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Plate break-up geometry in SE-Afar

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New structural data acquired in Djibouti strongly support the view of a magma-rich to magma-poor pair of conjugate margins developed in SE Afar since at least 9 Ma. Our model is illustrated by a crustal-scale transect that emphasizes the role of a two-stage extensional detachment fault system, with opposing senses of motion through time. The geometry and kinematics of this detachment fault pattern are mainly documented from lavas and fault dip data extracted from remote sensing imagery (Landsat ETM+, and corresponding DEM), further calibrated by field observations. Although expressed by opposite fault geometries, the two successive extensional events evidenced here are part of a two-stage continental extensional tear-system associated with the ongoing propagation of the Aden-Tadjoura oceanic axis to the NW. A flip-flop evolution of detachment faults accommodating lithosphere divergence has recently been proposed for the development of the Indian Ocean and continental margins (Sauter et al., 2013). However, the SE Afar evolution further suggests a radical and sudden change in lithosphere behavior during extension, from a long-term and widespread magmatic stage to a syn-sedimentary break-up stage where mantle melting concentrates along the future oceanic axis. Of special interest is the fact that a late and rapid stage of non-magmatic extension led to break-up, whose geometry triggered the location of the break-up axis and earliest oceanic accretion. New structural data acquired in Djibouti strongly support the view of a magma-rich to magma-poor pair of conjugate margins developed in SE Afar since at least 9 Ma. Our model is illustrated by a crustal-scale transect that emphasizes the role of a two-stage extensional detachment fault system, with opposing senses of motion through time. The geometry and kinematics of this detachment fault pattern are mainly documented from lavas and fault dip data extracted from remote sensing imagery (Landsat ETM+, and corresponding DEM), further calibrated by field observations. Although expressed by opposite fault geometries, the two successive extensional events evidenced here are part of a two-stage continental extensional tear-system associated with the ongoing propagation of the Aden-Tadjoura oceanic axis to the NW. A flip-flop evolution of detachment faults accommodating lithosphere divergence has recently been proposed for the development of the Indian Ocean and continental margins (Sauter et al., 2013). However, the SE Afar evolution further suggests a radical and sudden change in lithosphere behavior during extension, from a long-term and widespread magmatic stage to a syn-sedimentary break-up stage where mantle melting concentrates along the future oceanic axis. Of special interest is the fact that a late and rapid stage of non-magmatic extension led to break-up, whose geometry triggered the location of the break-up axis and earliest oceanic accretion.