ISSN 2219-6641

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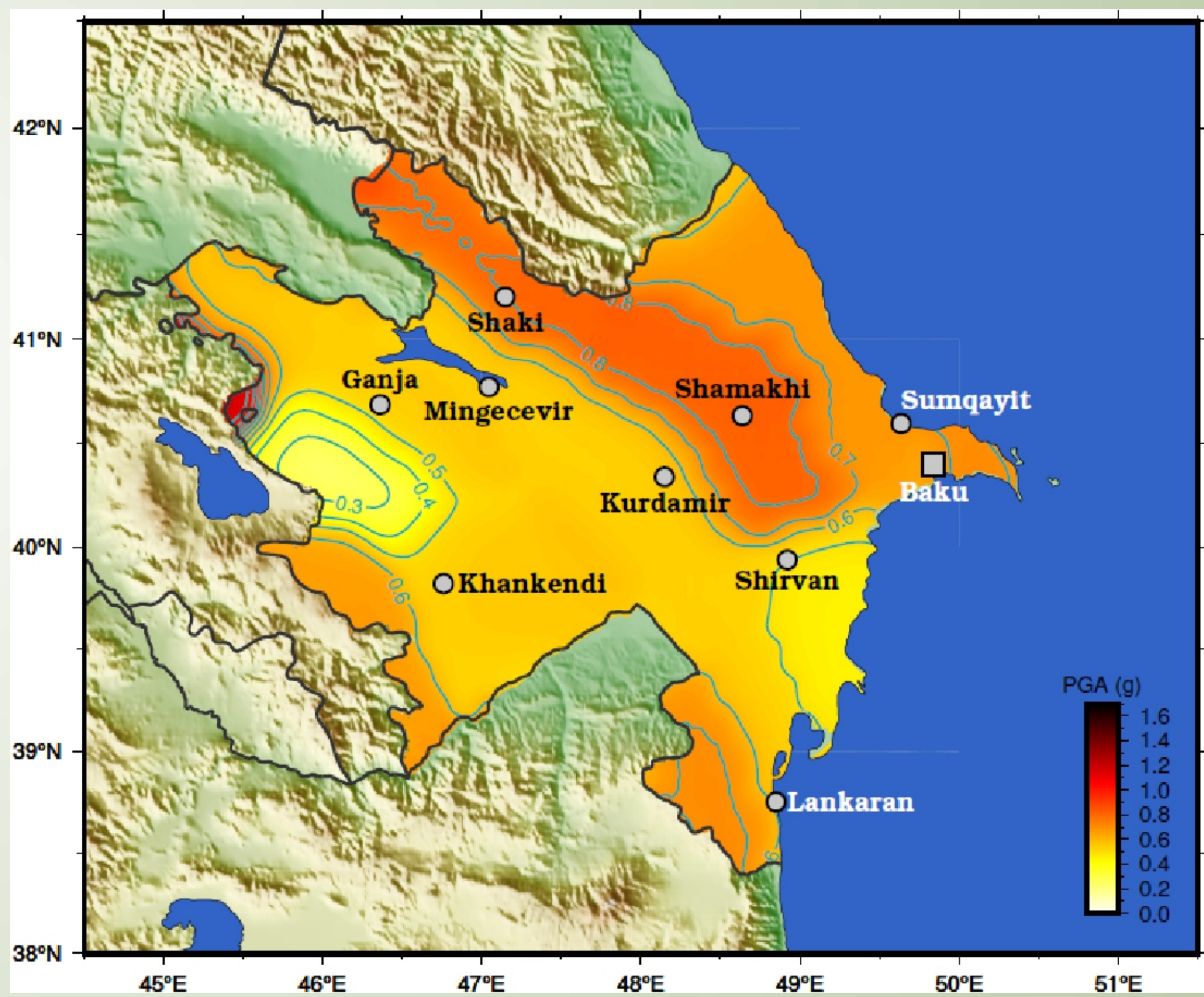

Volume 23, № 1, 2023
http://www.seismology.az/journal

ISSN 2219-6641

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Republican Seismic Survey Center of
Azerbaijan National Academy of Sciences

SEISMOPROGNOSIS OBSERVATIONS IN THE TERRITORY OF AZERBAIJAN

SOURCE MECHANISM OF TURKISH EARTHQUAKES OCCURRED ON 06.02.2023 WITH M=7.8, 7.6

G.J. Yetirmishli[1], L.J. Nabelek[2], S.E. Kazimova[1], I.E.Kazimov[1]

Introduction

After strong earthquakes in Turkey, the sea overflowed the region of the large port of Turkey - Iskenderun. Due to rising water levels, the boulevard, streets and avenues were flooded, banks and other offices were evacuated. The water did not recede from the area even 2 days after the earthquake.

In March 2022, scientists from the Middle East Technical University in Ankara published a study suggesting that the center of the Gaziantep region could be severely damaged by a magnitude 6.5 earthquake [16]. This is because most buildings in southern Turkey are extremely vulnerable to earthquakes. These are buildings with fragile brickwork and low-rise concrete frames, built close to each other. People often die in earthquakes precisely because of falling bricks and masonry.

After the tragedy of 1999, the Turkish government introduced new building codes and a compulsory earthquake insurance system. Today, if we look at the seismic hazard map of Turkey, we see that the Anatolian fault zones correspond to the maximum ground accelerations of 0.5 g, which corresponds to 10 points. However, many buildings affected by this earthquake were built before 2000. At the same time, there are even fewer seismically safe buildings in Syria, which led to the collapse of buildings in Aleppo and Idlib.

History of seismicity

Turkey is located in one of the most active seismic zones in the world. Strong earthquakes occur here every two years. The strongest shock in Turkey in the 20th century shook the province of Erzindjan. This happened on December 26, 1939. The earthquake power was 7.9 on the Richter scale, and the source depth was 20 km. As a result of this earthquake, 32,968 people died, more than 100,000 were injured and more than 200,000 houses were destroyed. The people left homeless froze to death. Further, on March 13, 1992, this source was again activated by an earthquake with M=6.8, when almost 500 people died and more than 8000 buildings were destroyed. Being on the same tectonic fault on August 17, 1999, the source was activated in the province of Kodjaeli, with M=7.6. The duration of the earthquake, 37 seconds, caused the death of more than 17,000 people [6] (Fig.1). Then the earthquake in Erzurum occurred on October 30, 1983, which claimed the lives of 1155 people. On October 23, 2011, an earthquake of magnitude 7.1 occurred near the city of Van. Its victims were 604 people; more than 600 thousand were left homeless. More than 30 states provided assistance to Turkey at that time [5].

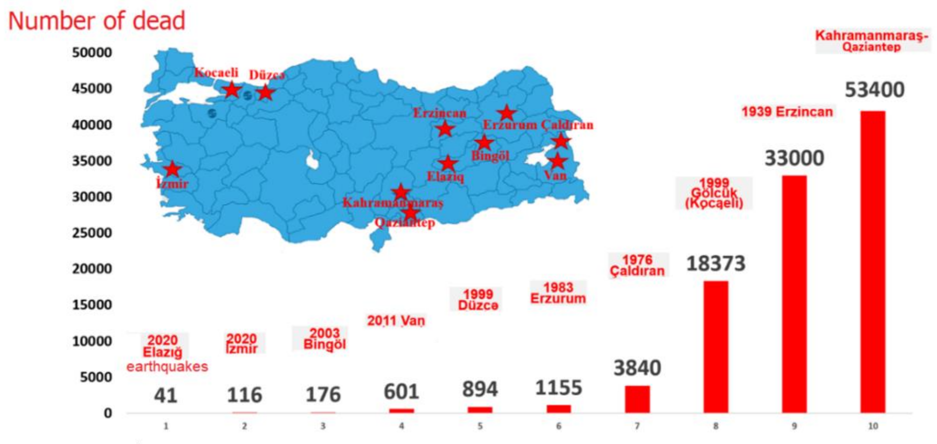

Figure 1. Graph of the sequence of strong earthquakes that occurred in Turkey for the period 1939-2023

On October 30, 2020, an earthquake of 7.0 on the Richter scale occurred in the Aegean Sea, it was felt in Athens and Istanbul. Izmir suffered the most, with about 20 houses collapsed. In total, 119 people died in Turkey as a result of this earthquake, 1,053 were injured.

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Of course, the reason for all these events is the tectonic structure of the region where Turkey is located. This region is located at the intersection of three tectonic plates: Anatolian, Arabian and African. According to GPS stations, the Eurasian plate is pressing from the north, the African plate from the south, and the Arabian plate from the east. As a result, the Anatolian Plate (on which most of Turkey is located) is pushed west to the Aegean Sea at a rate of 20 mm/year [2, 3, 6] (Fig. 2).

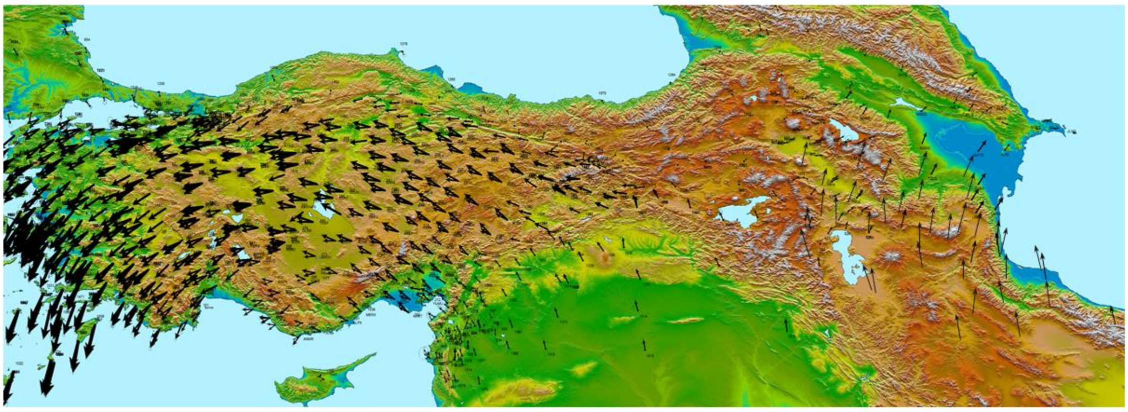

Figure 2. Map of the distribution of horizontal velocity according to the calculated GPS vectors on the territory of the Anatolian Plate and in the Caucasus for 2019-2022

Two large faults pass along the boundaries of the plates - East Anatolian and North Anatolian. Thus, the movement of tectonic plates creates pressure on the fault zones between them [1, 2]. It is the sudden release of the stored energy of this pressure that causes earthquakes.

Tectonics of the region

The source of the earthquake on February 6, 2023 is associated with the dynamics of the East Anatolian Fault. The East Anatolian Fault is one of the main NE-SW main tectonic structures in Turkey, starting from the Karliova Triple Junction in the north and connecting with the Dead Sea Fault in the south [10, 11].

The East Anatolian Fault is characterized by a left-hand shift slip and consists of various segments. Considering the length of the segments, each segment has the potential to cause an earthquake of magnitude 7.0 or greater (Figure 3). Earthquakes of the instrumental period testify to the high activity of the middle and northeastern parts of the East Anatolian fault in terms of destructive earthquakes. This is the Antakya earthquake of 1822 with M=7.5, which caused an almost 200 km rupture along the fault, The Karliova-Bingol earthquake of 1866 with M=7.2, it caused an almost 45 km rupture of the fault. Earthquake on the lake Amik in 1872 with Ms=7.2 caused a fault of almost 20 km, earthquakes on Lake Khazar in 1874 and 1875 with M=7.1 and M=6.7 and the Malatya earthquake of 1893 with M=7.1 [13]. Despite this, the southwestern part of the fault was not characterized by destructive earthquakes. In the Gölbashi-Turkoglu section, located in the south, not a single devastating earthquake has occurred over the past 500 years. This situation is quite remarkable. As you know, the Arabian Plate compresses the Anatolian block in a northeasterly direction. Within this tectonic structure, the East Anatolian Fault connects with the Dead Sea Fault to the SW [12]. The Dead Sea Fault, which is almost 1000 km long, consists of left-hand strike-slip systems, like the East Anatolian Fault. The Dead Sea Fault Zone follows a north-south direction across the eastern side of the Mediterranean Sea, reaching the Gulf of Aqaba and from there joining the Red Sea.

It is the Gulf of Aqaba and the Red Sea that are in expansion mode with the direction NE-SW. Depending on this expansion, the Arabian Plate is believed to be moving in a northeasterly direction. However, this plate movement is limited by the Bitlis-Zagros overlap belt. As a result of all this movement, the southern part of the Arabian Plate is moving counterclockwise and moving at a faster speed compared to the northern part. Depending on this movement, the thesis that the expansion in the Gulf of Aqaba can continue through the Dead Sea fault zone, and from there it can reach the southwest of the East Anatolian fault, called the Gölbashi-Turkoglu segment, where the source of this earthquake is located, is becoming increasingly important.

On faults, stress accumulates over years and decades. But at some point, the bowels are torn apart, having reached their ultimate strength, as a result of which energy is released. As a result of the current earthquake in Turkey, the tension accumulated along the faults was discharged over a huge area. From preliminary calculations it follows that the "active region" extended 190 kilometers in length and 25 kilometers in width.

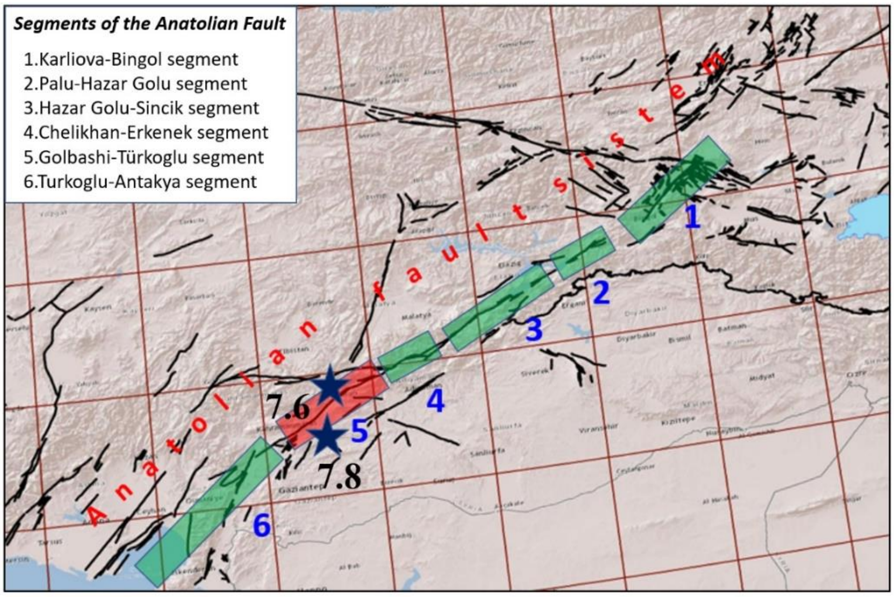

Figure 3. Scheme of the main sources of the Turkish earthquakes that occurred on February 6, 2023 and the main segments of the East Anatolian fault

Source mechanism of the Turkish earthquake

The reasons for the large-scale destruction of buildings are considered to be precisely the underestimation of the level of risks for this area, as well as the lack of regular inspections of the safety of buildings by local authorities. The earthquake caused such destruction, firstly, because of its strength - it is the strongest earthquake in Turkey since 1939 and because it happened right under the settlement. Another sad factor that led to large losses is the timing of the earthquake. The earthquake happened around 4 am. Houses collapsed directly on sleeping or sleepy people who did not have time to prepare for danger.

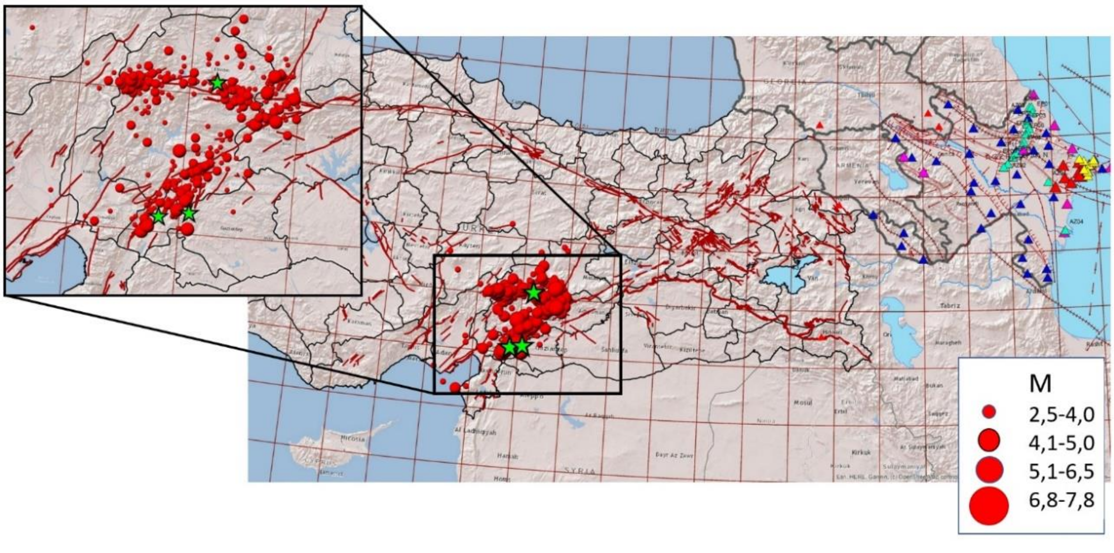

Figure 4. Map of earthquake epicenters after the strong Turkish earthquake on February 6, 2023

An analysis of the distribution of sources in depth showed two source zones located at a depth of 3 to 30 km (Fig. 4). Since the hypocenters of both seismic events were not deep, the intensity of the earthquakes was very high and reached 9 on the 12-point Mercalli scale.

Discharging of stress in a seismic source does not pass without a trace. Stresses are redistributed in the thickness of the rocks of the earth's crust and often occur at a considerable distance, becoming a source of numerous aftershocks. As can be seen on the graph, an average of 450 aftershocks was observed daily during the month (Fig. 5). As a result of this earthquake seismic energy 613*10^13 Joule was released (Fig.6). The magnitude of aftershocks mainly fluctuated within 1.0-4.0. Currently, seismic activity in the region is starting to subside. However, according to some experts, aftershocks after these earthquakes can continue for several more years (science knows such cases). This is due to the processes of stress discharge and restructuring of the medium in the source area.

The earthquake was recorded by all digital seismic stations of the Republican Seismic Survey Center of ANAS (Fig. 7).

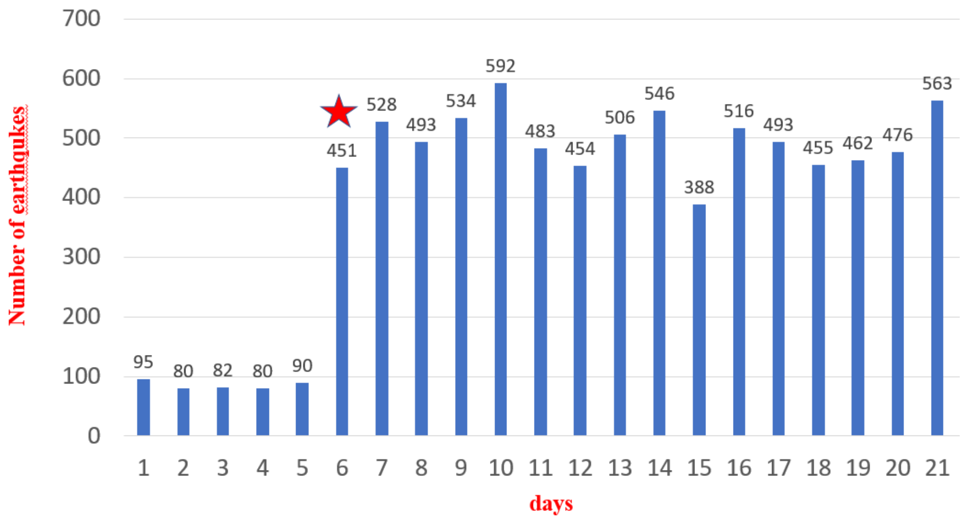

Figure 5. Graph of distribution of aftershock activity for 20 days after strong Turkish earthquakes on February 6, 2023

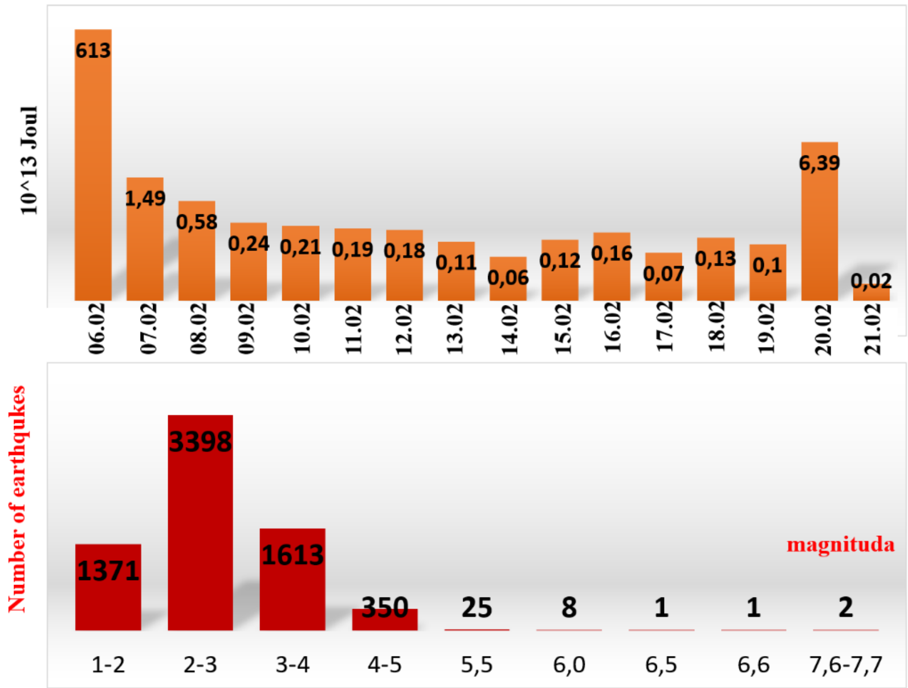

Figure 6. Graph of the distribution of seismic activity and aftershocks by magnitude

Considering the above, the source mechanism of a strong earthquake was constructed and analyzed. In this work, we used the waveform inversion algorithm developed by Professor John Nabelek from University of Oregon [8, 9]. The main source of seismograms is the Republican Seismic Survey Center. Seismograms are downloaded in SEED format for LH channels. The seismic moment tensor describes the equivalent forces acting on a seismic source and is the base value estimated for earthquakes of all scales.

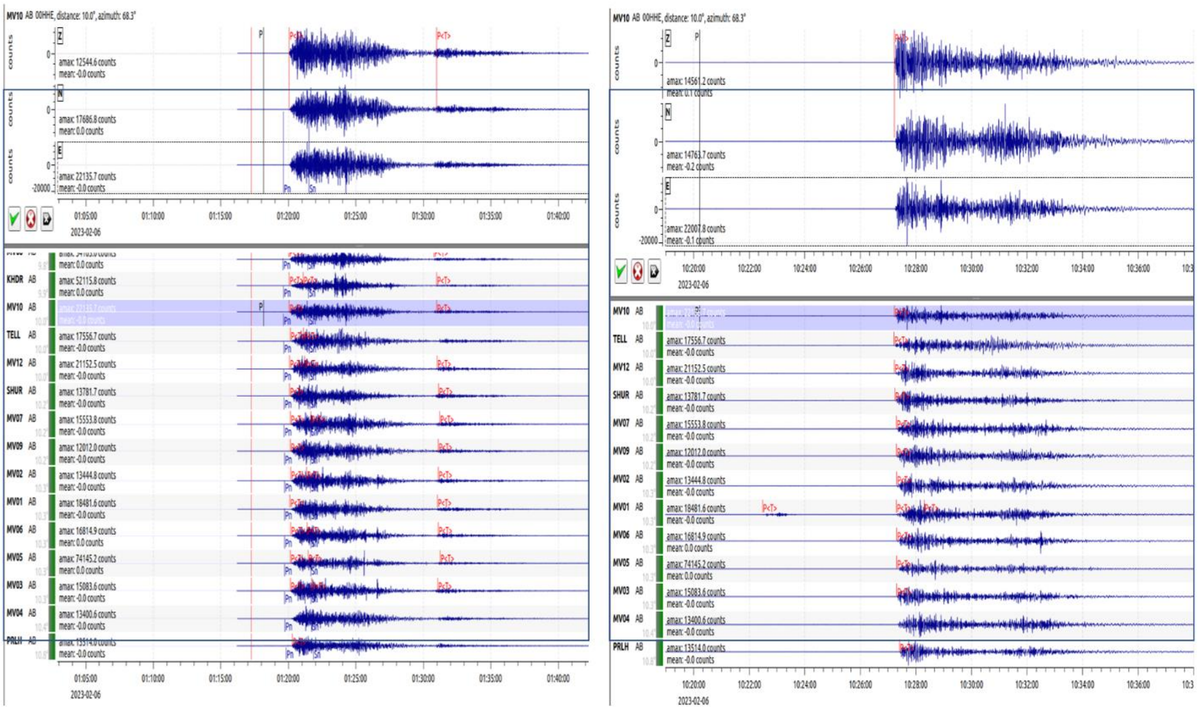

Figure 7. Recording of digital seismic stations of the RSSC ANAS

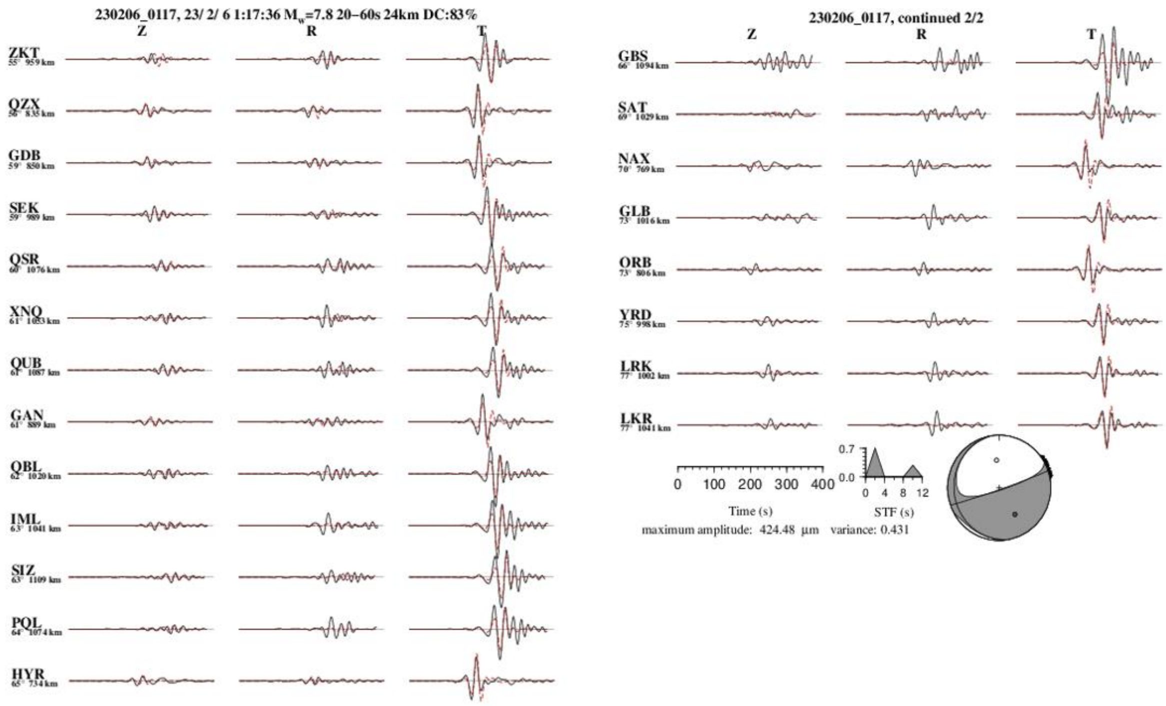

Figure 8. An example of a graphical output file for calculating the seismic moment tensor for the Turkish earthquake with M=7.8. Red lines are synthetic seismograms, black lines are original seismogram.

During the script operation, after reading the parameter files, station coordinates and output files of the location program, the following operations are performed: 1) correction of earthquake waveforms for the amplitude-frequency characteristic of recording devices and the transition from north-south, east-west, vertical to coordinates is radial, tangential, vertical; 2) band-pass filtering with a 4-order Butterworth filter; 3) calculation of the Green's functions used by the inversion of synthetic waveforms for the entire set of depths and source-receiver distances (obtained on the basis of the location program of the real-time subsystem) [14].

The output graphic file contains not only a graphic representation of the source mechanism and wave modeling, but also estimates of the parameters of earthquake sources. These parameters include the angles characterizing the position of the nodal planes (strike, dip, slip), strain tensor components, as well as the scalar seismic moment M0 (determined using the inverse method) and moment magnitude Mw. The main parameters are presented below:

Event: 230206_011736
Depth (km) 18.0 Number of station: 21
Moment Tensor: Scale = 10*27 dyn.sm
Component Value
Mxx -2.038 Myy 1.648
Mxy -1.110 Myz -0.402
Mxz 3.170 Mzz 0.390
Source Composition:
DC/49 CLVD/51 Iso/0
Principal Axes:

Axis	Value	Plunge	Azimuth
T	3.193	41	314
N	1.107	31	75
P	-4.299	33	188

Best Fitting Doble-Couple:
M0 = 3.75E+27 dyn.cm Mw = 7.7

Plane	Strike	Slip	DP
NP1	72	59	85
NP2	335	171	31

Results:

Thus, as a result of data interpretation, it was found that the source mechanism of the main shock is a left-sided strike-slip, consistent with the East Anatolian Fault. Plates move mostly horizontally. But this does not mean that the entire plate is moving. It remains motionless, displacement occurs only in a limited area. The Anatolian plate moves to the southwest at a rate of 20 mm/year, turning counterclockwise relative to Eurasia [4]. At the same time, the plates surrounding it, the Arabian and African, are moving north-northwest at 15 and 5 mm/year, respectively.

However, these velocity values show how the position of the plate changes over millions of years. The average speed of the plates is more or less uniform, and its fluctuations over long periods of time say nothing about the mechanics of earthquakes. Meanwhile, the movement of the plate is a complex process, broken down into local events. The plate deforms non-uniformly: somewhere, a section of the plate creeps a little, in another place it gets stuck, accumulating mechanical stress. And somewhere this stress exceeds the tensile strength and the section slips - a rupture and displacement occurs. And at this moment, the speed of the plate section changes very noticeably [15]. Such events are typical for faults, zones of contact between plates. They are just zones of high seismicity. As happened in this case, for the Turkish earthquake.

The East Anatolian fault runs from the southwest to the northeast along the border of the Anatolian and Arabian plates, only in the west touching the junction of the Anatolian and African. In general, continental blocks are displaced relative to each other mainly horizontally or undergo oblique compression. Accordingly, shear processes play an important role among seismic phenomena.

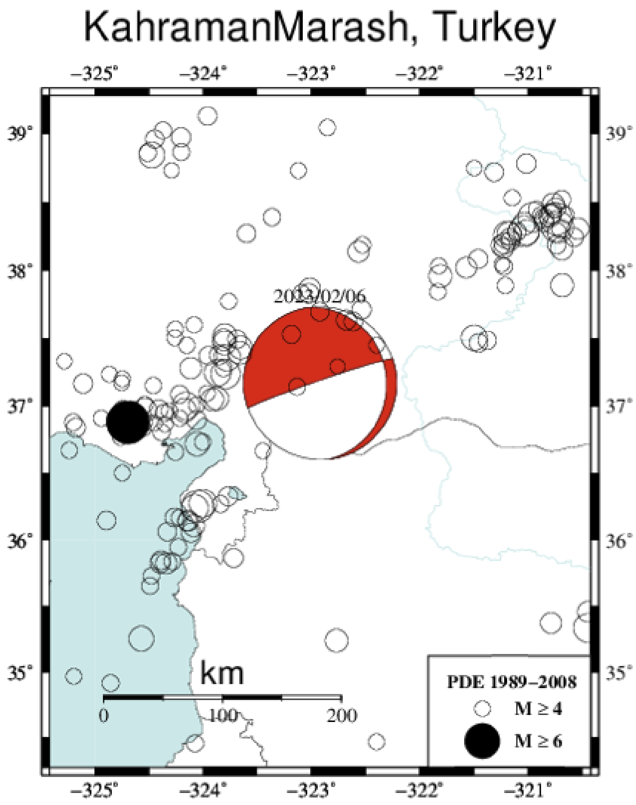

Figure 9. Source mechanism of the Turkish earthquake on February 6, 2023 with M=7.8

And on February 10, the Centre for the Observation and Modelling of Earthquakes, Volcanoes and Tectonics (COMET) reported that the rupture zones along the length of the fault, according to the Sentinel-1 satellite, reach a length of 300 and 125 kilometers [15]. The first gap was formed after an earthquake of magnitude 7.8, the second after a shock of magnitude 7.5. The size of the area affected by the shock shift near Gaziantep is 100×70 kilometers, the magnitude of the shift is about 3.4 meters.

REFERENCES

1. Aktuğ B, Nocquet JM, Cingöz A, Parsons B, Erkan Y, England P, Lenk O, Gürdal MA, Kilicoglu A, Akdeniz H, Tekgül A (2009) Deformation of western Turkey from a combination of permanent and campaign GPS data: limits to block-like behaviour. J Geophys Res 114.
2. Aktuğ B, Parmaksız E, Kurt M, Lenk O, Kılıçoğlu A, Gürdal MA, Özdemir S (2013) Deformation of Central Anatolia: GPS implications. J Geodyn 67:78–96. doi:10.1016/j.jog.2012.05.008
3. Aktug B., Nocquet J.M., A Cingöz, B Parsons, Y Erkan, P England, O Lenk Deformation of western Turkey from a combination of permanent and campaign GPS data: Limits to block-like behavior // Journal of Geophysical Research: Solid Earth 114 (B10), 2009
4. Barka A, Reilinger R (1997) Active tectonics of the Eastern Mediterranean region: deduced from GPS, neotectonic and seismicity data. Analli di Geofisica 40(3):587–610
5. Bilham R., H Ozener, D Mencin, A Dogru, S Ergintav, Z Cakir, A Aytun, ... Surface creep on the North Anatolian fault at Ismetpasa, Turkey, 1944–2016 // Journal of Geophysical Research: Solid Earth 121 (10), 7409-7431
6. Burgmann R., Ayhan M.E., EJ Fielding, TJ Wright, S McClusky, B Aktug, ...Deformation during the 12 November 1999 Duzce, Turkey, earthquake, from GPS and InSAR data // Bulletin of the Seismological Society of America 92 (1), 161-171, 2002
7. Herring, T.A., 1997. GAMIT/GLOBK Kalman Filter VLBI and GPS Analysis Program; Version 4.1. Massachusetts Institute of Technology, Cambridge.
8. Jochen Braunmiller, John L. Nabelek, Abdolreza Ghods Sensor Orientation of Iranian Broadband Seismic Stations from P-Wave Particle Motion // April 2020, Seismological Research Letters 91(3)

9. Karplus M.S., Mohan Pant, Soma Nath Sapkotaç Nabelek J.L. et al. A Rapid Response Network to Record Aftershocks of the 2015 M 7.8 Gorkha Earthquake in Nepal, May 2020, Seismological Research Letters, 91(4)
10. McClusky, S., Balasdsanian, S., Barka, A., Demir, C., Georgiev, I., Hamburger, M., Hurst, K., Kastens, K., Kekelidze, G... 2000. Global positioning system constraints on crustal movements and deformations in the eastern Mediterranean and Caucasus. J. Geophys. Res. 105, 5695–5719.
11. Özener H., Aktuğ B., Doğru A., Sabuncu A., B Turgut, K Halıcıoğlu, O Yılmaz, ... Slip rates and seismic potential on the East Anatolian Fault System using an improved GPS velocity field // Journal of Geodynamics, 2016
12. Parmaksız E., Aktuğ B., M Kurt, O Lenk, A Kılıçoğlu, MA Gürdal, S Özdemir Deformation of central anatolia: GPS implications // Journal of Geodynamics 67, 78-96
13. Straub, C., Kahle, H.G., 1995. Active crustal deformation in the Marmara Sea Region, NW Anatolia, inferred from GPS measurements. Geophys. Res. Lett. 26, 2513–2516. S¸ aroglu, F., Emre, ˘ O., Kus ¨ ¸c¸u, ˙I., 1992. Turkish Active Faults Map. Directoriate of Mineral Research and Exploration, Ankara, Turkey.
14. Воронина Е.В. Особенности механизмов очага сильнейших землетрясений Средиземноморья ВМУ. Серия 3. ФИЗИКА. АСТРОНОМИЯ. 2020. № 1. С. 64–69.
15. https://zemletryaseniya.ru/sejsmicheskie-zony-evropy-i-sejsmichnost-evropejskogo-regiona/
16. ORTA DOĞU TEKNİK ÜNİVERSİTESİ 6 Şubat 2023 Kahramanmaraş-Pazarcık Mw=7.7 ve Elbistan Mw=7.6 Depremleri Ön Değerlendirme Raporu, https://eerc.metu.edu.tr/tr/system/files/documents/DMAM_2023_Kahramanmaras-Pazarcik_ve_Elbistan_Depremleri_Raporu_TR_final.pdf

ASSESSMENT OF GEOLOGICAL RISKS IN THE TERRITORY OF ALIJANCHAY RESERVOIR

G.J.Yetirmishli[1], E. S.Garaveliyev[1], N.B. Khanbabayev[1], E.M.Baghirov[1]

Introduction

The research area is located in the Alijanchay river valley in the administrative territory of Oghuz region (Fig.1).

The purpose of the work: Determination of geologically probable dangerous areas on the basis of complex geophysical studies in the territory of Alijanchay reservoir.

Alijanchay River takes its source from the mountainous part of Oghuz region and joins Kura River near Yevlakh city. The absolute height around the study area is 400 m (Fig. 1, 2).

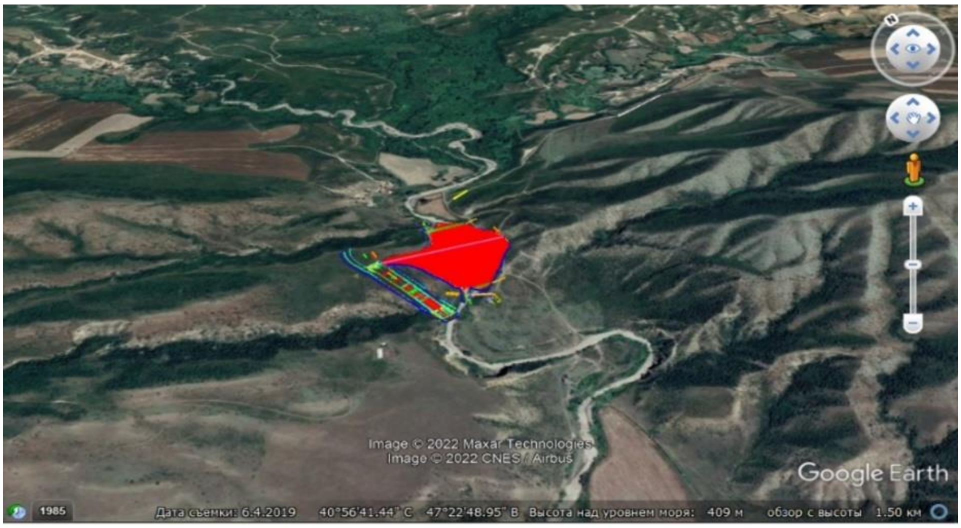

Figure 1. Area of the reservoir to be built on Alijanchay river, Oghuz region (marked red). On the right and left banks of the river slopes is 26-27^0 and 5-6^0, respectively.

Figure 2. Geological disturbances observed in the area where the reservoir will be built

The area where the reservoir will be built is tectonically located on the southern slope of the Greater Caucasus, within the Alazan-Ayrichay synclinorium, which is characterized by a complex geological structure. The structure belongs to the northern tectonic element of the Kura megasynclinorium. The Alazan-Ayrichay synclinorium is filled with thick Quaternary alluvial-proluvial sediments. The northern boundaries of the synclinorium are composed of a mixture of Quaternary and Mesozoic deposits. Landslides, collapse, and collapse is not excluded in the area where the reservoir will be built (photo 3).

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The sedimentary complexes of the Lower Agjaghil, Agjaghil, Absheron, Upper Absheron and Baku-Caspian layers are included in the stratigraphic section of the research area. The total thickness of this layer reaches 1000 m.

Quaternary sediments are widespread in the foothills, they are continental facies, and lie everywhere transgressively over sediments of Absheron age.

The lithological composition of the sediments consists of sand, sandstone, gravel, clay and silt. Its total thickness is 200-300 m.

Figure 3. Local landslide and fall areas observed in the reservoir area.
Engineering-seismic exploration works

In order to study the inclination, direction and depth of probable landslide planes in the area, surface engineer seismic exploration works have been carried out. During the seismic exploration works of the surface engineering, the method of seismic exploration "Tested Microtremor" (Tested Microseisms) was used (Lowi, 2001).

This method is considered a time-efficient seismic method for constructing the share wave velocity profile in the study area. “The phase data of the recorded wave fields are used in the "Tested Microtremor" (Tested Microseisms) method.

The GEODE-24 engineer seismic station, 24 seismic receivers, a 115-meter-long seismic survey wire and an 11 kg impact hammer were used to study the tested microseisms.

Microvibrations created by the impact method are perceived as seismic waves.

The method of data acquisition and collection consists of obtaining 12 microvibration recordings in 30 seconds.

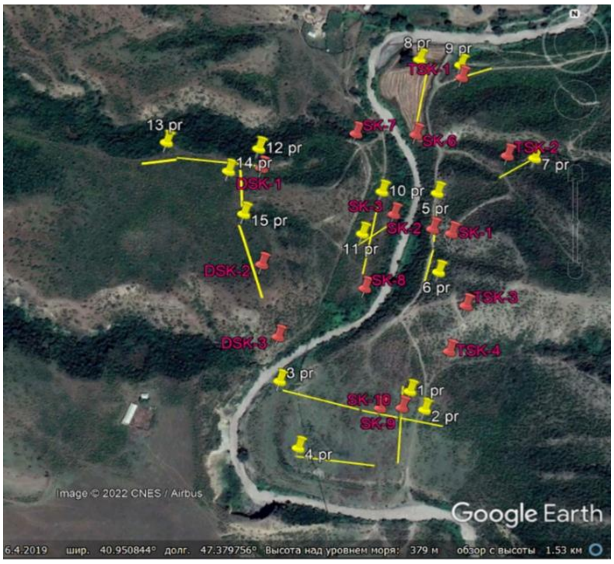

Figure 4. Location scheme of 15 seismic profiles in the research area.
Symbols: SK, DSK, TSK – red signs - exploration holes,
yellow signs - seismic profiles.

The results of the seismic profiles constructed in the research area (15 in number) were connected to geological exploration holes drilled in the area (two seismic sections are given as an example in the article, Fig. 5-6).

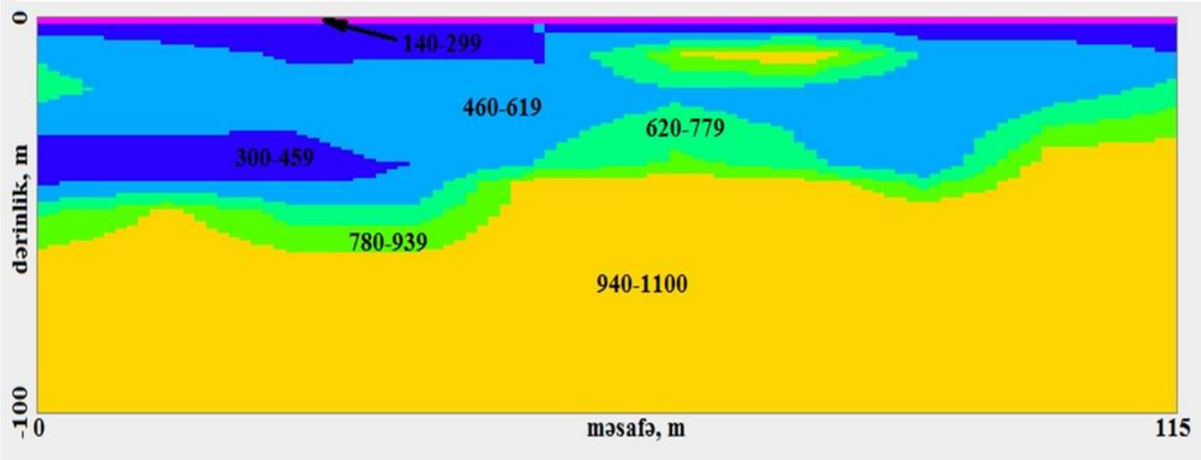

Figure 5. 2-Dimensional velocity cross section of transverse waves on seismic profile No. 1 (in m/s).

Seismic profile No. 1 was connected to hole SK-10 and the average transverse wave speed parameter was calculated in the field up to a depth of 30 m. The average transverse wave speed parameter is calculated by the following formula:

$$V_{s30} = \frac{30}{\sum_{i=1,N} \frac{h_i}{V_i}}$$

here h_i and V_i are layer thicknesses and transverse wave velocities down to a depth of -30 m. Based on the calculation, we get: V_{s30}= 440 m/s.

As can be seen from the profile, at a depth of 36-42 m, a weakly cemented clay-rich gravel bed is located. The transverse wave spread speed in this layer is 300-459 m/s.

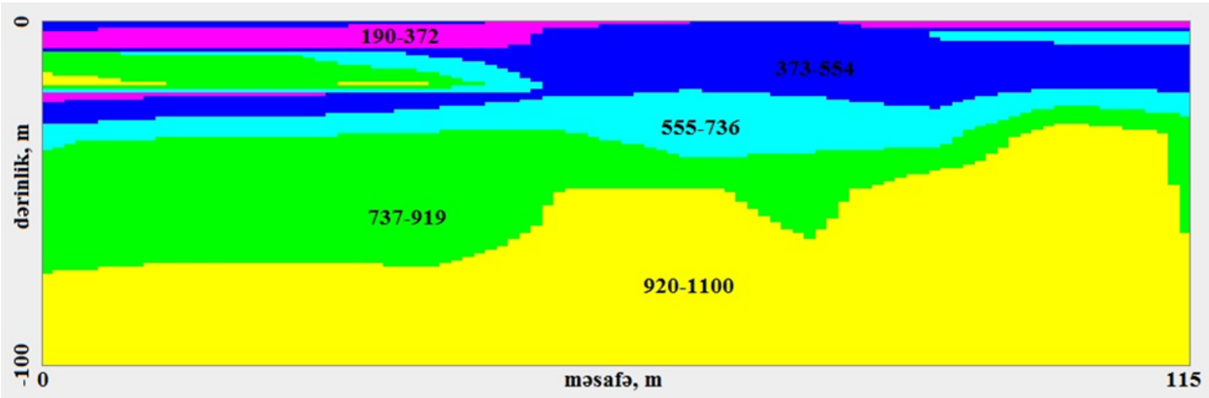

Figure 6. 2-dimensional velocity cross section of transverse waves on seismic profile No. 2 (in m/s).

Profile No. 2 was connected to the SK-10 hole and the average speed parameter of the transverse wave was calculated up to a depth of 30 m in the field. Vs30= 430 m/s

As can be seen from the profile, there is weakly moist, hard, semi-solid consistency with thin sand and sandy loams, sometimes with pebbles and gravel.

The transverse wave spread speed in this layer is 373-554 m/s. An additional lens-like layer with a speed of 310 m/s is observed inside the layer.

According to the normative document (Az DTN 3.2-1), soils on profiles are classified as class II due to their seismic properties.

On the basis of research conducted on 15 seismic profiles, 4 landslide prone and 2 collapse prone areas were identified in the region.

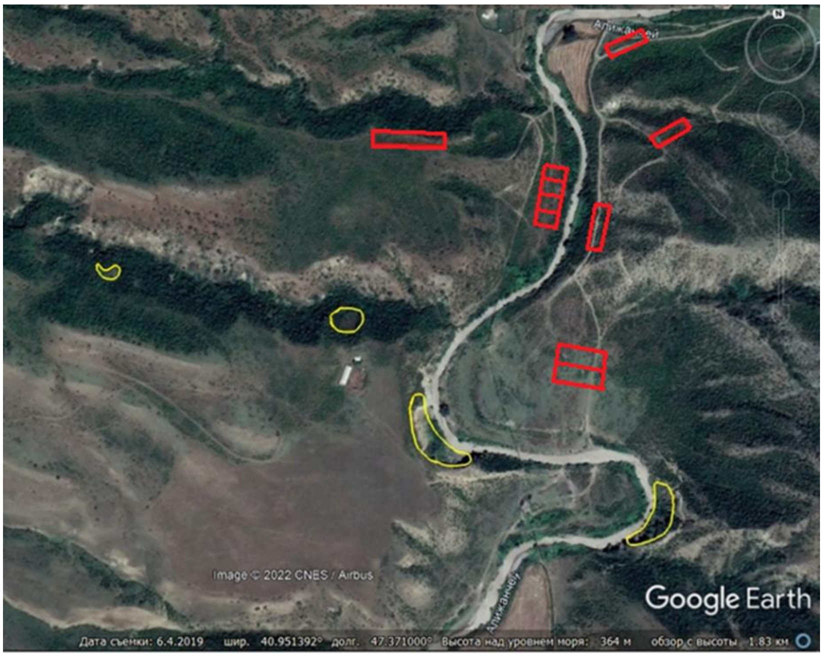

Figure 7. Probable landslide and collapse prone areas in the region
Method and results of gravimetric research studies
Symbols:
Observed collapse and landslide areas:
Lands prone to sliding
Areas prone to collapse

Gravimetric observations in the study area were performed by operators on foot with a high-precision CG-5 AutoGrav device made in Canada.

A local anomaly map and a 3D model were prepared in order to evaluate the distribution of gravity in the area and the depth dynamics by the gravimetric exploration method.

The obtained data allowed to monitor the geological-tectonic disturbances in different depth intervals in the area and to evaluate the geodynamic regime during the operation of the reservoir.

The research works were carried out by the method of repeated measurements at the observation and support points shown in the diagram (Fig. 8).

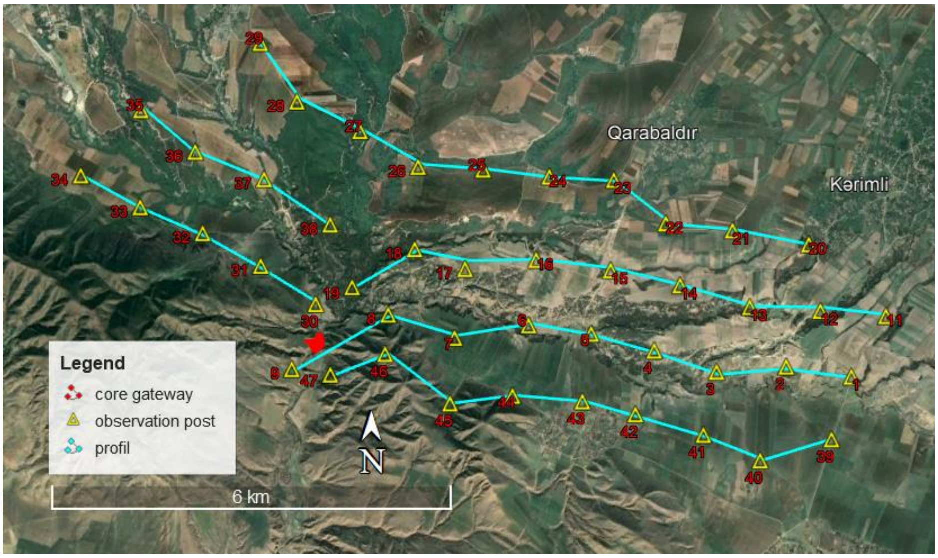

Figure 8. Location scheme of the gravimagnetometric observation points implemented in the research area.

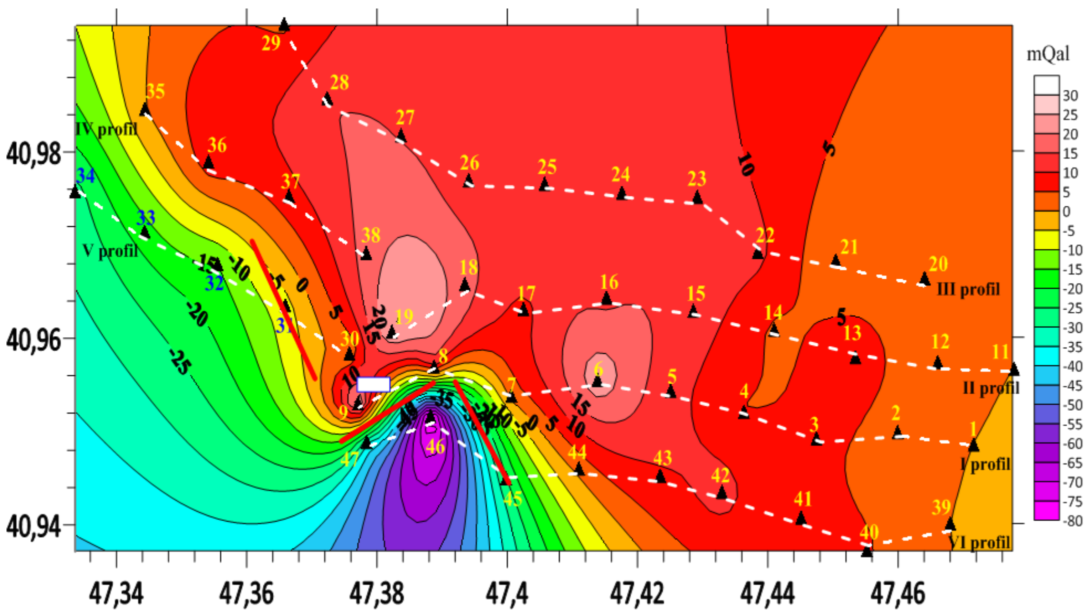

Figure 9. Gravity change map showing the stress-strain state of the study area.
Symbols: ▭ *reservoir dam.*
▲ *observation areas.* – – – *profiles.* ▬ *Fault zone*

As can be seen from the anomaly map reflecting the gravity field, there are anomalous zones marked by the variable value of the gravity force in the area. In the study area, gravity varies from 1.0 to 15 mGal with a monotonous increase from north to south. Another complex minimum-type anomaly in the gravity field is noted in the southwest wing of the map. In the anomaly, the voltage decreases from -5 mGal to -50 mGal.

The observation of minimum-type anomalies in the field suggests that there is a geological disturbance in a small area. A sharp change in the gradient around the mentioned minimum suggests that landslides, avalanches and subsidence will occur in these areas in the future.

Such a sharp opposite polarity of gravity anomalies in the area indicates the complex geological structure of the area. Based on the data of the gravity field, the results of the mentioned interpretation can be more accurately observed in the model built in 3D format, which reflects the stress-deformation state of the geological environment (Fig. 10).

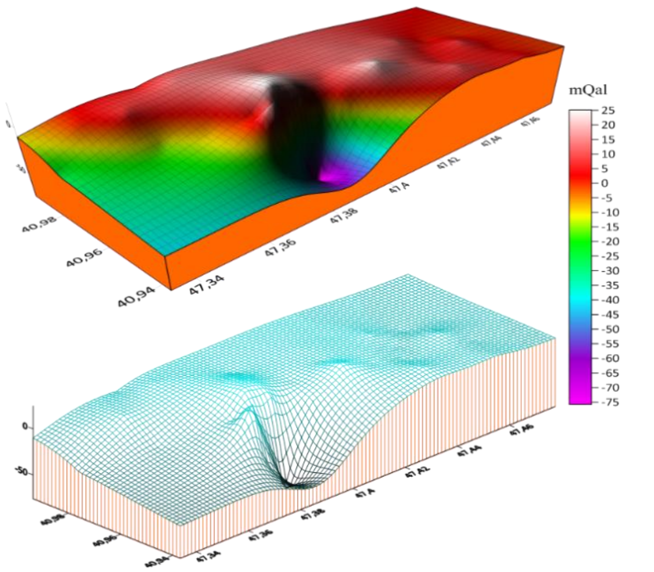

Figure 10. A 3D model representing the stress-strain state of the study area.

Method and results of magnetometric research studies

In order to assess the state of stress and deformation of the area where the reservoir will be built, magnetometric studies were carried out simultaneously with gravimetric studies.

In order to study the deep geological-tectonic structure of the area where the reservoir will be built, the magnetometric exploration method is of great importance in the complex conducted by engineering-seismic, geophysical and geodetic methods. With this method, maps reflecting the depth dynamics of the area and characterizing the change in geodynamic stress were drawn up.

The data obtained by the mentioned method allowed to monitor the tectonic disturbances (cracks) in different depth intervals in the area and to evaluate the geodynamic regime of the area.

Observations in the area were carried out by operators on foot, in 6 profiles with an American-made G-856 proton-type, high-precision, modern magnetometer.

Taking into account the topography of the area, a network of observation points was created and 2D map and 3D model reflecting the stress and deformation state of the magnetic field were constructed (Fig. 11-12).

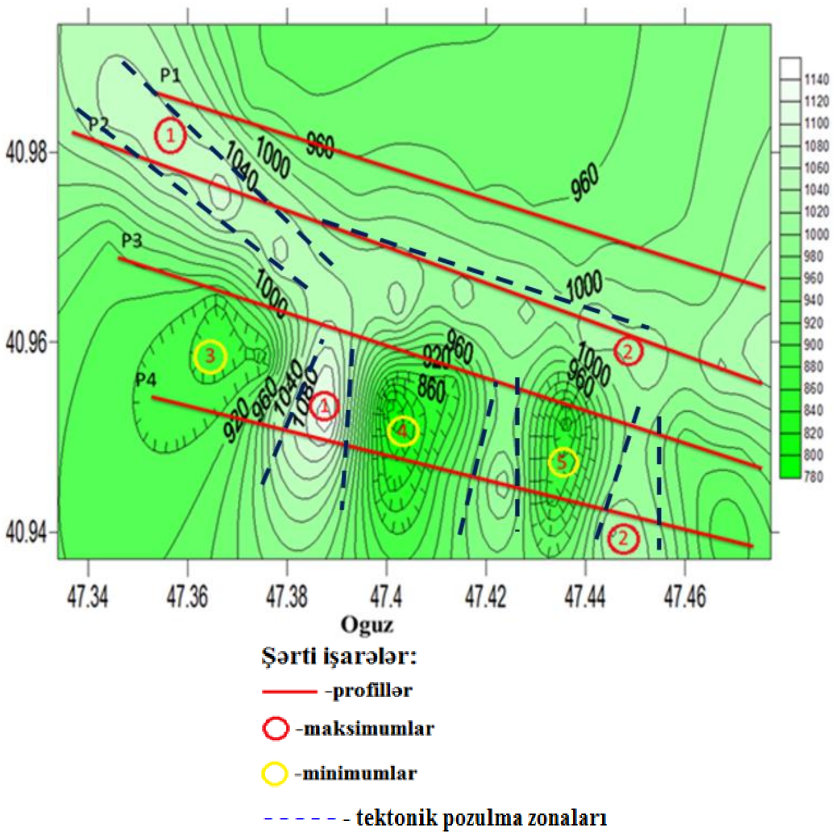

Figure 11. 2D Schematic map of the stress-strain state of the study area.

In the south of the map; Magnetic minima No. 3, 4 and 5 are observed. The minimums are arranged from the northwest to the southeast and are closed in a south-north direction. The intensity of these mentioned minimums continues with increases towards the edges, being 800 nT in the center.

In the center of maximum type geomagnetic anomaly No. 1, which is observed in the southwest of the map, the intensity is 1100 nT, and it is observed in a bent and stretched form up to the northwest wing of the research area.

While the northwestern part of this maximum is almost calm, it is observed in a complicated form in the south. It indicates complications in the geological structure of the southern wing of maximum No. 1 observed between two minimum anomalous areas in a small area. Such gradient changes in the magnetic field indicate that the geodynamic conditions of the area are complicated by tectonic disturbances.

The magnetic maximum No. 2 marked in the southeastern wing of the map has a differentiated form and is of a calm nature (Fig. 11).

As can be seen from the 3D model, the tension of the geomagnetic field continued to decrease from the northwest to the southeast, and the maximum and minimum magnetic anomalies were sequentially arranged (Fig. 12).

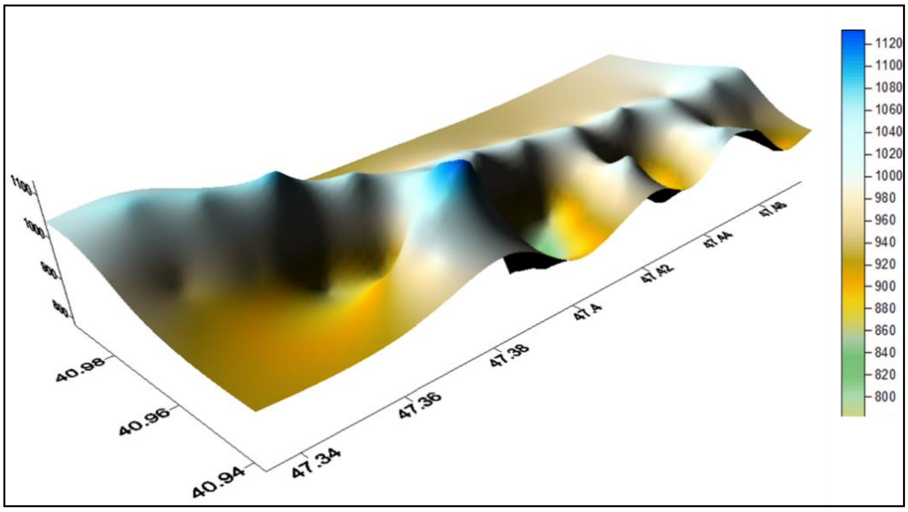

Figure 12. 3D model of the stress deformation state according to the magnetometric data taken in the area.

Results

1. On the basis of the researches, 3 tectonic fault zones with probable risk are separated and the active dynamics of the mass characterizing the anomalous areas are indicated
2. 4 landslide-prone and 2 landslide-risk local areas have been identified in the area.

REFERENCES

1. Fund of RSXM under ANAS
2. Rzayev A.Q., Yetirmishli G.D., Kazimova S.E. 2013. Reflection of the geodynamic regime in variations of the geomagnetic field intensity. News. Earth Sciences, N4, page 3-15.
3. SEISMOPROGNOSIS OBSERVATIONS IN THE TERRITORY OF AZERBAIJAN Seismoprogn. Observ.Territ.Az. 1980-2021-years.
4. Shikhalibayli E.Sh. 1956. Geological structure and development of the Azerbaijani part of the southern slope of the Greater Caucasus. Baku: Publishing House of the Academy of Sciences of Azerbaijan SSR, 218s
5. Kangarli T.N., Kadirov F.A., Yetirmishli G.J., Aliyev F.A., Kazimova S.E., Aliyev A.M., et al. 2018. Recent geodynamics, active faults and earthquake focal mechanisms of the zone of pseudo subduction interaction between the Northern and Southern Caucasus microplates in the southern slope of the Greater Caucasus (Azerbaijan). Geodynamics and Tectonophysics. 2018a; 9(4):1099-1126. DOI: 10.5800/ GT-2018-9-4-0385
6. Boulanger J.D. The study of non-tidal changes in the acceleration force. 1978. Sat. scientific works
7. Repeated gravimetric observations M., ed. “Oil geophysical”, Pp. 10-17.
8. Molodensky M.S. Selected works. gravitational field. The figure and internal structure of the Earth. M.: Nauka, 2001.570 p.

ISMAYILLI EARTHQUAKE WITH ML=3.8 OF JANUARY 31, 2023

G.J.Yetirmishli[1], E.M.Baghirov[1], A.T.Ismayilova[1], S.S.Ismayilova[1]

Introduction. The problem of studying and predicting earthquakes has been relevant for centuries. Mankind has always tried to understand the processes of occurrence of destructive earthquakes in the past.

The Shamakhi-Balakan geodynamic polygon, covering the areas of the southern slope of the southeastern subsidence of the Greater Caucasus, is one of the most seismically active parts of the meganticlinorium, where strong seismic events occurred in the early and middle of the 20th century. The polygon covers several seismically active zones with regime forecasting observations: Shamakhi-Ismayilli, Oghuz-Gabala and Sheki-Zakatala zones (Yetirmishli et al., 2018, 2021). The seismic regime of each zone differs in its parameters and changes over time (Baghirov, Ismayilova, 2019).

The stationary network of seismic stations in the Ismayilli-Shamakhi seismic zone has registered more than a thousand earthquakes of different energy classes. The ongoing seismic events convince of the importance of the problem of studying the seismicity of the Shamakhi-Ismayilli zone in order to identify the features of the manifestation of earthquakes and assess the degree of their potential seismic hazard, as well as the feasibility of conducting geophysical studies to predict the seismic process (Baghirov, Ismayilova, 2019).

Instrumental data. Below are the instrumental data within the Shamakhi-Ismayilli seismogenic zone.

A map of epicenters of historical earthquakes in the study area is shown in Figure 1, a map of earthquake epicenters for 2022 in the Shamakhi-Ismayilli region - in Figure 2, the distribution of the number of earthquakes and the release of seismic energy in the Shamakhi-Ismayilli seismogenic zone for 2022 - in Figure 3.

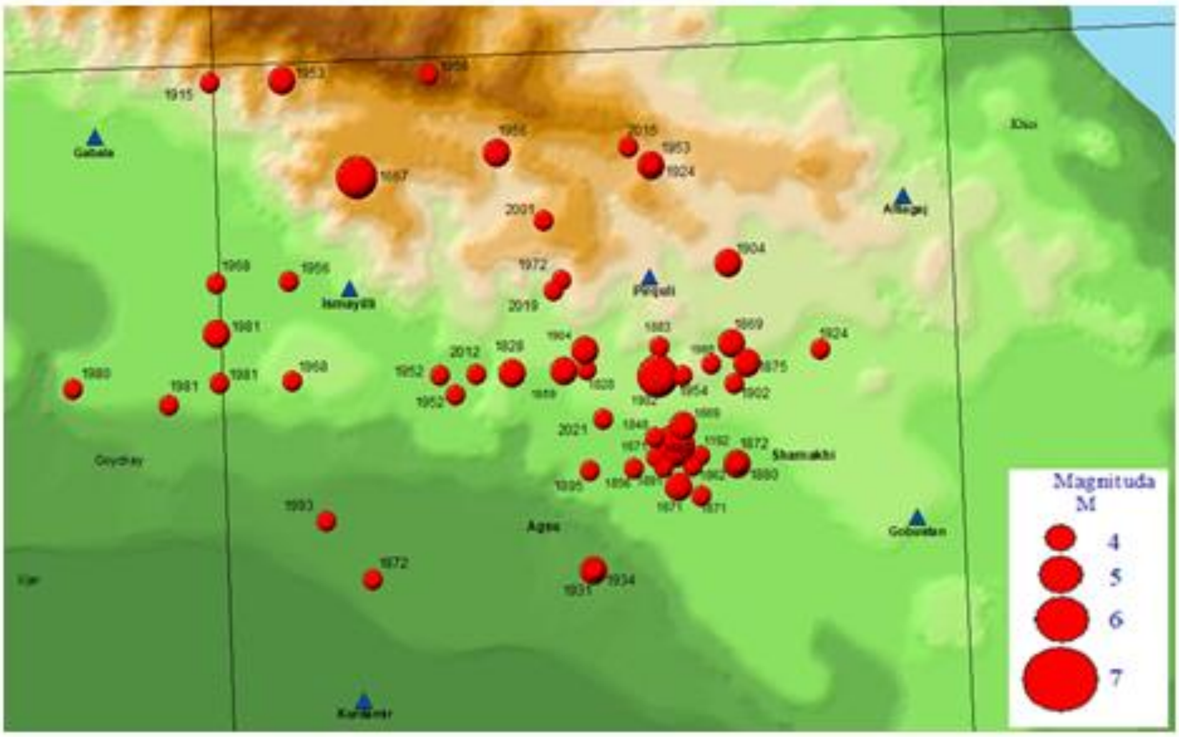

Figure 1. Map of epicenters of historical earthquakes, occurred in the study area (427-2022)

[1] *Republican Seismic Survey Center of Azerbaijan National Academy of Sciences*

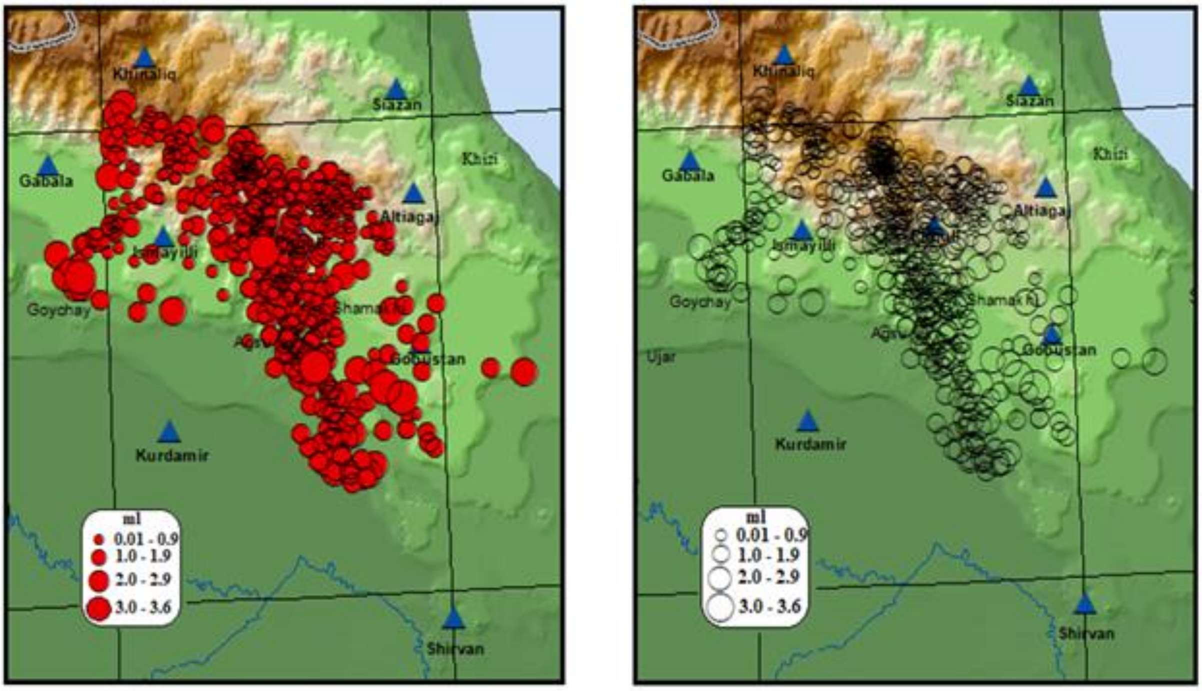

Figure 2. Map of earthquake epicenters in Shamakhi-Ismayilli region (2022)

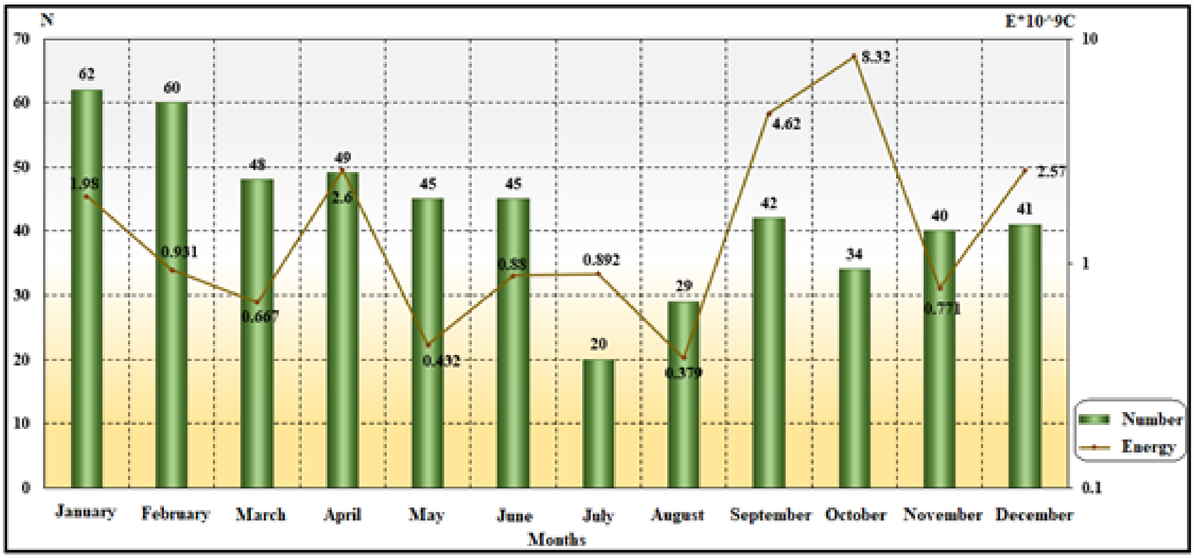

Figure 3. Distributions of the number of earthquakes and discharge of seismic energy in the Shamakhi-Ismayilli seismogenic zone (2022)

An analysis of the distribution of the number of earthquakes and the release of seismic energy in the Shamakhi-Ismayilli region in 2022 shows that the release of seismic energy in September and October is higher than in other months due to earthquakes with magnitude ≥3.0. (Table 1).

To predict the degree of seismic hazard of catastrophic earthquakes, not only the results of instrumental observations are of undoubted interest, but also the assessment of the potential energy of an earthquake for a given area, its magnitude and intensity, as well as the radius of action of an earthquake on gravimetric (Δg) parameters (seismogravimetric effect).

Research methods. The Shamakhi-Ismayilli seismically active zone is located on the southern slope of the Greater Caucasian meganticline between the Demiraparanchay and Meraz meridians. In this zone at different times V.Weber, A.Mishurin, A.Malikov, A.Alizade (1930-40), E.Khain (1939), A.Shikhalibeyli (1940-45), I.Tsimelzon (1953), N.Yakovenko (1962), R.Hajiyev (1965), T.Kengerli (1981-1995), A.Aliyev

(1981)-2007, E.Guliyev and E.Isayev (2002-2007) conducted geological and geophysical studies of different scale.

The study of geodynamic processes occurring in the area, in parallel with seismological studies based on modern geophysical instruments, is considered one of the most urgent tasks of our time. (Uspensky, 1968).

Table 1

№	Date d./m./y.	t_0, h./m./s.	Epicenter		h, km	MLH	MLH*	ML	K_p	I_0, point	Note
			φ°, N	λ°, E							
1.	10.03.2000	14:20:08	40.92	48.18	19		3.9	4.4	11.0		Ismayilli – 4 points
2.	26.11.2001	05:24:19.8	40.85	48.45	19		4.0	4.6	11.3	4	Pirkuli – 3-4 points, Shamakhi – 4 points
3.	08.06.2007	05:54:35.1	40.72	47.87	32		3.6	4.1	10.5		
4.	12.12.2007	10:25:30.5	40.55	48.15	24		3.7	4.2	10.7	3.5	Shamakhi – 4 points, Pirkuli – 3-4 points
5.	19.12.2008	15:11:03.2	40.87	48.49	5		3.9	4.4	11.0	5	Pirkuli, Demirchi – 4.5 points Shamakhi – 4 points, Ismayilli – 3.5 points
6	07.10.2012	11:42:50.6	40.70	48.35	41		4.5	5.3	12.2	5	Pirkuli, Shamakhi, Ismayilli, Akhsu – 5 points
7	20.04 2022	18:05:32	40.71	47.92	44			3.0			Ismayilli
8.	01.092022	18:21:50	40.75	48.48	13			3.4			Akhsu
9.	29.10.2022	13:50:45	40.45	48.83	4			3.6			Gobustan
10.	30.10.2022	04:08:12	40.43	48.88	4			3.1			Gobustan
11.	15.12.2022	19:09:28	40.50	48.62	32			3.2			Akhsu
12	16.01.2023	12:09:33	40.61	48.82	8			3.1			Gobustan
13.	31.01.2023	02:54:07	40.97	48.23	12			3.8			Ismayilli

The purpose of repeated gravimetric measurements carried out at the studied geodynamic test site is to detect seismic anomalous effects in non-tidal variations in relative gravity. Canadian gravimeters Scintrex AutoGrav CG-5 were used to study non-tidal variations in the acceleration of gravity, which are capable of providing the highest measurement accuracy during observations in the field (Fig. 4).

Figure 4. Gravimeter Scintrex CG-5

The discussion of the results. On the basis of gravimetric measurements on the southern slope of the Greater Caucasus, maps of the gravity field in 2D and 3D format were compiled. On the 2D gravimetric map (Fig. 5) in the Ismayilli region, a number of anomalous sections of the gravity field are observed.

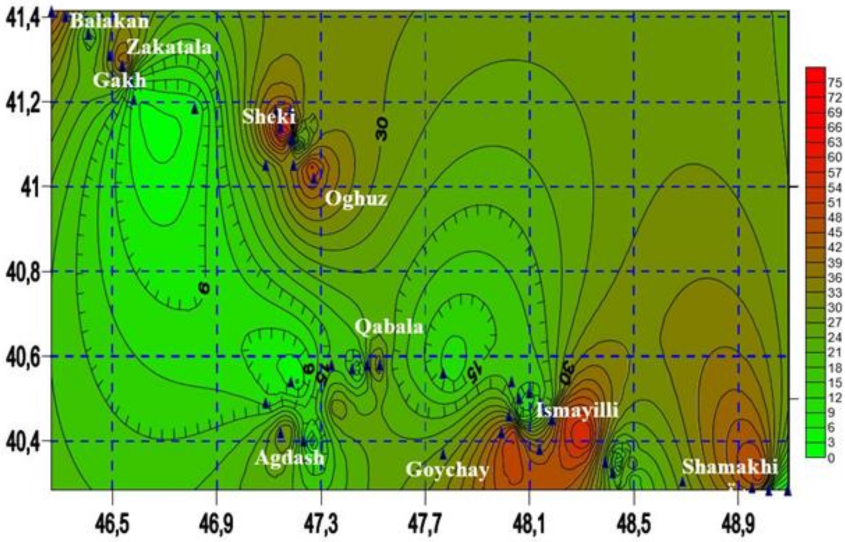

Figure 5. Map of isoanomalies of the gravity field of the southern slope of the Greater Caucasus.

Apparently, these anomalous areas are the result of the influence of intrusive masses, wedging out to the surface layers of the earth's crust.

The map of isoanomalies of the gravitational field in 2022 (Fig. 5) shows anomalous zones accompanied by an increase in the value of Δg in the seismogenic zones of Gabala, Ismayilli and Shamakhi a month before the Ismayilli earthquake.

As can be seen on the map of gravity field isoanomalies compiled in 2022 (Fig. 6), the main changes occurred in the Ismayilli and Shamakhi regions. We also observe an increase in intensity occurring here, which increased in these areas and was more pronounced locally in the Ismayilli-Karamaryam seismogenic zone. Thus, the relative strength of gravity of the entire region ranges from 0.002-0.051 mGal, in the Ismayilli region 0.018-0.050 mGal, and in the Shamakhi region 0.010-0.040 mGal. (Fig. 7).

From the conducted studies, it can be concluded that the high intensity in the Ismayilli-Karamaryam seismogenic zone at the Shamakhi-Ismayilli geodynamic polygon is on a more noticeable ascending line during the preparation of the Ismayilli earthquake of January 31, 2023. Qualitative analysis of field observations obtained during the period of the Ismayilli earthquake revealed anomalous manifestations in the gravitational field. (Fedynsky, 1967 and Nemtsov, 1962). The changes that were regularly recorded before the main earthquake were interpreted as earthquake precursors and reflected on the gravity field maps in 2D and 3D formats (Fig.6,7).

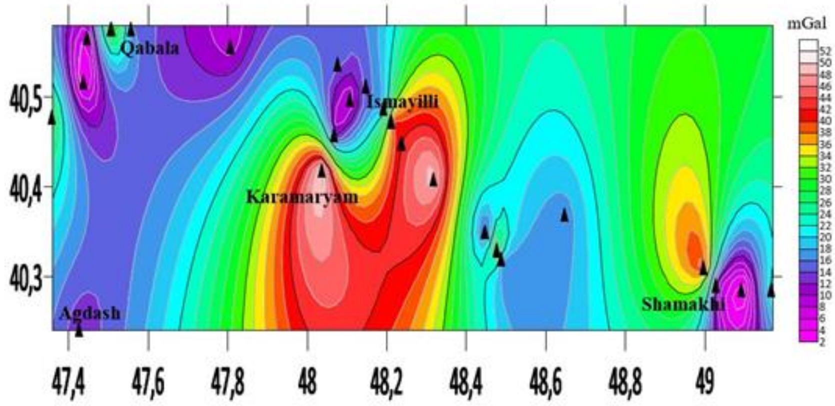

Figure 6. Map of isoanomalies of the gravitational field of the Shamakhi-Ismayilli test site before the Ismayilli earthquake (2022).

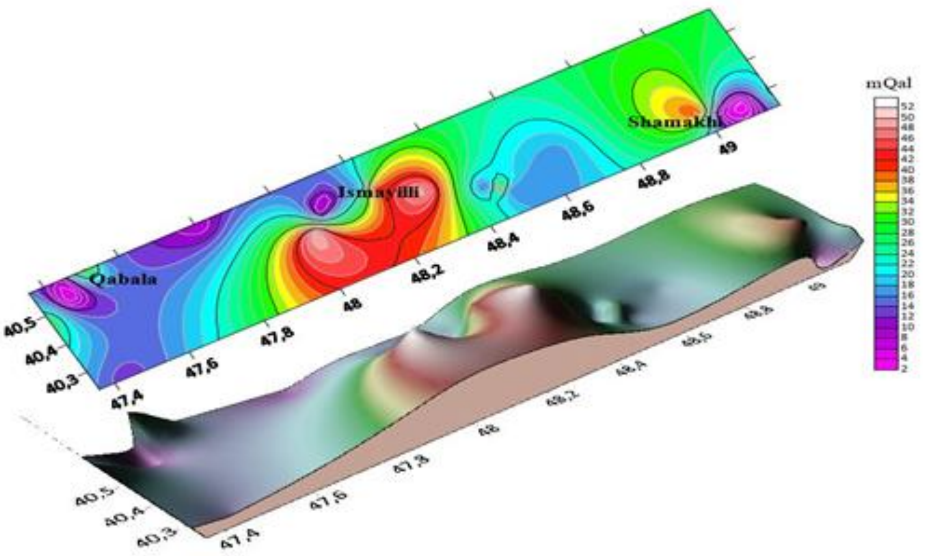

Figure 7. Map of isoanomalies of the gravitational field of the Shamakhi-Ismayilli test site before the Ismayilli earthquake (2022).

Consideration and analysis of the results of variations in gravimetric fields, comparison of these data with the seismicity and geodynamics of the region made it possible to establish the predominant factor disturbing geophysical parameters, which may be a tectonic process due to the activation of movements along the faults of the Shamakhi-Ismayilli seismically active zone. (Andreyev and Klushin, 1965).

Conclusion

1. Anomalous changes in the gravitational field were detected on the territory of the Ismayilli zone and quantitative information was obtained on the deformations of the earth's surface during the earthquake of January 31, 2023, which makes it possible to interpret them as earthquake precursors;
2. An assessment of the stress-strain state of the geological environment of the seismogenic zone is given.
3. Systematization of anomalous effects in gravitational fields showed that they belong to a single regional seismotectonic process.

REFERENCES

1. Андреев Б.А., Клушин И.Г. Геологическое истолкование гравитационных аномалий. Ленинград. Недра. 1965. 495с.
2. Немцов Л.Д. Способ расчета модельного гравитационного влияния пологих структурных форм// Труды НИИНП. 1962.
3. Багиров Э.М., Исмаилова А.Т. Анализ гравитационного поля в период до и после Шамахинского землетрясения (2018-2019гг.). Труды VII Международной конференции «Опасные природные и технологические процессы в горных регионах: модели, системы, технологии». Под ред. А.В.Николаева, В.Б.Заалишвили – Владикавказ: ГФИ ВНЦ РАН, 2019.
4. Федынский В.В. Разведочная геофизика. М., Недра, 1967, 662с.
5. Успенский Д.Г. Гравиразведка. М., Недра, 1968, 331с.
6. Етирмишли Г.Д., Исмаилова С.С., Казымова С.Э., Бекдамирова Г.И. Исмаиллинское землетрясение 7 октября 2012 г. с M_{LA3p} = 5.3?M_w = 5.1,I^p_o = 5-6 (Азербайджан).
7. Землетрясения Северной Евразии в 2012 году. Обнинск ЕГС РАН, 2018г. С. 392-400.
8. G.J.Yetirmishli, A.T.Ismayilova, S.E.Kazimova. Ismayilli earthquake on February 5th, 2019. Geology and Geophysics of Russian South. 11(4)2021.

STUDY OF LANDSLIDE PROCESSES USING GRAVIMAGNETOMETRY METHODS IN THE RESIDENTIAL AREA OF MASAZIR

A.G.Rzayev[1], E.M.Baghirov[1], M.K.Mammadova[1], A.N.Sultanova[1]

Introduction

The damage caused by landslide processes in the world amounts to tens of millions of US dollars. Anti-landslide measures based on geological-hydrogeological and topographic-geodynamic studies are a rather laborious process both financially and methodologically. On the other hand, work on assessing the stability of operated engineering structures, areas of the earth's surface of mass habitation, etc. are extremely important.

The solution to the problem of assessing deformation processes on the surface of the earth's crust is possible not only by classical geological, hydrological and geodetic methods, but also by a complex of geophysical studies, in particular, gravimagnetometry methods. The methodology of these studies was developed at the Republican Seismic Survey Center of the Azerbaijan National Academy of Sciences and is widely used in landslide areas of civil and infrastructure construction.

This article discusses the probability of a landslide (deformation) process on the territory of the Masazir residential complex (Azerbaijan Republic). Methods of magnetometric and gravimetric monitoring were used.

The discussion of the results

Gravimagnetic studies on the area of the village of Masazir were held in two stages - in April and May 2015.

The purpose of the work is to study the geodynamic regime and assess the stress state of the geological environment in the area of the village of Masazir.

Magnetometric and gravimetric observations were carried out along 5 geophysical profiles with a step of 50-100 meters. In order to “normalize” the variations in the geomagnetic field strength, a stationary magnetic variation station of round-the-clock operation (MVS) was installed on the territory of study. Equipment proton magnetometer G-856 (USA) in the amount of 2 sets, gravimeter CG-5 (Canada) in the amount of 1 set.

The results of magnetic and gravity surveys were presented as maps of spatiotemporal increments of the geomagnetic field strength ΔT~f(t) and non-tidal gravity variations Δg~f(t) in 2D and 3D formats (Fig. 1, 2, 3, 4, 5, 6, 7, 8).

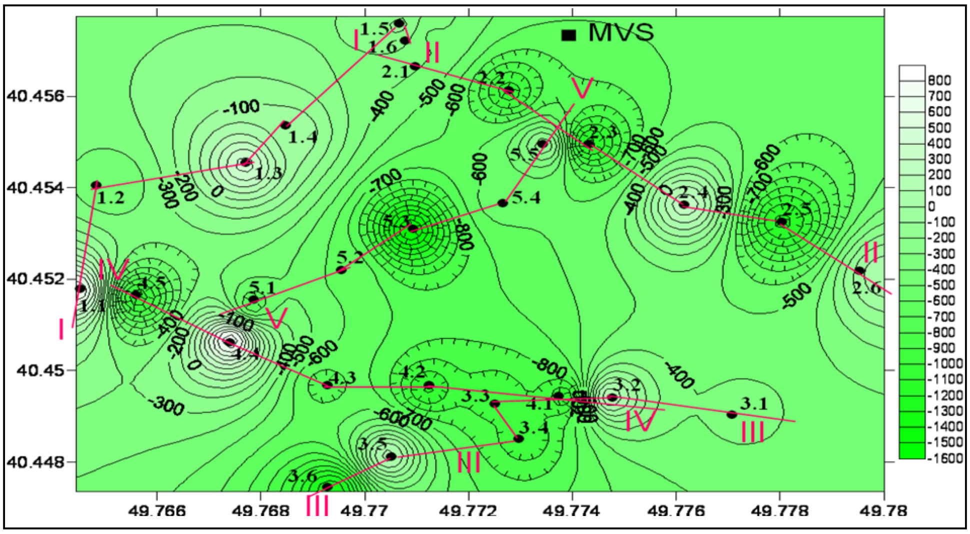

Figure 1. Stress-strain state of the geological environment in the Masazir area based on magnetometric data in 2D format (April, 2015).

[1] *Republican Seismic Survey Center of Azerbaijan National Academy of Sciences*

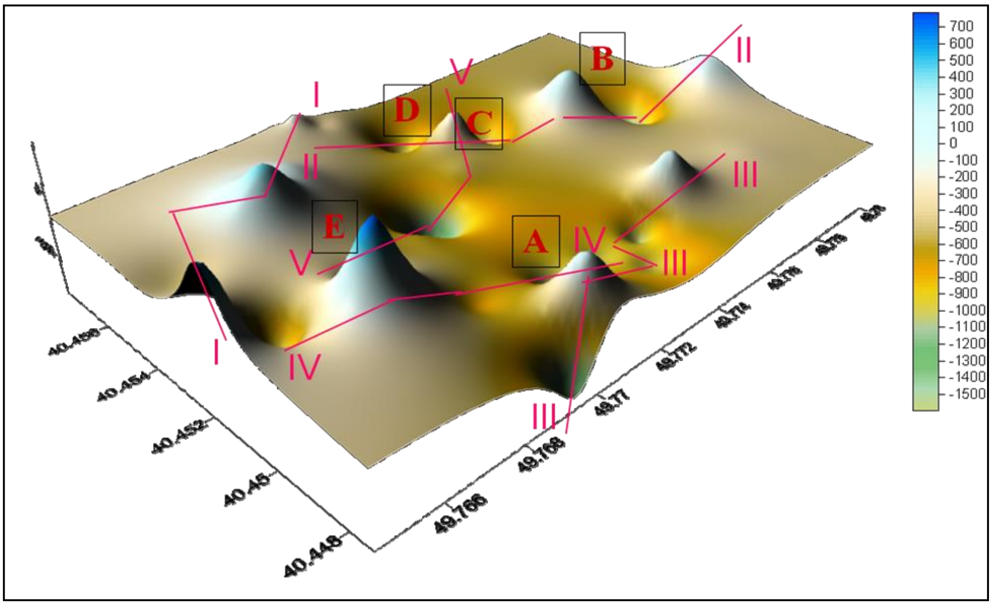

Figure 2. Stress-strain state of the geological environment in the Masazir area based on magnetometric data in 3D format (April, 2015).

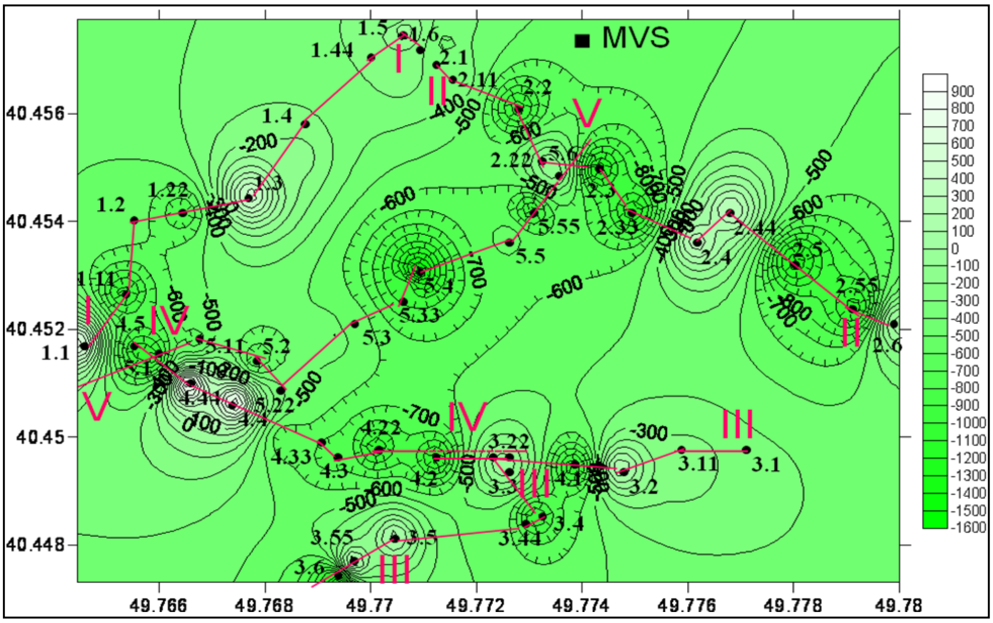

Figure 3. Stress-strain state of the geological environment in the Masazir area based on magnetometric data in 2D format (May, 2015).

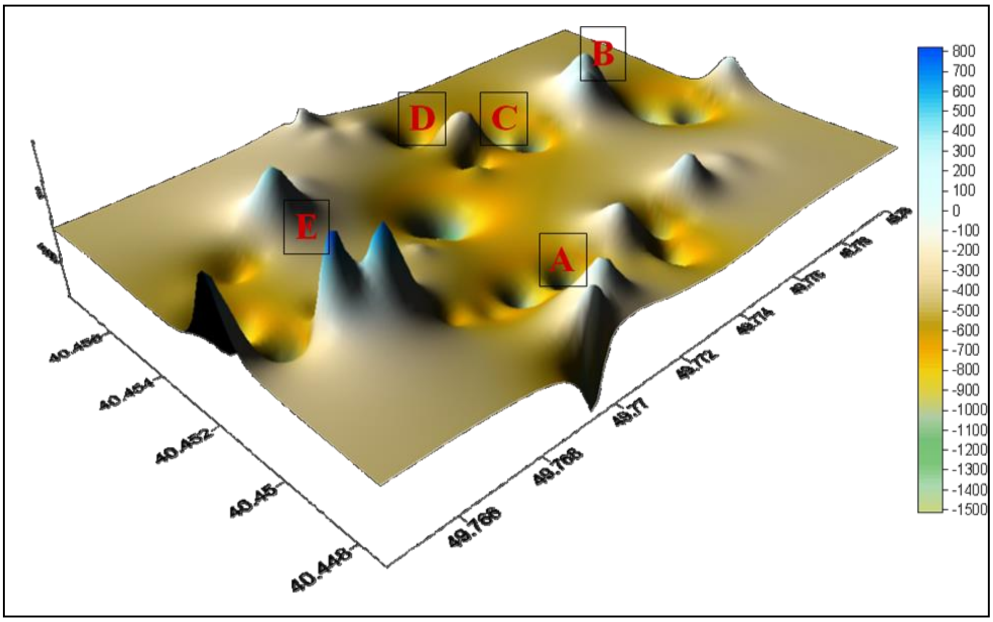

Figure 4. Stress-strain state of the geological environment in the Masazir area based on magnetometric data in 3D format (May, 2015).

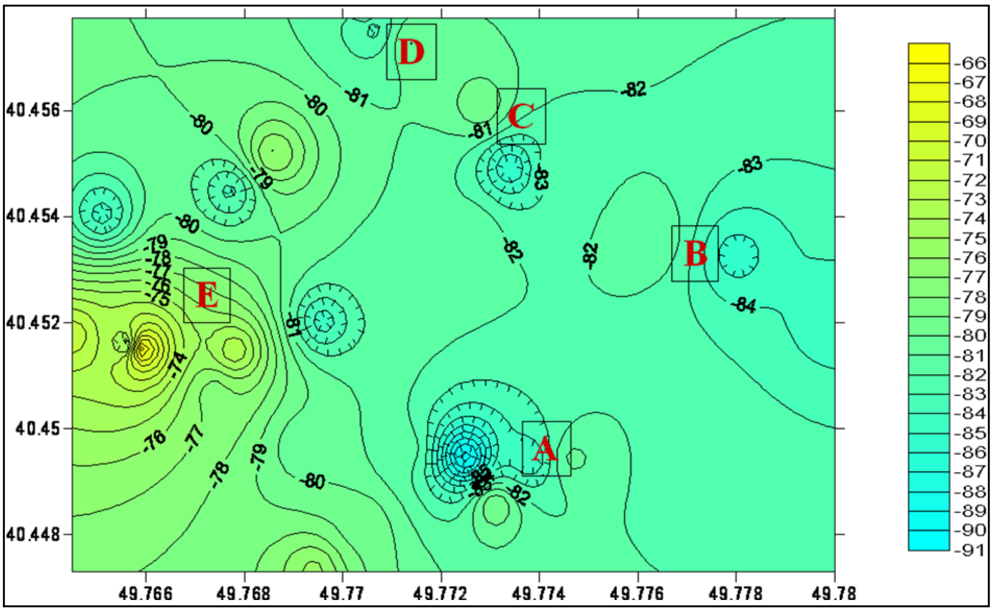

Figure 5. Stress-strain state of the geological environment in the Masazir area according to gravimetric data in 2D format (April, 2015).

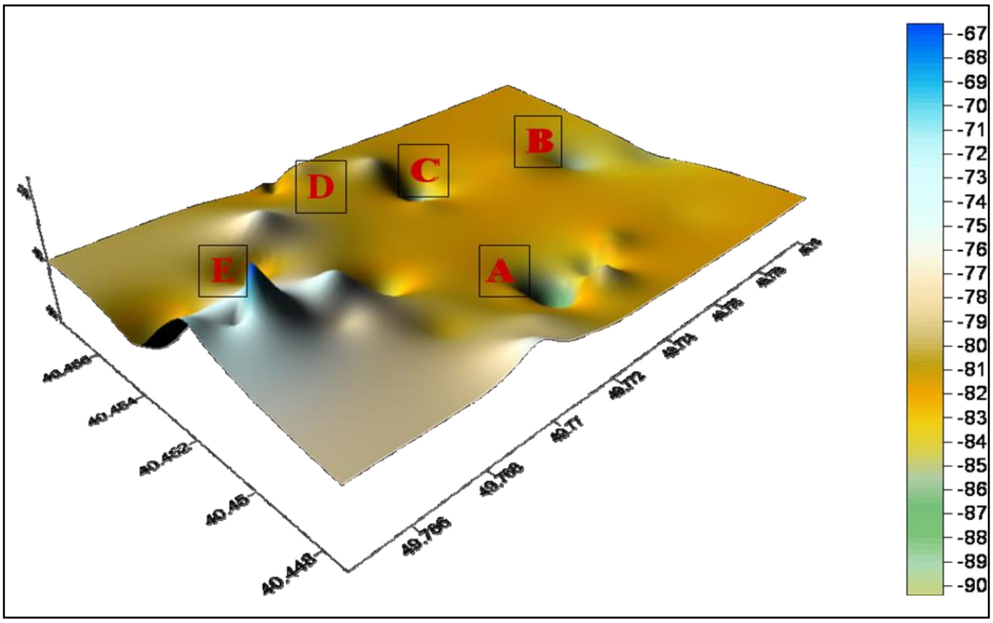

Figure 6. Stress-strain state of the geological environment in the Masazir area according to gravimetric data in 3D format (April, 2015).

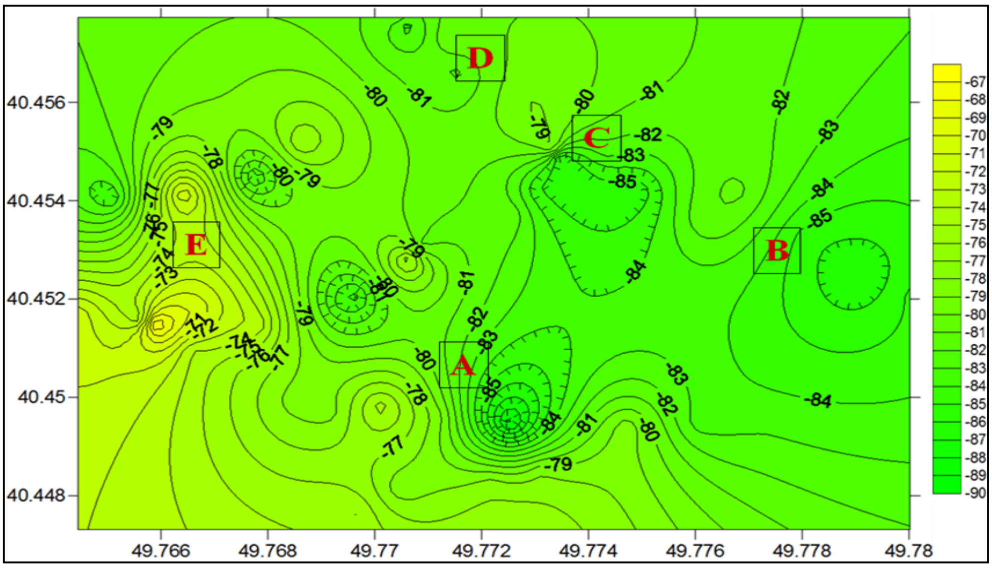

Figure 7. Stress-strain state of the geological environment in the Masazir area according to gravimetric data in 2D format (May, 2015).

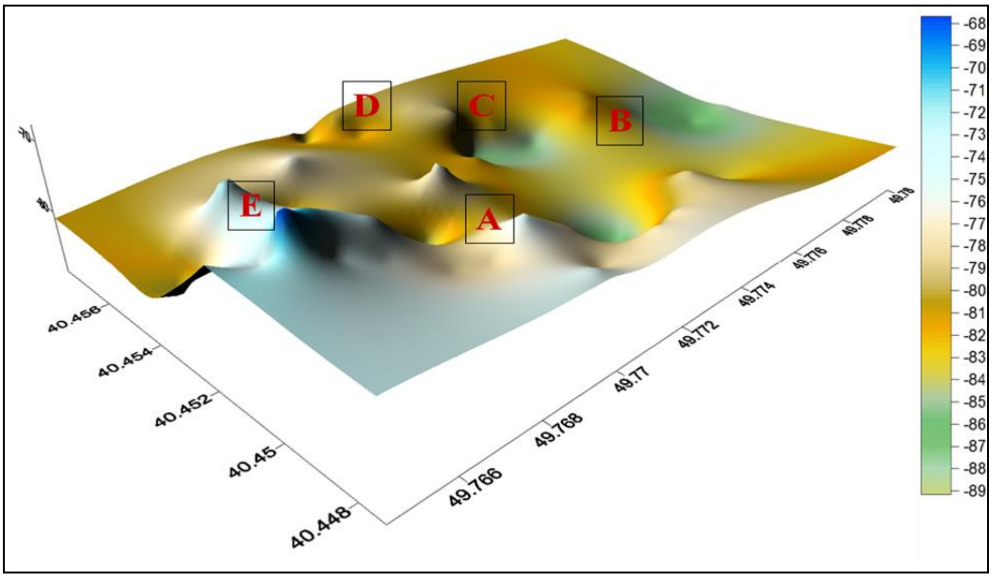

Figure 8. Stress-strain state of the geological environment in the Masazir area according to gravimetric data in 3D format (May, 2015).

Analysis of the results of gravimagnetic survey showed that the increments of the magnetic gradient ΔT~f(t) are in the range from -1606 nT to +788 nt, the gravitational field Δg~f(t) in Bouguer reduction is from -66.577 mg to - 90.404 mg. Residual fields are highly differentiated (non-uniform) in terms of increments ΔT and Δg. Sharply pronounced anomalies of the magnetic and gravitational fields are observed with both positive and negative increments of the field gradient. At the same time, magnetic and gravitational anomalies correlate with each other both in terms of the area of their manifestation and in terms of the sign of the field increment.

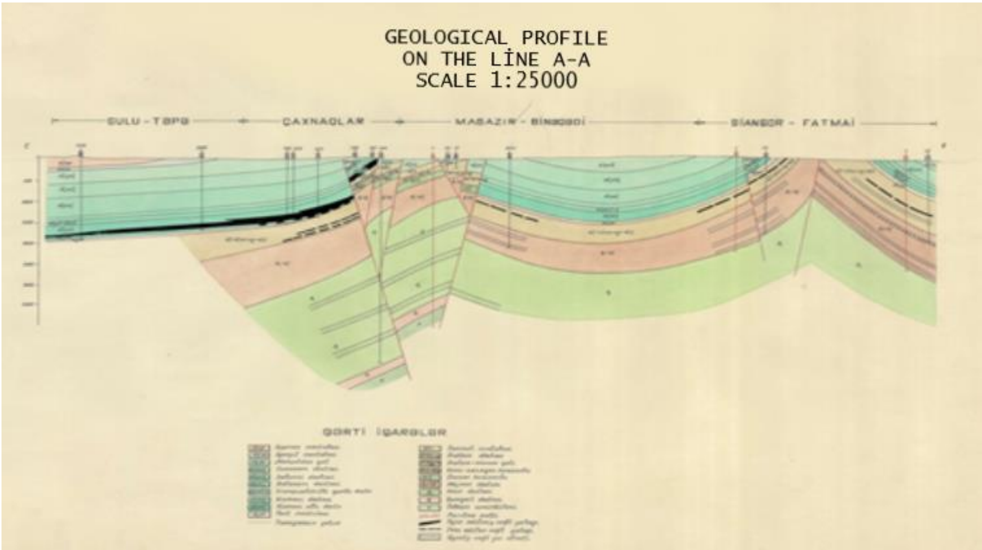

Figure 9. Geological section on the area of Masazir settlement.

It can be concluded that in the surface layers on the area of the village Masazir, there is a gravitational redistribution of perturbing masses of rocks under the action of compression (compaction) and tension (decompression) forces. The depth of penetration of disturbing masses is in the range of 70÷300 m, as indicated by the method of recalculating the gravitational field into the upper half-space.

This is a consequence of the accumulation of excess elastic energy under the action of geodynamic shifts, the direction of which, according to GPS observations, is north-northeast. It should be noted that the repeated gravimagnetic survey in May 2015 revealed the activation of the processes of decompression (stretching) of the environment in sector A, B, C, as well as the activation of compression processes in sector E, which is expressed in the formation of new (relative to the April survey) positive and negative anomalies geophysical fields (Fig. 5.7).

Remind that before the start of our research, an explosion of natural gas was noted in sector E in April 2015. At present, the tension of the environment is growing here. Compaction of rocks in sector E goes along profile I-I and is directed to the north-north-east (Fig. 7).

The results of gravimagnetic studies show that the high stress state of the geological environment in potentially dangerous sectors A, B, C, D and E can lead to a discontinuity of the environment and the release of gas and fluids to the surface. The radius of a single potentially dangerous gradient zone is about 80 m (about 0.02 km²). It is here that there is a sharp change in areas of compression and tension, which is the reason for the high tension of the near-surface layers of the earth's crust.

The stress state of the geological environment in the area of the village Masazir can be explained by the modern activation of geodynamic processes along transverse rupture shear dislocations in the wedging zone of Maikop clays (Fig. 9).

Conclusions

1. The redistribution of rock masses in the surface layers of the earth's crust continues in the area of the village Masazir, as evidenced by the formation of local areas of tension in the environment under the action of geodynamic forces of compression and tension.
2. Stressed areas are zones A, B, C, D and E. The most dangerous area is zone E, where shear compression of the geological environment can be traced along profile I-I. The direction of the shift and the formation of the compression zone is north-northeast.

REFERENCES

1. Рзаев А.Г. и др., 2006 Связь аномальных изменений в напряженности геомагнитности геомагнитного поля с сейсмотектоническими процессами в литосфере Земли AMEA Xəbərlər Yer Elmləri.
1. Рзаев А.Г., Етирмишли Г.Д., Казымова С.Э. 2013. Отражение геодинамического режима в вариациях напряженности геомагнитного поля. Xəbərlər. Yer Elmləri, N4, s. 3-15.№3, c.58-63.

MAPPING ALONG THE GRAVITY FIELD OF THE WESTERN SIDE OF THE SHIRVAN-KAZAKH GEODYNAMIC POLYGON

E.M Baghirov[1], A.T.Ismayilova[1]

For the development of science and industry, the expansion of geophysical work is of particular importance, among which gravity exploration is one of the leading ones. It is of great importance and is used at all stages of geological, prospecting and exploration work. Gravity exploration is also mandatory for state geological mapping. At the same time, it solves the problems of tectonic and lithological-petrographic zoning and identification of areas that are promising for setting up more detailed geophysical and geological work. In addition, it finds application in geologist exploration work to identify and trace mineral deposits and structural geological forms favorable for mineral accumulations.

At the first stage of mapping on the gravitational field in the horizontal plane, the contours of rock complexes with different effective densities are identified. The first stage is relatively simple with relatively thin overburden and steeply dipping contacts. The contours of the rock mass in plan view are lines connecting points with extreme values of the horizontal field gradient Δg. In this case, the relative error in determining the contact will not exceed ¼ of the ratio of the thickness of the overburden to the horizontal size of the studied massif. The main difficulty in determining the contacts is associated with the inclined boundaries of the massifs and the density heterogeneity of the rocks composing them. Gravity surveys map well tectonic faults of the fault type. On gravity maps, such areas are usually identified by isolines of the Δg field elongated along the tectonic fault.

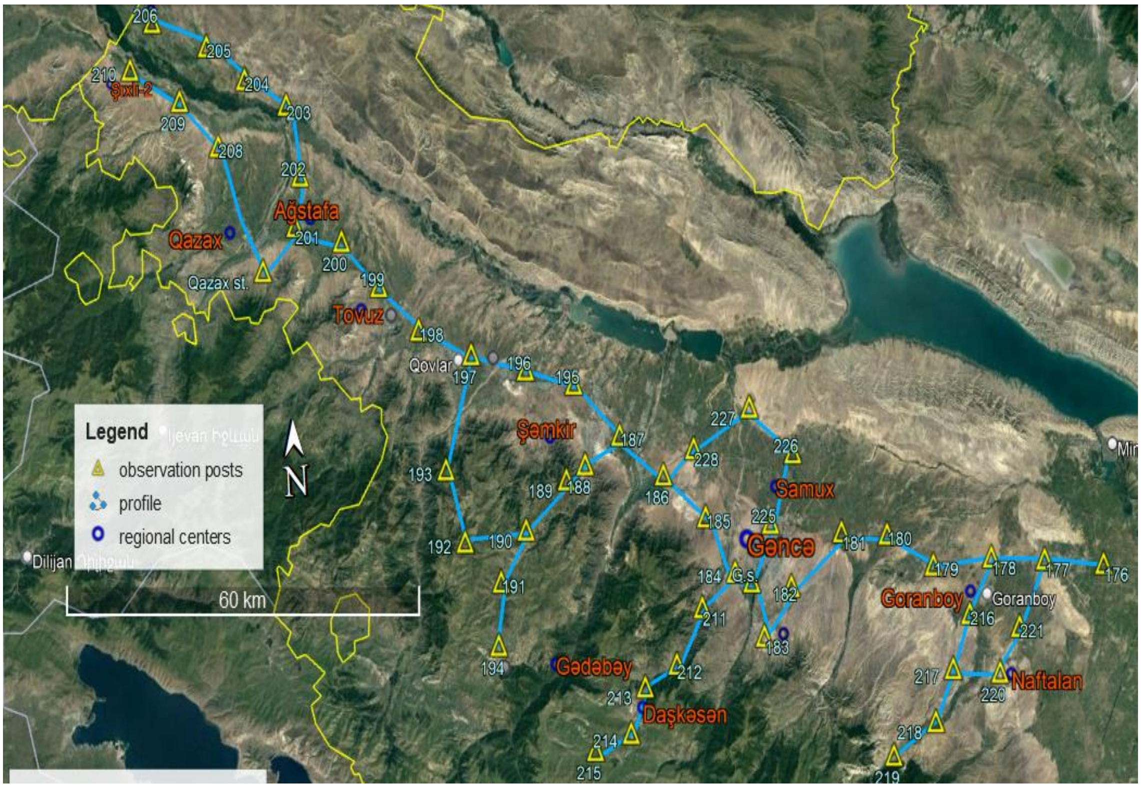

Figure 1. Scheme of the location of observation and strongholds of the western side of the Shirvan-Kazakh geodynamic polygon

So let's take a look at the repeated measurements of interest for research. These studies reflect the nature of the change in gravity variations over time between observation points, i.e. throughout the range.

The technique of field observations with high-precision gravimeters is determined in accordance with the requirements for identifying subjective and other factors that affect the accuracy and reliability of observations, the acceleration of free fall of non-tidal variations in time.

[1] *Republican Seismic Survey Center of Azerbaijan National Academy of Sciences*

High-precision gravimetric observations were carried out on the western section of the Shirvan-Kazakh geodynamic polygon (Fig. 1).

Let's consider the Δg map obtained in the area of tectonic disturbance (Fig. 2.). As can be seen, the isolines are elongated almost in the meridional direction, and the field is characterized by a high horizontal gradient. The map Δg, constructed along the profile located in the cross direction of the strike of a tectonic fault, has the form of an anomaly of the type of a gravitational step. This anomaly along the profile is characterized by the following features: a maximum horizontal gradient is observed above the tectonic fault. If the density of rocks in the uplifted part of the fault is greater than in the overburden, then the field values above the uplifted parts will be greater than over the lowered one.

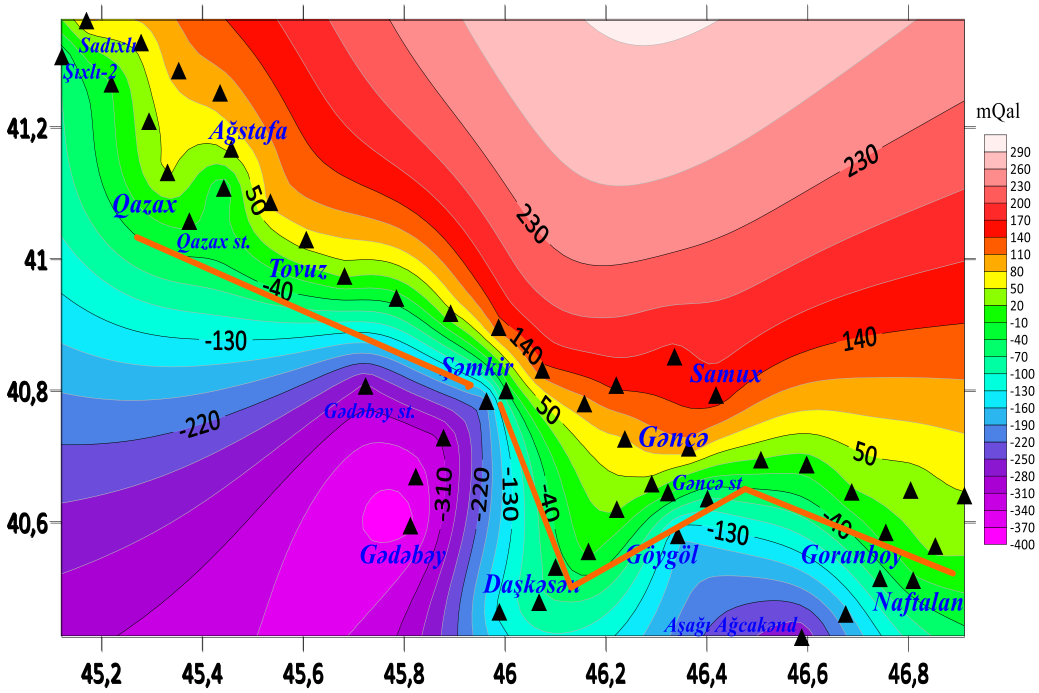

Figure 2. Map of anomalies of the gravitational field of the western side of the Shirvan-Kazakh geodynamic polygon

From the above, it can be noted with confidence that gravimetric studies make it possible to map ore-controlling faults and tectonic disturbances. Gravitational anomalies of the "fault" type include:

– linear anomalies characterizing geological formations directly within the fault;
– “gradient” anomalies caused by changes in the geological situation in the contacting blocks and their mutual displacements;
– change in the nature of the field - level, structure, direction of strike, caused by a difference in the composition of the rocks that make up the contacting blocks;
– linear zones of minima associated with zones of crushing and fragmentation.

Tectonic faults, accompanied by relatively wide crushing zones, are distinguished by linear anomalies of a reduced gravity field. Faults and uplifts with the movement of blocks of rocks of different density along the vertical are marked by gravitational steps. Disturbances can be fixed in the gravitational field also in the presence of small intrusions in them.

CONCLUSIONS

– When mapping along the gravitational field of the western flank of the Shirvan-Kazakh geodynamic polygon, the contours of rock complexes with different effective density were identified in the horizontal plane.
– Carried out mapping of ore-controlling faults and tectonic faults.

REFERENCES

1. Успенский Д.Г. «Гравиразведка» М., изд. "Недра",1968 г., Задачи, решаемые Гравиразведкой, стр.5.
2. Огильви А.А. Сборник задач по геофизическим методам разведки. М., изд. "Недра",1985 г.,стр.103-104.
3. Булах Е.Г. К вопросу о применении метода скорейшего спуска при Федеренко М.А. интерпретации гравитационных аномалий. В сб. Применение Математических методов и вычислительной техники в горном деле. Недра, 1965 г.,Стр. 25-27.
4. Гладкий К.В. Разделение суммарных гравитационных полей как процесс частотной фильтрации. В сб. Прикладная геофизика,вып.25.Гостоптехиздат,1960.

ANNOTATIONS

1. SOURCE MECHANISM OF TURKISH EARTHQUAKES OCCURED ON 06.02.2023 WİTH M=7.8, 7.6

G.J. Yetirmishli, L.J. Nabelek, S.E. Kazimova, I.E.Kazimov

The article considers the sources of strong Turkish earthquakes that occurred on February 6, 2023 with a magnitude of M = 7.8, 7.6, 6.7. Earthquakes were accompanied by large-scale destruction, deformation of the earth's surface and were felt in 10 provinces of the country, and on the territory of Israel, Iraq, Lebanon, Georgia, Armenia. The reasons for the large-scale destruction of buildings are considered to be precisely the underestimation of the level of risks for this area, as well as the lack of regular inspections of the safety of buildings by local authorities. In addition, the area where the disaster occurred is located in the junction zone of three tectonic plates: African, Arabian and Anatolian, and is one of the most seismically active regions in the world. The focal mechanism of a strong earthquake (M=7.8) was built and analyzed. In this work, we used the waveform inversion algorithm developed by prof. John Nabelek from Oregon University. It was found that the focal mechanism of the main shock is a left-lateral strike-slip, consistent with the East Anatolian Fault.

Key words: Anatolian plate, East Anatolian fault, Turkish earthquakes, focal mechanism.

2. ASSESSMENT OF GEOLOGICAL RISKS IN THE TERRITORY OF ALIJANCHAY RESERVOIR

G.J.Yetirmishli, E. S.Garaveliyev, N.B. Khanbabayev, E.M.Baghirov

Despite the presence of more than 140 reservoirs in Azerbaijan, they still do not meet the population's needs for drinking water and irrigation. The creation of new water reservoirs is considered one of the most urgent problems in the state program for ensuring efficient use of water resources.

There is a need to create new reservoirs in the country in order to improve the population's demand for continuous drinking water and to increase the water supply of agricultural fields. Alijanchay was formed by the combination of branches separated from Khalkhalchay, Oguzchay, and Galachay rivers flowing through the territory of Oghuz region. With the construction of the reservoir here, the water demand of the agricultural fields of the surrounding regions will be met and the drinking water supply of the population in the residential areas will be improved.

Key words: seismomagnetic effect, geodynamic regime, geomagnetic field strength, gravity force, gravimetric field strength, local anomaly, engineering-seismic exploration.

3. ISMAYILLI EARTHQUAKE WITH ML=3.8 OF JANUARY 31, 2023

G.J.Yetirmishli, E.M.Baghirov, A.T.Ismayilova, S.S.Ismayilova

On the basis of the analysis of new gravimetric data at the stage of preparation for the Ismayilli earthquake of 31.01.2023, ml=3.8 an assessment of the stress-strain state of the Shamakhi-Ismayilli seismogenic zone is given. The Shamakhi-Ismayilli seismogenic zone has been characterized by high seismic activity for centuries. An analysis of seismicity in recent years has shown an increase in its activity in this seismogenic zone.

Key words: Shamakhi-Ismayilli seismogenic zone, stress-strain state, earthquakes, variation, gravimetric fields, geophysical parameters, tectonic process.

4. STUDY OF LANDSLIDE PROCESSES USING GRAVIMAGNETOMETRY METHODS IN THE RESIDENTIAL AREA OF MASAZIR

A.G.Rzayev, E.M.Baghirov, M.K.Mammadova, A.N.Sultanova

The geodynamic regime was studied and areas of the stress-strain state of the geological environment were identified in the area of the Masazir residential complex. Monitoring was carried out using a new technology of gravimagnetometry methods.

Key words: stress-strain state, gravity variations, geomagnetic field strength, strength gradient.

5. MAPPING ALONG THE GRAVITY FIELD OF THE WESTERN SIDE OF THE SHIRVAN-KAZAKH GEODYNAMIC POLYGON

Baghirov E.M., Ismayilova A.T.

Gravity exploration is mandatory for state geological mapping. At the same time, it solves the problems of tectonic and lithological-petrographic zoning and identification of areas that are promising for setting up more detailed geophysical and geological work.

Key words: gravity exploration, anomalous zones, tectonic faults, gravity, stress conditions.

ANNOTASİYALAR

1. 06.02.2023-CÜ İL TARİXİNDƏ BAŞ VERMİŞ VƏ M=7,8, 7,6 OLAN TÜRKİYƏ ZƏLZƏLƏLƏRİN OCAQ MEXANİZMLƏRİ

Q.C. Yetirmişli, L.J. Nabelek, S.E. Kazimova, I.E.Kazimov

Məqalədə 6 fevral 2023-cü ildə maqnitudası M=7,8, 7,6, 6,7 olan baş vermiş güclü Türkiyə zəlzələlərinin ocaqları nəzərdən keçirilir. Zəlzələlər irimiqyaslı dağıntılar, yer səthinin deformasiyası ilə müşayiət olunub və ölkənin 10 əyalətində, həmçin İsrail, İraq, Livan, Gürcüstan, Ermənistan ölkələrdə hiss olunub. Binaların irimiqyaslı dağıdılmasına səbəb kimi məhz bu sahə üçün risk səviyyəsinin lazımi səviyyədə qiymətləndirilməməsi, habelə yerli icra hakimiyyəti orqanları tərəfindən binaların təhlükəsizliyinə mütəmadi yoxlamaların aparılmaması göstərilir. Bundan başqa, təbii fəlakətin baş verdiyi ərazi üç tektonik plitələrin: Afrika, Ərəbistan və Anadolu plitələrinin toqquşma zonada yerləşir və dünyanın seysmik cəhətdən ən aktiv bölgələrindən biridir. Güclü zəlzələnin (M=7.8) ocaq mexanizmi qurulmuş və təhlil edilmişdir. Bu işdə Oregona Universitetinin prof. Jon Nabelek tərəfindən hazırlanmış dalğa formasının inversiya alqoritmindən istifadə etdik. Əsas zəlzələnin ocaq mexanizminin Şərqi Anadolu sol tərəfli yerdəyişmə qırılması ilə müəyyən edilmişdir.

Açar sözlər: Anadolu plitəsi, Şərqi Anadolu qırılması, Türkiyə zəlzələləri, ocaq mexanizmi.

2. ƏLİCANÇAY SU ANBARI ƏRAZİSİNDƏ GEOLOJİ RİSKLƏRİN QİYMƏTLƏNDİRİLMƏSİ

Q.C.Yetirmişli, E. S.Qaravəliyev, N.B. Xanbabayev, E.M.Bağırov

Oğuz rayonunda inşası nəzərdə tutulan Əlicançay su anbarının ərazisində seysmik təhlükə 12-ballıq MSK-64 şkalası üzrə 9 bal intensivliklə səciyyələnir. Su anbarı tikiləcək ərazidə qravimaqnit sahəsinin gərginlik dinamikası öyrənilmiş, 2D formatında anomaliya xəritələri qurulmuş, 3D modeli tərtib olunmuş, risk təhlükəsi ehtimal olunan tektonik pozulma zonaları ayrılmış və anomal sahələrlə əlaqəli kütlənin aktiv dinamikası göstərilmişdir. Anbar ərazisinin sürüşmə, uçqun və çökmə riski qiymətləndirilmişdir.

Açar sözlər: seysmomaqnit effekt, geodinamik rejim, geomaqnit sahəsinin gücü, cazibə qüvvəsi, qravimetrik sahənin gücü, yerli anomaliya, mühəndis-seysmik kəşfiyyat.

3. 31 YANVAR 2023-CÜ İLDƏ BAŞ VERMİŞ ML 3.8 İSMAYILLI ZƏLZƏLƏSİ

Q.C.Yetirmişli, E.M.Bağırov, A.T.İsmayılova, S.S.İsmayılova

Məqalədə qravimetrik məlumatlar əsasında zəlzələlərin qısamüddətli və uzunmüddətli proqnozlaşdırılması məsələlərinə baxılır. Qravimetrik məlumatların təhlili əsasında Azərbaycanın Balakən-Qəbələ proqnostik poliqonu ərazisindəki Şamaxı-İsmayıllı seysmogen zonasının gərginlik-deformasiya vəziyyətinin qiymətləndirilməsi verilmişdir. Şamaxı-İsmayıllı seysmogen zonası əsrlər boyu yüksək seysmik aktivliklə səciyyələnir. Son illərdə seysmikliyin təhlili bu seysmogen zonanın aktivliyinin artdığını göstərmişdir.

Qravimetrik sahə variasiyaları nəticələrinin nəzərdən keçirilməsi və təhlili Şamaxı-İsmayıllı seysmogen zonasının gərginlik-deformasiya vəziyyətinin uzunmüddətli proqnozunu verməyə imkan verir.

Açar sözlər: Şamaxı-İsmayıllı seysmogen zonası, gərginlik-deformasiya vəziyyəti, zəlzələlər, variasiya, qravimetrik sahələr, geofiziki parametrlər, tektonik proses.

4. MASAZIR YAŞAYIŞ MASSİVİNDƏ SÜRÜŞMƏ PROSESLƏRİNİN QRAVİMAQNİTOMETRİYA ÜSULLARI İLƏ ÖYRƏNİLMƏSİ

A.Q.Rzayev, E.M.Bağırov, M.K.Məmmədova, A.N.Sultanova

Masazır yaşayış kompleksi ərazisində geodinamik rejim tədqiq edilmiş və geoloji mühitin gərginlik-deformasiya vəziyyətinin sahələri müəyyən edilmişdir. Monitorinq qravimaqnitometriya üsullarından istifadə etməklə yeni texnologiyadan istifadə edilməklə həyata keçirilib.

Açar sözlər: gərginlik-deformasiya vəziyyəti, ağırlıq qüvvəsinin variasiyası, geomaqnit sahəsinin gərginliyi, gərginlik qradiyenti.

5. ŞİRVAN-QAZAX GEODİNAMİK POLİQONUNUN QƏRB QANADININ QRAVİTASİYA SAHƏSİ BOYUNCA XƏRİTƏÇƏKMƏ

E.M.Bağırov, A.T. İsmayılova

Qravitasiya kəşfiyyatı dövlətin geoloji xəritələşdirilməsi üçün məcburidir. Eyni zamanda, tektonik və litoloji-petroqrafik rayonlaşdırma və daha ətraflı geofiziki və geoloji işlərin aparılması üçün perspektivli sahələrin müəyyən edilməsi problemlərini həll edir.

Açar sözlər: qravitasiya kəşfiyyatı, anomal zonalar, tektonik qırılmalar, qravitasiya, gərginlik şəraiti.

АННОТАЦИИ

1. МЕХАНИЗМ ОЧАГА ТУРЕЦКИХ ЗЕМЛЕТРЯСЕНИЙ ПРОИЗОШЕДШИХ 06.02.2023 с M=7,8, 7,6

Г.Дж. Етирмишли, Л.Дж. Набелек, С.Э. Казымова, И.Э.Казымов

В статье рассмотрены очаги сильных Турецких землетрясений, произошедшие 6 февраля 2023 года с магнитудой M=7.8, 7.6, 6.7. Землетрясения сопровождались масштабными разрушениями, деформациями земной поверхности и ощущались в 10 провинциях страны, и на территории Израиля, Ирака, Ливана, Грузии, Армении. Причинами масштабных разрушений зданий считается именно недооценка уровня рисков для этой местности, а также отсутствие регулярных проверок сохранности зданий со стороны местных властей. Кроме того район, где случилась катастрофа, располагается в зоне сочленения трех тектонических плит: Африканской, Аравийской и Анатолийской, и относится к числу одного из наиболее сейсмически активных регионов мира. Был построен и проанализирован механизм очага сильного землетрясения (M=7.8). В данной работе применялся алгоритм по методу инверсии волновых форм, разработанный проф. Орегонского Университета Джоном Набелеком. Было установлено, что механизм очага главного толчка, представляет собой левосторонний сдвиг, согласующийся с Восточно-Анатолийским разломом.

Ключевые слова: Анатолийская плита, Восточно-Анатолийский разлом, турецкие землетрясения, механизм очага.

2. ОЦЕНКА ГЕОЛОГИЧЕСКИХ РИСКОВ В РАЙОНЕ АЛИДЖАНЧАЙСКОГО ВОДОХРАНИЛИЩА

Г.Дж. Етирмишли, Э.С.Гаравелиев, Н.Б.Ханбабаев, Е.М.Багиров

Сейсмическая опасность на территории Алиджанчайского водохранилища, которое планируется построить в Огузском районе, характеризуется интенствностью 9 баллов по 12-балльной шкале МСК-64. В районе строительства водохранилища изучена динамика напряженности гравимагнитного поля, построены карты аномалий в формате 2D, составлена 3D модель, выделены зоны тектонических разломов с вероятным риском и показана активная динамика массы, связанная с аномальными зонами. Оценен риск оползней, лавин и обрушения территории водохранилища.

Ключевые слова: сейсмомагнитное воздействие, геодинамический режим, напряженность геомагнитного поля, сила тяжести, напряженность гравиметрического поля, локальная аномалия, инженерно-сейсморазведка.

3. ИСМАИЛЛИНСКОЕ ЗЕМЛЕТРЯСЕНИЕ ml=3.8 31 января 2023г.

Г.Д.Етирмишли, Э.М.Багиров, А.Т.Исмаилова, С.С.Исмаилова

Дается оценка напряженно-деформированного состояния Шамахы-Исмаиллинской сейсмогенной зоны на основе анализа новых гравиметрических данных на стадии подготовки Исмаиллинского землетрясения 31.01.2023, ml=3.8. Шамахы-Исмаиллинская сейсмогенная зона на протяжении веков характеризовалась высокой сейсмической активностью. Анализ сейсмичности за последние годы показал рост ее активности в этой сейсмогенной зоне.

Ключевые слова: Шамахы-Исмаиллинская сейсмогенная зона, напряженно-деформированное состояние, землетрясения, вариация, гравиметрические поля, геофизические параметры, тектонический процесс.

4. ИССЛЕДОВАНИЕ ОПОЛЗНЕВЫХ ПРОЦЕССОВ НА ПЛОЩАДИ ЖИЛОГО МАССИВА МАСАЗЫР МЕТОДАМИ ГРАВИМАГНИТОМЕТРИИ

А.Г.Рзаев, Э.М.Багиров, М.К.Маммедова, А.Н.Султанова

Изучен геодинамический режим и выявлены участки напряженно-деформированного состояния геологической среды на площади жилого комплекса Масазыр. Мониторинг проводился по новой технологии методами гравимагнитометрии.

Ключевые слова: напряженно-деформированное состояние, вариации силы тяжести, напряженность геомагнитного поля, градиент напряженности.

5. КАРТИРОВАНИЕ ПО ГРАВИТАЦИОННОМУ ПОЛЮ ЗАПАДНОГО КРЫЛА ШИРВАН-КАЗАХСКОГО ГЕОДИНАМИЧЕСКОГО ПОЛИГОНА

Багиров Э.М., Исмаилова А.Т

Гравиразведка применяется в обязательном порядке при государственном геологическом картировании. При этом она решает задачи тектонического и литолого-петрографического районирования и выделения участков, перспективных для постановки более детальных геофизических и геологических работ.

Ключевые слова: гравиразведка, аномальные зоны, тектонические нарушения, сила тяжести, напряженные условия.

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Volume 22, № 2, 2022
http://www.seismology.az/journal

Director of publishing house: **S.A.Gahramanov**
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Format 60x84 $^{1}/_{8}$
Print 500 copy
Price is under the treaty

Adress: AZ1001, 28 Istiglaliyyat str., Baku