: Replacive spinel dunite channel in spinel harzburgite from the Southern Lanzo Massif.

Design of Marine Protected Areas for Chemosynthetic Ecosystems Potentially Threatened by Human Activities in the Deep Sea

Debbie Milton and Maria Baker

Thirty-one experts in ocean governance, industry, and marine scientific (natural sciences and social sciences) research from 14 countries convened for four days in June at the Centre de Recherche et d'Enseignement sur les Systèmes Côtiers (CRESCO) in Dinard, France, with goals of formulating general guidelines for the design of networks of areas for conservation of chemosynthetic ecosystems and outlining research needs to allow better application of spatially based ecosystem management of vent and seep ecosystems.

The first two days of the workshop were devoted to brief presentations on background topics. The subsequent two days progressed through a series of break-out and plenary sessions. Discussions focused first on conservation goals, next on human activities within vent and seep ecosystems, then on design and management principles for conservation, and finally, on knowledge gaps. Five design principles were considered and developed:

1. Accounting for uncertainty through adaptive management.
2. Definition of management units at the level of biogeographic provinces.
3. Definition of bioregions to support ecosystem-based management and marine spatial planning.

4. Definition of protected areas within bioregions (size and spacing).
5. Definition of human uses and levels of protection.

This workshop was co-funded by the ChEss and other Census of Marine Life Groups, the International Seabed Authority, the US National Oceanic and Atmospheric Administration (National Marine Sanctuaries), the US Minerals Management Service (now the Bureau of Ocean Energy Management, Regulation, and Enforcement), and InterRidge.

Figure 1: Participants at the Design of Marine Protected Areas workshop in Dinard, France.

The Mohole: a Crustal Journey and Mantle Quest

Nick Harmon

(Some reporting of this workshop is in the Deep Earth Sampling Working Group report).

The 2010 MoHole workshop was held at Kanazawa University, Japan during 3-5 June 2010. This meeting was attended by ~65 people, and was very successful and productive. Participants to previous meetings in 2006 and 2009 reached consensus that a deep hole through a complete section of fast-spread ocean crust is a renewed priority for the ocean lithosphere community. The scientific rationale for drilling a MoHole in fast-spread crust is developed in the workshop reports (available online), and most thoroughly articulated in the 2007 IODP Mission Moho drilling proposal (IODP Prop 719MP; (http://www.missionmoho.org). In response to the two objectives - 1) to initiate a roadmap for technology development and 2) to identify potential MoHole sites in the Pacific – the scientific goals can be divided into the following principal tightly interconnected threads:

- What is the physical nature of the Mohorovicic Discontinuity? and what is the geological nature of this boundary zone?
- How is the (lower) oceanic crust formed at the mid-ocean ridges, and what processes influence its subsequent evolution? What are the geophysical signatures of these magmatic, tectonic, hydrothermal, and biogeochemical chemical processes?
- What can we infer about the global composition of the oceanic crust, and what are the magnitudes of interactions with the oceans and biology and their influence on global chemical cycles?
- What are the limits of life, and the factors controlling these limits? How do the biological community compositions change with depth, and the evolving physical and chemical environments through the oceanic crust?
- What is the physical and chemical nature of the uppermost mantle, and how does it relate to the overlying magmatic crust?

Full report is available at: http://mohole.org

Long-Range Exploration of the Ridge Crest *Colin Devey*

See report in Working Group Updates in this volume.

Full report is available at: http://www.interridge.org/files/interridge/LREWG_Report_Final_web_0.pdf

Online Resources and Publications

Resources available at the InterRidge website:

Screen grab of a new, searchable reference page developed by LDEO-MGDS and R2K Office staff.

Significant effort has been made this year to consolidate R2K references and integrate them within the primary database maintained by the R2K DMO. Reference information off the R2K website, with award, cruise, and focus site information for each reference is provided, together with direct access to data sets and cruise information, as well as options to save references in EndNote format.

InterRidge Global Database of Active Hydrothermal Vent Fields

http://www.interridge.org/IRvents

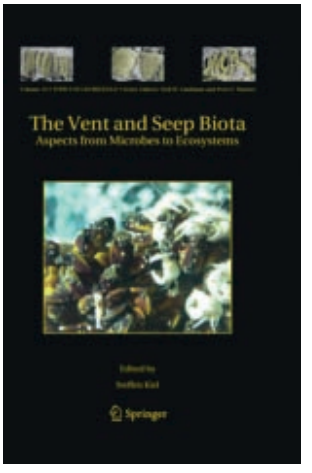
News of new sites or updates can be emailed to the InterRidge Office, to allow the database to be maintained.

Screen grab of interactive map, showing vent field positions displayed in Google Earth.

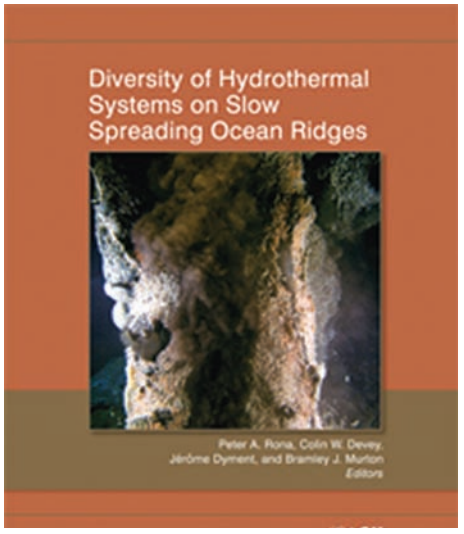
The Vent and Seep Biota

Aspects from microbes to ecosystems

Steffen Kiel (Ed.)



Oases of life around black smokers and hydrocarbon seeps in the deep-sea were among the most surprising scientific discoveries of the past three decades. These ecosystems are dominated by animals having symbiotic relationships with chemoautotrophic bacteria. Their study developed into an international, interdisciplinary venture where scientists develop new technologies to work in some of the most extreme places on Earth. This book highlights discoveries, developments, and advances made during the past 10 years, including remarkable cases of host-symbiont coevolution, worms living on frozen methane, and a fossil record providing insights into the dynamic history of these ecosystems since the Paleozoic.



Diversity of Hydrothermal Systems on Slow Spreading Ocean Ridges

Peter Rona, Colin Devey, Jérôme Dyment and Bramley Murton, (Eds.)

The papers in this volume present a multidisciplinary overview of the remarkable emerging diversity of hydrothermal systems on slow spreading ocean ridges in the Atlantic, Indian, and Arctic oceans… thus opening an exciting new frontier for ocean ridge exploration.

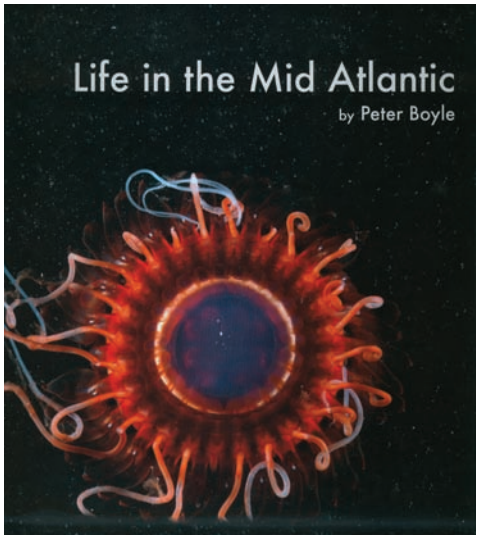
To order: http://www.agu.org/cgi-bin/agubooks?book=SEGM1884788

Geochemistry Geophysics Geosystems G3

"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/theme.shtml?collectionCode=MANTLE1&journalCode=GC

The goal of this volume is to unite a broad disciplinary range of specific and more interdisciplinary papers on the linkages between magmatism, tectonics, hydrothermalism and life on slow-spreading ridges. We would like to encourage colleagues from the InterRidge community to submit their research to this volume dedicated to providing a comprehensive description of recent research on slow-spreading ridges.



Life in the Mid Atlantic

Peter Boyle

This 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 team significantly enhanced the knowledge of biodiversity of the mid-ocean ridge system. Illustrations in the book include photographs produced by project partners, not least the renowned wildlife photographer David Shale, as well as historical illustrations of deepwater organisms by Thorolv Rasmussen from Bergen, Norway, and artwork by the contemporary Norwegian painter Ørnulf Opdahl. The author Peter Boyle (deceased) was professor of marine biology at the University of Aberdeen and a cephalopod specialist.

Upcoming Events

Dec. 13-17, 2010	AGU Fall Meeting 2010, San Francisco, CA, USA
Jan. 08-10, 2011	Geological carbon capture & storage in mafic and ultramafic rocks, Muscat, Oman
Feb. 12-17, 2011	ASLO 2011, Puerto Rico
Apr. 03-08, 2011	European Geosciences Union (EGU) General Assembly 2011, Vienna, Austria
Jun 14-18, 2011	22nd Pacific Science Congress: Meeting the Challenges of Global Change, Kuala Lumpur, Malaysia
Aug. 08-12, 2011	Asia Oceania Geosciences Society (AOGS) 8th Annual Meeting, Taipei
Oct. 24-29, 2011	7th WIOMSA Scientific Symposium, Mombasa, Kenya

Also in 2011 (*dates and venues to be determined*:)

- InterRidge Steering Committee, China
- Hydrothermal Energy and Ocean Carbon Cycles, SCOR Working Group, Hangzhou, China
- Mantle Imaging Working Group meeting

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

Country	Dates	PI	Ship	Cruise ID/Location	Research Objectives
Australia	Nov 2011	J. Whittaker	R/V Southern Surveyor	Perth Abyssal Plain	To understand the formation history of the Perth Abyssal Plain and the crustal nature and tectonic history of a number of surrounding submerged plateaus.
China	Jul - Dec 2010	COMRA	R/V Daoyangyihao	Central EPR	Investigation of hydrothermal plumes.
China	Dec 2010 - Jan 2011	COMRA	R/V Daoyangyihao	SWIR	Environment for physical and biological oceanography.
France	May 2011	F. Lucazeau; M. Cannat	R/V L'Atalante	MAR 35°N; Oceanograflux	
France	Jun 2011	J. Perrot	R/V Le Suroît	HYDROBS-MoMAR; 32-40°N	
France	Jul 2011	F. Lallier	R/V Pourquoi pas?	BioBaz 1; MAR Menez Gwen	
France	Jul 2011	M. Cannat; J. Blandin; P.M. Sarradin	R/V Pourquoi pas?	MOMARSAT 2; MAR Lucky Strike	
France	Dec 2011	N. Le Bris; F. Lallier	R/V L'Atalante	MESCAL 2; EPR 9-15°N	
Germany	June 2014	A. Boetius		AURORA, 83°N Gakkel Ridge	Will use a new hybrid ROV/AUV system developed by WHOI for under-ice diving in collaboration with C. German (WHOI)
Germany	Mar 2013	G. Bohrmann		Sandwich Plate	
Germany	Dec 2012 - Jan 2013	V. Schlindwein	R/V Polarstern	SWEAP, SWIR	
Germany	Sep - Nov 2011	K. Edwards; W. Bach	JOIDES Resolution	IODP 336, North Pond, MAR	Initiation of long-term coupled microbiological, geochemical, and hydrological experimentation within the seafloor at North Pond, western flank of the Mid-Atlantic Ridge.
Germany	Jan 2011	C. Devey	R/V Poseidon	Atlantis II Deep (Red Sea)	Using AUV to map the brine pool floor, looking for vents and also sampling the crustal rocks both in and around the pool to look at fluid sources.
Germany	Jun - Jul 2011	W. Bach		SO216, Manus Basin	
Germany	Jan - Mar 2011	Haase	R/V Sonne	Sonne 213, Pacific-Antarctic Ridge	
India	Oct - Nov 2010	K. Raju	R/V Sagar Nidhi	Carlsberg Ridge, Arabian Sea	

Japan	Nov -Dec 2010	K. Okino	R/V Hakuho-maru	KH-10-6, Indian Ocean triple junction	Integrated AUV survey, rock dredge, water and plankton sampling in hydrothermal plumes around Kairei for TAIGA project.
Japan	Oct 2010	T. Yamanaka	R/V Tansei-maru	KT10-22, Okinawa Trough	Microbiological and geochemical studies in sediment-rich hydrothermal sites.
Japan	Oct 2010	H. Yamamoto	R/V Tansei-maru	KT10-23, Okinawa Trough	Microbiological and geochemical studies in sediment-rich hydrothermal sites.
Korea	Mar 2011	KORDI		Lau Basin	Survey related to mineral resources (pending).
Korea	Feb - Mar 2011	KOPRI	R/V Araon	160ºE segment, SEIR	Collaboration between KOPRI, Univ. Victoria and NOAA. Mapping, sampling and hydrothermal surveys.
New Zealand; USA	Feb - Mar 2011			Kermadec Ridge	Mapping of several massive sulphide hosting caldera and cone volcanoes using AUV *Sentry*.
UK	2012	J. Copley		Cayman Rise	
UK	Jan - Feb 2011	P. Tyler	RSS James Cook	JC055, Bransfield Strait	Vents and seeps in Bransfield Strait.
UK	Nov - Dec 2011	A. Rogers	RSS James Cook	JC66, SWIR	Biology of SW Indian Ridge seamounts.
UK	Dec 2011	J. Copley	RSS James Cook	JC67, SWIR	Ecology and biogeography of hydrothermal vents on the SW Indian Ridge.
UK; France	Apr - May 2011	D. Teagle; B. Ildefonse	JOIDES Resolution	IODP 335, Eastern Pacific	Superfast spreading rate crust 4 - to test models of the accretion and evolution of the oceanic crust.
USA	2012	A. Koppers	R/V Revelle	SW Walvis Ridge	To study the young Walvis Ridge through mapping and dredging of 40 seamounts.
USA	Aug - Sep 2011	J. Delaney; R. McDuff	R/V T.G.Thompson	Juan de Fuca	
USA	Jun - Jul 2011	A. Fisher; J. Cowen; K. Becker	R/V Atlantis	JFR flank	Completion of single- and cross-hole hydrogeologic experiments on the eastern flank of the Juan de Fuca Ridge.
USA	Jul 2011	W. Chadwick; M. Lilley; R. Embley; R.Lee M. Zumberge	R/V Atlantis	Axial Seamount, Juan de Fuca	Monitoring inflation at Axial Seamount; resistivity probe deployments at the Endeavour ISS; to continue annual maintenance of seafloor instruments in the Juan de Fuca Ridge / NE Pacific region.
USA	Apr 2011	S. Webb	R/V Atlantis	9-10ºN EPR	Testing models of magma movement along the East Pacific Rise.
USA; Japan	Dec 2010 - Feb 2011	A. Koppers; T. Yamazaki	JOIDES Resolution	IODP 330, Louisville Seamounts Trail	Implications for geodynamic mantle flow models and the geochemical evolution of primary hotspots.

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Updated Oct. 2010

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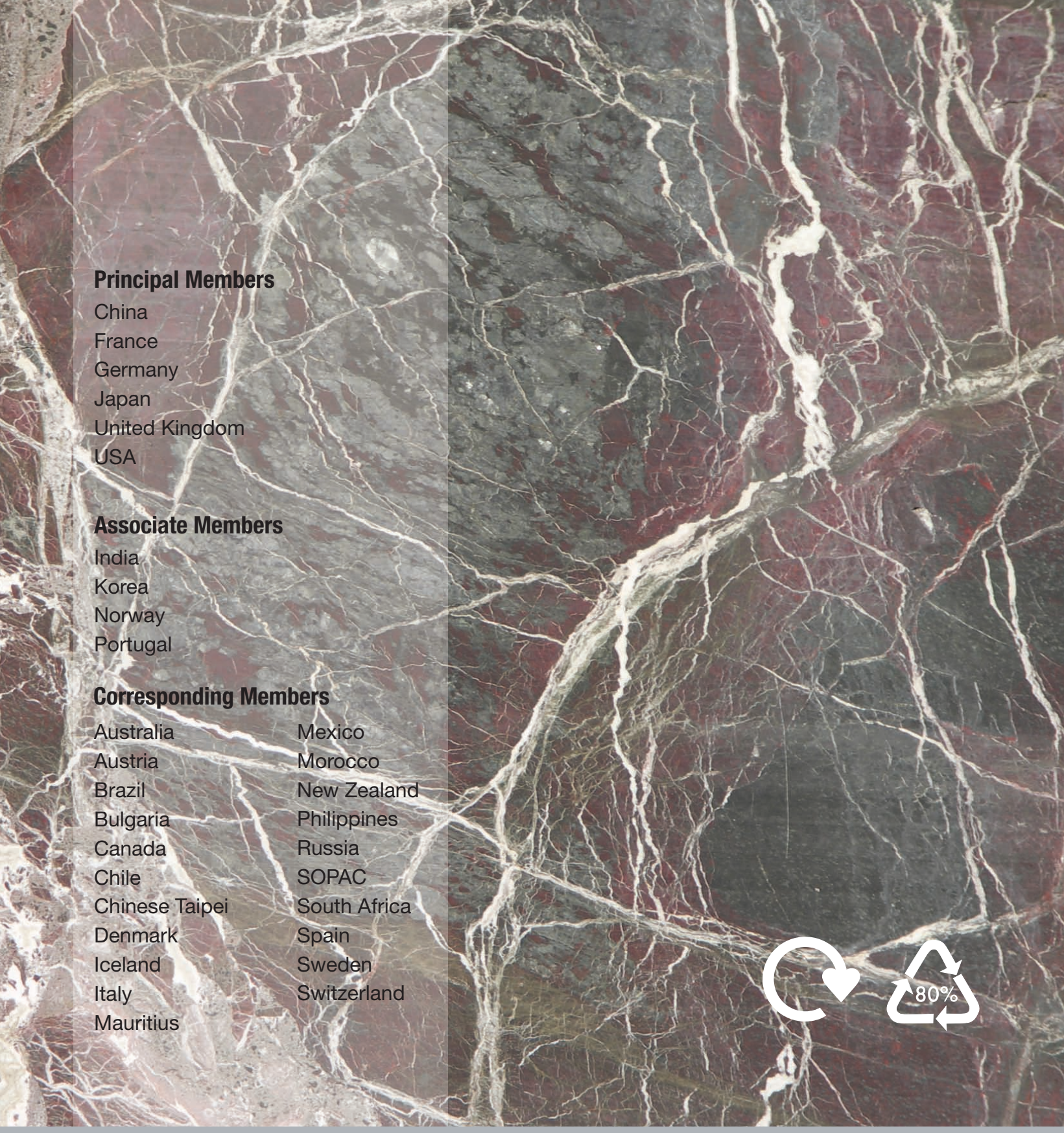
* New French member to be confirmed



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80%

Cover: Hydrothermal vent chimney on the East Scotia Ridge imaged by the UK ChEsSo Consortium, January 2010. Mosaic image by Leigh Marsh, Jon Copley (University of Southampton) and the *ISIS* ROV Team (National Oceanography Centre, Southampton)
Back Cover: Calcite-veined hematite-bearing serpentinites (mantle "ophicalcites") from Ligurian ophiolites. Image courtesy of Riccardo Tribuzio, Dipartimento di Scienze della Terra, Universita di Pavia, Italy.