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Removing mantle lithosphere under orogens: Delamination vs. Convective thinning

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Abstract: The phenomenon of lithospheric thinning is generally distribute on collision-related and subduction-related zone, and lithospheric delamination and convective thinning are believed to have played a major role in continental collisional orogens. The previous studies mainly focused on the effect of different parameters on lithospheric thinning based on the specific physical assumption of delamination or convective thinning. Moreover, it has given the quantitative discussion to convective thinning of lithospheric mantle based on viscous constitutive relations. However, what cause the diverse models? Whether viscous constitutive relation controls the Delamination? And what influence to deformation of lithospheric mantle based on more complicated rheological model? Consequently, we want to deal with two scientific questions: 1. what is the connection between lithospheric mantle deformation in collisional orogens and viscous constitutive relations? 2. What is the effect of plastic yield on lithospheric thinning in collisional orogens? On the basis of above two aspects, we systematically investigated the mechanism that control the delamination and convective thinning processes, and using a 2-D high-resolution thermomechanical model that finite-differences method used the marker technique, our results indicate that Viscous constitute relations controls lithospheric mantle thinning in collisional orogens in the following two aspects: a) The continuous deformation of viscous fluid based on assumption of Newtonian viscosity; b) There is positive feedback relationship between the effective viscosity and the second invariant of the strain rate tensor based on assumption of Power-law viscosity, and it is major reason that power-law fluid makes delamination under the situation of the low viscosity. Moreover, plastic yield caused by fluid/melt activity in continental lithospheric mantle is the key factor on lithospheric thinning in collisional orogens, and it is easier to delaminate for the assumption of Power-law viscosity than the assumption of Newtonian viscosity.