RV METEOR – M183
13.07. - 09.08.2022, Ponta Delgada - St. John´s

2nd Weekly Report (18. – 24.07.2022)

Our hunt for a suitable sediment pond for the planned observatories to record the turnover processes in the flanks of the mid-ocean ridges has been going on for a week now. Such sediment ponds are very numerous in the study area (Fig. 1). So which ones are suitable for our purposes? "Suitable" in this context means that we can find clear evidence of water flow beneath the sediment ponds and determine at least the general direction of flow.

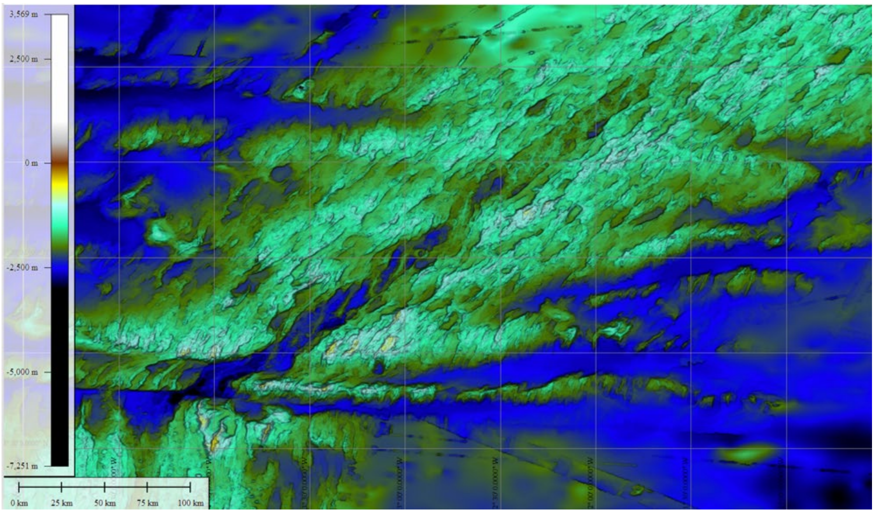

Fig. 1: The map shows the numerous oval sediment ponds in the flanks of Reykjanes Ridge on either side of the spreading axis in the center. The east-west trending structure is the Bight Fracture Zone at about 57°N and 34°W.

Our primary indicator of flow in ridge-flank crustal aquifers is heat flow data. We expect to find increasing heat flux densities in the direction the water is flowing because it warms slightly in the aquifer along the flow path, making the overlying sediment at the base slightly warmer than where the cold seawater enters the aquifer. So after surveying a sediment pond through the plumb bobs of the Meteor, Norbert Kaul, Niklas Warnken and Julian Seeliger of the University of Bremen get to work and lay traverses across the pond with the temperature-measuring lance to look for gradients in the heat flow. The lance penetrates the sediment-covered seafloor at the speed of a Sunday walker (about 1 m/s) and measures temperatures there with high precision along a 6-m-long sensor string at 21 points. The probe then sends a heat pulse into the sediment and records the subsequent cooling behavior. From the latter data, the thermal conductivity can be determined. If this is known, the detected temperature gradient can be converted into the heat flux density.
As close to the spreading axis as we are with the meteor, one would expect high heat flux densities (300-400 mW/m^2). The heat is lost in two ways: by conduction (conductive) and also convective, namely by the water flowing in the crustal aquifer. We know that these two mechanisms in the sum manage the mentioned high heat fluxes. With the heat flow lance, however, we can only measure the amount of heat that is transported away conductively. If these measured values are now very low, we see in them clear indications of a dominance of convective heat transport. Such low readings have been the rule in the course of our explorations so far. We conclude that the ocean crust in the working area is very strongly

cooled by seawater circulating beneath the sediments.
One of the three sediment ponds we have explored so far showed a very strong gradient in heat flux densities right from the first traverse. We are now concentrating our efforts on this location (Fig. 2) and making further heat flow measurements so that we can get a more accurate picture of the heat flow distribution and thus better determine the flow of water in the aquifer.

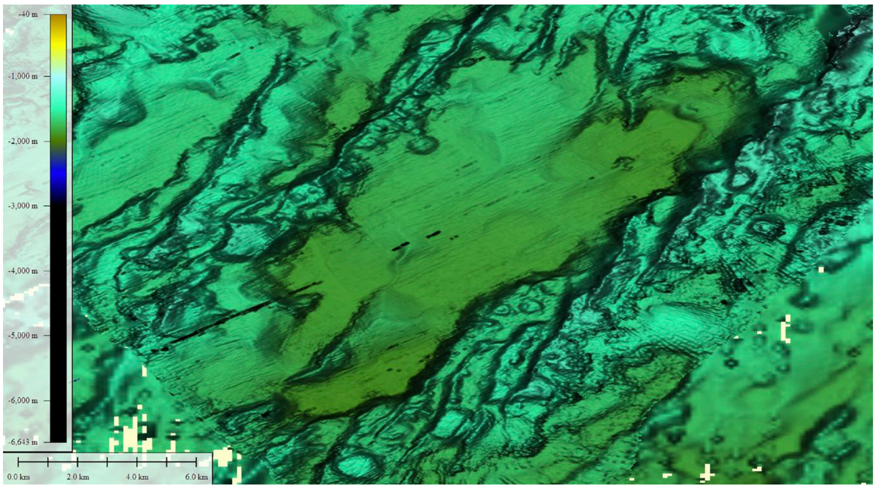

Fig. 2: Among the three ponds studied so far, the one depicted, which is at about 57°33'N, 32°17'W, is particularly promising. On the northwestern side the heat flux values are very high, while they seem to be low at the southwestern end.

The heat flow measurements are followed by sampling of the sediments by the gravity corer (Fig. 3). In the working area, six gravity cores with lengths between three and nine meters could already be taken in the first week. Pore water samples will be taken from the sediments, the composition of which will allow processes in the sediment and under the sediment cover to be determined. First findings from these investigations will be reported in the third weekly report.

Fig. 3: With combined forces, a gravity corer is prepared in the core setting rack for the removal of the sediment core.

For long-term measurements of the current conditions, the nutrient inventory and the CO2 partial pressure, an instrumented lander of the MARUM (Fig. 4) was deployed at a depth of 1840 m on Friday. The deployment of this lander is funded by the AIMS[3] project of the CDRmare mission of the German Alliance for Marine Research and is intended to prepare the planned research on CO_2 storage in the crustal aquifers of the ridge flanks. The scientist in charge on board is Mario Esposito from GEOMAR. He is also evaluating the CTD deployments and associated sampling of the water column, which took place twice over the course of the past week.

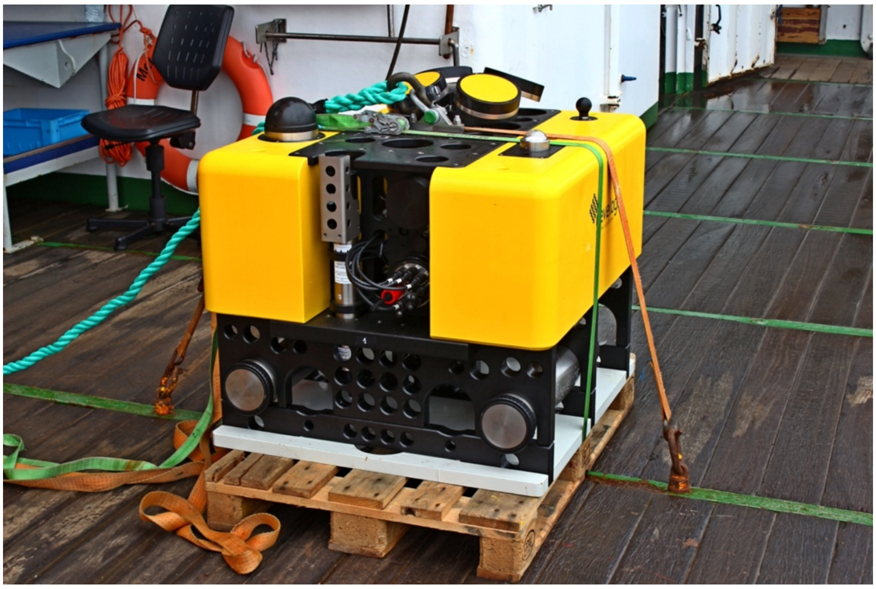

Fig. 4: This long-term measuring station (lander) was set down in the sediment pond currently under investigation on July 22 and will be recovered before the end of the cruise. The instrument allows measurements of a variety of parameters related to the CO_2 budget of the deep sea.

MARUM's submersible robot SQUID (Fig. 5) has so far helped with the hydroacoustic investigations to determine sediment distribution. Where a suitable sediment pond has now been found, we used SQUID today (Sunday, July 24) for the first time during the M183 cruise to make observations and take samples directly on the seafloor.

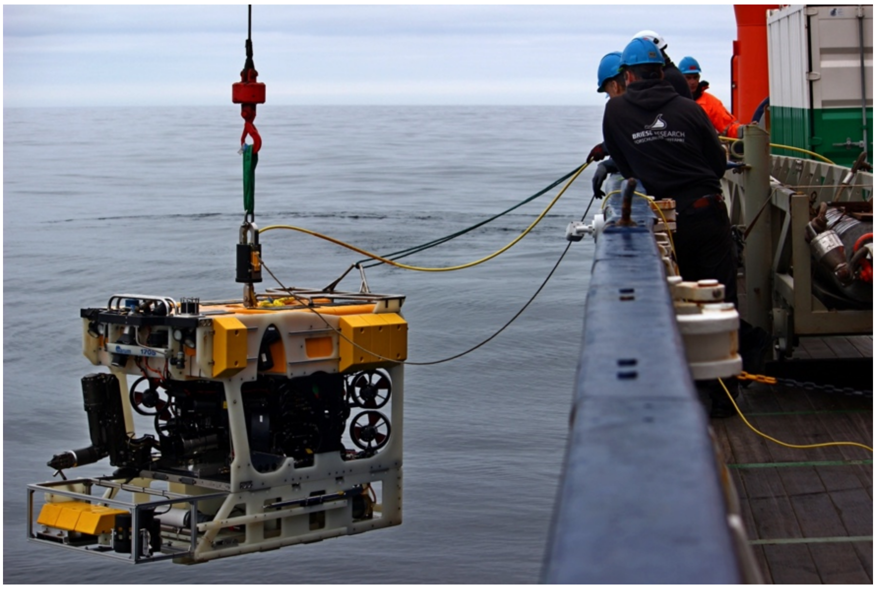

Fig. 5: The diving robot MARUM SQUID is hoisted over the ship's side in calm sea conditions to be deployed in 1800 m water depth.

The mood on board is excellent. Although the sun rarely shines, the sea is calm and has been conducive to all equipment operations so far.

With warm greetings, also on behalf of all participants in exit M183,

Wolfgang Bach (University of Bremen) — at sea near 58°N, 32°W