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Abstract title:

Dynamic models of slabs in the extended transition zone: stagnation and implications for deep seismicity

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Recently, seismic tomography reported several slabs stagnating below the 660-km boundary, at the base of the extended transition zone. Here we report the results of a numerical modeling study focused on slab stagnation or penetration in models with a smooth rheological transition between the upper and lower mantle. We demonstrate that the primary controlling factor of slab penetration or stagnation is the strength of the crustal decoupling layer that separates the subducting and overriding plates. We discuss the rheological parameterisation of this crustal layer and demonstrate that low constant viscosity of the crust results in stagnation above the 660 km, high crustal strength models show penetration, and nonlinear rheology of the crust results in changing the slab behavior from stagnant to penetrative in response to the strainrate variations during slab interaction with the major phase transitions. The nature of the viscosity transition between the upper and lower mantle plays a secondary role. However, in case of models with intermediate crustal viscosity, slab dynamics are close to a threshold between penetrative mode and stagnating mode, and in this case, the character of the viscosity transition between the upper and lower mantle selects for slab penetration or stagnation. We further apply our model to Pacific slab subduction under Japan Sea and to Nazca slab under Peru and show that our rheological model explains stress fields derived from the analysis of deep earthquakes.