Short Cruise Report of Leg M64/2 with RV METEOR

6.5.2005, Fortaleza – 6.6.2005, Dakar

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Abbreviations :

ASR	Alstom Schilling Robotics 201 Cousteau Place Davis, CA 95616 / USA
GeoB	Universität Bremen FB Geowissenschaften Postfach 330440 28334 Bremen / Germany
GPI	Geologisch-Paläontologisches Institut Westfälische Wilhelms-Universität Münster Corrensstraße 24 48149 Münster / Germany
IfBM	Universität Hamburg Institut für Biogeochemie und Meereschemie Bundesstr. 55 D-20146 Hamburg / Germany
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IfG	Universität Kiel Institut für Geowissenschaften Olshausenstr. 40 D-24098 Kiel / Germany
IUB	International University Bremen Geosciences and Astrophysics P.O. Box 750561 D-28725 Bremen / Germany
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SOC	Southampton Oceanography Centre, European Way, Southampton SO14 3ZH, U.K.

Research Program

The investigations of this cruise are a continuation of the program started between 14°45'N and 15°05'N on the Mid-Atlantic Ridge in 2004 (cruise M60/3). While in the 2004 cruise basic geochemical and biological studies were carried out in the Logatchev hydrothermal field, the emphasis of the 2005 cruise lies on the temporal variability of fluid emanations, fluid temperature and chemistry, microbial activities and associated fauna at selected hydrothermal vent sites. The overall goal of the proposed cruise is to advance the integrated study of the 14°45'N hydrothermal sites further through multi-disciplinary characterization and sampling at several sites. Biological, mineralogical and hydrological samples are to be taken in a well-characterized thermal environment so that the results on the samples can be interpreted in terms of the influence of the important environmental parameter temperature..

Long-term monitoring of all relevant environmental parameters is essential to assess the temporal variability observed in the biogeochemistry of the hydrothermal field. The parameters are (a) temperature, (b) absolute pressure, (c) mean micro seismicity and (d) local sea floor tilt. We will observe correlation and coupling between hot fluid outflow, hydrothermal activity, tidal loading, micro seismicity and recent tectonic processes with high resolution of amplitudes and time. Additionally, a plume temperature profiler for mapping the extend of the hydrothermal plume, a distributed temperature sensing system for monitoring in particular biological communities at the sea floor, a ROV temperature lance with online data transfer over the ROV communication system up to the ship and a temperature calibration facility for the temperature sensors is provided. Temperature measurements, the use of sensors and the sampling of fluids to determine the chemical composition of the fluids, material fluxes and spatial and temporal gradients give the basic information to characterize the environment in which the ecosystem develops. Three groups are mainly interested in the characterization of free living microorganisms, which are involved in carbon and sulfur cycling in hydrothermal vent areas. Methane consuming communities are studied in hydrothermal fluids, sediments and crusts with a special focus on the process of anaerobic oxidation of methane and in close cooperation with the gas geochemistry group. Another group is predominantly interested in sulfur bacteria and in the influence of temperature on microbial communities, cooperating closely with the groups analyzing sulfur species and isotopes. Environmental genomics are applied to investigate the metabolic capabilities of these microbial communities, thereby focusing on the finding of new genes and unexpected metabolic properties. The development of symbiotic communities (bacteria and host fauna) is directly related to the chemical content and energy of the fluids. However, the pathway of interactions does not only involve influence of the fluids on the development of organism communities, but microorganisms and fauna also change the fluid chemistry due to their uptake and excretion of chemical compounds.

Samples for the biologists are chosen in cooperation with the geochemists measuring the different abiotic parameters. The samples are shared between the different groups, analyzed in close collaboration and the results will be finally evaluated in the context of all geochemical and microbiological findings with respect to the bio-geo coupling. The aim is to develop an overall model for the temporal and spatial development of the Logatchev hydrothermal ecosystem.

Narrative of the cruise

The final preparations for cruise M64/2 were completed onboard the R/V METEOR in the harbour of Fortaleza (Brazil) between May 3 and 6. All 22 scientists of Leg M64/2 boarded the ship on May 5. A test of the ROV in the harbour was successfully carried out at midday on May 6.

The R/V METEOR cleared port of Fortaleza in the afternoon of May 6 and began her transit to 13°30'N and 45°00'W (Fig. 1). The scientists used the five-day transit to set up the laboratories and to test their sensors and water sampling equipment. Scientific work started in the afternoon of May 10 with a reference CTD hydrocast station at 13°30'N/45°00'W for sampling seawater from different waterdepths. Hydrosweep mapping along the ridge axis was carried out during the night. A 90 minute transit to our main working area, the Logatchev hydrothermal field (LHF-1; 14°45.20'N/44°58.80'S), was followed by a CTD hydrocast station to investigate the hydrothermal plume over the LHF-1.

In the morning of May 11 the first ROV station failed shortly after deployment due to communication problems between the ROV and the control container. Therefore, a hydrocast station was carried out SW of LHF-1 to investigate the hydrothermal plume dispersal in the water column. A TV-grab (222GTV) was taken about 300m SW of LHF-1 in order to sample the periphery. The samples comprised of serpentinized ultramafics, partly covered with Mn-crusts, and one rock with atacamite. The night of May 12 was filled with a MAPR (miniatur autonomous plume recorder) string jo-jo (5 MAPP's and 20 temperature loggers) to trace the turbidity anomalies of the hydrothermal plume in the area of LHF-1.4.

On May 12 another attempt of a ROV dive failed again due to communication problems. A TV-grab station taken ca. 50 m southwest of IRINA II sampled ultramafics and Mn crusts (Fig. 2). In the afternoon we started our first successful ROV dive (224) during our cruise M64/2. After reaching the seafloor we obtained an acoustic signal from the homer beacon 12 which we set up as a reference station during the cruise M60/3 at the QUEST site. We set up another beacon (Nr. 14; 14°45,199'N/44°58,783'W) and an ocean bottom tilt meter (OBT) ca. 42 m southwest of beacon 12 (Fig. 2). Fluid samples and temperature measurements were taken at a small active black smoker close to the IRINA-II smoker complex.

We continued our geological program with a TV-sled track from the NE to the SW over the LHF-1 in order to find hydrothermal precipitates and map the distribution of ultramafics in this area. Another hydrocast station should further map the distribution of the hydrothermal plume in the water column, whereas a stationary MAPR string over this area should map the temporal variations of the proximal hydrothermal plume. During May 13 a ROV deployment was not possible due to a high sea swell.

The night to the May 14 was filled with two TV-grab stations and one hydrocast station. 229GTV was taken ca. 50 m west of ANNA LOUISE. The samples comprised of weakly indurated to higher indurated brownish sediment, dark grayish sediment with fine dispersed pyrite crystals, and several Mn-crusts . At station 230GTV south of site „A" the samples consist of altered coarse-grained to pegmatoid orthopyroxenites. The hydrocast station (231CTD) sampled the hydrothermal plume ca. 200 m northwest of the QUEST site.

During dive 232ROV on May 14 biological and fluid samples were taken from a mussel field at the southern rim of the IRINA II compex. A special objective was a mussel transplant experiment. In this experiment we are investigating how the removal of the mussels from the

vent fluids will influence them and their symbiotic bacteria. Before collecting the mussels, insitu measurements of several physico-chemical parameters were taken (oxygen, temperature, sulfide, hydrogen, pH) with a profiler module. In addition, fluid samples were taken.

Plume mapping with the CTD was carried out during the night of May 14 to 15. The northernmost CTD station detected three turbidity anomalies at 2700 m, 2900 m and 3050 m ca. 1.5 km NNW of the LHF-1 suggesting at least one other unknown hydrothermal source. A TV-grab (st. 239) was taken ca. 250 m northeast of IRINA-II in order to sample the periphery of the LHF-1. Beside much sediment, crusts covered with atacamite and several pieces of talc were detected. On the sediment surface we found several mussel shells of *Bathymodyolus* and *Phymorhynchus*.

Hydrosweep mapping along 5 profiles was carried out during the night of May 16 to 17. The objective was to map the upper ridge flank east of the Logatchev field .

During dive 244ROV on May 17 the OBT was set up on a plain place together with beacon 14 to the SW of IRINA II. In the following we have continued the mussel transplant experiments of 232ROV by taking 5 nets with mussels and puting them in the inactive area of the OBT. Temperature measurements in the mussel field produced readings ranging between 5 and 50°C. Four hydrocast stations (st. 245 to 248) were carried out in the N of LHF-1. The objective of these stations was to investigate the distribution of the turbidity anomalies in 2700 m, 2900 m and 3050 m.

On May 18 station 249ROV was reserved for fluid sampling of black smokers at ANNA LOUISE and IRINA I. At both sites temperature measurements with an 8-channel temperature probe produced values of 205°C and 188°C, respectively. A TV-grab (st. 250) between IRINA II and site „B“ sampled a thick sediment unit showing colors from yellowish brown, reddish brown and green. A temperature measurement in the sediment yielded still 43°C. In addition, samples consist of silicified crusts and highly altered peridotites and pyroxenites.

The dive 252ROV on May 19 aimed at detailed mapping the southernmost area of LHF-1 including site „A“ which was not discovered during M60/3. After the installation of beacon 11 at IRINA I site we started our mapping profiles south of ANNA LOUISE. On the second profile we found a 5m high active black smoker which is related to site „A“, first described by Gebruk et al. (1997). We named this smoker „Barad-Dûr“ after the black tower of Mordor in the book „Lord of the Rings“. The marker “MB” indicates this site as a reference sampling station. We sampled several sulfide fragments from the underlying mound of Barar-Dûr and another rock sample from the IRINA I site. In the following, we deposited the markers “M4” and “M5” at site ANNA LOUISE and IRINA I, respectively.

Four hydrocast stations (st. 253-256) during the night from May 19 to 20 mapped and sampled the plume in 2700 to 2800 m ca. 600 m to the northwest of LHF-1.

During the day of May 20 the dive ROV257 placed 10 temperature loggers in the mussel field at IRINA II for longterm monitoring. Another main target of this dive was to sample fluids, sulfides and bacteria mats at site „B“. The onboard analyses of the fluids have shown a pH of 3.9. The following night two TV grab stations east and northeast of QUEST and a hydrocast station to the NNW of LHF-1 were carried out. The first TV grab (st. 258) sampled a few shells of the hydrothermal mussel species *Calyptogena* and several small peridotite pieces. The second TV-grab (st. 259) was empty. The hydrocast (st. 260) sampled 11 water samples from different water depth ca. 1.5 km NNW from LHF-1.

Station 261ROV on May 21 concentrated on fluid sampling at Site „A“ and IRINA I (indicated by marker “MD”). In addition, sulfides were sampled at both sites. During the night Hydrosweep mapping was continued on the upper ridge flank to the east.

During dive 263ROV on May 22 a special objective was a sampling program in the area of the Russian marker ANYA. We sampled two push cores for bacterial studies and mussels with a net. In addition, we set up a beacon (#11) to provide a precise site location because the original position according to Gebruk et al. (2000) appeared to be northwest of IRINA II.

We continued our program with two hydrocast stations west of LHF-1. Both stations showed no turbidity anomalies, but water samples between 2700-2800 m have still minor methan anomalies.

During ROV station 266 on May 23 fluid parameters were measured directly above five places in a diffuse venting mussel field of IRINA II by the profiler module. After the investigation of this site we picked up beacon 11 near the marker „ANJA“ and placed it 10 m east of site „B“. In the following, we took fluid samples at a black smoker which is close to the sampled smoker of 257ROV. Temperature measurements at both sites show values of 350°C and 300°C..

Four hydrocast stations (st. 267-270) ca. 0.5-1 sm south and southeast of LHF-1 did not show a turbidity signal of the plume. However, we have still identified the plume by a slight increase of CH_4 in water samples between 2700-2800 m

On May 24 we started with a deployment of a 25 m longterm temperature mooring from the ship (st. 271). During the following ROV station 272 we repositioned this mooring in the region between IRINA I and ANNA LOUISE (Fig. 2). Another target was the precise horizontal placement (angle of < 2°) of the OBT at beacon 14. In addition, we placed two push cores in the mussel field of IRINA II for microbial experiments and we took some samples from an inactive smoker ENE of IRINA II.

Another four hydrocast stations (st. 273-276) have indicated that the eastern ridge flank acts as a boundary for the distribution of hydrothermal plume to the east and northeast.

During dive 277ROV on May 25 we placed again the profiler module in the diffuse venting mussel field at IRINA II. Temperature measurements showed values up to 140°C. In addition, a baited trap was deployed on the mussel bed close to the chimney complex. Detailed video images were recorded along two horizontal profiles of the eastern part of the chimney complex for constructing a photomosaic of this whole structure. Diffusely venting fluids were sampled at the chimney complex close to the area which was already sampled during M60-3 (st. 38ROV). Hydrothermal fauna were collected here also. At the end of the dive we mapped the area east of IRINA II along two profiles.

A TV-sled track (st. 278) was carried out 2 sm north of LHF-1 in order to find indications of an active vent field creating the hydrothermal plume in 3050 m water depth. Due to an electric failure this station was aborted shortly after the first profile. In following two hydrocast station were carried out above the QUEST vent site and ca. 3 sm NW of LHF-1.

The main target of dive 281ROV was a sampling program at the QUEST site. First we placed a benthic chamber on a mussel bed at IRINA II to measure H_2 and S^{2-} for several hours. At QUEST site we sampled fluids and a net of hydrothermal fauna at a diffuse venting mussel bed. At this site we placed also 9 longterm temperature monitoring loggers. In addition, we took fluid samples, temperatures and sulfide samples from a hot venting black smoker (indicated by marker

"MC"). During the following night Hydrosweep mapping was continued on the upper eastern ridge flank.

At dive 283ROV on May 27 we continued our work at QUEST site. We deployed two 8-channel temperature loggers in the main mussel bed and sampled diffuse fluids with 3 Niskin bottles. A camera survey over the mussel bed was made to produce a photomosaic. Next we placed the OPT on more stable ground and took the last net for the mussel bed experiment. In the following we finished our sampling program in IRINA II taking another fluid samples, temperatures at two vents and a net with shrimps. At the end of the dive we picked up the beacon 13 and the baited trap. The night to May 28 was filled with another TV-sled station (st. 284) which investigated the area northwest of LHF-1 along several profiles searching unknown hydrothermal sites.

After this TV-sled track our last ROV station (285ROV) explored and mapped the area northwest of QUEST site in order to find an unknown vent site. After several profiles we found a new diffuse venting site with several highly altered crusts ca. 150 m northwest of QUEST site.

Station work of cruise M64/2 was finished after this station and R/V Meteor started her transit to Dakar. R/V Meteor arrived the port of Dakar on June 4, at 06:00 am. All containers were brought to the pier and loaded there by the scientific and technical crew. The scientists of cruise M64/2 disembarked until the early evening of June 6, 2005.

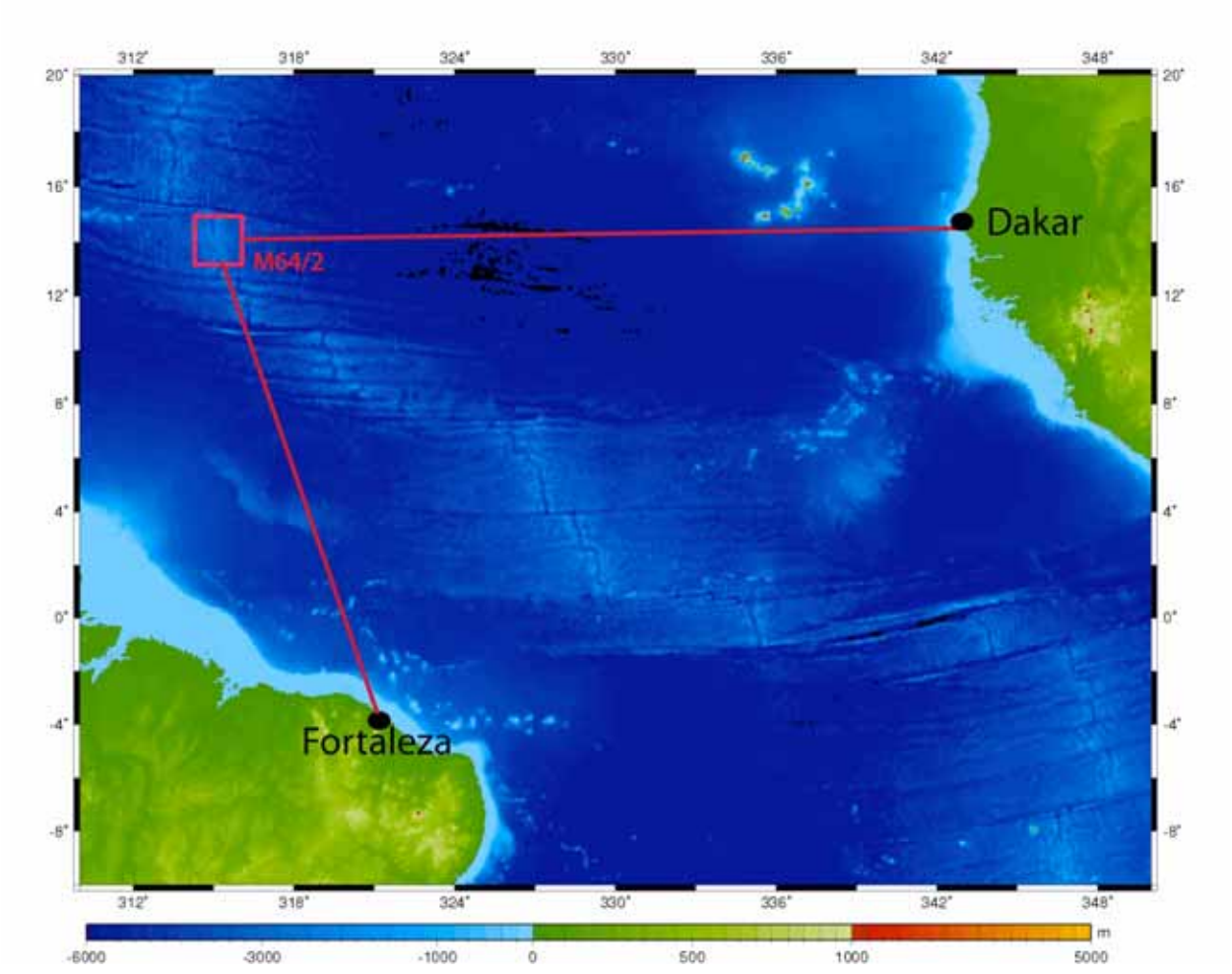

Figure 1. Map showing the track of RV Meteor during M64/2.

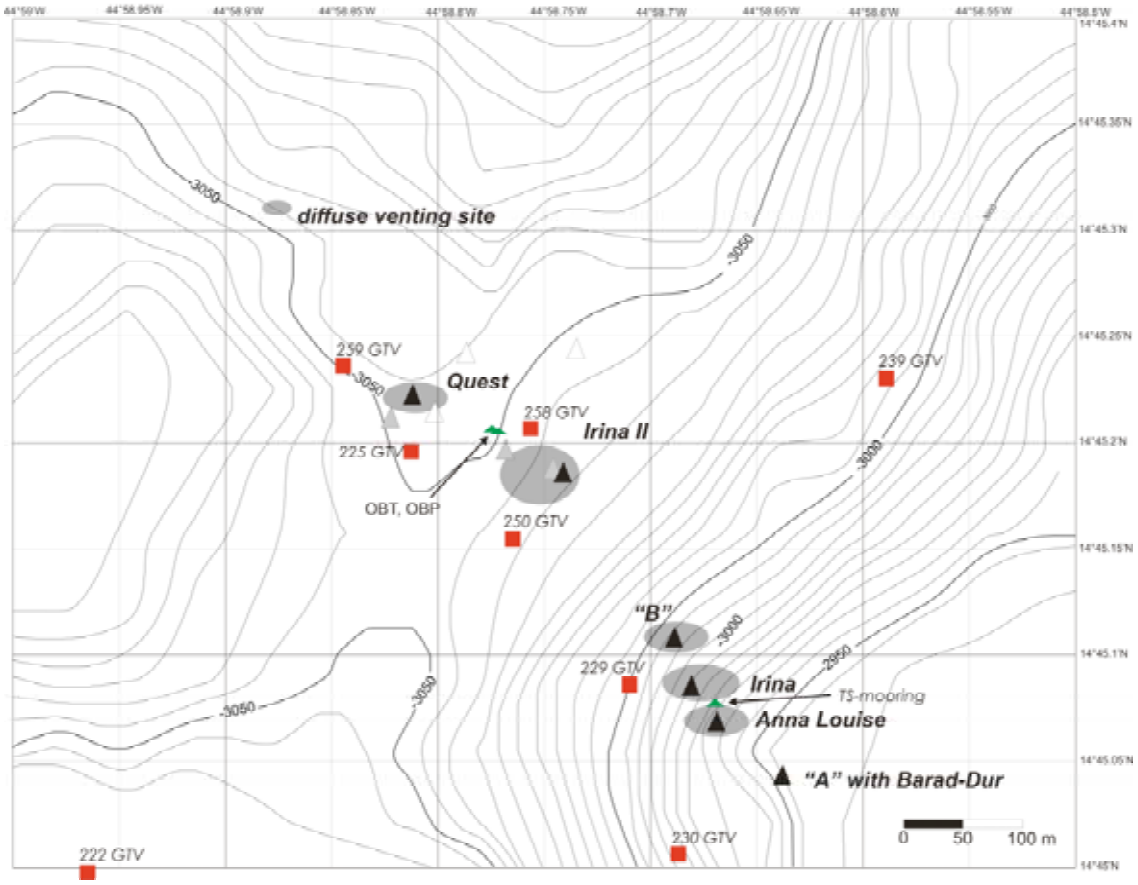

Figure 2. Map of the Logatchev-1 Hydrothermal Field showing active vent sites (black triangle), TV grab stations (red square) and instruments left on the seafloor (green triangle).