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Three-dimensional frictional plastic strain partitioning during oblique rifting

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Throughout the Wilson cycle the obliquity between lithospheric plate motion direction and nascent or existing plate boundaries prompts the development of intricate three-dimensional tectonic systems. Where oblique divergence dominates, as in the vast majority of continental rift and incipient oceanic domains, deformation is typically transtensional and large stretching in the brittle upper crust is primarily achieved by the accumulation of displacement on fault networks of various complexity. In continental rift depressions such faults are initially distributed over tens to hundreds of kilometer-wide regions, which can ultimately stretch and evolve into passive margins.

Here, we use high-resolution 3D thermo-mechanical finite element models to investigate the relative timing and distribution of localised frictional plastic deformation in the upper crust during oblique rift development in a simplified layered lithosphere. We vary the orientation of a wide oblique heterogeneous weak zone (representing a pre-existing geologic feature like a past orogenic domain), and test the sensitivity of the shear zones orientation to a range of noise distribution.

These models allow us to assess the importance of material heterogeneities for controlling the spatio-temporal shear zones distribution in the upper crust during oblique rifting, and to discuss the underlying controls governing oblique continental breakup.