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FACTORS FOR THE OCCURRENCE OF SMALL-FOCUS EARTHQUAKES IN THE MIDDLE AND LOWER KURA DEPRESSIONS

Abstract

The hypocenters of the earthquakes that occurred in the Kura depression are confined to the zones of its junction with the surrounding mountain structures of the Lesser Caucasus and the Greater Caucasus, where tectonic faults with complex properties are developed. At the same time, a significant part of earthquakes occur in zones where there are no breaks in the Earth's crust, and these events are not accompanied by ripping of the earth's surface.

According to the results of the structural interpretation of seismic data, it has been shown that there are no tectonic faults in the inner areas of the Kura depression, which are involved in the process of releasing elastic energy (stress) created as a result of the convergence of the Eurasian and Arabian lithospheric plates. It is shown that almost half of the total number of small focus earthquakes within the territory under consideration arise as a result of multidirectional spatial movement of blocks of a heterogeneous base (foundation) without provoking ruptures in the upper plastic geological medium and the Earth's surface. In some zones, such earthquakes also occur in the inner part of the Mesozoic stage of the geological section, which is also characterized by a heterogeneous structure. It is shown that some of the earthquake sources in the territory under consideration are formed as a result of thrusting of one mass onto another along planes that have a subhorizontal direction. Such processes occur in the Cenozoic interval of the earth's crust. It is shown that most of the discovered deposits in the territory covered by this study are associated with reservoirs created by paleo-river arteries and have no connection with tectonic faults. Thus, assumptions about the formation of hydrocarbon deposits with the participation of tectonic faults are not confirmed by the results of interpretation of seismic data. The studies were carried out with a joint integrated analysis of seismic data carried out in the period from 1993 to 2019 and seismological observations since 2003 to 2019.

Keywords: *earthquake focus, hypocenter, epicenter, reflected wave method, shallow-focus earthquakes, tectonic breaks*

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Orta və Aşağı Kür çökəkliklərində kiçik fokuslu zəlzələlərin baş vermə səbəbləri

Xülasə

Kür çökəkliyində qeydə alınan zəlzələlərin hiposentrləri onun Kiçik və Böyük Qafqazın dağları ilə təmaslarındakı mürəkkəb xassələrə malik tektonik qırılmaların inkişaf etdiyi zonalarda baş verir.

Eyni zamanda buradakı zəlzələ ocaqlarının əhəmiyyətli hissəsi yer qabığında qırılmaların olmadığı depressiya zonalarında baş verir və bu hadisələr yer səthində yarılmalarla müşayiət olunmur.

Seysmik məlumatların geoloji interpretasiyasının nəticələri Avrasiya və Ərəbistan tavalarının qarşılıqlı təsirindən Kür çökəkliyinin daxilində yaranan elastik enerjinin (gərginliyin) boşalması prosesində (relaksasiya) iştirak edən tektonik qırılmaların olmadığını göstərir. Məqalədə göstərilir ki, baxılan ərazi daxilində kiçik fokuslu zəlzələlərin ümumi sayının demək olar ki, yarısı üst elastik (plastic) geoloji mühitdə və Yer səthində qırılmalara səbəb olmadan heterogen təməlin (bünövrənin) bloklarının çoxistiqamətli məkan hərəkətləri nəticəsində yaranır. Bəzi zonalarda bu cür zəlzələlər həm də heterogen strukturu ilə xarakterizə olunan geoloji kəsilişin mezozoy mərtəbəsinin daxili hissəsində də baş verir. Göstərilmişdir ki, nəzərdən keçirilən ərazidə zəlzələ mənbələrinin bir hissəsi subhorizontal istiqamətli layların (müstəvilər) səthilə bir kütlənin digərinin üzərində yerdəyişmələri (üfüqi sıxılma nəticəsində) nəticəsində əmələ gəlir. Belə proseslər daha çox yer qabığının kaynozoy intervalında baş verir. Tədqiqatın nəticələri Kür çökəkliyindəki yataqların yaranmasında tektonik qırılmaların iştirak etmədiyini göstərmişdir. Burada aşkar edilmiş yataqlar ana süxurlarda əmələ gələn karbohidrogen flüidlərinin elə laydaxili miqrasiya vasitəsilə rezervuarlarda toplanması nəticəsində yarandığını vurğulayır. Tədqiqatlar 1993-cü ildən 2019-cu ilə qədər aparılan seysmik məlumatların və 2003-cü ildən 2019-cu ilə qədər aparılan seysmoloji müşahidələrin kompleks təhlili ilə aparılıb.

Açar sözlər: *zəlzələ ocağı, hiposentr, əks olunan dalğa üsulu, dayaz fokuslu zəlzələlər, tektonik qırılmalar*

Introduction

The territory of Azerbaijan is located in the zone of active interaction between the Arabian and Eurasian lithospheric plates, which causes the formation of a fold-thrust tectonic structure here, with an elongated strike of the Caucasian direction. The map of the distribution of earthquake epicenters (Fig. 1) also shows that the active geodynamic processes occurring here are expressed in the multidirectional movement of the earth's crust and seismicity. In the Greater and Lesser Caucasus, the maximum uplift rate reaches 10 and 6 mm/year, respectively, when the upper layers of the Earth’s crust in the Kura depression sag, in general, at a rate of 5 mm/year (Kadirov, 2015: 3-17; Lukk, 2019: 99-123). At the same time, the entire territory is moving to the northeast at a rate of 10 mm/year. According to the map of the distribution of earthquake epicenters shown in Fig. 1, it can be seen that in the junction zones of the Srednekura depression with the surrounding mountain structures of the Caucasus, a band of tectonic faults can be traced. Note that the locations faults indicated on the map (Kerimov, 2002) were refined using geological data and based on the results of interpretation of regional seismic works (Yusubov, 2017: 12-17; Yusubov, 2020: 11-17).

Along the line of contact between the Middle Kura depression and the Lesser Caucasus, two lines of tectonic ruptures can be traced − Cis-Malokavkazsky and Kurinsky.

In the junction zone of the Srednekura depression with the Ajinour trough, there is a band of ruptures, which include Udabno-Erkidar, Adzhichay-Alyat and Udabno-Geokchay. The Ajinour trough, in turn, is separated from the structures of the Greater Caucasus by deep faults North Kakheti-North Ajinour and Kvarelli-Gabala-Heradil. All of these deep faults cross the Meso-Cenozoic stage of the geological section.

The structure of the Kura depression, in contrast to the mountain structures of the Lesser and Greater Caucasus, is characterized by less structural dissection and relatively weak seismicity. Geological sections located in the Kura depression of the Middle and Nizhnekurinsky troughs separated by the Kurdamir-Saatly buried uplift, sharply different layers are distinguished, generally representing the section of the Alpine cover and the consolidated complex of the earth's crust. The structural features of these seismically active segments determine the conditions for the occurrence of small-focus earthquakes here, which is clearly expressed by the dynamic and kinematic characteristics of the seismic wave field recorded during seismic exploration by the method of reflected waves (Fig. 2, 3 and 4).

The Middle Kura trough, divided into two segments by the Saatly-Geokchai Mesozoic ledge, is filled with relatively thick strata of Cenozoic, Mesozoic, and, presumably, Paleozoic deposits. In the western part of the trough (the Kura-Gabyrry Interfluve) the upper structural stage of the sedimentary complex of deposits, represented by molasse formations and crumpled into narrow linear folds by the general Caucasian strike, is complicated by thrusts along which the northeastern limbs of the folds are pushed over the southwestern ones (Fig. 2). With depth, the folds are simplified; in the lower part of the Maikop Formation and the Paleogene era, as a rule, attenuation of thrusts is observed. In this part depressions Mesozoic deposits are practically not deployed. In the trough, Jurassic and Cretaceous deposits, characterized by a block structure, are located above the pre-Alpine basement with a heterogeneous structure composed of granitoids, gneisses, and crystalline schists. This interval of the geological stage (Jurassic-Cretaceous) will inherit the structure of the foundation (Fig. 3).

Morphostructure of the buried basement predetermined the different thickness of the sedimentary layer in the Srednekura depression. Here the Mesozoic surface lies at depths of 3-5 km in the west and 1-6 km in the east, and the consolidated crust at depths of 6-10 km in the west and 6-16 km in the east.

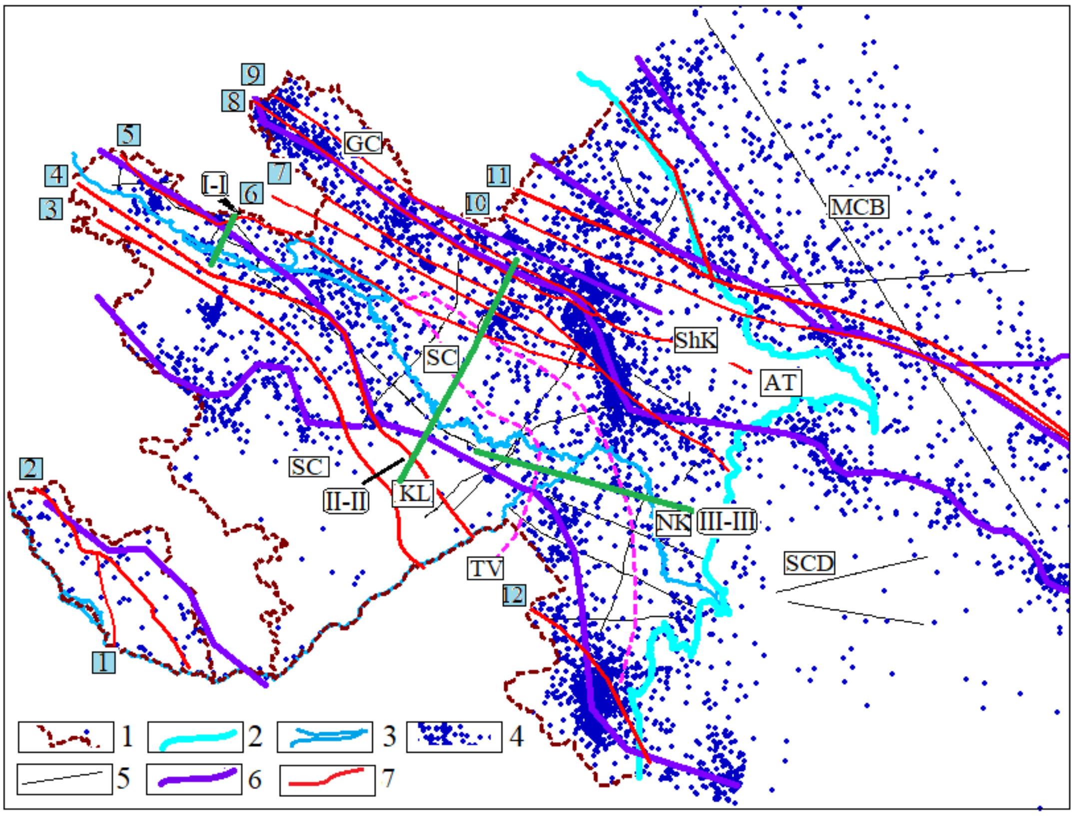


Fig. 1. Map of epicenters that occurred in 2003-2019 earthquakes, with magnitude Ml>3, according to the Azerbaijan Seismological Service. On the map, red and purple lines mark tectonic faults according to geological-geophysical and seismological data, respectively.

1 − state border; 2 − coastline of the Caspian Sea; 3 − bed of the Kura and Araks rivers; 4 − earthquake epicenters; 5 − lines of development of regional seismic profiles; 6 − lines of alleged faults according to seismological observations (determined by the author of the article); 7 − lines of tectonic faults according to geological and geophysical data.

Inside the squares, the main structural units are marked: BK − the Greater Caucasus; MK − Small Caucasus; SK, Srednkura Depression; NK − Nizhnekurinskaya depression; SK − South Caspian Depression; SKB, Middle Caspian Depression; ShK − Shamakhy-Kobystan trough; AP − Absheron trough; TV − Talysh-Vandam zone of Mesozoic uplifts (Saatly-Geokchay ledge); KN − Karabakh lowland. Inside the squares, the main structural units are marked: GC − the Greater

Caucasus; SC-Small Caucasus; SC − Srednkura Depression; NK − Nizhnekurinskaya depression; SCD − South Caspian Depression; MCB – Middle Caspian Bassin; ShK − Shamakhy-Kobystan trough; AT − Absheron trough; TV − Talysh-Vandam zone of Mesozoic uplifts (Saatly- Geokchay ledge); KL − Karabakh lowland.

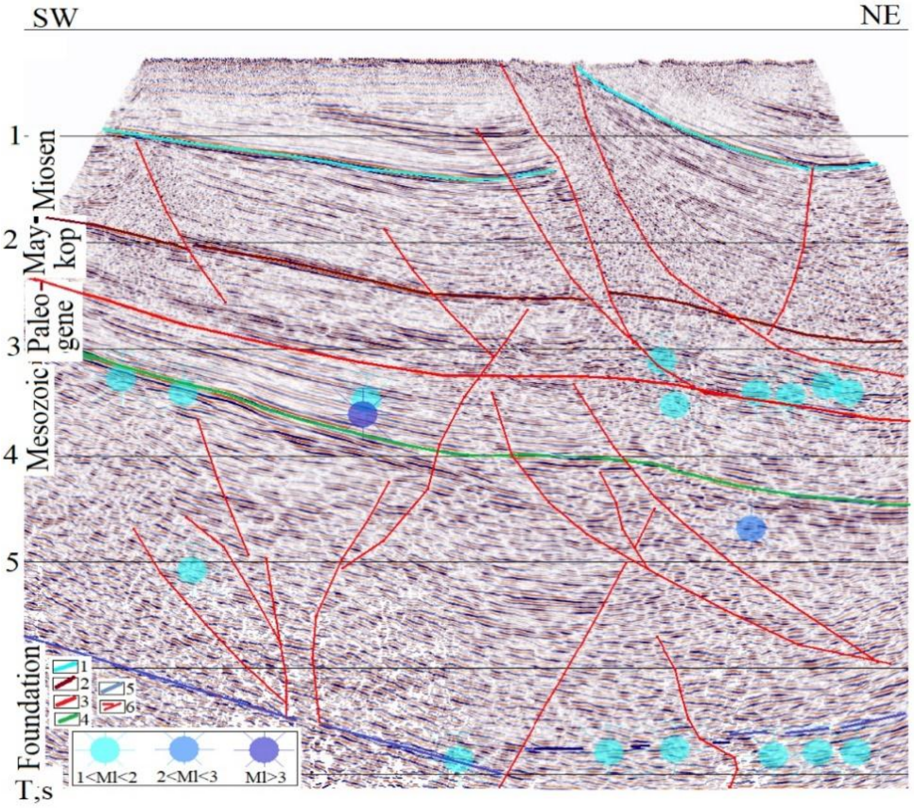


Fig. 2. Seismic time section along the profile of the worked out SW-NE direction, in the western part of the Srednekura depression (line I-I, in Fig. 1 is marked in green). In the lower left corner of the figure, inside the rectangle, earthquake magnitudes are marked with multi-colored circles: Seismic horizons on surfaces: 1 − Miocene; 2 − Maikop; 3 − Eocene; 4 − Mesozoic; 5 − foundation; 6 − tectonic faults and cracks.

In the Nizhnekura depression, the consolidated crust, with a heterogeneous structure, occurs at depths from 6 km in the southwest to 20 km in the northeast. It is covered by a sedimentary complex of Paleogene-Quaternary deposits. According to (Kerimov et al., 2002; Yusubov, 2020: 11-17), the depression is isolated in the northeast by the Adzhichay-Alyat, and in the west-southwest by the Perd Lesser Caucasus and Talysh faults. It seems to us that the last two faults are components of a single fault. In the south-west of the basin, up to the Pre-Talysh fault, the Jalilabad trough is isolated.

Between the Middle and Nizhne-Kura troughs, along the top of the Cretaceous deposits, the Kurdamir-Saatly ledge with a northwest-southeast strike clearly emerges (Fig. 1 and Fig. 4). Here, the top of Cretaceous rocks occurs at depths of 3.5-4.5 km versus 6-8 km in the troughs that limit it from the northeast and southwest. The eastern flank of this uplift plunges sharply towards the Caspian Sea, and in the west towards the Yevlakh-Agjabedi trough. There are opinions that this ledge is limited by two large faults − the West Caspian in the east and the Imishli-Goychay in the west (Kengerli, 2005: 32-42). These faults are not confirmed by the results of data interpretation (Yusubov, 2017: 12-17; Yusubov 2017a: 304-312; Yusubov, 2020: 11-17) of the seismic survey by the common depth point method (CDP) performed in 2017-2018. It is interesting that the distribution density of earthquake epicenters in the territory occupied by this protrusion and the zones of the Middle and Lower Kura depressions is almost the same.

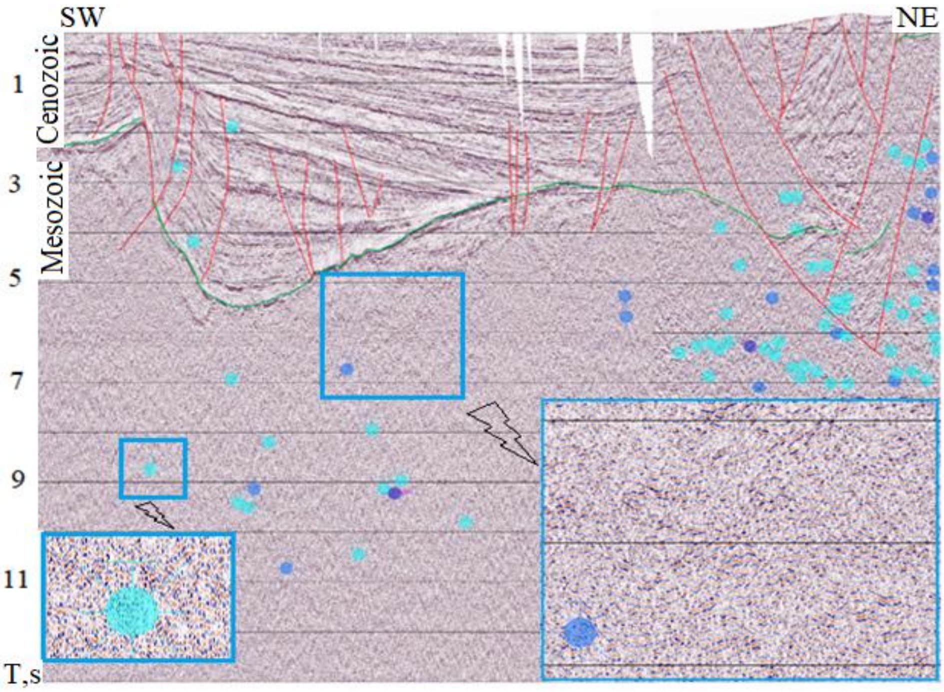


Fig. 3. Seismic time section along the profile in the developed SW-NE direction, in the central part of the Srednekurinsky depression (line II-II, in Fig. 1 marked in green). Inside the enlarged rectangles, it can be seen that the environment is characterized by a heterogeneous structure. Symbols are shown in Fig. 2.

Statistical analysis of seismic events

An analysis of earthquakes recorded in the territory of Azerbaijan for the period of 2003 to 2019 shows that the vast majority of them (99%) belong to the class of shallow-focus earthquakes. Often they appeared in groups (Fig. 1). A band of relatively weak seismicity during this period was observed within the Kura depression, in the South Caspian depression and the Karabakh lowland. The territory of the last two can practically be attributed to the aseismic category.

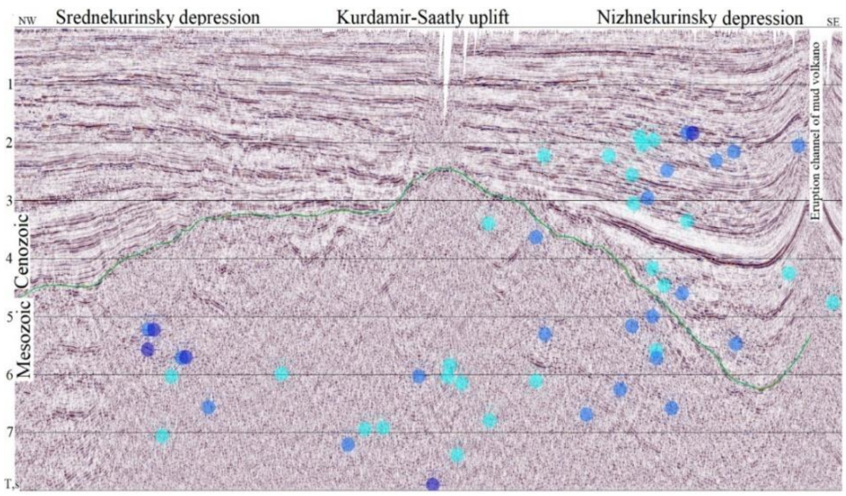


Fig. 4. Seismic time section along the profile in the developed NW-SE direction. In the central part of the section one can clearly see the Kurdamir-Saatly buried uplift, with a heterogeneous structure separating the Srednekura and Nizhnekura depressions (line III-III, in Fig. 1 marked in green). The time section shows that the Mesozoic interval is characterized by a heterogeneous structure. Symbols are shown in Fig. 2.

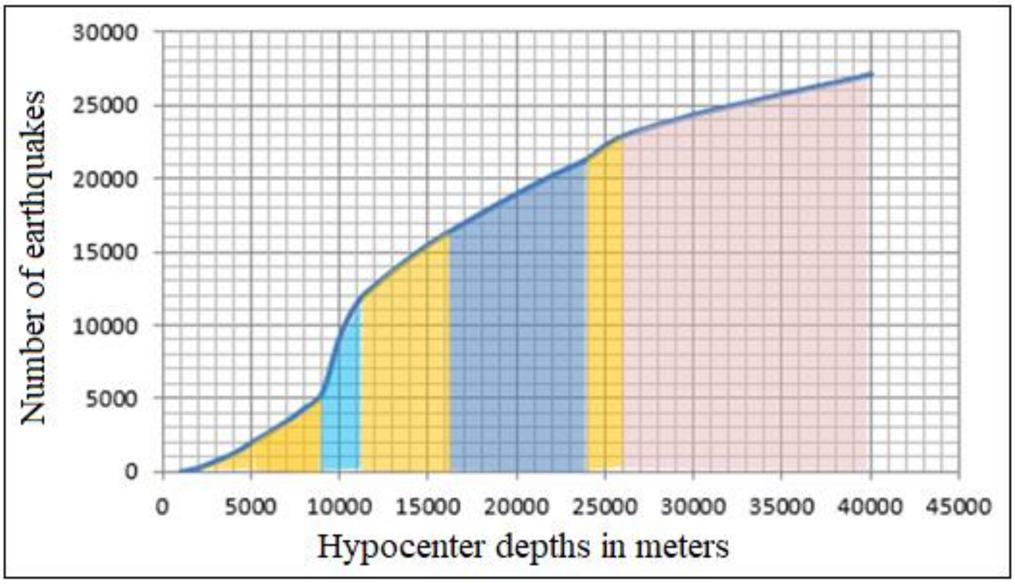
The number of earthquakes that occurred and the density of their distribution (Table No. 1) indicates that approximately 2.2 times more earthquakes occur in mountainous and foothill areas than in depression zones. At the same time, earthquakes with Ml > 3 occurred in depression zones during the period 2003-2019, 1.4 times more than in mountainous and foothill areas. Table No. 2 shows that the total number of earthquakes that occurred at depths of less than 16 km (the average depth of the sedimentary cover) and more than 16 km of earthquakes is almost the same. On the whole, 50% of earthquakes occur in the depth interval from 4 to 17 km (corresponds to the interval between the top of the basement and the bottom of the Mesozoic deposits). Figure 5 shows that the curve of dependence of the number (N) of earthquakes on the depth of hypocenters (H) can be divided mainly into 6 intervals (marked with colors). The strongest gradients along this curve are observed at depths of 9-11 km (closest to the bottom of the Cenozoic) and 24-26 (closer to the bottom of the sedimentary complex).

Table 1.
The number and density of earthquakes that occurred in 2003-2019

Area sq. k m	Total number of earthquakes		Quantity of land per 1 sq. km	Area characteristic
	PC.	%		
174000	27778	100	0.1 60	Whole territory
13 2000 _	8669	31	0.0 66	Lowland and sea. aquat.
4 2000 _	19109	69	0.454 _	Mountain and foothill areas

Table 1.
Earthquake epicenter depths and magnitudes

Area sq.k m	Total number of earthquakes	H>16 km	H<16km	ml>3	ml<3	Area characteristic
174000	27778	13941	13837	859	26919	Whole territory
132000	8669	6679	1990	420	8249	Nizm. and sea. aquat.
42000 _	16566	6219	1 0347	302	16194	Mountains and foothills



Rice. 5. Dependence of the number of incidents in the territory of Azerbaijan and peripheral regions, for 2003-2019 earthquakes, with hypocenters of depths up to 40 km. The curve is divided into 6 conditional, in depth, intervals with different gradients (marked with light scale): 1-9 km, 9-11 km, 11-16 km, 16-24 km, 24-26 km, 26-40 km. The intervals of the curve corresponding to depths differ in the highest gradient: 9-11 km (6000 earthquakes/2 km) and 24-26 km (5000 earthquakes/2 km). Depths of 9-11 km are closest to the bottom of the Cenozoic, and 24-26 to the bottom of the sedimentary complex.

On fault tectonics and connection of earthquake hypocenters with them.

The idea of a connection between earthquake sources and tectonic faults is supported by many specialists, including foreign ones (Jackson, 2001: 214-245; Aki, 1983: 510; Gadzhiev, 1965: 200; Sonnenstein, 1990: 327, etc.). According to *the plate tectonics hypothesis* (mobilism), the statement is correct. But there are no tectonic plates on the territory of Azerbaijan, at the contacts of which the centers of earthquakes would be located. In addition, according to the data of the work (Aki, 1983: 510) and the catalog (Yetirmishly, 2021: 3-18), mainly small-and rarely medium- focus earthquakes occur here. The results of the work (Kuzmin, 2018: 967-987; Mammadli, 2016: 5-16; Metaksas, 2011: 314-321; Piip, 2012: 45-51) make it possible, at first glance, to find an indirect connection between foci of intermediate-and deep-focus earthquakes with deep tectonic faults. Therefore, the study of tectonic faults is of paramount importance, both for a correct understanding of the modern dynamics and history of the development of any region, and for seismic hazard assessment. In addition, for the correct prediction of seismic risk in the region, it is important to know not only the position of the faults (in plan and at depth), but also the type of movements realized with their participation, the times of their activation, the characteristic amplitudes and velocities of movement along them.

There are three main types of faults, each of which can cause block-to-block earthquakes. During faulting (or a fault with a dip displacement) and shear, the main direction of movement occurs in the vertical and horizontal planes, respectively. Their simultaneous origin leads to displacements of tectonic blocks in both planes (Kuzmin, 2018: 967-987). Shallow-focus earthquakes, in the junction zones of the Middle and Lower Kura troughs with mountain structures of the Lesser and Greater Caucasus, occur according to such a pattern of movement in the upper part of the earth's crust (Fig. 3).

The map shown in Fig. 1 characterizes the distribution density of the events that occurred in 2003-2019. epicenters of earthquakes with magnitudes Ml>3 in the territory of Azerbaijan. In it, thin red lines show the fault lines determined from geological and geophysical data. When compared with the fault lines that we assume from seismological data (thick purple lines), it can be seen that there is a relative similarity between them. It can be seen from the figure that the hypocenters of many seismic events are concentrated along the ruptures of the Earth's crust indicated in it or areas adjacent to them. At the same time, the reverse picture is also observed on the map, i.e. many earthquake epicenters are located in zones where there are no tectonic ruptures coming to the surface of the earth.

According to this map, the territory of Azerbaijan on the surface of the crystalline basement is divided mainly into six tectonic blocks: the Middle Kura Depression (SK), the South Caspian Depression (SC), the regions of the Greater and Lesser Caucasus (BC and MC), and the Middle Caspian (NCW). The Nizhnekurinsky (NK), Shamakha-Kobystansky (SHK) and Absheron troughs (AP) are considered as part of the South Caspian depression. Note that in all troughs, the paleoconditions of the sedimentation basins of the Meso-Cenozoic sedimentary complex are similar. However, the paleosources of the demolition of terrigenous material and the paleofluvial arteries and the composition of the clastic material transported to the basins differ significantly. Note that the schematic map (Fig. 1) reflects the results of generalization of these works (Kerimov, 2002; Kengerli, 2005: 32-42; Yusubov, 2017: 12-17) and the results of seismic exploration interpretation for 1983-2018, and in the opinion the author of this article, it more accurately reflects the tectonics of the territory. Note that on this map there are practically no transverse faults (Kerimov, 2002), marked on the map of tectonic zoning of the territory of Azerbaijan (Yusubov, 2020: 11-17).

According to the data of works (Kerimov, 2002; Kengerli, 2005: 32-42), indicated in Fig. 1 map, tectonic faults were formed as a consequence of the Alpine folding. In the territory under consideration, this process began in the Late Cretaceous, and its formation coincides with the end of the Oligocene. According to seismic time sections (Fig. 2,3,4), a part of the sedimentary cover located above the surface of the Mesozoic deposits contains practically no information about this process. In other words, many tectonic breaks traced on the Mesozoic stage do not find their reflection in the upper interval (Cenozoic) of the geological section and vice versa. At the same time, the results of studies (Yusubov, 2017: 12-17; Yusubov, 2020: 11-17), based on seismic data, showed that there are no tectonic faults in the sedimentary cover of depression zones, with the exception of those indicated in Fig. 1 with numbers 3-12 having direct connection with the surface of the crystalline foundation.

These main conclusions, obtained from the analysis of available maps and seismological data, show that most of the earthquakes within the territory under consideration are not directly related to tectonic faults. At the same time, according to seismic survey data using the reflected wave method (Fig. 2, 3 and 4), the earth's crust in the area under consideration is characterized by significant heterogeneity, which is expressed in the uneven distribution of the density of epicenters (Fig. 1).

It is possible to draw several lines along the converging locations of earthquake epicenters and evaluate the zones they intersect as expected fault lines (purple). One of them runs along the eastern part of the Greater Caucasus Range and then continues in the South Caspian Depression. Other fault lines run parallel in the Middle Caspian Basin and along the Lesser Caucasus, continuing at the foot of the Talysh Mountains. At the same time, a number of spots of relatively isometric or irregular shape of dense clumps of epicenters attract attention. In our opinion, this is due to the branching of the main tectonic faults in these regions. The possibility of thickening of epicenters due to ascending flows of deep fluids, which play an important role in the processes of tectogenesis and seismogenesis, is also not ruled out (Luk, 2019: 99-123).

Heterogeneous seismicity and distribution of earthquake sources.

Heterogeneous systems in the Earth's crust are represented on time sections (Sheriff, 1982: 373) by three groups: the first group includes large-scale inhomogeneities ($2\ d >> R_{Fr}$), which form reflective and refractive seismic boundaries ; to the second − medium-scale inhomogeneities ($2\ d \approx R_{Fr}$), forming the fields of diffracted and reflected waves; to the third − small-scale inhomogeneities ($2\ d << R_{Fr}$), creating fields of scattered (Lisitsa, 2013:46-58) waves, described statistically by the level of the "wave background". Here, d is the length of the area reflecting seismic waves, $R_{Fr} = (0.5 xHxVxf^{-1})^{1/2}$ is the radius of the Fresnel zone. Where, H is the depth of the object reflecting seismic energy, V is the speed of propagation of the seismic wave to the object, f is the frequency of the seismic wave.

Let us dwell on the results of interpretation of seismic data based on these definitions. On fig. 2 shows a seismic time section with earthquake hypocenters plotted on it. When determining the depths of earthquake hypocenters on a time scale, average velocities were used. The figure shows that the upper Cenozoic part of the earth's crust corresponds to a sedimentary complex of deposits composed of plastic rocks (molasse). On this structural level, where the condition 2 d >> $R_{Fr \text{ is satisfied}}$, tectonic tension is expressed in such processes as folding, shear and thrust deformation occurring in a long geological time. Here, the spatial distribution of hypocenters is observed at the contacts of layers of a layered medium (Paleogene-Mesozoic, Maikop-Paleogene). At the same time, they are located far from the faults.

On the second from the top floor of the earth's crust, corresponding to the Mesozoic interval of the geological section, the earthquake hypocenters are distributed along the contact lines of the blocks of the heterogeneous medium. They could be taken as tectonic faults, but their small extent in three-dimensional space does not allow such a conclusion to be drawn. An analysis of a similar situation based on reflected seismic survey data shows that a weak energy discharge of the accumulated, as a result of the comprehensive compression of the region by the forces of the tangential direction, occurs due to the movement of blocks of a heterogeneous medium in three-dimensional space. At the same time, the upper plastic medium located above this medium reacts to these interblock displacements with small-scale plicative dislocations (Yusubov, 2017: 12-17; Yusubov, 2017a: 304-312; Yusubov, 2020: 11-17; Kerimov, 2021: 3-8).

Small-focus seismic events in the inner part of the heterogeneous basement occur according to a similar pattern.

Naturally, there is some connection between the events taking place in these three media, since the main reason for their manifestation is due to the activity of the accelerating convergence of the Arabian lithospheric plate to the Eurasian one, and when the accumulated elastic energy is released in the lower structural floors, tremors of the entire system occur.

A similar situation takes place in the areas of location of seismic time sections shown in Figs. 3 and Fig.4.

In the lower right part of Fig. Figure 3 shows a portion of the time section on an enlarged scale, corresponding to medium-scale inhomogeneities ($2\ d \approx R_{Fr}$), and on the left side, zones of small-scale inhomogeneities ($2\ d << R_{Fr}$).

As can be seen from Fig. 3 and 4, in the intervals of the time section corresponding to the Meso-Cenozoic part of the geological section, there are zones where there are sources of small-focus earthquakes that are not directly related to tectonic faults. At the same time, the time sections show that in the areas of the junction of the Kura depression with the mountain structures of the Caucasus, there are foci of earthquakes associated with deep faults.

The discussion of the results.

Based on the analysis of the kinematic and dynamic parameters of the reflected wave field (Fig. 2, 3 and 4), it can be concluded that in the region under consideration, the regional stress field is stable in time and is a field of near- horizontal compression oriented to the cross of strike of the main structures. At the same time, it is clearly seen from time sections that tectonic cracks and faults traced in the Cenozoic interval by multidirectional planes, in three-dimensional space, are not displayed in the Mesozoic stage of the geological section and vice versa. Consequently, under the influence of horizontal compression forces in the Kura depression, multidirectional and multiscale dislocations occur in the named structural stages. For this reason, the territory under consideration, according to the features of the geological structure, can be considered (Yusubov, 2012: 48-53; Yusubov, 2017a: 404-312) as a non-equilibrium system due to mechanical and phase instability, which manifests itself as a result of deformation processes and, possibly, defluidization of the Maikop and Eocene deposits. In this case, mechanical instability relaxes through various forms of shifts, faults, and sliding of individual blocks relative to each other, which cause shaking of a certain territory, i.e. micro and small- focus earthquakes are formed.

The parameters of the wave field presented on the time sections (Figs. 2, 3 and 4) show that the tectonic stress relief accumulated in the Kura depression should be distributed in the fault zones separating the mountain structures with the Kura trough from the southwest of the Lesser Caucasus and Kursk (No. 3 and No. 4) and with CB Udabno-Yerkidarsky and Udabno-Geokchay-Adzhychay-Alyatsky (No. 5 and No. 6). Therefore, earthquake sources should be distributed along these fault lines. However, this conclusion is not entirely supported by the actual data. Let's look at some of the many reasons.

As can be seen from Fig. 2, 3, and 4 the foci of earthquake groups were formed between the Maikop and Paleogene structural levels as a result of blocks sliding along tectonic faults along their contact zone. Another group of earthquakes results from sliding, consisting of relatively plastic rocks, the Paleogene complex of sediments, above the Mesozoic stage, composed of more competent rocks.

According to the parameters of the wave field reflected from the contact surfaces of the layers of the sedimentary complex of deposits, it can be concluded that the magnitudes of these shifts have small amplitudes and, therefore, the released energy of earthquakes formed in these intervals of the geological section does not have a magnitude $Ml > 3$.

As a result of the movement of the Arabian and Eurasian tectonic plates in a northerly direction at different speeds, the area of the depression zones decreases, which is clearly seen from the morphostructure of the surface of the Meso-Cenozoic deposits (Fig. 2, 3 and 4). At the same time, in the space near the contact zone of the Mesozoic and Cenozoic intervals of the crust, a sliding process occurs between the layers of the sedimentary complex of deposits. As a result of this process, the layers of sedimentary filling occur, which also manifests itself as an earthquake on the surface layers of the earth's crust. Figures 2 and 3 show that seismic horizons corresponding to the Cenozoic stage, especially its Neogene interval, are involved in shearing more than in the Mesozoic part of the section. This fact serves as evidence that tangential forces create displacements of different scales in the named intervals of the geological section, as a result of which earthquake foci arise in the inner part of the Cenozoic or in the contact surface of the Mesozoic and Cenozoic stages. But, such a mechanism does not exclude the possibility of earthquakes in the Mesozoic interval. Here, the released elastic energy leads to spatial displacements of blocks of a heterogeneous medium, which causes tremors of the earth's crust in a certain space.

Let us return to the analysis of the issue related to the condensation of the coordinates of epicenters (hypocenters) in some areas, which is clearly seen in Fig.1. They are distributed along the lines marked in the figure in thick purple. Attention is drawn to a number of spots of relatively isometric or irregularly shaped dense clusters of epicenters. They are located directly along: the northern slope of the Lesser Caucasus and the Talysh Mountains, the southern slope of the mountain-folded structure of the Greater Caucasus and its continuation in the Caspian Sea − the southern and northern sides of the Absheron-Balakhan uplift zone, the northeastern slope of the Greater Caucasus. In our opinion, this is due to the branching of the main tectonic faults in these regions.

Lower Miocene rocks of the Maikop series enriched with organic matter are the main source rocks for oil and gas deposits in the South Caspian Basin (Yusubov, 2022: 168), which also includes the Kura depression. Here, deposits associated with the Maikop parent layer were found in the areas of the Kura depression (Gazanbulag, Naftalan, etc.) and the Caspian-Guba oil and gas region (Siyazan monocline). The fields are formed in the presence of migration channels connecting the source of oil and gas formation with the upstream geological environment, where reservoirs and seals should be located. As shown in (Yusubov, 2021:168), most of the discovered deposits in the area covered by this study are associated with reservoirs created by paleo-river arteries and have no connection with tectonic faults. Thus assumptions about the formation of hydrocarbon deposits with the participation of tectonic faults are not confirmed by the results of interpretation of seismic data (Yusubov, 2022: 168) and this work.

Conclusion

According to the results of structural interpretation of seismic and seismological data, it is shown that almost half of the total number of shallow -focus earthquakes within the Middle and Nizhne-Kurinsk depressions arise as a result of multi-scale and multi-directional spatial movement of blocks of a heterogeneous base (foundation) composed of rocks that are hard in composition without provoking ruptures in the upper plastic geological medium and the Earth's surface. In some zones, such earthquakes also occur in the inner parts of the Mesozoic stage of the geological section, which is also characterized by a heterogeneous structure. Some earthquake sources are formed in the Cenozoic interval of the earth's crust as a result of thrusting of one mass onto another along planes that have a subhorizontal direction.

The field in the Srednekurinskaya depression was formed as a result of in-situ migration of hydrocarbons and their accumulation in the reservoirs of the source rock.

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