d9 Rift valleys and triple junctions

< aulacogen; East Africa, Red Sea, Gulf of Aden; Jibuti (Djibouti) >

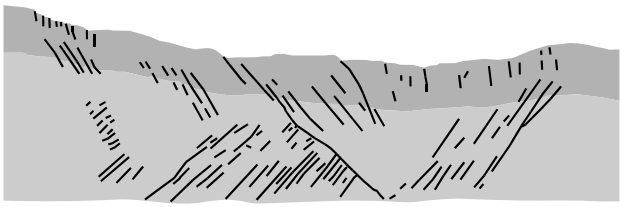
> Geology without fractures would be rather dull, and what would the geologist do if he were without faults when his imagination exceeds his geology? —Cloos.[1]

Rifts result from tensional stress. Lithosphere (plate) rifting can result from:[2]

Clay cake mounted on two boards that were then pulled apart.

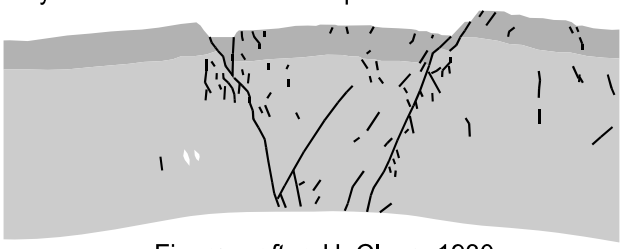
1) horizontal stretching (plate-pull).

Clay cake mounted on rubber sheet that was then stretched.



2) under-dragging by divergent asthenosphere flow.

Clay cake mounted on a rubber pad that was then inflated.



3) uparching (over a thickening asthenosphere).

Figures *after* H. Cloos, 1930.

[No figure]

4) outward-directed gravitational collapse of raised, laterally unsupported, lithosphere.

Land-traversing divergent plate boundaries are the Central Rift valley in Iceland and the Great Rift Valley of Africa. However, because divergent plate boundaries most often are where new deep-ocean floor opens they occur mostly within oceanic areas. There they are identifiable as “mid-ocean ridge” segments that have been made known by seafloor topographic-mapping (and which are not necessarily in the mid-ocean).

Divergent plate boundaries within oceanic areas are identified as the crest of wide oceanic rise-ridge mountain systems with innumerable abyssal hills, the crests of which, for long distances, parallel the ridge axis. A pronounced rift valley at the ridge (axial-valley) is the most characteristic topographic feature of the boundary between divergent lithospheric plates that are separating at slow (less than 3 cm per year) to intermediate rates (some 6 cm per year). Abyssal hills on the rises of fast (to as much as twice the intermediate rate) spreading ridges are of comparatively small relief and the ridge of these lacks a pronounced rift valley. Roger Buck and Alexel Poliakov in 1998 have proposed, persuasively, that the observed rise-ridge features can result from a self-organized critical stress state at the

spreading center and the hills that are a "frozen" fault topography rafted out of the axial valley.[3] Their model, which involves the stretching of the crust to produces a complex pattern of extensional faults with abyssal hills as their surface expression, does not require a temporal variation in magmatism at the ridge to explain the features.

In some places, three plates diverge from a common point.[4] This results in three rift valleys and associated ridges, which radiate with a T or a Y map pattern from a common point (triple junction). A triple junction, unlike a hotspot, is not fixed but moves in the direction of nearest subduction.[5] Triple junctions can be subducted. *Geosat* data have revealed such a pattern which could have originated as an organizational point 100 million years ago for the system of mid-ocean ridges from which the northeast and south Pacific seafloor has since spread.

In the case of a triple junction in a continental plate, two branches widen to form oceanic plates and one branch becomes a graben (but does not separate enough to open a deep ocean). An example of existing tectonically active triple junction is one that centers on the Afar triangle (***Figure d9.1***). The Gulf of Aden and the Red Sea rift branches are opening as two deep oceans whereas the East African Rift, the third branch, has not become oceanic.[6] Such a "failed" third arm is called an *aulacogen*.

An aulacogen (Gk. for furrow), as originally coined by N. S. Schatsky and A. A. Bogdanoff in 1960, is a fault trough in a craton that meets, more or less at right angles, a fold belt, or the edge of the continent.[7] ❑

Figure d9.1 [8] Three-armed rift in northeast Africa. Two arms are opening as deep oceans. These are the Red sea (between the Nubian and Arabian plates) and the Gulf of Aden (between the Arabian and Somalian plates). The remaining (third) arm is an aulacogen. This is the Great Rift valley of Africa which (incompletely) separates African plate into the Nubian and Somalian plates.