Expedition M190 of RV Meteor

Second Weekly Report, Juni 18th, 2023

The voyage of the research vessel Meteor westward to the first work area of the M190 cruise continued uneventfully. On June 12, a CTD (Conductivity, Temperature, Density) station combined with water column sampling was undertaken in an area far from the Mid-Atlantic Ridge. These samples give us a picture of the background, unaffected by hydrothermal sources, against which the data obtained later over the ridge are viewed.

In the evening hours of June 14, the work area was reached and a survey of the topography of the seafloor was made with the multibeam echo sounder. The first dive of the deep-sea robot, ROV for Remotely Operated Vehicle, MARUM QUEST4000 on the hot springs of the "Broken Spur" hydrothermal field was planned for June 15. These springs were already discovered in 1993; they are located in nearly 3100 m water depth and are up to 360°C hot. Our goal is to re-sample the springs, but according to a specific procedure that will allow us to maximize the linkage of geological, chemical and biological data. This type of sampling will be repeated during the cruise in other working areas located northeast of Broken Spur. Collectively, the springs are geologically and chemically diverse, and one goal of the cruise is to study the effects of this variability on the living organisms at the springs.

Fig. 1: The CTD with a Niskin water sampler rosette is deployed to investigate and sample the water column above the spring discharges.

The particular challenge in hydrothermal research with the ROV is the targeted sampling and measurement of the sources with sensors at extremely high pressures and temperatures. This can only succeed if the various technical components of the submersible robot function completely unrestricted. The slightest leakage or even the smallest leakage current can mean that a dive has to be aborted. This is what happened to us on June 15, because despite meticulous preparation, a critical drop in the pressure compensation system occurred during the descent to a depth of 900 m, forcing us to surface. The error was found on the same day and could be corrected immediately. We used the time freed up for sampling the water column above the hot springs with the ship's own water sampler rosette, which is arranged around a CTD measuring probe. This system allows the detection of hydrothermal signals in the water column, which can then be sampled immediately. The data and samples obtained in this way allow us to assess the dispersion in the ocean of the substances leaking at the sources.

On June 16, the ROV was to dive again, but Meteor's bow thruster was in danger of overheating with constant use. Thanks to the immediately initiated repair measures of the engineers and technicians of the ship technical service, the cooling circuit could be made functional again in the course of the day. Nothing more stood in the way of a dive on June 17, and this time everything worked out. Two wells in the southern part of the Broken Spur hydrothermal field could be sampled. The encountered vent structures are up to 20 m high and we were able to measure temperatures of over 320°C. More interesting for us than the extremely hot solutions of the springs are moderately tempered fluid seeps of less than 120°C. Up to this temperature, microbial life in the deep sea is possible. We sampled springs whose temperatures were around 80°C, and after the trip we examined the solutions in our laboratories for their chemical and isotopic compositions. Certain parameters, however, are

Fig. 2: The diving robot (ROV) MARUM QUEST 4000 is ready for operation on the working deck of the Meteor. In addition to a variety of possibilities for direct sampling at the seafloor, the ROV carries sensors and instructions that provide information about the nature of the sources already during the dive.

measured right on board, since some substances decompose when the samples are stored. The data collected indicate strongly elevated concentrations of hydrogen, methane and hydrogen sulfide. These substances are essential energy carriers for the metabolism of the microbes, which we concentrate with a specially developed system by pumping the solutions through special filters. By examining the genetic material and other biomolecules of the microbes, we can then later determine which microbes live in the springs and what metabolic functions they perform. Using a specially developed mass spectrometer, we can even detect the gases contained in the escaping solutions directly during the dive. This helps us decide where to take samples for the coupled chemical and biological investigations.
Today's dive is also extremely successful and will provide us with a large number of samples around 8 pm, which will then be processed in the laboratories until the early morning hours.

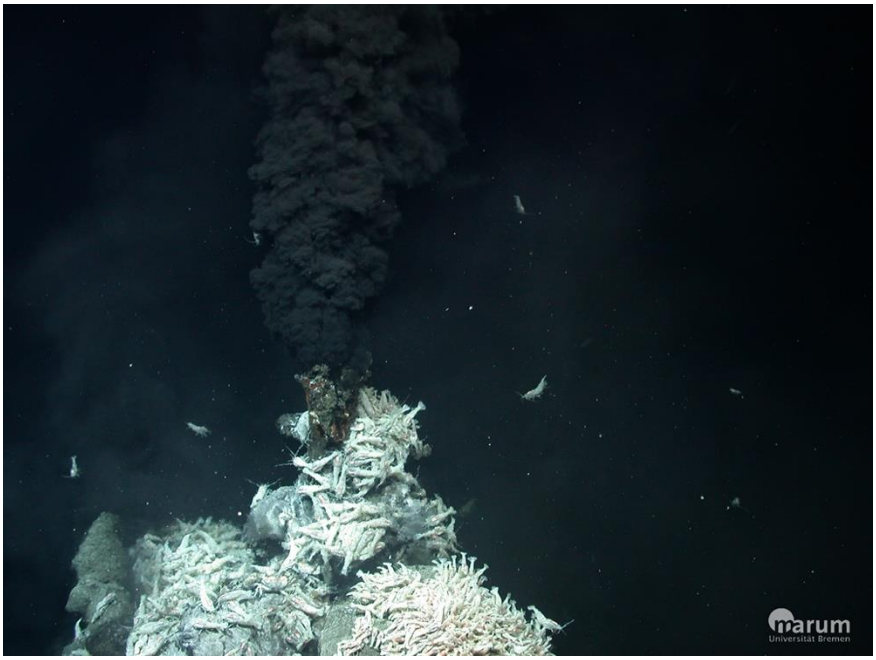

Fig. 3: A powerful hydrothermal vent ejects large amounts of >320°C hot water, which rises in black particle plumes and can be traced over long distances as an anomaly in the ocean. We sample the hot waters at the seafloor and the plumes in the water column.

Everyone on board continues to be in good health. The weather is excellent, as is the hospitality and great support in nautical and technical matters, as well as the varied assistance with work on deck, without which our operations would not even be possible.

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

Wolfgang Bach At Sea, 29°N, 43°W