Research Vessel SONNE

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During the past week we intensively investigated the mud volcanoes of the Olimpi mud volcano field and the United Nations Ridge. In principle, mud volcanoes transport a mixture of clay, rock fragments or clasts, water and gas. Due to its low density, the mixture is not stable in deeper sediment layers. The lithostatic pressure of the overlying sediment causes the mud to rise to the surface of the earth or to the seafloor along weak areas, e.g. tectonic faults, where it forms cone-like structures, which look similar to magmatic volcanoes. Mud volcanoes are particularly common on the Mediterranean ridge south of Crete, where the compressive stress field of the converging tectonic plates in particular promotes the rising of mud and the formation of mud volcanoes. For the Bremen ocean floor cluster, the exchange of fluids and gases from the mud volcanoes with the seawater, which we are investigating with our samples, is of particular importance. The small-scale distribution plays an important role in sampling, because the exchange of fluids and gases is very different in the chimney area of a mud volcano compared to older mud flow deposits or on sediments at the edge of the volcano. Therefore, the high-resolution bathymetric maps of the AUV surveys (Fig. 1 and 2) form an essential basis for very targeted sampling, which has only been possible since AUV mapping became technologically feasible. The advantage of targeted sampling with a high spatial resolution, which we conduct using the ship's own underwater navigation, was especially evident this week, because the pore waters from the sediment cores show very large deviations from the salinity of the sea water (39 ‰), with brines with a concentration of 200 ‰ and freshened formation waters with a concentration of 10 ‰.

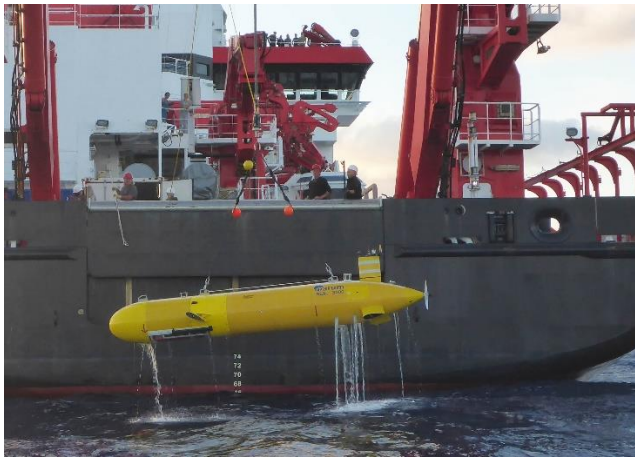

Figure 1: The MARUM AUV Seal 5000 is hoisted on deck with the A-frame on R/V SONNE after its 13-hour dive in 2000 m water depth (© Till von Wahl).

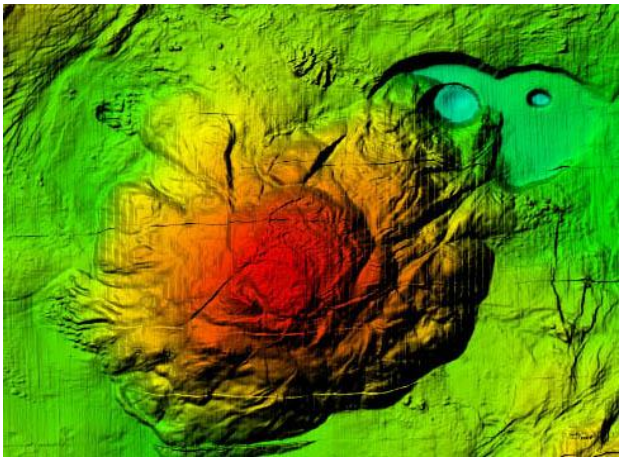

Figure 2: High-resolution bathymetric map of the raw data of the Monza mud volcano, which was measured by the AUV SEAL in several horizontal track lines 80 m above the sea floor.

We used the AUV on Monday, 02 November to map the Monza mud volcano (Fig. 2) and on Wednesday, 04 November on the Milano mud volcano. This mapping work was carried out during the night, with the device going into the water in the evening when it was still bright and coming out the next morning shortly after sunrise at 6:30 a.m. (Fig. 1). During the day we mainly carried out sediment core sampling and multicorer / minicorer stations (Fig. 4) for surface sediment sampling

on the Bergamo, Moscow, Maidstone, Milano and Leipzig mud volcanoes. The diverse names of the mud volcanoes show that international teams discovered mud volcanoes here as early as the 1990s and helped shape the term “marine mud volcanism”. The Monza mud volcano was measured on Tuesday, 03 November with a heat flow profile and on Wednesday, 04 November with an OFOS observation profile of the sea floor. In this operation, the AUV map again proved itself in a great way because it allowed very targeted navigation of the OFOS. We were able to discover numerous cold seeps with their typical chemosynthetic living organisms, such as tube worms, lucinid clams and bacterial mats (Fig. 3). Even small backscatter anomalies of 5-10 m in diameter were confirmed as seep regions, so that we can apply the findings to the entire map of the mud volcano.

Figure 3: Photo of the OFOS TV-sled from a Cold Seep on the flank of the Monza mud volcano with carbonate precipitates (light), bacterial mats (dark), tube worms, mussels and other inhabitants in 1900 m water depth.

Figure 4: The minicorer, a very simple instrument for taking precise seabed samples with bottom water, is received on the ship (© Tabea König).

Thursday, 05 November was a special day as it was the 25th day at sea and thus marked the middle of our 50-day expedition. We used the time on the transit to the United Nations Ridge for a longer mapping survey and to celebrate the halftime party that evening as part of a Mediterranean barbecue. Although several mud volcanoes have been described from the United Nations Ridge, we decided to map the Dublin mud volcano in more detail, on the grounds of its high backscatter values in the swath mapping. Since an atmospheric low (1012 hPa) south of Cyprus slowly shifted its center south-south-west and gave us a strong northerly wind current with isolated showers and a sea with swells up to 2.5 m high on Friday and Saturday, unfortunately, an AUV dive was possible neither on Friday, 06 November, nor on Saturday. So, after an interesting OFOS sled profile on the ground and after a sampling with the gravity corer and multicorer, we left our eastern work area and steamed back west to the Olimpi field. Today on Sunday, 08 November, it is sunny again and the swell has decreased significantly, so we plan to use our AUV Seal on the Nice mud volcano this evening. With today's survey we were also able to hydroacoustically detect an escape of free gas on the sea floor in 1800 m water depth for the first time this journey, with gas bubbles rising to 400 m above the seafloor. We will of course examine such an interesting location in more detail in the coming days and report on the results next week.

All participants are healthy!
Best regards also on behalf of the cruise participants,

Gerhard Bohrmann (Marum, University of Bremen) R/V SONNE, Sunday 08 November 2020