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Thermomechanical modelling of the Zagros collision: clues to the formation of the Iranian plateau.

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The Iranian plateau, located at the rear of the Zagros mountains, is a high region with smooth, average elevation of c. 1.5 km. Its formation results from the collision between the Arabian and Eurasian lithospheres (30-35 My ago), and represents an interesting analogue to the so far better documented Tibet plateau.
A number of recent studies suggest an implication of a recent (10± 5 Ma) slab break-off below Central Iran to explain the formation of the Iranian plateau. To test this hypothesis, we have designed large-scale (600*1500 km), high-resolution numerical models of oceanic-continental subduction followed by continental collision. Our models have free upper surface boundary, surface erosion, rheological stratification (upper crust, lower crust, lithospheric mantle and asthenosphere), brittle-elastic-ductile rheology, metamorphic phase changes (density and physical properties), and account for the specific crustal and thermal structure of the Arabian and Iranian continental lithospheres.
The initial model geometry corresponds to the pre-continental collision phase, with an oceanic, Neotethyan subducting lithosphere still separating the two continents. We tested the response of the transition from oceanic subduction to continental subduction and the impact of progressive continental subduction on the topography. Our experiments show that the transition from oceanic subduction to continental subduction very rapidly (< 1My) results in significant topography (∼1-3 km) and horizontal shortening. The topographic high is located directly above the zone of coupling between the two plates, relatively narrow (∼200 km), and chiefly depends on convergence rates (at least in the range 1-5 cm/yr). The trench is reproduced in the models by a downward ∼0.5-1 km lithospheric bulge, which rapidly (∼1.5cm/yr) 'retreats' once the continental lithosphere starts subducting. Our experiments also predict relatively fast exhumation dynamics (0.8-1 cm/yr) at the onset of continental subduction and/or slab retreat. The results of this study suggest that simple continental subduction alone cannot account for the formation of a topographic step such as the Iranian plateau and call for additional contributions, possibly from slab breakoff and/or mantle delamination.