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Modelling the architecture of the East African Rift System

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The western branch of the East African Rift is composed of an along-strike complicated succession of rift segments. These rift segments vary in terms of interaction geometry, fault architecture and kinematics, length, patterns of uplift/subsidence (erosion/sedimentation) and magmatism. This system of alternating and interacting basins forms a curved shape, and is located within Proterozoic mobile belts at the edge of an elevated plateau: the Tanzanian craton. Many parameters have been suggested to control rift development and the puzzling along-strike structural variability of the western branch. These include effective elastic thickness of the lithosphere, reactivation of old structures, and influence of the Afar mantle plume. Evolution of the western branch however remains controversial.

We present a model for evolution of the segmented western branch of the East African Rift System that is based on observations and results from both analogue and numerical experiments. The experiments that we performed suggest that a single mechanism can explain the location of the segmented rift zone, its overall shape, and most prominent characteristics. We show that the western branch of the East African Rift System is formed along old mobile belts at the edge of the Tanzanian craton, that has resisted extensional deformation. Numerical experiments predict that on a regional scale, its curved shape is adopted from the craton, which implies that -under a constant extensional stress field- part of the rift experienced an orthogonal extension and part an oblique or highly oblique extension. Lengthwise varying rift asymmetry, rift segmentation, border fault length and accommodation zones are among many characteristics of the rift that are well explained by this varying extension direction. At a more local scale, analogue modelling experiments show that the fault pattern and architecture of accommodation zones are controlled by the trend of inherited crustal fabrics.