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Spatial and temporal variations in the Messinian evaporites in the Mediterranean: a box model study

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In a landlocked basin like the Mediterranean, a change in the water budget, i.e. exchange at the gateway with the Atlantic, river discharge, precipitation and evaporation, severely impacts the basinal water chemistry. This happened in the Late Miocene, when evaporite-dominated sequences were deposited in marginal and deep basins of the Mediterranean Sea during the Messinian Salinity Crisis (MSC). In the marginal basins, the onset of gypsum deposition, characteristic for the first phase of the MSC, is synchronous and sequences throughout the Mediterranean contain correlatable precession-driven marl-gypsum cycles. In contrast, in the deeper parts of the western (WMed) and eastern Mediterranean (EMed) basins, MSC sequences appear to comprise a different number of depositional units and differ greatly in thickness. There exist numerous scenarios to explain evaporite deposition for either the marginal or deep basins, correlations between the two settings are difficult to establish because the deep basinal evaporite sequences have never been completely drilled nor dated. We employ a simple box model for the Messinian Mediterranean to examine the differences between the marginal and deep basins and come up with a quantitatively supported scenario for the MSC.

With a 2-box model including a parameterization of water column stratification, we can examine the causes of spatial variation in thickness and differences in the time of onset of deposition. Model results are compared with actual observations on the MSC sequences. The results show that a large connection between the western and eastern basin is necessary for, and some degree of water column stratification is conducive to, synchronous onset of the MSC in the marginal basins. Moreover, halite deposits in the deep basins are likely to be coeval and formed in $\sim$ 60 kyr after a (further) restriction of the Atlantic-Mediterranean connection during the MSC, but without a significant sea level drop. A difference in the net salt gain per unit volume caused the different halite deposition rates in the two basins. A scenario with only a simple restriction of the Atlantic-Mediterranean connection during the Late Miocene - without significant changes in Mediterranean sea level, the fresh water budget, or the size of the Strait of Sicily - is able to explain the synchronous onset of the MSC, the similar marginal evaporite deposits and the differences in the deep basinal sequences.

Reference:
R.P.M. Topper, P.Th. Meijer, A modeling perspective on spatial and temporal variations in Messinian evaporite deposits, Marine Geology, Volume 336, 1 February 2013, Pages 44-60, 10.1016/j.margeo.2012.11.009.