Research Vessel SONNE

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2nd Weekly Report: 19 – 25 October 2020

On the way to our destination south of Crete we crossed the border between Spain and Italy on Monday, 19 October. As we had obtained permission from the Italian authorities, we were able to start recording with the hydroacoustic systems at this point. On Tuesday, 20 October, we passed Sardinia to the south on our way into the Tyrrhenian Sea, where we could see the numerous volcanoes of the Aeolian Islands (Fig. 1). In the afternoon we came through the Strait of Messina, the only up to 3 km wide strait between the Calabrian mainland and Sicily. After the afternoon's clouds had cleared, we could even see the Etna, which is, at a height, of about 3325 m, the highest active volcano in Europe.

Figure 1: View from R/V SONNE to the Lipari Islands in the Tyrrhenian Sea with Lipari in the foreground, Paneria and Stromboli to the right (© Julia Kraft).

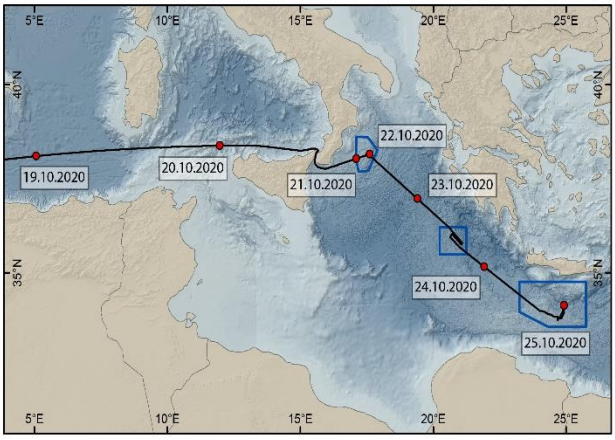

Figure 2: Ship track of the past week from the western to the eastern Mediterranean with the location of the 3 working areas.

During the night we reached our first working area in the Calabrian accretionary wedge (Fig. 2), where the Sartori mud volcano (MV) is located. With a diameter of 1 km and a height of 45 m, the Sartori mud volcano is a striking feature that belongs to the inner Pre-Messinian accretionary wedge. The entire area of the mud volcano, including some mud flows that flowed over the rim into the neighboring basins, can be seen in the 12 kHz data of the ship's multi-beam echo sounder due to increased backscatter. Moreover, a high-resolution bathymetric map acquired from an AUV dive carried out during the METEOR expedition M112 shows this flat mud-pie structure in much greater detail (Fig. 3). The 400 kHz multibeam data from the AUV also show two round chimneys, each 180 m in diameter, which serve as pathways for mud ascending from the subsurface, which is then extruded at the sea floor and distributed horizontally. We started station work on the morning of Wednesday, 21 October, by taking heat flow measurements along a 10-point profile over the crater (Fig. 3). Using a temperature lance, a temperature-depth profile was measured at each point down to a sediment depth of 5 m. A very high heat flow could be measured in both chimneys, although the eastern chimney is characterized by a larger heat gradient and has therefore been active more recently. In the afternoon we tested the AUV for its upcoming dives and used the following night to acquire a grid of Parasound profiles over the mud volcano and its neighboring deep-sea regions. The aim was to map individual mud flow deposits of the volcano in order to be able to assign them to

individual eruption events using also the correlation with gravity cores. On Thursday, 22 October we collected two gravity cores and two minicores, which were subsequently processed (Fig. 4).

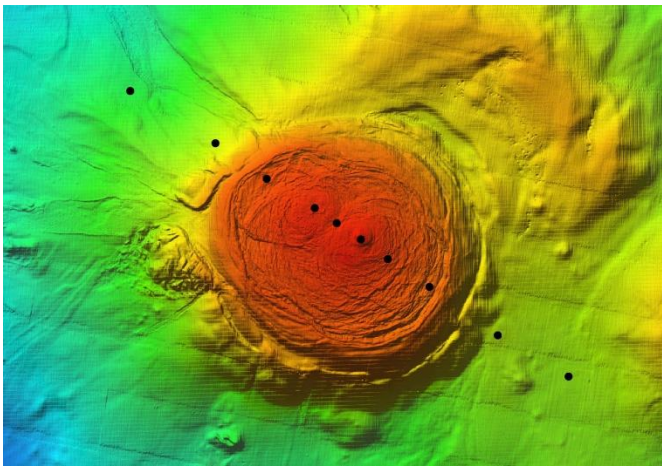

Figure 3: AUV map of the Sartori mud volcano. The 10 black points on the map mark the 10 locations at which a 5 m deep heat flow profile was measured.

Figure 4: The first recovered sediment core from the R/V SONNE cruise is labeled by our sedimentologists in the ship's hangar (©Tabea König).

The first gravity core taken from the eastern, recently active, chimney area of the Sartori mud volcano sampled over 2 m of mud breccia, a very fine-grained gray sediment with numerous clasts ranging from mm to several cm in size. The sediment had a high proportion of finely distributed gas bubbles, which, based on the dessert “Mousse au chocolat”, our sedimentologists described as sediment with a “moussy” texture. Measurements of the gas showed mainly methane and, to a much lesser extent, ethane as the main components. Both gases, however, are already used up within the upper 20 cm due to the formation of H_2S by microbial anaerobic methane oxidation. After great difficulty our geochemists eventually succeeded in extracting pore water samples with a volume of a few milliliters from the very porous mud, which are necessary to carry out important chemical analyses. In addition to the alkalinity the salt content of the samples was also determined, which decreased significantly from 39 ‰ (seawater concentration) near the seabed to 15.5 ‰ in the lower core section. The lower salinity in the deeper sediments is most likely caused by the release of relatively fresh water from mineral reactions, similar to the processes known from clay mineral transformation. Since the uppermost section of the core is composed of seawater we conclude that the mud breccia emerged a long time ago, and seawater subsequently diffused into the upper core section.

A second sediment core was taken about 3 nautical miles southwest of the Sartori MV and yielded pelagic sediments of the past 40,000 years. The age stems from the correlation of a tephra layer contained in our core with a dated tephra layer from other sediment cores of the area. On the evening of 22 October we continued our journey to the next working area in Greece (Fig. 2), where we gathered three hydroacoustic profiles across the mud volcanoes Aros, Novorossiyks and Prometheus on Friday, 23 October. Unfortunately, our hydroacoustic systems did not detect any active gas emissions from these features, and as a result we continued steaming to our main working area south of Crete (Fig. 2). Upon arrival on Saturday, 24 October, we passed and surveyed numerous mud volcanoes from the Olympi field, and we are currently processing and evaluating these data. Today, 25 October, the MARUM AUV SEAL dove to the seabed for the first time and used its mutlibeam echo sounder to map in detail the Bergamo mud volcano, whose activity we want to further investigate in the upcoming days.

To everyone’s delight the good weather in the Mediterranean thus far has allowed us to conduct good research even ahead of schedule and we look forward to the upcoming stations and surveys. All participants are healthy!

Best regards also on behalf of the cruise participants,

Gerhard Bohrmann R/V SONNE, Sunday 25 October 2020