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Viscosity in transition zone and lower mantle constrained by numerical models

J. Quinteros[1] and S. V. Sobolev[1]
[1]*Deutsches GeoForschungsZentrum, Potsdam, Germany*

Abstract The evolution of a subducting slab is strongly influenced by the viscosity of the mantle which it overlies. However, there is still no consensus about the viscosity in the transition zone and shallower lower mantle. We use a numerical self-consistent subduction model and run a set of experiments in order to find critical patterns of viscosity that would allow the evolution of the different subduction styles that can actually be found in nature. Our results show that a jump in viscosity of ∼5 times from transition zone to lower mantle gives the most reasonable results. Optimal values of viscosity in the transition zone are in the range of 3 * 10ˆ20–10ˆ21 Pa s. Higher values would produce piling up of the slab and later sinking or even slab flattening. Lower viscosities result in velocities (>30 cm/yr) that are too high, while the new slab subducts through the upper mantle and transition zone, a phenomenon that is rarely seen in nature. Reduction of the Clapeyron slope, related to the spinel-perovskite transition, variations in oceanic crustal thickness and in the age of the slab do not influence much the style of subduction. When overriding velocity is applied to the upper plate, the previously penetrating slab tends to lay at the 660 km boundary but does not substantially change the subduction velocity.