



Role of strain weakening on continental plate tectonics

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Much debate exists concerning the strength distribution of the continental lithosphere, how it controls lithosphere-scale strain localization and hence enables plate tectonics. No rheological model proposed to date is comprehensive enough to describe both the weakness of plate boundary and rigid-like behaviour of plate interiors. Here we show that the duality of strength of the lithosphere corresponds to different stages of microstructural evolution. Geological constraints on lithospheric strength and large strain numerical experiments reveal that the development of layers containing weak minerals and the onset of grain boundary sliding upon grain size reduction in olivine cause strain localisation and reduce strength in the crust and subcontinental mantle, respectively. The positive feedback between weakening and strain localization leads to the progressive development of weak plate boundaries while plate interiors remain strong.