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Plumes, plateaux and congestion in subduction zones

Louis Moresi (1), Peter Betts (2), Meghan Miller (3), and David Willis (2)

(1) School of Earth Sciences, Melbourne University, Melbourne, Australia, (2) School of Geosciences, Monash University, Clayton, Australia, (3) Dept of Earth Sciences, University of Southern California

The geologic record provides numerous examples where buoyant plumes, and their associated plateaux, have disrupted convergent plate margins. These interactions have produced a variety of responses in the overriding plate including transient episodes of arc magmatism, transient episodes of crustal shortening followed by plume-related magmatism in the overriding plate. The latter observation implies the plume must have transitioned from the subducting plate to the overriding plate. We present several 3D numerical models of plume heads of variable dimension and buoyancy interacting with a subducting slab. The models indicate that plume heads impact enormously on trench geometry. Arcuate trenches are created as the trench retreats around the edges of the plume head, whereas trench advance occurs in front of the plume resulting in transient crustal shortening in the overriding plate. Stalling of subduction when the plume head impacts the trench causes slab windowing. The size of the slab window is dependent on the size and buoyancy of the plume. The creation of the slab window provides a potential conduit for plume migration to the overriding plate. Alternatively, the plume head and plateau may be transferred to the overriding plate as subduction is re-established behind the plume. Models with "strong" slabs, characterized by high yield strengths, display different behavior. Plume-heads are entrained in the slab and are subducted without the development of a slab window. We discuss geological evidence for the processes observed in our models.