The Messinian Salinity crisis and its consequences on karst

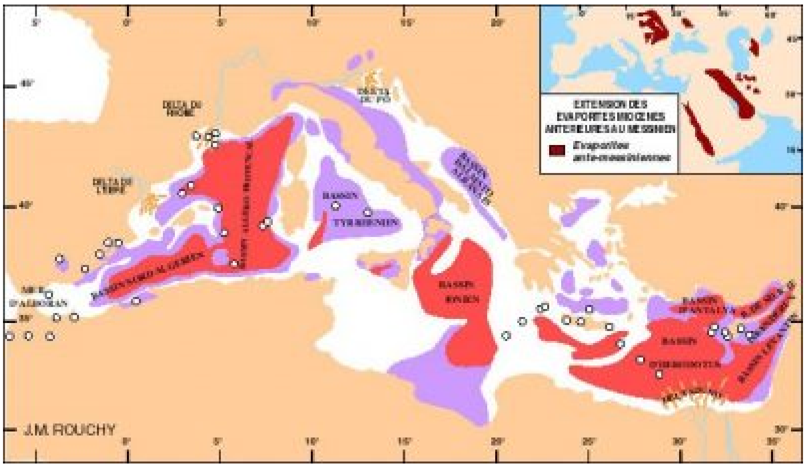

Figure 1. Map of the residual basins of the Mediterranean Sea in Messinian, with their gypsum and salt deposits (in purple and red). [Source: http://geologie.mnhn.fr/messinien.html, J.M. Rouchy, 2000)]

Over geological time, basal level variations have been frequent, but relatively slow, and especially of limited amplitude. For example, sea level variations related to glaciation (eustatic variations), have hardly exceeded 120 m, in a few tens of thousands of years during the descent and a few thousand years during the ascent [1]. In the Cretaceous, the global ocean has risen to a maximum of about 300 m.

At the end of the Miocene, in Messinian (from -7.246 to -5.333 Million years ago), an event exceptional in its scale and short duration affected only the Mediterranean basin: the Messinian Salinity Crisis (CMS). The closure of the Strait between the Atlantic and the Mediterranean has caused the basin to gradually dry up, with significant gypsum-salt deposits [2]. The maximum reduction was 1500 to 2500 m below the current level, depending on the residual basins, for about 600,000 years. CMS has forced all flows, both surface and underground, to adapt to this very low baseline level. The rivers have dug deep valleys going up very far upstream, the Nile to Aswan or the Rhône to Lyon. In carbonate rocks, karst has developed to their base, sometimes several hundred metres below current sea level [3]. The opening of the Strait of Gibraltar, marking the beginning of the Pliocene, caused the almost instantaneous flooding of the entire basin, favouring a thick sedimentation fed by the rivers, consisting of blue marine clays of the Zanclaean, surmounted by the deltaic and alluvial formations of the Astien.

Figure 2. Underwater karst spring of the Vise, Thau pond, Balaruc-les-Bains (Hérault). [Source: © M. Bakalowicz]

These marine clays isolate aquifers by protecting them from marine water intrusion. But they do not exist everywhere, either by lack of deposition or by erosion; aquifers, especially karst ones, then flow directly into the sea. As a result, the superficial karst phenomena developed in the Messinian period, then submerged by the marine transgression of the Zanclaean, allow exchanges between seawater and fresh groundwater. This very particular situation is at the origin of known underwater and brackish springs along all Mediterranean coasts where more than 90% of all known coasts in the world are located [4]. Those of Shekka, on the northern coast of Lebanon, are often considered among the most important in the world because of their flow estimated at several tens of m^3/s in flood [5]. In France, the spring at Port Miou, near Marseille, flows a few m3/s of brackish water [6].

These sources are supposed to discharge considerable volumes of fresh water directly into the sea; they are also the subject of abstraction projects, such as those in Port Riou [6] or La Mortola [7]. The detailed study of certain sources [4] [5] [6] shows that the natural salinization of groundwater is inherent in the very functioning of these coastal karst aquifers and that the capture of these sources at sea can only facilitate marine intrusion. This is why it is preferable to seek to capture fresh water from boreholes on land, by monitoring the operation of these sources to provide an "alarm" in the event of overexploitation [8].

References and notes

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