NEWLY DISCOVERED BRINE LAKES IN THE SEABED OF THE MEDITERRANEAN RIDGE, SOUTHWEST OF CRETE

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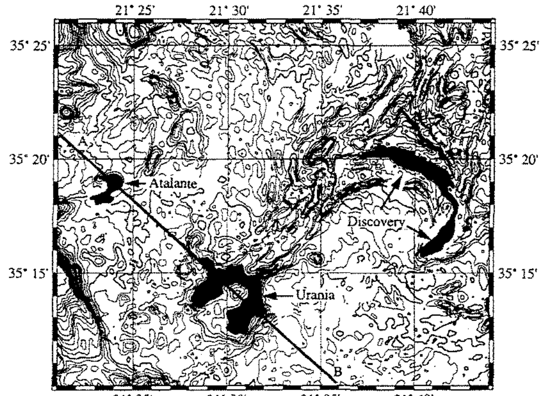
Ten years after the discovery of the Tyro basin, two more deep sea brine lakes were discovered in the eastern Mediterranean sea in September 1993, during cruise 93/19 of R/V Urania as part of the MAST-II programme MEDRIFF (An Integrated Investigation of the Fluid Flow Regime of the Mediterranean Ridge). The brine lakes were shown on acoustic and sparker profiles run across basins mapped by a multibeam bathymetric survey conducted by the N.O. L'Atalante the year before. A third brine lake was identified during a cruise of RRS Discovery which investigated the area in December 1993 and January 1994. The three basins have been named after the three oceanographic vessels. The Urania, L'Atalante and the Discovery brine lakes are located at the south-western edge of the Inner Plateau, a relatively flat and depressed area considered to act as the backstop to the Mediterranean Ridge accretionary complex, lying between the Ridge and the Matapan Trench. The Inner Plateau is separated from the Inner Deformation Front of the Mediterranean Ridge by a deep trough in which brines do not accumulate. The shape of the Urania Basin in plan view is of a horse shoe with a width of about 6 km, very similar to that of the Bannock Basin. The thickness of the brine lake is about 80 m at its axis except at its southwestern end, where it is locally deepened to 200 m. The surface of the lake is at approximately 3462 corrected metres below sea level. The bathymetric form of the Atalante and Discovery basins are less well defined, because the steep slopes occurring close to the edges of individual swaths prevented the multibeam system from resolving the seafloor adequately. The brine lakes are not part of the same hydrogeological system. The brine-seawater interface is located at different water depths in the three basins. A sparker profile shows that the M reflector (commonly referred to as the top of the Messinian evaporitic sequence) outcrops on the steep SE side of the Urania Basin, thus, similarly to the Bannock and Tyro basins, a mechanism of dissolution of salts in seawater and downward surface flow of brine could be invoked to explain the origin of the lake. However, in the deep hole at its southwestern end the lake floor lies within the Messinian evaporites. The level of the Atalante brine lake is much higher than the position of the M reflector on the sides of the basin, thus the brine level must be sustained by a certain hydraulic head, either originated in the escarpment to the NW of the basin, or by over-pressuring of fluids at depth below the seafloor, and being expelled into the basin. The surface of each brine lake is shown well on sonographs obtained with TOBI, a deep-towed sidescan sonar with an operating frequency of 30 kHz, where the lake lies beyond the critical distance at which sound is totally reflected from the lake surface. In the absence of back-scattered sound from the seabed the lake surface looks black. Where part of the lake lies closer than the critical distance, refraction of the sound rays at the lake surface enables precritical rays to image the lake bed beyond the critical distance, but progressive reduction in amplitude as the incident rays approach the critical angle limits the distance beyond the critical distance at which clear images of the lake bed are obtained. Reinforcement from multiple raypaths gives the seabed around the lake edge a locally bright appearance. The temperatures of the brine lakes were measured on both the Urania and Discovery cruises with CTD (Urania only) and heat-flow probes. Temperature in the Urania Basin at 16.7°C is 2.4°C greater than in the seawater above. There is slight increase of temperature with depth in the lake to about 16.75°C. In the few metres immediately above the lake bed, temperatures rise to about 18°C. In the deep hole, the temperature just above the seabed is 28.4°C. In the Atalante Basin the brine is stratified into three layers. The top, 16 m-thick, layer has a temperature of 13.82°C, which is 0.26°C less than the seawater above. The middle,30m-thick, layer has a temperature of 13.91°C, and the bottom, 40m-thick, layer has a temperature of 14.06°C. The temperature in each layer increases gently downward. The chlorinity of the brine in the Urania basin is 120 g/l, compared with 22 g/l for the seawater. The chlorinity of the porewater in the sediment beneath the beds of the lakes is 55 g/l for the deep hole in the Urania basin, increasing with depth at 1 g/l/m, 140 g/l elsewhere in the Urania basin, decreasing at 7 g/l, 180 g/l for the Atalante Basin, with a constant concentration with depth, and 310 g/l for the Discovery Basin, decreasing at 12 g/l/m with depth. In the case of the Urania basin it appears that the lake is locally deriving brine from enriched sediment beneath, whereas elsewhere in the basin and in the Discovery Basin a high concentration brine fed laterally into the basin is permeating downward into the sediment beneath the lake floor. During the cruises several candidate basins were investigated for the possible presence of brine lakes within the area. Not all the possible basins were investigated, but even so three basins were discovered within a comparatively small area of the Mediterranean Ridge. If this is representative of their density of occurrence in this tectonic province of the Ridge, then we might expect that many more brine lakes exist in the Ridge. Do they offer a significant source of the salinity of the Mediterranean sea ?



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