Solid earth response to Messinian Salinity Crisis events

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The salinity crisis of the Mediterranean during Messinian time was one of the most dramatic episodes of oceanic change of the past 20 or so million years. The onset at 5.96 Ma resulted in the deposition of kilometer thick evaporitic sequences during the Lower Messinian. Upper Messinian sequences followed from complete isolation of the Mediterranean from the Atlantic Ocean, resulting in a large and rapid drawdown of the Mediterranean water level, and erosion and deposition of non-marine sediments in a large 'Lago Mare' basin. Both the surface loading by the Lower Messinian evaporites, and the near instantaneous removal of the water load resulted in isostatic/flexural rebound that significantly affected river canyons and topographic slopes. We use flexure models to quantitatively predict possible signatures of these events. We first reconstruct the geometry, bathymetry and effective flexural thickness of the Mediterranean basin. The highly irregular shape of the reconstructed basin calls for a three-dimensional model. The typical time scale of dessication events likely is approximately 3000-8000 years, which is similar to the time scale for lithospheric flexure to develop fully. We focus on the resulting uplift/subsidence, basement tilting and stresses. Near basin margins, plate-bending effects are most pronounced which is why flexure is particularly important for a relatively narrow basin like the Mediter-ranean. We find that regional isostasy may have resulted in vertical deformation of hundreds of meters and substantial crustal stress changes (tens of MPa near the basement top). There is some observational support for marginal extension due to Lower Messinian loading, which is expected based on the flexure calculations. Our models also explain why dessication has not left a significant tectonic footprint. The models further predict a substantial increase in erosion rates in some regions. Significant basement tilting (up to several permils) indicates that significant slope instabilities may have resulted in marginal regions, and we discuss the intra-Messinian unconformity in light of these results.