

Lithospheric structure of the Arabian Shield and Platform from complete regional waveform modelling and surface wave group velocities

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SUMMARY

Regional seismic waveforms reveal significant differences in the structure of the Arabian Shield and the Arabian Platform. We estimate lithospheric velocity structure by modelling regional waveforms recorded by the 1995-1997 Saudi Arabian Temporary Broadband Deployment using a grid search scheme. We employ a new method whereby we narrow the waveform modelling grid search by first fitting the fundamental mode Love and Rayleigh wave group velocities. The group velocities constrain the average crustal thickness and velocities as well as the crustal velocity gradients. Because the group velocity fitting is computationally much faster than the synthetic seismogram calculation this method allows us to determine good average starting models quickly. Waveform fits of the *Pn* and *Sn* body wave arrivals constrain the mantle velocities. The resulting lithospheric structures indicate that the Arabian Platform has an average crustal thickness of 40 km, with relatively low crustal velocities (average crustal *P*- and *S*-wave velocities of 6.07 and 3.50 km s⁻¹, respectively) without a strong velocity gradient. The Moho is shallower (36 km) and crustal velocities are 6 per cent higher (with a velocity increase with depth) for the Arabian Shield. Fast crustal velocities of the Arabian Shield result from a predominantly mafic composition in the lower crust. Lower velocities in the Arabian Platform crust indicate a bulk felsic composition, consistent with orogenesis of this former active margin. *P*- and *S*-wave velocities immediately below the Moho are slower in the Arabian Shield than in the Arabian Platform (7.9 and 4.30 km s⁻¹, and 8.10 and 4.55 km s⁻¹, respectively). This indicates that the Poisson's ratios for the uppermost mantle of the Arabian Shield and Platform are 0.29 and 0.27, respectively. The lower mantle velocities and higher Poisson's ratio beneath the Arabian Shield probably arise from a partially molten mantle associated with Red Sea spreading and continental volcanism, although we cannot constrain the lateral extent of a zone of partially molten mantle.

Key words: crustal structure, lithosphere, surface waves, waveform analysis.