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Arching a retreating slab: a numerical model of the Gibraltar system

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The evolution of the Gibraltar Arc and the whole western Mediterranean region is still highly debated by geologists and geophysicists. This work is based on a recent geodynamic model proposing a lateral change in subduction polarity of the Ligurian Tethys oceanic domain to explain its formation and evolution since 46 Myr. The aim of this study is to reproduce and analyze the curvature evolution of the Rif-Gibraltar-Betic slab in such tectonic scenario by means of numerical modelling. The 3D numerical model is carried out via the Underworld framework that solves the Stokes flow equations using Finite Elements combined with a particle-in-cell approach, thus the discretization combines a standard Eulerian Finite Element mesh with Lagrangian particles. The model setup consists of two oceanic plates with a visco-plastic rheology subducting into the viscous upper mantle in opposite directions. In the present-day Alboran Basin region, the plate dips to the southeast with the trailing edge fixed to the Iberian margin, whereas in the present Algerian Basin region the plate dips to the northwest and the trailing edge is fixed to the African margin. To initiate subduction a small slab perturbation is initially imposed. In addition, we include a continental African plate segment west of the present Alboran Basin region, with different shear strength values. We study the influence of the lateral side plates on the trench curvature and the geodynamic consequences in terms of trench velocities, stress distribution, mantle flow, and plate deformation produced by the proximity between the opposite retreating slabs.

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