Crustal structures across the young and oblique North-eastern Gulf of Aden margin

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The Gulf of Aden is a young and active oceanic basin, which separates the south-eastern margin of the Arabian Plate from the Somali Plate. The rifting leading to the formation of the north-eastern Gulf of Aden passive margin started ca. 34 Ma ago when the oceanic spreading in this area initiated at least 17.6 Ma ago. The opening direction (N26°E) is oblique to the mean orientation of the Gulf (N75°E), leading to a strong structural segmentation.

The Encens cruise (2006) allowed for the acquisition of a large seismic refraction dataset with profiles across (6 lines) and along (3 lines) the margin, between the Alula-Fartak and Socotra-Hadbeen fracture zones, which define a first order segment of the Gulf. P-wave velocity modelling already allowed us to image the crustal thinning and the structures, from continental to oceanic domains, along some of the profiles. A lower crustal intermediate body is observed in the Ashawq-Salah segment, at the base of the transitional and oceanic crusts. The nature of this intermediate body is most probably mafic, linked to a post-rift thermal anomaly. The thin (1-2 km) sediment layer in the study area allows for a clear conversion of P-waves to S-waves at the top basement. Thus, most seismic refraction records show very clear S-wave arrivals.

In this study, we use both P-wave and S-wave arrivals to delineate the crustal structures and segmentation along and across the margin and add insight into the nature of the rocks below the acoustic basement. P-wave velocity modelling allows for the delineation of the structure variations across and along the margin. The velocity models are used as a base for the S-wave modelling, through the definition of Poisson’s ratios in the different areas of the models. Picking and modelling of S-wave arrivals allow us to identify two families of converted waves: (1) seismic waves converted at the basement interface on the way up, just before arriving to the OBS and (2) seismic waves converted at the basement on the way down, which travelled into the deep structures as S-waves. The first set of arrivals allows for the estimation the S-wave velocities (Poisson’s ratio) in the sediments, showing that the sediments in this area are unconsolidated and water saturated. The second set of arrivals gives us constraints on the S-wave velocities below the acoustic basement. This allows for an improved mapping of the transitional and oceanic domains and the confirmation of the mafic nature of the lower crustal intermediate body.