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Lithospheric structure across the central Tien Shan constrained by gravity anomalies and joint inversions of receiver function and Rayleigh group velocity data

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Shear wave velocity structure across the central Tien Shan orogeny was generated by jointly inverting Rayleigh wave phase and group velocity with teleseismic P-wave receiver functions at 40 broad band seismic stations of the MANAS project. The inferred seismic structure was validated by forward modeling of the complete Bouguer anomaly data. The joint inversion result reveals larger crust thicknesses beneath the Kokshaal (∼68–72 km) and Kyrgyz ranges (∼62–64 km), while other units have crustal thicknesses between 48 and 58 km. A fast velocity layer (Vs = 3.6–3.9 km/s) in the upper crust is found in some seismic stations within the Kazakh Shield. Our models show the presence of high velocity and density layers in the lowermost crust throughout the region, consistent with the presence of mafic/ultramafic lithologies. The large crustal thickness is associated with a thickened mafic layer in the lower crust, indicating that the thickened crust may be partly caused by magmatic underplating. The low velocity and density anomaly in the middle crust, and low upper mantle velocity observed in our model beneath the middle Tien Shan reflects the presence of partial melt in the crust due to the intrusion of hot mantle material. The lack of correlation between Moho depth and topography, together with the gravity results, suggests that the topographic compensation in the central Tien Shan is not confined to the crust. This requires significant support from the mantle to account for the relative high elevation of the middle Tien Shan.