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Dynamics of double-polarity subduction: application to the Western Mediterranean

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The evolution of the Western Mediterranean is a highly debated question by geologists and geophysicists. Even though most scientists agree in considering slab roll-back to be the driving mechanism of the tectonic evolution of this area, there is still no consensus about the initial setup and its time evolution. A recent model suggests a lateral change in subduction polarity of the Ligurian-Thetys oceanic domain to explain the formation and evolution of the Betic-Rif orogenic system and the associated Alboran back-arc basin. Such geodynamic scenario is also proposed for different converging regions. The aim of this study is to analyze the dynamic evolution of a double-polarity subduction process and its consequences in order to test the physical feasibility of this interaction and provide geometries and evolutions comparable to those proposed for the Western Mediterranean. The 3D numerical model is carried out via the Underworld framework. Tectonic plate behavior is described by equations of fluid dynamics in the presence of several different phases. Underworld solves a non-linear Stokes flow problem using Finite Elements combined with particle-in-cell approach, thus the discretization combines a standard Eulerian Finite Element mesh with Lagrangian particles to track the location of the phases. The final model consists of two oceanic plates with viscoplastic rheology subducting into the upper mantle in opposite direction and the problem is driven by Rayleigh-Taylor instability. We study the influence of the boundary conditions in the model evolution, and the slab deformation produced by the proximity between both plates. Moreover the case of asymmetric friction on the lateral sides of slabs is also considered. Simulations of single subduction models are used as a reference, to compare results and understand the influence of the second plate. We observe slight differences in the trench retreat velocity and the slab morphology near the contact area when plates are spaced less than 100 km.