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STRONG EARTHQUAKES ON THE TERRITORY OF AZERBAIJAN FOR THE PERIOD OF 2012-2014

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ABSTRACT. We consider the strong earthquakes that took place on the territory of Azerbaijan for the period of 2012 - 2014. Was identified the connection of the observed seismicity and tectonic structure of the region. The analysis of the mechanisms of strong earthquakes for the purpose of research of the stress strain state of the Earth's crust was considered and was identified the nature of shifts in the active parts of the deep faults.

The territory of Azerbaijan Republic is one of the seismically active regions of the Alpine fold system. According to historical records there have been strong and destructive earthquakes that led to a change in topography.

Strong earthquakes occur at the present stage. The activity of geodynamic processes taking place in the area is caused by ongoing since the late Miocene collision of Arabian and Eurasian continental plates.

To represent the character of the distribution of earthquakes' sources in Azerbaijan and the Caspian region was given a map of the epicenters of earthquakes for the period of 2004-2014 with ml≥4. There are allocated separate seismically active areas. This is primarily Shamakhi-Ismayilli, Sheki-Zagatala, Talish zone and the area of the Caspian Sea (Fig. 1).

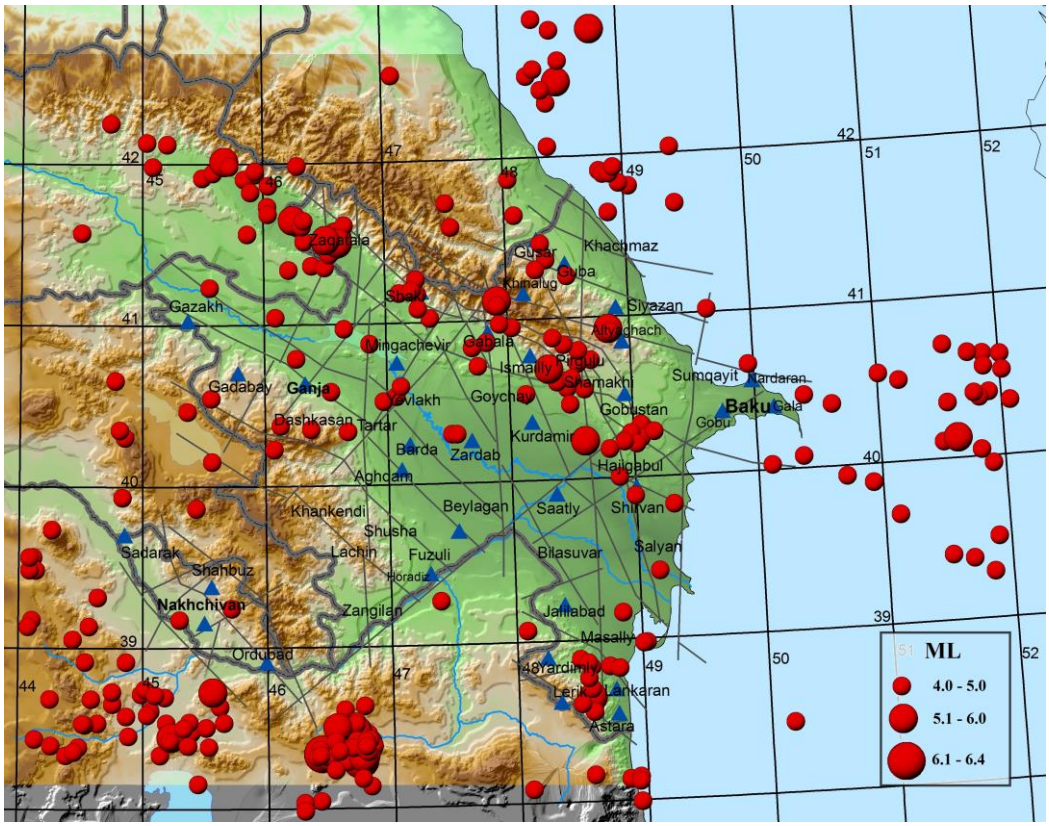

Figure. 1. Map of the epicenters of earthquakes with a magnitude of ml≥4.0 2004-2014.

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During the last years was registered outbreak of seismic activity on the territory of the republic. In 2012, and after a lull, in 2014 here, a series of strong earthquakes took place: Zagatala, with ml = 5.6,5.7, Balakan with ml = 5.8 in 2012, which were felt in the midst of a J0 = 7 b., as well as the Caspian 10.01.2014, with ml = 5.0 , Gadzhi-Gabul 10.02.2014, with ml = 5.8, Zagatala 29.06.2014, with ml = 5.3, the Caspian 06.07.2014 with ml = 5.6, and a series of Gabala 29.09 04.10.2014 with ml max = 5.5. They were felt, with the intensity of 6-7b in the epicentre (Fig.2).

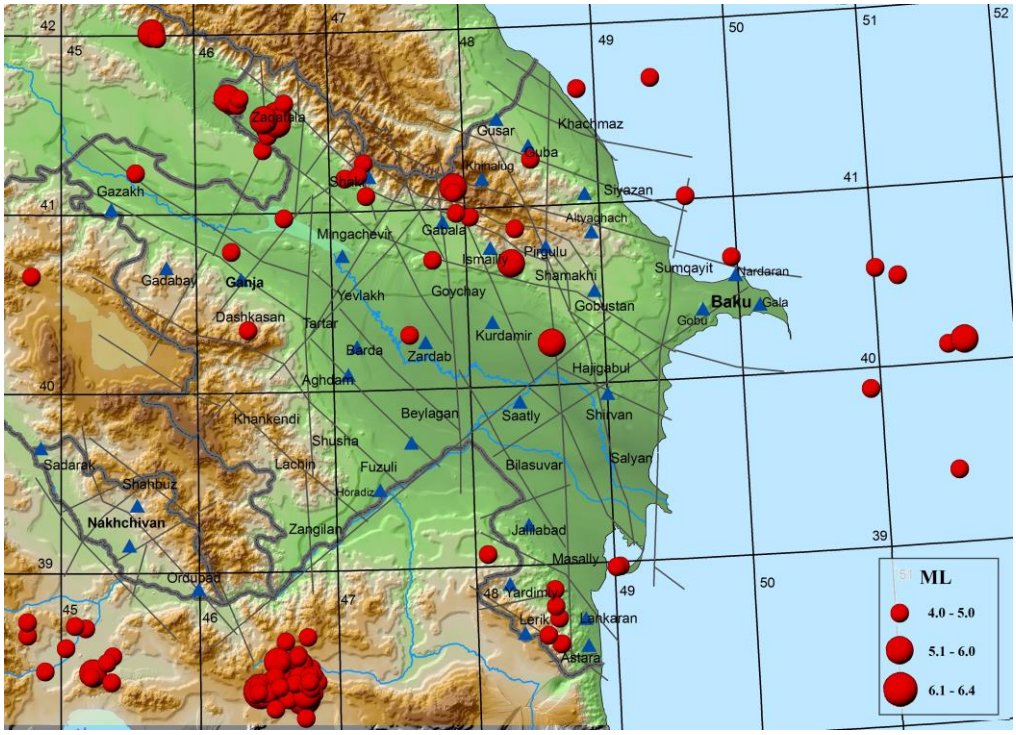


Figure. 2. Map of the epicenters of strong earthquakes on the territory of Azerbaijan (2012-2014) with ml≥4.0.

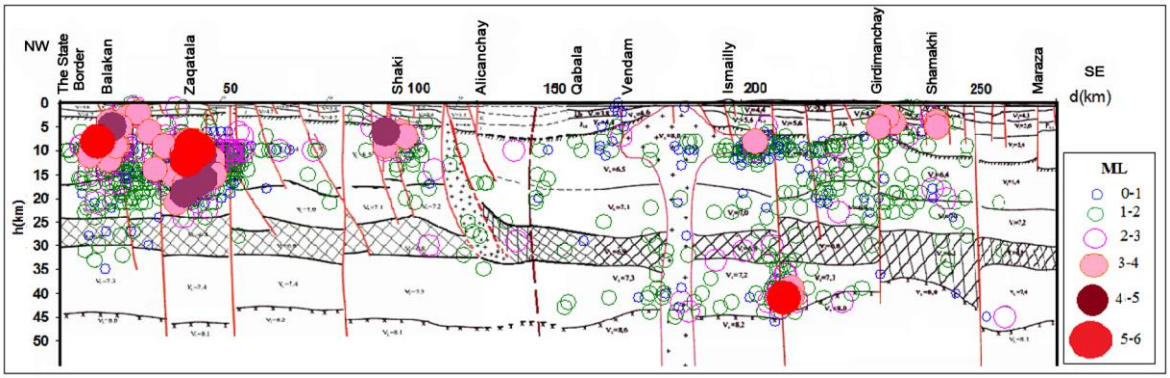
As we can see, most of the centers of tangible earthquakes are located at the junction of the Kura depression and southeast dipping of the Greater Caucasus. These are Zagatala, Sheki, Gabala and Ismayilli pockets.

In order to trace the dynamics of the seismic situation along the joint zone of Kura depression and the Great Caucasus in 2012 - 2014, the seismic sections of Caucasian stretch through Balakan – Maraza territory were built. The rise of seismic activity in the area of the dive began in 2012. The 2013 is the period of recession in seismicity. In 2014 seismic events took place in Zagatala-Balakan zone 29.06 with ml = 5.3, and in 29.09 sharply increased a seismic activity to the northeast of the Gabala (fig.3 a,b).

The comparison of the cuts of 2012 and 2014 years shows that activation took place in the areas of "lull" that occurred in 2012 between Balakan and Zagatala and Gabala district. As it is seen from the cuts the earthquakes' centers are located in the sediment, as well as in the upper part of the consolidated crust generally with a depth of 15-20 km.

Represented seismogeological incision shows that the condition of the geological environment is associated with complex structural-tectonic structure. Activation of seismotectonic events take place, the individual motions of tectonic structures that are realized in the form of tangible seven-point seismic events.

2012 (a)



2014 (b)

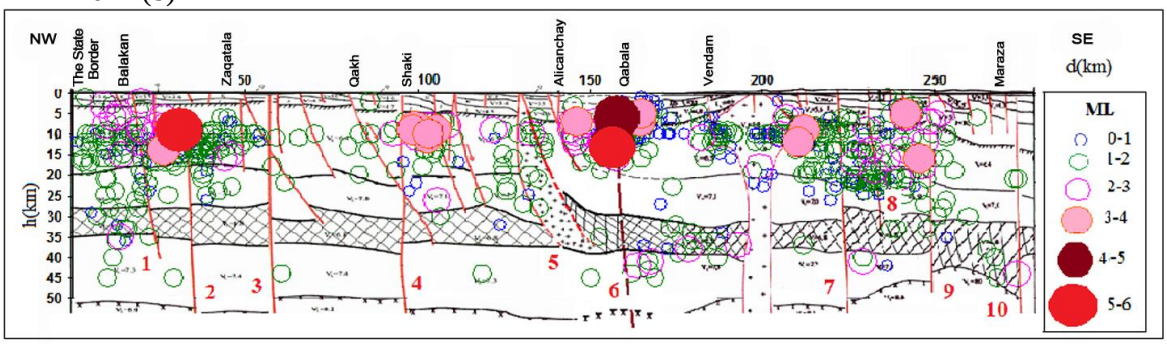


Figure. 3. a, b. Seismological cuts NW - SE trending along the southeast dipping of Greater Caucasus for the period of 2012 and 2014 (a, b).

Faults: Cross - 1.Balakanchay 2.Zagatala-Khudat 3.Guton-Zangilan (orthogonal) 4.Palantëkyan-Rutul 6.Arpa-Samur 7.Shahsultanly Diyalli 8.Girdymanchay 9.Padar-Gonagkend 10. Longitudinal - Mudrasa Dashgil

Revitalization of 2012 and 2014 is due to the accumulation of stress and post-discharge subduction shift interface of Mid-Kura and Vandam tectonic zones through Ganikh Ayrichay-Alat deep thrust. Discharge occurs in the weakest portions crossing between them and with the deep thrust (Fig. 4).

Analysis of the seismicity on the territory of Azerbaijan in the recent years has shown that there is a general distribution of the considered seismic zones along the Caucasian structures; however, in each of them there is a migration of epicenters in the anti-Caucasian direction. That is, when the overall revitalization of the zone along the joint Kura depression and the Greater Caucasus (or zones feat) for longitudinal faults there are failures in the transverse faults. Statistics show earthquake hypocenters in most cases are in the upper crust, where the processes of accumulation of elastic stresses lead to the formation and growth of new structures of the Earth's crust.

The seismic information obtained at 35 seismic stations, allows you to explore the seismic mode of the republic, to identify areas of seismic activities, to identify spatial distribution of source zones and earthquake focal mechanisms. Earthquake foci are usually confined to the boundaries of tectonic crustal blocks sandwiched in a strip of conflict interaction of the Arabian and Eurasian plates, and related to their advances. For example, let us consider Gabala earthquake of 2014 (Fig.5).

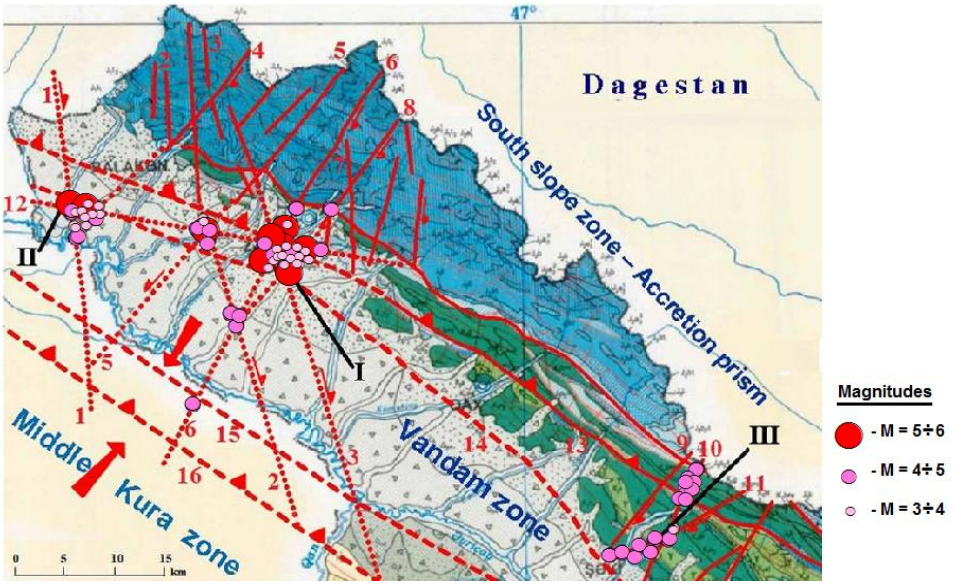


Figure 4. Focal areas of earthquakes (2012-2014) North-West of Azerbaijan.

Faults on the roof of the pre-Jurassic basement: A - submeridional: 1 - Himrih-Halatalin; 2 - Tinovroso-Kandaksky; 3-Bulanlygchay Verhiyansky;

B - transverse (north-eastern strike): 4 - Balakan; 5 - Katehchay; 6 - Zagatala; 7 - Meshlesh; 8 - Talachay-Lyalyalin; 9 - Kish; 10 - Sheki; 11-Gohmud Salyan; 15 - Aliabad;

C – sublatitudinal: 12 - Mazymgaryshan-Sarybash-Mugtadyr;

D - longitudinal (stretch-Caucasian)

13 - Kbaade-Zangi; 14 - Chamboul-Ismayilli; 15 - Dashyuz-Amirvan; 16 - Ganikh-Ayrichay.

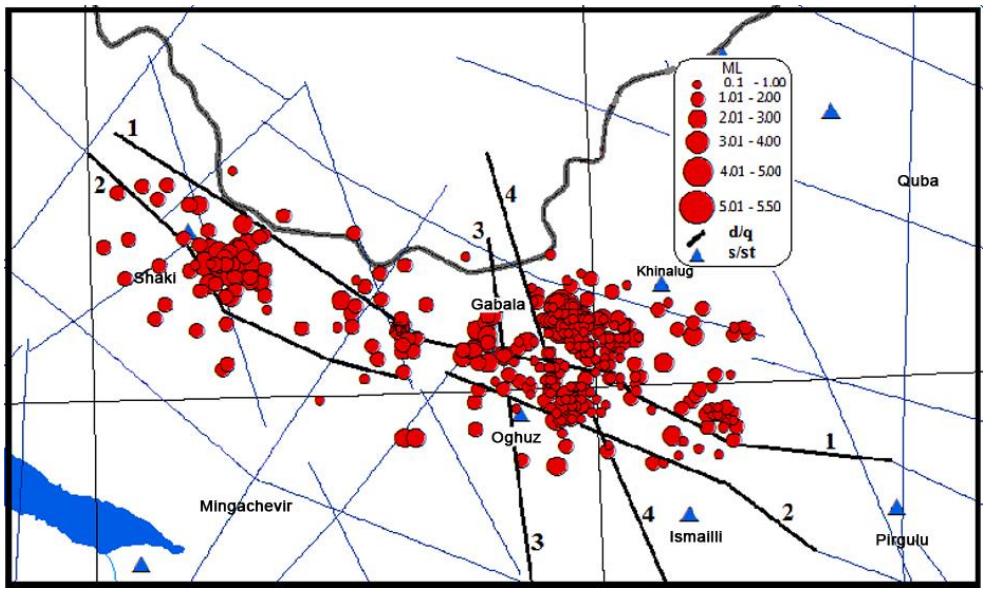


Figure 5. Map of earthquake epicenters with ml = 1.0 ÷ 5.5 occurred near Sheki-Gabala in 2014.

Faults: 1 - Dashgil-Mudrese 2 - Vandam (longitudinal); 3 – Ismayilli-Sighirli 4 - Chakhirli-Gabala (orthogonal).

Activation in 2014 began on January 10th, when the sea earthquake happened with ml = 5 in the north of the Azeri part of the Caspian Sea, and then on February 10th was registered a strong earthquake in Hajigabul with ml = 5.7. Those earthquakes had great depth; the latter was felt not only on the territory of the republic but also far beyond its borders. They had no aftershocks. Those earthquakes may have played a role in the further intensification, i.e. in accelerating seismic tectonic processes and the implementation of upcoming centers of earthquakes, the epicenters of which are located on the southeast dipping of the Greater Caucasus. Those earthquakes are: June 29th - in Zagatala-Balakan area with ml = 5.3; September 29th and October 4th - two earthquakes in north-east of Gabala (Vandam structure) with ml = 5.5 and ml = 5.0 respectively.

Progress of seismic process in the region of Gabala during the year is presented in Fig. 6. Foreshock activity was very weak and before the strong event with ml = 5.5, a seismic calm was observed. As can be seen from the schedule, activation in this area began in early March, when there was a series of earthquakes with ml = 3.0-3.8. Their epicentral area was located to the south of September 29th events. Analysis of the distribution of focal depths indicates that the earthquakes that occurred in March are related to the shifts at depths of 2-13 km, and of 4-18km in September.

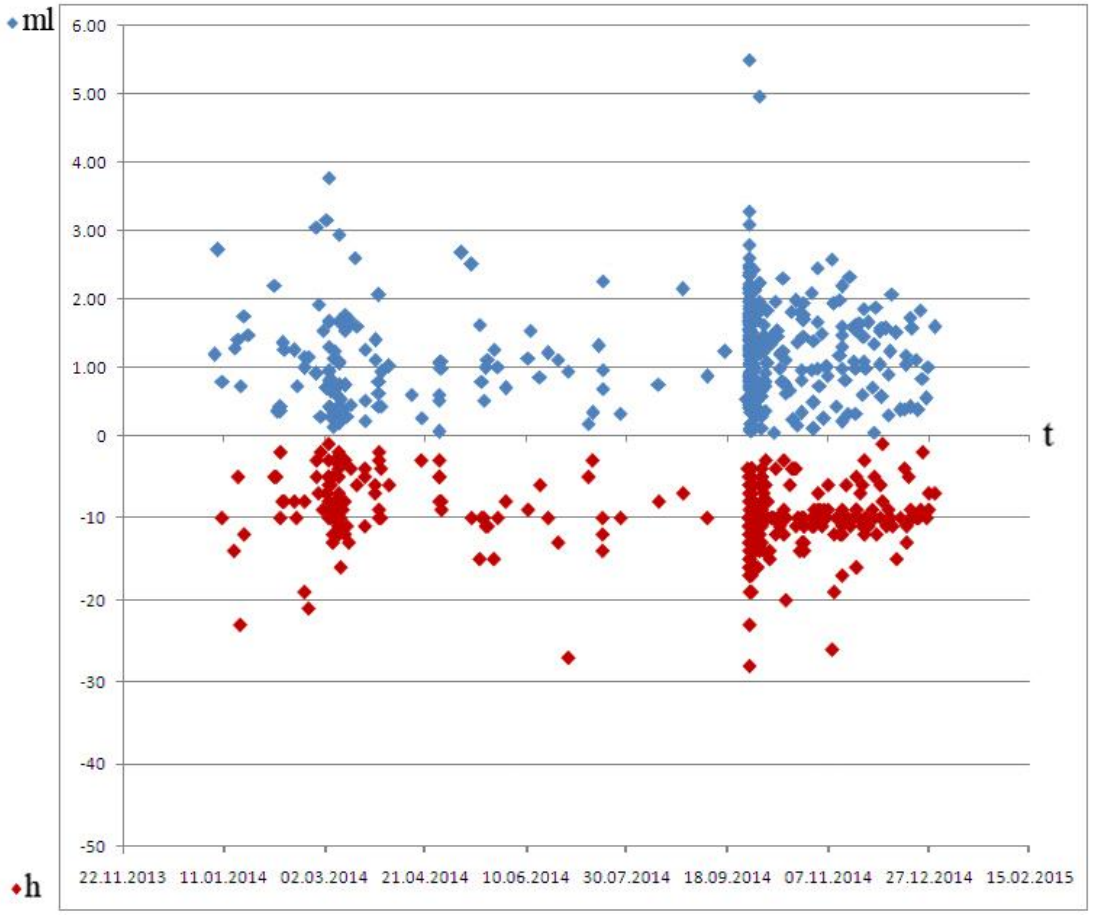


Figure 6. Time schedule of hypocenters' magnitude and depth in the area of Gabala in 2014.

In order to study the stress-strain state of the earth's crust of Azerbaijan, were built the mechanisms of earthquake source [6] with ml≥5 in 2014. (fig.7).

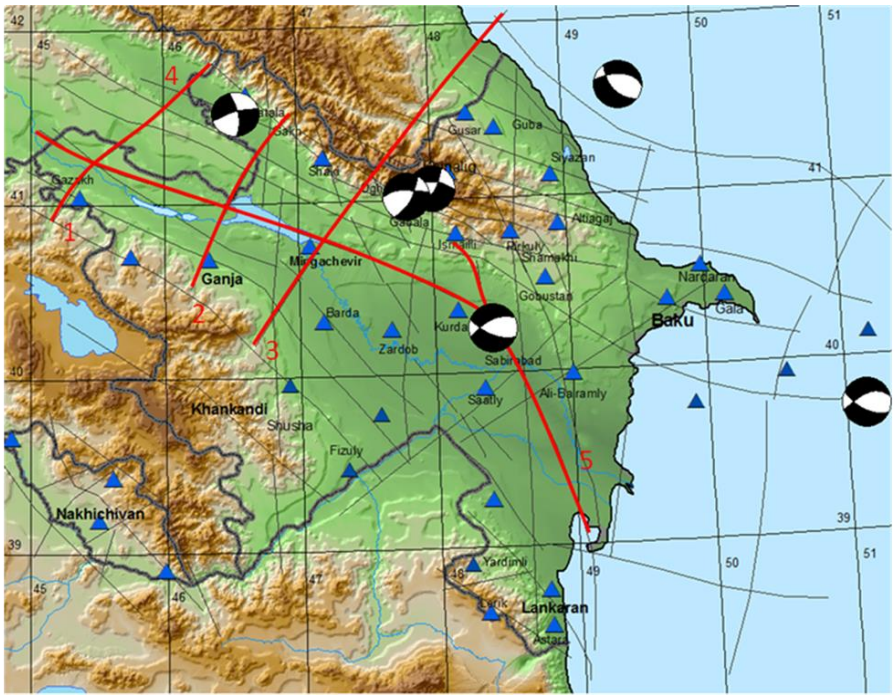


Figure 7. Earthquake focal mechanisms with ml≥5 in 2014.

Comparison of focal mechanisms of earthquakes that occurred in 2014 with schematic model of geodynamic regime of the south-eastern slope of the Greater Caucasus presented in research [3], indicates the predominance of tensile stresses, mainly related to the activity of cross faults.

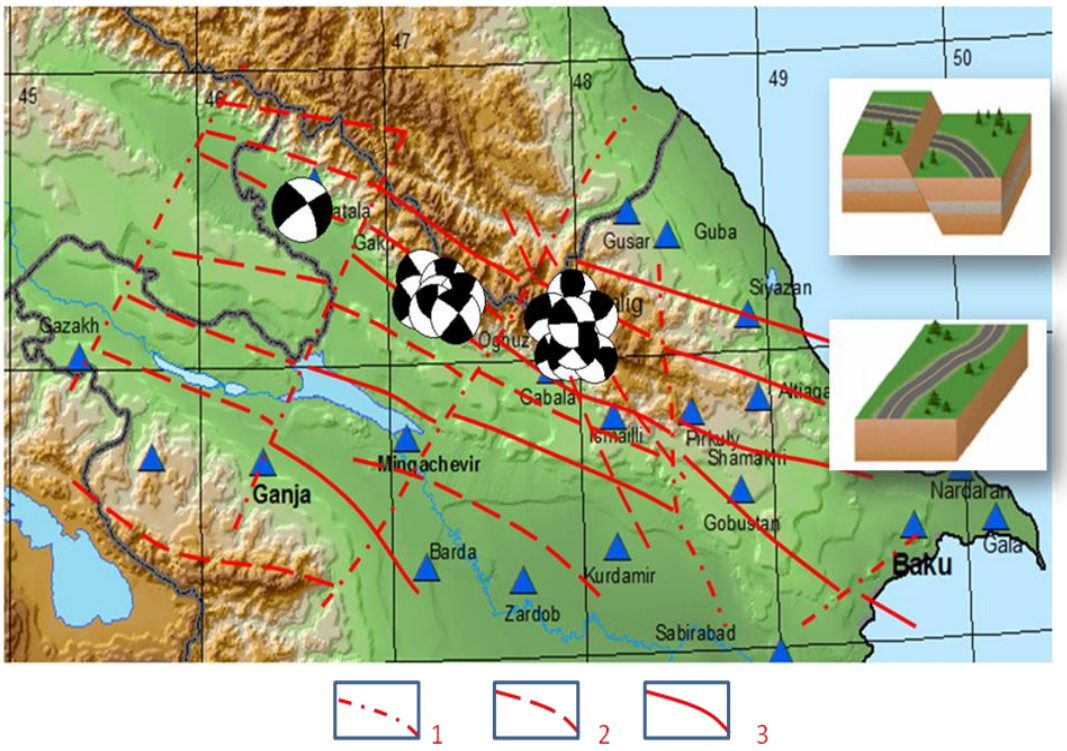


Figure 8. Main seismogenic faults and earthquake focal mechanisms with ml≥3.0 in the area of southeast immersion of the Greater Caucasus, 2014.

Main seismogenic faults, defining features of the geodynamic regime of the earth crust: 1-strike-slip, 2 normal fault, 3 reverse faults (arrows indicate the direction of horizontal movements).

Reverse faults: 1. Dashgil-Mudresin, 2. Vandam, 3. Geokchai, 4. Siyazan, 5. Zangi-Kozluchay, 6. Germian, 7. Adzhichay-Alat.

Shifts: 8. West Caspian, 9. Arpa-Samur, 10. Ganjachay Alazan, 11. Gazakh-Signaghi. Discharges: 12. North Adzhinour, 13. Yor, 14. Kur, 15. Mingachevir-Saatli, 16. Bashlybel, 17. Palmira-Absheron. Geodynamic elements: 4 –Rotation of blocks: A - in a clockwise direction; B – counterclockwise direction. 5 - Horizontal movements: A - tightening, B - thrusting, C – moving aside.

29th June earthquake, which occurred in the area of Zagatala-Balakan with ml = 5.3, was characterized by near horizontal compressive and tensile stresses, oriented to the southwest and northwest (Figure 8). The earthquake source was timed to steeply dipping faults bounding the raised blocks of igneous rocks. Focal mechanism of the earthquake - the shift-reset with left horizontal component, which is determined by geodynamics of a pair of right-shifts - Gazakh-Signakh and Ganjachay-Alazan [4].

For tangible February 10th earthquake, which occurred in the Hajigabul region, compressive stresses of east-north-east orientation were near vertical, and tensile stresses of south-southwest orientation - near horizontal. Type of motion on both planes - fault with shift components (Fig. 9).

The center of the earthquake is situated in the zone of geodynamic influence of West Caspian fault, i.e. tensile deformation, which characterized the geodynamics of the West Caspian strike-shift.

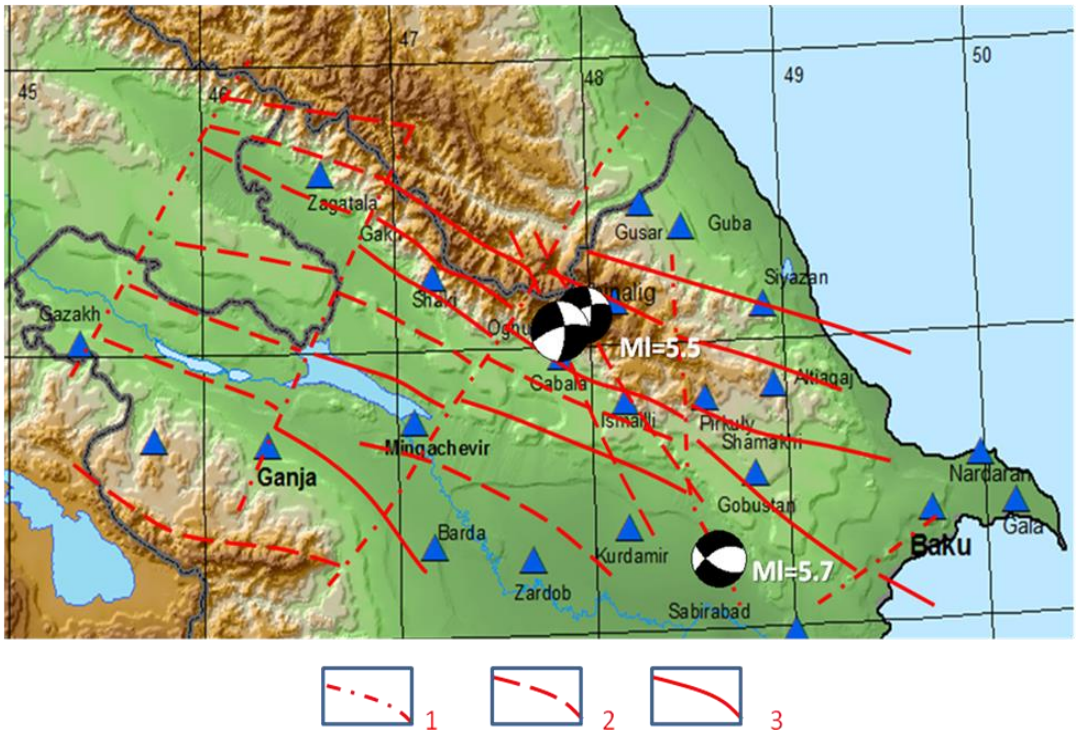


Figure 9. Geodynamic regime model and mechanisms of Hajigabul with ml = 5.7 in 10.02.2014. and Gabala with ml = 5.5, ml = 5.0 in 29.09. - 04.10.2014 earthquakes,
1-strike-slip, 2 normal fault, 3 reverse.

On September 29 and October 4 NE of Gabala, there were two earthquakes with ml = 5.5 and ml = 5.0, respectively. The source of the first earthquake was dominated by near vertical compressive

stresses. The type of motion along both planes is shift-discharge. Shifts in the source of the second earthquake occurred under the influence of near horizontal compressive stresses. The type of motion along both planes - shift with discharge elements.

The geodynamic situation of Gabala earthquakes' source formation is interpreted as a discharge-shifting deformation in the zone of geodynamic influence of orthogonal Ismayilli-Sighirli and a shifting deformation with discharge elements in the zone of influence of left cross fault of Arpa-Samur.

Gabala earthquake's sources are confined to the stretch zone and their mechanism is determined as a result of the right-sided shifting deformation in the zone of geodynamic influence of left-sided Arpa-Samur and Ismayilli-Sighirli faults, creating rotation of the block in the clockwise direction.

Thus, we can conclude the predominance of tensile stresses, mainly related to the activity of the transverse and orthogonal faults on the studied territory.

Examination of the space - time sequence of seismic shocks of varying magnitude to each seismic focal zone leads to the following conclusions:

- epicentral zones of most of the mentioned earthquakes are located in the foot hilled structural zone of Vandam;

- the spatial distribution of epicenters shows that the events of 2014 with ml≥5 are confined to cross (the north-western, north-eastern and sub-meridional strikes) disjunctive dislocations, but epicentral zones as a whole have a "common Caucasian" elongation and are located along Vandam tectonic zone of Ganikh Ayrichay-Alat deep thrust. The reason of seismic activity of the area is a combination of lateral compression forces with tensile forces;

- modern features of the area geodynamics are determined by the effect of discharges and emissions on the cross Caucasus stretch and transverse shifts SW-NE, intensified on post Alpine tectogenesis stage [5].

- is observed a shift structure of Kura River valley under the framework of the Greater Caucasus

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