Evolution of extensional faults between two rift systems: insights from sandbox experiments

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The interference between two offset propagating rift systems creates fractures, with a sigmoid shape in map view and previously referred to as accommodation zones (McClay et al, 2002). This peculiar kinematics may be observed in the Southeastern Brazilian margin in the Santos Basin, developed between the tips of two propagating, offset rifts. In this region, northward propagating rift was aborted during the southward propagation of another rift further to the east leading eventually to the opening of this segment of the South Atlantic. Could this structural setting explain the geometry and the position of the fracture zones in this basin?

To answer this question, we explore a range of geometrical and kinematic parameters with sandbox experiments to observe the deformation between these two propagating rift systems. The basement of the rift zones were modelled with rubber strips glued to rigid metal plates, following the setup of McClay et al, 2002. However, this setup suffers from the lateral contraction of the rubber due to its elastic extension (the Poisson's effect). This introduces a spurious kinematics, and in particular an unrealistic opening at the contact between the two rift parts. A new device, whereby thin metallic strips are glued to the sides of the rubber sheet reduces very substantially the Poisson effect and therefore improves the simulation of the overall extension.

Two main parameters are varied: the offset between the two rifts (D) and the relative velocity of extension of each rift. Narrowly spaced cross-sections of two experiments are interpreted to build 3D patterns.

The main results from the sandbox experiments are:

- Major and minor faults with the rifting zone localized by the rubber base present dips approximately equal to 75°.
- To obtain sigmoid fault array in map view best resembling the structural interpretation of Lebreton (2012), the rifts must be offsets (D>0) and the extension must be synchronous.
- The 3D fault patterns reveal that fault planes are not continuous in the accommodation zone, between the two rifts. If these major faults are not connected in the central zone as shown by the
physical models, then the fluid flow will be certainly influenced. This central relay zone could also be considered as a diffuse strain zone.

Numerical models will be helpful to introduce further material heterogeneities in this key area. The experimental results provide the data to validate the numerical modeling and to guide in the selection of the boundary conditions.