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How sedimentation affects rift segment interaction during oblique extension: a 4D analogue modelling study

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During the early stages of rifting, rift segments may form along non-continuous and/or offset pre-existing weaknesses. It is important to understand how these initial rift segments interact and connect to form a continuous rift system. Previous modelling of rift interaction structures has shown the dominant influence of oblique extension, promoting rift segment linkage (e.g. Zwaan et al., 2016) and eventual continent break-up (Brune et al., 2012). However, these studies did not incorporate sedimentation, which can have important implications for rift evolution (e.g. Bialas and Buck, 2009). Here we present a series of analogue model experiments investigating the influence of sedimentation on rift interaction structures under oblique extension conditions.

Our set-up involves a base of compressed foam and plexiglass that forces distributed extension in the overlying analogue materials when the model sidewalls move apart. A sand layer simulates the brittle upper crust and a viscous sand/silicone mixture the ductile lower crust. One of the underlying base plates can move laterally allowing oblique extension. Right-stepping offset and disconnected lines of silicone (seeds) on top of the basal viscous serve as inherited structures since the strong sand cover is locally thinner. We apply syn-rift sediments by filling in the developing rift and transfer zone basins with sand at fixed time steps. Models are run either with sedimentation or without to allow comparison.

The first results suggest that the gross structures are similar with or without sedimentation. As seen by Zwaan et al. (2016), dextral oblique extension promotes rift linkage because rift propagation aligns itself perpendicular to the extension direction. This causes the rift segments to grow towards each other and to establish a continuous rift structure. However, the structures within the rift segments show quite different behaviour when sedimentation is applied. The extra sediment loading in the rift basin prevents the viscous sand/silicone layer from isostatic rising as observed in the models without sedimentation. In models with syn-rift sedimentation, the rift wedge sinks into the viscous seed below. Analysis of surface structures indicates that sedimentation also results in differences in internal fault structures within the rift.

In order to validate our first experimental results, we will (re)run various models in a X-Ray CT-scanner to reveal their internal structure in detail. Combined with high-resolution surface scanning of the model topography, a thorough 4D surface and internal evolution assessment will be possible, including tomographic strain analysis using Digital Volume Correlation techniques (DVC).

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