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# STATISTICAL ASSESSMENT OF THE SEISMICITY OF AZERBAIJAN AND SURROUNDING REGIONS IN 2021 BASED ON THE DATA OF "KINEMETRICS" SEISMIC STATIONS

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**Annotation**

The territory of Azerbaijan is one of the most seismically active regions of the world. For this, a fairly extensive study of information about the current state of seismicity in a certain region is required. The analysis of seismicity based on digital data of 2021 is reflected in the article. Along with earthquakes, explosions were also analyzed. From these studies, it is known that an increase in the number of earthquakes and the released seismic energy is observed in 2021. Seismic activation is mainly observed along the Western Caspian, Ajichay-Alat, Ganjachay-Alazan, Gazakh-Sygnakh, Front Talish, Talish, Sharur-Ordubad, Sangachal-Ogurchu, Garabogaz-Safidrud, Agrakhan-Krasnovodsk deep faults.

***Keywords:*** *analysis of seismicity, earthquakes, seismic activity, tectonic faults.*

# "KİNEMETRİCS" SEYSMİK STANSİYALARIN MƏLUMATLARI ƏSASINDA 2021-Cİ İL ƏRZİNDƏ AZƏRBAYCAN VƏ ƏTRAF BÖLGƏLƏRİN SEYSMİKLİYİNİN STATİSTİK QİYMƏTLƏNDİRİLMƏSİ

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**Annotasiya**

Azərbaycan ərazisi – dünyanın ən seysmoaktiv bölgələrindən biridir. Bunun üçün müəyyən bir bölgədə seysmikliyin mövcud vəziyyəti haqqında məlumatın kifayət qədər geniş öyrənilməsi tələb olunur. Məqalədə 2021-ci il üçün rəqəmsal məlumatlar əsasında seysmikliyin analizi öz əksini tapmışdır. Zəlzələlərlə yanaşı partlayışların da analizi aparılmışdır. Bu araşdırmalardan məlum olur ki, 2021-ci ildə zəlzələlərin sayında və ayrılan seysmik enerjidə artım müşahidə olunur. Seysmik aktivləşmə əsasən Qərbi Xəzər, Acıçay-Ələt, Gəncəçay-Alazan, Qazax-Sığnax, Talış, Öntalış, Şərur-Ordubad, Sangaçal-Oğurçu, Qaraboğaz-Safidrud, Aqraxan-Kasnavodsk dərinlik qırılmaları boyunca müşahidə olunur.

***Açar sözləri:*** *seysmikliyin analizi, zəlzələlər, seysmik aktivlik, tektonik qırılmalar.*

# СТАТИСТИЧЕСКАЯ ОЦЕНКА СЕЙСМИЧНОСТИ АЗЕРБАЙДЖАНА И ПРИЛЕГАЮЩИХ РЕГИОНОВ В 2021 ГОДУ НА ОСНОВЕ ДАННЫХ СЕЙСМИЧЕСКИХ СТАНЦИЙ "KINEMETRICS"

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**Аннотация**

Территория Азербайджана является одним из самых сейсмически активных регионов мира. Для этого требуется достаточно обширное изучение информации о современном состоянии сейсмичности в определенном регионе. В статье отражен анализ сейсмичности на основе цифровых данных 2021 года. Наряду с землетрясениями анализировались и взрывы. Согласно исследованиям в 2021 году

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наблюдается рост числа землетрясений и выделившейся сейсмической энергии. Сейсмическая активизация в основном наблюдается на территории Западно-Каспийского, Аджичай-Алатского, Гянджачай-Алазаньского, Газах-Сигнахского, Переднего Талыша, Талышского, Шарур-Ордубадского, Сангачал-Огурчинского, Гарабогаз-Сафидрудского, Аграхан-Красноводского глубинных разломов.

***Ключевые слова:*** *анализ сейсмичности, землетрясения, сейсмическая активность, тектонические разломы.*

## INTRODUCTION

Earthquakes are one of the most dangerous natural processes on Earth. The Caucasus, including Azerbaijan, as well as the Caspian Sea, are part of the Alpine-Himalayan rift system, located in the collisional contact zone of the Eurasian and Arabian tectonic plates, and are characterized by fairly high seismic activity.

In 2021, an analysis of seismicity was carried out based on digital data. Earthquakes in neighboring states and the Caspian Sea also affect the territory of Azerbaijan. On 02.01.2021, an earthquake with a magnitude of ml=4.8 was recorded in the territory of Dagestan at 04:05 local time. The earthquake was felt in the border regions of Azerbaijan up to magnitude 4-3; On March 11, 2021, an earthquake with a magnitude of ml=4.5, h=7 km occurred in the territory of Iran at 05:46 local time, which was felt up to 3 points in the territory of Azerbaijan. 4 earthquakes were registered on the territory of Armenia. The most powerful of these earthquakes, with magnitude ml=5.2 and ml=5.5, depths h=2 and 4 km occurred. These earthquakes were felt in the border regions of Azerbaijan up to 5-3 points.

A map of the epicenters of the earthquakes that occurred in the region of Azerbaijan has been constructed (Figure 1).

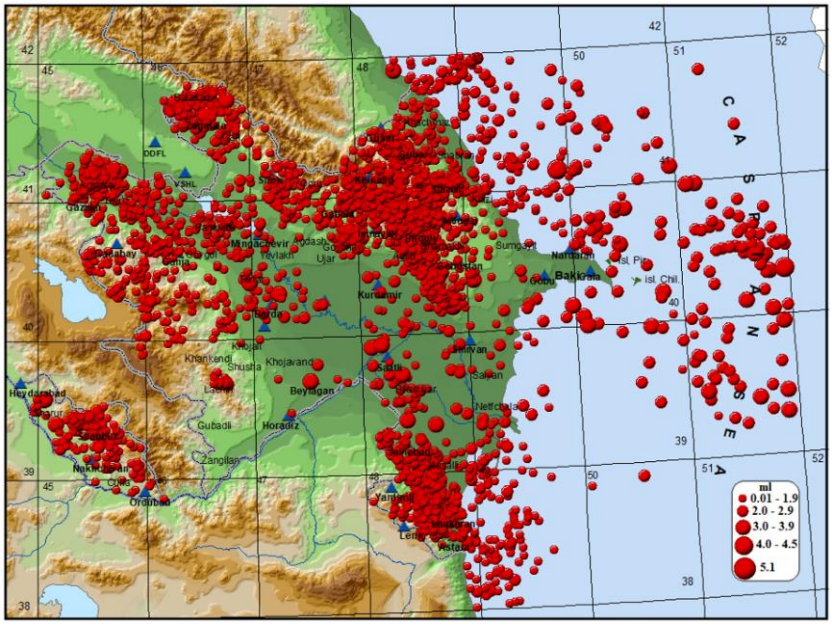
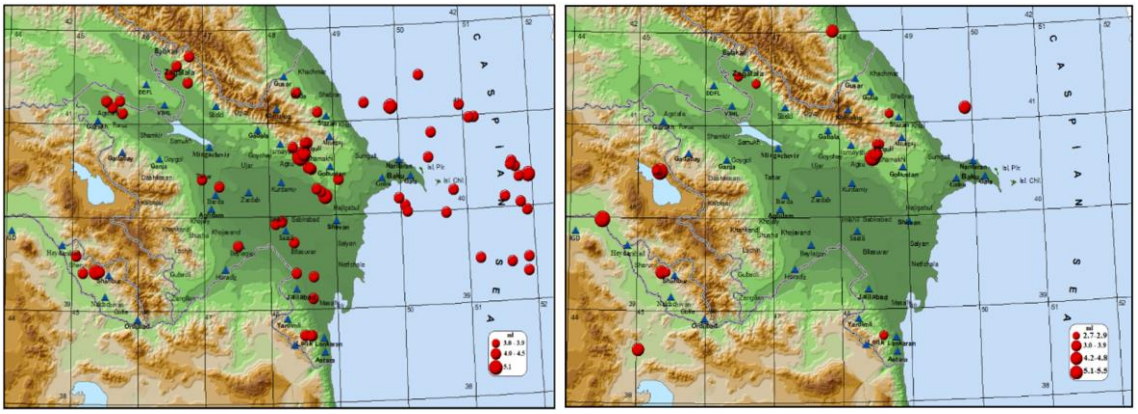



*Figure 1. Map of epicenters of earthquakes that occurred in the territory of Azerbaijan*

In 2021, an earthquake with a magnitude ml≥3 was recorded in the territory of Azerbaijan and 17 perceptible earthquakes were recorded in Azerbaijan and its adjacent territories (Figures 2a and 2b).



*2a* *2b*

*Figure 2. a) Map of epicenters of earthquakes with magnitude ml≥3 in the territory of Azerbaijan during 2021; b) Map of epicenters of earthquakes felt in Azerbaijan and adjacent areas during 2021.*

The analysis of the number of earthquakes and released seismic energy in the territory of Azerbaijan during 2010-2021 shows that in 2020, the number of earthquakes in the territory of Azerbaijan is 4030, the amount of released seismic energy is ∑E=13.1 • 1011C, while the highest magnitude is ml=4.9, in 2021 the number of earthquakes was 4184, the amount of released seismic energy was ∑E=14.3•1011C, the highest magnitude was ml=5.1 From the results of the analysis, it is known that the analysis of the number of earthquakes and the released seismic energy in the territory of Azerbaijan for 12 years (Figure 3) shows that the amount of seismic energy released in 2012 reached its maximum. This is related to the occurrence of strong (ml=4.0÷5.7) earthquakes in the territory of the republic in recent years.

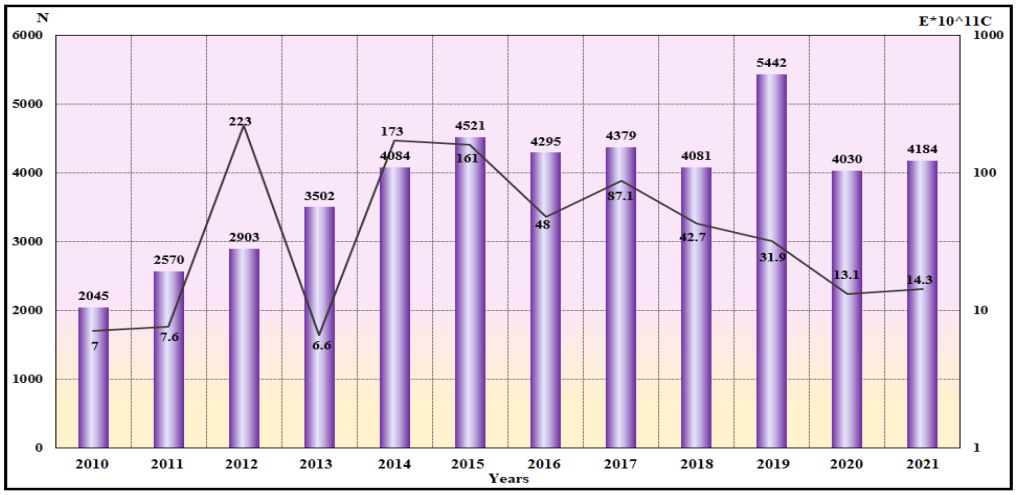



*Figure 3. Histogram of the distribution of the number of earthquakes and the released seismic energy in the territory of Azerbaijan during 2010-2021*

The analysis of the number of earthquakes and the release of seismic energy in Azerbaijan and adjacent areas by month (Figure 4) shows that the release of seismic energy was higher in February and November.

The high level of seismic energy released in February is related to the occurrence of earthquakes with ml≤5.5 on the territory of Armenia. The high energy in November is related to the earthquake with the magnitude ml-5.1 that occurred in the Shamakhi region.

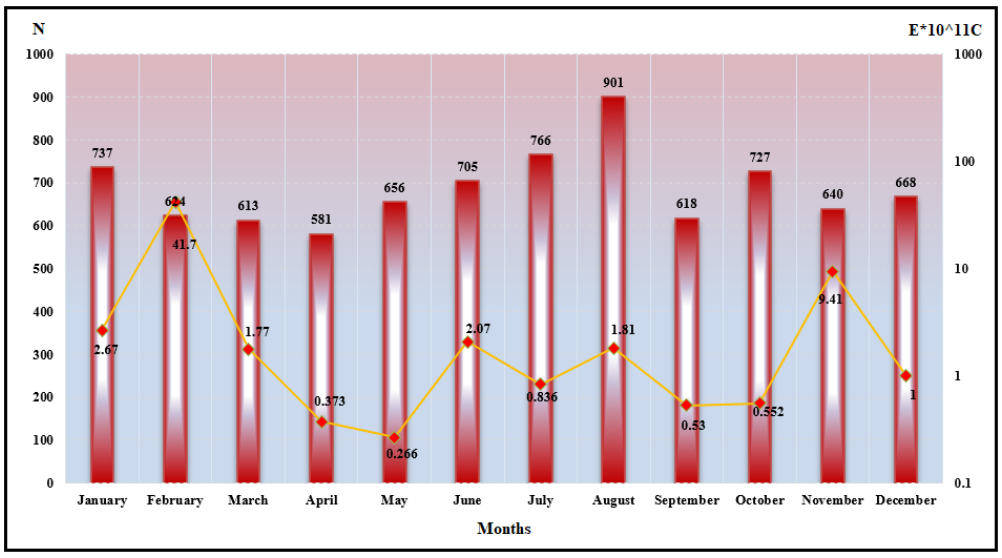



*Figure 4. Histogram of the distribution of the number of earthquakes and the released seismic energy in Azerbaijan and adjacent areas in 2021 by month*

A histogram and a map of the distribution of the depth of the earthquakes that occurred in Azerbaijan and adjacent areas in 2021 in space and time have been constructed (Figure 5). The analysis of the distribution of earthquakes according to depth shows that 40% of them occurred at a depth of ≤10 km.

The depths of earthquakes in the land area of Azerbaijan are 2-54 km, in the Caspian water area 2-62 km, and in the regional areas mainly between 2-35 km changes.

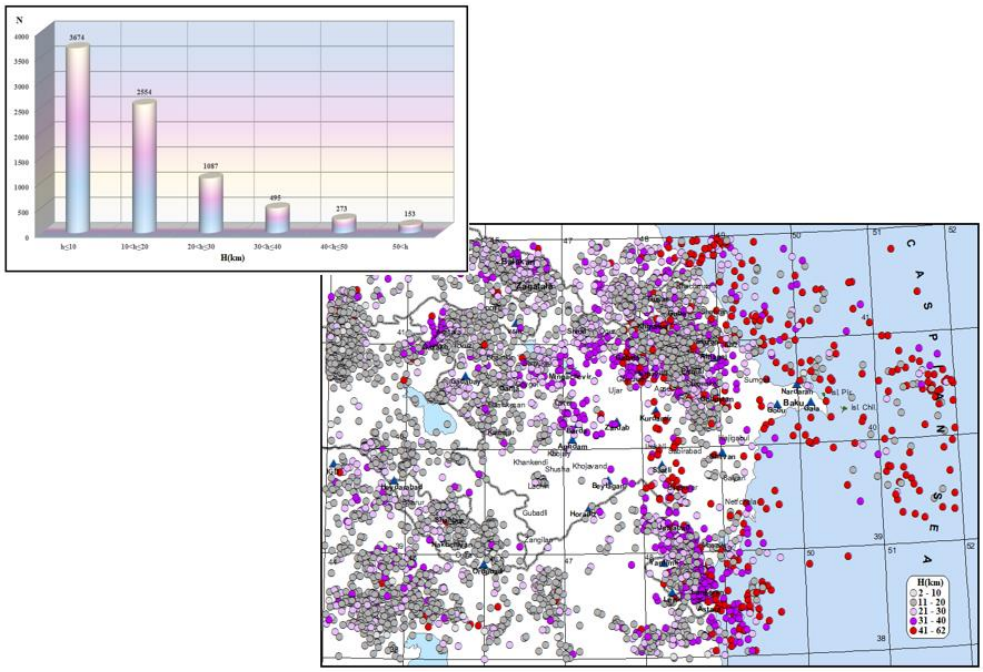



*Figure 5. Histogram and map of the depth distribution of earthquakes that occurred in Azerbaijan and adjacent areas in 2021*

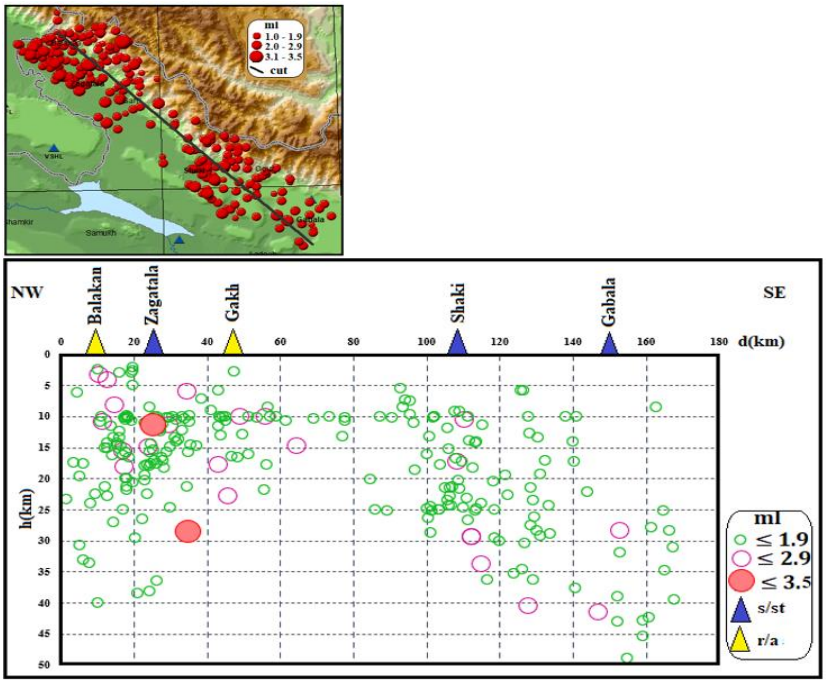



*Figure 6. Balaken-Gabala I-I seismological section*

In order to study the seismicity of the territory of Azerbaijan, seismological profiles were established for separate seismoactive regions.Seismological traction was established along the Balaken-Gabala II profile passing through the seismoactive zone of Azerbaijan (Figure 6). The profile extends along the Ayrichay-Alat deep fault in the pan-Caucasus direction.

As can be seen from the section, as in 2020, weak seismicity is observed along the profile.In the Zagatala area, 2 shocks with a magnitude of ml≤3.0 were recorded. An earthquake with a magnitude of ml-2.8 was recorded on August 18 at 13:37 local time in Zagatala district, 15 km southwest of Zagatala station. The earthquake was felt by some people. In the Zagatala-Balakén area, the pits are mainly distributed at a depth of 2-25 km. Magnitude ml-2.8 and ml-3. 1 imperceptible shock occurred within the sedimentary layer at a depth of 11 km.Earthquakes with a magnitude of ml≤2.9 were recorded in the territory of Gakh. An earthquake with a magnitude of ml-2.9 was registered in Gakh region on March 31 at 13:04 local time, 23 km south of Zagatala station. The earthquake was felt by some people. As can be seen from the cut, the earthquake occurred at a depth of 10 km. The earthquakes that occurred in the Zagatala-Balakan areas are located at the intersection of the Vandam and Sharur Zagatala faults. Weak seismicity is observed in the area of

In order to study the geodynamic conditions of the Shamakhi-Ismayilli zone and the Lower Kura basin, the northwest, southeast II-II profile was constructed (Figure 7) and the seismicity was higher than the background level. 2 strong perceptible tremors were recorded in this zone. First, on 20.11.2021 at 16:46 local time, an earthquake with a magnitude of ml-5.1 was recorded in Shamakhi area, 17 km south of Pirgulu station. The earthquake was felt up to 5 in the epicenter and 4-3 in the surrounding regions. Aftershocks were recorded after the earthquake. The magnitude of aftershocks varies in the range of ml=0.8-4.5. Second, an earthquake with a magnitude of ml=4.5 was recorded on 20.11.2021 at 16:48 local time in Shamakhi area, 13 km south of Pirgulu station. The earthquake was felt up to 4 in the epicenter and 3 in the surrounding regions. As can be seen from the cut, density of hypocenters is observed in the north-west direction. The strong aftershocks and aftershocks that occurred in the Shamakhi area were located in the zone of influence of the Achichay Alat and Western Caspian deep faults.

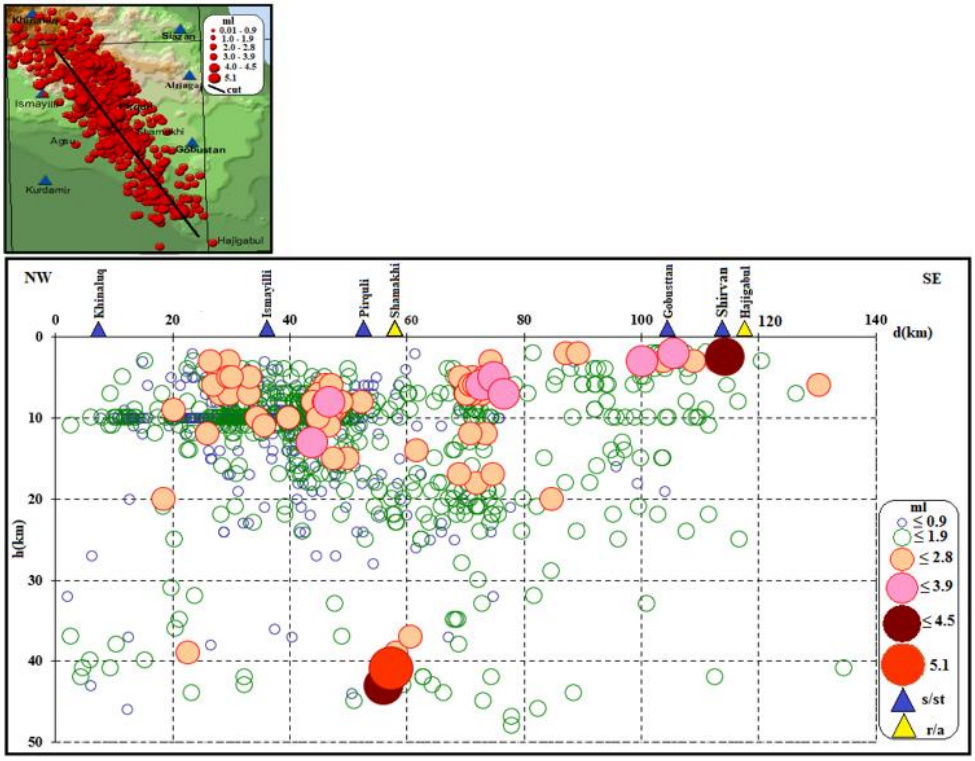



*Figure 7. Seismological section of Shamakhi-Ismayilli seismogenic zone II - II profile*

During the entire section, distribution is mainly observed at a depth of 2-48 km. Earthquakes with magnitude ml≥3.0 are distributed within the sedimentary layer at a depth of 2-12 km. As can be seen from the cross section, earthquakes with magnitude ml≥3.0 occur in the deep layer as well. The earthquake with a magnitude of ml-5.1 and its aftershocks were spread at a depth of 38-43 km. The main thrust occurred at a depth of 41 km.

The magnitude of the reduction of the hypocenters is ml≥3 as the section passes through the Lower Kura plain. 0 earthquakes are increasing. In the area, the hearths are distributed at a depth of 2-20 km. Earthquakes with magnitude ml≥3.0 occurred within the subsidence layer.

In 2021, seismicity was higher in Nakhchivan AR than in other years. In order to study the geodynamic conditions of the Nakhchivan area, a seismological cross-section (Figure 8) was constructed on the III-III profile in the northwest and southeast directions. Hypocenters were distributed along the cross-section at a depth of 3-25 km. Intensification of earthquakes is observed in the north-west direction. As can be seen from the section, mostly weak earthquakes occurred in the area. An increase in tremors with a magnitude of ml≥3.0 was recorded in the Shahbuz area.

The highest magnitude earthquake occurred in Nakhchivan area was ml=4.2. On January 23, at 17:22 local time, an earthquake occurred in Shahbuz district, 15 km west of Shahbuz station. The earthquake was felt at the epicenter with a magnitude of 5 and in the surrounding regions up to 4-3. Before the earthquake, on January 21 at 23:23 local time, an earthquake with a magnitude of ml=3.8 was recorded in Shahbuz district, 11 km northwest of Shahbuz station. The earthquake was felt up to 4 in the epicenter and 3 in the surrounding regions. The occurrence of earthquakes is related to the activation of the Sharur Ordubad fault. In 2021, 130 weak tremors (by a single station) were recorded at the Shahbuz station. Earthquakes with magnitude ml≥3.0 are observed to occur within the sedimentary layer at a depth of 3-10 km.

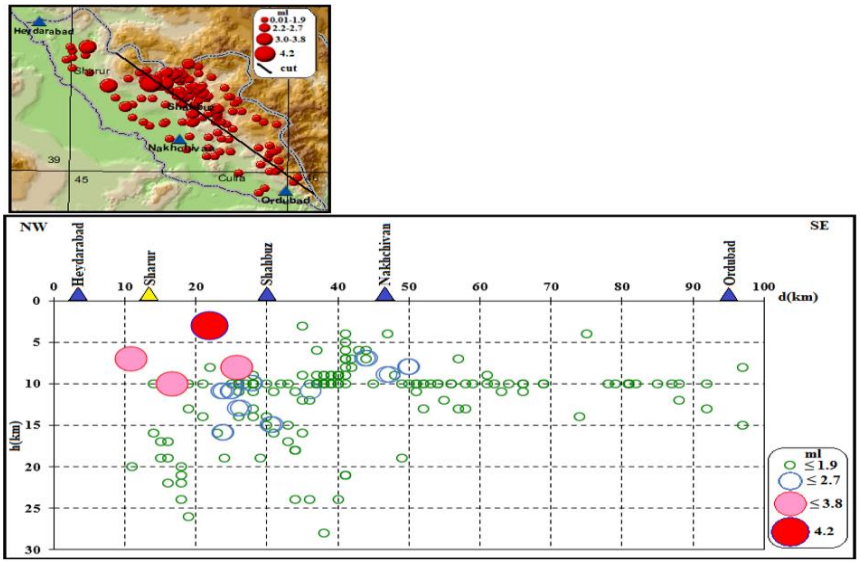



*Figure 8. Seismological section of the Nakhchivan area on the III-III profile*

If we look at the Caspian water area, we can see that the level of seismic activity has increased, 25 tremors with a magnitude of ml≥3 have been recorded (Figure 9). The highest magnitude earthquake recorded in the Caspian water area was ml=4.5. The earthquake was felt up to 3 points in Siyazan, Khizi regions, Sumgayit city.

The occurrence of earthquakes with magnitude ml≤4.5 in the Northern and Central Caspian waters is related to the activation of the Makhachkala-Krasnovodsk fault. The concentration of earthquakes in the center is observed at the intersection of the Agrakhan-Krasnovodsk and transverse Karabogaz Safidrud faults. The main mass of earthquakes with magnitude ml≥3.0 in the Caspian water area was recorded at a depth of 40-62 km, as well as at a depth of 12-14 km. Magnitude ml≥3 in the South Caspian Sea. The occurrence of earthquakes with 0 is related to the activation of the Sangachal-Ogurchu deep fault.

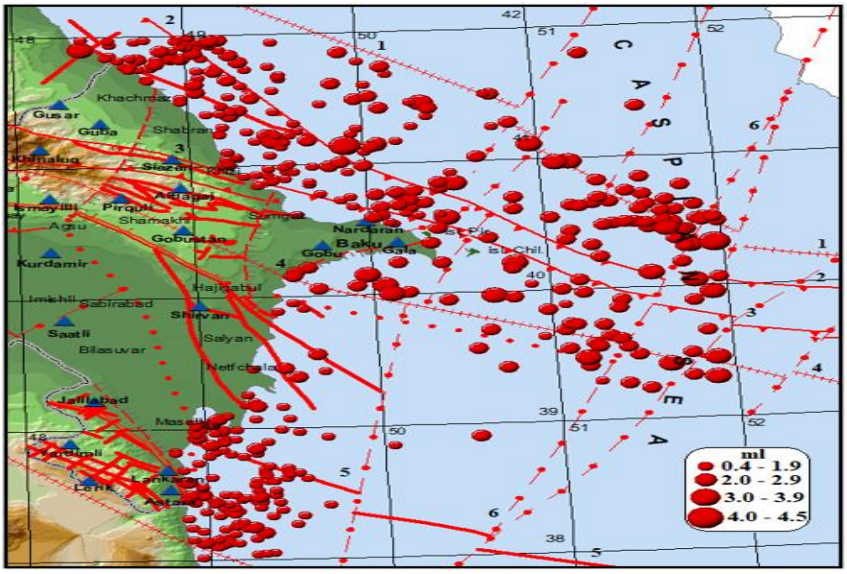



*Figure 9. Map of earthquakes, faults and epicenters of the Caspian watershed in 2021*
*Faults: 1- Agrakhan-Krasnovodsk; 2 – Makhachkala-Krasnovodsk; 3- Absheron-Near Balkhan;*
*4 – Sangachal-Ogurchu; 5- Mil-Chikhishlar 6 - Karabogaz-Safidrud; 7 - Lahiridcan.*

Earthquakes with a magnitude of ml≤2.8 that occurred in the Talysh coastal zone in the South Caspian basin were concentrated between the Mil-Chikhishlar and Lahiridjan marginal faults passing through the territory of Iran.

**Seismic activity**

Analysis of the seismic activity of the researched area, the earthquakes that occurred in 2021 were used from the catalog of the RSSC ANAS, and based on this, a seismic activity map was drawn up to monitor the change of the seismic regime over time (Figure 10).

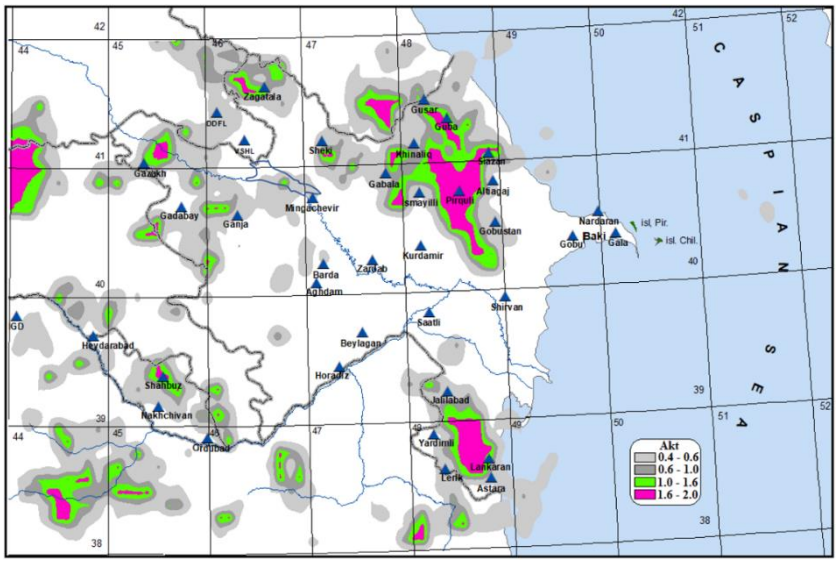



*Figure 10. Seismic activity map of Azerbaijan and adjacent territories in 2021*

In 2021, activity was high in Shamakhi-Ismayilli, Gusar-Guba, Talish zones. Zagatala-Balaken seismicity is weak on the southeastern slope of the Greater Caucasus. In 2021, unlike other years, seismic activity increased in Shahbuz district of Agstafa, Nakhchivan AR. Weak seismicity in the Lesser Caucasus and an increase in earthquakes within the Mingachevir reservoir are recorded. The southern and northern parts of the Caspian Sea are relatively calm, while the central part has been highly active. Seismicity was high on Iran-Turkey border and Georgia-Armenia border.

## CONCLUSION

During 2021, an increase in seismicity is observed in the northwestern region of Azerbaijan in the Shamakhi-Ismailli seismogenic zone, in the Talish mountainous zone, in the central part of the Caspian Sea, on the Iran-Turkey border, and on the Georgia-Armenia border. Seismicity was higher in Shahbuz district of Nakhchivan AR in 2021, unlike other years. Seismic activity is observed along the Western Caspian, Achichay-Alat, Ganjachay-Alazan, Gazakh-Sighnakh, Talish, Front Talish, Sharur-Ordubad, Akhvay, Sangachal-Ogurchu, Garabogaz-Safidrud, Agrakhan-Krasnovod deep faults. In 2021, an increase in the number of earthquakes and the released seismic energy is observed. During the year (ml=2.7-5.5) 17 perceptible earthquakes were registered. The analysis of the distribution of earthquakes by depth shows that the depths of earthquakes in the land area of Azerbaijan are 2-54 km, It varies between 2-62 km in the Caspian water area, and mainly between 2-35 km in regional areas. 40% of the foci at a depth of ≤10 km were deposited within the layer.

There is tension in the Caspian Sea. The southern and northern parts of the Caspian Sea are relatively calm, but the central part is in a tense situation. The largest part of hypotents occurs in the basalt layer and upper mantle at a depth of 40-62 km.

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