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Trench migration, net rotation and slab - mantle coupling

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Three-dimensional laboratory models have been realized to contribute to the definition of the resistance of the slab and its coupling with the ambient mantle over a geological time scale. Our models are setup with a viscous plate of silicone (lithosphere) subducting under negative buoyancy in a viscous layer of glucose syrup (mantle). For our goal, the lithosphere/upper mantle viscosity contrast has been systematically changed, ranging between about 10-100.000. We found that subduction characterized by a retreating mode is enhanced for viscosity ratios less than 10.000, subduction characterized by both a retreating mode and an advancing mode is enhanced for viscosity ratios ranging between about 100-10.000 while for ratios less than 100 the process is quasi-stationary. By combining our experimental results and kinematic data from current subduction zones in four reference frames which differed in the amount of net rotation, we observed that a lithosphere/upper mantle viscosity contrast of 150-500 is necessary to obtain realistic trench/subducting plate velocity ratios as well as the variability of subduction styles recognized in nature.