



Modelling the reorganization of drainage patterns forced by mantle processes

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The recognition of regions characterized by long-wavelength, low-amplitude uplift pattern drives the debate on topography formation due to mantle processes. In particular, it is proposed that the detachment of a lithospheric slab increases the buoyancy of the overlying crust and results in a significant increase in surface elevation. As erosional surface processes are controlled by both, tectonics and climate, a strong link between mantle processes and topographic pattern should exist.

Several studies constrained the physical parameters of slab tearing, either observed in field or derived from numerical experiments. The inferred horizontal velocity of slab tearing can vary significantly between 30-1000 mm/y. The slab breakoff process occurs in depths between 35-120 km. These parameters combined with variations in the elastic properties of the lithosphere and viscous properties of the asthenosphere control the horizontal extent, the amplitude and the rates of uplift.

In this study, we numerically investigate the impact of different scenarios of slab breakoff on the evolution of fluvial landscapes. We explore the impact of (a) the horizontal tearing velocity, (b) the geometry of the slab load, (c) the lithospheric strength and (d) the viscous relaxation time on uplift and drainage patterns. The numerical calculations are performed with OpenLEM and our results are subsequently visualized with the Generic Mapping Tools (GMT) package.

Our first results show that the temporal change of the uplift pattern generated by a tearing slab significantly affects the topology and geometry of the drainage network. The results show the formation of elongated catchments growing in direction of the tearing slab, which however leads to an unstable drainage configuration. The subsequent drainage network reorganization features migrating drainage divides and numerous river piracy events.