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Quantitative studies of the Messinian Salinity Crisis

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We aim to achieve quantitative, physics-based, insight into the processes that played a role during the Messinian Salinity Crisis of the Mediterranean basin. To this extent we study in isolation two configurations that are part of many of the proposed evolutionary scenarios: (1) that of sea-level drawdown or desiccation (and subsequent re-filling), and (2) that of continuous inflow of Atlantic water in combination with blocked outflow. While the blocked-outflow configuration probably dominated during deposition of the lower part of the evaporite sequence, desiccation most likely controlled the upper part. Calculations are performed on the basis of both the present-day geometry and a paleogeographic reconstruction and the sensitivity to variations in the freshwater budget is assessed.

Our results support previous inferences that desiccation and re-filling are fast; desiccation occurs on a time scale of 3-8 kyr, re-filling probably even faster. Equilibrium sea levels imply most water has gone from the western basin while a significant water column remains in the eastern basin. Whether or not the eastern basin reaches the level of halite saturation depends critically on the freshwater budget in particular. The fast rate of desiccation and re-filling imply that temporal differences in the onset of salt precipitation between western and eastern basin and between marginal basins and basin centres are below the resolution of (astronomical) dating. Also, when Atlantic sea level periodically varied from below to above the level of the intervening sill, the Mediterranean basin will have responded with repeated desiccation and re-filling. Fast re-filling is found to require only a small connection to the Atlantic ocean. This, in combination with the previous, suggests the Mediterranean is unlikely to attain stable intermediate water levels.

The configuration of blocked-outflow is examined using a simple box model with parametrised exchange between sub-basins. Main results are (1) the rate of salinity

increase is fast, (2) the western and eastern sub-basin evolve in concert except when exchange at the connecting strait is greatly reduced and then only when the basins are poorly stratified, and (3) near complete separation from the Atlantic is required to reach saturation.