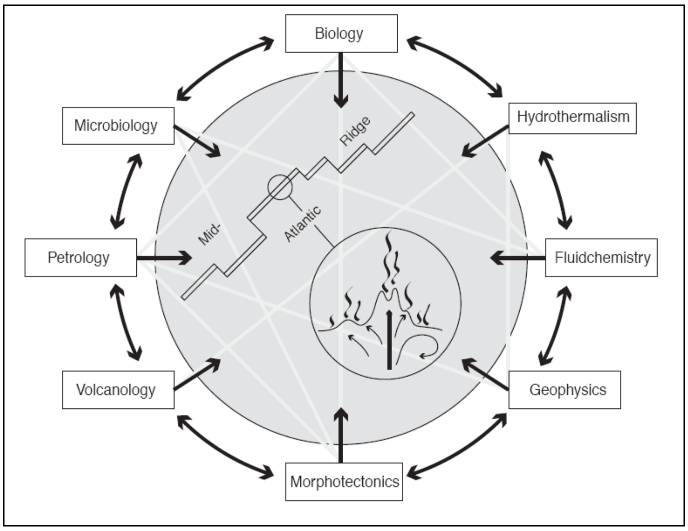


SPP-reader

The bi-annual newsletter of the DFG Priority Program SPP 1144
Issue 9, July 2009

The SPP 1144 web site is at:
www.deridge.de

Ninth Edition

The SPP 1144: "From Mantle to Ocean: Energy-, Material- and Life-Cycles at Spreading Axes" started on the first of October 2003, and with it this newsletter. In general, there will be two editions per year. We hope that you will find this newsletter useful. Please send any feedback you may have to Sabine Lange (slange@ifm-geomar.de).
Our bi-annual newsletter aims to bring you all the latest developments and news related to the SPP and other international activities at mid-ocean ridges.

In this issue

- Summary of Hydromar V II cruise with RV Maria S. Merian
- Summary of Marsued V cruise with RV Meteor
- Announcements
- News from the SPP 1144 data management
- SPP-Publication list
- SPP 1144 members in the news

Summary HYDROMAR VII (RV Maria S. Merian)

This was the last cruise to the Logatchev hydrothermal vent field (LHF) within SPP 1144 and the goal was to complete our investigations of spatial and temporal variability patterns of hydrothermalism and the associated biota and in particular to recover the geophysical instruments left on the seafloor by earlier cruises. The main working tool was the ROV Kiel6000 from IfM-GEOMAR. Other instruments used were the CTD/Rosette water sampler, Miniature Automated Plume Recorders (MAPR, NOAA) and the Kongsberg EM 120 multi-beam echosounder. Our extensive working program included final samplings and experiments for our time series program and also investigations that could not be completed during the short RV Atalante leg in the preceding year. The schedule of 36 cruise days including 25 days in the working area was therefore very promising.

An unplanned late release of our containers from customs delayed the beginning of our cruise by 3 days to the January 11th. On the second day of our transit we made a little detour to a seamount where we did short bathymetric mapping as a service for another German geology project. This stop was also used for a successful ROV test dive on the summit in 1800 m before we headed further to the LHF. Reaching our working area on January 17th, we deployed a 120 m long mooring 5 nm north of the LHF in 4000 m water depth for continuous measurements of oceanographic data until its recovery two months later by RV Poseidon. For the morning of the 18th we had planned our first ROV dive, but winds up to 7 bft and high waves were against it and instead, we ran CTDs and started deployments of in total 12 Ocean Bottom Seismometers (OBSs) to record seismic activity for two months around the LHF until their recovery by RV Poseidon.

Adventure in the beginning of week 2: On the evening of January 18th we received a distress call from a 36 ft sailboat with a broken mast about 100 nm to the west of us. As they were downwind from us and continued moving westwards (although with sails down), it took us almost 15 hours before we reached them around noon time of the 19th. The high waves made it impossible to bring the sailboat along side the Merian, and as the two sailors, an Italian couple living in the US, had decided to abandon their boat, Merian's Fast Rescue Boat was brought out to bring them to our ship. They were exhausted but otherwise healthy. From this moment on, we had two additional passengers travelling with us.

An unusually stable anticyclone centred around 28°N, 30°W bestowed on us average wind speeds of 6-7 bft (gusts up to 9 bft) and waves up to 4 m high for the entire rest of the cruise. This made diving impossible for most of the time. Instead, we continued deploying OBSs and started running CTD profiles and CTD/MAPR tow-yos, while the night program was largely filled with detailed bathymetric mapping of a wider area around Logatchev. On February 2nd we recovered three OBSs that had been deposited by RV Atalante in December 2007.

Earlier collected MAPR data had given indications for the existence of two separate buoyant hydrothermal plumes in 2700 m and 3000 m water depth around the LHF. The 3000 m plume signal northwest of the LHF was unlikely to originate from the LHF which is in the same depth. Therefore we initially concentrated the plume mapping in areas with greater water depths to the north, northwest and west of the LHF. Since the data obtained did not reproduce indications for another buoyant hydrothermal plume, we further mapped in the deepest rift valley. A number of methane values slightly enhanced above background and slight anomalies of temperature and Eh may indicate the presence of diffuse outflow in several places.

On January 25th, we were able to dive with the ROV for the first time in Logatchev. Although the dive was cut short after only 3 hours because of oil leakage, we were able to sample fluids for chemical and biological analyses and collect mussels for molecular and physiological measurements. Particularly exciting was the successful deployment of an in situ mass spectrometer developed by Peter Girguis and Scott Wankel (Harvard University). This instrument can measure all dissolved gases (e.g. H_2S, CH_4,H_2, O_2, CO_2, etc.) at depths down to 4000 m. It was operated by Stéphane Hourdez (CNRS, Roscoff Biological Station) who provided us with extremely valuable online readings of CH_4 and H_2. This enabled us for the first time to quickly assess while diving, which sites are strongly influenced by vent fluids and choose our samples accordingly. The nozzles of KIPS (fluid sampling system) and the MassSpec were combined in one unit, and we were able to characterize in situ and sample fluids from the same spot without repositioning instruments.

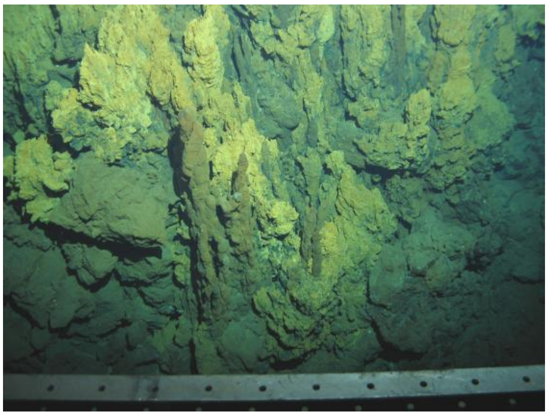
The weather conditions allowed only four more ROV dives on February 1st, 4th, 8th and 9th. Although we had to cut down the seafloor program dramatically, we completed a number of important tasks including in situ characterization of fluids with the MassSpec at all visited sites, sampling of diffuse fluids and mussels from the vent sites “Irnia II” and “Quest”, sediments and diffuse fluids from “Site F”, hot fluids from “Site B”, and wood pieces from a colonization experiment deposited in early 2007. We deposited three experiments for microbial colonization at “Irina II” and recovered them again after 8 days. Finally, we recovered geophysical instruments left on the seafloor by earlier cruises including two SMonis from “Irina II” and “Site B”, OBT 2 and OBP 1 and all remaining T-loggers from “Irina II”. The total bottom time of the Kiel6000 dives during HYDROMAR VII was 29 hours.

In the evening of February 9th we left the Logatchev area heading towards Fort de France where we arrived in the morning of February 13th.

Summary MARSUED V (RV Meteor)

Having taken place between April 1st (Port of Spain) and May 12th (Rio de Janeiro), this cruise was the last scheduled within the DFG Special Priority Program 1144 to the major study sites at 5° to 11°S, on the southern Mid-Atlantic Ridge (MAR), following the investigations performed during and subsequent to cruises M62/5, CD169, M64/1, M68/1, and L’Atalante II 2008. Work focused on cross-disciplinary core questions of the SPP 1144: How does the energy and mass transfer from the mantle into the ocean take place? What are the time scales on which processes at spreading axes occur? How does the regional geology influence and control vent fluid composition and spatial and temporal changes in hydrothermal fluxes? To answer these questions, a comprehensive set of data and samples was obtained by ROV (ROV “Kiel 6000”, IFM-GEOMAR), AUV (AUV “ABYSS”, IFM-GEOMAR), CTD equipped with carousel water sampler, ADCP, and turbidity sensor (University of Bremen), wax corer (IFM-GEOMAR), and the ship based multibeam echo sounding system (EM 120). A highlight was the first successful simultaneous operation of the AUV and the ROV. Four working areas were covered:

- Vents around 4°48´S: Found and sampled for the first time in 2004 during cruise M64/1, these vents provide a wide variety of fluid types, habitats and geological settings to investigate the linkages between magmatism, fluid circulation and ecosystems in the deep sea. All known hot (‘Red Lion’, ‘Turtle Pits’, ‘Comfortless Cove’) and diffuse-flow (‘Clueless’, ‘Golden Valley’, ‘Foggy Corner’) vent fields of this area were revisited and sampled. Moreover, three large hydrothermal mounds have been observed to the north of Turtle Pits as well as several new mussel beds in the vicinity of the Comfortless Cove area.



New hydrothermal mound north of Turtle Pits.

- Inside corner high (ICH) at 5°S: There is mounting evidence that the deep crust also plays an important role in hydrothermal circulation and that water in the deep crust can strongly influence magmatic processes. Earlier studies during M47/2 and L’Atalante 2008 have shown the presence of good lower crustal exposures on an inside corner high just south of the 4°48´S vents. An important result of our ROV work is the successful sampling of several mafic rocks corresponding to ultramylonite, suggesting that high-temperature tectonic processes pro-ceeded during the formation of the ICH complex. Moreover, we found that the occurrence of ultra-mylonites is not a local phenomenon, but that mylonites are present throughout a ~ 50 m thick zone beneath the roof of the complex.

- The ‘Nibelungen’ field found during M68/1 at 8°18′ S / 13°30′ W in 2915 m water depth. This is one of a few known ultramafic-hosted systems, the first of its kind to be found on the southern MAR. We succeeded to measure the temperature of venting (371.6°C) and obtained fluid samples of high quality for the first time.

- ‘Lilliput’ vent fields at 9°32´S: Discovered during M64/1, this area located in much shallower water than the 4°48´S vents provides an ideal compliment, enabling the study of the influence of water depth on hydrothermal and biological processes. An extended program on the geology of the area and the biology of vent mussels was realized and we started an investigation on the influence of tides on diffuse flow and associated microbiology. Work was crowned by several successful AUV-dives with the AUV launched during ongoing ROV-work.

Announcements

6th SPP 1144 - Workshop, 21-23 September 2009, Etelsen

Based on our positive experience during the last years, the workshop will be held again in Etelsen (near Bremen) from 21-23 September. The workshop will be used to present the results of the Merian cruise MSM10/3 and M78/2 as well as the results of the funded SPP 1144 DFG-projects. Please remember to register and to send your abstract until July 31.

Data Management Report 2009

During the first half of 2009 data management for the SPP1144 was a bit slow. Reasons were an extensive system update (hardware and software) which needs a few month and the absence of the data manager for an IODP expedition. During this time no import were possible. So, now again, data sets which have been accumulated in the meantime are in preparation and will be made available as soon as possible.

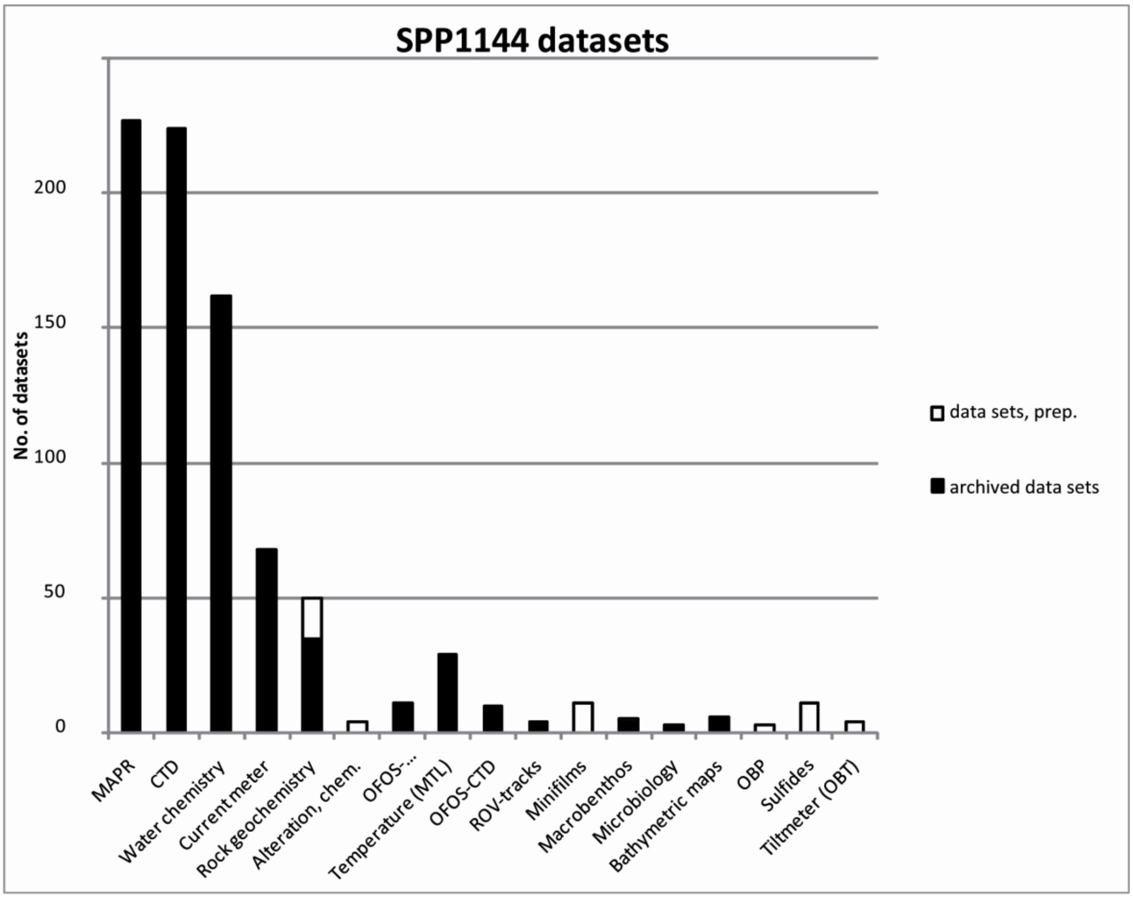
We like to ask you to send us your scientific results data to fill the project archive. Even if the project ends this year, data management will continue to capture data produced in the late phase of the project and beyond.

The table and graph provide an updated overview of the contents of the archive regarding the different scientific disciplines and the various expeditions.

Please have also in mind that there is a way to publish primary data in parallel to 'normal' scientific publications (also described in the last Newsletter), which offers a chance to publish large data sets useful to the scientific community. The new journal (*Earth System Science Data*, *ESSD*) is dedicated to publish articles on original research data according to the conventional fashion of publishing articles, applying the established principles of quality assessment through peer-review to datasets. The goals are to make datasets a reliable resource to build upon and to reward the authors by establishing priority and recognition through the impact of their articles. More information can be found on the *Earth System Science Data* web page (http://www.earth-system-science-data.net/). The data themselves can be stored at Pangaea as part of the SPP archive.

As decided on the last SPP1144 meeting all unpublished project data stored in the archive will be opened to the public ca.2 years after the project (01. January 2012).

Please use the support page of the project data website for further information and examples http://www.pangaea.de/Projects/SPP1144/supp.html. On questions about how to provide data, please contact: H.-J. Wallrabe-Adams, hwallrabe@pangaea.de or phone +49 (0)421 218 65592 or Sabine Lange, slange@ifm-geomar.de or phone +49 (0)432 600 2208.



	Datasets	in prep	Cruise(s)
Station list **			M60/3, M62/5ab, M62/4, M64/1, M64/2, M68/1, MSM03/2, MSM04/3, l'Atalante Leg1&Leg2
MAPR	227		M62/5, M64/1, M64/2
CTD	224		M60/3, M62/5, M64/1, M64/2
Water chemistry	162		M62/5
Current meter	68		M62/5
Rock geochemistry	35	~15	M60/3, M64/2, M41/2, ATA2
Alteration, Fluid chemistry		~4	M60/3, M64/2
OFOS tracks+images	11		M60/3
Temperature (MTL)	29		M60/3, M64/2
OFOS-CTD	10		M60/3
Minifilms		~11	MSM4/3
ROV tracks+images	4	~11	M60/3, MSM04/3
Macrobenthos	4		M60/3, M64/1
Microbiology	3		M60/3, M64/1-2, M68/1
Bathymetric maps/data	6		M60/3
OBP time series	3		M64/2
Sulfides		~11	M64/1, M68/1
OBT tiltmeter		~20	M64/2, MSM4/3, MSM6/2, MSM10/3

List of published and accepted SPP manuscripts

- **Almeev, R., Holtz, F., Koepke, J., Parat, P., and Botcharnikov,R.E.** (2007) The effect of H2O on olivine crystallization in MORB: Experimental calibration at 200 MPa. American Mineralogist, 92 (4), 670-674. #0006
- **Almeev, R., Holtz, F., Koepke, J., Haase, K. and C.W. Devey** (2007) Depths of partial crystallization of H2O-bearing MORB: Phase equilibria simulations of basalts at the MAR near Ascension Island (7-11°S). J. Petrology, 1-21. #0014
- **Amini, M., Eisenhauer, A., Böhm, F., Fietzke, J., Bach, W., Garbe-Schönberg, D., Bock, B., Lackschewitz, K.S. and F. Hauff** (2008) Calcium isotope ($\delta^{44/40}$Ca) fractionation along hydrothermal pathways, Logatchev Field (Mid-Atlantic Ridge, 14°45'N). Geochim Cosmochim Acta, 72 (16), 4107-4122. #0025
- **Augustin, N., Lackschewitz, K.S., Kuhn, T. and C.W. Devey** (2008) Mineralogical and chemical mass changes in mafic and ultramafic rocks from the Logatchev hydrothermal field (MAR 15°N). Marine Geology, 256 (1-4), 18-29. doi:10.1016/j.margeo.2008.09.004 #0030
- **Bach, W. and F. Klein** (2009) Petrology of rodingites: Insights from geochemical reaction path modeling. Lithos, in press. doi:10.1016/j.lithos.2008.10.022 #0038
- **Blumenberg, M., Seifert, R., Petersen, S. and W. Michaelis** (2007) Biosignatures present in a hydrothermal massive sulfide from the Mid-Atlantic Ridge. Geobiology, 5 (4), 435-450. #0013
- **Devey, C.W., Lackschewitz, K.S. and E. Baker** (2005) Hydrothermal and volcanic activity found on the southern Mid-Atlantic Ridge. EOS, 86 (22), 209-216. #0001
- **Devey, C.W., German, C.R., Haase, K.M., Lackschewitz, K.S., Melchert, B. and D. Connelly** The relationships between volcanism, tectonism and hydrothermal activity on the southern equatorial Mid-Atlantic Ridge. AGU Monograph, in press. #0041
- **Dubilier, N., Bergin C. and C. Lott** (2008) Symbiotic diversity in marine animals: the art of harnessing chemosynthesis. Nature Reviews Microbiology, 6, 725-740, doi:10.1038/nrmicro1992 #0028
- **Duperron, S., Bergin, C., Zielinski, F., Pernthaler, A., Dando, P., McKiness, Z.P., DeChaine, E., Cavanaugh, C.M., and N. Dubilier** (2006) A dual symbiosis shared by two mussel species, Bathymodiolus azoricus and B. puteoserpentis (Bivalvia: Mytilidae), from hydrothermal vents along the northern Mid-Atlantic Ridge. Environmental Microbiology, 8 (8), 1441-1447. #0002
- **Eickmann, B., Bach, W. and J. Peckmann** (2009) Authigenesis of carbonate minerals in modern and Devonian ocean-floor hard rocks. Journal of Geology, 117 (3), 307-323. #0032
- **Fabian, M. and H. Villinger** (2007) The Bremen Ocean Bottom Tiltmeter (OBT) – a technical article on a new instrument to monitor deep sea floor deformation and seismicity level. Mar Geophys Res, 28 (1), 13-26. #0017
- **Fabian, M. and H. Villinger** (2008) Long-term tilt and acceleration data from the Logatchev Hydrothermal Vent Field, Mid-Atlantic-Ridge, measured by the Bremen Ocean Bottom Tiltmeter. G^3, 9 (7). doi:10.1029/2007GC001917 #0026
- **Gärtner, A., Wiese, J. and J. Imhoff** (2008) Amphritea atlantica gen. nov., sp. nov., a gammaproteobacterium from the Logatchev hydrothermal vent field. International Journal of Systematic and Evolutionary Microbiology, 58, 34-39. doi:10.1099/ijs.0.65234-0. #0029
- **Haase, K.M., S. Petersen, A. Koschinsky, R. Seifert, C. Devey, N. Dubilier, S. Fretzdorff, D. Garbe-Schönberg, C.R. German, O. Giere, R. Keir, J. Kuever, K. Lackschewitz, J. Mawick, H. Marbler, B. Melchert, C. Mertens, H. Paulick, M. Perner, M. Peters, S. Sander, O. Schmale, J. Stecher, H. Strauss, J. Süling, U. Stöber, M. Walter, S. Weber, U. Westernströer, D. Yoerger, and F. Zielinski** (2007) Young volcanism and related hydrothermal activity at 5°S on the slow-spreading southern Mid-Atlantic Ridge. G^3, 8 (11). #0011
- **Ivanenko, V.N., Arbizu, P.M. and J. Stecher** (2006). Copepods of the family Dirivultidae (Siphonostomatoida) from deep-sea hydrothermal vent fields on the Mid-Atlantic Ridge at 14°N and 5°S. Zootaxa 1277: 1-21. #0003
- **Ivanenko, V.N. Martínez Arbizu, P. and J. Stecher** (2006) Lecithotrophic nauplius of the family Dirivultidae (Copepoda; Siphonostomatoida) hatched on board over the Mid-Atlantic Ridge (5°S). Marine Ecology, 28 (1), 49-53. doi:10.1111/j.1439-0485.2006.00142.x #0007
- **Keir, R. S., Schmale, O., Walter, M., Sültenfuß, J., Seifert, R. and M. Rhein** (2008) Flux and dispersion of gases from the "Drachenschlund" hydrothermal vent at 8°18'S, 13°30'W on the Mid-Atlantic Ridge. Earth and Planetary Science Letters, 270 (3), 338-348. doi: 10.1016/j.epsl.2008.03.054 #0015
- **Keir, R. S., Schmale, O., Seifert, R. and J. Sültenfuß** (2009) Isotope fractionation and mixing in methane plumes from the Logatchev Hydrothermal Field. G^3, 10 (5) , doi:10.1029/2009GC002403 #0035

- **Klein, F. and W. Bach** (2009) Fe-Ni-Co-O-S phase relations in peridotite-seawater interactions. Journal of Petrology, 50 (1), 37-59. doi:10.1093/petrology/egn071 #0039

- **Koschinsky, A., Garbe-Schönberg, D., Sander, S., Schmidt, K., Gennerich, H. H. and H. Strauss** (2008) Hydothermal venting at p-T conditions above the critical point of seawater, 5°S on the Mid-Atlantic Ridge. Geology 36 (8), 615-618. doi:10.1130/G24726A.1 #0016
- **Melchert, B., Devey, C.W., German, C.R., Lackschewitz, K.S., Seifert, R., Walter, M., Yoerger, D.R., Baker, E.T., Paulick, H., and K. Nakamura** (2008) First evidence for high-temperature off-axis venting of deep crustal/mantle heat. The Nibelungen Hydrothermal Field, Southern Mid-Atlantic Ridge. EPSL, 275, 61-69. doi:10.1016/j.epsl.2008.08.010 #0027

Meyer, B. and J. Kuever (2007) Phylogeny of the alpha and beta subunits of the dissimilatory adenosine-5'-phosphosulfate (APS) reductase from sulfate-reducing prokaryotes – origin and evolution of the dissimilatory sulfate-reduction pathway. Microbiology, 153, 2026-2044. doi 10.1099/mic.0.2006/003152-0 #0018
- **Meyer, B. and J. Kuever** (2007) Molecular analysis of the distribution and phylogeny of dissimilatory adenosine-5'-phosphosulfate reductase-encoding genes (aprBA) among sulfur-oxidizing prokaryotes. Microbiology, 153, 3478-3498. doi 10.1099/mic.0.2007/008250-0 #0019
- **Meyer, B., Imhoff, F. and J. Kuever** (2007) Molecular analysis of the distribution and phylogeny of the soxB gene among sulfur-oxidizing bacteria – evolution of the Sox sulfur oxidation enzyme system. Environmental Microbiology, 9 (12), 2957-2977. doi 10.1111/j.1462-2920.2007.01407.x #0020
- **Meyer, B. and J. Kuever** (2007) Molecular analysis of the diversity of sulfate-reducing and sulfur-oxidizing prokaryotes in the environment, using aprA as functional marker gene. Applied and Environmental Microbiology, 73 (23), 7664-7679. doi 10.1128/AEM.01272-07 #0021
- **Meyer, B. and J. Kuever** (2007) Phylogenetic diversity and spatial distribution of the microbial community associated with the caribbean deep-water sponge polymastia cf. corticata by 16S rRNA, aprA, and amoA gene analysis. .Microbial Ecology, online article. doi 10.1007/s00248-007-9348-5 #0022
- **Meyer, B. and J. Kuever** (2008) Homology Modeling of Dissimilatory APS Reductases (AprBA) of Sulfur-Oxidizing and Sulfate-Reducing Prokaryotes PloS one, 3 (1): e1514. doi 10.1371/journal.pone.0001514 #0023
- **Pasava, J., Vymazalová, A., and S. Petersen** (2007) PGE fractionation in seafloor hydrothermal systems: examples from mafic- and ultramafic-hosted hydrothermal fields at the slow-spreading Mid-Atlantic Ridge. Mineralium Deposita, 42 (4), 423-431. #0008
- **Perner, M., Seifert, R., Weber, S., Koschinsky, A., Schmidt, K., Strauss, H., Peters, M., Haase, K. and J.F. Imhoff** (2007) Microbial CO(2) fixation and sulfur cycling associated with low-temperature emissions at the Lilliput hydrothermal field, southern Mid-Atlantic Ridge (9°S). Environmental Microbiology, 9 (5), 1186-1201. #0005
- **Perner, M., Kuever, J., Seifert, R., Pape, T., Koschinsky, A., Schmidt, K., Strauss, H. and J.F. Imhoff** (2007) The Influence of Ultramafic Rocks on Microbial Communities at the Logatchev Hydrothermal Field, located 15°N on the Mid-Atlantic Ridge. FEMS Microbiology Ecology, 61 (1), 97-109. #0009
- **Perner, M., Bach, W., Hentscher, M., Koschinsky, A., Garbe-Schönberg, D., Streit, W. R. and H. Strauss** (2009) Short-term temporal microbial and physico-chemical variability in low-temperature hydrothermal fluids near 5°S on the Mid-Atlantic Ridge. Accepted by Environmental Microbiology. #0036
- **Petersen, S., Kuhn, K., Kuhn, T., Augustin, N., Hekinian, R., Franz, L., and C. Borowski** (2009) The geological setting of the ultramafic-hosted Logatchev hydrothermal field (14°45'N, Mid-Atlantic Ridge) and its influence on massive sulfide formation. Accepted by Lithos. doi:10.1016/j.lithos.2009.02.008 #0034
- **Sander, S.G., A. Koschinsky, G. Massoth, M. Stott and K.A. Hunter** (2007) Organic complexation of copper in deep-sea hydrothermal vent systems. Environmental Chemistry, 4 (2), 81-89. #0010
- **Schmidt, K., Koschinsky, A., Garbe-Schönberg, D., de Carvalho, L.M. and R. Seifert** (2007) Geochemistry of hydrothermal fluids from the ultramafic-hosted Logatchev hydrothermal field, 15°N on the Mid-Atlantic Ridge: Temporal and spatial investigation. Chemical Geology, 242 (1), 1-21. #0004
- **Zielinski, F.U., Pernthaler, A., Duperron, S., Raggi, L. Giere, O., Borowski, C. and N. Dubilier** (2009) Widespread occurrence of an intranuclear bacterial parasite in vent and seep bathymodiolin mussels. Environmental Microbiology, 11, 1150-1167. doi:10.1111/j.1462-2920.2008.01847.x #0024

SPP members in the news

Rheinischer Merkur – 21. Mai 2009

Schwarzer Raucher: Die mineralienreiche Thermalquelle „Kandelabra" sprudelt in 3000 Meter Wassertiefe mitten im Atlantik.

Planet Tiefsee

MEERESKUNDE Weite Teile der Ozeane sind unerforscht. Mit Tauchrobotern und ferngesteuerten Observatorien gehen Wissenschaftler dem Unbekannten sprichwörtlich auf den Grund

Von Ralf Nestler

Auch wenn die Weltmeere vom All aus gesehen blau leuchten – gemessen an dem, was wir über sie wissen, sind es riesige weiße Flecken. „Mehr als 90 Prozent des Meeresbodens sind uns völlig unbekannt", sagt Klas Lackschewitz vom Leibniz-Institut für Meereswissenschaften IFM-Geomar in Kiel. Das liegt vor allem daran, dass die meisten Areale von einer mehreren Kilometer dicken Wasserschicht bedeckt sind. An deren Grund herrscht ein immenser Druck, dem nur wenige Messgeräte standhalten. Entsprechend lückenhaft sind die Informationen aus den Tiefen der Ozeane.

Mithilfe moderner Technik gelingt es den Forschern aber immer besser, die verborgene Welt zu erkunden. Neuestes Beispiel ist ein Tauchroboter, den die Kieler Meereswissenschaftler Anfang Mai erstmals auf Tiefenexpedition schickten. „AUV Abyss" heißt die knallgelbe Hightechröhre. Die Abkürzung steht für „Autonomes benthisches Hydrothermal-Suchsystem". Der vier Meter lange Roboter ist mit zahlreichen Sensoren ausgerüstet und soll unter anderem heiße Quellen am Meeresboden aufspüren.

Nach umfangreichen Tests an Bord und in der Nähe des Forschungsschiffs „Meteor" startete Abyss die ersten eigenständigen Erkundungsfahrten zu dem in 1500 Meter Tiefe gelegenen Hydrothermalfeld „Liliput" vor der Küste Brasiliens. Dort tritt 100 Grad warmes Wasser aus dem Boden. Der Roboter fuhr das gesamte Unterwassergelände entlang eines programmierten, schlangenförmigen Suchpfades ab. Die dabei erfassten, räumlich aufgelösten Messdaten – unter anderem zur Temperatur, Leitfähigkeit und Trübung des Wassers – stellen die bislang genaueste Kartierung dieser Unterwasserregion dar.

„Dank leistungsstarker Lithium-Batterien kann Abyss bis zu 24 Stunden lang unter Wasser bleiben und in dieser Zeit 20 bis 30 Quadratkilometer Ozeanboden erkunden", sagt Lackschewitz, der das Abyss-Team leitet. Mit bemannten Tauchbooten oder Unterwasser-Robotern, die über ein Kabel mit dem Mutterschiff verbunden sind, sei nur ein Bruchteil der Fläche zu schaffen. Zudem würden die Forschungskapazitäten besser genutzt. „Während Abyss abtaucht, kann das Team an Deck zusätzliche Experimente machen", fügt der Geomar-Wissenschaftler hinzu. Schließlich kostet jeder Tag auf einem großen Forschungsschiff mindestens 30 000 Euro.

Auch der Roboter ist nicht billig: 2,3 Millionen Euro schlagen für das Gerät zu Buche. Damit es nicht verloren geht, ist es mit einem GPS-Empfänger ausgerüstet. So kann Abyss nach dem Auftauchen automatisch seine Position ermitteln und ans Mutterschiff funken, damit ihn die Forscher in den Weiten der See wiederfinden.

Messstation „Abyss": Per Autopilot dringt das unbemannte U-Boot des IFM-Geomar bis in 6000 Meter Tiefe vor, um den Meeresboden zu kartieren.

Um abzutauchen, muss der Tauchroboter seine Propeller benutzen. Er ist so konstruiert, dass er einen minimalen Auftrieb hat. Fällt der Antrieb aus, steigt Abyss automatisch zurück an die Oberfläche. „Das ist wie bei einem Stück Styropor, das man mit einem Finger unter Wasser drückt", sagt Lackschewitz.

Der Auftrieb ist unabhängig von der Tauchtiefe, sodass die Propeller in 100 Meter Tiefe genauso viel leisten müssen wie in 6000 Meter. Noch weiter soll Abyss auch gar nicht absinken. Sonst könnte der Wasserdruck zu groß werden und die Titanhülle beschädigen.

400 Grad Celsius heißes Wasser

Abgesehen von einigen Tiefseegräben, liegt der Grund der meisten Ozeanbecken bei drei bis fünf Kilometer. Die ozeanischen Rücken ragen sogar noch weiter nach oben. Für die Geomar-Forscher sind sie besonders interessant. Abyss soll dort nach hydrothermalen Quellen suchen, wo überhitztes Wasser mit bis zu 400 Grad Celsius aus dem Gestein austritt. Es handelt sich um Meerwasser, das in den Ozeanboden eindringt, durch heißes Gestein zirkuliert und dann unter Druck wieder austritt. Auf seinem Weg löst das Wasser Mineralien und Salze aus dem Gestein, darunter Sulfide, die als dunkle, schlotartige Kruste am Rand der heißen Quellen wieder abgeschieden werden. „Schwarze Raucher" nennen Geologen diese Formationen.

„Bislang haben wir die meisten dieser Quellen nur durch Zufall entdeckt", sagt Lackschewitz. Abyss ermögliche eine systematische Suche. Wenn seine Sensoren die Abwasserfahne erfassen, kann der Roboter ihr gezielt bis zum Ursprung folgen. So wollen die Forscher herausfinden, wie viele solcher Schwarzen Raucher und anderer Quellen es überhaupt gibt und unter welchen Bedingungen sie entstehen.

Für Meereswissenschaftler ist das eine wichtige Frage. „Über die Quellen gelangen riesige Mengen gelöster Stoffe, aber auch Wärmeenergie in die Ozeane", sagt Lakschewitz. Bislang könne man höchstens erahnen, welche Auswirkungen das auf die Lebenswelt der Tiefsee habe.

Abyss allein reicht für derartige Untersuchungen nicht aus. Der Roboter sammelt nur Messdaten, die nach dem Auftauchen auf die Computer der Forscher überspielt werden. Er kann keine Bodenproben nehmen, und auch für Videoaufzeichnungen sind Batterie und Speicher zu schwach. Er liefert nur einen groben Überblick. Detaillierte lokale Untersuchungen werden weiterhin mit Tauchgeräten wie „Kiel 6000" gemacht. Dieser Roboter wird über ein Kabel vom Forschungsschiff aus gesteuert und kann Proben nehmen und filmen. Wie die aktuelle Expedition gezeigt hat, ist diese Arbeitsteilung ideal, um große Gebiete zu erkunden und dennoch zahlreiche Detailinformationen von interessanten Punkten zu erhalten.

Ein völlig anderes Konzept zur Erforschung der Tiefen des Meeres verfolgen US-Wissenschaftler im Pazifik. Im Projekt „Mars" (Monterey Accelerated Research System) installieren sie in 900 Meter Wassertiefe vor der Küste Kaliforniens einen ganzen Park von Messgeräten, um das Leben in der Dunkelheit langfristig studieren zu können. Das Herz der umgerechnet rund zehn Millionen Euro teuren Anlage ist ein Verbindungsmodul, das einerseits Strom über ein 52 Kilometer langes Kabel vom Festland zu den Unterwassersensoren leitet. Andererseits liefert es die Messdaten in Echtzeit an die Computer der Forscher. Sie können von nun an trockenen Fußes im Büro das Tiefseegeschehen rund um die Uhr live verfolgen.

Mars erlebte im Frühjahr 2008 einen Fehlstart, als Wasser in die Verteilerstation eindrang. Doch mittlerweile ist der Schaden behoben. Seit November ist die Verbindung zwischen Meeresgrund und Festland stabil.

Derzeit sind die Forscher mit dem schrittweisen Auf- und Ausbau der Messstationen am Boden beschäftigt. Dazu gehört unter anderem eine Spezialkamera, die das Leben der Tiefseebewohner beobachtet. Das funktioniert sogar, obwohl dort unten ewige Dunkelheit herrscht. Der Grund: Viele Meerestiere senden selbst Licht aus. „Biolumineszenz" nennen Wissenschaftler den Effekt, den man auf dem Festland von Glühwürmchen kennt.

Da die Tiefseekamera fest installiert ist und nicht wie ein Tauchboot Geräusche und Schwingungen verursacht, hoffen die Forscher, die Meeresbewohner besonders lebensnah filmen zu können. Um bei Bedarf die Szenerie besser auszuleuchten, gibt es zusätzlich rote Lampen. Sie stören wenig, da rotes Licht von den meisten Tiefseetieren nicht wahrgenommen wird.

Raumfahrt auf Erden

Andere Sonden im Mars-Netz zeichnen kontinuierlich wichtige Messwerte aus den Tiefen auf – etwa Temperatur, Salzgehalt, elektrische Leitfähigkeit und chemische Kenngrößen. Die Sensoren dienen Experimenten, mit denen die Forscher unter anderem die Auswirkungen der Ozeanversauerung erforschen wollen. Dafür ist geplant, geringe Mengen Kohlendioxid in die Tiefsee zu pumpen, um dann zu beobachten, wie die Tiere am Meeresboden darauf reagieren.

Mars ist nicht das einzige Projekt dieser Art. Vor der Westküste Kanadas läuft bereits seit drei Jahren das verkabelte Unterwassermessnetz Venus (Victoria Experimental Network under the Sea), wenn auch nur in 100 bis 300 Meter Wassertiefe. Zudem hat der Bau von „Neptune Canada" begonnen. In den nächsten Jahren soll es zum größten Meeresobservatorium der Welt heranwachsen. Die Planungen sehen vor, bis zu 300 Quadratkilometer Tiefseeboden vor Vancouver Island mit Versorgungs- und Messstationen in 600 bis 2600 Meter Wassertiefe auszustatten.

Die Meeresforscher haben die Projekte übrigens nicht zufällig nach fernen Planeten benannt. „Tiefseeforschung und Raumfahrt haben viele Gemeinsamkeiten", sagt Peter Girguis vom Monterey Bay Aquarium Research Institute. Beide seien technisch sehr aufwendig und teuer. Und selbst viele wissenschaftliche Fragestellungen, etwa die Suche nach dem Leben unter Extrembedingungen, seien durchaus vergleichbar.

FOTOS: MARUM; IFM-GEOMAR; MINDEN PICTURES/MAURITIUS

SPP 1144 Newsletter is published by

C.W. Devey	S. Lange	K.S.Lackschewitz
Program Chair	Coordination	SPP 1144 member

Leibniz-Institut für Meereswissenschaften - IFM-GEOMAR

FB Dynamik des Ozeanbodens

Wischhofstr. 1-3, 24148 Kiel, Germany

We thank C. Borowski, R. Seifert and H.-J. Wallrabe-Adams for their contributions.