Geophysical Research Abstracts
Vol. 21, EGU2019-2886, 2019
EGU General Assembly 2019


# A rheological model of the rift–drift transition in the Red Sea

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We present a general rheological model of the continental lithosphere during the rift–drift transition, founded on theoretical considerations, numerical modelling, and supported by geophysical and geological evidence from the Red Sea region. It is shown that the necking lithospheric mantle of the continental margins retains and accumulates recoverable elastic strain during the rifting phase, while an asymmetric melting regime forms even before the final break-up, determining underplating of magma in the axial zone. After the onset of sea–floor spreading, strain recovery and release of the strain energy accumulated in the lithospheric mantle occurs through a phase of non–linear anelastic relaxation. During this phase, the upper crust of the conjugate continental margins experiences post–rift deformation with tectonic inversion of former extensional structures, while the extra–space created along the axial zone as a consequence of the rapid contraction of the margins triggers a rapid upwelling of asthenosphere that induces an initial pulse of fast spreading followed by a steady phase of oceanic crust accretion. We present geophysical evidence supporting this model, including: 1) The observed pattern of oceanic magnetic anomalies in the Red Sea, 2) The distribution of finite crustal strains across the continental margins of Nubia and Arabia, and 3) The distribution of earthquake epicentres along the western margin of the Arabian plate. We also present new structural data acquired during three geological campaigns performed in 2015 and 2016 along the western Arabian margin, which are consistent with a post–rift phase of compression and inversion of the rift structures. We will also show that a selection of realistic rheological parameters supports non–linear viscoelastic behaviour of the continental lithosphere during the rift–drift transition. Finally, we will show that in the case of the Red Sea $\sim$40% of the total extensional strain accumulated during the rifting stage has been recovered in the southernmost part of the Arabian margin conjugate to the Nubian plate ($\sim$19°N), while this percentage decreases to $\sim$14% around 23.8°N, where the continental margin faces the youngest spreading segment, and it is zero north of this area, where the Red Sea is still in the rifting stage.