Study of different lithospheric responses to continental collision: Insight from numerical models

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The lithospheric response to continental collision may progress in different ways, the cause of which is still poorly understood. Here, we investigate the conditions leading to different responses to continental collision using numerical models. Our numerical results indicate that the lithospheric response to collision is mainly dominated by three types of processes: a) subduction polarity reversal, b) delamination and back-stepping, and c) continued subduction. The switches between these processes are controlled by the competition between three (potential) weakness zones: a) the mantle wedge, b) the lower continental crust, and c) the plate interface.

Subduction polarity reversal occurs if the mantle wedge is the weakest zone in the system. In arc-continent collision, this happens only if the viscosity of the mantle wedge is at least one order of magnitude lower than the aver age viscosity of the lithosphere. In continent-continent collision, one additional condition needs to be satisfied for subduction polarity reversal to occur: the ratio of the viscosity of the lower continental crust to the viscosity of the upper lithospheric mantle must be higher than 0.006. Subduction polarity reversal occurs as a result of failure of the overriding plate along the arc/back-arc boundary. Several factors affect the time of lithospheric failure including the convergence rate, the sinking velocity of the detached slab and relative strength of the mantle wedge, arc and back-arc. The response to collision is delamination and back-stepping if the lower continental crust is the weakest area in the system and is continued subduction if the plate interface is the weakest zone.