Merian Expedition MSM03/2 (HYDROMAR IV)
Fort de France – Fort de France
8.11.-30.11.2006
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The cruise "HYDROMAR IV" took the new German research vessel MARIA S. MERIAN to the central Mid-Atlantic ridge where we used a new British drilling device to drill into a modern seafloor black smoker system (Fig. 1). These submarine hydrothermal systems occur in all oceans along the mid-ocean spreading axes. They influence the ocean chemistry and are an important link to the understanding of the formation of new oceanic crust as well as to the heat and geochemical fluxes from the mantle to the ocean. Our understanding of these systems is often hampered by the lack of structural, petrological and geochemical data from the subseafloor. The main objective of cruise MSM03/2 was therefore the investigation of the shallow subsurface in the ultramafic-hosted Logatchev hydrothermal field, situated at 14°45'N on the Mid-Atlantic Ridge. This hydrothermal field is unusual when compared to other systems, since it is located in upper mantle crust, while most hydrothermal fields occur in upper crustal, basaltic rocks. Logatchev is situated in a water depth of 3000m, a few kilometers off the ridge axis, and is one of the two target areas of a priority program of the German Science Foundation (SPP 1144 "From Mantle to Ocean") which is investigating hydrothermal systems on multiple scales and over a time scale of several years.

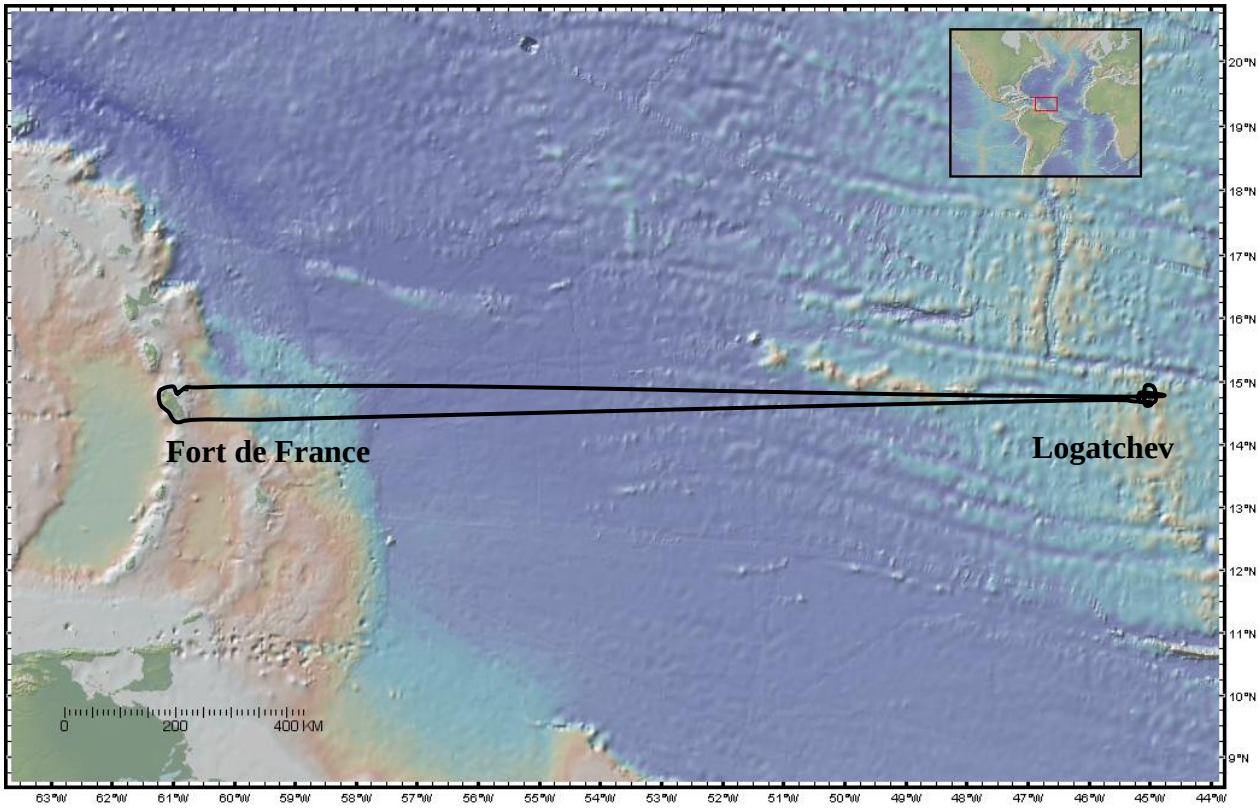

Fig. 1: Cruise track of cruise MSM03/2.

The mobile drilling platform used is the lander-type, remotely operated Rockdrill 2 of the British Geological Survey in Edinburgh (UK). Our main goals were to investigate and understand the depth zonations of the mineralization and alteration as well as their age relationships and the establishment of the variability of the subsurface biosphere and their influence on the formation and alteration of hydrothermal mineral precipitates. The Rockdrill 2 (Fig. 2) is lowered to the seafloor and is capable of drilling up to 15 m deep holes in water depths up to 3100m. After an initial shallow water test of the equipment in the territorial waters of France (Martinique), this newly built instrument was able to achieve 14 drilling stations within the Logatchev field as well as at the eastern rift valley wall. Several active black smoker sites with known vent temperatures up to 350°C were approached within the Logatchev field and drilling was performed in the vicinity of the black smokers at "Quest", "Irina 1" and "B". The deepest hole reached a depth of 10.5 m below the seafloor. Massive sulfides are rare in the drill core suggesting that most parts of the Logatchev hydrothermal field are underlain be fine-grained, altered material of highly-variable composition. Few massive sulfide pebbles have been encountered in the lower parts of drill holes (up to 10 m deep; Fig. 3). The heterogeneity of the material encountered suggests that the subseafloor is largely composed of talus material. Additional drill holes were targeted at sites of known low-temperature venting or in areas of proposed past hydrothermal upflow zones.

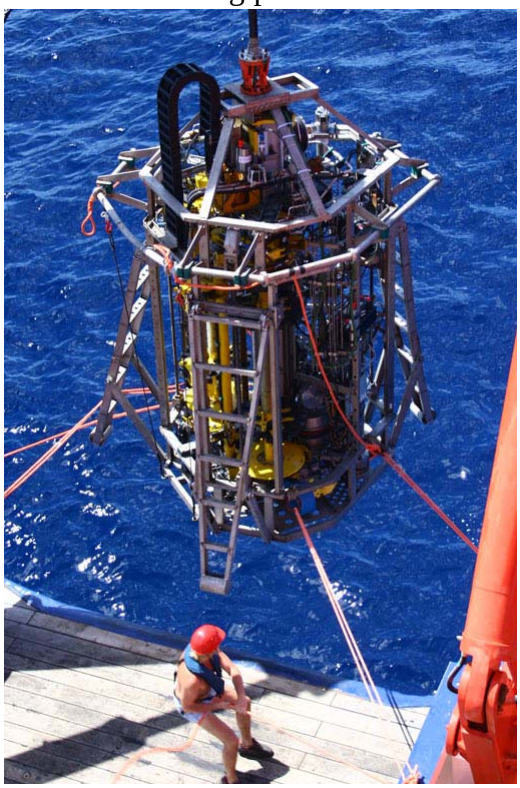

Fig. 2: The British Rockdrill 2 being lowered to the seafloor.

A gravity corer provided additional information about the shallow subseafloor and especially the past hydrothermal activity along and across the NW-SE axis of the Logatchev field. We were able to retrieve a number of hydrothermally influenced sediment cores sometimes including layers of secondary sulfide gravel.

Additionally, we mapped the parts of the Mid-Atlantic ridge surrounding the Logatchev field with a multibeam echo sounding system (Kongsberg EM120) using a reduced beam angle (22°) in order to obtain bathymetric data with a higher resolution (~20m) than previous maps. This detailed bathymetry shows a clear link of the location of the hydrothermal field to crosscutting fault structures. Dredging of a number of locations along the rift valley floor and at a circular depression close to the eastern wall recovered least-altered, partly glassy pillow basalt or fragments of basalt flows. Other dredges along the eastern rift

Fig. 3: Massive sulfide pebbles within hydro-thermally altered wallrock.

valley floor contain mafic intrusive material and ultramafic rocks in variable amounts. Mafic rocks consist of fine grained, medium/coarse grained and pegmatoidal gabbronorites, whereas ultramafic rocks are peridotites or serpentinites. 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 a horst structure immediately adjacent to the Logatchev field which recovered coarse-grained gabbronoritic cumulate.

Samples were taken for geochemical and mineralogical studies of sulfides, altered wallrocks and sediments. Additionally, investigations of the hydrogen storage capacity of sulfides, the geochemical sulfur cycle, the S-isotopic composition, and age dating are planned. Microbiological investigations are aimed at identifying micro-organisms characteristic for the specific habitats (different rock types) in the subsurface of the Logatchev field.

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 took part in the cruise.