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Crustal structure of the rifted volcanic margins and uplifted plateau of Western Yemen from receiver function analysis

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We analyse P-wave receiver functions across the western Gulf of Aden and southern Red Sea continental margins in Western Yemen to constrain crustal thickness, internal crustal structure, and bulk seismic velocity characteristics in order to address the role of magmatism, faulting and mechanical crustal thinning during continental breakup. We analyse teleseismic data from 21 stations forming the temporary Young Conjugate Margins Laboratory (YOCMAL) network together with GFZ and Yemeni permanent stations. Analysis of computed receiver functions shows that (1) the thickness of unextended crust on the Yemen plateau is $\sim$35 km; (2) this thins to $\sim$22 km in coastal areas and reaches less than 14 km on the Red Sea coast, where presence of a high velocity lower crust (HVLC) is evident. The average Vp/Vs ratio for the western Yemen Plateau is 1.79, increasing to $\sim$1.92 near the Red Sea coast and decreasing to 1.68 for those stations located on or near the granitic rocks.
Thinning of the crust, and by inference extension, occurs over a $\sim$130 km wide transition zone from the Red Sea and Gulf of Aden coasts to the edges of the Yemen plateau. Thinning of continental crust is particularly localized in a <30-km-wide zone near the coastline, spatially co-incident with addition of magmatic underplate to the lower crust, above which at the surface we observe the presence of seaward dipping reflectors (SDRs)_and thickened Oligo-Miocene syn-rift basaltic flows. Our results strongly suggest the presence of high velocity mafic intrusions in the lower crust, which are likely either synrift magmatic intrusion into continental lower-crust or alternatively depleted upper mantle underplated to the base of the crust during the eruption of the SDRs. Our results also point toward a regional breakup history in which the onset of rifting was synchronous along the western Gulf of Aden and southern Red Sea volcanic margins followed by a second phase of extension along the Red Sea margin.