Short cruise report of METEOR cruise M68/1

Dates: April 27 – June 2, 2006
Port calls: Bridgetown (Barbados) – Fortalezza (Brazil)
Chief scientist: Andrea Koschinsky (International University Bremen)

List of participants:

Name	**Discipline**	**Institution**
Koschinsky, Andrea, Prof. Dr.	*Chief Scientist*	IUB
Billings, Andrew	AUV	WHOI
Devey, Colin, Prof. Dr.	Geology, Petrology	IFM-GEOMAR
Dubilier, Nicole, Dr.	Hydrothermal Symbioses	MPI Bremen
Duester, Alan	AUV	WHOI
Edge, David	ROV	NOC
Garbe-Schönberg, Dieter, Dr.	Fluid Chemistry	Univ. Kiel
German, Chris, Dr.	AUV, photo mapping	WHOI
Giere, Olav, Prof. Dr.	Zoology	MPI Bremen
Keir, Robin, Dr.	Gases (Methane)	IFM-GEOMAR
Lackschewitz, Klas, Dr.	Documentation ROV	IFM-GEOMAR
Mai Hoang, Anh	ROV	MARUM
Marbler, Herwig, Dr.	ROV	IUB
Mawick, Jule	Fluid Chemistry	IUB
Melchert, Bernd	Bathymetry	IFM-GEOMAR
Mertens, Christian, Dr.	Physical Oceanography	Univ. Bremen
Peters, Marc	Sulfur Isotopes	Univ. Münster
Sander, Sylvia, Dr.	Fluid Chemistry	IUB/Univ. Otago
Schmale, Oliver	Gases (Methane)	IFM-GEOMAR
Schmidt, Werner	ROV	MARUM
Seifert, Richard, Dr.	Gases (Hydrogen)	Univ. Hamburg
Seiter, Christian	ROV	MARUM
Stöber, Uwe	Physical Oceanography	Univ. Bremen
Suck, Inken	ROV	MARUM/Fielax
Walter, Maren, Dr.	Physical Oceanography	Univ. Bremen
Weber, Stefan	Gase (Hydrogern)	Univ. Hamburg
Yoerger, Dana, Dr.	AUV	WHOI
Zarrouk, Marcel	ROV	MARUM
Zielinski, Frank	Hydrothermal Symbioses	MPI Bremen
Ochsenhirt, Wolf-Thilo	Weather Technique	DWD

Goals and work plan of cruise M68/1 as part of the SPP 1144 program

Cruise M68/1 was part of the SPP 1144 program on material, energy and life cycles at spreading axes, focussing on hydrothermal systems at the Mid-Atlantic Ridge. Following the investigations performed during and subsequent to cruises M62/5, CD169 and M64/1 it was of prime importance during cruise M68/1 to continue the detailed interdisciplinary work at the selected vent sites on the southern Mid-Atlantic Ridge (MAR). This included mapping and exploration for additional hydrothermal vent systems on a regional scale and sampling of hydrothermal vent fluids, associated vent fauna (both macro- and microbiology), host rock and sulphide samples.

Our goals were

(1) Locating and characterising the vents for the 4°48'S, 8°10´S, 8°18´S and 9°33´S hydrothermal plumes, where the hot vent sources have not yet been found;
(2) Quantifying the hydrothermal fluxes (heat, gases, metals) and the role of mixing for plume dispersal and distribution of hydrothermal fluids and gases;
(3) Assessing the origin and dispersal of vent fauna and variability of the communities linked to the physico-geochemical environment;
(4) Determining the factors controlling the composition and temporal variability of hydrothermal fluids and the microbial communities they support.

The work plan included detection and mapping of the hydrothermal plumes by CTD and turbidity sensors and localization of the hydrothermal emanation sources using the Autonomous Underwater Vehicle (AUV) ABE (Woods Hole Oceanographic Institution). ABE dives consisted of three phases, first looking for the largest hydrothermal signal in the neutrally buoyant plume, then searching for the interception of the rising plume, and in the third phase a detailed sensor and photo mapping of the active area was carried out. Bathymetric mapping was carried out with the multibeam system of RV Meteor, and high-resolution mapping of the AUV. The ROV Quest (MARUM, Univ. Bremen) was deployed in parallel and subsequent to the AUV discoveries in the known and newly discovered fields to sample rocks, sulfides, fluids and animals. Sample recoveries were complemented by onboard measurements of chemical compounds in the fluids, microbial experiments, and preparation of animal samples.

Short cruise narrative and first results

Cruise M68/1 began on 27 April, sailing from Bridgetown, Barbados, with a transit of 12 ½ days. The three target areas that were investigated in detail in 19 working days are the following:

(1) 5°S, where two hot vent fields (Turtle Pits and Red Lion) and a diffuse-flow mussel field (Wideawake) had been found and sampled in 2005 (cruises CD169 and M64/1),
(2) 8°S (Nibelungen) where a hydrothermal plume had been detected during cruise M62/5 in 2004, but the hydrothermal source had not been found,
(3) 9°S where a diffuse vent field with young mussel populations named Lilliput was located during cruise M64/1.

In the 5°S area, all known vent fields were revisited and sampled for comparison with the 2005 data. The young, post-eruptive vent field at Turtle Pits was still extremely hot, and the highest temperature ever measured so far in a hydrothermal fluid (407°C) was recorded. It is characterised by phase separation and the venting of a salt-poor and hydrogen, iron and copper rich supercritical vapour phase. Based on the AUV dives another field was detected (Comfortless Cove), located between Turtle Pits and Red Lion, with the hot smoker "Sisters Peak" (399°C) and two diffuse vent sites, one of them ("Golden Valley") showing very high mussel coverage. The "Sisters Peak" vent has a very similar chemistry as the Turtle Pits vents, suggesting it is fed from the same source. In contrast, the four smokers in the Red Lion field, with temperatures between 190° and 349°C and chlorinities similar to seawater do not seem to have experienced phase separation. AUV and CTD data indicated the existence of further active venting sites in the 5°S area, which, however, could not be searched for due to time constraints.

In the 9°S area the AUV detected at signals for several hydrothermally active sites, one of them being the known Lilliput mussel field at 9°33'S. The other sites were also all low-temperature sites with diffuse flow and populations with young mussels. This is in contrast to the Wideawake mussel field at 5°S, where mostly older and larger mussels were found. This field is driven by volcanic activity, as the 5°S area, and many lava flow structures were observed. At one site lava columns and hollow lava structures had formed in a former lava lake.

In the Nibelungen field at 8°18'S, a very complex current pattern, indicated by current meter and CTD measurements, complicated the search for the source of the extensive plume, which changed its intensity and location on short time scales. Finally the AUV and ROV dives detected a large smoking crater resembling the craters observed in the Logatchev field at 15°N, which we named "Drachenschlund". Many extinct smokers were found in the vicinity, but no other hot vent field. The fluid chemistry clearly indicates reactions with mantle rocks, similar to the Logatchev field. The absence of hydrothermal fauna around the crater was striking. While the fluids from 5°S and 9°33´S are clearly influenced by reaction with basalt, the Nibelungen vent "Drachenschlund" emanates water which has clearly reacted with ultramafic rocks, as testified to by their high methane, hydrogen and iron contents. High copper contents and H_2/CH_4 ratios suggest a relatively high venting temperature (360-400°C) for the waters – we were not able to measure this directly as the vent itself was inaccessible for the ROV.

The hydrothermal fauna in the investigated areas can be divided into three types: communities associated with diffuse flow, smoker chimneys and the Nibelungen vent. Bathymodiolus mussels with varying size distributions dominate the diffuse Wideawake and Lilliput sites. Occasionally the much rarer Calyptogena clams are also present. Predators are represented by various polychaete worm groups, crabs and a large conid snail. Shrimps are much more rare than at the hot smokers. The fauna at the hot smokers has a lower diversity than that of the vent mussel fields and is clearly dominated by the white shrimps. The surroundings of the powerful smoker "Drachenschlund" at Nibelungen were devoid of the typical vent fauna except for numerous parchment-like, flexible tubes of polychaetes which were attached to the loose alterated rocks and sand of the crater walls. In comparison, the M68/1-studies of fauna communities in the MAR hydrothermal fields south of the equator show essentially a similar taxonomic composition and ecological structure as those in the north. The preliminary conclusion drawn from these results that delineation of a separate zoogeographical province for the South Atlantic vent sites near the equator is not required has, however, to be confirmed by genetic analyses.

In summary, the combined deployments of AUV, ROV and CTD meant that, in addition to revisiting and better characterising the four fields known from last years cruise, we were able in only three weeks to find and investigate three more fields at 5°S (one hot vent, two diffuse flow areas), three more diffuse fields at 9°33´S and to finally locate the Nibelungen vent. Two further attempts, at 8°10´S and 7°58´S, to find hydrothermal vents had to be curtailed prematurely due to time limitations – the data collected will however allow subsequent cruises to the area to refine the search appreciably.