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Seismic mantle anisotropy associated with subduction polarity reversal: Insights from numerical models

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The deep dynamics of continental collision is one of the least understood plate tectonic processes. One interesting process that is believed to be a feature of continental collision is a flip in subduction polarity. A prominent location where such a flip is proposed by different seismic tomography studies (e.g Kissling et al., 2006) are the eastern alps.

The aim of our study is to find a particular signature in the seismic anisotropy of the upper mantle that is the result of a temporal subduction polarity reversal. In our case the seismic anisotropy is produced by the LPO of mantle minerals due non-Newtonian deformation rates.

We use the thermo-mechanical 2D finite-difference code FDCON which has been extended to include a free surface with an erosion/sedimentation mechanism. For the geometrical setup an oceanic plate is placed between two continental plates. Subduction of the oceanic plate beneath the right continent is prescribed. The overriding plate (right) is pushed by constant kinematic boundary conditions. Among other parameters we varied a) the plastic strength of sediments (very weak to strong), b) the ductile rheology of the lower crust (felsic or mafic) and c) the convergence velocity of the two continents (1 - 10 cm/yr). From our results we can identify at least two different mechanisms for a subduction polarity switch.

To estimate the full elastic tensor at the grid points of interest, we use a modified version of DREX (Kaminski et al., 2004) that can handle a time dependent flow field. Using the full elastic tensors, we can calculate, e.g with MSAT (Walker & Wookey, 2012), effective delay times and fast shear wave polarization directions for arbitrary azimuths.

Our first results show significant differences between models with and without a subduction polarity reversal.