Solid earth response to MSC events as predicted from a 3D regional isostasy model

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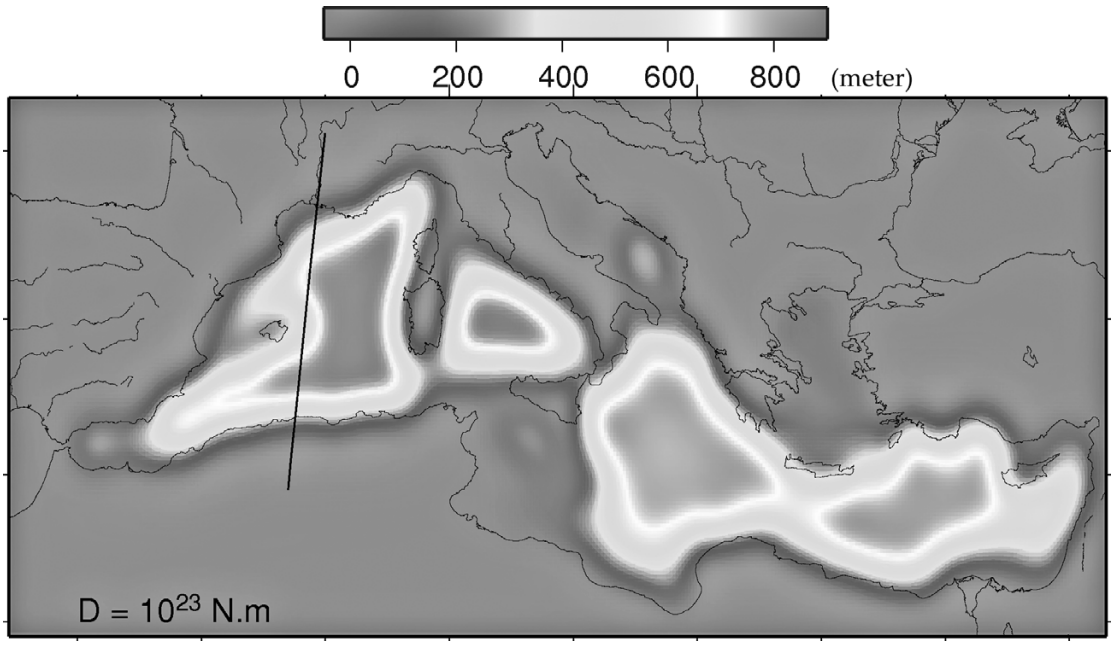
The reconstruction of Mediterranean canyon and margin profiles during the Messinian sea level drop has been the topic of many studies. Isostasy is an important component in these reconstructions. We use flexure models to quantitatively predict possible signatures of the Late Messinian removal of the Mediterranean water load, and of the deposition of Lower Messinian evaporites. The typical time scale of dessication events is probably 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 Mediterranean. The highly irregular shape of the Mediterranean basin calls for a three-dimensional model. Our results can be understood best if we simplify the history of loading or unloading. We find that regional isostasy may have resulted in vertical deformation of the margins of 100s of meters, substantial crustal stress changes (tens of MPa near the basement top) and basement tilting up to several ‰. The model further predicts a substantial increase in erosion rates in some regions. Even if we ignore the existing variability of lithospheric properties, uplift patterns are highly variable. Prominent signatures of Late Messinian dessication in onshore geology are predicted in northern Algeria, western Corsica and Sardinia, the Nile Delta and Northern Syria. Uplift of the Gulf of Lions margin is substantially less than previously predicted on the basis of 2D models. The famous Messinian localities on Sicily are probably difficult to interpret because of the complexity of the flexural pattern and due to the nearby presence of an active plate boundary.



Predicted solid earth vertical deformation resulting from near-complete dessication.