Analysis of Complex Rift Fault Systems Using Analogue Models

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The 4-D evolution of complex rift fault systems has been investigated in a series of scaled analogue models of orthogonal and oblique asymmetric rifts. The model evolution and deformation was monitored with digital photography and high-resolution surface laser scanning. 3-D visualization and volume reconstructions using VoxelGeo (courtesy of Paradigm Geophysical) and fault analyses using Traptester (courtesy of Badley Geoscience) were used to analyse the full 3-D geometry of the resultant rift fault systems.

All models show similar asymmetric rift characteristics after approximately 50% extension. The extended margin shows variable fault lengths over a broad deformation zone whereas the stationary margin exhibits greater organisation over a narrow fault zone. Orthogonal and near-orthogonal rifts formed typically hard-linked fault arrays. Oblique rift models' faults are characterised by increased fault segmentation and relay structures with en-echelon border fault arrays oriented parallel to the basement discontinuity. In contrast, intra-rift fault systems are more complex. In the early stages of deformation their faults are orientated at high angles to the extension direction, with increasing extension they become hard-linked and aligned sub-parallel to the basement discontinuity.

These laboratory models can be used as templates for structural styles in complex reservoirs in rift systems. The fault architectures have implications for rift geomorphologies, for sediment dispersal patterns and for trap formation as well as for fluid migration pathways during burial. The rift models are compared with natural examples from the East African rift systems and the North Sea.