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The development of topographic plateaus in an India-Asia-like collision zone using 3D numerical simulations

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The Himalayas and the adjacent Tibetan Plateau represent the most remarkable feature of the Earth's surface as the largest region of elevated topography and anomalously thick crust. Understanding the formation and evolution of the Himalayan-Tibetan region has become of high interest in the scientific community and different models have emerged over the last decades. They range from wholescale underthrusting of Indian lithospheric mantle under Tibet, distributed homogeneous shortening or the thin-sheet model, slip-line field model to the lower crustal flow model for the exhumation of the Himalayan units and lateral spreading of the Tibetan plateau. While some of these models have successfully illustrated some of the basic physics of continental collision, none can simultaneously represent active processes such as subduction, underthrusting, delamination, channel flow or extrusion, which are thought to be important during continental convergence, since these mechanisms require the lithosphere to interact with the underlying mantle.

As such, 3D numerical models prove to be powerful tools in understanding the dynamics of coupled systems. However, because of yet recent developments and various complexities, the current 3D models simulating the dynamics of continental collision zones have relied on certain explicit assumptions, either focusing on crustal dynamics or slab-mantle dynamics.

Here, we employ the parallel 3D code LaMEM (Lithosphere and Mantle Evolution Model), with a finite difference staggered grid solver, which is capable of simulating lithospheric deformation while simultaneously taking mantle flow and an internal free surface into account, which allows for the development of topography. We investigate the way deep processes affect continental tectonics at convergent margins, addressing the role continent subduction and collision have on the future of the subducting and overriding plates, and we discuss the implications these offer for the Asian tectonics. We also address the question of how large topographic plateaus, such as the Tibetan Plateau, can form in an integrated lithospheric and upper-mantle scale model.

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