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Active deformation in Iberia: The role of gravitational potential energy

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Iberia and its offshore areas, in the southwestern tip of Europe, display complex networks of active faults, many of which slip at low rates (< 1 mm/yr), generating remarkable seismic activity, with numerous destructive earthquakes in the historical record. Previous studies suggest that the observed complex pattern may result from the existence of various driving forces at work. In this study we use numerical modelling to investigate the role of different forces in driving deformation in Iberia. In particular, we investigate gravitational potential energy (GPE) as a potential driver of deformation in Iberia and its surrounding areas. We depart from the recent neotectonic modelling developed for Iberia and northwest Africa by Neres et al (2016). We consider two models – one including only the stresses generated by GPE, and the other reproducing the total stress field (TOTAL). We then compare model predictions with updated stress indicators, hypocenter clusters and geodetic strain rates. Model TOTAL shows a better fit to data near the plate boundary, where the Nubia-Eurasia convergence, the westward-driven Alboran tectonic block and fault activity are the main drivers of lithospheric deformation. GPE becomes relevant in high topography regions, which often display extensional regimes. The main regional-scale effect of GPE is to induce second-order spatial variations in the stress field. In north Iberia, especially in the Pyrenees but also in Cantabria, GPE is in agreement with the extensional regime over the highest peaks. In the Iberian Chain and eastern Betics, GPE is in agreement with the observed extensional deformation. Locally, GPE maxima coincide with normal mid-focal mechanisms of shallow earthquake clusters. Within intraplate Iberia, long-wavelength land topography has the same overall NW-SE orientation as the most compressive stress (SHmax) imposed by the Nubia-Eurasia convergence. The analysis suggests that both GPE and the long-wavelength land topography record the plate boundary forces that acted in Iberia during the Eocene to Lower Miocene time span.