

Structural style and tectonic evolution of the easternmost Gulf of Aden conjugate margins (Socotra - Southern Oman)

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Observations from distal rifted margins in present day magma-poor rifted margins led to the discovery of hyperextended crust and exhumed sub-continental mantle. This finding allowed to better figure out how thinning process are accommodate by tectonic structures, forming various crustal domains, as the deformation localized towards the future area of breakup. However, some of the current challenges are about clarifying how factors as oblique kinematic, pre-existing structures and volcanism can control the 3D geometry and crustal architecture of the passive margins? A key to better understand the rifting evolution in its entirety is to study conjugate margins. The gulf of Aden is a young oceanic basin (with a global trend about N75°E) oblique to the divergence (about 30°N), separating Arabia from Somalia of less than 800 km. Thanks to its immersed margins and its thin post-rift sediment cover, the gulf of Aden basin is a natural laboratory to investigate conjugate margins and strain localisation throughout the rift history.

In this contribution, we focus our interest on offshore Socotra Island (Yemen) and its conjugate in Southeastern Oman. This area extends from Socotra-Hadbeen (SHFZ) and the eastern Gulf of Aden fault zones (EGAFZ). In the easternmost part of the gulf of Aden, we provide new insights into crustal deformation and emplacement of the new oceanic crust thanks to bathymetric, magnetic, gravimetric data and single-, multi-channel, high speed seismic reflection data collected during Encens-Sheba (2000), Encens (2006) and the more recent Marges-Aden (2012) cruises respectively.

The results obtained after compilation of these data, previous geological (field works) and geophysical (receiver functions, Pn-tomography, magnetic anomalies, heat flow) studies on the focused area, allowed us to provide new structural mapping and stratigraphic correlation between onshore and offshore parts of Socotra and Oman margins. We precisely defined and map crustal domains, syn-tectonic structures and oblique accommodation zones to highlighted asymmetrical margins, characterized by strong lateral variability of crustal domains along and across strike. From external to internal domains of the margins and in between SHFZ and EGAFZ (first-order segment), this study details sharp necking domain and complex transition from hyperextended to oceanic crust characterized by: (i) hyperextended crust affected by volcanic extrusions; (ii) detachment faulting in the distal part of the margins allowing exhumation; (iii) volcanic constructions in the exhumation domain; (iv) a complex proto-oceanic crust. We highlight a significant second-order segmentation characterized by six N20°E trending transfer zones, limiting seven 25 – 60 km length segments and affecting necking domain as well as the ocean-continent transition. Based on interpretative cross-sections and detailed stratigraphic analysis, we discuss the complex temporal and spatial evolution of conjugate margins: (i) the margins segmentation and the relationship with structural inheritance (ii) the set-up of a long-offset detachment fault and the nature of the exhumed basement (iv) the origin and timing of magmatic events and the onset of proto-oceanic crust.