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Topography of the Betics: crustal thickening, dynamic topography and relief inheritance

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The main mechanism that explains high orogenic topographies is the isostatic adjustment due to crustal thickening. However in the Betic Cordillera (South Spain), the present-day elevation and crustal thickness are not correlated. That is at odds with the general premise of isostasy and requires reappraising the question of the driving mechanisms leading to the current topography. The Betics are located at the western edge of the alpine Mediterranean belt. Its Cenozoic orogenic building was disrupted by a major crustal thinning event induced by a slab rollback in the internal zones (Alboran domain) during Neogene. Topography was largely levelled and flooded by the sea during Neogene extension, and then has been folded since the Late Tortonian inversion. The present-day topography shows flat summits still preserved from fluvial regression in the internal zones (central and eastern Betics). These low-relief surfaces may be inherited from the Neogene planation toward sea-level as rocks cooling histories inferred from low-temperature thermochronology seem to point it out. Post-Tortonian shortening estimated thanks to a crustal-scale N-S cross-section in the eastern Betics (at the Sierra Nevada longitude) does not exceed few kilometers which is much lower than the shortening required by isostatic equilibrium, and is thus insufficient to explain the post-Tortonian topography building. We tested the hypothesis that mantle dynamics could in fact be an important mechanism that explains the topography of the Betics. We first computed the residual topography (i.e. the non-isostatic component of the elevation) using the most recent published Moho mapping of the area. In the western Betics, our results show important negative residual topography (down to -3 km) possibly associated with the west-Alboran slab suction. In the eastern Betics however, positive residual topography is important (up to +3 km) and can be explained by the dynamic mantle support of the topography, possibly associated to tearing of the Iberian slab. Finally, the timing of topographic rise is approached thanks to an analysis of river profiles. It reveals a regional transient stage of the topography rather compatible with a large-scale uplift. We conclude that mantle dynamics contribute substantially to the Late Neogene building and evolution of the topography in the Betics.