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Tectonic uplift competing with erosion along the Betic-Rifean corridors: regulating the Messinian Salinity Crisis

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The timing and processes involved in the Messinian Salinity Crisis remain controversial, with two end-member models being addressed in the literature: 1) a succession of multiple desiccations and floods, and 2) a long initial stage with little or null drawdown, followed by a pronounced drawdown and then a single flood. In both cases, competition between tectonic uplift at the connecting corridors in the Gibraltar Arc and global sea level changes are widely seen as the main control (e.g., CIESM, 2008). However, no geodynamic mechanism has been identified to date that can support a succession of uplift/subsidence episodes as required by the multiple-flooding hypothesis. Neither for the second hypothesis, where the different time-scales of sea-level and tectonic processes are difficult to reconcile with a long initial phase of shallow but persistent connection (Gargani et al., 2007) required for the first evaporitic phase.

I will show forward models resulting from a combination of mathematical approaches to water-flow erosion, salt precipitation, and climatic processes, showing that seaway erosion by the Atlantic inflowing water allows a long-term connection of a few tens of meters between the Ocean and the Mediterranean by reaching a dynamic equilibrium with tectonic uplift. Furthermore, the cyclicity observed in gypsum outcrops may be the result from harmonic coupling between Mediterranean evaporation and seaway erosion, predicting oscillations of the Mediterranean level of up to 500 m, and cycles of salt precipitation of 2-10 kyr, although this interpretation calls for a future independent assessment. More relevant is the result that the predicted uplift rates required to block the inflow of Atlantic water are consistent with the present altitude of uplifted marine sediments (Iribarren et al., 2009; Babault et al., 2008) and with geodynamic models of a proposed lithospheric slab detachment under the Gibraltar Arc (Duggen et al., 2003; Wortel et al., 2004; Andrews et al., 2009).

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