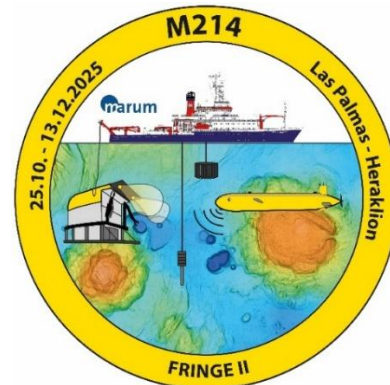


Research Vessel METEOR

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After experiencing rather rough weather on Sunday, which prevented a dive with the ROV Kiel 6000, we avoided the bad weather by heading southeast as part of a survey, in order to begin a dive on Monday 8 December at the so-called "Thetis brine lake." The Thetis hypersaline anoxic lake forms an elongated depression in the seabed at the transition between the northern edge of the Mediterranean Ridge and the backstop of the collision zone between Africa and Europe. The Thetis lake is approximately 10 km long and up to 2 km wide. Using the Parasound echo sounder, we could clearly see both the brine surface at a depth of 3260 m and the seabed, which lies 160 m deeper. The brine was found to be saturated with NaCl, with a total salinity of 345‰, one of the highest values known from such hypersaline lakes. The brine lake was discovered in 2008 and named after the Italian research vessel that sank under dramatic circumstances in 2007. Previous investigations have focused on microbial communities at the seawater-brine interface, where a steep pycnocline and chemocline exist with strong gradients of salinity and electron donors. During our dive, we primarily examined the lake's shoreline (Fig. 2) and individual cliff areas on the lake's northern side to identify potential brine-rich inflows. The brines are formed by the dissolution of solid salt rocks of the Messinian Evaporite Formation, which are found in the vicinity of Lake Thetis. We repeatedly sampled the rocks with the ROV, but this did not yield any evidence of the presence of salts.



Fig. 1: When ROV Kiel 6000 is back on board and securely fixed by the team on the working deck, it will be exciting for the scientists to see which samples the ROV has brought back.
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Fig. 2: Shoreline area of the "Thetis brine lake", a hypersaline, anoxic lake in the western part of the Mediterranean Ridge at a water depth of 3260m (© GEOMAR).

We observed only traces of former, downslope-flowing brine solutions, presumably draining from cavities in the underlying rock. ROV-Kiel 6000 returned to the ship with abundant rock, water, and brine samples, along with numerous photos and videos (Fig. 1). That same night, the METEOR steamed north again to the Helios mud volcano, where, during another ROV dive, we investigated the salt lake at its base. Unlike Lake Thetis, this lake is only a few decimeters deep. Our measurements of the brine lake's water, at 70‰, indicate a lower salinity than Lake Thetis, strongly

suggesting a mixture of a more concentrated brine with the bottom water, which has a salinity of 40‰. In the sediments below, which we were able to sample with a gravity corer more than 5 m long, the pore waters are significantly more concentrated, reaching concentrations of up to 270‰. While the lakebed is clearly visible, the brine surface is barely discernible. However, the brine surface is very clearly visible in the ROV's sonar, as the entire lake shows no backscatter, while the shoreline areas exhibit strong backscatter. Therefore, the outline of the brine lake is very easy to trace. Numerous patchy cold seeps occur in the vicinity of the lake, macroscopically conspicuous due to bacterial mats (Fig. 3). As our sampling shows, the salt solutions in the sediment are enriched with dissolved methane, which, together with the sulfate from the seawater, provides sufficient sulfide through anaerobic methane oxidation in the area of the cold seeps for the bacterial mats to utilize. Furthermore, we were always able to detect carbonate precipitates in the form of crusts below the bacterial mats, which also arise as a product of anaerobic methane oxidation.



Fig. 3: Patchily distributed bacterial mats at the base of the Helios mud volcano at a water depth of 2900 m. The bacterial habitats are connected to gas and fluid solutions in the subsurface and have each developed a calcareous crust in the uppermost centimeters of the seabed. (© GEOMAR).



Fig. 4: During the cruise, we extracted 23 sediment cores from the seabed using a gravity corer. The scientists and crew work together to retrieve the gravity corer from the deck, either during the day or at night. (© Andreas Täuber).

We were able to conduct our fifth and final dive on Wednesday, 10 December, again at Lake Thetis. This was followed by a night program involving gravity coring and heat flow measurements in the vicinity of the hypersaline Lake Thetis. On Friday, 12 December, the scientific work was suspended at 5:50 p.m. before we crossed the boundary of the research area, and the METEOR set course for Heraklion, where we arrived at 9:00 a.m. local time on Saturday. Thus ends a voyage that had to overcome many challenges. Nevertheless, some scientific successes were achieved, certainly not to the extent that would have been desired or attainable had the refugee crisis not intervened. That these successes were achieved, however, we owe to the METEOR, its captain Rainer Hammacher, and his outstanding crew. Great praise is also due to the command center in Hamburg and the embassies in Athens and Rome, which provided us with tremendous support throughout the expedition. The expedition leader looks back with a touch of melancholy on his 13 expeditions on this wonderful ship, the METEOR, whose retirement after 40 years is set to come next year.

All participants are healthy, and we send our greetings for the third Sunday of Advent on behalf of everyone.