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Effects of Oblique Extension and Inherited Structure Geometry on Transfer Zone Development in Continental Rifts: A 4D Analogue Modeling Approach

Frank Zwaan and Guido Schreurs
University of Bern, Bern, Switzerland (frank.zwaan@geo.unibe.ch)

INTRODUCTION

Inherited structures in the crust form weak zones along which deformation will focus during rifting. Along-strike connection of rift segments may occur along transfer zones, as observed in East Africa. Previous studies have focused on numerical and analog modeling of transfer zones (e.g. Acocella et al., 1999, Allken et al., 2012). We elaborate upon those by investigating the effects of 1) oblique extension and 2) the geometry of linked and non-linked inherited structures on the development of transfer zones. A further improvement is the use of X-ray Computer Tomography (CT) for detailed internal analysis.

METHODS

The experimental set-up (see Schreurs & Colleta, 1998) contains two sidewalls with a base of compressed foam and plexiglass bars stacked in between. Decompressing this base results in distributed deformation of the overlying model materials. Deforming the model laterally with a mobile base plate produces the strike-slip components for oblique extension. Divergence velocities are in the order of 5 mm/h, translating to ca. 5 mm/Ma in nature, and 1 cm represents 10 km. A 2 cm thick layer of viscous silicone represents the ductile lower crust and a 2 cm quartz sand layer the brittle upper crust. Inherited structures are created with thin lines of silicon laid down on top of the basal silicone layer. Several models were run in a CT-scanner to reveal the 3D evolution of internal structures with time, hence 4D.

RESULTS

Localization of deformation along the pre-defined structures works well. The models show that the structural style changes with extension obliquity, from wide rift structures to narrower rifts with internal oblique-slip and finally strike-slip structures. Furthermore, rift offset is an important parameter influencing the occurrence of linkage: increasing rift offset decreases linkage as previously observed by Allken et al. (2012). However, increasing divergence obliquity promotes transfer zone formation, as does the presence of rift-connecting inherited zones, whose strike is at an angle of $>15^{\circ}$ with respect to the divergence direction.

CT-analysis indicates that faulting initiated shortly after the start of the experiments, while structures become only clearly visible at the surface only after 1:30h (4% extension). Rift boundary fault angles tend to decrease from an initial 70° to ca. 55° after 4:00h (10% extension). Further CT-analysis will reveal the 3D evolution of the transform zones in more detail.

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