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The Gibraltar slab dynamics and its influence on past and present-day Alboran domain deformation: Insights from thermo-mechanical numerical modelling

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The origin and tectonic evolution of the Western Mediterranean region, specifically the Gibraltar Arc system, is the result of a complex geodynamic evolution involving the convergence of the Eurasia and Africa plates and the dynamic impact of the Gibraltar slab observed in tomographic studies. Although geologic and geophysical data collected in the last few years have greatly increased our knowledge of the Gibraltar Arc region, it is still unclear the mechanical links between the Gibraltar slab and the past deformation of the overriding Alboran lithosphere as well as present-day motion shown in detailed GPS observations. In this work, we use the code ASPECT to model the geodynamic evolution of the Alboran slab in 2D over the last 20 million years. The initial model setup simulates a vertical WE section at a latitude of about 36^{o}N and represents the situation at 20 Ma, when the trench had already fully rotated to the southwest and the predominantly westward rollback of the Gibraltar slab started taking place. We conduct a parametric study varying the rheological parameters and the initial slab properties (dip angle and length) to properly fit the robust current slab features, particularly, its position and its curved morphology extending eastward. We show how after 20 Myr of model evolution, i.e. at present time, the slab pull appears to have a still significant influence on surface velocities. We find a westward surface motion in the Gibraltar arc caused by the negative buoyancy of the slab. These velocities increase westwards from 1 to 4 mm/yr consistently with geodetic observations. Our models roughly reproduce the Alboran basin evolution, initially developing the West Alboran Basin and then the East Alboran Basin. Finally, preliminary 3D models further support these results and properly the main trends of the coupled dynamics of the Gibraltar slab and Alboran basin evolution during the last 20 Myr.