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Seismotectonic movements – one of the main receptors in exodynamic processes

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Abstract

One of the most important tasks in the modern civilization is the study of the mechanism of exodynamic processes in nature, catastrophes caused by them and the problem of management of such processes. Defending society from natural disasters has become more actual problem nowadays, as disorganized and often irrational human interference in natural processes is often followed by sharp imbalance in the environment and development of vast natural catastrophes. The problem is especially acute in mountainous regions.

In Georgia the complicated geomorphologic and geotectonic conditions provoke activation of landslides, mudflows, erosions, which in their turn, in case of deterioration of harsh climate conditions cause activation of disastrous processes, damage of living environment and often human loss. Dimensions of landslide-gravitational processes in Georgia are conditioned by the fact that the bulk of the territory is situated within the VII-IX intensity earthquake belt. Georgia is characterized with complex geomorphologic and geotectonic structure and belongs to so called continental collision block, the tectonic processes in which are expresses by the seismicity in the region. As a global phenomenon it is observed as deformations caused by collision of lithospheric plates and movement of the Arabian continental block by several cm per annum in the northern direction.

According to catastrophe risk index Georgia belongs to the list of countries with medium and high risks.

Increase in occurrence and intensity of the natural catastrophes, high level of disasters risks have required adopting of international strategies and programs.

Exodynamic natural processes depend on multiple, different from one anther, always active and time variation factors. These factors stipulate genesis, development and activation of exodynamic processes.

The main factors that cause disastrous processes may be divided in two parts: 1. the main, internal factors depending on the geotectonic structure of the region and 2. the external factors caused by natural phenomena – climate variation, human influence on the dynamic imbalance of the upper crust of the earth, etc [1,2,4].

The main factors determining the exodynamic processes are the engineering-geologic structures of the rocks in the region. Rocks are considered as a multicomponent dynamic system, the state (structure and properties) of which regularly changes from diagenesis to hypergenesis. Geomorphologic structure of the environment, relief shapes, its energy gradients that are tightly connected with the contemporary tectonic movements are very important for development of the above mentioned processes. Formation of morphogenesis is substantially influenced by the gravity force – a stress vector that is determined by tectonic movement gradient and energy potential of the relief [1,4].

Unity of endogeneous processes in soil and exodynamic processes on the day surface form the landscape shapes of the Earth crust and geomorphologic formations of the environment. Besides, activation of exodynamic processes mainly depends on contemporary seismotectonic vibrational processes.

The contemporary seismotectonic vibrational motions are very important for formation of geologic condition of a region. It may be admitted that contemporary tectonic movements and seismic phenomena are the main receptors for gravitational processes. In Georgia there is a great

deal of information on neotectonics and seismology as a result of numerous investigations. However, the qualitative and quantitative assessments of the contemporary movements and seismic hazard risks have not been completely done.

For assessment of the contemporary geomorphologic formation of the Earth's crust it is necessary to briefly review the history of its geological development.

The neotectonics of the regions of the Caucasus and Ponto refer to the fact that here new stage of geological cycle is developing that refer to certain cyclic nature of the late Alpine tectonic movements and consequently the innateness of the relief morphostructure.

The present shape of the Caucasus region was formed at the beginning of Miocene and Pliocene, the time when the Caucasian mega-anticlinorium was intensely and the Greater and Lesser Caucasus were formed. The rate of vertical movements especially increased in antropogen period when that main ridge of the Caucasus rose by 3-5 km (Hain), and the one in the Lesser Caucasus – by 2-3.5 km (Milanovsk). By this time in the sinking zones of the Transcaucasian territory the basins of the Caspian and the Black Sea were formed, and in the rising zones some crystal massifs appeared. The summarized movement amplitude in the region was 10-11 km. In the Pliocene-Miocene period the rise amplitude in the central segment of the Greater Caucasus was 4.75 km, in the then-time western and eastern regions – 2.5-3 km. Such a diapason of the neotectonic movement stipulated high energy potential of the relief. Consequently, the rising rate in the mountain system of the Caucasus increased and accumulation of coarse-granular continental sediments in the sinking zones was more massive as well. In the post-upper-Pleistocene period the rising rate of the Alpine orogenesis mountain system increases more intensely and reaches the maximum point in the Holocene.

The orogenic movements were accompanied by deep fault formation. Faults of seismic origin were especially observed in the cases of block compositions of geological structures where separate blocks moved by irregular speed. It was expressed in relief morphology, in slope inclinations by different angles, in the formation of low density sediments and development of hydrologic net in them.

In the middle of the twentieth century a new cycle of activation of seismic phenomena was recorded in the Caucasian region, examples of which are the earthquakes of Gegechkori in 1957, Madataph in 1959, Klukhori and Chkhalta in 1969, Zangezuri and Alaverdi in 1968, Dagestan in 1970, Dmanisi in 1976, Spitak in 1988, Racha-Imereti in 1991, Mtiuleti in 1998, Vani in 2010, etc. Some periods of earthquake recurrence were observed. The period of strong, intensity IX earthquake recurrence in the Caucasus lasted during 60-100 years, intensity VIII earthquakes – 10-15 years, intensity V earthquakes – 4 years, and intensity II earthquakes – 2 years. On slopes with tectonic stress the gravitational processes were manifested as intensity III-IV earthquakes; on the slopes with more than 40% inclination some landslide processes were activated and conditions for development of mudflows were prepared [1,3,4].

The geomorphologic and geodynamic investigations make it obvious that all the strong earthquakes in the Caucasus are caused by sign-changing movements of morphostructure blocks. The contemporary strong seismodislocations and gravitation phenomena are directly linked with seismotectonic zones.

The foci of all the strong earthquakes recorded in the Caucasus are situated in the granite layer. The earthquake foci on the Javakheti Highland are situated in the 5-10 km depth, on the Caucasus – in the 15-30 km depth, and on the Georgian block – 20 km depth.

The slope-gravitation processes caused by earthquakes are very quick-acting and do not depend on time factor. It mainly depends on slope stress, material constitution and water intrusion quality of the rocks.

There are two main cases of earthquake influence on gravitation processes: 1) the earthquake is manifested as force factor and reason for quick action (landslide, avalanche, vast collapse); 2) the earthquake is a mechanism that stimulates imbalance in gravitation slopes followed by development of landslides and mudflows, e.g. in the Adjara shore line the intensity IV-V

earthquake in 1968 caused activation of calmed earthquake foci in the Kobuleti and Khelvachauri regions.

Activation of exodynamic processes are mainly stipulated by endogenic processes in soil, in particular, earthquakes that may provoke landslides, mudflows, rock-avalanches and any microtectonic movements. A typical example for it was the Racha-Imereti earthquake that caused rock-avalanche and in its turn, it destructed the whole village of Khakhieti in Racha.

During the recent years the increased activation of exodynamic processes, high level of catastrophe risks stipulated working out international strategies and programs. Within the framework of the UNDP Development Program many of projects have been planned. The projects aim to eliminate probable risks and damages. These programs meet the priorities of the main working program and serve to the interests of the world development.

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References

[1] Церетели Э.Д. – Природно-катастрофические явления и проблема устойчивого развития Грузии и приграничных территорий. Диссертация на соискание ученой степени докт. геогр. Наук, Тбилиси, 2003.

[2] წერეთელი ე., გობეჯიშვილი ხ., ბოლაშვილი ნ., გაფრინდაშვილი გ., ნანობაშვილი თ. – ბუნებრივი ეგზოდინამიკური კატასტროფების მდგომარეობა და ანთროპოგენური დატვირთვის რისკი საქართველოში, მათი მართვის ოპტიმიზაციის ქმედებები, გეოგრ. ინსტ. შრომათა კრებული, ახალი სერია, №4(83), თბილისი, 2012.

[3] Цицишвили Д.А. – Инжинерная геофизика в условиях горной страны. Тбилиси, Мецниереба, 1980, с 216.

[4] ჭელიძე თ. – გეოფიზიკური მეთოდები ბუნების დაცვაში, თბილისი, 2004, გვ. 267.

Сейсмотектонические явления – основные рецерторы экзодинамических процессов

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Резюме

Экзодинамические процессы зависимы от многих, отличающих друг от друга постоянных и меняющихся во времени факторов. Они определяют возникновение, развитие и активизацию экзординамических процессов. Современные тектонические движения и сеисмические явления представляют собой основные рецепторы гравитационных процессов. На Кавказе все сильные землетрясения обусловлены знакопеременными движениями морфоструктурных блоков.

სეისმოტექტონიკური მოძრაობები – ეგზოდინამიკური პრიოცესების ერთ-ერთი ძირითადი რეცეპტორები

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რეზიუმე

ბუნებაში მიმდინარე ეგზოდინამიკური პროცესები მრავალ, ერთმანეთისაგან განსხვავებულ მუდმივ მოქმედ და დროში ცვალებად ფაქტორებზეა დამოკიდებული. ისინი განაპირობებენ ეგზოდინამიკური პროცესების წარმოშობას, განვითარებას და აქტივიზაციას. თანამედროვე ტექტონიკური მოძრაობები და სეისმური მოვლენები არის გრავიტაციული პროცესების ერთ-ერთი ძირითადი რეცეპტორები. კავკასიაში ყველა ძლიერი მიწისძვრა განპირობებულია მორფოსტრუქტურული ბლოკების ნიშანცვლადი მოძრაობებით.