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Joint Inversion of P- and S-Wave Receiver Functions and Dispersion Velocities : A New Technique for Determining Detailed Lithospheric Structure in the Arabian Shield

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We have developed lithospheric and sub-lithospheric velocity models for 17 broadband stations in Saudi Arabia from the joint inversion of PRFs, SRFs, and Rayleigh-wave group-velocities (fundamental mode). The velocity models successfully image detailed S-velocity variation with depth down to ∼250 km depth, giving important constraints on key structural parameters such as crustal thickness, lithospheric thickness, lid velocity and (in some instances) thickness and minimum velocity of the low-velocity channel (asthenosphere).
The analysis of the PRFs reveals values of 25 - 45 km for crustal thickness, with the thin crust next to the Red Sea and Gulf of Aqaba and the thicker crust under the platform, and Vp/Vs ratios in the 1.70 – 1.80 range, suggesting a range of compositions (felsic to mafic) for the shield's crust. The migrated SRFs suggest lithospheric thicknesses in the 80-100 km range for portions of the shield close to the Red Sea and Gulf of Aqaba and also near the Arabian Gulf.
We used the ambient noise method to image the shear velocity in the crust and uppermost mantle beneath the Arabian Peninsula. We calculated the ambient noise correlation Green's functions for all available station pairs within the Saudi seismic networks, which provide hundreds of unique paths exclusively sampling the region. We measured group velocities in conjunction with the joint-inversion of receiver functions and dispersion velocities. Separately, we inverted the Green's function waveforms for the best 1D models along each path and created a 3D model based on those results. Greatest resolution is determined by station density and is greatest along the western part of the kingdom along the Red Sea.