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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 the combined effects of crustal rheology and varying surface process efficiency (erodibility, sea level) on structural style of rift and passive margin formation. 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 loading of offshore basins can generate crustal ductile flow. In extreme cases sediment deposition delays lithospheric rupture. These mechanisms are enhanced when fluvial erosion, transport and deposition are efficient. We show that removal of mass from rift flanks and sedimentary loading in the basin area provide a first order feedback with tectonic deformation and control on rifted margin tectonic-morphology. However, surface processes do not change the first order mode of rifting, which is largely controlled by crustal rheology. Rift escarpment morphology is function of paleo-topography and sea level. Variation of strain localization in natural rift systems correlates with the observed behavior and suggests similar feedbacks as demonstrated by the forward numerical models.