Deformation field and local seismicity interaction in the North Caucasus

Guseva T.V., Krupennikova I.S., Mokrova A.N., Rozenberg N.K.

Schmidt Institute of Physics of the Earth of the Russian Academy of Sciences, Moscow, Russia

e-mail: guseva@ifz.ru

Trigger impact of different nature on the geological system cause the development of geodynamic processes that are reflected both in deformation and seismicity, and in their possible interaction. The introduction of satellite geodetic methods and modern mathematical processing in the practice of repeated high-precision coordinate definitions allows to track the geodynamic situation and its sudden change within large geostructures.

The Caucasus region is a part of the non-stable Alpine-Himalayan belt. This is a complicated geological object, its development continues in present. It is characterized by the formation of a fold-thrust structure with active movements of the earth's crust, complex fault systems, volcanism, active seismicity.

Here the results of the data analysis of repeated GNSS (global navigation satellite systems) observations at the geodynamic networks of the North Caucasus and adjacent territories from 2004 to 2014 are presented. Research task was to determine the current movements and deformations of the earth's crust in different reference systems and their correlation with the amount of released seismic energy in a determined time interval. Simultaneous GPS+GLONASS measurements on the North Caucasus geodynamic network (between the Black and Caspian seas) executed by differential positioning method in static mode using two-frequency receivers. Processing of "raw"data was carried out using Bernese 5.0 software.

The horizontal displacement velocity vectors in the ITRF coordinate system (mainly reflecting the rotation of the structure around the Euler pole) have a North-Eastern direction and vary from 25 mm/year to 33 mm/year. The rate of horizontal displacement within the North Caucasus relative to the East European platform (EEP) reaches several millimeters, which possibly reflects the influence of the Arabian plate, as well as local tectonic and exogenous factors.

The first invariant of the strain tensor within the studied time interval is calculated. As a result, the rates of changes in area deformations of the North Caucasus region, as well as adjacent areas of the EEP and the Arabian plate, are obtained. There is a differentiated areal deformation with velocities $\pm 2 \cdot 10^{-8}$ per year in the presence of anomalous zones of compression and tension up to ±10-12-8, oriented from North to South and is a continuation of similar zones in the adjacent areas of the EEP.

Earthquake data provided by the US Geological survey were used to compare the deformation field and seismic activity. For the selected time interval within the considered territory 436 seismic events with magnitudes (Ms) 1.0-5.7 were recorded, 7 of them with Ms>5. The distribution of seismicity is irregular, a large activity was inherent in the Eastern part of the region. The average released energy is 10^7-10^9 J/km^2, reaching 10^{15} J/km^2 in some places.

The North Caucasus region continues to develop under the conditions of convergence of the Eurasian and Arabian lithospheric plates, which in the considered time interval is appeared in the regional transverse compression and longitudinal tension. In addition, there are areas of abnormal compression and stretching, possibly caused by internal local factors.