RV METOR - M183

13.07. - 09.08.2022, Ponta Delgada - St. John´s

3rd Weekly Report (25.07. – 31.07.2022)

For the past nine days we have been working in the area of "our" sediment pond at approximately 57°32'N and 32°17'W and are finding very clear evidence of directional movement of seawater flowing beneath the sediments. As reported in previous weeks, this flow is due to circulation currents within the rocky foundation of the sediments. This process plays an essential role in the setting the fluxes of heat and elements between the rocky part of our planet and the oceans. Clear evidence of these processes has rarely been presented, and a quantitative description of the phenomenon remains elusive. Our observations collected so far make us optimistic that the sediment pond we have chosen is an excellent location for future work with research observatories installed in the seafloor. But first things first! What findings feed this optimism? A week ago, I gave a detailed account on the importance of heat flow measurements and reported on initial indications that point to temperature differences in the basaltic crust on the opposite shores of the sediment pond. In the meantime, we have collected findings in the course of six further nocturnal heat flow measurement campaigns that clearly confirm this picture (Fig. 1).

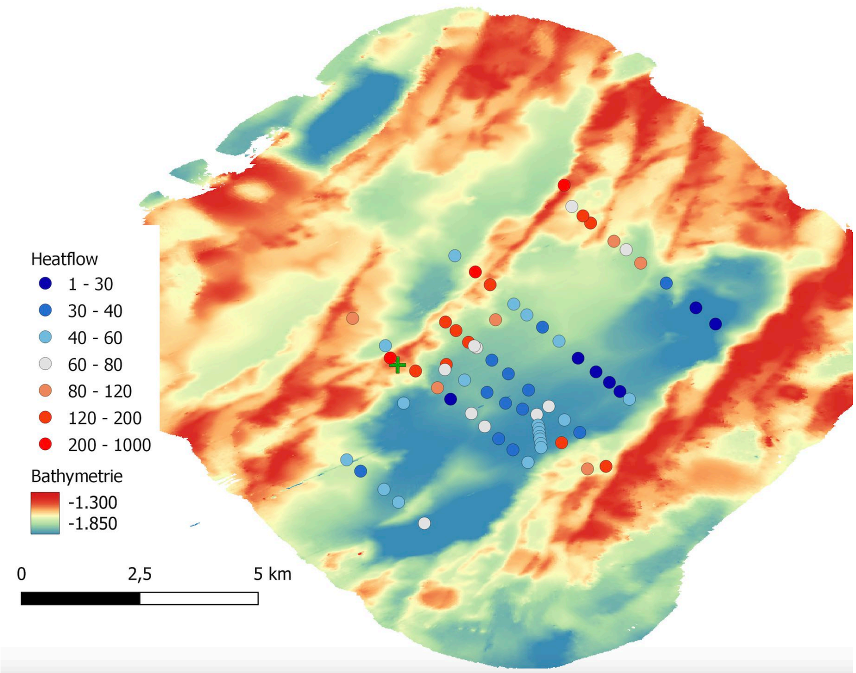

Fig. 1: The map shows the positions of the heat flux measurements in the sediment pond. High heat fluxes are concentrated in the northwest boundary of the sediment pond. Map: Isabel Kremin

Additional clues are provided by chemical parameters measured with the gravity sounder immediately after the sediments have been extracted. A team of geochemists collects these data and takes samples for very extensive chemical and isotopic investigations in the laboratories of GEOMAR in Kiel and AWI in Bremerhaven (Fig. 2).

Fig. 2: In Meteor's geo-lab, Christopher Schmidt and Kim Moutard (left) sample sediment cores with Jessica Volz, which Aaron Roehler had previously sawn open professionally.
Photo: Aaron Roehler

Jessica Volz and Christina Nadolsky measure the concentrations of oxygen and iron dissolved in the pore water (Fig. 3). Christopher Schmidt and Kim Moutard determine a parameter (alkalinity) that allows statements about the amounts of dissolved carbonate in the pore water. Microorganisms live in the sediments and utilize food sinking to the seafloor in the form of organic compounds, consuming oxygen in the process.

Fig. 3: Christina Nadolsky reads sensor signals that are used to calculate the oxygen concentrations. These measurements can take place over an entire night and take place at a cool 4°C. Kudos!
Photo: Aaron Roehler

In the working area, a great deal of this food rains down on the seafloor and thus a great deal of oxygen is respired, so that the oxygen concentration in the sediments already approaches zero within the upper centimeters. In the underlying layers of the sediments live microbes that do not need oxygen, but respire nitrate or rust-like iron substances. These processes lead to predictable changes in the above-mentioned material parameters in the sediments on the seafloor: the oxygen content decreases and the content of dissolved iron increases. Because organic carbon is oxidized to carbonate in the course of microbial metabolism, alkalinity also increases. What we can observe, however, is a reversal of these trends in the deeper sections of the sediment cores. This can only mean that oxygenated seawater is entering the sediments not only from above, but also from below. However, we see the characteristic increases in oxygen at low alkalinities only on the northwestern side of the sediment pond, where the heat flux is also increased.
These data indicate to us a direct coupling between the flow of seawater through the ocean crust and the heat and solute turnover in the seafloor. The signal strength of the physical and chemical anomalies detected far exceed our expectations and make the explored sediment pond seem eminently suitable for the installation of a ridge-flank observatory. Our task: the

exploration of a suitable ridge flank in water depths < 2000 m - and thus accessible for the marine drill rig MeBo of MARUM - is thus already quite far fulfilled.

We still have three working days, which we can use very well with additional dives of the ROV and heat measurements as well as further gravity sounding missions to locate the optimal positions for the MeBo drilling planned in 2023. The dives with the ROV SQUID are especially fun considering the incredibly diverse and colorful communities on the rocky sections of the seafloor (Fig. 4).

Fig. 4: Fascinating faunal assemblages live on the barren rocks of the basaltic crust. Corals, sponges, snails, worms, bryozoans and sea anemones can be seen, with sponges being particularly numerous and rich in species.

With the ROV, we can also recover sediment cores about 30 cm long (Fig. 5) and - thanks to the inventive talent in the ROV team - even measure temperatures in the sediment.

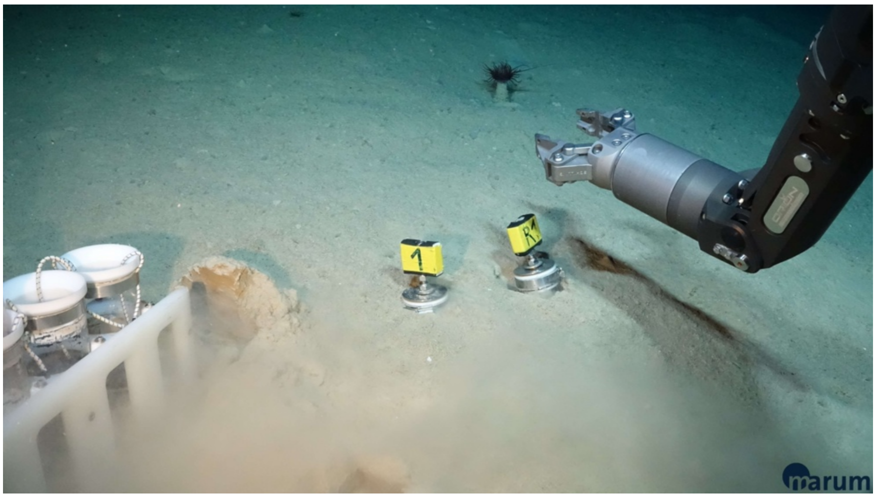

Fig. 5: The diving robot MARUM SQUID takes sediment samples with a push corer at a water depth of about 1600 m.

Everyone on board is well and working hand in hand in station operations around the clock. Bridge, deck and engine make it possible and support us in an affectionate manner through professional dedication. The food is really excellent, and the mood is correspondingly exuberant in an always well-filled mess hall.

With warm greetings, also in the name of all those who participate in the M183 excursion,

Wolfgang Bach
(University of Bremen) at sea at approx. 58°N, 32°W