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Collisional subduction: how it works

Anne Replumaz (1), Paul Pitard (1), Francesca Funiciello (2), Laurent Husson (1), and Claudio Faccenna (2)
(1) ISTerre, CNRS, UGA, Grenoble, France (anne.replumaz@univ-grenoble-alpes.fr), (2) Dipartimento Scienze, Università degli Studi, Roma TRE, Italia (francesca.funiciello@uniroma3.it)

It is now well established than continental lithosphere less dense than the mantle subducts in a collision context. But the mantle kinematics and dynamics that allows such counter-intuitive subduction not driven by positive slab pull is not yet well understood. By doing analogue experiments, we explore the kinematics of the southward Asian lithosphere subduction below Tibet, not attached to any dense oceanic slab (collisional subduction), in front of a continental plate subducting northward (Indian indenter), attached to an oceanic slab (Tethys ocean). The indenter is pushed by a piston reproducing the far field forces leading to the northward motion of India since the beginning of the collision. During the oceanic subduction, the main component of slab motion is vertical driven by its negative buoyancy, while the trench rolls back. The convective pattern is well studied, consisting in a pair of wide convective cells on both sides of the oceanic slab. But when the indenter (Indian analogue) reaches the trench, it curves and plunges in the mantle while the trench motion reverses, and the associated convective pattern is mostly unknown. The advance of the trench transmits the far field forces to two upper plates (Tibetan block analogues), one frontal plate more viscous which thicken, one attached to the back wall of the box less viscous which subducts. During a short transition phase, a pair of sub-lithospheric convective cells is observed on both sides of the back wall slab, driven by the thickening of the frontal plate, and in turn favoring the back wall plate subduction. Then during the rest of the experiment, such collisional subduction is maintained by a wide cell with a mostly horizontal mantle flow passively advecting the back wall slab. We conclude that the collisional subduction of the Asian lithosphere is a process mostly driven by horizontal forces, dominated by the far field forces modelled by the piston motion, transmitted through the Indian indenter forward motion.