Geophysical Research Abstracts
Vol. 14, EGU2012-6538, 2012
EGU General Assembly 2012

Curved orogen and syntaxes formation during subduction and collision

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The sustained convergence between India and Asia with successive stages of oceanic subduction, continental subduction and continental collision has lead to the formation of the Tibetan plateau while the Himalayan orogenic front acquired an arcuate shape convex toward the South. The Indian plate is bounded by north-south strike-slip faults, which accommodate a large indentation of Asia, between two oceanic subductions, beneath Makran to the west, beneath Indonesia to the east. Two syntaxes formed at both east and west termination of the Himalayan orogenic front at the transition between Indian and Asian plates.
In order to better understand this particular configuration, we performed analog experiments at the Laboratory of Experimental Tectonics of Roma TRE to simulate, at the scale of the mantle – lithosphere system, the mechanics of the indentation process. The configuration is set to drive the India indenter towards the Asian continent with a motor-controlled-piston, to simulate far field stresses necessary for indentation. In particular, we test (1) which geometry and rheological parameters favor arcuate orogen and syntaxes formation, (2) what are the consequences on the topography of both the orogenic front and the plateau, and (3) how they relate with the subduction/collision dynamics. The setup is composed of a subducting and an overriding plate made of visco-elastic silicone putty, floating on low-viscosity syrup simulating the asthenosphere. The subducting plate simulates an oceanic lithosphere followed by a continental indenter (analog for the Indian craton) flanked or not by oceans (analog for Makran and Indonesian domains), while the upper continental plate simulates the Tibetan plateau.
Results show that the curvature of the orogen and syntaxes' formation are primarily controlled by the strength and gravitational potential energy of the upper plate, and the shape of the subducting plate. A relatively strong upper plate flanked by oceans leads to a concave indentation-shaped orogen associated with thickening and limited lateral escape of the plateau. On the contrary, the total absence of oceans on the sides (simulating the Indian plate bounded by strike-slip faults with strong lateral decoupling) lead to the development of small perturbations at the extremities of the subducting plate, comparable to proto-syntaxes. During the collision stage, a weak upper plate induces collapse and transversal flow toward the indenter that amplifies the proto-syntaxes and produces a convex orogen. The upper plate then undergoes global thinning and important lateral escape.