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Constraints on dynamics of Tien Shan from integrative modelling of gravity, GPS and seismic data

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Tien-Shan is one of the largest and most active intracontinental orogens. The present day shortening rates derived from GPS measurements are very significant and reach 23 mm (Reigber et al., 2001), despite Tien Shan is located very far from the plate boundary between India and Eurasia. Our goal is to through light on formation of this unique structure. New geophysical data, which became available recently, form a basis for this study together with the GPS observations. These are new gravity data obtained with the GRACE mission, which form a consistent grid for the entire region together with ground observations. We also use new seismic data based on the receiver function analysis (Vinnik et al., 2004), which provides a 3D image of the crust and upper mantle. Based on a joint analysis of the gravity and seismic data we produce 3D density model of the lithosphere and determine its isostatic state. This region is characterized by very high variation of the isostatic anomalies. The part of Tarim plate, which bounds the southern flank of the Tien Shan Range, is characterized by strong negative anomalies, while the adjoining part of Tien Shan is characterized by the opposite sign isostatic anomalies. If we assume Airy type of isostasy, the deflection of Moho from its 'isostatic' position is about +15 km (deeper) in the northern part of Tarim Basin and -15 km (shallower) in the central part of Tien Shan. The boundary between these fragments is very sharp and also located at the southern flank of the Tien Shan Range. This situation may be explained if we assume underthrust of Tarim Plate under Tien Shan, which is a result of plate convergence. This idea is also supported by the analysis of GPS data. We found also strong density anomalies in the lower crust and upper mantle, which correspond to seismic anomalies (Vinnik et al., 2004) and could be a result of magmatic underplating. This process might play a significant role in the recent tectonic evolution of the central Tien Shan together with crustal shortening.