Expedition M210 "Dive@MAR 2"

4. Weekly Report, 18.05.2025

The new week began with another dive with the ROV MARUM QUEST 5000 at the so-called Rainbow Pits – a group of trough-shaped depressions in the seafloor located at a depth of 2000 m and about 1.5 km east of the Rainbow hydrothermal field, where diffuse hydrothermal fluids are escaping. The Rainbow Pits were discovered in May 2022 during the French deep-sea expedition Arc-En-Sub'22 with the ROV Victor 6000 and the AUV Idef^{x} and were also dived during our previous expedition M190 in June 2023 with the ROV QUEST 4000. Due to their proximity to the hot Rainbow vents, it is assumed that the pits are part of the Rainbow hydrothermal system. Unlike the hot Rainbow fluids, which emerge from the seafloor at temperatures around 350°C and create spectacular chimneys and black smoke when they come into contact with the cold surrounding seawater, the temperatures of the Rainbow Pits fluids only reach a maximum of about 95°C and emerge as crystal-clear "shimmering water" from inconspicuous cracks in the seafloor. We are investigating the chemical composition of these fluids and comparing them with those of Rainbow to find out what transformations they undergo during their migration underground.

An important goal of this dive was to recover the long-term measuring instruments that we deployed on the seafloor two years ago during M190 together with our colleagues from the Université de Lyon. These long-term observatories house a series of sensors that measure physicochemical parameters such as temperature, pressure, pH and turbidity of the water to determine the dynamics of the environmental conditions in the pits and draw conclusions about the rhythms of their hydrothermal activity. All sensors returned to the RV METEOR intact, and the data collected on the seafloor over the course of two years will be evaluated by our French colleagues at their home institutes following our cruise.

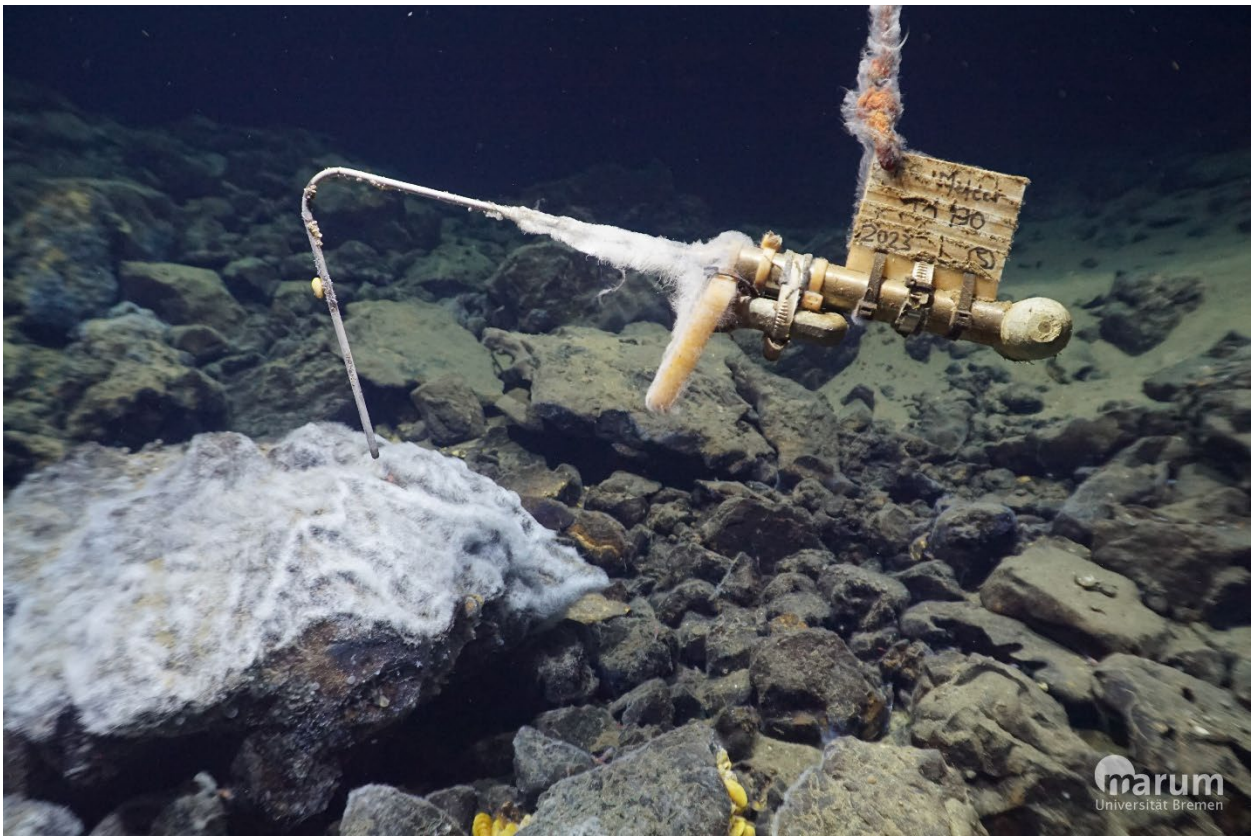

Figure 1: Image of a temperature sensor from the "Big Pit" that was placed on the seabed in June 2023 during the M190 expedition.

Unfortunately, the wind and waves soon changed again to our disadvantage, so that diving was out of the question by Tuesday, and according to the weather forecast, these conditions were expected to continue until the weekend. We used this time to sample a 200 km transect of CTD stations laid across the Mid-Atlantic Ridge to determine the long-range transport of hydrothermal inputs into the ocean. We mapped the Saldanha Seamount with additional multibeam lines to increase the resolution of our bathymetric data and conducted further CTD/MAPR towyos to obtain evidence of the presence of a hydrothermal plume in Saldanha. Furthermore, we began bathymetric mapping of another section of the AMAR segment of the Mid-Atlantic Ridge, where signals of a hydrothermal plume had already been detected in the early 1990s.

On Saturday, the weather was finally suitable for diving again, and we immediately took advantage of this to conduct another dive at the hot Rainbow Springs, where we sampled both active and inactive black smoker vents. These samples will be used to analyze the vent structures and investigate the microbial colonization of the vents. These samples,

along with those obtained from the hot fluids, which are extremely valuable for comparison with the fluids from the pits, made the fourth dive of our trip a complete success.

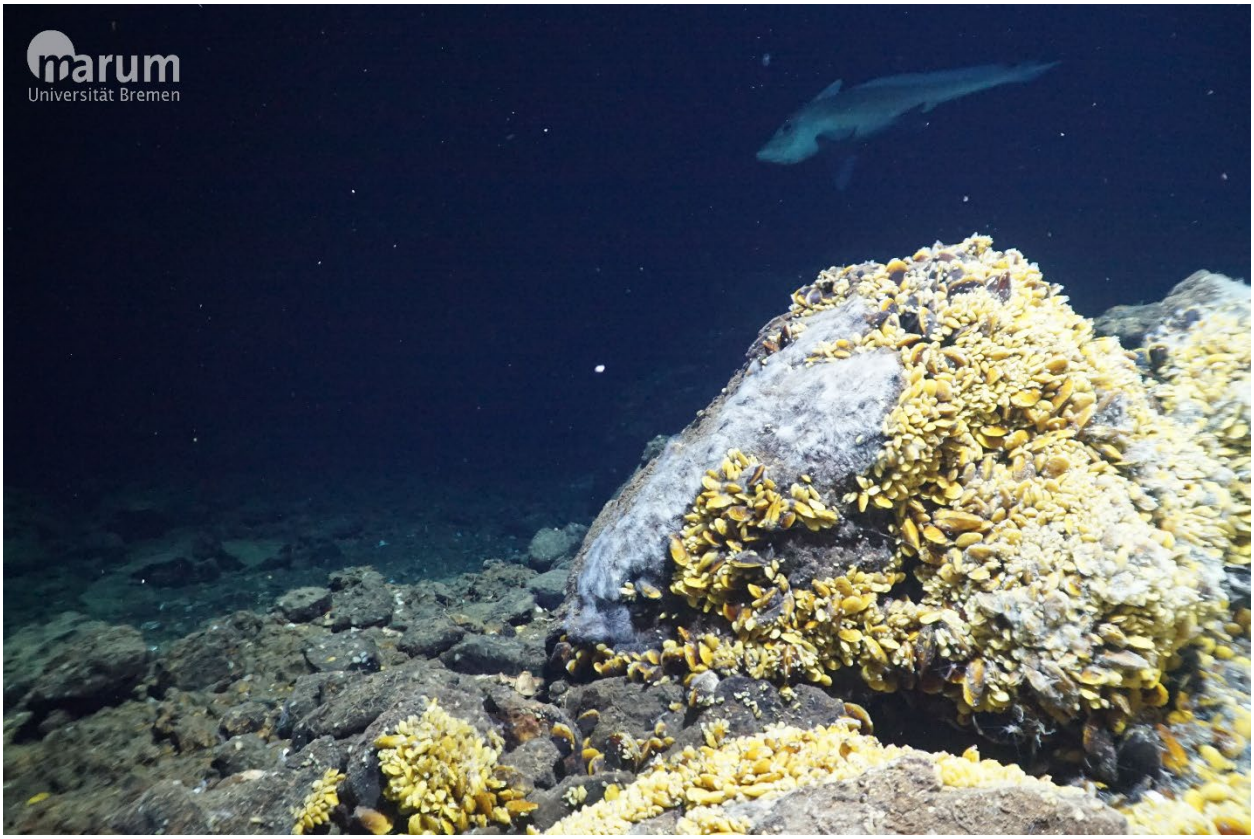

Figure 2. Boulders at the edge of the "Big Pit" overgrown with symbiotic Bathymodiolus azoricus *mussels and dense mats of filamentous bacteria. Both indicate the emergence of diffuse fluids from the cracks between the boulders. A chimera can be seen in the background.*

Today, Sunday, we dived again at the Rainbow Pits and began our work with photo and video mapping of the seafloor. This involves using forward-facing video cameras that provide continuous images of the seafloor, as well as a vertical still camera that produces high-quality photos at regular intervals. To achieve this, it is important that the ROV maintains a predetermined height above the seabed and a predetermined speed throughout the entire recording route so that the scale of the image sections remains the same. Due to the overlap of image sections from successive photos and entire photo series taken in close succession, it is ultimately possible to seamlessly stitch all images

together into a large photo mosaic that depicts the entire mapped area. Such photo mosaics allow the geological structures of the pit floor to be seen in detail. This will enable changes in the hydrothermal activity of the pits to be identified in comparison with previous years. They thus contribute to research into the temporal dynamics of the pits. The photo mosaics are also used to identify and quantify the seafloor fauna and are therefore an extremely important source of data for deep-sea ecological studies.

Unfortunately, this dive had to be ended prematurely because the wind picked up in the early afternoon and was blowing perpendicular to the swell, making it too risky to retrieve the ROV later in the evening due to the expected strong rolling of the ship. We therefore very much hope that we will be able to carry out the planned sampling for microbiological, symbiotic, and geochemical studies during a later dive. For now, we ended this week by completing our sampling of the CTD transect late into the night.

The wind and waves are unusually strong for this time of year, and we are also frequently plagued by cross seas, where two different swells from different directions meet. Under such conditions, it was rarely possible to safely launch and recover the ROV last week. We are therefore hoping for the last few days in the working area, for which the weather forecast fortunately predicts much calmer and more favorable diving conditions.

Greetings from aboard on behalf of all participants

Christian Borowski