MFO 1971 Tectonophysics -- now found at Osmaston.org.uk website publication no 3.

Genesis of ocean ridge median valleys and continental rift valleys.

Tectonophysics 11, 387-405 (1971)

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Abstract

Separative motion of tectonic plates that are much thicker than the crust involves important upward movement of hot mantle material between them. It is shown that the loss of heat from this material to the bounding walls is likely to produce structural effects that differ fundamentally from those of purely crustal separation. Notably, the heat loss affects the buoyancy and, through its effect on viscosity, the level of emplacement of the new material. Consequently, support for the crust in the separation zone varies with plate separation rate. This is shown to explain qualitatively the observed variation of axial structures with separation rate. In particular, it yields a mechanism, discussed in detail, that enables oceanic median valleys to be continuously regenerated structures. Buoyancy forces successively elevate the valley floor to form the sides. The model appears consistent with present observations. Some critical tests are proposed.Continental rifting is distinguished by much greater heat transfer to the bounding walls, because separation is very slow (perhaps 0.1–0.5 cm/year) and the plates are probably much thicker (implying hotter source material and initially cooler walls). Crustal support at the axis during the earliest stages of separation is therefore poor, resulting in down-faulted rift valley floors. The heat gained by the plate edges, however, is shown to be of major significance, probably causing the large-scale upwarping of rift margins. Comparisons with the Rhine graben and the rifts of eastern Africa support several evolutionary aspects of this interpretation. Interrupted continental rifting and rifting that is transitional to oceanic conditions are also considered.