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The Focal Mechanisms from the Seismic Zones within Greater Caucasus

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SUMMARY

As it is known, Caucasus is being a part of the Alpline-Himalaya orogenic belt is located between Eurasian and Arabian plate, which in its turn is acting toward north-west and making collision zone. This circumstance drives this area as earthquake-prone zone. A special interest is attracting southern slope of the Greater Caucasus. So that, there occurred strong and destructive earthquakes from historical time here, as well as the earthquakes with a strong enough magnitude were taking place in Instrumental period too. A series of strong earthquakes that occurred here in 2012 once more revealed the actuality of the problem of the seismic hazard assessment in this region. With this study the foci zones of the earthquakes that occurred here recently have been analyzed.

Focal mechanisms of earthquakes in the separate groups reveal different, mainly close-to-vertical, planes of fault and fault-slip type movements in the earthquake focuses. Only in four cases established were strictly upthrust and upthrust-overthrust type movements.

Introduction

The Greater Caucasus has formed during last stage of the tectogenesis in a geodynamic condition of the lateral compression, peculiar to the zone pseudo-subduction interaction zone between Northern and Southern Caucasian continental microplates.

Its present day structure formed as a result of horizontal movements of the different phases and sub-phases of Alpine tectogenesis (from late Cimmerian to Valakhian), and is generally regarded as zone where, along Zangi deformation, the insular arc formations of the Northern edge of South Caucasian microplate thrust under the Meso-Cenozoic substantial complex contained in the facials of marginal sea of Greater Caucasus. The last, in its turn, has been pushed beneath the North-Caucasus continental margin) of the Scythian plate (epihersynian platform) along Main Caucasus Thrust fault.

Materials and methods

Within the Azerbaijanian territory tectonically stratified alpine substantial complex of the marginal sea of Greater Caucasus is distinguished as a structural Southern Slope zone. Compressed between Major Caucasus from the north and Kbaad-Zangi from the south thrusts, the megazone is classified as allochthonous accretionary prism in the front of first deformation with its' roots buried under southern brow of the Scythian plate.

Allocated beneath accretionary prism of the Southern Slope, the autochthonous bedding is presented by Meso-Cenozoic complex of the northern Vandam-Gobustan margin (megazone) the South-Caucasian microplate, which is in its' turn crushed and lensed into southward shifted tectonic microplates gently overlapping the northern flank of Kura flexure along Ganykh-Ayrichay-Alyat thrust. Formation process of folded-cover structure of the Greater Caucasus accretionary prism is studied in direct connection with intracontinental S-subduction (pseudo-subduction) under pressure of the Arabian plate.

This assumption is justified by a number of researches to cover Caspian-Caucasus-Black Sea region. Described process continues also at the present stage of alpine tectogenesis as demonstrated by real-time GPS survey [1]. Monitoring of data on the distribution of horizontal shift velocity vectors, produced during 1998-2012 by GPS geodesic stations in Azerbaijan, indicates considerable (up to 17-18 mm/year) north-northwestward shifting velocity of the southwestern and central parts of South Caucasus microplate, including territories of the Southeastern part of Lesser Caucasus, Kur depression and Talysh. At the same time, within the microplate's northeastern flange confined to Vandam-Gobustan megazone of Greater Caucasus, velocity vectors reduce by 8-12 mm/year, while further to the north, on a hanging wall of Kbaad-Zangi deep underthrust, e.g. directly within the boundaries of accretionary prism the velocity becomes as low as 0-4 mm/year (2010-2012 data) [2].

Discussion

The reduction of GPS velocity rates reflects consecutive accumulation of elastic deformations within pseudo-subduction interaction zones between structures of the northern flank of South Caucasus microplate and the accretionary prism of the Greater Caucasus. Continued pseudo-subduction is indicated by unevenly distributed seismicity by depths (seismic levels of -2-6, -8-12, -17-22 and -25-45 km): distribution analysis of the earthquake cores evidences the existence of structural-dynamic interrelation between them and the subvertical and subhorizontal contacts in the earth crust. Horizontal and vertical seismic zonality is explained from the viewpoint of block divisibility and tectonic stratification of the earth crust, within the structure of which the earthquake cores are confined mainly to an intersection knots of the ruptures with various strike, or to the latitudes of deep tectonic failures and lateral shifts along unstable contacts of the substantial complexes with different competency.

Types of focal mechanisms in general correspond to the understanding of geodynamics of the microplates' convergent borders, where the entire range of focal mechanisms, from normal-fault to upthrust, is observed. At the contemporary stage of tectogenesis the maximum seismic activity is indicated in structures of the northern flank of South Caucasus microplate controlled by Ganikh-Ayrichay-Alat deep overthrust of the "general Caucasus strike" in the west, and submeridional right-slip zone of the West-Caspian fault in the east of the Azerbaijani part of Greater Caucasus.

Under lateral compression the small-scale blocks that constitute the region's earth crust become reason for the creation of transpressive deformations, which combine shift movements along limiting

transversal deformations with compression structures to include general Caucasus strike ruptures. Such regime leads to a creation of multiple concentration areas of the elastic deformations confined to mentioned dislocations and their articulation knots. It is just the exceeded ultimate strength of the rocks that causes energy discharge and brittle destructions (according to stick-slip mechanism) in such tectonically weakened regions of the southern slope of Azerbaijani part of Greater Caucasus.

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This fact is particularly proved by earthquakes which have taken place between May and December, 2012 in Zagatala, Sheki and Balakan (Figure 1.).

Figure 1 Map of Earthquake foci zones of the North-West Azerbaijan (I – Zagatala, May, 2012, II – Balaken, October, 2012, III – Sheki, May, 2012).

Zagatala earthquake

Focal zone of the earthquake is confined to a complex intersection knot of different strike faults, and is located in Pre-Jurassic basement. The very seismic event is mainly related with activity of Zagatala fault with northwestern strike which caused activation of connected dislocations.

Balakan earthquake

Focal zone of the earthquake is confined to a complex intersection knot of the faults with various strike, and is located in the upper part of Pre-Jurassic basement. Discharge of seismic energy occurred in most granulated zones confined to the intersection knots of these dislocations with faults of the general Caucasus strike.

Sheki earthquake

Earthquake's focal zone is situated in the upper part of Pre-Jurassic basement. Seismic event is connected with activity of subvertical faults with northeastern strike. Discharge of seismic energy occurred in most granulated zones confined to the intersection knots of these dislocations with faults of the general Caucasus trace.

Conclusion

Study of space-time succession of seismic impacts with various magnitudes in each seismic focal zone brings out following conclusions:

- Epicenters' spatial distribution demonstrates that mentioned events are confined to transversal disjunctive dislocations.

- Hypocenters of major seismic impacts ($M = 4,5-5,7$) and absolute majority of aftershocks are confined to a pre-Jurassic basement's surface or its' depths of up to 20 km;
- Lateral compression firstly contributed to a creation of transpressional failures along the displacement planes of various-strike transversal dislocations, and the energy discharge in most granulated and weakened areas confined to the intersection knots of these dislocations between each other and with deep overthrust with its' northern rear flakes.

References

Kadirov, F., Mammadov, S., Reilinger, R. and McClusky, S. [2008] Some new data on modern tectonic deformation and active faulting in Azerbaijan (according to Global Positioning System Measurements). Proceedings Azerbaijan National Academy of Sciences. *The Sciences of Earth*. №1 p.82-88.

Philip, H., Cisternas, A., Gvisiani, A. and Gorshkov, A. [1989] The Caucasus: An actual example of the initial stages of continental collision. *Tectonophysics*, **161**, 1–21