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Rift propagation and rift interaction in scissor extension tectonics: insights from 4D analogue models

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When simulating rift systems, analogue and numerical modellers often apply a continuous magnitude along the strike of an extensional structure, rift or rift system. Yet in nature, significant extension intensity variations are observed along strike of a rift system, as the natural consequence of tectonic plates moving apart about a pole of rotation, resulting in scissor extension and rift propagation.

We performed various analogue tectonic experiments to assess the differences in (1) rift development and (2) between rifts and transfer zones (zones of interaction between individual rift segments, along predefined crustal weaknesses) forming in traditional orthogonal extension settings versus scissor extension settings. Various models are analysed with X-Ray computed tomography techniques, allowing a detailed 4D assessment of the internal model deformation.

Our modelling efforts give the following results: (1) Rift development in scissor tectonics settings develops a strong structural gradient in both space and time along the strike of the system. (2) Although scissor extension and orthogonal extension produce quite different large-scale structures, local features in scissor extension systems can be regarded as forming in an orthogonal extension setting. (3) Various degrees of lateral underlap between rift segments produce three basic modes of rift linkage structures. Low lateral underlap experiments develop rift pass structures. With increasing underlap, transfer zone basins develop, whereas high degrees of underlap tend to result in sub-basins.

Several of these structures occur in previous models and in nature. Yet a direct comparison is challenging, as various parameters not modelled here might significantly affect the structural development of rifts and rift interaction zones.