Physics of the subduction polarity switch: Constraints from first 2D thermo-mechanical 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) is the eastern alps region. Some numerical models of continental collision also show a flip in subduction polarity (e.g Faccenda et al., 2008) as a stable and common feature but do not explore in detail the physical conditions necessary to obtain the flip.

We use the thermo-mechanical 2D finite-difference code FDCON that can handle a free surface to model continental collision. In our study we vary several input parameters (initial thermal structure and model geometry, lower crustal rheology, convergence velocity) to get detailed knowledge under which conditions a flip is possible and to get an idea of the physical mechanisms that can produce a flip in subduction polarity. We find three different modes of subduction polarity switch. Two of these modes are related to strong compression in the overriding plate followed by the development of a weak zone near the compositional transition between lower crust and mantle lithosphere. The third mode seems to be a result of differences in the thermal structure between the two colliding continental plates.