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Predicting SKS-splitting from 35 Myr of subduction and mantle flow evolution in the western Mediterranean

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We investigate the development of mantle anisotropy associated with the evolution of the Rif-Gibraltar-Betic (RGB) slab of the western Mediterranean and predict SKS-splitting directions for comparison with the recent observations compiled in Diaz and Gallart (2014). Our numerical model of slab evolution starts at 35 Ma and builds on our on recent work (Chertova et al., 2014) with the extension of imposing mantle flow velocities on the side boundaries of the model (Chertova et al., 2017).
For the calculation of the evolution of finite strain deformation from the mantle flow field and for prediction of SKS-splitting directions we use the modified D-Rex program of Faccenda (2014). We test the predicted splitting observations against present-day shear wave splitting observations for subduction models with open boundary conditions (Chertova, 2014) and for models with various prescribed mantle flow conditions on the model side boundaries. The latter are predicted time-dependent (1 Myr time steps) velocity boundary conditions computed from back-advection of a temperature and density model of the present-day mantle scaled from a global seismic tomography model (Steinberger et al., 2015). These boundary conditions where used recently to demonstrate the relative insensitivity of RGB slab position and overall slab morphology for external mantle flow (Chertova et al., 2017).
Using open boundaries only we obtain a poor to moderate fit between predicted and observed splitting directions after 35 Myr of slab and mantle flow evolution. In contrast, a good fit is obtained when imposing the computed mantle flow velocities on the western, southern, and northern boundaries during 35 Myr of model evolution. This successful model combines local slab-driven mantle flow with remotely forced mantle flow. We are in the process to repeat these calculations for shorter periods of mantle flow evolution to determine how much of past mantle flow is implicitly recorded in present-day observation of SKS splitting.
In combination with our recent work on the influence of external mantle flow on RGB slab evolution (Chertova et al., 2017) we have also demonstrated that (1) the preferred slab evolution model of Chertova et al. (2014; their “Scenario 1” in which RGB subduction starts at the Baleares margin some 35 Myr ago and then rolls back southward to Africa and next to the W and finally to NW to create the future Rif-Gibraltar-Betics cordillera), is robust with respect to the impact of global mantle flow for the past 35 Myr and that (2) only the combination of global flow with local slab-induced flow leads to mantle anisotropy prediction that consistent with present-day observations of present-day SKS splitting.

Steinberger, B., W.Spakman, P.Japsen and T.H.Torsvik (2015), The key role of global solid Earth processes in the late Cenozoic intensification of Greenland glaciation. Terra Nova, 27
Chertova, M.V., W.Spakman, T. Geenen, A.P. van den Berg, D.J.J. van Hinsbergen (2014), Underpinning tectonic reconstructions of the western Mediterranean region with dynamic slab evolution from 3-D numerical modeling. J. Geophys. Res. Solid Earth
Chertova, M., W.Spakman and B.Steinberger (2017), Mantle flow influence on subduction evolution, submitted to J. Geophys. Res. Solid Earth
Faccenda, M. (2014), Mid mantle seismic anisotropy around subduction zones, Physics of the Earth and Planetary Interiors
Diaz, J., and J. Gallart (2014) Seismic anisotropy from the Variscan core of Iberia to the western African Craton: New constraints on upper mantle flow at regional scale. Earth and Planetary Science Letters