InterRidge News

Promoting international cooperation in ridge-crest studies

Vol. 16 **2007**

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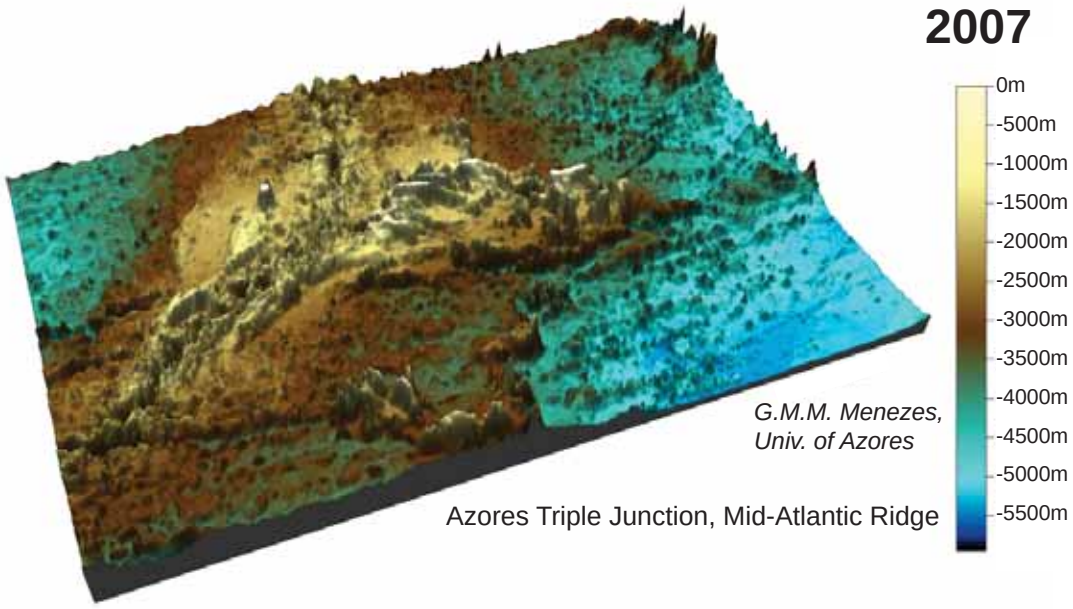
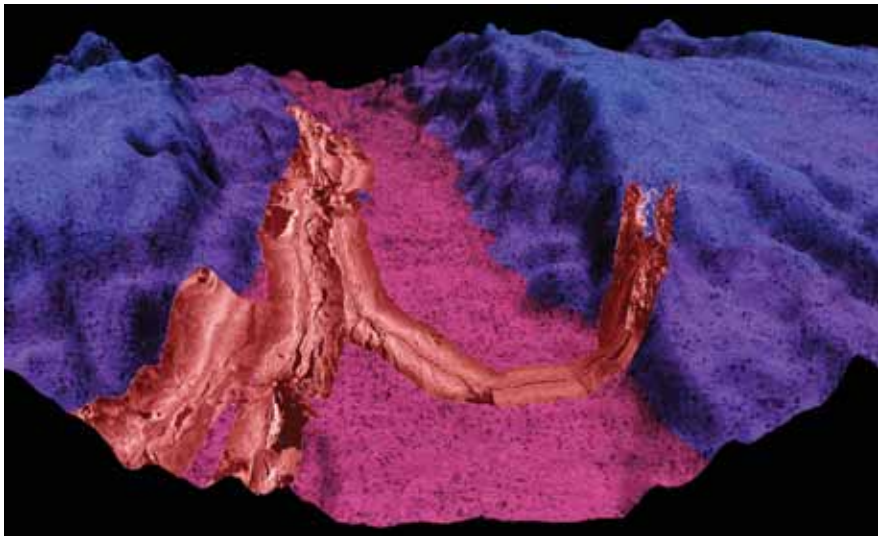


G.M.M. Menezes, Univ. of Azores

Azores Triple Junction, Mid-Atlantic Ridge

Image Competition Winners

More images on back cover!



Great Dodo Lava Plain, Central Indian Ridge *A. Asada, Univ. of Tokyo*

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INTERRIDGE NEWS

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LAYOUT
Stace Beaulieu

FOR CONTRIBUTORS
Please send all items for publication via email to the InterRidge Office (coordinator@interridge.org).
Text should be in Microsoft Word format. Figures should preferrably be sent in eps or tif format for optimal printing, although other formats are accepted.

DEADLINE FOR INTERRIDGE NEWS VOL. 17 CONTRIBUTIONS
30 SEPTEMBER 2008

LETTER FROM THE CHAIRS

Jian Lin and Chris German

We are delighted to bring the exciting news of ongoing international progress in mid-ocean ridge research to you in this first issue of the annual InterRidge Newsletter from the Woods Hole office. InterRidge promotes interdisciplinary, international studies of oceanic spreading centers by creating a global research community, planning and coordinating new science programs that no single nation can achieve alone, exchanging scientific information, and sharing new technologies and facilities. InterRidge is also dedicated to reaching out to the public, scientists and governments, and to providing a unified voice for ocean ridge researchers worldwide. Following are just a few examples of exciting progress in 2007 and new developments for 2008.

1. Contributions from emerging-economy nations

One important trend in the last few years has been that emerging economies, such as India, China, and Korea, are developing national programs in ridge exploration and research, together with rapid increase in investments in deep-sea technology and strengthening of ties to the international community. In fall 2007, China has officially become an InterRidge Principal Member nation. China is the first new IR Principal Member in almost a decade. China is also the first developing country and newly industrialized country to become an IR Principal Member. In Nov. 2007, the IR Steering Committee meeting was held in Rio de Janeiro, Brazil, thanks to the warm hosting of Dr. Sidney Mello and his Brazilian colleagues. Subsequently a very successful Mid-Ocean Ridge special session was held at the 10th International Conference of the Brazilian Geophysical Society. These events are part of an effort to promote ocean ridge research and exploration in South American countries and to strengthen ties within the IR community. With that in mind we are pleased to welcome Chile as our newest IR Corresponding Member nation. Exciting advances in ridge-crest science are taking place in many IR countries (see National News, this issue), and efforts are underway in Russia and New Zealand, among others, to upgrade their national IR memberships.

2. New InterRidge Working Groups to start in 2008

The IR Working Groups (WGs) play an essential role in promoting and coordinating new research that follows a focused theme of emerging scientific promise, or is conducted in a unique geographic setting along global ridge-crests where advances in science will benefit significantly from IR coordination. Four of our current WGs will continue into 2008: *Biogeochemical Interaction at Deep-Sea Vents*, *Deep Earth Sampling*, *Monitoring and Observatories*, and *Ultraslow Spreading Ridges*. The *Biology* WG has completed its mission (see Working Group Updates, this issue).

In 2007 we invited new WG proposals from any IR member - or groups of members - and received seven high-quality WG proposals representing a diverse group of active international researchers. Following thorough review, the IR Steering Committee considered the following four proposals as mature enough to form new WGs. The proponents were asked to submit their revised proposals by the end of 2007, ready for WG activities to begin in 2008.

- *Imaging Crustal and Mantle Structure Beneath Mid-ocean Ridges* (Contact: Nobukazu Seama, Japan). This WG will lead a planning effort to 1) promote experiments to image the mantle structure at one or two ridge systems through pooling of international expertise, instruments, and resources; and 2) encourage scientists to link effectively for interpreting and using the high quality images that result.
- *Vent Ecology* (Contacts: Chuck Fisher, USA, and Stephane Hourdez, France). The primary goals of this WG are to foster international collaboration of research that will advance our understanding of the ecology of hydrothermal vents and to promote expanded collaborations between geologists, chemists and ecologists to understand the changes in vent communities over time.
- *Seafloor Mineralization* (Contact: Maurice Tivey, USA). This WG will promote and coordinate international research on the science of seafloor mineral deposit formation, maturation, and evolution. The WG will promote development of techniques to locate such deposits, and to investigate the processes, including the biological roles, that are responsible for their formation and preservation.
- *Systematic Long-range Ridge Exploration* (Contact: Colin Devey, Germany). This WG will promote international collaboration and develop strategies of using cutting-edge AUV technology and state-of-the-art sensors for the systematic investigation of hydrothermal and other ridge processes on regional to ocean-basin length scales.

3. New InterRidge Student Fellowship Program

The IR Steering Committee has recommended a new IR Student Fellowship program. Two IR Student Fellowships, each up to $3000 US, will be awarded in 2008. This new program is designed to encourage international collaboration on any aspect of ridge-crest science by students (undergraduate or graduate). In particular we encourage applications seeking support for international cruise participation or laboratory use that add an international dimension to a student's thesis work. A full description of the program will be announced in January 2008 with an expected application due date of March 2008. Be ready!

We look forward to another exciting year, advancing ridge-crest research with the InterRidge community, in 2008!

COORDINATOR UPDATE

R. Waller and S. Beaulieu

New Office

This year the InterRidge Office moved to the USA, at the Woods Hole Oceanographic Institution (WHOI). We'd like to thank the Germany Office for the very smooth transition, as the handover was completed electronically. We moved the InterRidge electronic mailing list from majordomo to a Mailman server at WHOI, and issued the first biweekly e-news to interridge-mail on January 29th, less than a week after establishing the new physical office at WHOI. On May 30th we started a second mailing list, interridge-classifieds, for job postings. As of 5 Nov. 2007, we have posted 21 biweekly emails to interridge-mail (1613 users) and 30 emails to interridge-classifieds (92 users). In addition, we printed a new InterRidge flier which was first distributed at the IR Theoretical Institute in Sept. 2007.

IR Website

One of the major activities for the Coordinator this year was transferring the IR website (http://www.interridge.org) to Drupal, a free and open source modular content management system. As of early Nov. 2007, the online Member Database contained 2463 registered members from 59 different countries. We recently completed transferring the contents of the Cruise Database (cruises from 1992 through 2005) to the website, and will soon add the more recent cruises (2006 - present). We also created an online entry form for cruises – old or new – to add to the database, with standard fields that you will be able to sort within the tabular display. One of the new additions to the website is "News from the Ridge Crest," which includes links to cruise websites with daily dispatches. We expect to post a revised Vents Database in 2008. We'd like to thank Andy Maffei, Julie Allen, and Katherine Joyce at WHOI for help in designing and posting the website.

IR Theoretical Institute

Another major activity this year was coordinating the IR Theoretical Institute (IRTI) which was held at WHOI on September 10-14. The Institute consisted of three days of talks and two days of workshops, with 127 participants from 10 countries (see report on p. 49). We'd like to thank Christina Cuellar, Andrew Daly, and Julie Allen for additional help in organizing the IRTI.

Other activities

In June 2007 the InterRidge Office received a request to serve on a panel at the eighth meeting of the United Nations Open-ended Informal Consultative Process on Oceans and the Law of the Sea. Dr. M.K. Tivey, a geochemist from WHOI, presented the InterRidge statement of commitment to responsible research practices at deep-sea hydrothermal vents, as published on our website and in InterRidge News Vol. 15, 2006. In June 2007 the IR Office also sent out a call for proposals for new Working Groups. We received seven proposals which were reviewed by the IR Steering Committee (for more information, see the Letter from the Chairs, this issue).

New IR Coordinator for 2008-2009

Dr. Rhian Waller served as IR Coordinator from January to October 2007. One of the lasting legacies of Rhian's work is likely to be the IR Student Fellowship Program (for more information, see the Letter from the Chairs, this issue). Dr. Stace Beaulieu, a research biologist at WHOI, is serving as the new IR Coordinator. Rhian and Stace worked together during the month of October, and then both attended the Steering Committee Meeting in Rio de Janeiro to ensure a smooth transition (photo below). Stace's first major activity as Coordinator was editing this issue of the IR News.

IR Steering Committee in Rio de Janeiro, Brazil, Nov. 2007
Front (left to right) : R. Waller, S. Beaulieu, K. Kusek, J. Lin, C. German, S. Mello; Middle: B. Ildefonse, S. Sichel, M. Maia, C. Devey, H. Kumagai, J.-I. Ishibashi, S.-H. Park; Back: J. Diaz-Naveas, S. Hourdez, D. Blackman, F. Gaill

EDUCATION AND OUTREACH UPDATE

K. M. Kusek

This year's efforts have been focused on reaching out to the general public and to the science community—and finding long-term funding. Funding for this position is available through June 2008. Kristen Kusek has held the position of E&O coordinator as an independent contractor since the inception of the program in 2004, and appreciates all of the support she has received from InterRidge colleagues around the world. For any additional information, please contact Kristen: *kristenkusek@aol.com*.

IR in the Spotlight

Two articles in *Oceanus*, the magazine of Woods Hole Oceanographic Institution whose online version receives 40,000 hits per month, highlighted InterRidge. Visit them at:

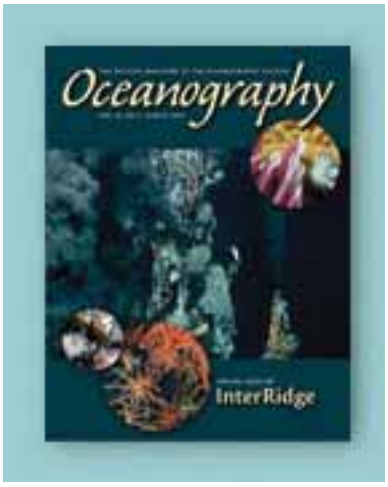
Building International Bridges to Explore Ridges
http://www.whoi.edu/oceanus/viewArticle.do?id=32246&sectionid=1002

A Ridge Too Slow? WHOI team collaborates on Chinese discovery expedition in Indian Ocean
http://www.whoi.edu/oceanus/viewArticle.do?id=26106&sectionid=1021

Also forthcoming in the magazine will be a spotlight feature about the recent IRTI on Biogeochemical Interaction at Deep-Sea Vents.

***Oceanography* Magazine**

The publication of a special InterRidge-focused issue of *Oceanography* magazine in March 2007 marked a tremendous milestone for the IR outreach mission. This is the first tangible product the IR community has ever had that showcases the interdisciplinary, international team-oriented research that defines InterRidge. The attractive 208-page issue included 16 diverse articles written by members of the international IR community—available online at http://tos.org/oceanography/issues/issue_archive/20_1.html.



We distributed a significant number of hard copies of the magazine to colleagues at the National Science Foundation, National Oceanic and Atmospheric Administration, the International Seabed Authority, the Census of Marine Life, COMRA (China Ocean Mineral Resources R&D Association), key partners in our member countries, the article reviewers, lead authors, IR Steering Committee Members, the participants of the IRTI, and more. All subscribed members of the Oceanography Society also receive a copy of the magazine. The feedback we received was overwhelmingly positive. The issue editors, Colin Devey, Chuck Fisher and Kristen Kusek, greatly appreciated the effort put forth by the InterRidge authors, as well as the ever-patient Oceanography staff, and the funding partners: NSF, NOAA's Ocean Exploration program, IR member nations, the Biogeography of Deep-Water Chemosynthetic Ecosystems (ChEss) program of the Census of Marine Life, the German DFG, WHOI, and Ridge 2000.

ChEss Galapagos Meeting

ChEss and the Census of Marine Life held their annual meeting in the Galápagos Islands during June 27-29, 2007 to honor the 30th anniversary of vent discovery along the Galápagos Spreading Center (see Workshop Report by Baker et al., this issue). InterRidge assisted in the planning, development and execution of the public event, held on June 29th for Galapagoan students and the general public. An international press release written by Kusek was distributed to raise awareness of the program. The event featured hands-on exhibits and contests, video and poster displays, a screening of the giant-screen film "Volcanoes of the Deep

Above: School children from Puerto Ayora, Galápagos, learning to pilot submersibles around model hydrothermal vents.

Left: Cover of *Oceanography* magazine, March 2007

Sea," and public talks (in English and Spanish) by Fred Grassle (The discovery of hydrothermal vents - an explorers perspective), Emory Kristof (The discovery from the eye of a lens), Cindy Van Dover (The exotic fauna of deep-sea oases), and Chris German (Modern vent investigations and links with space exploration). While we anticipated roughly 30 students, more than 150 showed up to participate, and—unexpectedly chaotic as that was—we could not have been more pleased with their enthusiastic interest in the deep sea.

Euroscience Open Forum (ESOF) 2008

InterRidge teamed up with the ChEss program of the Census of Marine Life to submit an outreach proposal for ESOF 2008, to be held in Barcelona in July 2008 (www.esof2008.org). According to the ESOF website, ESOF is "Europe's most important interdisciplinary meeting on science, technology and the humanities." Its mission is to provide an open platform for debate and communication for the science community of Europe and the world. The meeting attracts leading scientists, young researchers, policy-makers, journalists and other members of the general public. The title of our proposed session is: Life in the Sunless Sea: Recording the Big, the Small and All by 2010. IR ran a very successful outreach program for ESOF 2006 in Munich, Germany—which attracted more than 2,100 participants from 58 countries, including 485 journalists—and we are hoping to repeat this success in Barcelona.

Science Writer-at-Sea

A significant proportion of time in 2007 has been devoted to trying to secure long-term funding for Science Writer-at-Sea, IR's flagship E&O program, which was pilot-tested in 2005. The training and outreach program immerses the world's future reporters – science journalism students – on ocean expeditions, and broadcasts the stories they write to a diversity of informal learning environments, having the potential to reach literally millions of people. Since the pilot test, the partner list has grown exponentially and includes MOSI (Museum of Science and Industry in Tampa, FL), ASTC (Association of Science-Technology Centers, 540 member museums in 40 countries), NOAA Teacher at Sea, Natural History magazine, The Tampa Tribune, *Oceanus*, Michigan State University's Knight Center for Environmental Journalism, Columbia University's Earth & Environmental Science Journalism program, and The Society of Environmental Journalists. An advisory board has also been assembled. K. Kusek continually receives email requests about the program from interested parties and student journalists who want to participate. However, two significant proposals submitted earlier this year to the NOAA Ocean Exploration program and NOAA's Environmental Literacy program (for which we teamed up with NOAA's Teacher at Sea program), were unfortunately declined for funding. In fact, both of these funding programs no longer exist. We made it to the top 10 of the Environmental Literacy opportunity (180 proposals were submitted; 60 were invited to submit full proposals; we made it to the top 10). The reviews were overwhelmingly positive, including phrases such as "lots of very strong partners, innovative distribution scheme, strong leadership in terms of the PI and advisory board members, the proposal is strong in satisfying NOAA's 3rd educational objective," and so on, but many also suggest one of the main problems is the budget: Given IR's tight budget (currently, the IR E&O position is funded through June 2008), we have asked for significant salary support for PI Kusek, but this is not being well received. Kusek has since contacted many key members of NOAA and the National Science Foundation for feedback on the program and specific recommendations so that the funding search can move forward. Kusek is actively pursuing other funding possibilities—now turning to foundations.

IR at WHOI Exhibit Center

IR is sponsoring an aquarium exhibit to be available seasonally at the WHOI Exhibit Center in Woods Hole, Massachusetts (http://www.whoi.edu/page.do?pid=9135). Kusek is working with Kathy Patterson, manager of the exhibit center, on the details of the exhibit, which will feature an aquarium tank and remote-controlled submarines for students to operate amongst model hydrothermal vents. The concept is based on the very successful exhibit run at ESOF 2006 and for the Galápagos outreach event, originally inspired by ideas from IR's Gretchen Fruh-Green of Switzerland who participated with Kusek in ESOF 2006. Our long-term goal is to form partnerships with other international science exhibit centers to inspire the interest of the public, and especially students, in deep-sea exploration and science.

Science Writer-at-Sea Website homepage (see Education and Outreach > Projects on http://www.interridge.org)

Partnership with GLOBE / FLEXE

InterRidge is excited to be partnered with Ridge 2000's FLEXE program (From Local to EXtreme Environments), a new deep ocean focal theme of the international NASA and NSF-sponsored GLOBE earth science education program. The 12-year-old GLOBE program involves 109 countries, and joins students, teachers and scientists in the GLOBE network in support of student learning and research. FLEXE involves middle and high school students in structured, guided analyses and comparisons of real environmental data.

In September, FLEXE / Ridge 2000 E&O coordinator Liz Goehring visited Kiel, Germany, to train a group of German school teachers who will test one of the FLEXE curriculum units. Former IR chair Colin Devey participated in the workshop and delivered a lecture on ridges. Devey's participation signals the beginning of our exploration of how IR scientists can be specifically involved in FLEXE by serving as mentors for teachers, content experts, giving presentations in classrooms, offering tours of lab facilities, and more. For more information, see http://www.globe.gov/fsl/html/templ.cgi?flexe&lang=en&nav=1.

MATE Center ROV Competition

IR was invited to participate in the annual ROV competition held by the Marine Advanced Technology Education (MATE) Center (www.marinetech.org). The year 2008 will be the first year the competition is focused specifically on hydrothermal vents, and as of last year the competition is international in scope—so IR's participation seems a natural fit. Student teams from middle schools, high schools, home schools, community colleges, and universities participate in the events, to be held at Scripps Institution in June 2008.

International Year of Planet Earth

Plans are underway for the IR E&O program to submit an outreach proposal to this United Nations-driven initiative, announced for 2008. The main website is: http://www.esfs.org. Many IR researchers are involved in the Ocean Science theme, which is one of 10 included in the proclamation.

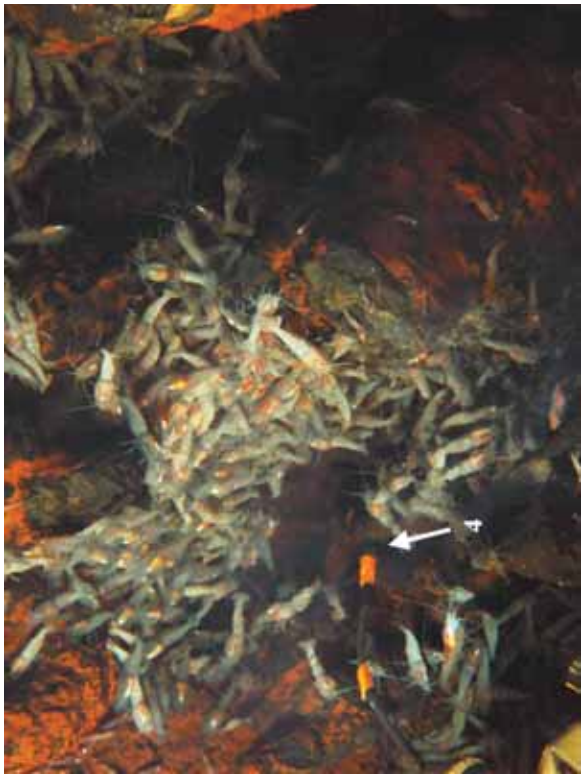
New Focus for 2008 and Beyond

Plans for the future of IR's E&O program were discussed at the Steering Committee meeting in Rio de Janeiro, Brazil. Highlights from 2004-2007 are listed below.

2004	2005	2006	2007
IFM-GEOMAR	**IFM-GEOMAR**	**IFM-GEOMAR**	**WHOI**
Start-up ▪ Outreach research ▪ Program design ▪ Implementation ▪ Leverage opps. from work on IMAX film (*Volcanoes of the Deep Sea*) Other ▪ Website transfer from Tokyo ▪ 1st IR flier ▪ Grant proposals: VW Foundation, NSF Informal Science Meetings* ▪ Talk at IODP ▪ Fall AGU poster Publications *The Marine Scientist* (Note: Kusek in Lau Basin Sep-Oct)	Science Writer-at-Sea (SWAS) ▪ Program design ▪ Outreach ▪ Recruitment ▪ Web design ▪ Pilot test in July/Aug: Norway ▪ Museum, media, university outreach; formal letters followed up with phone calls to acknowledge receipt and confirm future participation ▪ Follow-up and set objectives (Note: SWAS had to cancel participation on Searle cruise due to lack of funding) Meetings* ▪ Fall AGU talk ▪ EGU poster ▪ IR vent biology symposium: Scripps (outreach) ▪ NERC (UK)	Media/Public/Science Outreach ▪ AAAS symposium (St. Louis, MO) ▪ ESOF (Germany) ▪ *Oceanography* magazine: coordinate, recruit, implement SWAS ▪ Partner recruitment ▪ Invited to partner with Museum of Sci. and Ind. in FL to find grant opps. (partner with Association of Science-Technology Centers) ▪ Proposal to NOAA OE Other ▪ Field inquiries from international media re: code of conduct Meetings* ▪ GSA talk ▪ Fall AGU Publications *J. Marine Education*, *Teaching Earth Sciences*	Media/Public/Science Outreach ▪ *Oceanography* published March; outreach ▪ 30th anniversary ChEss event (Galapagos) ▪ IR exhibit in WHOI Exhibit center SWAS ▪ Partner with NOAA Teacher at Sea ▪ Proposal to NOAA Environmental Literacy ▪ Grant opps. explored: contacted by VW Foundation re: new funding initiative for SWAS; contacted by Poynter Institute for Media Studies Other partnerships ▪ GLOBE/FLEXE Publications *Oceanography*, *Oceanus* Note: Kusek was also science writer (*Oceanus*) for '07

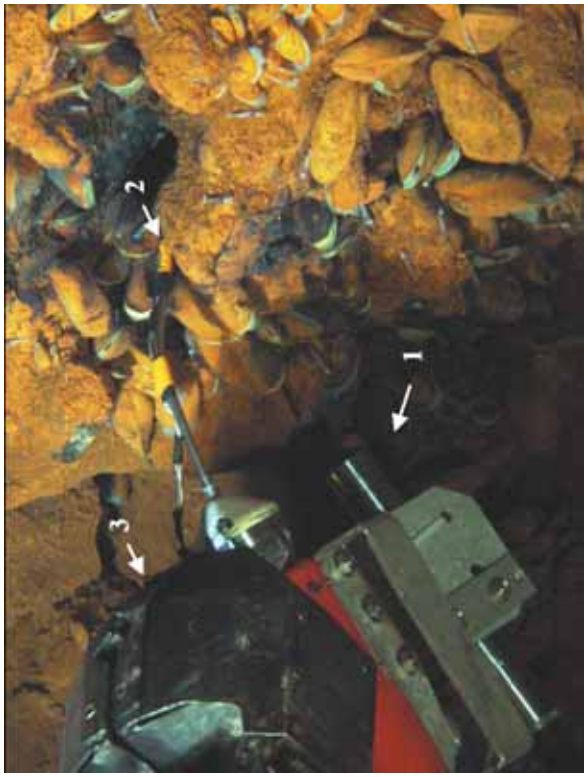
* Meetings only include meetings at which E&O presentations were given.

This is the first year that we are including color in the InterRidge News! However, we are constrained to using color on only a select number of pages. Images from each of the International Research articles and from several of the National Updates can be found here and on pages 57 and 60-61. Figure captions are within the respective articles.

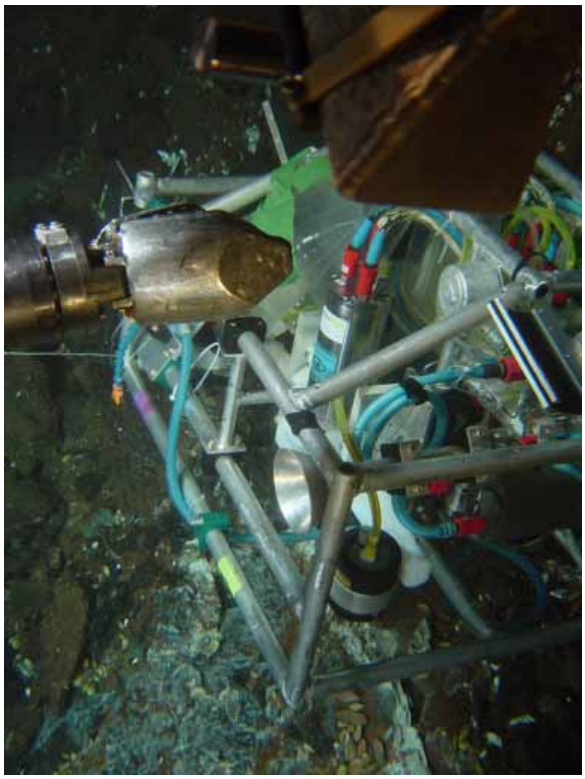


Gaill et al., Fig. 1B

Tao et al., Fig. 2 (from p. 25)



Gaill et al., Fig. 1A (from p. 15)



Sarradin et al., Fig. 1 (from p. 18)

INTERNATIONAL RESEARCH: *MID-ATLANTIC RIDGE*

A NEW HYDROTHERMAL FIELD AT 13º30' N ON THE MID-ATLANTIC RIDGE

V. Beltenev[1], V. Ivanov[1], I. Rozhdestvenskaya[1], G. Cherkashov[2], T. Stepanova[2], V. Shilov[1], A. Pertsev[3], M. Davydov[2], I. Egorov[2], I. Melekestseva[4], E. Narkevsky[1], and V. Ignatov[1]

From November 2006 to June 2007, integrated geological-geophysical studies were carried out during the 30th cruise of R/V *Professor Logatchev* by the Polar Marine Geosurvey Expedition (PMGE) together with VNIIOkeangeologia (St.Petersburg, Russia). The aim of the expedition was to find indicators of recent/extinct hydrothermal activity and related mineralization within the Mid-Atlantic Ridge (MAR) rift valley between 13° to 14°N. Below we describe the discovery of four inactive hydrothermal sites associated with a seamount situated at the western slope of the rift valley near l3º30'N. Detailed geological sampling led to the recovery of sulfide precipitates from the western, northern and eastern slopes of the seamount. The hydrothermal deposits, containing iron and in lesser amounts copper-zinc sulfides, were related both to basalts and ultramafic rocks. The geological setting of hydrothermal deposits associated with a seamount is unusual for the MAR.

The following methods were used on the cruise:
- temperature and conductivity surveys using a CTD SBE 9llplus (Sea-Bird Electronics) and water sampling by SBE 32 Carousel system,
- near-bottom side-scan sonar profiling of the sea-floor using a MAK-1 (Yuzhmorgeologia) system,
- electric survey by means of a deep-towed Rift-3 (Sevmorgeo) system recording electric potential (EP) in the near-bottom waters,
- underwater photo-TV surveying,
- geological sampling by means of dredge, rectangular corer, and TV-controlled grab system.

Initial processing of geological and water samples was made on board the ship. Mineralogical analyses (optical microscopy of the heavy fraction) were performed to determine the distribution of hydrothermal minerals in the sediment surface layer (0-5 cm) recovered by corer and TV-grab.

As a result of reconnaissance studies the most promising area for indicators of hydrothermal activity was selected near the seamount at 13°30'N. The bathymetric base map was from a multi-beam survey at a scale of 1:200000, conducted by R/V *Yuzhmorgeologia*.in 2004. The seamount is located at depths of 2500-2800 m on a terrace of the western slope of the rift valley and has dimensions of ~10 x 4.5 km with height 850 m (Fig. 1). It is orthogonally oriented to the rift axis. Based on side-scan sonar data, sediments cover much of the east and west slopes of the seamount. High concentrations of hydrothermal minerals such as barite and iron oxyhydroxides were found in the sediments at the western foot of the seamount. Towed profiling with the Rift-3 system across this zone detected an EP anomaly. Geological sampling recovered massive sulfides at four sites around the seamount (Fig. 1):

1. 13° 30.87'N, 44° 59.24'W (western slope)
2. 13° 31.13'N, 44° 58.03'W (western slope)
3. 13° 30.70'N, 44° 55.00'W (eastern slope)
4. 13° 30.24'N, 44° 54.07'W (eastern slope).

Fig. 1. See p. 60.
Hydrothermal deposits discovered on the slopes of the seamount at 13º30'N, MAR.
1. Serpentinitized peridotites
2. Gabbro
3. Basalts and metabasalts
4. Plagiogranites
5. TV-grab geological stations
6. Dredge geological stations (the start of dredging is indicated by triangle)
7. Hydrothermal deposits (numbered 1-4)

[1]Polar Marine Geosurvey Expedition, 24 Pobedy Str., Lomonosov, Russia (ocean-party@peterlink.ru); [2]VNIIOkeangeologia, 1 Angliysky Pr., St. Petersburg, Russia; [3]IGEM RAS, 35 Staromonetny, Moscow, Russia; [4]Institute Mineralogy UB RAS, Il'mensky Reserve, Miass, Russia

Serpentinitized peridotites were recovered from the northern (st. 30L289), southern (st. 30L144 and 30L290), and western (st. 30L148 and 30L186) slopes of the seamount. Serpentinitized peridotites at st. 30L144 were associated with moderately hydrothermally-altered lava sheets of pillow basalts that might have flowed directly on peridotites or represent sheet relics, preserved on elevated blocks of deep-seated intrusive rocks. Dolerite-basalts were associated with serpentinitized peridotites at st. 30L144, 30L186, and 30L289 and can be considered as dikes both in peridotites and in ancient basalt lavas. At the northern st. 30L289 serpentinites were associated with metabasites (microamphibolites?) intruded by plagiogranites. Plagiogranites occurred as isometric clasts up to 30x30x26 cm containing abundant metabasite xenoliths of different size. Noteworthy was the rare occurrence of gabbro which was recovered in association with serpentinitized peridotite only at southern st. 30L290. In the eastern part of the seamount only differently hydrothermally-altered pillow basalts, might well occur; no gabbro-peridotites were recovered at depths 2400 to 2800 m (st. 30L145, 30L153 and 30L284). At the summit of the seamount at depths 2100-2200 m (st.. 30L295), fairly "fresh" pillow basalts formed probably due to activation of a magma chamber.

All the hydrothermal deposits discovered at the slopes of the seamount, described below, are latitudinally aligned. Deposit 1 is related to serpentinitized peridotites, while deposits 2, 3, and 4 are associated with basalts.

Hydrothermal deposit 1 lies at depths of 2570-2620 m and according to TV observations was represented by a mound or a chain of mounds with products of their destruction (talus) around. The maximal observed extent of the hydrothermal zone was ~ 175x200 m. The southern boundary of the field was not evident. Hydrothermal precipitates were recovered from four stations (30L134, 30L186, 30L292 and 30L293). Massive sulfides (above 200 kg) recovered from stations 30L186 and 30L292 consisted of pyrite and marcasite replacing primary pyrrhotite mineralization. Mineralization at site 1 exhibited a high content of barite (up to 20%), both dispersed (st. 30L292) and as veinlets (st.. 30L186). Oxyhydroxide ferrous siliceous crusts were also recovered within the field at stations 30L134 and 30L293.

Hydrothermal deposit 2. This site was dredged only once (st. 30L287) at depths 2480-2750 m and has not been encountered by TV-profiling. Massive sphalerite-chalcopyrite mineralization was enriched in opal (35-40%) impregnating the samples. About half of the material was composed of mainly chalcopyrite debris in loose opal matrix.

Hydrothermal deposit 3 was also dredged once (st. 30L284) at depths of 2400-2600 m and has not been encountered by TV-profiling. A large amount of sulfide breccia in opal matrix was recovered. Sulfide clasts up to 15 cm in size were composed of pyrite and marcasite. Dense dark opal cement varied from 5 to 40% of the samples. Breccia was partly cemented by barite.

At hydrothermal deposit 4, TV surveying revealed massive sulfides at depths of 2560-2950 m. The deposits were represented by extensive edifices and could be subdivided into northern and southern groups. The northern group consisted of three (?) ore bodies 210x100 m, 525x200 m and l00x 200 m in size. The southern group was represented by four (?) ore bodies 200x100 m, 700x75 m, 150xl50 m and 50 m. Exposed basalts partly overlain by sediments were recorded between the northern and southern groups. Sulfide edifices were consistently recorded on two TV profiles for over 1500 m (!). Exact boundaries of the deposits have not been determined. 500 kg of massive sulfides were recovered from site 4. Hydrothermal precipitates were represented by massive (st. 30L145) and disseminated sulfides in altered basalts (st. 30L153). In both cases, pyrite was in fact the only sulfide mineral. Sulfides recovered from st. 30L145 were porous and highly oxidized. Barite was present, but did not account for greater than 5%. No anomalies were detected in the near-bottom waters confirming that the hydrothermal activity which generated the sulfide deposits at this site had already ceased.

Therefore, the data available imply that:

1. The newly discovered, inactive hydrothermal sites are related to both basalts and ultrabasic rocks.
2. The type of the structural control of deposits is very unusual: the hydrothermal fields are situated at the foot of an elongated seamount orthogonally oriented to the Mid-Atlantic Ridge rift valley.
3. Hydrothermal precipitates are represented mainly by the pyrite-marcasite type of massive sulfides except for deposit 2 composed of copper-zinc sulfide minerals.
4. Preliminary estimates indicate that these deposits are bigger than Krasnov deposit at 16°38'N, MAR (17.4 metric mln tonnes), and therefore could be the largest submarine hydrothermal field on the MAR.

Acknowledgements

The authors thank the scientific team and crew of the 30th cruise of R/V *Professor Logatchev*. We also thank Sergey Petukhov for help in preparation of this article. This cruise was financially supported by the Federal Agency for Management of Mineral Resources of the Russian Federation.

SHALLOW-DRILLING OF THE ULTRAMAFIC-HOSTED LOGATCHEV HYDROTHERMAL FIELD AT 14°45'N ON THE MID-ATLANTIC RIDGE USING A NEW LANDER-TYPE SEAFLOOR DRILL

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During cruise MSM03/2 of the German R/V *Maria S. Merian* in November 2006, a new lander-type remotely operated seafloor drill (Rockdrill2; Fig. 1) of the British Geological Survey in Edinburgh (UK) was used to investigate the shallow subsurface in the Logatchev hydrothermal field at 14°45'N on the Mid-Atlantic Ridge. The ultramafic-hosted Logatchev field is situated in 3000 m water depth and has some characteristics that are unique to this hydrothermal system. The chemistry of the high-temperature vents (350°C, Douville et al., 2002; Charlou et al., 2002; Schmidt et al., 2007) reflects the influence of ultramafic as well as mafic host rocks at depth. It is interesting to note that the black smoker venting at Logatchev is not only taking place at chimneys or mounds that are common to hydrothermal systems worldwide, but also some of the venting takes place within and at the rim of small depressions, so-called smoking craters (Bogdanov et al., 1997), with diameters up to 10 m. The formation of these unique depressions is still not understood.

Another characteristic feature of the Logatchev site when compared to most other seafloor hydrothermal systems is a distinct Au-Cu enrichment of the massive sulfides at least partially related to secondary processes affecting primary Cu-rich sulfides (Krasnov et al. 1995; Murphy and Meyer 1998; Mozgova et al. 1999; Petersen et al., 2005). It is not established if these secondary processes are solely surface processes or if some of the enrichment is due to the remobilization of metals from depth. However, sites of hydrothermal upflow are suggested by geoelectrical measurements carried out by the Russian R/V *Prof. Logatchev* in 2004. The observed vertical and horizontal variations of the specific resistivity, caused by higher conductivity in the subsurface, may be interpreted as areas of subseafloor mineralization (unpublished data from G. Cherkashov, 2004, VNIIOkeangeologia).

Our main goals were therefore to investigate the nature of the immediate subsurface of the Logatchev field in order to document the nature of the underlying rocks, the possible depth zonations of the mineralization and alteration as well as their age relationships.

Fig. 1. The new Rockdrill2 is retrieved during cruise MSM03/2 of R/V *Maria S. Merian*.

Other goals include pore water and sediment sampling in order to better understand the sulfur cycle, and the variability of the subsurface microbiology and its influence on the formation and alteration of hydrothermal mineral precipitates.

The BGS Rockdrill2 is lowered to the seabed on a power and lift umbilical and takes rock samples using a rotary diamond bit coring system. The drill is designed for drilling in water depths up to 3100 m and currently has the capability to core down to 15 m using multiple core barrels and rods. We tested the newly built instrument in water depths around 1700 m at the eastern valley flank

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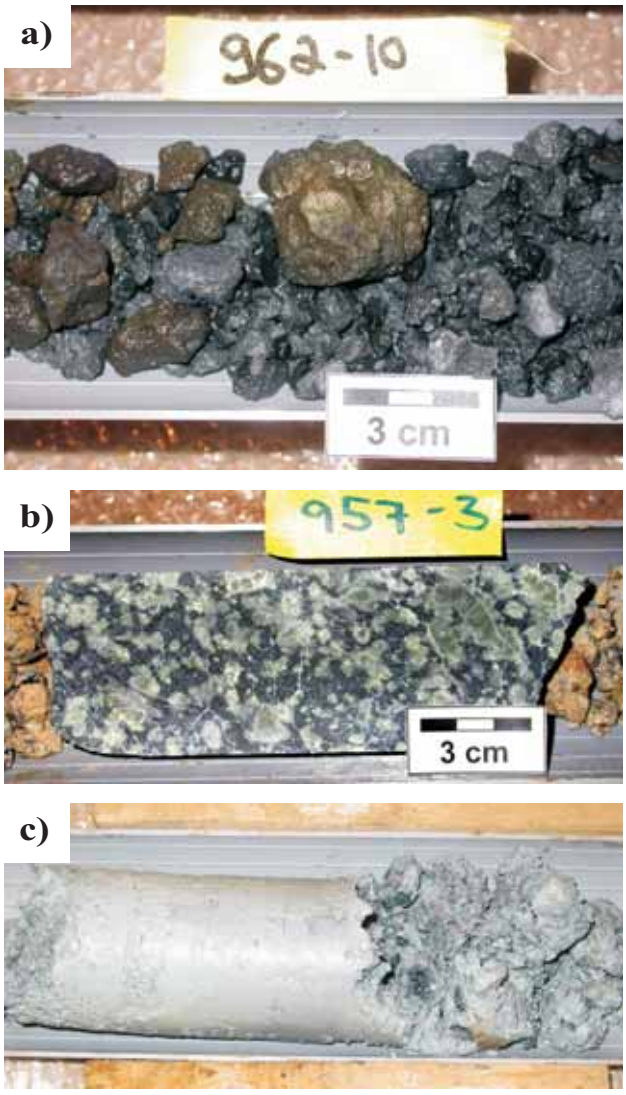

Fig. 2. a) Massive sulfide cobbles associated with altered wall rock fragments at 10.3 m below the seafloor near site "B". **b)** Massive serpentinite drilled to the north of "Quest". **c)** Clay-altered serpentinized material recovered near site "B" (Hole 954RD).

Fig. 3. See p. 60.
Location of the Rockdrill (RD) and gravity corer (GC) stations in relation to the revised location of the Logatchev vent sites (see Borowski et al., this issue). The underlying ship-based bathymetry is from cruise MSM03/2; map processed by N. Augustin (IFM-GEOMAR).

near the Logatchev site and cored some basaltic material. The instrument was then used to successfully core 9 sites during this cruise. Of these, 5 deployments were achieved in water depths around 3000 m. Within the Logatchev field itself several active sites were targeted including the "Quest", "Irina 1" and "B" smoking crater. Other targets drilled include areas of abundant Fe-oxide staining reflecting past hydrothermal activity and areas of diffuse hydrothermal venting. The deepest hole was drilled to the west of the smoking crater site "B" and reached a depth of 10.5 m. With this and with a total cored length of 48 m, the Rockdrill2 system proved its ability to routinely operate down to 3050 m water depth in active hydrothermal systems. Our operations indicate that coring the upper parts of hydrothermal systems, which are often not sampled during (I)ODP operations, is possible using such a system.

The recovered cores were dominated by altered mafic and ultramafic rocks intermixed with minor massive sulfide fragments and some sulfide sand (Fig. 2a). Serpentinites and their altered equivalents were also common (Fig. 2b,c). Massive sulfides were, overall, rare in the drill core suggesting that most parts of the Logatchev hydrothermal field are underlain by altered talus material with the massive sulfides only forming a thin veneer on top of a clay-altered substrate. The heterogeneity of the host rock material encountered and the rounded nature as well as the abundance of gravel-sized material within the core indicates that most sections cored talus material. Gravity coring provided additional information about the shallow subseafloor and especially the past hydrothermal activity along and across the NW-SE axis of the hydrothermally active areas. The gravity cores confirmed the gravel-like nature of the subseafloor over wide areas. Rock samples were taken for geochemical and mineralogical studies as well as for investigations of the hydrogen storage capacity of sulfides, the geochemical sulfur cycle and the S-isotopic composition. Microbiological investigations are aimed at identifying microorganisms characteristic for the specific habitats (different rock types) in the subsurface.

During the cruise we collected bathymetric data around the Logatchev site using a Kongsberg EM120 multibeam system with a reduced beam angle (22°) in order to obtain a higher resolution (~20 m) than previous ship-based maps. This detailed bathymetry shows a clear link of the location of the hydrothermal field to crosscutting fault structures (Fig. 3). The location of the individual vent sites is based on recent LBL-navigation using the WHOI ROV *Jason II* during cruise MSM04/3 in 2007 (see Borowski et al, this issue).

Dredging of a number of locations along the rift valley floor and at a circular depression close to the eastern wall

recovered the least altered pillow basalt or fragments of basalt flows. Other dredges along the eastern rift valley floor contained mafic intrusive material and ultramafic rocks in variable amounts. Mafic intrusive material often dominates over ultramafic material in the vicinity of the Logatchev field indicating the importance of magmatic processes in the area. Notable is a dredge targeted at the horst structure adjacent to the Logatchev field which recovered coarse-grained gabbronoritic cumulate.

Scientists from Germany representing the fields of economic geology, petrology, geochemistry and microbiology, technicians and engineers from the UK as well as scientists from Russia, China and Switzerland participated in the cruise.

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References

Bogdanov, Y.A., N.S. Bortnikov, I.V. Vikentyev, E.G. Gurvich, and A.M. Sagalevich. A new type of modern mineral-forming systems: black smokers of the hydrothermal field at 14°45'N latitude, Mid-Atlantic Ridge, Geology of Ore Deposits, 39, 68-90, 1997.

Charlou, J.-L., J.P. Donval, Y. Fouquet, P. Jean-Baptiste, and N. Holm. Geochemistry of high H2 and CH4 vent fluids issuing from ultramafic rocks at the Rainbow hydrothermal field (36°14'N, MAR). Chemical Geology, 191, 345-359, 2002.

Douville, E., J.-L. Charlou, E.H. Oelkers, P. Bienvenu, C.F. Jove Colon, J.P. Donval, Y. Fouquet, D. Prieur, and P. Appriou. The Rainbow vent fluids (36°14'N, MAR): the influence of ultramafic rocks and phase separation on trace metal content in Mid-Atlantic Ridge hydrothermal fluids. Chemical Geology, 184, 37-48, 2002.

Krasnov, S.G., G.A. Cherkashev, T.V. Stepanova, B.N. Batuyev, A.G. Krotov, B.V. Malin, M.N. Maslov, V.F. Markov, I.M. Poroshina, M.S. Samovarov, A.M. Ashadze, L.I. Lazareva, and I.K. Ermolayev. Detailed geological studies of hydrothermal fields in the North Atlantic. In L.M. Parson, C.L. Walker, and D.R. Dixon (eds) Hydrothermal Vents and Processes: London, Geological Society Special Publication, 87, 43-64, 1995.

Mozgova, N.N., A,V. Efimov, Y.S. Borodaev, S.G. Krasnov, G.A. Cherkashov, T.V. Stepanova, and A.M. Ashadze. Mineralogy and chemistry of massive sulfides from the Logatchev hydrothermal field (14°45'N Mid Atlantic Ridge). Exploration and Mining Geology, 8, 379-395, 1999.

Murphy, P.J., and G. Meyer. A gold-copper association in ultramafic-hosted hydrothermal sulfides from the Mid-Atlantic Ridge. Economic Geology, 93, 1076-1083, 1998.

Petersen, S., T. Kuhn, P.M. Herzig, and M.D. Hannington. Factors controlling precious and base-metal enrichments at the ultramafic-hosted Logatchev hydrothermal field, 14°45'N on the MAR: New insights from cruise M60/3. Proceedings of the 8th biennial SGA meeting, Beijing, China, 679-682, 2005.

Schmidt, K., A. Koschinsky, D. Garbe-Schönberg, L.M. de Carvallo, and R. Seifert. Geochemistry of hydrothermal fluids from the ultramafic-hosted Logatchev hydrothermal field, 15°N on the Mid-Atlantic Ridge: Temporal and spatial investigations. Chemical Geology, 242, 1-21, 2007.

NEW COORDINATES FOR THE HYDROTHERMAL STRUCTURES IN THE LOGATCHEV VENT FIELD AT 14°45'N ON THE MID-ATLANTIC RIDGE

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After the discovery of the active Logatchev Hydrothermal Vent Field (LHF) on the Mid-Atlantic Ridge by Russian scientists in early 1994, the first detailed descriptions of the individual hydrothermal structures and their associated fauna were published by Gebruk et al. (1997, 2000) on the basis of video surveys and slurp gun sample material of a total of nine dives with the submersibles *Mir*, *Nautile* and *Alvin*. The video-based site descriptions came with micro-scale maps of the biologically most active vents at "Irina II" and the diffuse vent site "Anya's Garden", which is the only location

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on the MAR described to harbour vesicomyid clams. The published overview maps of the LHV vents, however, were still based on the original map by Krasnov et al. (1995) that lacked exact coordinates, and the relative positions of the vents to each other remained somewhat vague. As a consequence during later expeditions, the relocation of sites without eye-catching hydrothermal edifices could be time consuming. This was in particular the case for the relocation of "Anya's Garden" during the German *Meteor* cruises M60/3 and M64/2 in 2004 and 2005 because the unambiguous "marker organisms", the vesicomiyid clams, have not been found again. The discovery of the new hydrothermal structure "Quest" by the German R/V *Meteor* and ROV *Quest* in early 2004 (Kuhn et al., 2004) confirmed that the geographical dimensions of the LHF are not yet entirely explored, and the need for an accurate mapping of the LHF became more and more evident.

During cruise MSM04/3 with the German R/V *Maria S. Merian* in Jan - Feb 2007, we located the individual vents based on long baseline (LBL) navigation using the WHOI ROV *Jason II*. The purpose of this cruise, which was part of the German priority research program SPP 1144: "Mantle to Ocean: Energy-, Material- and Life-cycles at Spreading Axes", was to continue the geophysical, geochemical and biological time-series investigations started in the LHF in 2004. Two LBL navigation transponders equipped with 200-300 m long tethers in order to minimize acoustic shadows were positioned 0.8 and 1.3 nautical miles upslope of the LHF vents in 2566 m and 2510 m water depth, respectively (positions 14.76980096, -44.96712766 and 14.75699538, -44.9659013). During *Jason II* dives, the additional use of a Doppler Velocity Log (DVL) together with DVL software provided highly accurate relative positions. During a total of 11 dives dedicated to an extensive research program on geochemical and geophysical *in situ* measurements, geochemical and biological sampling of hot and diffuse fluids, microbial communities and symbiotic organisms, we repeatedly visited all known hydrothermal structures that align along roughly 520 m distance in NW-SE direction between the smoking crater "Quest" and the chimney structure of "Site A". The resultant coordinates of the positions of the LHF hydrothermal vent structures are listed below (Table 1) and the relative positions can be seen in the map provided by Petersen et al. (p. 60, this issue).

In addition to the exact positions of the vents, the accurate navigation data also reveal that the south-eastern smoking crater structures have been misinterpreted in the past. Gebruk et al. (2000) described "Anna Louise" as a double crater structure separated from the "Irina I" smoking crater. Our data clearly show that the distance between the two "Anna Louise" craters is almost equal to the distance between "Anna Louise" and "Irina I". In order to avoid confusion, we named the south-easternmost crater structure "Smokey Strobe" and kept the name "Anna Louise" for the structure between "Smokey Strobe" and "Irina I". The name "Smokey Strobe" derives from a small yellow strobe light lost by an earlier expedition, which we found sitting on the western crater rim.

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References

Gebruk, A.V., L.I. Moskalev, P. Chevaldonné, P., S.M. Sudarikov, E.S. Chernayev. Hydrothermal vent fauna of the Logatchev area (14°45, MAR): Preliminary results on the Mir and Nautile dives in 1995. InterRidge News 6(2), 10-14, 1997.

Gebruk, A.V., P. Chevaldonné, T. Shank, R.A. Lutz, R.C. Vriejenhoek. Deep-sea hydrothermal vent communities of the Logatchev area (14°45'N, Mid-Atlantic Ridge): Diverse biotopes and high biomass. Journal of the Marine Biological Association, U.K. 80, 383-393, 2000.

Krasnov, S. G., G.A. Cherkashev, T.V. Stepanova, B.N. Batuyev, A.G. Krotov, B.V. Malin, M.N. Maslov, V.F. Markov, I.M. Poroshina, M.S. Samovarov, A.M. Ashadze, L.I. Lazareva, I.K. Ermolayev. Detailed geological studies of hydrothermal fields in the North Atlantic, in Parson, L.M., Walker, C.L., and Dixon, D.R., eds., Hydrothermal Vents and Processes: London, Geological Society Special Publication 87, 43-64, 1995.

Kuhn, T., B. Alexander, N. Augustin, D. Birgel, C. Borowski, L.M. de Carvalho, G. Engemann, S. Ertl, L. Franz, C. Grech, P.M. Herzig, R. Hekinian, J.F. Imhoff, T. Jellinek, S. Klar, A. Koschinsky, J. Kuever, F. Kulescha, K. Lackschewitz, S. Petersen, V. Ratmeyer, J. Renken, G. Ruhland, J. Scholten, K. Schreiber, R. Seifert, J. Süling, M. Türkay, U. Westernstöer, F. Zielinski. The Logatchev Hydrothermal Field - revisited: Preliminary results of the R/V Meteor cruise Hydromar I (M60/3). InterRidge News 13, 1-4, 2004.

CRUISE MOMARDREAM-NAUT AND OTHER MOMAR EXPERIMENTS AT RAINBOW AND LUCKY STRIKE IN SUMMER 2007

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I. Operations at Rainbow Site: Project MoMARDREAM

The Rainbow vent site, one of the few known sites with ultramafic basement rock, is an ideal target for the multidisciplinary study of hydrothermal phenomena. A few years ago the research community decided to include studies at Rainbow as part of the MoMAR project. This site is characterized by the abundance of iron, an element that plays a major role in active processes at the scales of the spreading center down to molecules. The international program IODP (Integrated Ocean Drilling Program) is also considering Rainbow as a possible drilling site.

After several reconnaissance cruises, the main objective outlined for project MoMARDREAM is to define Rainbow using a multidisciplinary approach. The MoMARDREAM project is headed by Jérôme Dyment (IPGP-Paris), Françoise Gaill (CNRS-Université Paris 6) and Yves Fouquet (Ifremer). Its goals are two-fold: to study the role of iron in geological, hydrological, and biological processes; and to survey the site to prepare for the drilling project. Beyond the requirement of a "zero state" for repeated observations, and eventually the site monitoring required as part of the MoMAR project, the research community needs a comprehensive inventory of Rainbow's biological populations in order to preserve its fragile environment. Therefore we proposed to map the site in detail (including geological, physical/chemical and ecological parameters); to collect rock, fluid, and biological samples; and to deploy and recover colonization modules. In our initial proposal we planned to use the R/V *Pourquoi pas?* and ROV *Victor*; however, for technical reasons we had to use deep-sea manned submersible, *Nautile*, for the first cruise—hence the cruise name, MoMARDREAM-Naut.

The first 9 *Nautile* dives (July 8th-19th 2007) were dedicated to the biology and the geology of the Rainbow site. F. Gaill was chief scientist of this cruise, and J. Dyment was project leader. A major objective of the biological work was to understand the role of iron in the symbiotic relationship between *Rimicaris exoculata* shrimps and their associated bacteria. These interactions were studied *in situ* and for the first time, *in vivo*, in pressurized aquaria (IPOCAMP) sampled with PERISCOP designed by B. Shillito and G. Hamel. Microbiology was a primary focus of this first cruise. Microbial diversity, including bacteria, virus, fungi, protists and shrimp symbionts, will be studied by a team led by M.A. Cambon. J. Ravaux and J.Y. Toullec studied the stress responses of shrimps. The genomic characteristics of arthropod species will be analyzed by E. Bonnivard.

The microhabitat of these shrimps and other fauna was physically and chemically characterized by N. Le Bris and K. Bucas (Fig. 1). Additional physico-chemical measurements on symbiotic systems such as mussels were performed, and *in situ* experiments were monitored for 3 days. Colonization experiments, previously deployed at the Rainbow site during the MoMARETO cruise in 2006, were recovered successfully by O. Gros and F. Gaill (Fig. 2).

Fig. 1. See p. 8.
In situ measurements in **A.** *Bathymodiolus azoricus* and **B.** *Rimicaris exoculata*.

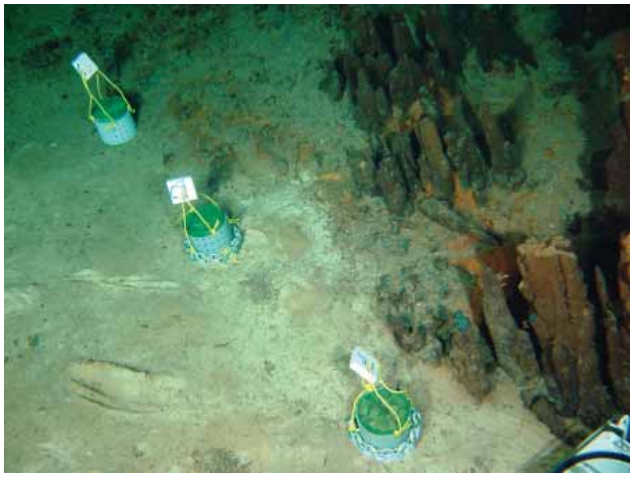

Fig. 2. Colonisation experiments at Rainbow using TRACs.

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H. Le Guyader classified the collected animals. Preliminary results indicate that organic substrates are colonized by fauna after one year of deployment. These experiments are part of CHEMECO, a project funded by the European Science Foundation (http://www.esf.org/activities/eurocores/programmes/eurodeep.html). Samples were also collected for the University of the Azores because a Portuguese team is also associated with this project.

About 20 fluid samples were collected by C. Konn and J.L. Charlou from 6 different vents exhibiting a temperature close to 350°-360° C (Fig. 3). The purpose was to collect new hydrothermal fluids samples from Rainbow in order to extend existing time series. Fluids were already sampled during cruises Flores (2004), and Exomar (2005), so one of the major aims will be to track any change in the fluids composition with time. Previous results indicate that all sampled fluids at Rainbow would exhibit a unique geochemical signature at the scale of the hydrothermal site.

Two *Nautile* dives and a dredging program were achieved by B. Ildefonse, M. Andreani and E. Hoisé to further constrain the lithology and geological structures on the seafloor at the scale of the massif that hosts Rainbow. This massif presents the characteristic dome morphology and varied lithology of oceanic core complexes. The abundant sediment cover of the massif precludes continuous geological mapping and successful dredging. The Rainbow serpentinite basement was continuously observed to a distance of about 1 km to the south of the hydrothermal site. Serpentinites were also found on the northwestern, northern, and northeastern flanks of the massif. Olivine-orthopyroxene-bearing gabbro was observed ~ 8700 m north of the site. Basalts and fresh basaltic glass were also recovered in talus and sediments on the southwest and northeast flanks of the massif.

Fig. 3. Fluid sampling with titanium syringes.

A second part of the MoMARDREAM cruise will hopefully take place in 2008 using the ROV *Victor*. The goal will be to perform high resolution microbathymetric and magnetic surveys.

II. Other MoMAR operations

Better understanding of the temporal and spatial variability of the water column is another key to the MoMAR project. The oceanographic studies initiated in 2006 during the Graviluck'06 cruise have been complemented with CTD casts both at Rainbow and Lucky Strike. This work has two purposes: 1) document variability in the water column to properly interpret the pressure records at the seafloor in order to extract a geodetic signal; 2) quantify the effect of seafloor topography on turbulent mixing, a key process in the transfer of dense bottom water masses to the surface, allowing a better understanding of the global oceanic cycle.

As part of the implementation of the MoMAR integrated study site at Lucky Strike, we carried out several experiments during the MoMARDREAM-Naut, BBMoMAR, and MARCHES2'07 cruises in 2007. First, we deployed a network of 4 short-period and one long-period OBS to monitor microseismicity, centered at the Lucky Strike volcano and with a total aperture of ~9 km. This microseismicity study was complemented by the recovery and redeployment of four hydrophones moored west and south of the Azores Plateau. This turn over was achieved as part of the MARCHE regional, long-term (July 2005-Summer 2008) acoustic monitoring program. Microseismic and hydroacoustic monitoring for 2006-2007 is complemented with pressure gauge records in the lava lake at the center of the hydrothermal field, and at the base of the volcano's east flank. These temporal studies will be continued through 2008-2009, with the deployment of temperature sensors at several hydrothermal vents at the Lucky Strike site during the Bathyluck'08 cruise, scheduled for June 2008.

The next major step in the MoMAR observatory effort is to develop and install two pilot seafloor observatory nodes acoustically linked to a surface buoy with telemetry to land. This effort will be coordinated within the EU ESONET project as one of several proposed multidisciplinary seafloor observatories.

EXTREME ECOSYSTEM STUDIES IN THE DEEP OCEAN: TECHNOLOGICAL DEVELOPMENTS

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Abstract

The general objective of EXOCET/D was to develop, implement and test specific technologies aimed at exploring, describing and quantifying biodiversity in deep-sea fragmented habitats, as well as at identifying links between community structure and environmental dynamics. The first leg of the MoMARETO cruise, held in summer 2006 on the new French oceanographic vessel *Pourquoi pas?* constituted the final demonstration of EXOCET/D. In addition to sea trials, the scientific objective of the cruise was to study the spatial and temporal dynamics of hydrothermal communities colonizing active hydrothermal sites on the Mid-Atlantic Ridge. Three vent fields, ranging from 850-m to 2300-m depth, were visited by the ROV *Victor 6000* during the cruise. Here, we present the first deployment and at sea validation of 13 prototype instruments developed within EXOCET/D. The instrument development was focused on three major topics: 1) Quantitative imaging, 2) Sampling and *in situ* measurements, and 3) Faunal sampling and *in vivo* experiments.

Project Objectives

The aim of EXOCET/D was the technological development of specific instrumentation allowing the study of naturally- or anthropogenically-perturbed ecosystems in the deep ocean. Ecosystems of particular interest to the EXOCET/D program included those with reduced fluids (cold seeps, hydrothermal vents), topographic structures such as seamounts, and those subjected to massive organic inputs or disturbances such as pollution or earthquakes. In contrast to much of the abyssal plain, the targeted ecosystems are characterized by patchy faunal distributions, unusual biological productivity, steep chemical and/or physical gradients, high perturbation levels and strong organism/habitat interactions at small (< 1 m) scales. Their reduced size and unique biological composition and functioning make these ecosystems difficult to study with conventional instrumentation and require the use of specialized technology such as submersibles to work at reduced scales on the seafloor. The development of autonomous instruments and seafloor observatories for long-term monitoring is also urgently needed (e.g. EU projects including ASSEM, Blandin & Rolin, 2005 and ESONET, http://www.ifremer.fr/esonet/). In addition, the increasing anthropogenic pressure on these poorly known deep-sea ecosystems emphasizes the need for rapid development of technologies dedicated to their investigation. Several European countries are now purchasing or developing deep-sea underwater vehicles, but their acquisition alone is not sufficient to realize effective integrated deep-sea studies. There is an urgent need for fast but long-term stable multi-sensor instrumentation that can be either connected to autonomous seafloor observatories or deployed on underwater vehicles.

The objective of this project was to develop, implement and test specific technologies aimed at exploring, describing and quantifying biodiversity in deep-sea fragmented habitats, as well as at identifying links between community structure and environmental dynamics. Onboard experimental devices complemented the approach, enabling experiments on organism physiology. The themes that were addressed in EXOCET/D include:

- 3D video imagery and small-scale reconstruction, long term video module, and simultaneous collection of acoustic and video imagery for ecosystem mapping,
- *in situ* analysis of habitat chemical and physical components using *in situ* analyzers and sensors (methane, flow) associated with water sampling,
- quantitative sampling of macro- and micro-organisms and *in vivo* experiments in simulated *in situ* conditions,
- integration of multidisciplinary and multi-scale data on Geographic Information System (GIS) software,
- instrument implementation on deep-submersibles,
- scientific validation during final demonstration cruise in 2006.

EXOCET/D was a three-year project started in 2004 and funded by the European Commission (STREP, FP6-

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GOCE-CT-2003-505342). It involved partners from ten research institutions and three small and medium enterprises. The project coordination was carried out by Ifremer (P.-M. Sarradin). The project was organized in 6 thematic workpackages. The project management and animation was carried out through a web site (http://www.ifremer.fr/exocetd). This site gathered both a private access for the EXOCET/D consortium, acting as a management and information sharing tool, and a public access presenting the objectives and progress of the project to the general public.

MoMARETO: final demonstration of EXOCET/D

The first leg of the MoMARETO cruise (Sarrazin et al. 2006), held from August 6 to September 6, 2006 on the new French oceanographic vessel *Pourquoi pas?*, constituted the final demonstration of EXOCET/D. The main objective of this cruise was to study the spatial and temporal dynamics of hydrothermal communities colonizing the MoMAR zone, located on the Mid-Atlantic Ridge (MAR) near the Azores Triple Junction (ATJ). The cruise was organized in two legs, permitting 56 scientists to work on board. The first leg of the cruise was dedicated to the final integration and validation phase of 13 equipment prototypes developed during the project. A fine-scale bathymetric study of the Lucky Strike area was also conducted (Simeoni et al. 2007). The approach for the second leg was to study the response of different hydrothermal species to their environment at two temporal scales: a very short-term response of organisms to habitat micro-variations (hours-days) and a longer observatory-type scale where the dynamics of faunal assemblages will be linked to broader-scale habitat variations (months-years). The second leg heavily relied on the instrumentation tested during the first leg. Three vent fields, ranging from 850-m to 2300-m depth, were visited by the ROV *Victor 6000* during the cruise.

The MAR in the vicinity of the ATJ has been extensively studied over the past 15 years, leading to the discovery of three major vent fields - Menez Gwen, Lucky Strike and Rainbow - located on three segments of the south-eastern limb of the ATJ. The vent fields differ by their depths (850 to 2300 m), their tectonic settings, the composition of their host rocks (mantle-derived serpentinized peridotite vs. basalt), the nature of associated volcanism, their fluid composition and the dominance of different key faunal assemblages (Charlou et al. 2000, 2002; Desbruyères et al., 2001; Douville et al., 2002).

Validation of the EXOCET/D prototypes

Quantitative imaging

Two stereo-video cameras, CAMEREO and IRIS, were tested during the cruise. The underwater video imagery obtained by the cameras will be used to make projective 3-D reconstructions of small-scale scenes. IRIS is based on stereovision techniques and is operated by a robotic arm on *Victor 6000* (Brandou et al., 2007).The image acquisition phase was done by visual servo-control that allows a precise control of the camera position. This not only improves the image mosaicking process but permits the scaling of the features present in the image (e.g., organism size and density) and to associate the precise positioning of *in situ* measurements to faunal distribution.

An advanced 3D viewer software (A3DV) was tested during the cruise. Real 3D data issued from IRIS stereo camera imagery were to be annotated and visualized by the A3DV. Unfortunately, 3D reconstructions from the stereo camera required too much processing time on board and were not available during the trials. A compromise solution was found by using recently acquired bathymetric data as a 3D mesh. The newly-developed A3DV was able to visualize and annotate the 3D bathymetric mesh.

TEMPO (Fig. 1), a long-term imaging module was developed to study community dynamics and patterns of succession in remote habitats (Sarrazin et al., 2007a). This module is comprised of a deep-sea autonomous video camera and two LED projectors. The video camera is able to activate the projectors and to record digital pictures on a hard disk. A biofouling protection based on localized microchloration was installed on the camera port and on the lights. TEMPO was also equipped with a CHEMINI Fe *in situ* analyzer and

Fig. 1. See p. 8.
In situ chemical analyzer CHEMINI implemented on the TEMPO autonomous station (Ifremer).

Fig. 2. New methane sensor with attached flow-through chamber and CTD pump as commercially available from Franatech GmbH.

with three temperature probes, and was powered by a Sea-Monitoring Node (SEAMON; Blandin & Rolin, 2005). *Victor 6000* was used to precisely position the module near a mussel assemblage and a Contact Less Serial Iinductive link was used to control the complete setting (camera and CHEMINI probe). The operational module was moored for one year and should be recovered during the RECO cruise in the summer 2007. However, due to technical problems, the recovery was delayed to 2008.

To evaluate the potential of using acoustic backscatter data to study deep-sea community distribution and dynamics, a Tritech Super SeaKing Dual Frequency Profiler was installed on *Victor 6000*. The longitudinal axis of the sonar housing was perpendicular to the axis of the ROV's main video camera. The sonar was programmed to acquire and log each ping's backscatter at the highest resolution available. A series of tests were performed to acquire acoustic and vision data. Several vertical transects were done on different hydrothermal edifices and habitat types during both legs. Visual data were used to train classification algorithms and validate the results obtained. Future work will include the use of these algorithms to georeference acoustic bottom returns, thus contributing to the development of accurate 3D models of the observed structures.

Sampling and in situ measurements

Hydrothermal vent ecosystems are characterized by limited spatial scales, steep biogeochemical and physical gradients, and the coexistence of chemically reactive species (hydrogen sulfide, reduced metals) and dissolved gases (oxygen, methane). Appropriate instrumentation is necessary to study the extreme variability of environmental factors. *In situ* analyses are preferable when possible in order to avoid sample artifacts and alterations caused by depressurization and temperature effects. Different analyzers and sensors were adapted and optimized from existing instruments and tested during the cruise. A second-generation *in situ* chemical analyzer based on flow analysis and colorimetric detection was tested (Le Bris et al., 2000). Two CHEMINI modules (Fig.1) were used for the analyses of total sulfide and Fe II or total Fe (Sarradin et al., 2005). The module is designed around an engraved manifold and a miniaturized photometric system. The first results obtained showed analytical performance comparable to a bench-top system, with detection limits close to 0.2 µM for both variables. In parallel, a second *in situ* chemical analyzer (Deep Probe Analyzer DPA) was developed and tested for the same chemical variables.

Sampling followed by on-board analysis often remains the only analytical way to complement the range of geochemical species covered by *in situ* sensors. It is also used to validate data obtained by *in situ* measurements. PEPITO is a small-volume water sampler enabling the intake of a high number of samples (up to 23). It was tested and used during the cruise for many different purposes: ground-truthing of the methane sensor, *in situ* filtration on 0.45 µm filters, water sampling in the vicinity of hydrothermal assemblages (pH, methane, dissolved and particulate Fe, Cu, Cd, Pb and organic matter) and microbial mat sampling.

Capsum (Germany) type methane sensors (METS) that had been modified and optimized within EXOCET/D were tested during the cruise. Two different sensors were used in a flow system using either a CTD pump or the PEPITO pump (Fig.2). The sensors were installed on the *Victor 6000* survey module in line with the PEPITO water sampler. Water samples were taken in parallel with the *in situ* measurements for direct comparison with the sensor signal.

The isosampler (ISObaric SAMPLER) hydrothermal flux sensor (Earth-Ocean Systems Ltd, UK) is designed to determine simultaneously the temperatures and flow rates in the hydrothermal vent habitat. The isosampler was deployed to quantify the fluxes of fluid and heat within faunal assemblages located on Menez Gwen and Lucky Strike fields. It operated over a wide variety of temperatures and flow rate regimes.

Faunal sampling and in vivo experiments

Microorganisms play a crucial role in biogeochemical processes, and recent studies based on molecular biological methods suggest that less than 5% of marine microbial species have been identified. Thus a variety of biochemical pathways and key enzymes remain to be discovered. The development of advanced sampling technologies is required to pursue the discovery of new microorganisms. AISICS is an instrumented microbial colonization system. This autonomous device allows the *in situ* col-

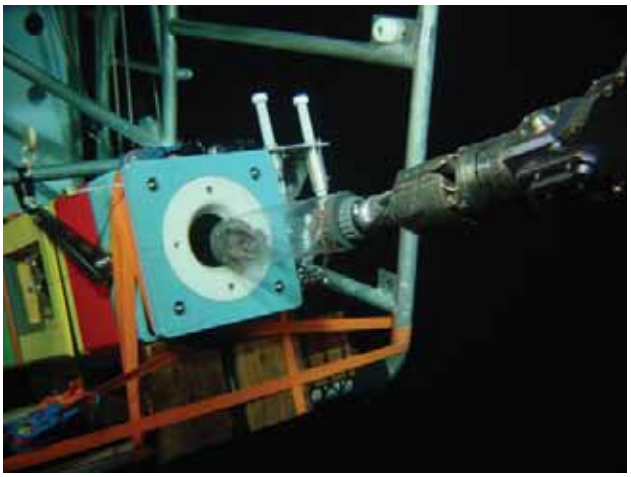

Fig. 3. PERISCOP hyperbaric sampling device (UPMC).

onization of a specific substratum by indigenous microorganisms. It is coupled with a water sampler and a temperature probe, providing information on temperatures and fluid composition during colonization events. AISICS was deployed four times (from 50- to 70-h periods) on an active hydrothermal chimney during the cruise. Temperature was continuously recorded inside the system and fluids were sequentially sampled (4 samples per deployment).

Live organism studies represent a luxury that deep-sea biologists rarely access. Yet, this type of research has proved very valuable towards understanding the biology of such organisms. In the case of hydrothermal vent ecosystems, relevant biological features such as thermotolerance, reproduction, or primary production have been determined using *in vivo* experimentation at native pressure. A pre-requisite to successful *in vivo* pressure experiments of collected organisms is to insure their survival throughout recovery. PERISCOP is a hyperbaric sampling device, allowing the collection and recovery of deep-sea organisms at their natural pressure (isobaric collection) at depths reaching 3000 m (Fig. 3). It allows an access to live animals or bacteria, by avoiding a traumatic and often lethal decompression. PERISCOP was tested successfully during the first leg. At the end of the cruise, the pressure retention of PERISCOP was almost perfect (95%) and the temperature inside the system remained fairly low (6.5°C for a bottom temperature of 4.5°C). Several types of organisms were collected using the PERISCOP, from two different depths, 1700 and 2300 m.

In addition to collection devices, high-pressure instruments to study the physiological processes of vent-endemic and other deep-sea fauna are still rare. DESEARES (DEep-SEA RESpirometer - Fig. 4) was developed to better understand, by an ecophysiological approach, the mechanisms responsible for the life and evolution of key organisms living in extreme deep-sea habitats. DESEARES is composed of three small pressure chambers, two dedicated to experiments and a third one serving as the control. The temperature inside the chambers is controlled and the circulating fluid is composed of sea water with known concentrations of different gases mimicking the *in situ* conditions of the animals. The system that controls fluid composition is called SYRENE. It was developed during the VENTOX European project. DESEARES and SYRENE were installed on-board the ship during the entire cruise.

Fig. 4. The three pressure chambers of the DESEARES DEep-SEA RESpirometer (SB Roscoff).

In addition to work during the MOMARETO cruise, an *In situ* Incubator (InSinc) designed for applications on remotely operated vehicles and submersibles was successfully deployed during three expeditions to cold seeps (Viking cruise to Haakon Mosby Mud Volcano with R/V *Pourquoi pas?* and ROV Victor, Bionil cruise to the Nile deep sea fan with R/V *Meteor* and ROV *Quest*, and JAMSTEC cruise to the Nankai trough with R/V *Yokosuka* and submersible *Shinkai*). This incubator allows the *in situ* injection and incubation of radiotracer in surface sediments (0-40 cm). HMMV, the Nile deep sea fan, and the Nankai trough are characterized by elevated methane concentrations, thus anaerobic methane oxidation and sulfate reduction rates in surface sediments make these structures ideal for InSinc applications.

Communication plan during the MoMARETO cruise

In addition to scientific and technological objectives, one of the major goals of this cruise was to share the excitement of our science with the public. For this, the results of the project were shared through different media. A day-to-day log book of the cruise allowed close interactions with web users (http://www.ifremer.fr/momareto/), and cruise events were reported in several national and international newspapers, radio and TV shows. The most challenging communication event was the real-time transmission of *Victor 6000* video imagery from the bottom to a 250 person audience on land (Sarrazin et al., 2007b). Finally, a movie tracing the cruise was presented to Oceanopolis aquarium during the Oceanographic film festival and was also used during several general public conferences.

Conclusion

The MoMARETO cruise was the main demonstration action of the EXOCET/D project. After nearly three years of development, the project was a real success with the at sea trial and validation of 13 instrument prototypes developed for the study of deep-sea extreme habitats, tested during the first leg of the cruise. After this necessary validation, the prototypes were effectively used for scientific studies during the second leg and additional cruises. Future cruises and European projects (Hermes, ESONET) should make the most of this up-to-date technology.

Acknowledgments
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References

Blandin J. and J.F. Rolin. An Array of Sensors for the Seabed Monitoring of Geohazards, a Versatile Solution for the Long -Term Real-Time Monitoring of Distributed Seabed Parameters. Sea Technology, 46: 33-36, 2005.

Brandou, V., A.G. Allais, M. Perrier, E. Malis, P. Rives, J. Sarrazin, P.M. Sarradin. 2007. 3D reconstruction of natural underwater scenes using the stereovision system IRIS. OCEANS'07 IEEE Aberdeen Conference Proceedings, ISBN n° 1-4244-0635-8, 2007.

Charlou J. L., Donval J. P., Douville E., Jean-Baptiste P., Radford-Knoery J., Fouquet Y., Dapoigny A., Stievenard M. Compared geochemical signatures and the evolution of Menez Gwen (37°50'N) and Lucky Strike (37°17'N) hydrothermal fluids, south of the Azores Triple Junction on the Mid-Atlantic Ridge. Chemical Geology, 171: 49-75, 2000.

Charlou J. L., Donval J. P., Fouquet Y., Jean-Batiste P., Holm N. Geochemistry of high H2 and CH4 vent fluids issuing from ultramafic rocks at the Rainbow hydrothermal field (36°14', MAR). Chemical Geology, 191: 345-359, 2002.

Desbruyères D., Biscoito M., Caprais J. C., Colaço A., Comtet T., Crassous P., Fouquet Y., Khripounoff A., Le Bris N., Olu K., Riso R., Sarradin P. M., Segonzac, M. and Vangriesheim A. Variations in deep-sea hydrothermal vent communities on the Mid-Atlantic ridge near the Azores plateau. Deep-Sea Res. I 48: 1325-1346, 2001.

Douville E., Charlou J. L., Oelkers E. H., Bienvenu P., Colon C. F. J., Donval J. P., Fouquet Y., Prieur D., Appriou P. The rainbow vent fluids (36°14'N, MAR): the influence of ultramafic rocks and phase separation on trace metal content in Mid-Atlantic Ridge hydrothermal fluids. Chemical Geology 184: 37-48, 2002.

Le Bris N., Sarradin P., Birot D. and Alayse-Danet A. A new chemical analyzer for *in situ* measurement of nitrate and total sulfide over hydrothermal vent biological communities. Marine Chemistry, 72: 1-15, 2000.

Sarradin P.-M., Le Bris N., Le Gall C. and Rodier P. Fe analysis by the ferrozine method: Adaptation to FIA towards *in situ* analysis in hydrothermal environment. Talanta, 66: 1131-1138, 2005.

Sarradin, PM, J. Sarrazin, K. Olu, E. Sauter, R. Serrão Santos, A. Pascoal, B. Shillito, F. Zal, A. Schultz, D. Lane, H. du Buf, C. Waldmann, A. Cormack, L. Sanfilippo, M. Masson. 2007. EXtreme ecosystem studies in the deep OCEan: Technological Developments. EXOCET/D. OCEANS'07 IEEE Aberdeen Conference Proceedings, ISBN n° 1-4244-0635-8, 2007.

Sarrazin J., P.M. Sarradin and the MoMARETO cruise participants: MoMARETO: a cruise dedicated to the spatio-temporal dynamics and the adaptations of hydrothermal vent fauna on the Mid-Atlantic Ridge. InterRidge News, 15, 24-33, 2006.

Sarrazin, J., J.P. Lévèque, L. Delauney, S. Dentrecolas, P. Dorval, J. Dupont, D. Leroux, J. Legrand, P. Léon, P. Rodier, R. Vuillemin, P.M. Sarradin. 2007a. TEMPO: a new ecological module for studying deep-sea community dynamics at hydrothermal vents. OCEANS'07 IEEE Aberdeen Conf. Proceedings, ISBN n° 1-4244-0635-8, 2007.

Sarrazin J., Sarradin P.M., Desbruyères D., Lecornu F., Millet B., Clodic G., Le Rest J., Le Fur, Y., Jannez, M., Christophe A., Fouquet Y., Lux S., Lefort, O., Guillemet, P. 2007b. A real-time dive on active hydrothermal vents. OCEANS'07 IEEE Aberdeen Conf. Proceedings, ISBN n° 1-4244-0635-8, 2007.

Simeoni P., Sarrazin J., Nouzé H., Sarradin P.M., Ondréas H., Scalabrin C., Sinquin J.M. Victor 6000: New High Resolution Tools for Deep Sea Research : « Module de Mesures en Route ». OCEANS'07 IEEE Aberdeen Conf. Proceedings, ISBN n° 1-4244-0635-8, 2007.

INTERNATIONAL RESEARCH: *SE AND SW INDIAN RIDGES*

PRELIMINARY REPORT ON THE PLURIEL CRUISE, SAINT PAUL-AMSTERDAM PLATEAU, INDIAN OCEAN (MAURITIUS, SEPTEMBER 18 - LA RÉUNION, OCTOBER 31, 2006)

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Abstract

The goal of the PLURIEL cruise was to study the temporal evolution of the interaction between the St. Paul-Amsterdam (SPA) hotspot and the Southeast Indian Ridge (SEIR) over the last 10 m.y. The SPA-SEIR system is a good target to study the early phases of a ridge-hotspot interaction and the building of an axial plateau. Northeast of the SPA plateau, which corresponds to the near-axis phase of the hotspot activity, a chain of volcanoes possibly marks its intraplate activity. The preliminary results of the cruise show that the transition from an intraplate phase of activity (a volcanic chain) to an axial phase (the plateau) took place quickly. The building of the SPA plateau started roughly 10 m.y. ago and evolved in a complex pattern of ridge jumps, propagations and rotations, likely with periods of increased magmatic activity.

Introduction

The PLURIEL Cruise was held between September 18 and October 31, 2006 on board the *Marion Dufresne II*, in the area of the Saint Paul-Amsterdam Plateau. The scientific objective of the cruise was to study in detail the interaction between the Southeast Indian Ridge (SEIR) and the Saint Paul-Amsterdam (SPA) hotspot during the last 10 m.y. (Maia et al., 2007). We carried out a complete survey of the area east of the ridge axis with multibeam bathymetry and side-scan imaging, gravity and magnetics, as well as 30 successful dredges (Figure 1).

The portion of the SPA plateau near the ridge axis was first surveyed and sampled during the Boomerang cruise in 1996 (Conder et al., 2000; Johnson et al., 2000; Scheirer et al., 2000). Their results revealed a complex recent history for the plateau, with ridge jumps, axial propagations and rotations. They also suggested that the plateau is presently being rifted from south to north by the SEIR, with a near-normal accretion regime being installed in the south in the last million years. The hotspot activity is presently concentrated on the western flank of the plateau, with several recent lava fields and an active volcano located between Amsterdam Island and the SEIR axis, the Boomerang seamount.

East of the area surveyed by the Boomerang cruise, satellite altimetry maps (Sandwell and Smith, 1997) show the prolongation of the plateau depth anomaly, bounded to the north by the Amsterdam fracture zone (FZ). Its southern border approximately coincides with the trace of the St. Paul FZ, no longer active in the ridge area. This area of shallow depths is visible to 81°30'E, where it merges with a volcanic chain, which continues northeastward roughly until Broken Ridge. The chain emplacement is in good agreement with the past positions of the SPA hotspot in the

Fig. 1. See p. 61.
Multibeam bathymetry for the SPA Plateau and the volcanic chain with cruise tracks and dredge stations. The Boomerang tracks are plotted in green and the PLURIEL tracks are plotted in red. Black circles correspond to dredge stations with basaltic samples. White circles correspond to dredges without basalt.

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last 20 m.y., and it is therefore reasonable to consider that it represents the trace of the intraplate activity of the hotspot, before its interaction with the SEIR. The PLURIEL cruise surveyed and sampled the area of the depth anomaly as well as most of the volcanoes of the chain (Figure 1). Our main objectives were:

1. To characterize the volcanic chain in terms of chemical composition and ages, in order to determine its origin and links with the SPA hotspot and the plateau;
2. To understand the early phases of the construction of an axial volcanic plateau and to follow its evolution in time;
3. To understand the transition between the intraplate phase of activity of a hotspot and its axial phase of activity, or, in other terms, the beginning of a ridge-hotspot interaction.

Preliminary results

East of the plateau

The preliminary results of the cruise reveal that the depth anomaly is indeed the continuation of the SPA plateau and that it extends up to the volcanic chain (Figure 1). The structure of this part of the plateau displays the same kind of complexity discussed by Conder et al. (2000) and Scheirer et al. (2000) for the near-axis portion, with ridge jumps and propagations. Due to this instability, the identification of magnetic anomalies is difficult. A few identifications allow us to place some age constraints in the evolution of this part of the plateau and to calculate a residual depth anomaly (Figure 2). The asymmetry between the east and the west flanks of the SEIR for the period between the beginning of anomaly 5 (9.8 Ma.) and the present is of about 100 km and suggests the existence of southwestwards ridge jumps on the eastern flank of the SEIR. This older part of the plateau can be divided in two segments of approximately 50 km in length, separated by a discontinuity that is marked by the presence of small volcanic cones, either isolated or forming clusters of smaller edifices. This discontinuity exists at least since the end of anomaly 4A (9.6 Ma.) and corresponds to a small offset of 20 km. These two segments have a very different behavior in terms of ridge instability. They may correspond to segments I1 and I2 in the notation of Conder et al (2000).

Fig. 2. See p. 61.
Residual bathymetry, corresponding to the bathymetry minus the subsidence, calculated from the age grid derived from magnetic anomaly identifications. Magnetic anomalies are labeled (e.g., C2A) and indicated by black lines. The dashed lines show the location of the ridge axis from Conder et al. (2000). Possible failed axes are shown by dotted lines.

The southern segment will be referred to here as segment I2', for paleo-segment I2, and it might have been divided into two smaller segments in the past, as suggested by a small offset near the end of anomaly 4A. It displays a regular pattern of abyssal hills, oriented parallel to the present day ridge direction. The residual depth maps show three different morpho-structural styles, at different time periods. Between 9.6 and 5.2 m.y. (end of anomalies 4A and 3), the residual depth shows anomalous shallow values and a smooth morphology. Between 5.2 and ~3 m.y. (end of anomalies 3 and 2A), the average depth increases and abyssal hills are larger and more marked. A series of deep grabens are visible, and one corresponds to an old rift, at which activity ceased at anomaly 2A. A few km west of this failed axis, the average depths increase again as we reach the more recent part of the SPA plateau. A series of high and elongated sinusoidal ridges marks this transition. Close to these ridges, a series of elongated depressions may mark another failed rift. So, at least two failed rifts were identified, but it is highly likely that a third one existed between 9.6 and 5.2 m.y. (end of anomalies 4A and 3). The southern border of this segment corresponds roughly to the trace of the St. Paul FZ. Lavas flowed on the ocean floor south of this border from the plateau, showing the intense magmatism occurring there.

The northern segment will be named segment I1'. It displays a very complex structural pattern with "V" shaped and sinusoidal features, indicating that the accretion instabilities were accommodated differently for segments I2' and I1'. While at I2' the ridge instability appears as a series of successive ridge jumps at short time intervals, at I1', it corresponds to propagations and rotations. As a consequence, the magnetic anomalies are very difficult to follow. The Amsterdam FZ corresponds to a sharp boundary north of segment I1'.

Several volcanic features of this part of the plateau were dredged during the cruise (Figure 1), often yielding basaltic samples. In addition, three dredges at the ridge axis completed the sampling of the Boomerang cruise. On the ridge between Amsterdam and St. Paul Islands, three dredges recovered volcano-sedimentary breccias and pumice, which are suggestive of explosive volcanism at shallow depths. Two small volcanic cones located on the discontinuity between segments I1' and I2' as well as volcanoes located south of Amsterdam FZ yielded vesicular basalts. One dredge (DR34) hauled at the southern border of the plateau yielded massive basalts. These samples will allow us to study the evolution of the composition of the lavas erupted under the influence of the SPA hotspot.

The volcanic chain

The volcanic chain is emplaced on the segment of oceanic lithosphere bounded by the Amsterdam and the St Paul fracture zones. Along the chain, most of the edifices are grouped into clusters. Their shape is seldom circular and frequently elongated, showing a preferential direction, oblique to the neighboring fracture zones. Some summits reach depths as shallow as 200 m. A large number of edifices were surveyed and sampled. Dredged rocks suggest old ages, with vesicular basalts often covered by a thick manganese crust, sometimes showing traces of hydrothermal activity. The basalts are more vesicular than those dredged on the plateau itself and more crystallized. A particular edifice, located over the edge of the St Paul fracture zone is cross-shaped and clearly controlled by the fracture zone and by the orthogonal abyssal hill directions. Its emplacement on the edge of an inactive segment of the fracture zone indicates an age younger than the oceanic crust. The edifices are located on a regional depth anomaly.

Transition from intraplate to axial activity and plume pulses?

The transition from the intraplate phase, marked by the volcanic chain, to the axial phase, marked by the beginning of the first depth anomalies and ridge instabilities, happens in a short period of time, around the beginning of anomaly 5. It corresponds to a rapid reduction in the size of the volcanoes and to the shallowing of the axial depths. Since this time, the ridge axis apparently jumps systematically to the southwest, as if trying to remain close to the SPA hotspot. At the earlier phases of the ridge-hotspot interaction, the volcanic activity at the ridge axis resulted in an area of shallow depths and relatively smooth topography, similar to the morphology currently observed at fast spreading ridges. Preliminary gravity models also suggest this period may also correspond to increased crustal production. After this period, an episode of lower magmatic budget corresponds to an increase in the average depths and to morphology comparable to that of slow spreading ridges. A second magmatic phase begins around 3 m.y. and marks the building of the more recent part of the SPA plateau. A comparison between the residual depth anomalies corresponding to the two more magmatic periods shows that the second period corresponds to a broad, shallow depth anomaly, the first period displaying smaller volcanic ridges and a smaller extension. It is possible that these two periods correspond to an increase in the flux of the SPA hotspot and therefore to two successive pulses, separated by an interval of ~2.5 m.y.

General conclusions

The interaction between the SEIR and the SPA hotspot lasted about 10 m.y., yielding variations in the ridge morphology and probably in the crustal structure, as well as strong instabilities in the axis location. During this period, the plume flux appears to have varied, with two phases of more intense activity being reflected by shallow and smoother axial topography. The transition between the intraplate phase of activity—characterized by the building of individual or grouped volcanoes, and the axial phase—characterized by a plateau—happened in a short time interval.

References

Conder, J.A., D. S. Scheirer and D. W. Forsyth. Seafloor spreading on the Amsterdam-Saint Paul hotspot plateau. J. Geophys Res., 105, 8263-8277, 2000.

Johnson, K.T.M., D. W. Graham, K. H. Rubin, K. Nicolaysen, D. S. Scheirer, D. W. Forsyth, and L.M. Douglas-Priebe. Boomerang Seamount: the active expression of the Amsterdam – St Paul hotspot, Southeast Indian Ridge. Earth Planet. Sci. Lett. 183, 245-259, 2000.

Maia, M. and the PLURIEL team, New constraints on ridge-hotspot interactions from the PLURIEL cruise, Saint Paul-Amsterdam Plateau, Indian Ocean. Geophysical Research Abstracts, Vol. 9, 07622, 2007.

Sandwell, D.T. and W.H.F. Smith. Marine gravity anomaly from Geosat and ERS1 satellite altimetry. J. Geophys. Res., 102, 10039-10054, 1997.

Scheirer D. S., D. W. Forsyth, J.A. Conder, M.A. Eberle, S-H. Hung, K. T. M. Johnson and D. W. Graham. Anomalous seafloor spreading of the Southeast Indian Ridge near the Amsterdam-St Paul plateau. J. Geophys. Res., 105, 8243-8262, 2000.

DISCOVERY OF THE FIRST ACTIVE HYDROTHERMAL VENT FIELD AT THE ULTRASLOW SPREADING SOUTHWEST INDIAN RIDGE: THE CHINESE DY115-19 CRUISE

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Abstract

The first active hydrothermal field on the Southwest Indian ridge (SWIR) was discovered during Legs 1 & 2 of Cruise DY115-19 aboard the Chinese research ship R/V *Da Yang Yi Hao* (8 January - 11 March 2007). This finding followed the earlier discovery of strong hydrothermal plume anomalies along this section of the SWIR in November 2005 using Miniature Autonomous Plume Recorders (MAPRs), during the Indian Ocean Leg of the first modern Chinese around-the-globe expedition sponsored by the China Ocean Mineral Resources R&D Association (COMRA). This newly discovered hydrothermal field is in the central-eastern portion of the SWIR and located at the western end of a magmatically robust spreading segment, west of the Gallieni transform fault. Hydrothermal sulfide deposits, chimney samples and around 5000 photos were obtained by TV-guided grab and WHOI's autonomous underwater vehicle ABE (Autonomous Benthic Explorer).

The DY115-19 Leg 1 & 2 survey programs

The first evidence for the presence of hydrothermal activity on the SWIR was reported by the InterRidge cruise "FUJI" in 1997 (German et al., 1998). During the FUJI cruise, the MAPR sensors (Baker and Milburn, 1997) were suspended both above and below the TOBI deep-tow vehicle as it conducted surveys at between 300–500 m above the seafloor along two adjacent 200 km-long sections of ridge crest (German et al., 1998). In November 2005, preliminary evidence for strong turbidity anomalies in a ridge segment west of the Gallieni transform fault was first measured by R/V *Da Yang Yi Hao* (Lin and Zhang, 2006).

Hydrothermal activity was visually confirmed in this area during the 2007 expedition DY115-19, which was the second COMRA-funded cruise to the Indian Ocean. The first color video footage of the seafloor in the vent area was obtained by a towed video camera (Fig. 1) in February 2007 during Leg 1 of the expedition. Major water column turbidity anomalies, noticeable temperature anomalies and methane anomalies were all detected at that time. This vent field was then more extensively surveyed and photographed during Leg 2 using the ABE (Autonomous Benthic Explorer) autonomous underwater vehicle (Fig. 2). More than 5,000 near-bottom color photos were taken and several types of water column data were recorded during three phases of ABE dives, revealing detailed seafloor geology, water column anomalies, and ecological features. Hydrothermal sulfide deposits were then successfully obtained using a TV-grab (Fig. 3).

Fig. 1. The 6000-m integrated plume detection tow-system that was used during the DY115-19 expedition. This system includes video, camera, ADCP, CTD and USBL sensors, together with add-on MAPR and Mets sensors. Photo courtesy of DY115-19 Science Party.

Fig. 2. See p. 8.
Deployment of the ABE (Autonomous Benthic Explorer) vehicle on board R/V *DaYang YiHao* during the DY115-19 expedition. The ABE vehicle was developed at Woods Hole Oceanographic Institution. Photo courtesy of Dana Yoerger. The 3-phase method used for vent-exploration is described in detail by German et al. (in press, 2008).

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The geological and geophysical data were obtained using a Kongsberg EM120 multibeam bathymetry system, Geometric G-880G magnetometer, single channel seismic system, and GSS-2 and L&R S-133 gravitimeters. The TV-grab was used for geological sampling, while the deep-sea video camera system was used for color ocean floor observation. A large number of *in situ* stations and tow-yo profiles were conducted. During each deployment a string of sensors, including the MAPRs, Mets (an *in situ* methane sensor), CTD, and ADCP instruments, was clamped onto a co-axial cable at varying heights above the deep-towed video camera vehicle or the TV-grab. We also conducted *in situ* station measurements by placing MAPR and Mets sensors above a SBE911 CTD and Niskin bottle rosette. Ultra-Short Base-Line (USBL) navigation was used whenever possible to obtain the most accurate location of the towed vehicles. After the vent field was approximately located during Leg 1, Leg 2 used the ABE to narrow down the precise position of the vent field.

The active vent field

The new vent field is located at the western end of spreading segment 28 (Sauter et al, 2001), between the Indomed (46.0°E) and Gallieni (52.2°E) transform faults. This segment is associated with unusually shallow seafloor and negative residual mantle Bouguer gravity anomaly (Georgen et al., 2001), indicating strong magma supplies.

ABE images included photographs of black smoke, chimney structures and vent-related fauna, all of which will be reported elsewhere, in the peer-reviewed literature. Preliminary analyses of a selection of sulfide chimney samples from the new vent field reveal enrichments in precious metals including Au and Ag as well as Cu, Fe and Zn. The limited SWIR samples examined so far appear to have lower concentrations of Cu and Zn but higher Fe concentration than the samples from the Mid-Atlantic Ridge.

Fig. 3. TV-guided grab used during the DY115-19 expedition to recover hydrothermal sulfide deposits. The device was developed by the Pioneer Hi-Tech R&D Inc. in Beijing and funded by COMRA. Photo courtesy of DY115-19 Science Party.

The discovery of the first active hydrothermal vent field at the ultraslow spreading SWIR is an important event for geological, hydrothermal, and biological research in the Indian Ocean and, indeed, for all ultraslow spreading ridges. This is also a milestone event in Chinese oceanographic research and exploration of ocean mineral resources. The success of the DY115-19 expedition represents further strong testimony for the importance of international cooperation in mid-ocean ridge research.

Acknowledgements

We are grateful to Captain Songgang Zhen and the crew of the R/V *Da Yang Yi Hao* for their professionalism and dedication during Cruise DY115-19 Legs 1 & 2. We also wish to acknowledge the professional contributions made by the WHOI ABE team engineers Al Duester and Andy Billings. The DY115-19 expedition was organized and funded by COMRA with additional support from the Woods Hole Oceanographic Institution and the Census of Marine Life's Biogeography of Deep-Water Chemosynthetic Ecosystems (ChEss) program.

References

Baker, E.T. and H.B. Milburn, MAPR: A new instrument for hydrothermal plume mapping, Ridge Events, 8, 23–25, 1997.

Georgen, J.E., J. Lin and H.J.B. Dick, Evidence from gravity anomalies for interactions of the Marion and Bouvet hotspots with the Southwest Indian Ridge: Effects of transform offsets, Earth & Planetary Science Letters, 187, 283-300, 2001.

German, C.R., E.T. Baker, C.A. Mevel, and K. Tamaki, Hydrothermal activity along the South West Indian Ridge, Nature, 395, 490–493, 1998.

German, C.R., D.R. Yoerger, M. Jakuba. T.M. Shank, C.H. Langmuir and K. Nakamura Hydrothermal exploration using the Autonomous Benthic Explorer, Deep Sea Research, in press, 2008.

Lin, J. and C. Zhang, The first collaborative China-international cruises to investigate mid-ocean ridge hydrothermal vents, InterRidge News, 15, 33-34, 2006.

Sauter, D., P. Patriat, C. Rommevaux-Jestin, M. Cannat, A. Briais, and Gallieni Shipboard Scientific Party, The Southwest Indian Ridge between 49°15'E and 57°E: Focused accretion and magma redistribution, Earth & Planetary Science Letters, 192, 303-317, 2001.

NATIONAL NEWS

CANADA

S. Scott

NEPTUNE Canada gets wet!

The Canadian NEPTUNE project has completed the laying of 800 km of cable for its first set of observatories on the Juan de Fuca Plate in the NE Pacific Ocean. The details of the program were revealed by NEPTUNE scientists and engineers at the "Ocean 2007 MTS/IEEE" conference (about 1500 attendees) held in Vancouver, October 2-4 (see also the NEPTUNE web site at http://www.neptunecanada.ca). The cable, purpose-built for NEPTUNE in Calais, France, was laid in a loop by Alcatel-Lucent's ship *Ile de Sein* running from Port Alberni on Vancouver Island, down the Alberni Inlet and out into the abyss. Four nodes will soon be installed: at ODP site 889 on the continental slope, the Endeavour spreading segment of the Juan de Fuca Ridge (a marine protected area), mid-plate ODP site 1027, and Barkley Canyon on the continental slope (see Fig. 1, from NEPTUNE Canada News, September 2007). Scientific instruments will be installed soon thereafter utilizing extension cables to be laid by the Canadian *ROPOS* ROV with a system designed and built by the ROV team (Fig. 2). A fifth node to service the Middle Valley hydrothermal site on the Juan de Fuca Ridge is waiting for funding. The cable laying was preceded by an August 2007 cruise with the *ROPOS* onboard the University of Washington's *Thomas G. Thompson* to survey part of the route and some of the node locations. A shore station is being created in a modern building to receive and transmit the data from the observatories to the University of Victoria base and beyond on the internet.

The scientific and engineering objectives of NEPTUNE Canada are:

- the structure and seismic behaviour of the ocean crust
- seabed chemistry and geology
- ocean climate change and its effects on marine life at all depths
- the diversity of deep-sea ecosystems
- engineering and computational research.

At least 20 years of exciting real-time data are anticipated in this new way of doing marine science, much of it related to InterRidge's interests.

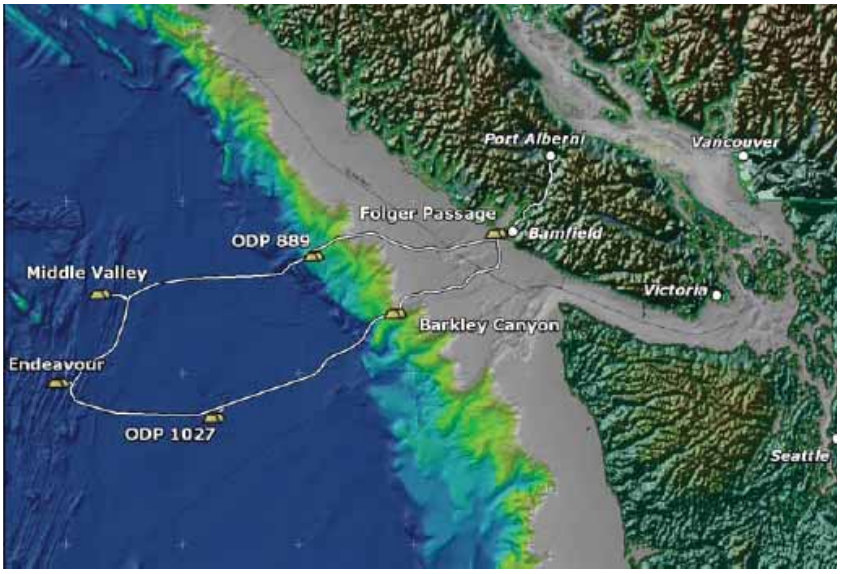
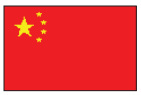


Fig. 1. NEPTUNE Canada cable route layout.

Fig. 2. See p. 57.
Cable laying system on ROV *ROPOS*.



CHINA

Y.J. Chen

For the year 2007 there are several major events related to InterRidge that occurred in China, reflecting the rapid development of InterRidge-related activities in China.

1. The second Chinese expedition to the mid-ocean ridges in the Indian Ocean and the discovery of the first active hydrothermal vent field on the ultraslow spreading Southwest Indian Ridge near 50ºE.
Supported and funded by COMRA (China Ocean Mineral Resources R&D Association), scientists from more than 15 institutions in China conducted a three-leg cruise to the mid-ocean ridges in the Indian Ocean on board the R/V *Dayang Yihao* from January to March 2007. In particular, during the DY115-19 Leg 2 in February, the first active hydrothermal vent field on the ultraslow Southwest Indian Ridge was discovered using WHOI's ABE vehicle near 50º E on the SWIR, where a major hydrothermal plume was discovered during China's first around-the-globe expedition in 2005 (see article by Tao et al., this issue, and *Oceanus* article by K. Kusek, http://www.whoi.edu/oceanus/viewArticle.do?id=26106&sectionid=1021). In late March and April 2007, the DY115-19 Leg 3 expedition surveyed the SWIR further east and identified evidence of new hydrothermal deposit sites (see article by X. Han, http://interridge.whoi.edu/RidgeCrestNews). Multi-leg cruises are planned to return to the SWIR near 50ºE in the coming years to conduct multi-disciplinary studies, leading to a possible long-term seafloor observatory of China.

In January 2007, a strong hydrothermal plume was also detected at the segment K on the Southeast Indian Ridge, about 250-km southeast of the St. Paul-Amsterdam hotspot. This plume is near the hydrothermal plume detected at this segment 10 years ago, which was the first hydrothermal plume ever detected using the technology of MAPR (Miniature Autonomous Plume Recorders) developed by Dr. Edward T. Baker at NOAA, USA.

2. The first Chinese expedition to Lau Basin, a back-arc spreading center.
Chinese scientists on board R/V *DaYang YiHao* conducted a month-long cruise to the back-arc spreading center at Lau Basin. A new active hydrothermal vent field was detected with a deep-tow video system along the spreading center between two known sites. More cruises are being planned for the Lau Basin.

3. The first joint conference of InterRidge-China and InterMARGINS-China.
Over 150 scientists participated in the two-day conference on InterRidge and InterMARGINS in Hangzhou from September 24-25, 2007. Dr. Edward T. Baker was invited to give a keynote presentation on hydrothermal systems at mid-ocean ridges during the morning session of the first day of the conference. Notably, 50 of the participants were graduate students from various institutions in China.

4. A multi-leg cruise is planned in spring of 2008.
We will conduct a survey using WHOI's ABE vehicle of the East Pacific Rise near the equator, where a strong hydrothermal plume was discovered during China's first around-the-globe expedition in 2005.

5. Upgrading China to InterRidge Principal Member.
A proposal to upgrade China to an InterRidge Principal Member nation was submitted and funded. China has officially become an InterRidge Principal Member Nation in fall 2007. Dr. Y. John Chen (Peking University) and Dr. Jiabiao Li (Second Institute of Oceanography, State Oceanic Administration) will represent China in the InterRidge Steering Committee.

The recent discovery of the first active hydrothermal vent field at the ultraslow spreading Southwest Indian Ridge is an important event for research of the geology, hydrothermal, and biological processes of the Indian Ocean and ultraslow spreading ridges. It is also the first time that an active hydrothermal vent field was discovered by Chinese researchers on board a Chinese research vessel, marking a milestone event in Chinese programs of ocean research and exploration of ocean mineral resources. It reflects China's increasing contributions to international ocean ridge research since China became an InterRidge Associate Member nation in late 2003. It is anticipated that China will play an increasingly important role in mid-ocean ridge research and exploration in the coming years and will continue to strengthen its cooperation with the InterRidge program and the international community.

FRANCE

J. Dyment

Once more, the ridge activities in France have been focused on the Mid-Atlantic Ridge, specifically the MOMAR and 15°N areas.

1. MOMAR activities

Two cruises onboard R/V *Le Suroît* were devoted to geophysical investigations near the MOMAR area on the Mid-Atlantic Ridge south of the Azores. Cruise BBMOMAR, led by Wayne Crawford and Pascal Tarits in July 2007, was devoted to (1) mooring both broadband and standard Ocean Bottom Seismometers (OBS) of the French National OBS facility near hydrothermal site Lucky Strike, and (2) recovering Electro-Magnetic (EM) stations installed with a Portuguese vessel in 2006 in the same area. Cruise MARCHE 2, led by Jean Goslin in August 2007, recovered hydrophones moored in the SOFAR channel in 2006 and re-installed these hydrophones for another year of measurements. The combination of both experiments, BBMOMAR and MARCHE in 2007-2008, will provide OBS and hydrophone data in the same area over the same time, offering a unique chance to compare the seismicity derived from these different methods in the Lucky Strike area.

Two cruises were scheduled onboard R/V *Pourquoi pas?* with ROV *Victor* in June and July 2007. Cruise MOMARDREAM, prepared by Jérôme Dyment and Françoise Gaill, had two multidisciplinary objectives on hydrothermal site Rainbow, located on ultramafic outcrops: (1) to investigate the role of iron from the scale of the micro-organism to that of the whole site, and (2) to prepare for IODP drilling by making a detailed and complete survey of the site and an inventory of the fauna and their distribution. The cruise was supposed to (1) collect geological, fluid and biological samples, (2) perform detailed surveys of chemical and physical parameters around the vents, micro-bathymetry and magnetic field over the whole site and its surroundings, and (3) install and recover biological colonization modules. Experiments GRAVILUCK 2, RECO-07 and BATHYLUCK 0, prepared by Valérie Ballu, Pierre-Marie Sarradin and Javier Escartin, respectively, were devoted to the hydrothermal site Lucky Strike (and an off-axis reference site). GRAVILUCK 2 was expected to recover and reinstall two pressure gauges, RECO-07 to recover the biological module TEMPO, and BATHYLUCK 0 to install temperature sensors for a year of measurements, before recovery during cruise BATHYLUCK, pre-scheduled for 2008. These three experiments had been combined into a single cruise. However, for technical reasons, ROV *Victor* could not be operated in June and July 2007, and both cruises were canceled. The deep-sea submersible *Nautile*, which was available in Toulon but had never been used on R/V *Pourquoi pas?*, was tested on this ship, and both sailed rapidly to the Azores for a single cruise gathering parts of these experiments that could be realized with *Nautile* in a short time. Nine dives were successively achieved on site Rainbow (see article by Gaill et al., this issue) and rocks, fluids, shrimps *Rimicaris exoculata* and other animals, as well as microbiological samples, were collected. Dredges and CTD were performed during the nights. Nine other dives were scheduled on site Lucky Strike. Unfortunately, the A-frame of R/V *Pourquoi pas?* broke during the first launch of *Nautile* at site Lucky Strike, and the cruise was discontinued.

In 2008 we expect three or four cruises on the MOMAR area. The recovery of the hydrophones re-moored during cruise MARCHE 2 will take place onboard a Portuguese ship. Cruise BBMOMAR 2 is scheduled to recover the various OBS installed during cruise BBMOMAR. As for cruises requiring ROV *Victor*, the best scenario includes a cruise on site Rainbow, to complete experiment MOMARDREAM, and a cruise on site Lucky Strike, including the experiments that could not be realized in 2007 and a large part (detailed micro-bathymetric and magnetic surveys) of cruise BATHYLUCK.

2. Other cruises at mid-ocean ridges

Cruise SERPENTINE in March 2007 led by Yves Fouquet onboard R/V *Pourquoi pas?* with ROV *Victor*, as part of a French-Russian long-standing collaboration, investigated three hydrothermal sites, active sites Achadze and Logatchev on ultramafics and fossil site Krasnov on basalt. All sites are located near 15°N on the Mid-Atlantic Ridge. This multidisciplinary cruise used the whole capabilities of ROV *Victor* with the acquisition of micro-bathymetric, magnetic, physical and chemical data as well as the collection of rock, sulfide, fluid, animal and micro-organism samples. A detailed day-to-day description of this very successful cruise is given on website http://www.ifremer.fr/serpentine/english/index.htm (with both English and French versions).

No other ridge cruise was conducted on a French research vessel in 2007. French researchers actively participated on cruises on foreign ships, including one on R/V *Revelle* on the Central Indian Ridge at 19°S (P.I.'s

Evelyn Fueri and David Hilton, five French participants).

Although the detailed schedule is not available yet, it appears that no ridge-related cruise is scheduled beyond the MOMAR cruises in 2008. Ridge-related cruise proposals that have been positively reviewed in 2007 but are not scheduled in 2008 are listed below.

A specific problem is to be mentioned in the Indian Ocean, where a network of three hydrophones was moored in the SOFAR channel in 2006 for 12 to 18 months, as a piggy back experiment of cruise PLURIEL (see article by Maia et al., this issue). These hydrophones should help to better define the seismicity in the broad diffuse plate boundaries separating the India, Capricorn and Australia plates, and also along the Southeast Indian Ridge. Two of these instruments can be recovered in 2008 by R/V *Marion Dufresne*, but not the third one, located northeast of Amsterdam Island, at 31.6°S, 83.3°E. The data from this hydrophone are critical to the whole experiment, since triangulating the location of earthquakes requires a minimum of three instruments. We are therefore looking for any ship of opportunity passing in this area in 2008 (contact: jean-yves.royer@univ-brest.fr).

Cruise name	Area	Discipline	Proponent	Ranking
Parisub	EPR	Geosciences	Pascal Gente	Priority 1
GeiSeir	SEIR	Geosciences	Christophe Hémond	Priority 1
Mescal	EPR	Biology	François Lallier / Nadine Le Bris	Priority 1
Big	EPR	Biology	Anne Godfroy	Priority 1
Gala	Lau Basin	Geosciences	Etienne Ruellan	Priority 2a
SmoothSeaFloor	SWIR	Geosciences	Mathilde Cannat	Priority 2a

GERMANY

C. Devey

The German ridge program, running as a priority program of the German Science Foundation (DFG), had two major funding successes in 2007. The first was the funding of a proposal to acquire an AUV for ridge research. The vehicle will be constructed by the U.S. company Hydroid and will have a 6000-m depth capability. On board sensors will include multibeam (Reson 7125, 200/400kHz) and Edgetech side-scan & sub-bottom profiler, CTD, turbidity and eH sensors. The vehicle will be equipped with a launch and recovery system to enable easy deployment in sea states up to 5. All the equipment will fit in two 20´ containers.

The second funding success was part of a final grant renewal. The DFG had previously committed to fund ridge research in three periods of two years. In August the decision on the third and final round of funding was a record 3 million Euros to be distributed for proposals covering the period Oct 2007 - Sept 2009 (official end of the priority program). This funding also secures the full membership of Germany in InterRidge until 2009!

Into all this good news there was some bad news as well, mostly concerning the new German research vessel *Maria S. Merian*, which has had repeated problems with its innovative POD propulsion system. The ship came into Kiel for an unscheduled repair docking in late August and is, at the time of writing still there (11 October 2007). The future is uncertain. An immediate consequence of these problems is, however, that the scheduled ridge cruises to Logatchev (Oct - Nov 2007) and Turtle Pits (Nov - Dec 2007) will not be occurring with the *Merian*. Wheels are in motion to salvage a skeleton cruise with the French vessel *L´Atalante*; it is clear, however, that some funded programs will have to wait until next year to go to sea.

Scientifically, the German program is running smoothly, with several notable papers coming out in fields as diverse as biology and magmatic petrology. Details of these and all other German ridge activities can be found at: http://www.deridge.de.

JAPAN

N. Seama and K. Okino

We established a new framework to maintain the InterRidge-Japan community and to promote ridge-related studies in Japan. Our framework includes organizing an annual symposium, improving the web site of InterRidge-Japan, and using an InterRidge-Japan email list. A symposium for ridge-related studies will be held on October 30-31, 2007, at Ocean Research Institute, the University of Tokyo. The purposes of the symposium are: 1) to share information on results of recent research cruises by the principal investigators' summary reports, 2) to understand different approaches to ridge-related studies (microbiology, geochemistry, geology, and geophysics) by review talks, which would lead to future interdisciplinary research, and 3) to encourage graduate students to present their research. Twenty-six talks including 13 graduate students' talks, are expected, and enough time is given to discuss each talk in detail (30 minutes for each talk). The InterRidge-Japan web site (http://ofgs.ori.u-tokyo.ac.jp/~intridgej/; only in Japanese) has been improved, and it provides us with information and reports on meetings and cruises for ridge-related studies. The web site is useful not only for the InterRidge-Japan community, but also for sharing our activity with the general public. The InterRidge-Japan email list is also used to provide our community with similar information. The members of the InterRidge-Japan email list also receive the InterRidge bi-weekly news from the InterRidge office, which removes a barrier of language from undergraduate students and persons with the similar level to access the InterRidge activity. Furthermore, we reassembled an interdisciplinary research project among microbiology, geochemistry, geology, and geophysics as the domestic long-range plan, and we submitted the proposal to JSPS, but unfortunately without success. We will try again to start the project in the next fiscal year.

Seagoing research is very active; seven cruises were funded in FY2007. Three R/V *Natsushima* cruises focused on hydrothermal fields located in Okinawa Trough and Izu-Ogasawara Arc. A remotely operated vehicle, *Hyper-Dolphin*, was used for microbiological and geochemical studies on the hydrothermal fields. Three cruises were for back-arc basin studies. Two of these cruises were with R/V *Hakuho-maru* in Parece Vela back-arc basin, with rock sampling by dredging, 3.5kHz sub-bottom profiling, and deep-tow magnetic survey for Godzilla Mullion, the biggest known oceanic core complex. The remaining of these back-arc cruises will be with R/V *Kairei* in late 2007; two ocean bottom electro-magnetometers (OBEMs) will be recovered as a part of Magnetotelluric (MT) transect across the central Mariana arc-backarc area. Due to an approaching typhoon during a recovery cruise in 2006, we were forced to leave these OBEMs in the survey area. Finally, a R/V *Hakuho-maru* cruise in January 2008 will target the Southwest Indian Ridge near the Marion hot spot (26°-39°E). Geophysical mapping, seismic reflection and refraction surveys using air-guns and ocean bottom seismographs, deployment of OBEMs for MT transect across the spreading axis, and rock sampling will be conducted.

Note from the InterRidge Office...
Would you like to receive the InterRidge News as a hard copy in the mail?

If yes, please log on to the InterRidge website (http://www.interridge.org) with your Username and Password and update your User Profile (in the IR Member Menu > My account > Edit > Other Info).

If you are not an InterRidge Member, please join by creating a new user account. Questions? Contact coordinator@interridge.org

NEW ZEALAND

I. Wright

Since last reporting in Fall 2005, New Zealand researchers have continued InterRidge-related science, with continued focus on active Kermadec arc processes and renewed interest in the Havre Trough backarc during a series of collaborative and international projects.

In April - May 2006, GNS Science personnel participated on the NOAA/PMEL (Ocean Exploration) cruise to the Mariana arc as part of the series of "Ring of Fire" expeditions. Here, they witnessed for the first time an eruption on the seafloor, small 'lakes' of molten sulfur at the summits of two volcanoes, and liquid CO_2 being expelled at another. Further details of the cruise can be seen at http://www.oceanexplorer.noaa.gov/explorations/06fire/background/marianaarc/marianaarc.html.

In October 2006 JAMSTEC researchers, in collaboration with NIWA and GNS, and Australian and US groups, undertook new multibeam mapping of the Havre Trough backarc rift system between 33°S and 36°S including two *Shinkai 6500* dives into a 4000-m deep active rift. These submersible dives are now the deepest in the New Zealand region and have recovered primitive basalts from the backarc rift floor.

In May 2007 NIWA and GNS scientists participated on the German / Canadian MANGO 3 cruise onboard the R/V *Sonne* with *ROPOS* ROV studies of the previously mapped Calypso submarine vents immediately offshore of the Taupo Volcanic Zone, North Island, and seafloor hydrothermal studies (including vent-faunal studies) of active venting associated with caldera volcanoes of the southern Tofua (Tonga) arc. Volcanic activity was observed at Monowai Seamount south cone with a variety of sea-surface phenomena. Also in May 2007, the R/V *Tangaroa* completed a collaborative NIWA and University of Auckland voyage undertaking detailed multibeam and geophysical mapping, and seafloor pumice sampling, of three separate but characteristic Kermadec silicic caldera volcanoes.

In July – August 2007 a collaborative GNS, NOAA/PMEL (Ocean Exploration), and IFM-GEOMAR project as part of the New Zealand American Submarine Ring of Fire expedition onboard the R/V *Sonne* performed detailed mapping and ROV studies of the hydrothermal vent fields at Brothers caldera (southern Kermadec arc), discovering a new active field and an ancient one. The voyage conducted the first AUV survey in the New Zealand region, using the Woods Hole Oceanographic Institution's AUV ABE to complete some detailed and spectacular mapping of the caldera wall and central cone. The cruise also completed some commissioning trials of a new German deep-water ROV, CTD casts in several pull-apart basins, including the Ngatoro Rift, and ~30,000 km^2 of new multibeam mapping of the Havre Trough backarc rift system. Further details of the cruise can be seen at http://www.oceanexplorer.noaa.gov/explorations/07fire/welcome.html.

GNS personnel will also participate in a forthcoming hydrothermal plume mapping survey of the 12 major submarine volcanic centers of the Aeolian arc onboard the R/V *Urania* for 12 days beginning in early November 2007. Also in November 2007 the Census of Marine Life program will hold its five-year meeting at the University of Auckland and will include meetings for the Chemosynthetic Ecosystems (ChESS) and Census of Seamounts (CenSEAM) projects that have interest in vent fauna and ecosystem science of relevance to InterRIDGE. The CenSEAM secretariat is hosted at NIWA in Wellington (see http://censeam.niwa.co.nz/).

Of final note is that NIWA will host the 4th International Deep-Sea Coral Symposium in Wellington in 2008 (see http://coral2008.niwa.co.nz/). This International Symposium is designed to bring together scientists, resource managers, students, and policy-makers from around the world who are actively involved in research and management of deep-sea corals and other deep-sea habitats and fauna.

NORWAY

R. Pedersen

The Norwegian Research Council recently awarded a new Centre of Excellence in geobiology to the University of Bergen. The name of this new center is: Centre for Geobiology: Deep Seafloor, Deep Biosphere, Deep Time & the Roots of Life. As indicated by this name, the research themes for the new center will span from modern ridge processes to early Earth environments, and from geodynamics to molecular biology. The center has been awarded for a period of up to 10 years, and several post-doctoral and Ph.D. positions on ridge relevant topics will be announced in the coming year. More information about the center and upcoming positions may be found at http://www.geobio.uib.no. Ridge-related research at the center will be focused on the Arctic Mid-Ocean Ridge. This summer the center organized a cruise to the southern Knipovich Ridge with R/V *G.O. Sars* (for daily dispatches, see 'Field activities 2007' on http://www.geobio.uib.no). The objectives of this cruise were to investigate core complex formation and to locate new, deeper vent sites than those discovered in 2005 at 71° N. A large seawater anomaly was located in the study area, and we aim to locate the vent site(s) at the seafloor during a cruise in 2008.

PHILIPPINES

G.P. Yumul Jr.[1]*, C.B. Dimalanta[1], L.R. Zamoras[2], E.J. Marquez[3], K.L. Queaño[4], R.A. Tamayo, Jr.[1], J.A.S. Gabo[1], M.G. Asio-Montes[1], E.G.L. Ramos[1], N.T. Ramos[5], L.T. Armada[1]

OCEANIC PLATE STRATIGRAPHIC SEQUENCES AND AN OPHIOLITE COMPLEX IN PANAY ISLAND: FEATURES CHARACTERIZING THE ARC-CONTINENT COLLISION IN CENTRAL PHILIPPINES

The arc-continent collision in Central Philippines continues to be a topic of great interest to researchers in the Philippines. The tectonic model proposes a Miocene collision between a continental fragment, the Palawan microcontinental block, and the arc-related Philippine mobile belt (e.g., Karig, 1983; McCabe et al., 1985; Yumul et al., 2003). This collision resulted in rotations of some islands in the Philippines, and the counter-clockwise rotation of Luzon Island initiated subduction in the Manila Trench. Despite recognizing the significance of this event in the geologic evolution of the Philippine island arc system, there are still certain aspects of the collision event for which no consensus has been reached, and some questions remain unanswered. Studies are now focused in Northwest Panay to investigate the southernmost boundary of the collision zone in Central Philippines, particularly in the Buruanga Peninsula and its vicinity (Figure 1). The peninsula is believed to be part of the continental fragment that comprises the Philippine archipelago: the Palawan microcontinental block. This terrane was part of the East Asian accretionary complex that separated from the Asian mainland due to the rifting and opening of the South China Sea.

The peninsula, previously mapped to consist of a metamorphic complex, is comprised of alternating chert-clastic sequences juxtaposed with limestone blocks (Fran-

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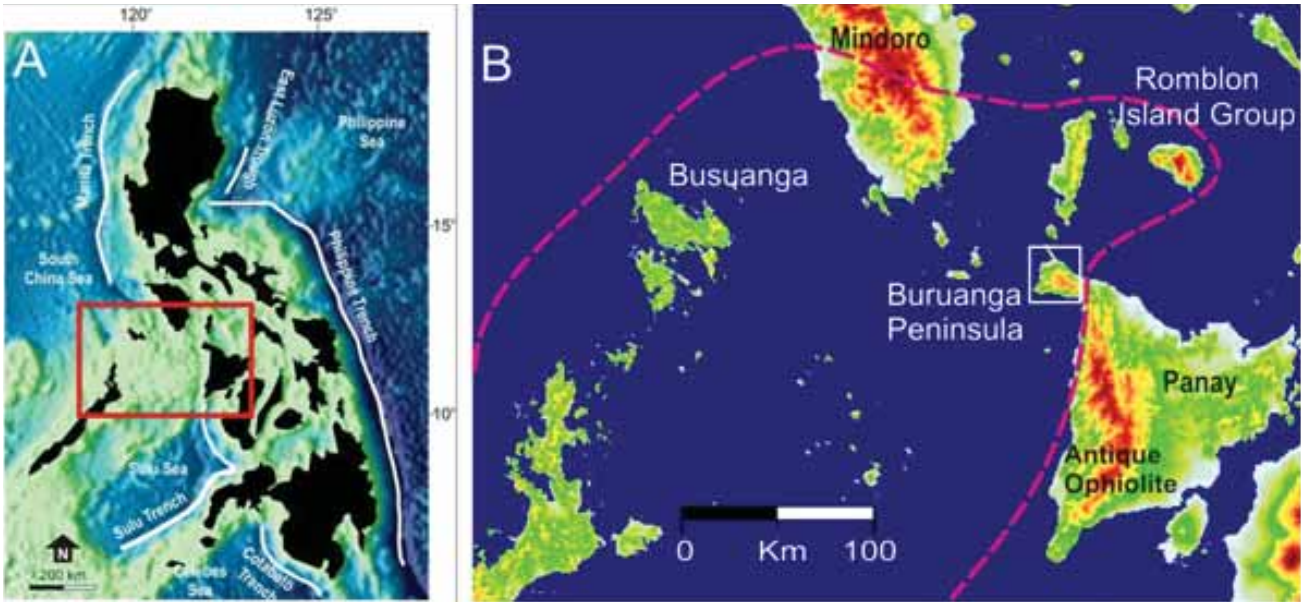


Fig. 1. The Palawan Microcontinental Block (red dashed line in B) includes north Palawan, Busuanga Island, Buruanga Peninsula, Romblon Island Group and southwest Mindoro. This block was rifted from mainland Asia due to the opening of the South China Sea and collided with the Philippine Mobile Belt in the Miocene.

cisco, 1956). These sedimentary sequences in Buruanga Peninsula are comparable to the sequences observed in Busuanga Island in North Palawan: Lower-Middle Jurassic chert sequences overlain by Middle-Upper Jurassic clastics juxtaposed with pelagic limestone (Figure 2). These sequences are typically observed in accretionary complexes and their stratigraphic succession has been referred to as ocean plate stratigraphy (OPS; Wakita and Metcalfe, 2005). The OPS of the Buruanga Peninsula correlates with the JR5-JR6 (Callovian to Oxfordian of the Middle Busuanga Belt. These findings provide evidence that Buruanga Peninsula is part of the Palawan microcontinental block, which collided with the Philippine mobile belt.

Moreover, the rocks in Buruanga Peninsula completely differ from those found in the Antique Range, east of the peninsula. The rocks in the Antique Range consist of Middle Miocene basaltic to andesitic pyroclastic and lava flow deposits with reefal limestone and arkosic sandstone. This difference in lithology and age between units exposed in Buruanga Peninsula and Antique Range suggests that the boundary between these two marks the collision zone between the Palawan microcontinental block and the Philippine mobile belt.

In addition, a dismembered Antique ophiolite has also been mapped in the southern portion of Panay Island (Santos-Yñigo, 1949; Rangin et al., 1991; Tamayo et al., 2001). It includes fragments of pillow lavas with minor sheet flows, rare sheeted dikes, isotropic gabbros, subordinate layered mafic and ultramafic rock sequences and serpentinites that were affected by thrusting and shearing caused by the suturing of Palawan microcontinental block and the Philippine mobile belt (Tamayo et al., 2001). The geochemistry of the units of the Antique Ophiolite Complex suggests oceanic ridge and fore-arc crust fragments emplaced as a result of the collision.

The ocean plate stratigraphy of Buruanga Peninsula, the difference in age and lithology between the Buruanga Peninsula and the Antique Range, and the emplacement of the Antique ophiolite are some of the aspects related to the collision present in Panay Island. These are all critical pieces of information that help us better understand the Miocene arc-continent collision in central Philippines.

Fig. 2. See p. 57.
Oceanic plate stratigraphy of Busuanga Island and Buruanga Peninsula both consist of chert-clastic sequences juxtaposed with limestone blocks, which are typical of accretionary complexes (diagram modified from Zamoras and Matsuoka, 2004). Inset shows the location of Busuanga Island and Buruanga Peninsula.

References

Francisco, F. 1956. The pre-Tertiary rocks of Buruanga Peninsula, Panay Island, Philippines. Eight Pacific Science Congress Proceedings 2, 482-502.

Karig, D.E. 1983. Accreted terranes in the northern part of the Philippine archipelago. Tectonics 2, 211-236.

McCabe, R., Almasco, J. and Yumul, G.P. Jr. 1985. Terranes in the Central Philippines. In: Howell, D. (ed.), Tectonostratigraphic Terranes of the Circum-Pacific, Circum-Pacific Council on Energy and Mineral Resources Series 1, 421-435.

Rangin, C., Stephan, J.F., Butterlin, J., Bellon, H., Muller, C., Chorowiez, J. and Baladad, D. 1991. Collision néogène d'arcs volcaniques dans le centre des Philippines: Stratigraphie et structure de la chaine d'Antique (île de Panay). Bulletin de la Societe Geologique de France 162, 465-77.

Santos-Yñigo, L.M. 1949. Report on the geology and pyrite deposits of Antique Province. Bureau of Mines and Geosciences Internal Technical Report, 47pp.

Tamayo, R.A. Jr., Yumul, G.P. Jr., Maury, R.C., Polvé, M., Cotten, J. and Bohn, M. 2001. Petrochemical investigation of the Antique Ophiolite (Philippines): Implications on volcanogenic massive sulfide and podiform chromitite deposits. Resource Geology 51, 145-164.

Wakita, K. and Metcalfe, I. 2004. Ocean plate stratigraphy in East and South Asia. Journal of Asian Earth Sciences 24, 679-702.

Yumul, G.P. Jr., Dimalanta, C.B., Tamayo, R.A.Jr. and Maury, R.C. 2003. Collision, subduction and accretion events in the Philippines: a synthesis. The Island Arc 12, 77-91.

Zamoras, L.R. and Matsuoka, A. 2004. Accretion and postaccretion tectonics of the Calamian Islands, North Palawan block, Philippines. The Island Arc 13, 506-519.

RUSSIA

S. Silantyev

Among the most significant activities of the Russian-Ridge scientific community in 2007 are the following:

1. Workshop of Russian-Ridge.

A workshop was held in Moscow on 5-7 June 2007. This Workshop was dedicated to the memory of Professor Leonid Dmitriev, who was the founder of Russian-Ridge and pioneer of studies in petrology and geochemistry of mid-ocean ridges. The main subject of this workshop was petrological and geophysical segmentation of mid-ocean ridges and relationships with geodynamic parameters of the oceanic lithosphere accretion. Particular emphasis was placed on different aspects of Mid-Atlantic Ridge (MAR) hydrothermal deposit formation. Our colleagues from Canada, France, Germany, and Italy participated in the workshop as invited speakers: Dr. E. Bonatti (Instituto di Geologia Marina C.N.R., Italy), Dr. D. Desbruyeres (IFREMER, France), Dr. H. Bougault (IFREMER, France), Dr. S. Scott (University of Toronto), and Dr. S. Petersen (IFM-GEOMAR, Germany). All abstracts for talks presented in the R-Ridge Workshop'07 can be found in a PDF file on the IR web site. One important outcome of discussion during the workshop was the unanimous decision of all participants on the necessity to upgrade Russian membership in InterRidge.

2. Collaborative study of the MAR crest zone.

An ongoing collaborative study of the MAR crest zone involves scientific cooperation between the Russian Academy of Sciences, the Federal Agency for Sciences and Innovations of the Russian Federation, and IFREMER, France. This cooperation includes investigations under the bilateral project "The Mid-Atlantic Ridge geodynamics and the ore formation processes". Five Russian scientists participated in Expedition SERPENTINE in Feb. 2007 on the French R/V *Pourquoi Pas?*. The aim of the SERPENTINE cruise was to study the geochemical, biological, and microbiological variability of hydrothermal processes in serpentinized ultramafic environments along slow spreading ridges. Three hydrothermal fields located on the MAR between 12°58' and 16°38'N were visited and studied in detail on this extremely successful cruise: Achadze, Logatchev and Krasnov. All three hydrothermal fields and massive sulfide deposits studied during the SERPENTINE mission were initially discovered by Russian marine geologists from St.

Petersburg (PMGE and VNIIOkeangeologia) in expeditions onboard the Russian R/V *Professor Logatchev* during the last 15 years (e.g. article by Beltenev et al., this issue). The results of the explorations on the SERPENTINE cruise lead to the discovery of three new, high-temperature, active hydrothermal sites (Ashadze 1, Ashadze 2, and Logatchev 2) and of one inactive hydrothermal site (Logatchev 5). The cruise also confirmed the importance of the Krasnov site as the largest currently known accumulation of sulfides in the oceans (Cannat et al., 2007, and Fouquet et al., 2007).

3. Investigations of the Knipovich Ridge.
Investigations of the northern part of the Knipovich Ridge were continued by the Geological Institute of the Russian Academy of Sciences under the project "Late Mesozoic - Cenozoic tectonic-magmatic history of the Barents Sea shelf and slope as a clue to paleodynamic reconstructions in the Arctic Ocean" (for details see: www.ginras.ru, in Russian).

References

Cannat et al., Geological Context of Ultramafic-Hosted Hydrothermal Vent Fields in the 13-15°N Region of the Mid Atlantic Ridge: Preliminary Results of the Serpentine Cruise, abstract submitted to AGU Fall Meeting 2007.

Fouquet et al., Diversity of Ultramafic Hosted Hydrothermal Deposits on the Mid Atlantic Ridge: First Submersible Studies on Ashadze, Logatchev 2 and Krasnov Vent Fields During the Serpentine Cruise, abstract submitted to AGU Fall Meeting 2007.

SPAIN

R. Lunar

Recent ridge-related scientific activities in Spain include studies focused on:

1) Hydrocarbon-related systems in the Gulf of Cadiz (SW Spain), including the discovery of both chimneys and Fe-Mn nodules;
2) Fossil shallow-marine hydrothermal systems (SE Spain, Antarctica) with regard to the exploration of Mars;
3) Fluid-rock interactions in Iceland.

Some recent articles about these topics are the following:

González, F.J., Somoza, L., Lunar, R., Martínez-Frías, J., Martín Rubí, J.A., and Díaz del Río, V. (2007) Fe-Mn nodules associated with hydrocarbon seeps: the new discovery of the Gulf of Cadiz (eastern Central Atlantic). Episodes 30(3): 187-196.

Maestro, A., Somoza, L., Rey, J., Martinez Frías, J., and López-Martínez, J. (2007) Active tectonics, fault patterns and stress field of Deception Island: A response to oblique convergence between the Pacific and Antarctic plates. Journal of South American Earth Sciences 23: 256-268.

Martínez-Frías, J., Lázaro, E,. and Esteve-Núñez, A. (2007) Geomarkers versus biomarkers: Paleoenvironmental and astrobiological significance. AMBIO: Journal of the Human Environment 36(5): 425-427.

Martinez-Frias, J., Delgado-Huertas, A., García-Moreno, F., Reyes, E., Lunar, R., and Rull, F. (2007) Oxygen and carbon isotopic signatures of extinct low-temperature hydrothermal chimneys in the Jaroso Mars analog. Planetary & Space Science 55: 441-448.

Conference Proceedings:

González, F.J., Somoza, L., Lunar, R., Martínez-Frías, J., Martín Rubí, J.A., Torres, T., Ortiz, J.E., and Díaz del Río, V. (2007) Internal features, mineralogy and geochemistry of Fe-Mn nodules from the Gulf of Cadiz. I INTERNACIONAL SIMPOSIUM IN MARINE SCIENCES. VALENCIA.

González, F.J., Somoza, L., Lunar, R., Martínez-Frías, J., Martín Rubí, J.A., León, R., Alveirinho-Dias, J.M., and Díaz del Río, V. (2006) Costras de pirita autigénica de origen bacteriano en montículos fangoso-carbonatados ligados al escape de fluidos en el Golfo de Cádiz. V SIMPOSIO SOBRE EL MARGEN IBÉRICO ATLÁNTICO. AVEIRO (PORTUGAL). 85-86.

González, F.J., Somoza, L., Bohoyo, F., Martín Rubí, J.A., Puga, E., Maldonado, A., Lunar, R., and Martínez-Frías, J. (2006) Costras de Fe-Mn ricas en Co en dorsales oceánicas del Mar de Scotia (Antártida): procesos de biomineralización en ambientes extremos. VII SIMP. ESPAÑOL DE ESTUD. POLARES. GRANADA. 143-145.

UK

T. Henstock

In the UK this year there have been two important developments in terms of marine science infrastructure, as well as a certain amount of ridge-related activity. Most significant was the naming in February of RRS *James Cook*, followed by her introduction to the science program in March, replacing the RRS *Charles Darwin*. The deep-diving ROV *Isis* also had its first major scientific outings, in the Antarctic and then on the Portuguese margin. The first scientific cruise of RRS *James Cook* was to the Mid-Atlantic Ridge, led by Roger Searle. Searle's cruise JC007 to 12.5-14.5º N on the Mid-Atlantic Ridge used a combination of TOBI (Towed Ocean Bottom Instrument), the BRIDGE rock drill, and dredging to characterize a number of oceanic core complex targets. A cruise report is available on the National Marine Facilities planning website at http://www.noc.soton.ac.uk/nmf/mfp. Another cruise, JC011, in July and August, led by Monty Priede, was part of the ongoing ECOMAR consortium project to study ecosystems around the Charlie Gibbs Fracture Zone in the North Atlantic.

In 2008 there will be several ridge-related projects: Chris MacLeod is leading JC021, taking ROV *Isis* to Hess Deep in January; Roger Searle is leading JC024 in May-June to study axial volcanic ridge development at 45º N using *Isis*, TOBI, and the AUV ABE; a new consortium program, led by Paul Tyler, will study hydrothermal vents and their ecosystems along back-arc spreading centers of the East Scotia Ridge and in the Bransfield Strait. In the longer term, the process of commissioning a replacement for RRS *Discovery* just began; the new ship is planned to start doing science in 2011/2012.

We would also like to welcome Alex Rogers as our new InterRidge Steering Committee member. He will take over for Paul Dando. Many thanks to Paul for his efforts, and thanks to Alex for taking the helm.

USA

K. Phillips and D. Blackman, Ridge 2000 Office

1. Research Updates

The Ridge 2000 Program (R2K) is beginning to transition from its initial phase (2001-2007) to the envisioned second phase of the program (2008-2014). The scope of the second phase will be determined by the results of the upcoming mid-term review by the program sponsor, the U.S. National Science Foundation (NSF). One hallmark of R2K's first phase was multi-disciplinary data acquisition at three Integrated Studies Sites (ISS) in the Pacific basin: the Endeavour segment of the Juan de Fuca Ridge, 8°-11°N on the East Pacific Rise (EPR), and the Eastern Lau Spreading Center (ELSC). During its second phase, R2K plans to continue field work at some ISS, and to shift the focus at others from sea-going data collection to in-depth integration of scientific results. Detailed comparison of results between ISS should now be possible for several aspects of the spreading and hydrothermal systems. A step in this direction was made at the AGU Fall Meeting in 2006, with two R2K sessions that focused on comparison of findings between R2K ISS and other sites. In one session, the recent eruption at the EPR was paired with that of a western Pacific volcano (NW Rota). The other session included results from focus studies at many spreading centers around the world.

This spring the R2K Steering Committee endorsed a strategy for transitioning ISS. The committee consensus is that both the EPR and Endeavour ISS have obtained sufficient multi- and inter-disciplinary data so that they will be ready to transition to a phase where science integration takes priority over sea-going data collection. Ramping down R2K-funded field work at these sites will allow startup of a new ISS at the MoMAR region of the Mid-Atlantic Ridge (MAR). The selection of MoMAR as the top priority Atlantic site was made by the R2K community at a

workshop held in 2004 (http://www.ridge2000.org/science/downloads/workshop_reports/R2K_MAR04Report.pdf). New field studies at this site are envisioned to enable key comparisons to the current Pacific ISS, while science integration, the heart of program, will continue at all ISS. The ELSC ISS will remain active for another coordinated field season or two, and then the status of that site will be evaluated in terms of readiness for transition. EPR will transition to science integration status in 2008. Endeavour will transition in 2009. U.S. field work at both of these sites is likely to continue, but new sea-going proposals will be evaluated by the appropriate core program within NSF Ocean Sciences, not by the R2K review panel.

An R2K community workshop will be held in March 2008. The first part of the meeting will focus on in-depth scientific exchange, with emphasis on the interplay between various aspects of spreading and hydrothermal processes and comparisons of the ecosystems, structure, and process rates at different sites. The second part of the meeting will focus on developing an Implementation Plan for R2K work within the ~35°-37°N region of the MAR. This work will entail significant collaboration with InterRidge MoMAR colleagues. Further information on the meeting will be available on our website at (http://www.ridge2000.org/science/meetings/eventDetail.php?id=spring08).

2. The 2006-2007 Field Season

The R2K 2006/2007 field season included successful cruises to all three ISS. At the EPR near 9°50'N, there was a suite of mapping including morphology, video imaging of the 2005/2006 lava flow extent, CTD, and current measurements in the overlying ocean. Sampling included micro- and macrobiology, fluid chemistry, and sediment traps and instrument recoveries (OBS, bio-colonization) were conducted. Geodetic sensors were deployed and crustal compliance measurements were made. These cruises provided excellent opportunities to document the evolution of the system following the 2005/2006 eruption (Tolstoy et al., 2006; Cowen et al., 2007). Seafloor mapping and sampling was also conducted at the 9°03'N overlapping spreading center (Figure 1) and a new hydrothermal vent field was discovered on this cruise (http://ridge2000.org/science/iss/epr/news_2007_04_18.php). At the Eastern Lau Spreading Center, biological studies (mapping, instrument recoveries) were conducted at several hydrothermal vent fields to study the relationship of biological communities to fluid composition (Figure 2). Work at the Endeavour ISS included the successful recovery of microbial incubators deployed in 2005. One of these incubators will be transitioned to the NEPTUNE Canada cable at the Endeavour node in 2008. The Keck network of seismometers, deployed since 2003, was recovered (Figure 3), and new observations at Main Endeavour field have just been completed. Other non-R2K funded, relevant work at the site included testing and deployment of a Raman spectroscopy instrument, vent fluid and chemistry sampling, genetic studies of tubeworms, water column studies, and recovery of fluid and particulate samplers from some vent fields.

3. R2K involvement with Ocean Observatories

The U.S. Ocean Observatories Initiative (OOI) will not include a buoy at a mid-ocean ridge in the first phase. Both the EPR and MAR were seriously considered for locating a high-powered, high-bandwidth buoy, and ridge sites were among the top 5-6 priorities in the initial version of the buoy network design. Funding limitations, however, resulted in only the top 2-3 buoy sites

Fig. 1. See p. 57.
Sampling EPR vent fluid from *Alvin*. NSF-funded cruise AT15-17 of R/V *Atlantis* operated by WHOI (chief scientist E. Klein).

Fig. 2. Thermistor and osmo samplers deployed at Kilo Moana vent field on the Eastern Lau Spreading Center. Image obtained by ROV *Jason II* during Fall 2006 cruise (chief scientist C. Fisher).

being included in the current network design that is targeted for phase one implementation. Opportunity for monitoring collaboration at MoMAR is one exciting aspect for discussions of possible R2K work at that site.

The NEPTUNE Canada cabled observatory will include a node at the Endeavour ISS. R2K scientists are working with NEPTUNE Canada to connect some instrumentation at Endeavour to the cable. The cabled observatory is in its first stage of installation this year, with the first data streams expected in 2008. The OOI regional cabled observatory plans include a node at Axial Seamount.

4. Education and Outreach

R2K continues to maintain an active education and outreach program that brings the excitement of ridge research to both students and the public through a number of different outlets. On the student front, R2K has just completed the first year of a four-year grant to work with the international GLOBE Program (www.globe.gov) to create online learning modules based on deep-sea research. The project, called FLEXE (From Local to EXtreme Environments), encourages student inquiry in the earth sciences through the collection, analyses and comparison of data from both local and deep-sea environments. The project also involves students in online peer review of written reports based on the data collection and analyses. Newly developed instructional materials will be piloted in classrooms in the U.S. and Germany during Fall 2007. As GLOBE is an international web-based science education program, R2K welcomes the involvement of all interested deep-sea scientists. We are excited to start working through InterRidge to engage InterRidge and ChEss scientists.

Efforts to bring ridge research to the public through informal learning opportunities are moving forward as well. Currently, R2K is working with both the California Science Center in Los Angeles, CA and the Birch Aquarium at Scripps in La Jolla, CA to support the development of hydrothermal vent exhibits. The California Science Center, which has an annual visitation of approximately 1.5 million people, is developing a new extreme environment exhibit that will be part of their permanent collections. The Birch Aquarium exhibit will be part of a rotating exhibit showcasing research on the deep sea. In addition to these museum exhibits, R2K frequently updates the VentureDeepOcean website (http://www.venturedeepocean.org/), the public portal for the R2K program that brings ridge research to everyone.

References

Cowen, J.P., D.J. Fornari, T.M. Shank, B. Love, B. Glazer, A. Treusch, C. Holmes, S.A. Soule, E.T. Baker, M. Tolstoy, and K.R. Pomranin (2007) Volcanic eruption and the East Pacific Rise near 9°50'N. Eos 88(07), 81, 83.

Tolstoy, M., J.P. Cowen, E.T. Baker, D.J. Fornari, K.H. Rubin, T.M. Shank, F. Waldhauser, D.R. Bohnenstiehl, D. Forsyth, R. Holmes, B. Love, M. Perfit, R. Weekly, S.A. Soule, and B. Glazer (2006) A seafloor spreading event captured by seismometers, Science, 314, 1920-1922.

Fig. 3. Recovery of seafloor seismometer at Endeavour ISS. Image taken by ROV *ROPOS* during cruise led by University of Washington investigators that included initial work for NEPTUNE Canada.

WORKING GROUP UPDATES

BIOGEOCHEMICAL INTERACTION AT DEEP-SEA VENTS

Chair - N. Le Bris (IFREMER)
Group Members - A. Boetius (Max Planck Institute für Marine Mikrobiologie); M.K. Tivey (WHOI); G.W. Luther III (University of Delaware); C.R. German (WHOI); F. Wenzhöfer (Max Planck Institute for Marine Microbiology); J.-L. Charlou (IFREMER); W.E. Seyfried Jr (University of Minnesota); D. Fortin (University of Ottawa); F.G. Ferris (University of Toronto); K. Takai (JAMSTEC) & J.A. Baross (University of Washington)

Objective:
To strengthen the scientific exchange between chemists, biogeochemists, geochemists, and microbial ecologists thereby gaining a better understanding of the interplay between biotic and abiotic processes in hydrothermal environments.

2007 Update (submitted May 2007, prior to the IRTI in September 2007):
Special session at EGU General Assembly - "Biogeochemical interactions in chemosynthetic deep-sea ecosystems: methods, tools and strategies", Vienna, Austria, April 15-20, 2007.
In the past year the activity of the "Biogeochemical Interactions" Working Group has been first concretized through the organisation of the 3rd edition of the session "Biogeochemical interactions in chemosynthetic deep-sea ecosystems: methods, tools and strategies" co-listed in Biogeosciences and Ocean Sciences programmes of the EGU General Assembly (April 2007, 15-20 Vienna, Austria). 6 orals and 13 posters were presented. Most of them concerned the hydrothermal vent environments. Recently-developed *in situ* measurement devices and innovative approaches to the study of biogeochemical interactions were presented. The session also included several studies related to other chemosynthetic habitats (sunken woods) and their links to hydrothermal ecosystems. Abstracts are available at http://www.cosis.net/members/meetings/sessions/accepted_contributions.php?p_id=236&s_id=4587 (Biogeosciences BG 6.05).

InterRidge Theoretical Institute - "Biogeochemical interactions at deep-sea vents", Woods Hole, September 10-14, 2007.
The preparation of a Theoretical Institute to be held in Woods Hole in September 2007 has been the main focus of our WG activity since the beginning of 2007. Several members of the working group and the IR office have been involved in the definition of the IRTI programme, request for funding and organisation of the event. The goal of this Theoretical Institute is to encourage multidisciplinary convergence in the study of interactions occurring between the biological and geochemical components of the deep-sea vent environments, and to increase collaborative efforts to develop new techniques for making key measurements to achieve this goal. Participants will gain an understanding of the links that occur at vent sites among key geological, physical, chemical, and biological processes through the biogeochemical cycling of elements, and should come away with a better understanding of how to more effectively investigate these interactions. The first 2-day short courses and advanced lectures will present the state of the art to a group of scientists from a range of backgrounds. Topics will range from consideration of environmental conditions (e.g., the chemical background as defined by vent fluid geochemistry, reactive transport modelling and direct *in situ* measurements) to appreciation of constraints on energy transfer from chemical to biological systems (e.g. considering thermodynamic constraints, microbial carbon-fixation pathways, symbiotic associations) and acknowledgment of their role in vent ecosystem dynamics (e.g., influence on colonization processes and biological succession). It will be followed by a 3-days workshop, including a first open-day of talks introducing new issues in vent research that require to address biogeochemical interactions. With a limited number of participants, five working group sessions are envisioned for the last two days of the workshop. The 5 working groups topics retained are: plume studies and water column biogeochemistry; element cycling and microbial diversity in the hidden biosphere; life strategies and adaptations in extreme environments; new approaches and technologies for biological and chemi-

cal sensing; tools and strategies for long-term observations of seafloor ecosystems. Working Group participants will be encouraged to explore new ideas and discuss collaborative projects/experiments to be developed in the coming years.

Special sessions at 10th International Congress of the Brazilian Geophysical Society - "Deep-sea hydrothermal vents & biology", Nov. 20, 2007, Rio de Janeiro, Brazil. This special session is co-convened by Nicole Le Bris (IFREMER, France), Francoise Gaill (CNRS, France), Paulo Suguio (IOUSP, Brazil), and Chris German (WHOI, USA). It is to be featured on Nov. 20, 2007 together with another special session "Tectonic & volcanic processes at mid-ocean ridges" to be co-convened by Marcia Maia (IUUM/UBO, France), Sidney Mello (LAGEMAR/UFF, Brazil), and Jian Lin (WHOI, USA). These mid-ocean ridge sessions are convened in an effort to strengthen participation of researchers and students from South American countries in ridge-crest research. *(IR Office Note: The above two sessions have been combined into one session on Multidisciplinary Studies at Mid-ocean Ridges.)*

Future activities

Future plans for the end of 2007 and 2008 will focus on the implementation of the outcomes of this IRTI. Particularly, our working group is expected to provide an opportunity to plan multi-disciplinary contributions to international programmes and/or collaborative projects, for which benefits should be gained from interdisciplinary approaches. The publication of a monograph presenting an overview of the most advanced researches and innovative approaches in this context will be also considered on the basis of IRTI communications and working group discussions.

BIOLOGY

Chairs - C. Fisher (Pennsylvania State Univ), N. Dubilier (Max Planck Inst for Marine Microbiology)
Group Members - M. Baker (National Oceanography Centre, Southampton); M. Bright (University of Vienna); C. Cary (University of Delaware); A.V. Gebruk (Russian Academy of Sciences); S. Hourdez (Station Biologique de Roscoff, France); T.M. Shank (WHOI); K. Takai (JAMSTEC); A. Metaxas (Dalhousie University); J.-H. Hyun (KORDI) & A. Colaço (IMAR-University of the Azores)

Objective:

To increase international collaboration in hydrothermal biological studies and work on integrating ridge-crest biological and geological research.

2007 Update (submitted July 2007):

The Biology WG last met at the "3rd International Symposium on Vent and Seep Biology" at La Jolla, California, from September 12 – 16, 2005. At this meeting, the two previous Chairs of the WG, Francoise Gaill (France) and Kim Juniper (Canada) stepped down and Chuck Fisher (USA) and Nicole Dubilier (Germany) took over as the new Co-Chairs of the WG. Three scientists were taken up as new Group Members: Maria Baker (UK), Monika Bright (Austria), and Stéphane Hourdez (France). The WG members agreed to change the name of this group from the Mid-Ocean Ridge Ecosystems to the Biology WG, as the focus of this WG extends beyond the biology of mid-ocean ridges and includes other vent systems such as back arcs and subduction zones. The WG unanimously supported the decision of the Organizing Committee of the "3rd International Symposium on Vent and Seep Biology" to host the "4th International Symposium on Vent and Seep Biology" at JAMSTEC, Japan.

The main focus of the Biology WG in 2006 was the drafting of an "InterRidge statement of commitment to responsible research practices at deep-sea hydrothermal vents" (http://interridge.whoi.edu/node/185). This statement describes responsible, environmentally friendly research practices for research at hydrothermal vents and was unanimously supported by the IR Steering Committee and Chairs of all IR Working Groups.

In 2007, the Biology WG had an intensive, on-line discussion about the future of this group. The Group Members were asked to answer the following questions:

1) Is there a continued need for a Biology WG in IR?

If you answered yes to question 1:

2a) What are the "burning issues" or "big science questions" for the Biology WG?

2b) How can IR help push forward these "burning issues" and "big science questions"? What can IR contribute through international collaboration and coordination to work on the "burning issues" and "big science questions" that is not already being done by national programs?

If you answered no to question 1:

3) What are your arguments for disbanding the WG?

This discussion led to the following conclusions:
1) It was unanimously agreed that the Biology WG should not continue in its present form. The main reason was that the common scientific mission of this group was no longer clear.

2) It was agreed there is a continued need for a WG in the general area of biology that should be more focused, structured, and interdisciplinary in nature. The need for such a WG clearly extends beyond the ChEss program (Biogeography of Chemosynthetic Ecosystems) of the Census of Marine Life (http://www.noc.soton.ac.uk/chess/home.php), which is currently only funded until 2010. The goals of ChEss are to improve knowledge of the diversity, abundance and distribution of species from chemosynthetically-driven ecosystems. This goal only covers areas of diversity and biogeography research at vents and is primarily related to marine biology while an IR WG would be much more interdisciplinary and involve a broad range of scientists from different disciplines.

3) Stéphane Hourdez and Chuck Fisher proposed forming a new WG, on the ecology of hydrothermal vent fauna. The objectives will include community ecology (succession, roles of life history variables, biological interactions, and chemical/physical constraints in structuring communities) and physiological ecology (which must include symbiotic adaptations). Addressing the first order questions in these fields requires a focused, international, and interdisciplinary effort to discuss and facilitate manipulative experiments, long-term observations, standardization of sampling methods, and the use of new methods, equipment and approaches for *in situ* and laboratory research on vent fauna. This WG would continue to take the lead with issues connected to vent site "environmentalism issues", which is one of IR's stated purposes. Such a WG would be highly interdisciplinary and include chemistry, geology, and microbiology. A proposal for an Ecology WG was submitted to IR by Hourdez and Fisher in July 2007.

4) There is strong agreement that the International Vent and Seep Biology Meetings are one of the most successful outcomes of the Biology WGs and that these meetings should continue, independent of the discussion of whether to disband the Biology WG. These meetings should continue to be held with the help and support of IR. The proposed new WG in ecology was asked to consider taking over the responsible role for organizing this meeting.

DEEP EARTH SAMPLING

Chair - Benoit Ildefonse (CNRS/ISTEEM)
Group Members - P.B. Kelemen (Columbia University); M. Cannat (CNRS); J. Miller (IODP); J.M. Peter (Geological Survey of Canada); C.J. MacLeod (University of Wales, Cardiff); W. Bach (University of Bremen); K. Edwards (USC); Y. Ohara (Hydrographic & Oceanographic Dept of Japan); H.J.B. Dick (WHOI); D.A.H. Teagle (National Oceanography Centre); D.R. Toomey (University of Oregon); K. Gillis (University of Victoria) & S. Umino (University of Shizuoka)

Objective:
This group was formed at the start of the Next Decade Program. Its specific aim is to strengthen the ties to, and use of, global deep earth sampling facilities such as IODP, ICDP etc. The working group, through international meetings and planning sessions will develop a long term plan for the drilling by conducting and participating in long term planning for ocean and continental drilling. This Working Group will organize the preparation of specific drilling proposals for submission to the Integrated ocean drilling program, monitor the progress of the program, and identify and encourage key groups of proponents.

Themes: Drilling of Active Hydrothermal Systems; Evaluation of Zero-age Ocean Crust and Axial Mantle; Exploring the Deep Biosphere; Drilling in Ophiolites; an International Crustal Penetration Drilling Project.

2007 Update (submitted May 2007):
Associated Scientists: Natsue Abe - JAMSTEC, Yokosuka, Japan; Donna Blackman - SCRIPPS, San Diego, USA; John Chen - Beijing University, Beijing, China; David Christie - UFA, Fairbanks, USA; Nadine Le Bris - Ifremer, Brest, France; Jim Natland - University of Miami, RSMAS, Miami, USA; Kyoko Okino - ORI, Tokyo, Japan.

Mission Moho:
Over the last year, most of the WG members were involved at various degrees with the "Mission Moho" project (missionmoho.org). This IODP mission proposal is an outcome of an international workshop, co-funded by IODP, JOI, Ridge 2000 and InterRidge, and co-chaired by B. Ildefonse and D. Christie, held in Portland, Oregon, on September 7-9, 2006. It has been submitted to IODP in April 2007. Mission Moho is an integrated campaign to understand the formation of the oceanic lithosphere with the ultimate goal of drilling a complete section through intact ocean crust, across the Moho and into peridotites of the upper mantle. It is the culmination of a four-decade quest by IODP and its predecessors (ODP, DSDP) to increase our understanding of the oceanic lithosphere through deep scientific drilling.

Active IODP proposals designed to drill at or close to mid-ocean ridges:
522-Full5 - D.A.H. Teagle - Superfast Spreading Crust - OTF
532-Full - B.E. Tucholke - Kane Megamullion - SSEP
535-Full5 - H.J.B. Dick - 735B Deep - SSEP
545-Full3 - A.T. Fisher - Juan de Fuca Flank Hydrogeology - OTF
547-Full4 - M. Fisk - Oceanic Subsurface Biosphere - SPC
551-Full - K.M. Gillis - Hess deep Plutonic Crust - SPC
584-Full2 - P.A. Rona - TAG II Hydrothermal System - SPC
640-Pre - Y. Ohara - Godzilla Mullion - SSEP
646-Full - B.J. Murton - Iceland Hotspot - SSEP
655-Pre - E.E. Davis - Juan de Fuca Observatories - SSEP
677-Full - K. Edwards - Mid-Atlantic Ridge Microbiology - OTF
719-MP - B. Ildefonse - Mission Moho - SSEP

Full: full proposal; Pre: pre-proposal; MP: Mission proposal
OTF: Operations Task Force (logistics being planned; expedition not yet scheduled)
SPC: Science Planning Committee (project is being ranked relative to other proposals)
SSEP: Science Steering & Evaluation Panel (under review or prior panel advice is being incorporated before revised version submitted)

Recent, forthcoming or proposed survey and test activities:
1) Test of a new 15m seabed rock drill.
The British Geological Survey spent 6 days testing "RD2", a new seabed rockdrill that allows drilling 15m long cores, in the hydrothermal areas of the Mid-Atlantic Ridge at ~15°N (water depths 2980 - 3050 m). Read the news item in: http://www.intoceansys.co.uk/cgi-bin/news.cgi?section=news (also, see the article by Petersen et al., this issue).

2) Serpentinite-rich seafloor at the Mid-Atlantic Ridge.
The beginning of 2007 was very active on the front of surveying serpentinite-rich seaflloor areas and related hydrothermal sites, with the french cruise "Serpentine" (http://www.ifremer.fr/serpentine/) and the british cruise "JC07" (http://www.noc.soton.ac.uk/gg/classroom@sea/JC007/). The effort continues this summer 2007 (June-July), with the MOMAR-DREAM Cruise (R/V *Pourquoi Pas?*, ROV surveying and sampling), in the area of the serpentinite-hosted Rainbow hydrothermal field at 36°N.

3) Godzilla Mullion site survey, R/V *Hakuho-maru*, Aug-Sep 2007.
Basic site survey at Godzilla Mullion (IODP pre-proposal 640-Pre) has already been completed (full-cover bathymetry, MCS, seismic refraction study using OBSs). The main objective of this cruise (PI: Y. Ohara) is to increase the number of dredge sites to map lithological variations along this ~ 120 km-long oceanic core complex. 3.5 KHz sub-bottom profiling and deep-towed magnetometer survey will also be conducted.

4) Hess Deep (JC20). RRS *James Cook*, Jan - Feb 2008.
This NERC funded cruise (MacLeod and Teagle) will survey the Hess Deep area (ROV surveying + Seabed rock drilling) to further constrain the seafloor geology and the location of future drill sites (Proposal 551-Full).

5) Proposal for 3D seismic imaging of the Atlantis Massif (Mid-Atlantic Ridge, 30°N).
Following the IODP Expeditions 304-305, a proposal for further integrated geophysical experiments at the Atlantis Massif has been recently submitted to NSF (Blackman et al.). The main component of the project is a 3D seismic survey of the massif. The new seismic results is intended to provide a framework to integrate existing and future geological results at Altantis Massif, including further deep drilling in IODP Hole U1309D.

MONITORING AND OBSERVATORIES

Chairs - J. Escartin (IPGP) & R. Santos (Univ. Azores, Portugal)
Group Members - K. Mitsuzawa (JAMSTEC); P.-M. Sarradin (IFREMER); A. Schultz (NSF); P. Snelgrove (Univ. Newfoundland) & P. Tyler (National Oceanography Centre)

Objective:
Understanding the dynamic processes of ridge systems and the complex interaction of the various components of these systems requires sustained time-series observations using a multidisciplinary suite of tools. The development of a seafloor observatory at a designated mid-ocean ridge site where infrastructure can support the installation, maintenance, and data telemetry for a broad spectrum of seafloor instruments led to the concept of MoMAR, or Monitoring the Mid-Atlantic Ridge.

Themes:
What are the interdependencies between the various components of the geological, chemical and biological systems of an active hydrothermal site?
What is the evolution and temporal variability of a seafloor hydrothermal system?
How do ridge crest hydrothermal systems impact the environment of the ridge?
How are the heat and mass originating from hydrothermal discharge dispersed into the ocean?
How can a deep-sea observatory be best used to conduct controlled experiments outside of the laboratory?

2007 Update (submitted May 2007):
The MOMAR Working Group, after the last meeting, has been inactive for the following reasons:
- As a result of the 2 MOMAR InterRidge meetings, several proposals were put in place, assuring the field work carried yearly through 2007 and planned (funded) through 2008.
- The USA community decided to focus their ISS sites at the EPR, Juan de Fuca and Lau, leaving the slow spreading site for a later time. Given the current funding climate, this meant research activities in MOMAR on an individual basis, with no community-wide implication.
- Following several EU projects (MOMARNET, ESONET...) and French projects (ANR, cruises) there has been a high degree of coordination both at the French level (MOMAR France Steering committee) and EU (ESONET).

It is felt that the coordination is best assured then associated with the funding of the projects (EU and France primarily). The role of InterRidge WG has thus been necessarily reduced.

Based on the apparent, possible shift of RIDGE2000 integrated study sites program, with a ramp-in of slow-spreading ridges, there is a critical need to coordinate efforts so as to optimize scientific return and field operations. As of 2007, there will be instrumentation at the seafloor, including autonomous thermometers, seismometers, pressure gauges, and other instrumentation. Thus an integration of the US side on the management of both the experiments and the data-sharing is required, particularly for monitoring and observatory-type experiments.

Lack of coordination, that can easily arise given the 'autonomous' nature of US science with respect to international efforts, can result in serious problems including:
- overlap of cruises for field work on the same area as the weather window is narrow (Aug-Sep basically)
- Interference and duplication of instrument deployment, risk of damaging previous experiments
- Incompatible management strategies and approaches, developed at different rates and different levels.

InterRidge can play a role on:
- Insuring that there is a communication channel between different 'MOMAR' countries and agencies, if MOMAR spreads beyond Europe/France and US particularly develops a Ridge2000 plan there (otherwise, implication of individual scientists/projects should not be a problem)
- A working group should then be basically the means to pass information between the different 'managements' (EU, France, USA) - the Fr and EU management structures have huge overlap and therefore the integration comes naturally.
- Eventually, there is room to organize a meeting at the end of 2008 or early 2009 on 'Integrated study sites and seafloor observatories at slow spreading ridges', this could encompass results on hand (Lucky Strike, Rainbow, Lost City, TAG, among others) as well as perspectives.
- As discussed in the past about 'complementarity' of instruments/protocols - this is a technical issue to be dealt with the engineers involved in the different projects. It may be advisable to renew this effort, as developments and changes will probably go fast with the risk of divergence and incompatibility.

ULTRA-SLOW SPREADING RIDGES

Chair - Jon Snow (University of Houston)

Objective:
Ultraslow spreading ridges (<20mm/yr full spreading rate) represent a class of divergent plate boundary that possesses quite different geological, physical and chemical characteristics than slow, intermediate and fast spreading ridges. In addition, most of the ultraslow spreading ridges are found in polar or near-polar regions, including the circum-antarctic plate boundary and the Arctic spreading system. This class of mid-ocean ridges thus poses an interrelated set of unique scientific and logistical problems, but promises unusual benefits and insights into the workings of all mid-ocean ridges.

Themes: Lithosphere/Asthenosphere interaction; Magma genesis and mantle composition; Hydrosphere/Lithosphere interaction; Biogenesis; Biogeography.

2007 Update (submitted April 2007, appended November 2007):
A large segment of the ultraslow spreading ridge community met in fall 2006 in Sestri Levante, Italy at the InterRidge-European Science Foundation-funded "Polar Ridges Meeting and Workshop". During 3 days of talks, workshop and field trips, the main topics discussed were the cutting edge of ultraslow spreading ridge science, concrete plans for new expeditions on ultraslow spreading ridges, and new countries (notably China and Korea) who are interested in increasing their involvement in the study of ultraslow spreading and polar mid-ocean ridges. See Polar Ridges Workshop 2006 on the IR website: http://interridge.whoi.edu/WG/ultraslow/06PolarRidges.

Progress is being made about the role of thick-skinned rifting in the breakup of continents as well as the evolution of ultraslow spreading ridges. This is outlined in a new general review of ultraslow spreading ridges (Snow and Edmonds, 2007), and was a featured topic in a second meeting in 2006, the IODP Workshop on Continental Breakup held in September 2006 in Pontresina, Switzerland, near the site of the original outcrops on which the term 'ophiolite' was defined (http://www.iodp.org/continental-breakup).

Significant progress has taken place in investigation of the ultraslow Southwest Indian Ridge. An important contribution was made by Mathilde Cannat and colleagues, who reported on a pioneering study of off-axis morphology, tectonics and geophysics on the Southwest Indian Ridge (Cannat, et al., 2006). In early 2007, the first active high-temperature hydrothermal vent field was discovered at the Southwest Indian Ridge west of the Gallieni fracture zone by an international team of scientists on board the Chinese R/V *DayangYihao* using the ABE vehicle of the Woods Hole Oceanographic Institution (Tao et al., 2007; also, see article by Tao et al., this issue).

This year, extensive under-ice AUV operations are planned by Rob Reves-Sohn and colleagues along the Arctic Gakkel Ridge, in order to better characterize the hydrothermal activity found there.

References

Cannat, M., D. Sauter, V. Mendel, E. Ruellan, K. Okino, J. Escartin, V. Combier, and M. Baala (2006) Modes of seafloor generation at a melt-poor ultraslow-spreading ridge. Geology v. 34; no. 7: 605-608.

Snow J., and H. Edmonds (2007) Ultraslow Spreading Ridges: Rapid Paradigm Changes. Oceanography, Vol. 20, No. 1: 90-101.

Tao, C., J. Lin, S. Guo, Y.J. Chen, G.W.X. Han, C.R. German, D.R. Yoerger, J. Zhu, N. Zhou, X. Su, E.T. Baker, and DY115-19 Science Party (2007) First discovery and investigation of a high-temperature hydrothermal vent field on the ultra-slow spreading Southwest Indian Ridge, EOS Trans. AGU, Fall Meet. Suppl., Abstract T52B-07.

WORKSHOP REPORTS

WORKSHOP REPORT: BUILDING A GLOBAL DATA NETWORK FOR STUDIES OF EARTH PROCESSES AT THE WORLD'S PLATE BOUNDARIES

Summary provided by Workshop Conveners: S. Carbotte and K. Lehnert (LDEO of Columbia University), S. Tsuboi (JAMSTEC), and W. Weinrebe (IFM-GEOMAR)

The international geoscience community is actively engaged in scientifically aligned goals through the InterRidge and InterMARGINS programs -- broad multi-disciplinary initiatives focused on understanding the fundamental processes of crustal formation, modification and destruction at the Earth's plate boundaries. Under these programs, intensive multi-disciplinary and multi-national investigations have been conducted within focused geographic locations, some of which fall within territorial boundaries of partner nations. At present there are no formal agreements within these programs for data sharing between foreign partners; data exchange occurs primarily by informal agreements between scientists directly involved in specific projects. However, significant benefits to these marine-terrestrial geoscience research efforts could be achieved internationally if data collections maintained as national efforts were better linked, and if broader access were initiated. Rapid advances have occurred over the past decade in Information Technology for scientific research, providing new access to data from distributed data resources, and new tools for data visualization and integration. These technologies will enable independent, globally distributed sites to share, link, and integrate their data holdings and services while maintaining full ownership and credit for these holdings. Along with these advances in Information Technology has come the growth of digital data collections for a broad suite of data across the sciences. These advances hold great promise for the solid earth sciences, an inherently multi-national and multi-disciplinary field, which involves the collection of typically unique data sets during oceanic and terrestrial expeditions and subsequent laboratory work conducted by research institutions around the globe.

To explore current opportunities and challenges for international data exchange to support mid-ocean ridge and continental margin research, a workshop entitled "Building a Global Data Network for Studies of Earth Processes at the World's Plate Boundaries" was convened May 9-11, 2007,

Participants at the International Data Exchange Workshop, May 9-11, 2007, Kiel, Germany

in Kiel, Germany. The workshop was jointly sponsored by InterMARGINS, InterRidge, MARGINS and Ridge2000. The US National Science Foundation and the German project "The Future Ocean" provided additional financial support. Seventy-one people from 14 countries attended the workshop, including scientists from InterRidge and InterMARGINS, data managers, and information technologists.

The meeting agenda included presentations on science needs for data access, existing data centers or data resources relevant for continental margins and mid-ocean ridge research, and emerging technologies for data interoperability and sharing. Working group sessions focused on technological as well as organizational and cultural issues of global data exchange and were organized into four themes: Science User Needs & Concerns, Data Documentation and Publication, Data and Metadata Interoperability, and Opportunities and Obstacles for International Data Sharing. From the working group sessions, participants reached agreement on a number of recommendations, broadly summarized here:

• Open public access to data is fundamental to verifiable scientific progress. All data that are necessary to reproduce published scientific results need to be published and archived in accepted archives. Earth scientists require access to multidisciplinary data and data integrated from both the marine and terrestrial world.

• Uniform best practices and standards need to be developed, promoted, and used routinely within the international community for data acquisition, data submission to data centers, and data publication. Best practices should include the use of globally unique identifiers for data and samples. New automated tools that support metadata acquisition at sea, in the field, and in the lab are needed to further the implementation of best practices.

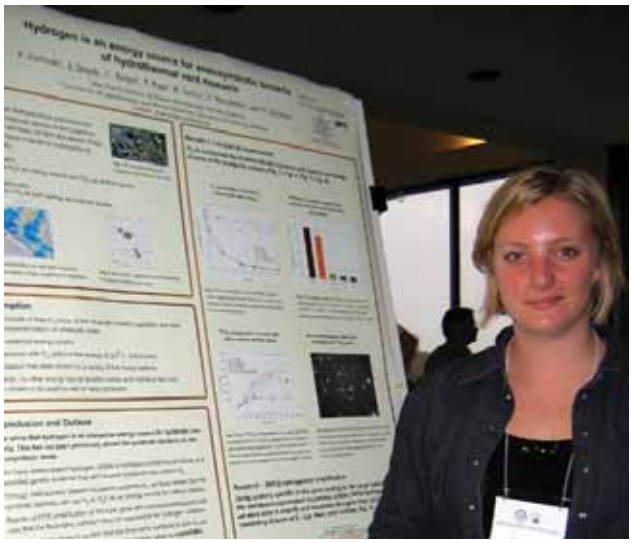
• To support interoperability across distributed data resources, the community must minimize the proliferation of metadata standards and work toward a uniform approach for scientific metadata building upon the work of existing community-based projects. Data centers should work to expose their data resources via web services to enable data access through programmatic interfaces and a broader range of options for data analysis and visualization.

• International programs and bodies such as GEOSS, the eGY, and ICSU should be leveraged to promote an initiative for a global data network for marine and terrestrial geoscience data. A dedicated task group is needed to advance the implementation of a global data network along with special interest groups in order to share experience and solutions on issues concerning metadata and interfaces.

Further information is available at the meeting website (http://www.nsf-margins.org/Datawkshp07/), including PowerPoint presentations and a PDF file of the workshop report. Contact the InterRidge Office if you would like a printed copy of this report (coordinator@interridge.org).

INTERRIDGE OUTSTANDING STUDENT POSTER AWARD 2007

This year's InterRidge outstanding student poster award ($700) went to Jillian Struck, a graduate student at the Max Planck Institute for Marine Microbiology in Germany. Jillian's poster at the IRTI was titled "Hydrogen is an energy source for endosymbiotic bacteria of hydrothermal vent mussels." A molecular microbiologist by training, Jillian has been working with geochemists lately, thanks to a project that involves incubating the gill tissue of mussels with radioactively labeled compounds. She said, "By taking an interdisciplinary approach and interacting with researchers from other fields, young scientists can take advantage of not only their own training and knowledge, but also learn much more about other subject areas. You can do this just by walking up to the next department, knocking on the door, and asking." She added, "I was once asked why I go to the trouble of doing research on animal-bacterial interactions in the deep sea, where sampling is complicated and expensive, and keeping the organisms alive in the lab still difficult to impossible." She continued, "But if we didn't do it, then we wouldn't know what's at the bottom of the sea. I enjoy the exploratory nature of the research."



Jillian (Petersen) Struck with her poster at the IRTI Biogeochemal Interaction at Deep-Sea Vents

CHESS AND INTERRIDGE CELEBRATE THE 30TH ANNIVERSARY OF THE DISCOVERY OF HYDROTHERMAL VENTS

M. Baker[1], E. Ramirez-Llodra[1,2], K. Kusek[3], P. Tyler[1], C. German[3]

Scientists from the Biogeography of Deep-Water Chemosynthetic Ecosystems (ChEss) and Census of Marine Life (CoML) programs honored the 30th anniversary of the discovery of hydrothermal vents by holding their annual meeting in June 2007 at the Charles Darwin Research Station in the Galápagos Islands—roughly 350 kilometers from the site of the initial discovery. CoML is a global network of researchers engaged in a 10-year initiative to assess the diversity, distribution and abundance of life in the oceans. ChEss is one of the 14 CoML field projects, aimed at understanding the biogeography of species from deep-water chemosynthetic ecosystems. The meeting, funded by the Alfred P. Sloan Foundation, included discussions about new—and controversial—issues facing vent science, such as the onset of deep-sea mining and plans for conservation and management. Roughly 50 scientists attended.

ChEss Steering Committee Meeting: A Synopsis

During the ChEss Steering Committee meeting on 27-28 June, ChEss scientists discussed plans for synthesis, aiming towards the end of the Census of Marine Life program in 2010. One of the main decisions was to organize a series of taxonomical workshops to compile known data and create taxonomic resources that will be available online for some of the main vent, seep and whale-fall taxa.

Fig. 1. Paul Tyler, Chris German, Eva Ramirez-Llodra and Maria Baker (ChEss office) celebrate the 30th anniversary of the discovery of hydrothermal vents.

A general biogeography workshop, potentially in combination with other deep-sea CoML projects, will be organized at the final stages of ChEss to compile all known data, and to discuss the emergent trends and patterns. A number of synthesis articles, visualization tools and outreach activities will also be developed. The steering committee also discussed the important issue of the imminent exploitation of deep-sea sulphides at hydrothermal vents.

Reaching Out to the Public: From the Galápagos Around the World

A special highlight of the meeting was the public outreach event held on 29th June, which was co-organized with InterRidge (see synopsis and photo in Education and Outreach Update, this issue). The event featured interactive displays (remote-controlled submarines, a tubeworm anatomy station, and porthole-coloring competition), a showing of the giant-screen film "Volcanoes of the Deep Sea," and lectures by some of the vent science "pioneers" (given in both English and Spanish). The auditorium was a packed house; at least 150 local school children and adults from Puerto Ayora, Galápagos, came to learn about vents, far exceeding our expectations for attendance.

Fred Grassle of Rutgers University kicked off the public event: "We knew right away this was the biggest discovery in biology in the past century" said Grassle, who mounted the first biological expedition to the vents in 1979. "At the time it was thought that the deep ocean was devoid of life, and what little life there was, was thought to depend on food falling from above" Grassle said. Emory Kristof, long-time photographer at the National Geographic who was on scene during the discovery, described the evolution of underwater photography since the early days, and discussed the significance of photography and video to spreading the word of the discovery worldwide. Cindy Van Dover went on to thrill the audience with her account of the exotic fauna of the deep sea oases and the differences and similarities we see in animal composition between vents. Chris German concluded the talks by describing modern vent exploration and the links with outer space. He told how the applications and robotics for vent research are not just important for exploring Earth's remotest oceans, but may also represent the explorers of the future searching for life in outer space.

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Further information:

- All abstracts and podcasts from two of these talks are at the ChEss website: http://www.noc.soton.ac.uk/chess/.
- CoML: http://www.coml.org.
- Richard Lutz of Rutgers University and Emory Kristof screened the film "Volcanoes of the Deep Sea," which was originally released in 2003. More information can be found at: http://www.volcanoesofthedeepsea.com.

Fig. 2. The ChEss steering committee with Jesse Ausubel (Program Director for the A.P. Sloan Foundation) and Ron O'Dor (CoML Senior Scientist).

Fig. 3. The exhibition area opened to the public.

INTERRIDGE THEORETICAL INSTITUTE: BIOGEOCHEMICAL INTERACTION AT DEEP-SEA VENTS

Summary provided by IRTI scientific committee and working group chairs:
N. Le Bris[1], M.K. Tivey[2], C.R. German[2], S.M. Sievert[2], K. Takai[3], F. Gaill[4], J. Lin[2], W. Bach[5], K. Edwards[6], P.-M. Sarradin[1], J. Holden[7], D. Connelly[8], and M. Lilley[9]

Introduction

The Biogeochemical Interaction at Deep-Sea Vents Working Group held the third InterRidge Theoretical Institute (IRTI) at Woods Hole Oceanographic Institution (WHOI) in Woods Hole, Massachusetts, USA during September 10-14, 2007. The goal of the IRTI was to foster multidisciplinary research on the interactions between the biological and chemical components of deep-sea environments associated with hydrothermal circulation— particularly the biogeochemical processes driving these interactions. The event was co-sponsored by InterRidge, Ridge 2000 (USA), JAMSTEC (Japan), IFREMER (France), CNRS (France), and WHOI's Deep Ocean Exploration Institute.

The IRTI featured two days of lectures, a poster session, and a three-day workshop. The first two days included introductory talks focusing on the key issues requiring interdisciplinary approaches. The final days featured five working groups that enabled scientists to discuss strategies and collaborative projects. More than 127 scientists attended the lectures, and roughly 80 participants attended the working group discussions (see

[1]Ifremer, France; [2]Woods Hole Oceanographic Institution, USA; [3]JAMSTEC, Japan; [4]CNRS, France; [5]University of Bremen, Germany; [6]University of Southern California, USA; [7]University of Massachusetts Amherst, USA; [8]National Oceanographic Centre, Southampton, UK; [9]University of Washington, USA

group photo below). Students and post-docs were particularly well represented. Of the 47 poster presentations, most were given by students. Jillian (Petersen) Struck from the Max Planck Institute for Marine Microbiology in Bremen, Germany, won the outstanding student poster award (see p. 47, this issue). Abstracts and some PowerPoint files for presentations are available on the IR website (http://interridge.whoi.edu/IRTI/2007); the full report of the IRTI will be available soon for download as a PDF file.

Advanced workshop lectures: "The international school"

In the initial lectures, experts summarized the current collective understanding of the links between key geological, physical, chemical, and biological processes at vents including: the processes driving the variability of environmental conditions associated with hydrothermal venting, the thermodynamic and physiological constraints on energy transfer from chemical to biological systems, and their role in vent ecosystem dynamics.

It was first emphasized that the diversity of end-member chemical composition is likely to be infinite— reflecting complex interactions between rocks and seawater, and phase separation processes at high temperature and pressure. Transport and mixing pathways below and above the seafloor, as well as biological activity itself further complicate this variability and generate a mosaic of microenvironments with highly diverse physico-chemical properties. The wide diversity of microbial communities and the variety of chemosynthetic energy pathways they rely on, provide another layer to this environmental diversity. The question of whether 'chemistry drives biological diversity' or 'biology drives chemical conditions' remains a matter of debate. A concluding message from the lectures was that the interaction of processes that define the molecular architecture of these biogeochemical systems is more complex than previously thought. At the scale of whole communities and ecosystems, biological interactions and physical processes should still play a major role in regulating these fundamental interactions in space and time.

This "international school" established that a better understanding of the reciprocal influences between the abiotic and biotic components of the systems is needed— not only to improve the understanding of biogeochemical processes and their role in the ecosystems, but also to investigate how biological systems may serve as indicators of geophysical and geological processes taking place beneath the seafloor. Proposed strategies to achieve these goals included: developing *in situ* and *in vivo* approaches to characterize the diversity, modeling from which hypotheses can be formulated, and experiments to test these hypotheses. Examples of the advances made in the following areas were presented: *in situ* electrochemical sensing of chemical speciation, combined cultivation approaches and molecular biology techniques for microbial diversity and gene expression studies, and integrated multidisciplinary *in situ* experiments.

Working Group discussions

The aim of the workshop was to focus on some key issues that will drive vent research in the near future. Five Working Group (WG) topics were chosen as focus topics that would benefit from international cooperation.

Working Group 1. Regional-scale plume studies and water column chemistry/biogeochemistry

The focus of this working group was to consider the large-scale impact of hydrothermal venting on global-scale ocean biogeochemistry, and to decide how best to address the topic. One particular emphasis was on how the InterRidge and GEOTRACES pro-

IRTI Biogeochemical Interaction at Deep-Sea Vents, Sept. 2007, Woods Hole, MA, USA

grams could work together to achieve common goals.

Our discussions followed three themes:

- What had already been discussed by GEOTRACES prior to the WG;
- What InterRidge biogeochemists would recommend as an *ideal suite* of observations in a large-scale hydrothermal plume investigation;
- How water-column processes and fluxes could be coordinated with seafloor observations at one or more sites of hydrothermal venting from the seabed.

Choice of study site

There is widespread international agreement that the large-scale (>1000 km) hydrothermal plume discharging from the southern East Pacific Rise near 15°S would make an excellent target for investigating large-scale plume biogeochemistry. The plume is large, already well-constrained geographically, coincides with the site of *predicted* largest hydrothermal fluxes to the oceans, and is known to have been stable over timescales that are long with respect to thermohaline circulation. This gives us confidence that it is a suitable location to invest significant international resources to obtain results representative of the global-scale impact of hydrothermal venting on ocean biogeochemistry.

Scope of Study

To address the impact of hydrothermal venting on the oceans, we identified three kinds of measurements that would be required:

- *Distributions* of conservative tracers, metals, gases, nutrients, microbiology and suspended particulate matter. Measurements of trace elements and isotopes most important to GEOTRACES as well as InterRidge, in this context, would include metals (including their stable isotopes) with a particular focus on those known to be related to enzymes (includes: Fe, Mn, Al, Cu, Zn, Cd, Co, Ni, Mo, V, As, Pb & Os) and those related to dissolved-particle interactions – notably Th, Pa, Rare Earth Elements, Be.
- *Biogeochemical dynamics and rates* – this would include both standard C-fixation and respiration and N-cycling studies and novel fertilization experiments (e.g., Fe, Mn, Zn, others?).
- *Input/output fluxes & time scales* – Key considerations here would be to determine: end-member vent-fluid concentrations and fluxes from buoyant plumes (which will only be possible through access to deep-submergence assets); through-plume fluxes (e.g., using $^{222}Rn/^{3}He$, ARGOS floats program, lowered ADCP on CTD-rosette); vertical fluxes into/out of plumes (e.g., adopting ^{234}Th-based upper-ocean techniques, sampling core-tops for long-term record).

Implementation Strategy

Implementing the full scope of what is envisaged will require more than one single research cruise. Rather, what will be required will be a combination of a large-scale basin-wide *section* (as already envisaged by GEOTRACES) coupled with a submersible-enabled *process*-oriented study to vent sites at the ridge-axis. An obvious way forward, therefore, would be for InterRidge to continue to work together with GEOTRACES in developing this project:

- GEOTRACES should take lead responsibility for developing the *section*-based study - to ensure complementarity with all other global-scale section studies.
- InterRidge should take responsibility for i) developing the *process*-based study that would provide first-time users from the GEOTRACES community access to the seafloor via submersibles, and ii) identifying which complementary studies might be accommodated on the section-based investigation, in addition to what is already envisaged as core measurements for GEOTRACES.

Working Group 2. The hidden biosphere: metabolic diversity, element fluxes and mineral signatures

Hydrothermal vent systems are obvious targets for biogeochemical research on subseafloor life. Examining the physical and chemical limits of life and antiquity of the deep biosphere for primary production will help fill in gaps on the tree of life, and reveal novel genetic and biochemical information.

Although it is challenging to sample the high-temperature and/or rock-hosted biosphere by drilling, obvious advantages of drilling include the ability to instrument-boreholes to investigate fluid flow and fluid chemistry, and to use the holes as natural laboratories for incubation studies. Working Group 2 identified diffuse hydrothermal mixing zones and lower temperature recharge zones off-axis and in ridge flanks as subseafloor habitats where most of the primary production likely occurs.

Microbiologists and geochemists in WG2 developed ideas, strategies, and procedures for investigating these largely unexplored environments. Apart from subseafloor mixing zones, areas of seawater-peridotite interaction and resulting high hydrogen levels in the system were deemed particularly interesting. Regardless of the type of setting, results from detailed seafloor surveys and data analyses should be used to develop working hypotheses of subseafloor conditions and processes of fluid mixing and heating/cooling.

The shallowest parts of the system are difficult to core by IODP drilling methods, which therefore need to be coupled with other seafloor drilling platforms in order to maximize coverage. Shallow drilling, using ROV-mounted drills and rock drill units, has been developed to

sample the uppermost meters to decimeters of basement.

Working Group 3. Life in extreme environments: strategies and adaptations

Because hydrothermal vent organisms and microorganisms face a wide range of environmental extremes, they are unique models for studying life adaptation strategies (e.g., chemoautotrophy, heavy metals detoxification, thermotolerance, symbiosis, respiratory adaptation in metazaons, etc.). However, the variability of habitats above or below the substrate-seawater interface poses unique challenges not only for the organisms inhabiting these environments, but also for sampling and studying them. Although much progress has been made in the last decade, many gaps remain.

Identifying the important microbial players in the various habitats was discussed in light of the great strides made in the last decades. Along with the need to cultivate organisms to identify genes and proteins expressed under defined conditions, metagenomic and eventually proteomic approaches offer much promise to further elucidate functional aspects at *in situ* conditions. Conducting these studies at vents still represents a great challenge, particularly in light of the physical, chemical and biological heterogeneity of these systems.

Additionally, while thermodynamic calculations allow us to place an upper constraint on available metabolic energy to produce biomass in the system, models have to be refined to estimate how much of this biomass is actually produced. Better constraints are needed on growth efficiencies of microbes at optimal and suboptimal conditions, as well as on the rates of abiotic reactions. We also need to better assess the role of symbiotic invertebrates themselves as biogeochemical drivers because substantial consumption rates of electron donor and acceptor consumption, carbon fixation and metabolite excretion are supported by their communities. Also challenging is sampling animals while minimizing stress for *in vivo* studies, or including *in situ* preservation. A few systems for the preservation of biological samples *in situ* are now available, some being adapted to small animals.

Modeling requires us to better characterize boundaries and their spatial and temporal variability by small-scale measurements and good descriptive observations. Multiparameter techniques like voltammetry and mass spectrometry, now available, together with new methods using micro-arrays or planar optodes for 1D or 2D chemical mapping, should allow a more complete description of these chemical environments. We need to better understand the physics of these systems, particularly in the turbulent mixing zone where vent invertebrate communities live, but this calculation is still limited by the acquisition of accurate flow rate measurements. It was agreed that international cooperation should help to address these challenges. Benefits should especially be gained by focusing efforts on target sites (i.e., R2K integrated study sites, or ISS's, extended to an international level). This would encourage at-sea collaboration and allow for consistent data sets to be obtained with various sensors, the development of common instrumentation platforms both for *in situ* and *in vivo* monitoring and experiments (e.g., landers /autonomous sensors, instrumented aquaria, etc.), and the sharing of money and facility access for genomic works (sequencing).

Working Group 4. Observatories: tools and strategies for long-term seafloor ecosystems studies

The purpose of this working group was to discuss the current status of cabled network observatories to hydrothermal vent sites in the northeastern Pacific Ocean (i.e., the U.S. regional cabled observatory, or NEPTUNE) and the Mid-Atlantic Ridge (i.e., ESONET system to MoMAR), and to brainstorm strategies for biogeochemical experiments using this technology. The working group stressed the importance of using the observatories to answer hypothesis-driven research. The kinds of questions that could be addressed more thoroughly using the observatory approach include 1) successional, cyclic (e.g., seasonal), and singular events that impact the system, 2) fluid and chemical fluxes, and 3) linkages with the water column.

The advantages of running experiments using a cabled network include: a much larger power supply for instrumentation (compared to battery-driven instruments), and the ability to make, retrieve, and respond to observations in real time. New instruments and coordinated arrays of instruments would need to be developed. In addition to the deployment of sensors that could transmit this information directly through the cable, fluid samples would need to be collected and sent to the surface for retrieval in order to correlate chemical and microbial community compositions. There is also a need for mobile sampling platforms (e.g., AUVs) that could be directed remotely, allowing 3D chemical sensing with coordinated imagery and chemical sensing over a defined target area.

The working group strongly recommends that a common core package of instruments be deployed at each of the cabled vent sites for direct cross correlation of the data retrieved from the sites. Successful cabled observatories will require a phased approach and long-term commitments for deployment and maintenance. There is also a need to continue developing strategies for how the data from the observatory will be processed, managed, and disseminated to the broader community and public.

Working Group 5. New approaches and tools for biological and chemical sensing

Existing or emerging sensor technologies for deep-sea vents were reviewed, and some exciting prospects for increasing the range of analytes were presented. In addition to 'solid-state' methods, such as voltammetric (micro) electrodes, the potential for using Raman spectroscopy, Gas Chromatography-Mass Spectrometry (GCMS) and Laser-Induced Breakdown Spectroscopy (LIBS) was discussed in the light of the very active programs for these systems.

The wish list compiled illustrates the wide range of chemicals that need to be measured along with temperature, including H_2, O_2, H_2S, CH_4, CO_2, SO_4^{2-}, Cl^-, Fe, Mn, $S_2O_3^{2-}$, NH_4^+, PO_4^{3-}, NO_3^-, NO_2^-, DOC, Zn, Cu, Hg, Si, Mn along with pH and Eh. A short list of the most desired chemical parameters came down to pH, O_2, H_2S, and H_2. Reliable methods to determine flow rate are still needed, along with methods to determine chemical transformation rates. Biologists also pointed out the need for the development of *in situ* methods for Fluorescent In-Situ Hybridization (FISH), cell counts, particle measurements and organismal identification.

The development of the deep-sea observatories leads to an increased realization that we are lacking sensors that can deployed on these networks. It is yet clear that techniques are in development for a large number of these measurements in hydrothermal systems, or are used by other groups working in the upper ocean. Opportunities for the adoption of sensors used in other fields of science and industry, and the potential to make our existing sensors more 'black-box' in operation to allow more widespread use will hopefully be provided in this context.

While most sensors take at least 10 years for development, getting funding for sensor development has always been challenging. The formation of 'excellence centers', be it real or in the virtual world, would be a positive way of addressing not only the issue of lobbying for funding but also most of the issues raised in this working group, including those related to data management and to the integration of sensors between platforms and countries through the use of standardized electrical operation. The positive note is that there is a growing desire to develop sensors not only in our field but also across all of the environmental sciences.

Conclusions

While great advances have been made in the understanding of the biogeochemistry of hydrothermal systems, great challenges still lie ahead. Thirty years after the discovery of vents, we still know relatively little about the mechanisms driving energy and chemical element transfer in these seafloor/subseafloor environments, and their impact on ocean biogeochemistry. One main reason is the challenge posed by the spatial and temporal heterogeneity of hydrothermal biogeochemical systems.

As these issues are inherently interdisciplinary, continued efforts are needed for the development of multidisciplinary collaborative approaches. Research will benefit from developing integrated strategies at the scale of the InterRidge community, focusing on study sites where obvious links are emphasized between sub-seafloor, seafloor and water column processes. In addition to the need to develop new sampling techniques, chemical and biological sensing, and standardized procedures, the groups emphasized the benefits of establishing virtual or real 'excellence centers' to acquire and maintain complex or expensive instruments and training to allow more widespread use of these tools.

This InterRidge Theoretical Institute provided opportunities to plan IR-scale multi-disciplinary contributions to international programs such as GEOTRACES and IODP. Beyond these specific initiatives, we felt that the field would profit from a more coordinated international effort to address outstanding issues and develop synergies between national and international programs. Working Group 3 further proposed the idea of conducting a vent field-scale experiment to address the outstanding question of biomass: how much biomass is produced at a vent system (and how), including that consumed within the system and exported to the surrounding deep-sea, and how much production occurs above vs. below the seafloor. Proposing a SCOR working group on this topic was the first step recommended to achieve this goal.

UPCOMING EVENTS

Dec. 10-14, 2007	AGU Fall Meeting 2007, San Francisco, CA, USA
March 2-7, 2008	Ocean Sciences Meeting 2008, Orlando, Florida, USA
March 25-26, 2008	Ridge2000 Community-Wide Meeting: "Mantle to Microbe: Integrated Studies at Oceanic Spreading Centers," Portland, Oregon, USA
March 27-28, 2008	Ridge2000 MAR 35°-37.5°N Implementation Plan Workshop, Portland, Oregon, USA
April 13-18, 2008	EGU 2008, Vienna, Austria (see next page)
April 21-24, 2008	Reunion Annuelle des Sciences de la Terre, Nancy, France (see next page)
May 26-28, 2008	Québec 2008, Joint Annual Meeting GAC - MAC - SEG – SGA, Québec, Canada
May 27-30, 2008	AGU Joint Assembly 2008, Fort Lauderdale, Florida, USA
June 16-20, 2008	5th Asia Oceania Geosciences Society Conference, AOGS 2008, Busan, Korea (see p. 56)
June 26-28, 2008	MATE International Student ROV Competition, "Diving to the Deep: Uncovering the Mysteries of Mid-Ocean Ridges," San Diego, USA
July 8-11, 2008	SCAR/IASC IPY Open Science Conference, St. Petersburg, Russia
July 18-22, 2008	ESOF 2008, Barcelona, Spain (see Education & Outreach Update)
July 29 - August 1, 2008	Western Pacific Geophysics Meeting 2008, Cairns, Australia
August 6-14, 2008	33rd International Geological Congress, Oslo, Norway (see p. 56)
August 29 - Sep. 1, 2008	6th International Conference on Asian Marine Geology, Kochi, Japan
Oct. 20-21, 2008	InterRidge Steering Committee Meeting and SCOR 50th Anniversary Symposium, Woods Hole, MA, USA
Oct. 22-24, 2008	SCOR General Meeting 2008, Woods Hole, MA, USA
2009	4th International Symposium on Vent and Seep Biology, Japan

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

EUROPEAN GEOSCIENCES UNION GENERAL ASSEMBLY, VIENNA, AUSTRIA, 13-18 APRIL 2008 (http://meetings.copernicus.org/egu2008/)

Deadline for abstract submission: 14 Jan. 2008

Session co-sponsored by InterRidge (GM6.2):
Seafloor expression of tectonic and geomorphic processes

Conveners: J. Hillier, N. Mitchell, M. Maia & T. Mulder

Bathymetry records and preserves a wealth of information about tectonic (e.g. fault scarps), geomorphic (e.g. channel erosion & landsliding), volcanic and geodynamic processes. New bathymetry (e.g. multibeam), especially when combined with sub-seafloor measurement, provides an exciting opportunity to combine geomorphology & geophysics and to extend geomorphology offshore.

This interdisciplinary session aims to examine the causes and consequences of the underwater landscape. The goal is to stimulate interdisciplinary work by bringing together researchers who quantify and characterize the shapes that form the seafloor, seek to understand the sub-surface processes at work and their impacts, or use bathymetry as a model input. A range of scales from ocean-wide (e.g. lithospheric cooling) to abyssal hills at the scale of meters, and datasets from satellite-predicted to multibeam are anticipated.

We welcome any exciting submissions in the spirit of the session, even if your particular process or bathymetric expression has not been explicitly mentioned. Perhaps: Hot-spot ridge interaction; Submerged glacial geomorphology; Quantifying underwater volcanoes; What stops subduction earthquakes -- seafloor features?

REUNION ANNUELLE DES SCIENCES DE LA TERRE, NANCY, FRANCE, 21-24 APRIL 2008 (http://www.rst2008.u-nancy.fr/)

Session on "Ridges, Ophiolites, and Rifting":

Conveners: David Jousselin, Mathilde Cannat

The oceanic lithosphere covers about three quarters of the Earth surface. Therefore, it is of paramount importance to understand the processes involved in its formation for a better view of the global Earth dynamic. However, several key questions concerning the elementary processes involved in the accretion of oceanic ridges are still debated.

How is rifting initiated? Is mantle flow the result of viscous drag from the separating plates, or is mantle flow dynamic? What are the relationships among mantle flow, melt flow, mantle composition, ridge morphology, and segmentation? How does hydrothermal circulation affect characteristics of the melt zone, crustal structure and composition, and ridge morphology?

Geophysical advances have lead to recent results that are not taken into account in most popular models. In parallel, the study of ophiolites is still a fruitful alternative way of exploration. These studies, coupled to deep drilling programs, and to the establishment of under-sea observatories, are leading to radical changes in our comprehension of ridge processes. This session aims at gathering recent observations, which have been carried out on current and incipient oceanic ridges, and on various ophiolitic complexes, in order to debate on the various hypotheses made about the genesis of the ocean crust.

5TH ASIA OCEANIA GEOSCIENCES SOCIETY CONFERENCE, AOGS 2008, BUSAN, KOREA, JUNE 16-20, 2008 (http://www.asiaoceania.org/aogs2008)

Session (SE72):
Recent Multidisciplinary Studies of Mid-Ocean Ridges and Ophiolites

Conveners: Sung-Hyun Park, Jian Lin, John Chen, Susumu Umino, Natsue Abe, Raju Kamesh

Mid-ocean ridges are the largest volcanic system on Earth and play an important role in the exchange of energy and material among various domains of our planet. In recent years, several Asian countries including Japan, China, India, and Korea have started scientific programs to explore and investigate geological, hydrothermal, and biological processes at mid-ocean ridge and deep seafloor, while increasing collaborations with the US and European counterparts under the auspices of InterRidge. Ophiolites, which are ancient oceanic crust exposed on land, have also attracted scientists in Asia as they offer important accessible sections of mid-ocean ridges. In this session, we invite scientific contributions on diverse issues related to mid-ocean ridges and ophiolites. In particular, we welcome new results and interpretations from recent sea-going cruises, fieldworks, and laboratory studies.

33RD INTERNATIONAL GEOLOGICAL CONGRESS, OSLO, NORWAY AUGUST 6-14, 2008 (http//www.33igc.org/)

Topical Symposium EME-05:
The Future of Marine Resources

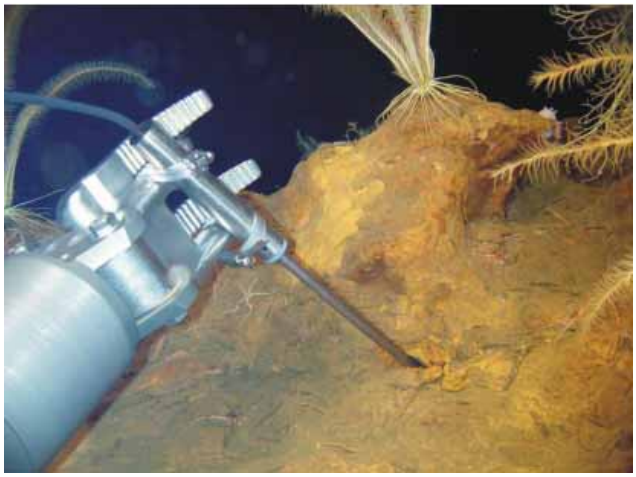
Conveners: Sven Petersen, James Hein, Klaus Wallmann, Michael Wiedecke

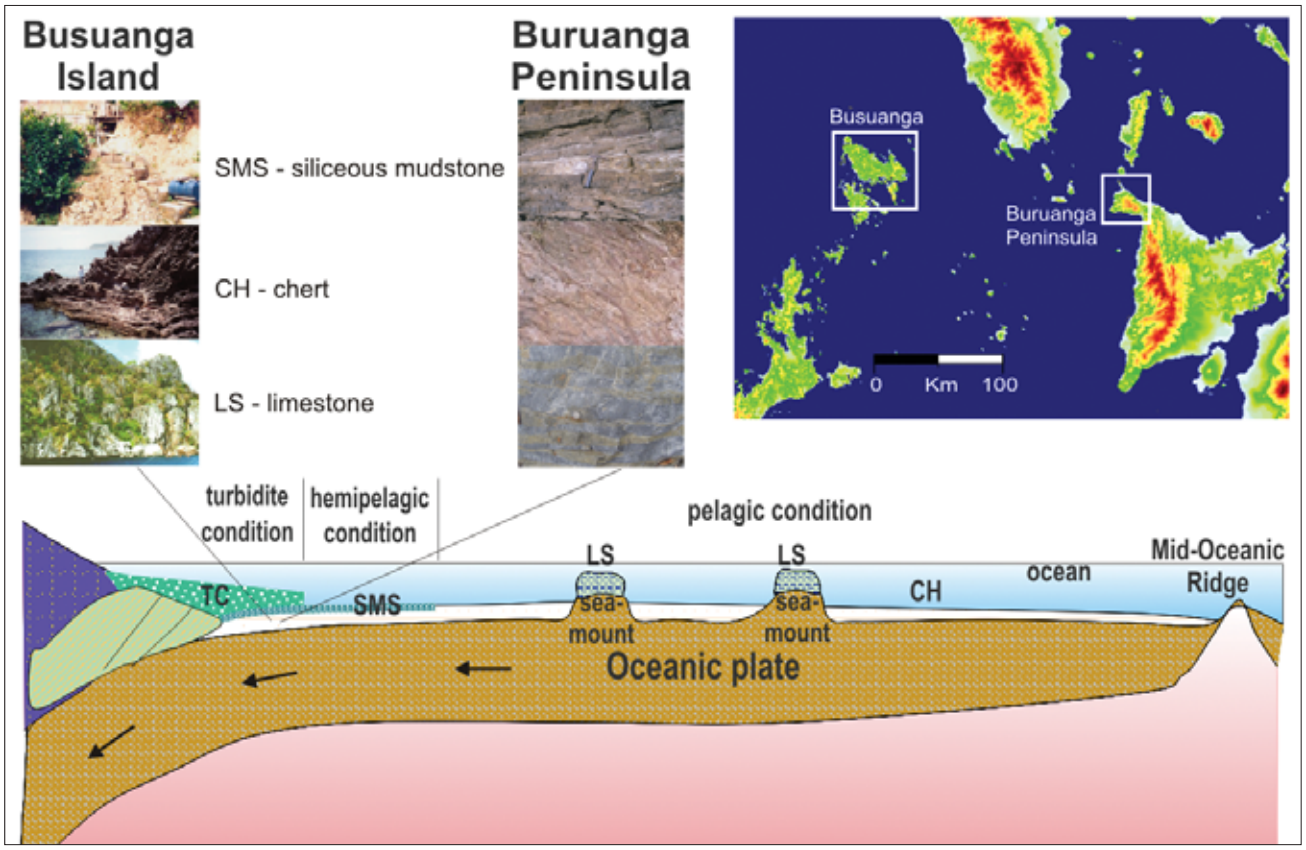
Deep-ocean mining will become a reality within this decade. Consequently, this is a crucial time for the consolidation and advancement of our understanding that can be applied to the exploration for and development of marine resources world wide. These efforts are being driven and promoted by National concerns and private industry alike. Energy and metal prices have as much as quadrupled over the past five-to-ten years and clearly show that economic and political factors will drive increasing exploration and exploitation in the oceans over the near term. This Special Session will emphasize the presentation of overview talks on individual marine resources, their resource potential, and their impact on humankind and the environment. Examples of potential resources that will be stressed include polymetallic/massive sulfides, ferromanganese crusts, manganese nodules, phosphorites, and gas hydrates.

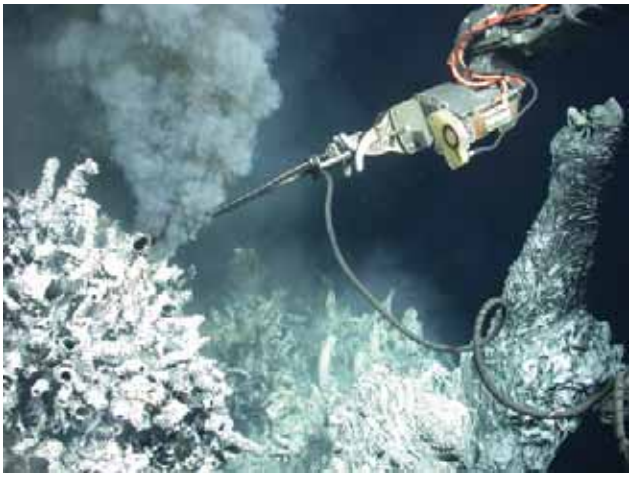
Biogeoscience General Symposium BGB-02:
Geomicrobiology: Low-temperature alteration, mineralization, and microbial interactions

Conveners: Ingunn Thorseth and Crispin Little

The importance of microorganisms in many surface and subsurface geochemical processes (e.g. rock weathering, diagenesis, hydrothermal activity) is widely recognized. However, further extensive interdisciplinary research effort is required to fully explore and evaluate these processes. The objective of this session is to present the latest results and approaches in linking water-rock geochemical reactions and microbial processes. Contributions ranging from laboratory experiments, field studies and modeling are welcome.







Color images from National News articles

Above, top: Philippines, Fig. 2 (from p. 34)
Oceanic plate stratigraphy of Busuanga Island and Buruanga Peninsula.

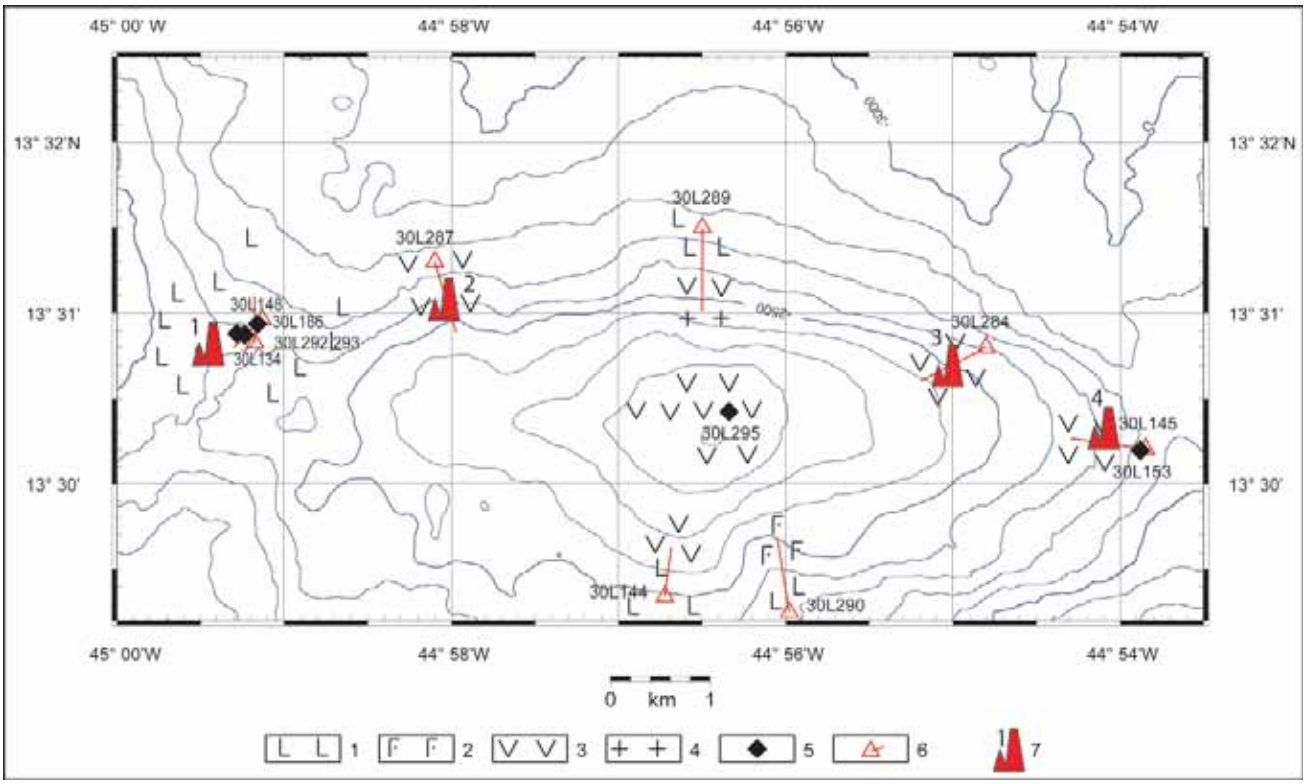
Above, middle: USA, Fig. 1 (from p. 38)
Sampling EPR vent fluid from *Alvin*.

Left: Canada, Fig. 2 (from p. 27)
Cable laying system on ROV *ROPOS*.

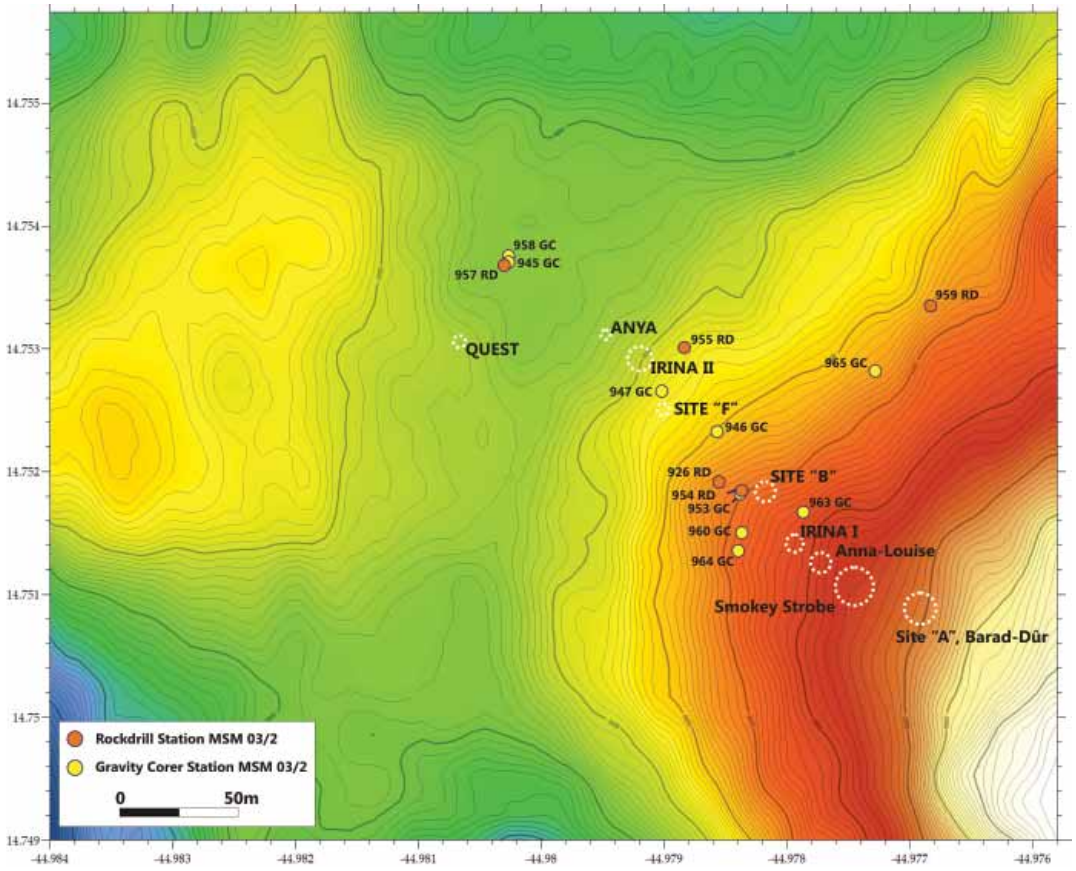
Country	Dates	PI	Ship	Cruise ID / Location	Research Objectives
China / USA	May 2008	C. Tao, J. Lin, C. German, D. Yoerger	R/V DayangYihao with ABE	DY115-20 / EPR (Equatorial)	Locate vents where hydrothermal plume was discovered in 2005
China / USA	11-17 Sep 2008	COMRA, C. German	R/V Atlantis with Alvin	Juan de Fuca (Endeavour)	Vent research and training of Chinese HOV engineers and pilots
France	15 Jun - 18 Jul 2008	V. Ballu, P-M. Sarradin, J. Escartin	R/V Pourquoi Pas? with ROV Victor	Bathyluck'08 / MAR (Lucky Strike)	MOMAR – Lucky Strike
France	Summer 2008	W. Crawford	R/V Le Suroît	BBMOMAR 2 / MAR	Recover and re-install OBSs from BBMOMAR in 2007
France	2008, dates undetermined	J. Dyment, F. Gaill, Y. Fouquet	R/V Pourquoi Pas? with ROV Victor	MOMARDREAM'08 / MAR (Rainbow)	See MOMARDREAM article by Gaill et al., this issue
France	2008, dates undetermined	J.Y. Royer	R/V Marion Dufresne	Indian Ocean	Recovery of hydrophones moored in 2006 during cruise PLURIEL
France / Portugal	2008, dates undetermined	J. Goslin	To be determined	MAR (Lucky Strike)	Recovery of hydrophones re-moored during MARCHE 2 in 2007
Germany	9 Sep - 19 Oct 2008	R. Seifert	R/V Meteor with ROV and AUV	M77/1 / MAR (4-11°S)	Biology, fluid chemistry
Germany	20 Nov - 22 Dec 2008	I. Grevemeyer	R/V Maria S. Merian	MSM10/2 / MAR (15°N)	Geophysics
Germany	15 Jan - 15 Feb 2009	N. Dubilier	R/V Maria S. Merian with ROV	MSM10/3 / MAR (15°N)	Biology, fluid chemistry, time series measurements
Japan	26 Nov - 3 Dec 2007	N. Seama	R/V Kairei	KR07-16 / central Mariana arc-backarc	Recovery of ocean bottom electromagnetometers (OBEMs)
Japan	5-27 Jan 2008	H. Kumagai, K. Okino, N. Seama	R/V Hakuho-maru	KH07-4-2 / SW Indian Ridge near the Marion hot spot (26-39°E)	Geophysical surveys, deployment of OBEMs, and rock sampling
Japan	Feb 2009	H. Kumagai, K. Okino, N. Seama	R/V Hakuho-maru	KH08-4 / SW Indian Ridge near the Marion hot spot (26-39°E)	Dredging and geophysical mapping, OBEM recovery
Japan	25 Nov 2008 - Jan 2009	N. Abe	R/V Mirai	MR08-06 Leg 1 / Chile Triple Junction	Oceanic crust formation
New Zealand / Italy	Nov 2007	C. de Ronde	R/V Urania	Aeolian arc	Hydrothermal plume mapping survey of submarine volcanic centers
Norway	2008, dates undetermined		To be determined	N Atlantic / Arctic Knipovich Ridge	Locate vents in vicinity of seawater anomaly discovered in 2007
Russia	Nov 2007 - Jul 2008		R/V "Professor Logatchev"	MAR (19-22°N)	Regional surveying and mapping in axial zone
Russia / India	Summer 2008		R/V "Akademik Boris Petrov"	Indian Ocean	Multidisciplinary investigations
UK	Jan 2009	R. Larter	RRS James Cook	E Scotia Ridge	ESR survey and plume/vent location
UK	Jan 2010	P. Tyler	RRS James Cook with ROV Isis	E Scotia Ridge	Detailed analysis of ESR vents

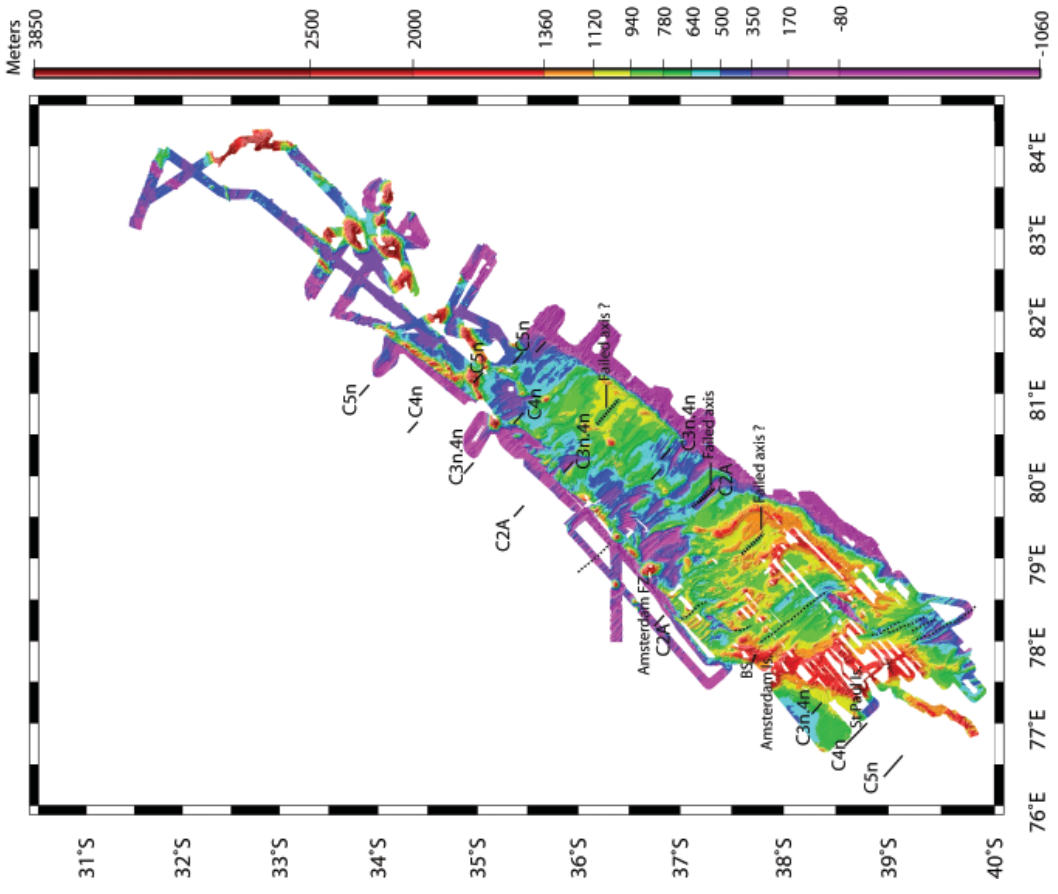
UK	Jan 2011	A. Rogers	RRS James Cook with ROV Isis	Bransfield Strait	Vents and seeps in Bransfield Strait
USA / France / UK	7-25 Nov 2007	E. Fueri, D. Hilton	R/V Revelle	Central Indian Ridge (Rodriguez and Magi)	Multibeam survey and rock dredge sampling
USA	13 Nov - 3 Dec 2007	L. Mullineaux	R/V Atlantis with Alvin	LADDER 3 / EPR (9°N)	Dispersal of hydrothermal vent species
USA	28 Nov - 9 Dec 2007	J. MacKinnon	R/V Revelle	SW Indian Ridge	Internal waves and mixing in the water column above the SWIR
USA	8-22 Dec 2007	K. Von Damm	R/V Atlantis with Alvin	EPR (9°N)	Temporal variations in hydrothermal fluid chemistry
USA	28 Dec 2007 - 19 Jan 2008	S. Sievert, K. Ding	R/V Atlantis with Alvin	EPR (9°N)	Microbiology and *in situ* chemistry of hydrothermal vent fluids
USA	31 Dec 2007 - 17 Jan 2008	H. Singh	R/V Knorr with AUVs	Dive and Discover #12 / S MAR	Exploration of hydrothermal vents with autonomous underwater vehicles
USA	7-30 Jan 2008	J. MacKinnon	R/V Revelle	SE Indian Ridge	Internal waves and mixing in the water column above the SWIR
USA	7 Apr - 8 May 2008	F. Martinez	R/V Kilo Moana	Lau Basin	Sonar and hydrothermal plume/field mapping
USA	3-18 Jun 2008	G. Luther, S. Nooner	R/V Atlantis with Alvin	EPR (9°N)	*In situ* chemistry
USA	3-22 Jul 2008	R. Lee, D. Di Iorio	R/V Atlantis with Alvin	Juan de Fuca	Hydrothermal vent flow and turbulence
USA	Summer 2008	D. Toomey	R/V Langseth	Juan de Fuca (Endeavour)	Seismic survey
USA	9 Jul - 15 Aug 2008	A. Reysenbach, K. Ding, J. Seewald	R/V Revelle with ROV Jason II	MAR (Lucky Strike, Rainbow, Lost City, Snake Pit)	Microbiology, vent chemistry
USA	27 Jul - 12 Aug 2008	J. Cowen, A. Fisher, M. Tivey	R/V Atlantis with Alvin	Juan de Fuca	Microbial ecology and instrumentation for optical communication to sensors
USA	17 Aug - 6 Sep 2008	J. Holden, D. Di Iorio	R/V Atlantis with Alvin	Juan de Fuca (Endeavour)	Microbiology and hydrothermal vent flow and turbulence
USA	13-29 Oct 2008	A. Teske	R/V Atlantis with Alvin	Guaymas	Microbiology
USA	3-23 Nov 2008	D. Caron, K. Wommack	R/V Atlantis with Alvin	Guaymas and EPR (9°N)	Protists and viruses at hydrothermal vents
USA	28 Nov - 17 Dec 2008	S. Sievert	R/V Atlantis with Alvin	EPR (9°N)	Microbiology and biogeochemistry
USA	2009, dates undetermined	D.Wiens	R/V Langseth	Lau Basin	Seismic survey
USA	2009, dates undetermined	C. Fisher, A. Reysenbach	To be determined	Lau Basin	Macro- and microbiology at vent fields

Beltenev et al., Fig. 1 (from p. 9)

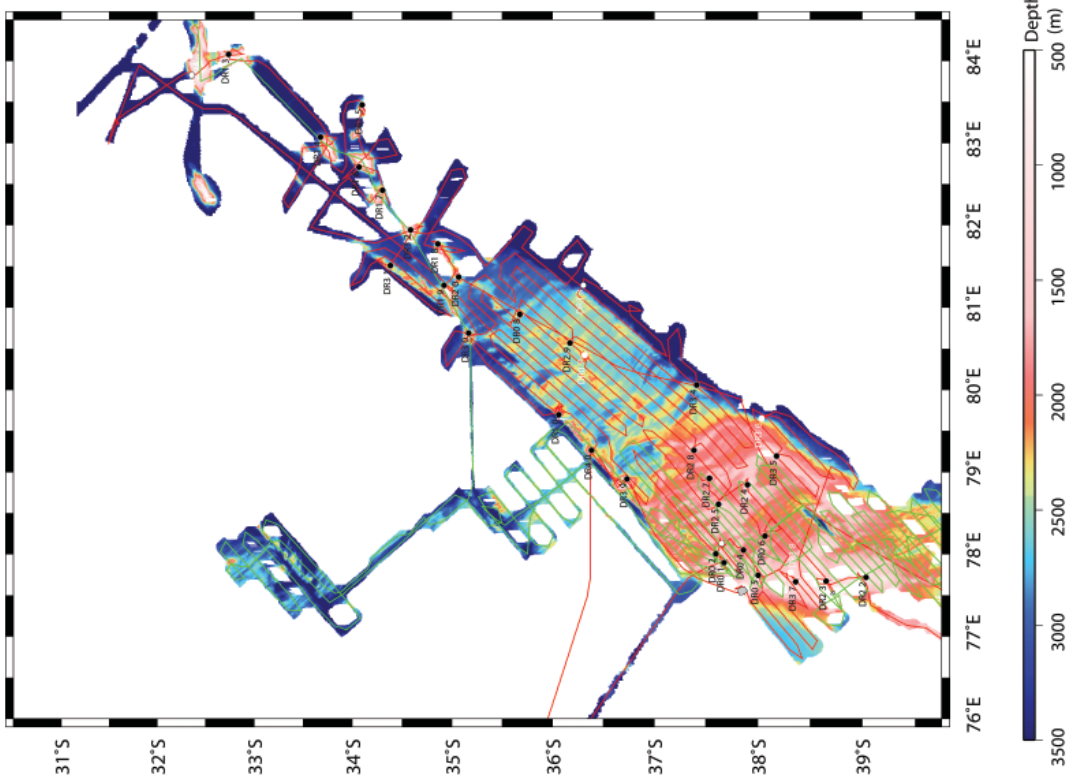


Petersen et al., Fig. 3 (from p. 12)





Maia et al., Fig. 2 (from p. 23)



Maia et al., Fig. 1 (from p. 22)

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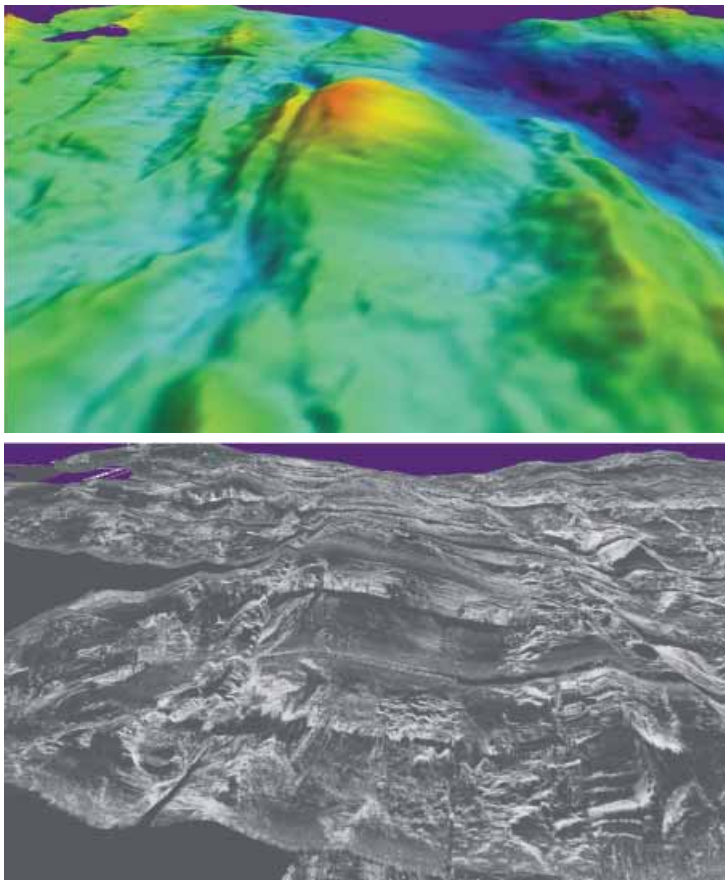


Images on front cover

Top: Azores Triple Junction.
Bathymetric data downloaded from: http://topex.ucsd.edu/sandwell/sandwell.html. Contour maps of seafloor topography estimated using the kriging method of Surfer v.7.00 (Golden Software, Inc.).

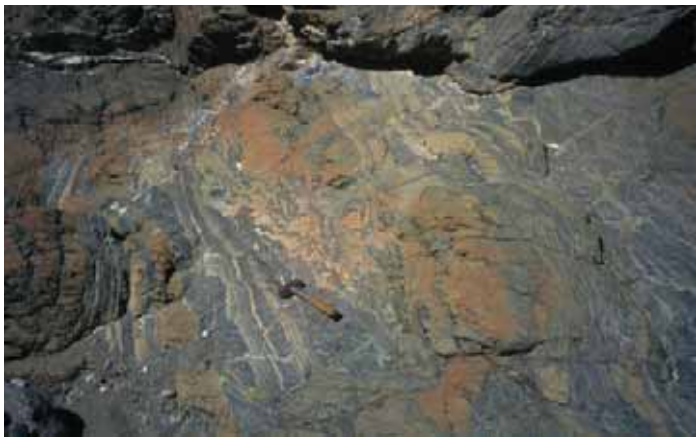
Bottom: Great Dodo Lava Plain in Segment 16 of Central Indian Ridge taken by MNBS of R/V *Hakuho-Maru* (Chief Scientist: K. Tamaki, Univ. Tokyo) with side-scan image taken by AUV "r2D4" (developed by T. Ura, Univ. Tokyo).

Left: FUJI Dome Oceanic Core Complex.
3D Fledermaus views of bathymetry (top) and TOBI sidescan draped on bathymetry (bottom), looking west along the south flank of the SW Indian Ridge near 64°E.

R. Searle and A. Bralee, Durham Univ. (Published in Geochemistry, Geophysics, Geosystems, Vol. 8, 2007)

Right: Celebrations!
Scientists on R/V *DaYang YiHao* celebrating their successful recovery of the first active hydrothermal samples from the SW Indian Ridge.

D. Yoerger, WHOI



Left: Oman Ophiolite.
Outcrop of a chromite pod at the top of the mantle section in the Oman ophiolite; chromite is used as an indicator of intense melt circulation in the uppermost mantle. A thin train of chromite grains and podiform chromitites have recently been recovered at Hess Deep ODP site 895 and at the MAR 15°N ODP site 1271, respectively.

D. Jousselin, Univ. Nancy