ABSTRACT: Rift Basin Patterns and Processes: A Time for Remodeling?

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There seem to be five aspects of rift basin half-graben development on which there is considerable agreement: (1) cross-section balancing models allow prediction of the geometry of the basin boundary faults at depth, and the prediction is that a listric geometry of the faults is common, with the faults soling out into a subhorizontal detachment; (2) there tend to be along-strike alternations of the "polarity" of the boundary faults, and the plan view of the fault trace is arcuate, concave on the down-thrown side; (3) folds with axial traces at high angles to the boundary faults are due to late-stage

basin-axial compression or transpression, which somehow seems to happen in almost all rifts (4) specific types of volcanism are associated with rifts or at least different rift styles, so that rift style can be predicted by the type of volcanism; and (5) rift environments of deposition follow a trajectory as a result of a series of predictable tectonic and sedimentological events.

Examination of available "ground truth" in a variety of rifts strongly suggests that these generalities are unsuccessful at explaining many first-order observations in half-graben and rift systems. For some of these aspects of conventional wisdom, there are replacement theories standing in the wings. Most notable are new physical dynamic models that reconcile rock mechanic concepts and neotectonic observations, linking fault vertical displacement to fault length. These theories explain the remarkable scale-independent similarity of linked hinging wall and foot wall deformation in planar normal faults observed over five orders of magnitude of fault length. In other cases, it is possible only to conclude that current theories are unsuccessful or at least unsatisfying. While kinematic mo els such as balanced cross sections are extremely useful heuristic tools, they can never provide unique solutions to problems or knowledge of the physical processes involved. The same is true of historical scenarios. We need to have more emphasis on forward physical dynamic models, and we need a vastly improved, reliable observation database to allow rigorous testing.

AAPG Search and Discovery Article #91012©1992 AAPG Annual Meeting, Calgary, Alberta, Canada, June 22-25, 1992 (2009)