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Evolution of topography, sediment yield and efficiency of erosion in intra-continental rift settings: A perspective from numerical modeling using coupled surface processes and tectonic models.

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Disentangling the interactions and possible feedbacks between tectonic and earth surface processes has been a focus of geoscientific research for the past decades. Recent work has highlighted the importance of erosional processes at the Earth's surface for impacting e.g. the evolution of topography, deformation or the sedimentary yield. Many of these studies were conducted in convergent settings and fewer studies focused on extensional settings. Here, we present the results from forward numerical models, using a geodynamic model (Fantom) coupled with a landscape evolution model (Fastscape) in order to explore the coupling and interactions between tectonics and earth surface processes in extensional continental rift settings.

We model the formation of continental extensional rift systems and compare, how the structure of the subsequent rifts, topography and sedimentary yield evolve over time depending on the combination of five key parameters. For this, we run and compare a series of model experiments, varying crustal rheology (weak to strong crust), duration of extension (5 – 20 Myr), distribution of inherited strain (single vs. distributed weakness), efficiency of erosion (through different rock erodibilities) and the base level for erosion. The modeling results show that structure and topography of the intra-continental rift strongly depend on crustal strength, on the distribution of inherited strain and on the duration of extension. Formation of a major rift basin followed by considerable uplift of the rift shoulders and generation of topography is facilitated by models with a strong crust. The distribution of inherited strain controls the distribution of deformation, such that models with a distributed area of inherited strain yield wider rift zones with partly several, smaller basins. Additional to the respective base level of erosion, the build-up of topography plays a key role in driving the efficiency of erosion, such that high erosion rates are observed for models with significant topography. Hence, models that produce high topography (i.e. models with high crustal strength) display a significant sediment flux during the syn-rift phase. Furthermore, the activity of single faults is impacted by sediment loading, resulting in different styles of deformation, depending on the amount of delivered sediment. For all simulations, topography is erased rapidly (i.e. <5 Myr) following the cessation of rifting activity and rock uplift, if the erosional efficiency is high.

Taken together, our results suggest a strong dependency of the formation of topography, sediment flux and erosion on the respective tectonic circumstances. However, given that surface

processes are efficient, the style of rifting can be impacted. Hence, our simulations suggest significant feedbacks between tectonic and surface processes.

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