Structural inheritance and evolving rift kinematics in transform and oblique rift systems: A comparison of global examples

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A spectrum of rift types from orthogonal, through oblique to pure transform-type systems have been documented. In addition, it is well-established that during rift evolution transition between these kinematic regimes may occur. The effects of obliquity are extensive, often leading to distinctive structural settings dominated by transtensional and transpressional processes. The complexity of these settings, as well as their global prevalence, emphasises the need for better understanding, so that the role of oblique rifts and transforms in larger-scale plate tectonics can be fully appreciated.

The development of oblique rifts and transforms is influenced by a number of interrelated factors including: 1) oblique crustal and mantle inheritance, 2) a reduced force required for plastic yielding, 3) changes in far-field forces, 4) asthenospheric dynamics, and 4) grain size changes in the lower crust and mantle. However, although their development is controlled by this array of processes, it is known that the influence of oblique crustal and mantle inheritance, as well as changes in far-field forces is substantial. Yet, the relative importance, and prevalence, of these two factors amongst rift systems globally is insufficient. As such, the aim of this study is to determine to what extent these two processes prevail.

Structural inheritance refers to heterogeneities produced by previous geological processes that proceed to influence subsequent geological events. This process plays a substantial role in oblique rift and transform development at both the crustal and mantle scale. Specifically, large-scale mantle structures may localise crustal deformation, whilst reactivation of discrete structures in the pre-rift crystalline basement can influence the geometry and kinematics of rift basins and margins. On the other hand, changes in the orientation and magnitude of far-field forces mean that as a rift proceeds from inception to possible breakup, the kinematic regime may evolve such that the orientation of extension with respect to the rift boundary is spatiotemporally variable. Such changes in rift kinematics allow structures established under one kinematic regime to be subsequently reactivated, overprinting multiple rift episodes, whilst variable extension magnitude
may introduce further complexities.

To better understand these processes we systematically compare the structural and tectonic evolution of several oblique rifts and transform margins, which were chosen to represent a diversity of rift types. Specifically, we compare: 1) the Davis Strait, 2) the Bay of Biscay 3) the Gulf of California, 4) the Red Sea, and 5) the East African margin. This is achieved by extracting rift velocity and extension directions from published plate tectonic models using GPlates, which are then compared with model results, as well as geological and geophysical observations. Preliminary results indicate that most oblique rifts and transforms express a strong influence of structural inheritance and a substantial change in kinematics during their evolution, emphasising the importance of these factors in oblique rift development.