

Expedition M190 of RV METEOR

Third Weekly Report, June 25th, 2023

Work in the Broken Spur hydrothermal field at 29°N and 43°W on the Mid-Atlantic Ridge was successfully completed. During three dives there, hydrothermal solutions with temperatures up to 368°C were sampled shooting out of narrow orifices of various vents. In addition, samples were also taken from solutions that emerge leisurely and widely around the vents. Samples of the sulfide vents were also taken. Immediately after recovery of the QUEST submersible robot, the concentrations of hydrogen, methane, and hydrogen sulfide were measured on the fluid samples. The measured values explain the composition of the sulfide vents, because they contain high proportions of pyrrhotite and sphalerite, whose pitch-black color indicates high iron contents. In order to explain the occurrence of these minerals, we had assumed that the solutions must contain relatively much hydrogen and rather little hydrogen sulfide. This assumption was confirmed by the measured values.

In the Broken Spur hydrothermal field we found a very colorful and individual-rich fauna, dominated by shrimps. Thousands of these animals frolic in the areas where the moderate-temperature solutions escape widely. Our sampling focused on these areas (Fig. 1). In addition to the aqueous solutions and sulfides, we were also very interested in sampling mussels that live in symbiosis with chemosynthetic bacteria because the Broken Spur Hydrothermal Field is located between two biogeographic provinces. Previous studies have shown that two geographically distinct species of mussels hybridize here. Therefore, Broken Spur mussels are extremely valuable for studying the evolution and biogeography of both the hosts and their bacterial symbionts.



Fig. 1: Warm waters, which we prefer to sample at M190, emerge from under a hydrothermally formed crust (right). The suction port of the sampling system can be seen in the picture as well as a mussel, shrimps and tiny brittle stars.

Photo: MARUM

The search for the desired mussels was not easy, but a few specimens could nevertheless be tracked down and collected. At the Max Planck Institute for Marine Microbiology in Bremen,

the recovered mussels and their bacterial symbionts will be genetically examined after the expedition.

In the evening hours of June 19, we left Broken Spur and steamed northeast for 64 hours to the next working area at 36°13'N and 33°53'W. There, a dome-shaped mountain called Rainbow is developed, which is about 10 km in diameter and about 1200 m high. This mountain consists mainly of rocks of the upper mantle, which reached the seafloor here directly at the plate boundary by tectonic processes. When these mantle rocks, which consist mainly of the mineral olivine, react with water, large quantities of hydrogen and methane are produced - valuable energy for the chemosynthesis-dependent life at the hot spring on the seafloor.

A large hydrothermal field on the western slope of the Rainbow Massif has been known for 25 years. There are a large number of vents there that emit water at temperatures of up to 370°C. During an expedition with the French research vessel *Pourquoi Pas?* last year, our cooperation partners from Paris and Lyon were able to locate warm spring vents far from the known hydrothermal field. We visited these warm springs twice during the week, deployed long-term instrumentation there, and collected numerous samples for our geochemical and biological work (Fig. 2). The spring outlets are in shallow depressions (pits); no vents build up there. The water samples taken showed temperatures ranging from 20 to 96°C and had widely varying dissolved gas contents. Mussels and rocks were also sampled.



*Fig. 2: A chimaera (a cartilaginous fish of the deep sea) did not want to miss our sampling of a mussel field at the "pits" area of the Rainbow Massif.
Photo: MARUM*

At night, we sampled the plumes of the hot hydrothermal field with its numerous vents, located northwest of the Pits, with our CTD/crane water sampler. In some of these deployments, a deepwater pump is mounted on the wire above the survey probe. We then hover the instruments about 30 m above the hydrothermal field and let the pump push water through filters for several hours, on which single-celled microorganisms are collected.

On today's dive we explored hill structures in the southeast of the Rainbow Massif. No one had been here before us! We were excited to find that the structures were hydrothermal in origin. However, no spring discharges could be found; the hydrothermal vents seem to have dried up there.



Fig. 3: The diving robot MARUM QUEST 4000 is deployed via the A-frame of FS Meteor. Even in the best weather and calm seas, this operation requires the highest concentration from the bridge, deck and ROV team. Foto: Christian Ostertag-Henning

The weather continues to be excellent and allows our planned station work without restrictions (Fig. 3). The diving videos can be followed from anywhere on board. Consequently, there is no lack of entertainment during the day. We are well taken care of by the crew. Accordingly, everyone on board is doing very well.

With best regards also in the name of all cruise participants,

Wolfgang Bach

At Sea, 36°N, 34°W