Cruise M190 with Research Vessel Meteor

1st Weekly Report of June 11, 2023

The German research vessel *Meteor* left the port of Las Palmas de Gran Canaria in the morning hours of June 8. On board is a science team of geologists, biologists, geochemists and oceanographers, including seven members of the team that will use MARUM's QUEST4000 deep-sea robot that was brought along. The scientific goal of Meteor cruise M190, titled "Dive@MAR" (Distribution of Venting Along the Mid-Atlantic Ridge (29-38°N) and Implications for Hydrothermal Exchange and Vent Ecosystems), is to develop an understanding of coupled geological-geochemical-biological processes at hydrothermal vents along the Mid-Atlantic Ridge between 29 and 38°N and in water depths between 3,100 and 800 meters. The cruise is organized and carried out by the Cluster of Excellence (EXC) "Ocean Floor" of MARUM - Center for Marine Environmental Sciences of the University of Bremen. In the EXC, scientists* from the University of Bremen, the Constructor University Bremen and the Bremen Max Planck Institute for Marine Microbiology are united in the research of hydrothermal vents. In addition, scientists from the University of the Azores and the University of Lyon, Göttingen and Münster as well as the Federal Institute for Geosciences and Natural Resources in Hanover are involved in the M190 project.

Fig. 1: A view of the Meteor in in the port of Las Palmas. Photo: Harald Strauss

The R/V Meteor is sailing on a westerly course to the submarine hydrothermal vents at the Mid-Atlantic Ridge. From Las Palmas to our first work area is a distance of 1,500 nautical miles. At a speed of 10 nautical miles per hour, we will be underway for just over six days before we reach our first study area on the Mid-Atlantic Ridge.

The Mid-Atlantic Ridge (MAR) is part of the longest mountain range on Earth. With a total length of about 60,000 km, these so-called mid-ocean ridges are found in all oceans. Here the large tectonic plates of the earth spread apart and new seafloor is formed. In the northern Atlantic, the plates are spreading at a rate of 2-3 cm/year, steadily increasing the distance between Europe and North America. Most of this seafloor consists of basaltic rock that forms when the upper mantle rises beneath the MAR and partially melts. This upward movement of

the mantle occurs in response to theergent motion of the plates along the MAR. Because hot material of relatively low density rises beneath the MAR, the seafloor there is higher than elsewhere in the deep ocean of the Atlantic. This ridge of the MAR lies between 2,500 and 3,500 m water depth. Away from the ridge, the crust and mantle cool and become denser, causing the seafloor in the deep-sea basins on both sides of the MAR to sink to water depths of > 4,000 to 5,000 m.
Together with the movement of the basaltic magma filling the gap between the diverging plates, enormous amounts of heat are brought to the seafloor. This high heat flux initiates the circulation of seawater through the newly formed and highly fractured seafloor. Cold seawater seeps down through cracks between the rocks of the seafloor and is heated there. Interaction with the hot rocks of the ocean crust changes the chemical composition and physical properties of the circulating seawater, which becomes an ultra-hot fluid with temperatures of up to 400°C or more! These fluids are enriched in a variety of dissolved metals, sulfides, and various gases. They rise rapidly through cracks in the seafloor and are discharged into the oceans through hydrothermal vents. Upon contact with the 2°C cold seawater, the dissolved metals and sulfides immediately precipitate as minerals, forming meter-high vent structures on the seafloor. Most of the minerals, however, are ejected from the vents into the ocean as black smoke, forming plumes of particles that rise up to hundreds of meters above the seafloor before spreading laterally.
Fascinating and diverse oases of life have developed near the hydrothermal vents. The basis of the food web in deep-sea vent ecosystems is not photosynthesis! Instead, microbes use chemical energy stored in dissolved metals, sulfide, and gases to convert carbon dioxide into biomass. These microbes can be free-living, forming mats that cover the seafloor, or they can live in symbiosis with other higher organisms, such as mollusks and snails.

The first submarine hydrothermal vent system was discovered in the eastern Pacific Ocean in 1977. Since then, more than 120 hydrothermal vents have been studied in all parts of the world's oceans. The objective of the M190 research cruise is to visit four working areas between 29 and 38°N along the Mid-Atlantic Ridge: Broken Spur, Rainbow, Lucky Strike, and Menez Gwen. These areas are well known to anyone concerned with submarine hydrothermal vents. However, there is still much to discover there, and the entire science team can hardly wait to reach the first working area. Until then, the scientists are installing the equipment they brought with them in the ship's laboratories. The science team consists of geologists, chemists, biologists and engineers with different goals and tasks. Daily meetings facilitate interaction between the different groups on board. We will report in more detail on the various scientific questions and methods used in the coming weeks.

Everyone on board is well. In their usual friendly and professional manner, the crew is ensuring that the preparatory work runs smoothly during the long transit. On Wednesday, June 14, we will arrive at the first working area, and in the next weekly report we will probably be able to present pictures and findings from the first dives with the deep-sea robot. Until then we will enjoy the excellent service provided by “team galley” and relish the sunny weather and the calm sea.

With best regards, also on behalf of all cruise participants,

Wolfgang Bach At sea, 30°N, 30°W