Long-term coupling and feedbacks between surface processes and tectonics during rifting

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Whereas significant efforts have been made to understand the relationship between mountain building and surfaces processes, limited research has been done on the relationship between surface processes and extensional tectonics. Here we present high-resolution 2-D coupled tectonic-surface processes modeling of extensional basin formation. The main aim is to find out how erosion and deposition affect the deformation in extensional systems. We test sensitivity of the rift mode to the combined effects of crustal rheology and varying surface process efficiency (erodibility, sea level). The results show that both erosion of rift flank areas and basin deposition enhance localization of crustal deformation. Frictional-plastic extensional shear zones accumulate more deformation during a longer period of time, and time of lithospheric rupture is delayed when fluvial erosion, transport and deposition are efficient. We show that removal of mass from rift flanks and sedimentary loading in the basin area are the main cause of the feedbacks providing a first order control on the style of extensional basin formation. Variation of strain localization in natural rift systems correlates with the observed behavior and suggests similar feedbacks as demonstrated by the forward numerical models.