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Influence of upper plate structure and mantle viscosity on subduction geometry in South America: insights from numerical modeling

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Subduction of oceanic plates beneath large continental masses is a rare process and at present it occurs only along western South America and Central Mexico. Likewise, flat subduction, understood here as where the slab enters at a normal angle and reverses its curvature to flatten at ˜70-100 km depth, only occurs at present beneath South America. In general, the angle at which subduction occurs in the depth range of ˜100 to ˜200 km reflects the balance between negative buoyancy of the slab, elastic resistance of the slab to change the angle of subduction, and non-hydrostatic pressure forces induced by subduction-driven flow within the asthenosphere. The latter force, known as suction force, acts to prevent the slab from sinking into the mantle, and its magnitude increases with increasing subduction velocity, narrowness and viscosity decrease of the mantle wedge. Recent observations show that the upper plate structure varies along the Andean margin, indicating that it is thicker and stronger above flat subduction zones and suggesting a correlation between upper plate structure and subduction angle [Pérez-Gussinyé et al., 2008]. In this study we use numerical models to explore the extent to which upper plate structure, through its influence on asthenospheric wedge shape and viscosity, can affect the angle of subduction. We test for which upper plate thickness and asthenospheric viscosity repeated cycles of steep and flat subduction are reproduced and compare our results to estimations of lithospheric thickness and the duration of flat and steep subduction cycles hypothesized along the

Andean margin. Preliminary results show that when an oceanic plate subducts beneath thin continental lithosphere, the angle of subduction is steep. However, when the oceanic plate subducts beneath a thick and highly viscous continent, shallower slab geometry is developed. Continuing trenchward motion of the thick continental lithosphere results in flat subduction. Finally, the upper plate is likely to be hydrated and weakened in time, and we model this effect by progressively reducing the viscosity at the plate contact, finding that after ˜5 Ma of convergence a steep slab geometry is developed again.