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High differential stress in upper crust is required to maintain the relief of the Tibetan plateau

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Stress magnitudes in the upper crust are still disputed. Studies based on (i) stress-drops associated with earthquakes and (ii) the assumption that these stress-drops are close to total stress-drop argue that maximal values of differential stress in the crust are typically smaller than 10 MPa. On the other hand, studies based on lateral variation of gravitational potential energy (GPE), in situ stress measurements in deep wells and boreholes, and piezometer-based stress estimates suggest that maximal differential stresses can be a few hundred MPa in the upper crust. We perform a systematic series of two-dimensional thermo-mechanical numerical simulations to model the gravitational collapse of a continental plateau. The model configuration is based on geophysical observations of the Indian craton and foreland, and the Tibetan plateau. We systematically vary the internal friction angle of the crust and the transition width of Moho deepening from the craton to beneath the continental plateau. The results indicate that differential stresses of at least 150 MPa are required in the upper crust to maintain the continental plateau and associated topographic relief for ca. 10 Ma. An upper crust in which differential stresses are limited to10 MPa at most is not able to support a continental plateau and its relief for even 1 Ma. This suggests that stress-drop estimates from earthquakes of typically 10 MPa represent only a small fraction of crustal stresses and are not representative for maximal stresses in the upper crust.