HYPERSALINE EASTERN MEDITERANEAN BRINES: COMPOSITION AND ORIGIN (*)

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During the last few years an increasing number of deep brine lakes has been discovered in the eastern Mediterranean and characterized in successful EU projects such as PALAEOFLUX, MEDRIFF, SAP, and BIODEEP, and the French-Dutch MEDINAUT programme.

These anoxic hypersaline deep basins are amongst the most extreme environments found in the deep Mediterranean, with one of the highest dissolved sulphide concentrations ever reported for the 'open marine' environment (upto more than 12 mM), and demonstrating large compositional differences between different brine pools: going from a nearly 5 M MgCl2 solution and below seawater Na content (Discovery Basin) to a nearly saturated 5.3 M NaCl solution (Tyro Basin). The recently discovered Nadir brine has a high conductivity, is high in NaCl, methane, and possibly sulphide, is relatively shallow (2088 dbar compared to > 3200 dbar for al other brines) and seems rather 'recent'.

One of the most extreme environments thusfar discovered is Urania Basin which contains the highest radiogenic supersaturations ever observed for the marine environment (^3He / ^4He of 1.10^{-7} and ^{40}Ar / ^{36}Ar of 470; ref. 1), the most extreme d11B (28‰; ref. 2), the highest methane content (> 260 ul/ml), and the highest bottomwater temperature (> 48°C). Irregular methane-driven (?) mud-eruptions appear to occur from the latter bottom at least upto 600 m above the basinfloor, i.e. to a waterdepth of 2900 m.

The composition of most of the brines seems to relate to a 'relict brine' or the dissolution of evaporites both originating from the Messinian period during which the Mediterranean is thought to have been dessicated (Bannock, Atalante and Tyro Basins). On the basis of various isotopes for most of these basins the 'relic brine' option seems the most plausible. In addition, the compositions of relevant major and minor elements appear to be in near coincidence with the theoretical seawater evaporation path.

Urania brine is the most extreme exception to this picture, its major and minor element composition, but in particular its isotopic signature clearly relates to a source area that must be much deeper than that of the Messinian evaporites, and which is clearly influenced by high-temperature interactions with old sediment and volcanic (ash layers ?) units.

In addition to their individual compositional characteristics, each brine demonstrates a typical and for most of them rather stable internal brine structure of various different brine levels. Subtle as well as outspoken temperature and compositional differences occur between the different brine levels in individual basins. The transition between different brine levels, and between brine and seawater may be relatively gradual but usually is extremely abrupt (Fig. 1; see also ref. 3). In particular the seawater/brine transition is dramatically changing from seawater to 10x seawater concentration within a depth interval of 100 cm. The interface is further characterized by a strong dip in Transmission (= high suspended matter content, but possibly partly related to reflections while waters of different densities are mixed; Fig. 2). Not only redox-related changes occur at these abrupt interfaces (ref. 3,4), but also the distinct presence of specialized bacterial communities are hypothesized, resulting in bacterial mats. These latter have thus far been encountered in the underlying brine sediments only, usually at the base of a slump deposit, suggesting their entrainment upon entering the brine.

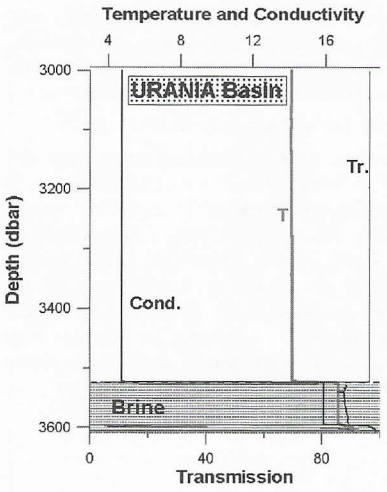

Fig. 1 -Temperature, conductivity and transmission *versus* depth below 3000 dbar for Urania basin. Note the low transmission at seawater/brine and brine I /brinne II interface.

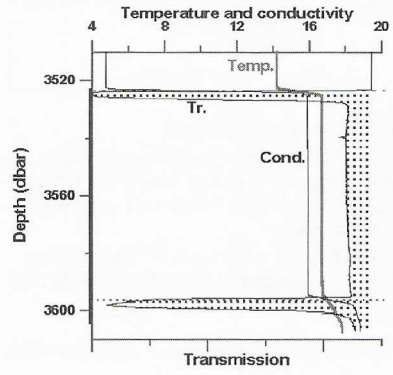

Fig. 2 - Detailed graph of temperature, conductivity and transmission *versus* depth below 3510 dbar for Urania basin. Transmission values below normal seawater values are indicated in grey; total brine interval by thick line on left.

(*) Results have been obtained during EU projects MEDRIFF, PAELEOFLUX, SAP, BIODEEP, during French/Dutch bilateral project MEDINAUT, during MEDMUD and PASS2 projects, and are ongoing during BIODEEP.

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