Cruise M190 of RV METEOR

Forth weekly report of July 2nd, 2023

Work at the beginning of last week focused on sampling the hot hydrothermal vents on the western slope of the large *Rainbow* Massif. Two dives with the ROV yielded a large number of observations and samples. In the central part of the approximately 200 m wide hydrothermal field, vent structures were encountered that were inactive or showed only sparse discharge of hydrothermal solutions. Along the crest of a prominent hill in the western part of the field, however, we encountered a sea of vents that emitted >370°C hot solutions and billowing black plumes with remarkable fierceness (Fig. 1). As in the *Broken Spur* hydrothermal field, we focused sampling on solutions and animals in the vicinity of mussel colonies.

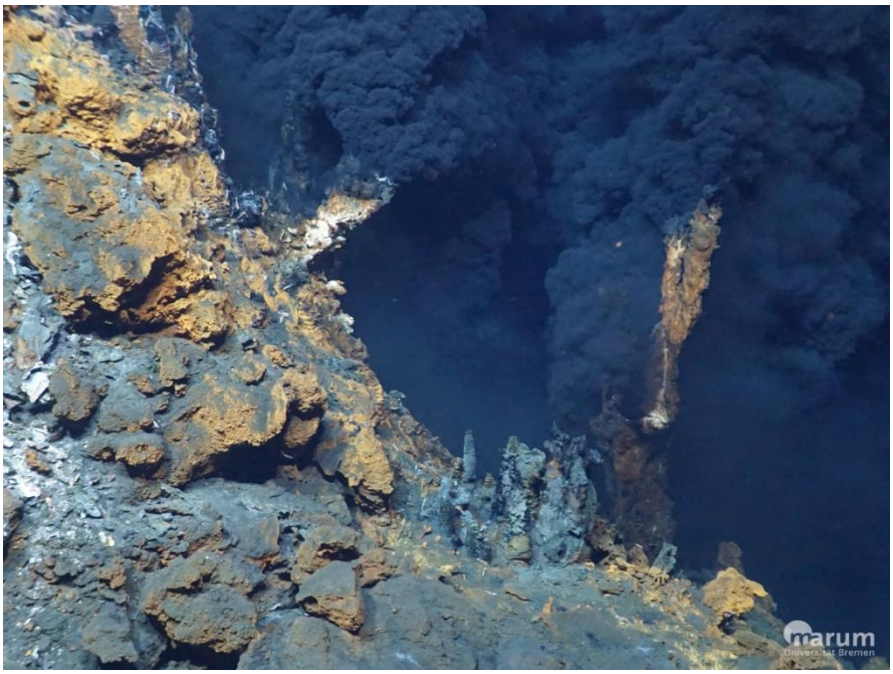

Fig. 1: In the Rainbow hydrothermal field, very hot and metal-rich solutions escape through slender, rusty-looking vents. The metals cannot remain in solution in contact with the cold seawater and form black particle plumes that spread over the vents in a billowing manner. Photo: MARUM

After successfully completing our work, we left *Rainbow* on Tuesday evening, but not without recalling a fitting scene from the first days of our stay over this fascinating patch of ocean floor (Fig. 2).

Our next work area is already located in Portuguese highaltitude waters at 37°17'N and 32°17'W and is called "Lucky Strike". The name commemorates the discovery of the large hydrothermal field located there by a U.S. expedition in 1992, when a dredge's completely blind sampling of the seafloor unexpectedly brought massive sulfides of hydrothermal vents aboard the ship. The *Lucky Strike* seamount is a cone-shaped volcano that is situated directly at the spreading zone and extends from >3000 m to <1700 m water depth. Over the past 30 years, *Lucky Strike* has been studied several times during research cruises and our French collaborators share their very precise maps with us. With their help, we are finding extensive mussel beds around warm springs south of the large hydrothermal field located in the summit area of the volcano, which have not been studied geochemically and biologically before. On

Friday, we were able to make this exciting and productive dive in 1770 m water depth. Before that, a westerly moving low-pressure system and the associated freshening winds forced us to take two days off from diving. We used these two days to map the seafloor northwest of *Lucky Strike* in an area called *Menez Gwen* (Breton for white mountain) and a seamount even closer to the Azores archipelago at 38°20'N, which has no name. These two submarine volcanoes rise to water depths <800 m. At such comparatively shallow water depths, carbon dioxide-rich gas bubbles often emerge from the rocky subsurface along with hot aqueous solutions. These gas bubbles rise high up into the water column, and they can be visualized there with Meteor's modern multibeam echo sounder. During our two-day exploration cruise, we consequently focused on recording acoustic signals in the water column above the ocean floor. We were able to successfully image the already known hydrothermal vent at *Menez Gwen* using the method employed (Fig. 3). Inspired by this confirmation of our methodological approach, we conducted exploratory surveys on the two seamounts mentioned above on Wednesday and Thursday. However, no signals approaching in intensity the plume of gas bubbles over *Menez Gwen* could be detected. However, the evaluation of the data is still ongoing and we are following up on indications of possible additional gas seepage sites at *Menez Gwen* during the coming week.

Fig. 2: Perhaps not by chance, a very beautiful rainbow appeared while we were in the area of the Rainbow hydrothermal vents. Photo: Sophia Schillai

Initial dives on *Menez Gwen* were completed with purpose over the weekend. Extensive mussel beds surround sulfide vents on the steep eastern slope of the volcano, which emit boiling water. Here, in 830 m water depth, there is a pressure of about 85 bar; there the salty sea water boils at a good 300°C, which corresponds to the measured temperature. A large part of the recovered mussels will be transferred to a high-pressure aquarium, where these animals and the interactions with the symbiotic bacteria embedded in their gill tissue can be studied in more detail.

During an earlier Meteor research cruise in 2010, additional hot springs were located about 4 km south of the *Menez Gwen* hydrothermal field. The discovery was made towards the end of that trip; there was little time for sampling. Already at that time it was gas bubbles in the water column that gave the decisive clue. This hydrothermal field was named *Bubbylon*, and it is the goal of the Sunday work program to visit and systematically sample these sources.

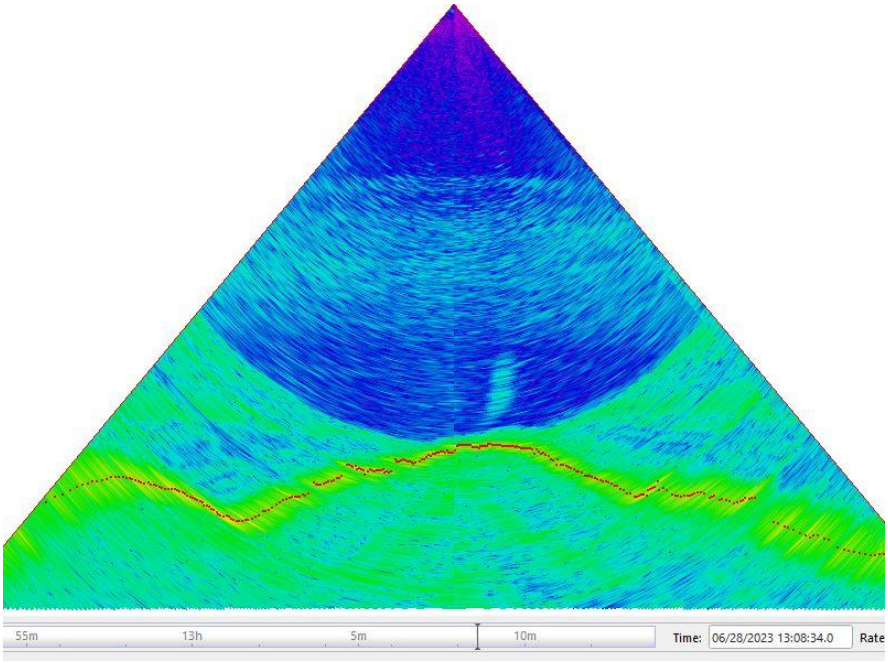

Fig. 3: The recordings of Meteor's multibeam echosounder showed plumes of gas bubbles above the Menez Gwen hydrothermal field, which could be detected acoustically. The search for such signals can be used in the detection of unknown source discharges in water depths of less than approx. 1200 m.

Everyone on board is well and very satisfied with the progression of the research cruise. The unwavering support of our scientific program by the entire crew is the basis for this positive course of the voyage.

With best regards also on behalf of all who participate in cruise M190

Wolfgang Bach At Sea, 36°N, 34°W