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Comparing different tectonic reconstructions of the westernmost Mediterranean based on 3D fully dynamic numerical subduction modelling.

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Since ∼30Ma ago the westernmost Mediterranean region (Betic-Rif-Alboran region) has undergone a long and complicated subduction evolution comprising rollback and lithosphere tearing processes. A number of geodynamic reconstructions have been proposed for this region which differ in length, position, and width of the initial subduction zone, as well as in the initial amount of the subducted slab, position of transform faults, the major direction of slab rollback, or even in initial direction of the subduction. Proposed tectonic reconstructions are purely kinematic based on plate reconstruction and describing the motions of subduction trenches and geological fragments.
Here we model the subduction processes that possibly underlie the tectonic reconstructions such as slab rollback, lithosphere tearing, back-arc opening and slab stagnation. Detailed seismic tomography images of this region allow us to compare our results of the 3D subduction modelling with the present day slab position and shape in the mantle which may help to discriminate between proposed tectonic reconstructions.
We create a 3D numerical subduction model of the region incorporating rheological and paleogeographic data and corresponding to the past ∼30Ma of tectonic evolution. We implement visco-plastic rheology consisting of diffusion and dislocation creep using a stress limiter approach to control lithosphere strength in our model. Selective weakening of lithospheric material at continent-ocean boundaries is (optionally) used to allow for lithosphere tearing. To minimize the influence of the side-boundaries of the 3D model on the subduction process, we implement "open" side boundaries (Chertova et al. 2012).
We use constraints from plate motion models to incorporate Europe(Iberia)-Africa convergence. The different tectonic reconstructions of the Western Mediterranean region are based on different interpretations of the initial lateral extent of the subduction trench and the initial amount of subduction at ∼30Ma. We use this as initial condition on our modeling and predict present-day slab position and –geometry, which can be compared to the tomographic image of the slab.
As the main result, we present a 3D numerical fully dynamic model of the evolution of this region, which correlates with geological, tectonic, paleogeography and seismic tomography data. We demonstrate that tectonic reconstructions based on initially short (∼50-100 km) NW dipping subduction restricted to the Balearic margin shows a better correlation with present-day mantle structure than slab predictions from other reconstructions.