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Lithospheric-scale effects of a subduction-driven Alboran plate: improved neotectonic modeling

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The presence of a subducted slab under the Gibraltar arc is now widely accepted. However, discussion still remains on whether subduction is active and what is its influence in the lithospheric processes, in particular in the observed geodesy, deformation rates and seismicity. Aiming at bringing new insights into the discussion, we have performed a neotectonic numerical study of a segment of the Africa-Eurasia plate boundary, from the Gloria fault to the Northern Algerian margin. Specifically, we have tested the effect of including or excluding an independently driven Alboran plate, i.e. testing active subduction versus inactive subduction (2plates versus 3plates scenarios). We used the dynamic code SHELLS (Bird et al., 2008) to model the surface velocity field and the ongoing deformation, using a new up-to-date simplified tectonic map of the region, new available lithospheric data and boundary conditions determined from two alternative Africa-Eurasia angular velocities, respectively: SEGAL2013, a new pole based on stable Africa and stable Eurasia gps data (last decades); and MORVEL, a geological-scale pole (3.16 Ma). We also extensively studied the variation within the parametric space of fault friction coefficient, subduction resistance and surface velocities imposed to the Alboran plate. The final run comprised a total of 5240 experiments, and each generated model was scored against geodetic velocities, stress direction data and seismic strain rates. The preferred model corresponds to the 3plates scenario, SEGAL2013 pole and fault friction of 0.225, with scoring results: gps misfit of 0.78 mm/yr; SHmax misfit of 13.6° and correlation with seismic strain rate of 0.62, significantly better than previous models. We present predicted fault slip rates for the recognized active structures and off-faults permanent strain rates, which can be used for seismic and tsunami hazard calculations (the initial motivation for this work was contributing for calculation of tsunamic hazard induced by geodynamic constraints, in the frame of ASTARTE project, FP7 Grant No.:603839.). The preferred model predicts for the Alboran plate a SW-directed basal force, i.e. in the direction of the roll back of the slab, supporting the existence of a driving mechanism, other than the Africa-Eurasia convergence, being applied at the base of the Alboran plate. We conclude that the Gibraltar subducted slab is still exerting its influence at the surface, either by direct pull and/or suction or by slab-induced mantle flow.
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