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Comparing estimates of crustal deformation in Altai-Sayan mountain region based on seismic and GNSS data

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We compare crustal deformation parameters obtained from seismic (seismotectonic deformation, STD) and space geodetic (based on Global Navigation Satellite System, GNSS) data. The analysis was done for the Altai-Sayan mountain region.

We computed distribution of crustal deformation rate tensor values based on a catalogue of velocities of space geodetic observation networks' points for the period of the last 25 years. Data from three space geodetic networks were used: Altai GNSS network (Altai Mountains), Baikal-Mongolian GNSS network (Gobi and Mongolian Altai, Sayans and Baikal Rift Zone) and Central Asian GNSS network (Kazakh platform). We calculated earth surface points' velocity gradient tensor by solving system of equations based on linear part of Taylor expansion of function of point's velocity versus its radius vector.

Then we studied territory of Altai-Sayan mountain region using the seismotectonic deformation (STD) method. The calculation of STD was done based on approaches proposed in publications by Yu.V. Riznichenko and S.L. Yunga. We analyzed directions of STD using focal mechanisms data for 591 earthquakes occurred between 1963 and 2021. For each value of STD directing tensor we calculated four angles that completely describe it. Of these angles two characterize mode of deformation and of the other two one shows azimuth of maximal horizontal shortening axis. We plot on maps distribution of horizontal part of STD directing tensor using classification of STD modes.

Between seismic and GNSS deformation's tensors we compare directions of horizontal shortening and extension and also a sum of tensor's horizontal components. This comparison was done for two areas where STD results are available in greater detail: Gorny Altai (the region of 2003 Chuya earthquake) and a region including Academician Obruchev ridge, southern part of Eastern Sayan Mountains and Southern Baikal region. The analysis showed that a good agreement between the computed values of deformation is observed in areas where there are both a good amount of seismic data and a sufficient number of GNSS observation points.