Dremel, Fabian[1]; Robl, Jörg[1]; Hergarten, Stefan[2]; Haunsperger, Viktor[1]; Villamizar-Escalante, Nicolas[1]; von Hagke, Christoph[1]

Old Orogens - Young Topography: Exploring the Effects of Continental Rifting on Erosional Dynamics and Topographic Development

[1]*Paris Lodron Universität Salzburg, Österreich;*
[2]*Universität Freiburg, Deutschland;*
fabian.dremel@plus.ac.at

The evolution of collisional orogens and their drainage systems has been extensively studied. However, there are numerous active intercontinental mountain landscapes that are not located in the immediate vicinity of collisional zones and are therefore influenced by other processes, such as mantle-lithosphere interactions. These interactions include continental rifting, a process whereby rift flanks are uplifted due to graben subsidence in the center and lithospheric unloading, with the Upper Rhine Graben as a prominent example. The Vosges Mountains and the Black Forest delineate the eastern and western boundaries of this graben, respectively, with peak elevations exceeding 1,400 meters.
In a first step, a one-dimensional time-dependent numerical landscape evolution model that incorporates flexural isostasy was used to capture the genesis and evolution of the rift flanks. This model was able to successfully reproduce the high topographic and erosional asymmetry observed across rift flanks. The diverging erosion rates observed on either side of the rift flank can be attributed to variations in the topographical gradient. These, in turn, are directly related to the lithospheric strength, which represents the critical factor in determining the rate of rift flank retreat, and consequently the mobility of the watersheds. Furthermore, an initial topography has been identified as a crucial element influencing the evolution of rift flanks.
However, considering that continental rifting is not solely a one-dimensional problem, the second phase of this study is based on a two-dimensional landscape evolution model, specifically OpenLEM. This approach allows for a model representing a two-dimensional landscape, as opposed to two longitudinal river profiles sharing a common watershed. The model setup includes flexural isostasy, an initial topography, and normal faulting and is used to monitor the evolution of river catchments, local erosion rates, and catchment-wide erosion rates over time.

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