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# Numerical modeling of the integrated plate-mantle system: The evolution of subducted slabs

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We have performed numerical simulation to understand various dynamics of subducted slabs. We have first developed a new numerical code to solve resolution problem in the simulation of an integrated plate mantle system. We define dual layers of the grid to solve a system of transport equations and hydrodynamic equations. In the layer for the hydrodynamic equation, the mesh has variable spacing to reduce computation time increasing resolution at the plate boundary..

Using the develoed code, we have constructed self-consistent dynamic models of the subduction in the integrated plate-mantle system. We incorporate history-dependent yielding to generate thrust-type plate boundary into the rheology model. In our model, plate-like motion of the surface lithosperic layer is generated without imposed velocity. We systematically investigate effects of plate rheology on the generation of plate-like motion and asymmetric subduction. Generation of the subduction is very sensitive to the friction of the plate boundary. Only when the friction is as small as that inferred from torque-balance analysis (Forsyth and Uyeda, 1975), the subduction is initated. On the contrary, the generation of the subdcution is robust to the variation of the substantial yield strength in the plate. We also analyze driving forces working on the plate to interpret this sensitivity. This shows that the asymmetric structure of the subduction zone is a key to produce stable and robust plate motion and subduction.

We applied our dynamic subduction models to simulating subducted lithosphere interacting with the mantle transition zone. In our models, any velocity conditions are not imposed to the model lithosphere so that the subducting and overriding plates, and the trench are freely movable. The slab rollback in the early stage of the subduction causes a shallow dip angle of the slab in the transition zone. The shallow-angle collision of the slab with 660 km phase boundary relatively enhances effects of the phase boundary because it reduces stress to bend the slab upward and broadens the depression of the phase transition. The horizontally-lying slab is therefore formed with the Clapeyron slope of -3 to -1 MPa/K. The megalith-type slab is formed when the grain-size reduction decreases the viscosity of slab or viscosity jump by a factor more than 10 exists at the phase boundary. In these cases, avalanche of the stagnant slab is generated.