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Shortening of hot lithospheres, from Archaean orogens to modern high plateaus

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Dynamics of hot and thickened lithospheres in compression is a key issue for the tectonic understanding of Archaean orogens as well as modern high plateaus. We used analogue and numerical modeling techniques to study the mechanical behavior of such weak lithospheres. The experiments simulate the shortening of three layers brittle-ductile-ductile systems representing a thin upper brittle crust overlying ductile lower crust and lithospheric mantle. Models were shortened at various velocities to identify the modes of lithospheric-scale deformation. Both analogue and numerical models provide comparable deformation patterns and show that the deformation mode of weak lithospheres is drastically different from the one of strong lithospheres that involve a high strength sub-Moho mantle. Models emphasize that overall deformation patterns can be basically interpreted in terms of “pop-down” thrusting of brittle crust and “pure-shear” type ductile flow of crust and mantle combined with lateral ductile flow which preserve flat-lying Moho and topographies. High Moho temperatures ($>$ 800˚C) are required to develop such deformation patterns. Modeling results provide new insights on Archaean tectonics and high plateaus development, such as Tibet. We emphasize in particular that the pop-down mode of upper crust deformation offers a simple solution to the tectonic paradox of high plateaus (like Tibet), where the crust is significantly thickened without neither significant topographic gradients nor evidence of strong shortening at surface.