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SEISMOLOGICAL-GEOPHYSICAL RESEARCH CONDUCTED IN DASHKESAN SKARN-IRON ORE GROUP BED AND ASSESSMENT OF THE RISK OF LANDSLIDE THAT MAY OCCUR IN THE AREA

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Annotation

1. In the article, it is noted that the value of the average transverse wave speed parameter varies between 400-515 m/s in the seismic profiles developed in the waste and landslide areas of Dashkasan skarn-iron ore group beds up to a depth of 30 m. In the left wing of the resulting landslide, a geological disturbance was determined in the direction of the fault-falling layer. A layer with a low transverse wave speed (350-441 m/s) is observed in the landslide area in seismic profiles No. 4 and 5 at a depth of 30-44, 30-47 m, respectively. This layer is assumed to be a clay layer. Inside the clay layer, a lens with a value of transverse wave speed varying between 263-351 m/s is observed. It is assumed that this lens has a layer of watery clay and the sliding plane corresponds to this layer.

2. In the direction of Mollahasanli village, a layer with low transverse wave speed (305-425 m/s) is observed at a depth of 30-45 m, and a lens with low wave speed is not observed inside this layer. From this point of view, the current condition of the retaining dam is considered stable compared to the landslide area.

3. In the waste and landslide area of Dashkasan skarn - iron ore group beds, the geodynamic regime was evaluated, the tension dynamics of the gravity and geomagnetic field were studied, and tectonic fault zones were found. These areas are assumed to be prone to landslides.

4. In the area of the new landfill, the observed gravity and geomagnetic stress are at background levels. For this reason, the new dump site is more durable and stable from the geological point of view than the previous (slid on 03.09.22) dump site.

Keywords: *SME-seismomagnetic effect, nT- nanotesla, mechanism of earthquake source, geodynamic mode, geomagnetic field stress, ml-magnitude, gravity force, gravimetric field stress, local anomaly, engineering-seismic exploration.*

DAŞKƏSƏN SKARN-DƏMİR FİLİZ QRUPU YATAQLARINDA APARILMIŞ SEYSMOLOJİ-GEOFİZİKİ TƏDQİQATLAR VƏ ƏRAZİDƏ BAŞ VERƏ BİLƏCƏK SÜRÜŞMƏ RİSKİNİN QİYMƏTLƏNDİRİLMƏSİ

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Annotasiya

1. Məqalədə Daşkəsən skarn-dəmir filiz qrupu yataqlarının tullantı və sürüşmə sahələrində işlənmiş mühəndisi- seysmik profillərdə 30 m dərinliyə qədər orta eninə dalğanın sürət parametrinin qiymətinin 400-515 m/s arasında dəyişdiyi qeyd olunur. Nəticədə baş vermiş sürüşmənin sol qanadında qırılıb-düşmə tipli layın yatım istiqamətində geoloji pozulma müəyyən edilmişdir. Sürüşmə sahəsində 4 və 5 saylı seysmik profillərdə uyğun olaraq 30-44, 30-47 m dərinlikdə aşağı eninə dalğa sürətinə (350-441 m/s) malik lay izlənilir. Bu layın gil qatı olması güman edilir. Gil qatının daxilində eninə dalğa sürətinin qiyməti 263-351 m/s

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arasında dəyişən linza izlənilir. Bu linzanın sulu gil layı olması və sürüşmə müstəvisinin də bu laya uyğun olması ehtimal edilir.

2. Mollahəsənli kəndi istiqamətində dayaq bəndində isə 30-45 m dərinlikdə aşağı eninə dalğa sürətinə malik (305-425 m/s) lay izlənilir və bu lay daxilidə aşağı dalğa sürətinə malik linza müşahidə edilmir. Bu baxımdan dayaq bəndinin mövcud durumu sürüşmə sahəsinə nisbətən stabil qəbul edilmişdir.

3. Daşkəsən skarn - dəmir filiz qrupu yataqlarının tullantı və sürüşmə sahəsində geodinamik rejim qiymətləndirilərək qravitasiya və geomaqnit sahəsinin gərginlik dinamikası öyrənilmiş risk təhlükəsi olunan tektonik pozulma zonaları aşkar edilmişdir. Bu sahələrin sürüşməyə meyilli olduğu güman edilir.

4. Yeni tullantıxana ərazisində qravitasiya və geomaqnit sahəsində müşahidə olunan gərginlik fon səviyyəsindədir. Bu səbəbdən yeni tullantıxana sahəsi əvvəlki (03.09.22-ci ildə sürüşmüş) tullantıxana sahəsinə nisbətən geoloji nöqteyi nəzərdən daha davamlı və stabil xarakterlidir.

Açar sözlər: *SME-seysmomaqnit effekt, nT- nanotesla, zəlzələ ocağının mexanizmi, geodinamik rejim, geomaqnit sahə gərginliyi, ml-maqnituda,ağırlıq qüvvəsi, qravimetrik sahənin gərginliyi, lokal anomaliya, mühəndisi-seysmik kəşfiyyat.*

СЕЙСМОЛОГО-ГЕОФИЗИЧЕСКИЕ ИССЛЕДОВАНИЯ, ПРОВЕДЕННЫЕ В ДАШКЕСАНСКОЙ СКАРНОВО-ЖЕЛЕЗОРУДНОЙ ГРУППЕ ЗАЛЕЖЕЙ И ОЦЕНКА РИСКОВ ВОЗМОЖНЫХ ОПОЛЗНЕЙ НА ТЕРРИТОРИИ

Г.Д.етирмишли, Р.Б.Мурадов, Н.Б.Ханбабаев, Э.С.Гаравелиев, Э.М. Багиров

Аннотация

1. В статье определено изменение значения среднего параметра скорости поперечных волн до глубины 30 м в разработанных инженерно-сейсмических профилях на отваловых и оползневых участках месторождений Дашкесанской скарново-железорудной группы в пределах 400 -515 м/с. В результате в левом крыле образовавшегося оползня установлено геологическое нарушение в направлении слоя сбросопадения. В зоне скольжения на сейсмических профилях № 4 и № 5 на глубинах 30-44 и 30-47 м соответственно наблюдается слой с низкой скоростью поперечных волн (350-441 м/с). Предполагается, что эти породы представляет собой слой глины. Внутри слоя глины наблюдается линза со значением скорости поперечных волн, варьирующимся в пределах 263-351 м/с. Предполагается, что эта линза представляет собой водянистый слой глины и что этому слою соответствует плоскость скольжения.

2. У подпорной дамбы в направлении села Моллагасанлы на глубине 30-45 м наблюдается слой с низкой скоростью поперечных волн (305-425 м/с), внутри этого слоя не наблюдается линза с низкой скоростью волн. С этой точки зрения существующее состояние подпорной дамбы можно считать стабильным по сравнению с оползневой зоной.

3. В отбросно-оползневом районе Дашкесанской скарно-железорудной группы месторождений оценен геодинамический режим, изучена динамика напряженности гравитационного и геомагнитного поля, выявлены зоны тектонических нарушений. Эти области склонны к скольжению.

4. Наблюдаемая гравитационная и геомагнитная напряженность на территории нового полигона находится на фоновом уровне. По этой причине новая свалка геологически более прочна и устойчива, чем предыдущая (сползла 03.09.22) свалка.

Ключевые слова: *SME-сейсмомагнитный эффект, nT-нанотесла, механизм очага землетрясения, геодинамический режим, напряжение геомагнитного поля, ml-магнитуда, сила тяжести, напряжение гравиметрического поля, локальная аномалия, инженерно-сейсмическая разведка.*

INTRODUCTION

In Dashkasan skarn-iron ore group deposits, since the middle of the last century, blasting and geophysical exploration related to exploitation works have been carried out. During the search and exploration works, geodynamic activity is observed in areas with the risk of avalanches, subsidence and landslides due to the impact of explosions carried out in the exploitation process. On September 3, 2022, a landslide occurred in the waste field near Mollahasanli village of Dashkasan district and the road was closed as a result of the avalanche.

Ensuring the safe conduct of blasting operations, studying the effect of blast shock and other seismic waves is a very urgent problem.

The purpose of the work: assessment of the geodynamic conditions of the area and the effect of impact and other seismic waves generated during blasting operations on the environment, including the stability of the landslide area, using complex seismological-geophysical methods in the South-East area of Dashkasan skarn-iron ore group bed.

The following seismological, engineering-seismic and geophysical research works were carried out in order to solve the issues raised by RSXM:

Engineering-seismological research works in the South-East field;

- Investigation of the geological-tectonic structure of the sliding area with gravi-magnetometric studies, determination of the location and direction of tectonic faults, geological disturbances;
- Detection of other landslide-prone areas by seismological-geophysical methods;
- Assessment of the stress-deformation state of the geological environment with magnetometric and gravimetric studies, construction of a schematic map and 3D model in 2D format.

Brief overview of Dashkasan skarn-iron ore group deposits

The Dashkasan skarn-iron ore group beds are located in the northeast of the Lesser Caucasus at an altitude of 1500-2000 m, 36 km from the city of Ganja, 8 km from the Gushchu railway station, in the immediate vicinity of the city of Dashkasan (Figure 1.).

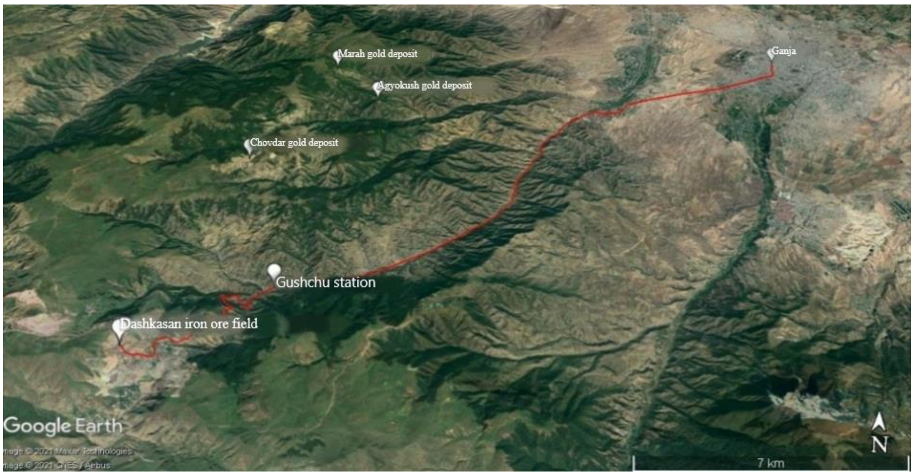

Figure 1. Aerial view of Dashkasan iron ore group deposits

The geological structure of Dashkasan skarn-iron ore group beds includes sedimentary rocks of Middle and Upper Jurassic age. Upper Jurassic sediments are more widespread in the Dashkesan area. The ores of the Dashkasan deposit were mainly formed in the Upper Jurassic sediments. Upper Jurassic sediments begin with agglomerate tuffs, calcareous tuffites and tuff breccias, limestones (up to 250 m thick), argillites with tuffs and tuffites, sandstone and marl.

Tectonically, the area containing the Dashkasan skarn-iron ore group beds is located in the Lok-Karabakh structural-formation zone of the Lesser Caucasus. The tectonic movements after the intrusion caused the formation of a large number of faults in the direction of northwest extension. These faults are more widespread between the northwest in the Gushchu area and the southeast of the village of Dardara. In the northwest, the relatively largest fault extends from the Kamargaya river valley to the North Cobalt mine [1].

Table of earthquakes (ml≥2.0) that occurred in Dashkasan region during 2021-2023

Date	hour	lat	lon	h	Ml
22.05.2021	13:15:17.178	40.63	46.05	2	2.31
31.05.2021	14:03:32.667	40.61	46.01	9	2.40
11.01.2021	10:55:24.277	40.33	45.96	9	2.22
05.01.2022	9:27:20.007	40.48	46.20	10	2.23
21.01.2022	10:03:40.480	40.65	46.21	18	2.21
19.05.2022	18:53:10.516	40.35	46.43	12	2.93
31.08.2022	8:08:04.557	40.21	46.49	17	2.37
26.09.2022	5:22:47.894	40.43	46.38	1	3.54
28.10.2022	7:09:16.700	40.30	46.46	11	3.03
19.01.2023	14:35:33.408	40.34	46.18	12	2.55

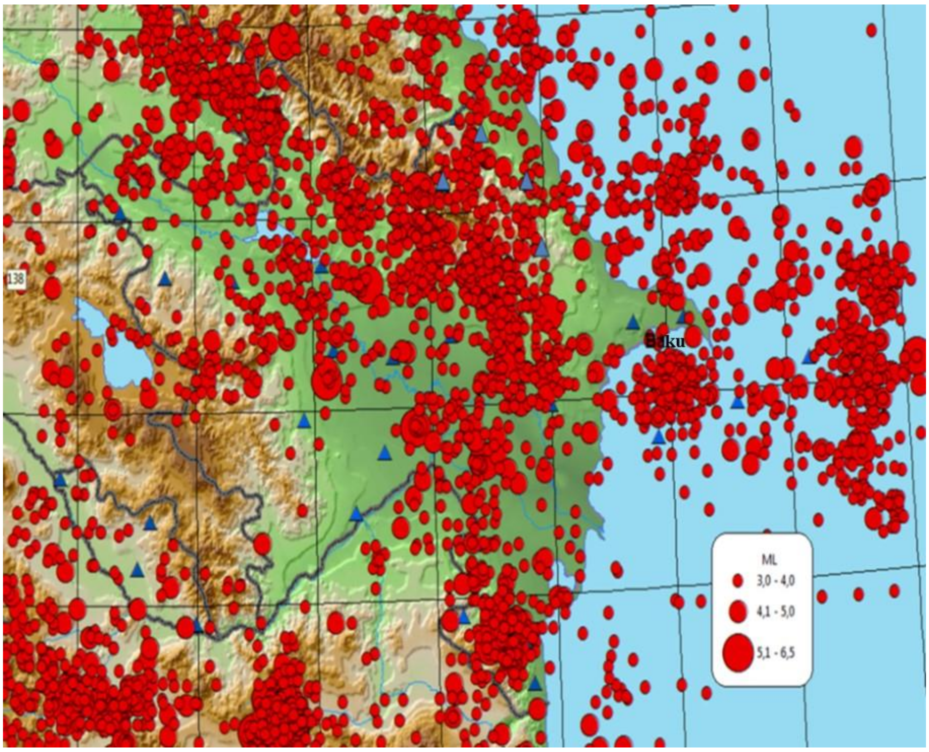

Figure 2. Map of epicenters of M≥3.0 earthquakes that occurred in Azerbaijan and adjacent territories during 1980-2022

This map shows the uneven distribution of weak and moderate earthquakes as well as strong earthquakes in the territory of Azerbaijan.

Strong earthquakes that create a seismic hazard occur in the study area, although not often. In the past, quite strong and moderate earthquakes have occurred in these areas, including Dashkasan region and Ganja region, and seismic events will be repeated in the future.

The method of engineering seismic exploration works

The GEODE-24 engineer seismic station, 24 seismic receivers, a 115-meter seismic survey wire and a 12 kg impact hammer were used to study the tested microseisms. Noises from the environment and microvibrations created by the impact method are considered as a seismic source.

The method of data acquisition and collection consists of obtaining 12 microvibration recordings of 30 seconds. The transformed wavefield of the received recordings shows the dispersion curve of the transverse waves. The transverse wave dispersion curve is selected from the transformed wave field and modeled to calculate the velocity profile of the underground transverse waves.

In order to obtain recordings in the research area, software such as ReMiVspect4.0 and ReMiDisper4.0 were used during the processing of recording results obtained from the Seismodule Controller software package.

Seismic data processing and interpretation

While performing engineering-seismic exploration works, the research area is divided into 2 areas. In the first stage, the research works were carried out in the 1st area, which includes the area where the landslide occurred.

In the second stage, the researches were carried out around the next possible landslide in the direction of Mollahasanli village on the border of the landslide area.

The total volume of works done in both areas was 2645 sq m.

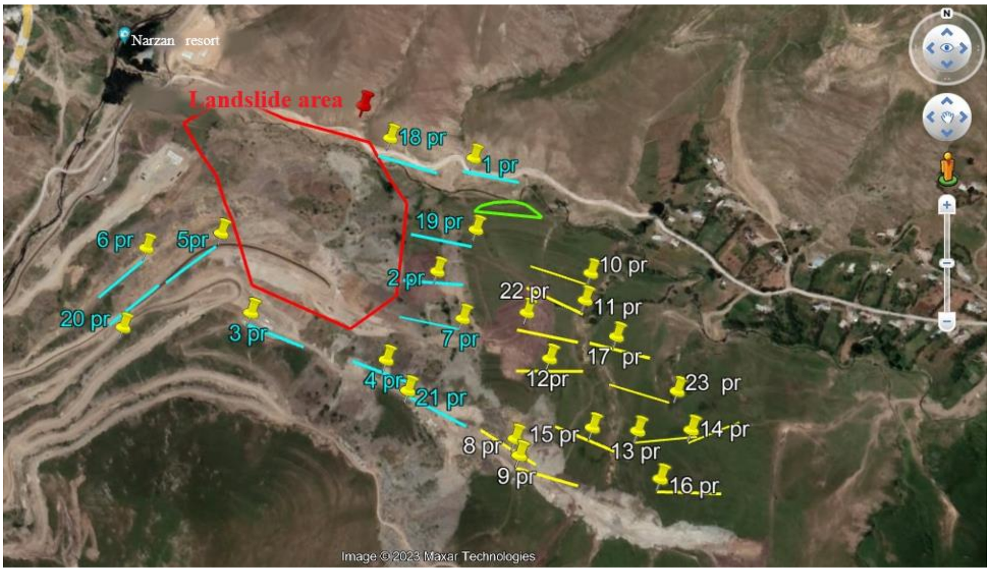

Figure 3. Location scheme of seismic profiles around the sliding area

In the field, cross-sections of the speed change depending on the depth were established for each profile.

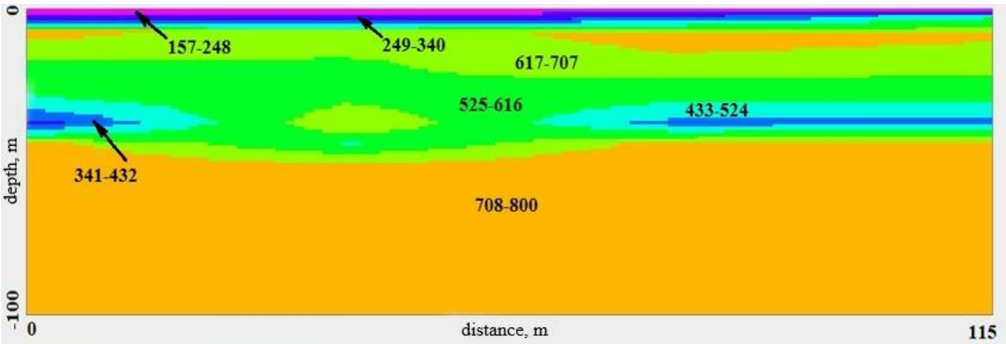

Figure 4. 2-dimensional velocity cross section of transverse waves on seismic profile #1 (in m/s).

In profile #1, the average transverse wave velocity parameter was calculated up to a depth of 30 m. The average transverse wave speed parameter is calculated by the following formula:

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

where hi and Vi are the thicknesses of the layers up to a depth of -30 m and their corresponding transverse wave velocities. Based on the calculation, we get:

Vs30= 490 m/s.

As can be seen from the profile, a layer with a low wave speed (341-432) is observed within the high-velocity layer (525-616) at a depth of 36.5-42 m. At these depths, the transverse wave propagation speed in the layer is 300-459 m/s.

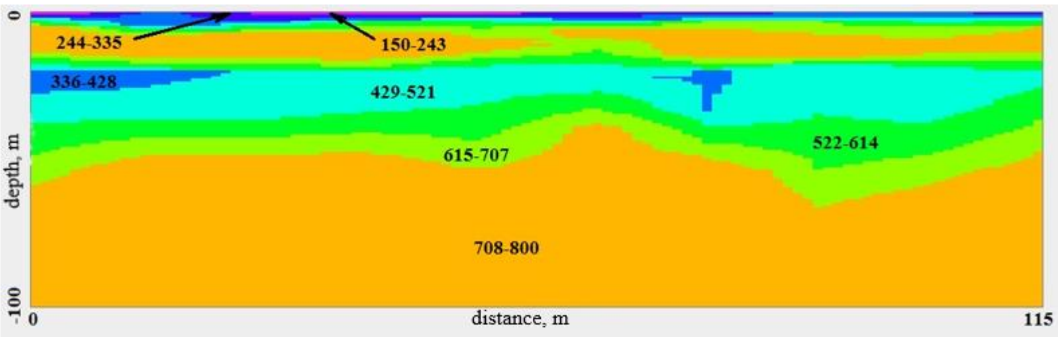

Figure 5. 2-dimensional velocity cross section of transverse waves on seismic profile No. 3

The average transverse wave velocity parameter up to a depth of 30 m was calculated on profile No. 3

Vs30= 510 m/s.

As can be seen from the profile, 20 At the depth of -32 m, the layer with low wave speed has penetrated into the high-velocity layer in the form of a lens at the beginning of the cut (left wing). At these depths, the transverse wave propagation speed in the layer is 336-428 m/s. At a depth of about 50-60 m, the top of the layer recorded at a speed of 708-800 m/s has a rise shape in the center of the profile and penetrated the bottom of the fast layer of 615-707 m/s, and a completely opposite picture was observed on the right wing of the profile. This indicates geological disturbances in the stratification within the section.

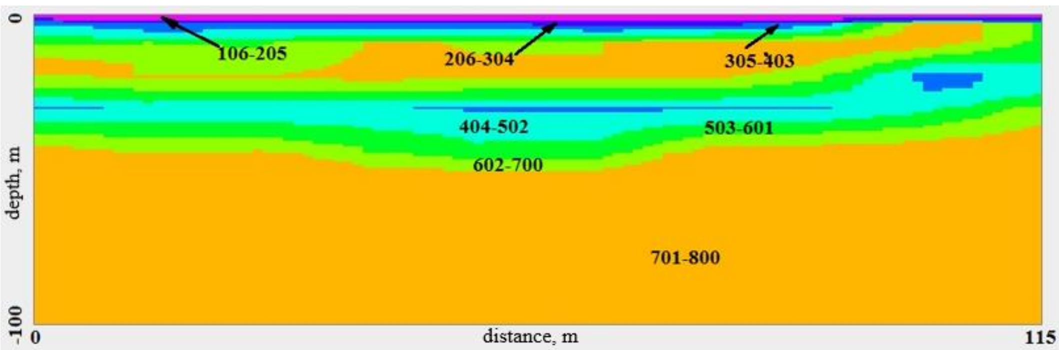

Figure 6. 2-dimensional velocity cross section of transverse waves on seismic profile No. 10

In profile No. 10, the average transverse wave speed parameter up to a depth of 30 m was calculated

Vs30= 440 m/s.

In this profile 30- A layer with a low wave speed is observed at a depth of up to 45 m. At these depths, the transverse wave propagation speed in the layer is 305-403m/s.

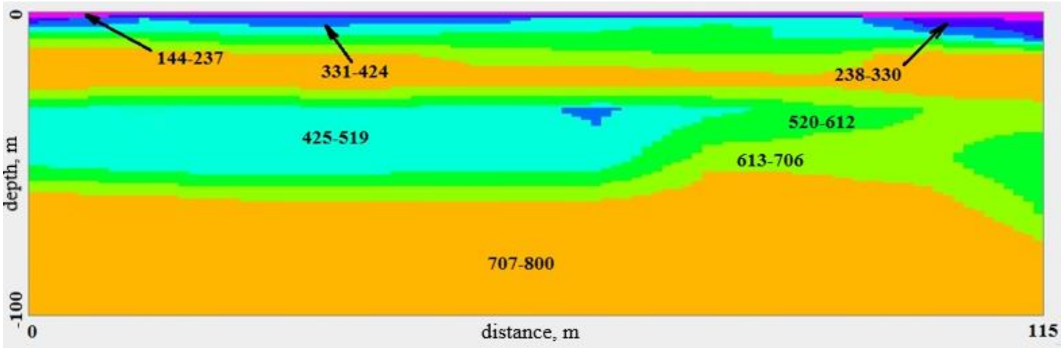

Figure 7. 2-dimensional speed cut of transverse waves on seismic profile No. 14

In profile No. 14, the average transverse wave speed parameter up to a depth of 30 m was calculated Vs30= 490 m/s. On the left wing of the profile, the 20 m thick fast layer of 425-519 m/s disappeared completely, despite the increase in speed at the end of the profile. On the contrary, at the end of the profile, the ceiling of the 707-800 m/s high-speed layer penetrated the bottom of the low-speed layer lying above it in the form of an ascent.

Methodology of conducting magnetometric research

The results of the magnetometric research carried out in the waste and landslide areas of the skarn-iron ore group beds in the Dashkasan region of the Republican Seismological Service Center were investigated. The magnetometric research works carried out for the purpose of landslide risk assessment were carried out by fully covering the area. A network of profiles was created in the research area and the goal was set to determine the probable voltage dynamics of the magnetic field.

The mentioned method made it possible to monitor tectonic disturbances (cracks) at different depth intervals in the area and to evaluate the geodynamic regime of the mineral bed.

Processing and interpretation of magnetometric data.

Magnetometric observations in the waste and landslide-prone areas of the Dashkasan field were performed by an operator on foot along the profiles with a G-856 proton-type magnetometer made in America (Figure 8).

Figure 8. The appearance of the proton-type magnetometer G-856, manufactured in America.

Magnetometric observation works were carried out in the above-mentioned areas and the measurement data received on the developed profiles were initially analyzed. The research works were carried out in six parallel and two profiles that cross them in the north-south direction with a distance of 250 m between the points and profiles (Figure 9)

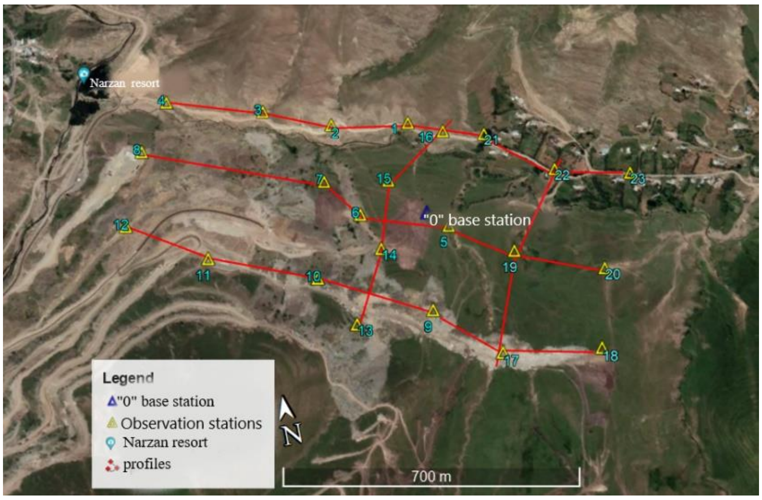

Figure 9. Layout scheme of gravi-magnetometric profiles performed in waste and landslide areas of Dashkasan skarn-iron ore group beds.

Based on the analysis and interpretation of magnetometric data, the anomalous areas that may be at risk of landslides have been outlined (Figure 10) and the depth of the planes that can cause landslides according to the lithological composition of geological sections in these areas has been determined (Figure 11). A schematic map and a 3D model were prepared in 2D format.

As can be seen from the prepared maps, it is observed that the geomagnetic field voltage is almost unevenly distributed in Dashkasan skarn-iron ore beds and waste areas.

In this local area, the geomagnetic field voltage varies with gradient increases and, albeit episodic, decreases.

The geomagnetic field gradient is characterized by sharp changes in the 2D map of the area.

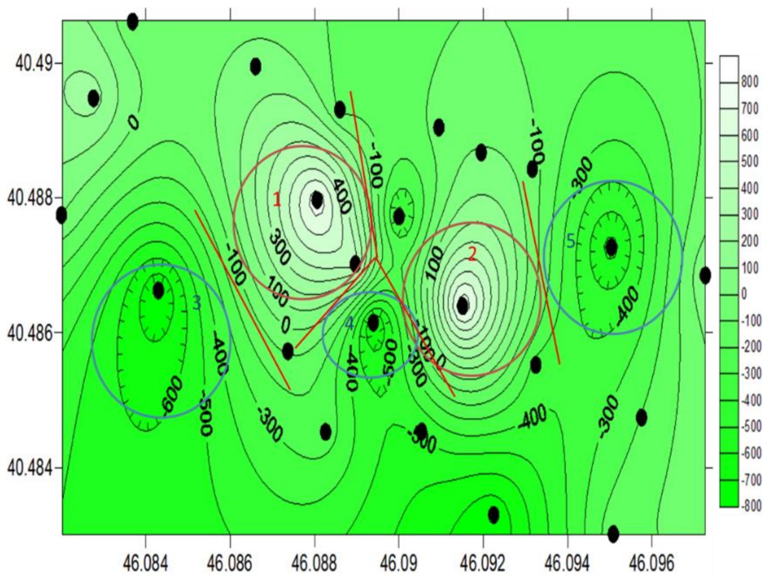

Figure 10. Map of the stress-deformation state of the geomagnetic field in the waste and landslide areas of Dashkasan skarn-iron ore group beds in 2D format

Conventional signs:

Geological fault lines

Magnetic observation points

Geomagnetic anomaly (maximum) 1-2

Geomagnetic anomaly (minimum) 3-4-5

In the south and southwest wing of the map, geomagnetic anomalies of minimum type 3, 4, and 5 are observed in the east. All three minimum-type anomalies are elongated in the south-north direction. The intensity of the noted anomalies is around -400 ÷ -500 nT.In the center of the research area, intense anomalies of maximum type 1 and 2 are observed in the geomagnetic field. The mentioned maximum-type anomalies are stretched in the south-north direction, just like the minimum-type anomalies. In the contact zone of the maximum and minimum type anomalies observed on the map, there were sharp gradient changes related to the stress in the geomagnetic field (Figure 11). These are areas of transition from intense maximum No. 1 and No. 2 to minimum No. 3-4-5.

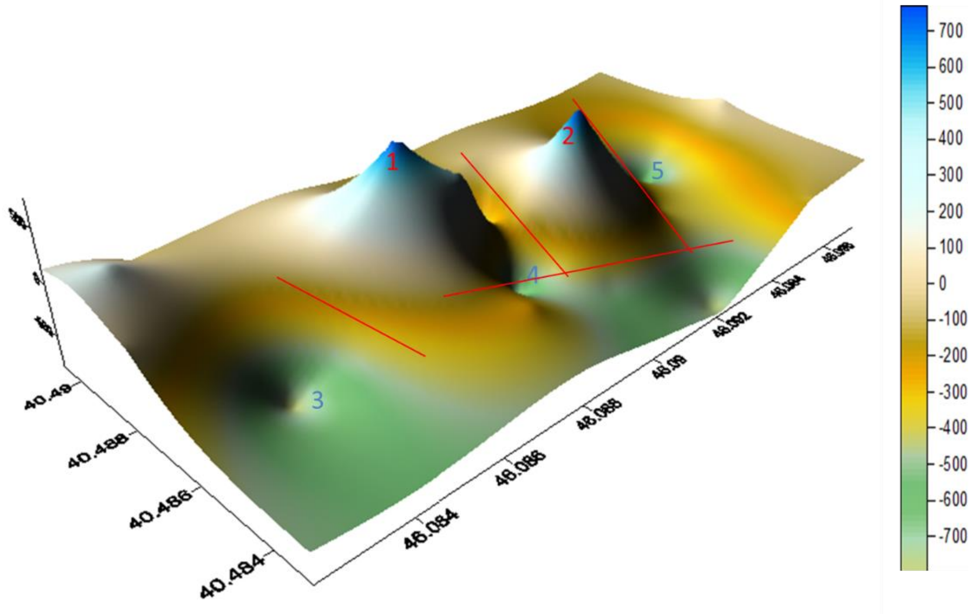

Figure 11. The model of the stress-deformation state of the geomagnetic field in the waste and landslide areas of Dashkasan skarn-iron ore group beds in 3D format

1-2 Maximum
3-4-5 Minimum
Geological fault lines

The above-mentioned maximum and minimum type of local geomagnetic anomalies are more precisely expressed in the schematic model drawn up in 3D format. Maximums 1 and 2 observed in the geological structure of the area with gradient changes in the geomagnetic field (surges) occur here in the lower layers of the earth's surface. It is assumed to be related to complications (Figure 12). On the basis of the results of complex geological, hydrogeological, seismological, engineering-seismic and geophysical data, anomalies are contoured in the study area, and there is a risk of landslides, it can be said that Dashkasan skarn iron ore group beds It shows that the dynamics of activation in the area is intense and it is important to take measures that can reduce the risk of landslides.

The method of gravimetric research.

A gravimetric network has been established to investigate the geological-tectonic structure of the landfill and the adjacent landslide zone, and to determine the location and direction of tectonic faults and disturbances (Figure 9).

Gravimetric studies have drawn up a schematic map, vector scheme and 3D model reflecting the tension of the gravity field, depth dynamics, and the distribution of gravity in the landfill and its adjacent areas.

The obtained data allowed to monitor the tectonic disturbances in different depth intervals in the area and to evaluate the geodynamic regime of the area. It was performed with a high-precision gravimeter of the CG-5 AutoGrav type, manufactured in Canada (Figure 12).

Figure 12. View of the Canadian-made CG-5 AutoGrav type gravimeter under research.

Processing and interpretation of gravimetric data

A 2-dimensional isoanomaly map (Figure 13), a 3-dimensional model (Figure 14) and a vector scheme (Figure 15) of the gravity field according to the results of calculations and changes of the gravity field on each profile in the waste and landslide areas of Dashkasan skarn - iron ore group deposits were drawn up.

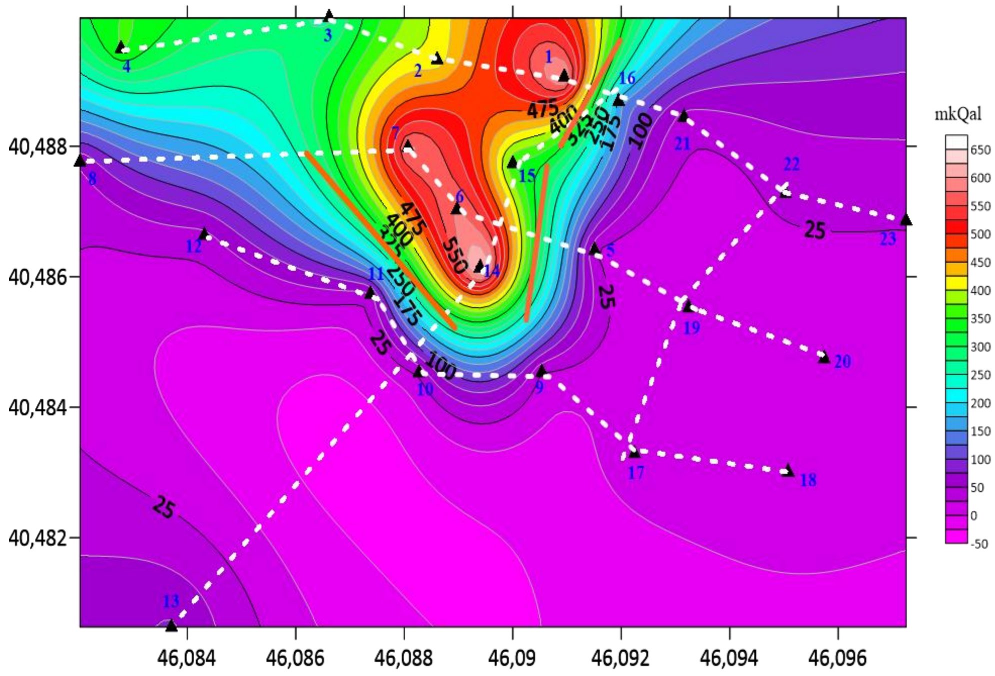

Figure 13. General isoanomaly map of the gravity field reflecting the stress-deformation state in the waste and landslide area of Dashkasan skarn - iron ore group beds.

As can be seen from the isoanomaly map of the gravity field, the anomalous zones accompanied by the variable value of the relative gravity force are precisely covered has been done. Thus, the relative gravity varies between 400 and 650 μGal, spreading to the south-west and south of the study area with a maximum value. This mentioned anomaly is spread from north to south and is closed in both directions.

In the southern wing of the map, there is a complication in the gravity field, which is exactly the opposite of the anomaly in the north-south direction. An anomalous zone is observed with a decrease in the gravity field from 250 μGal to 175 μGal with a minimum value.

The presence of this type of anomalies in the area suggests that there is a geological disturbance in the local area, where the gradient has changed sharply, resulting in a landslide.

The fact that the gravity field anomalies of the area are so sharply opposite means that the research area has a complex geological structure. The results of the above-mentioned interpretation are more clearly visible in the 3D model and vectorial map of the stress-deformation state of the geological environment based on the data of the gravity field in the waste and landslide area of Dashkasan skarn - iron ore group deposits (Figures 14-15).

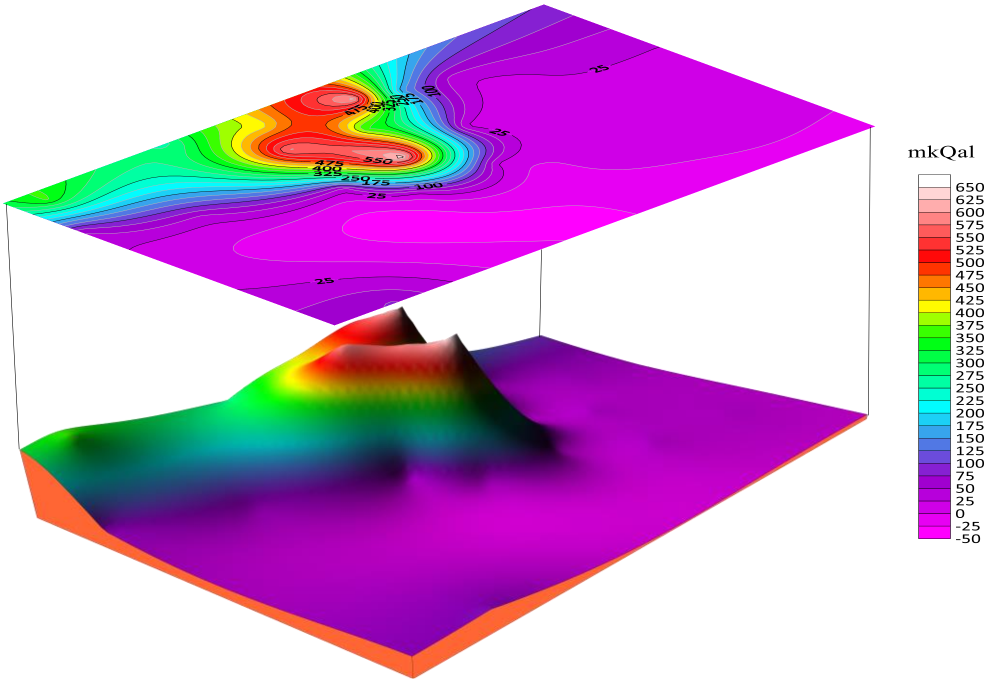

Figure 14. Dashkasan skarn - a model built in 3D format reflecting the stress-deformation state of waste and landslide area of iron ore group beds.

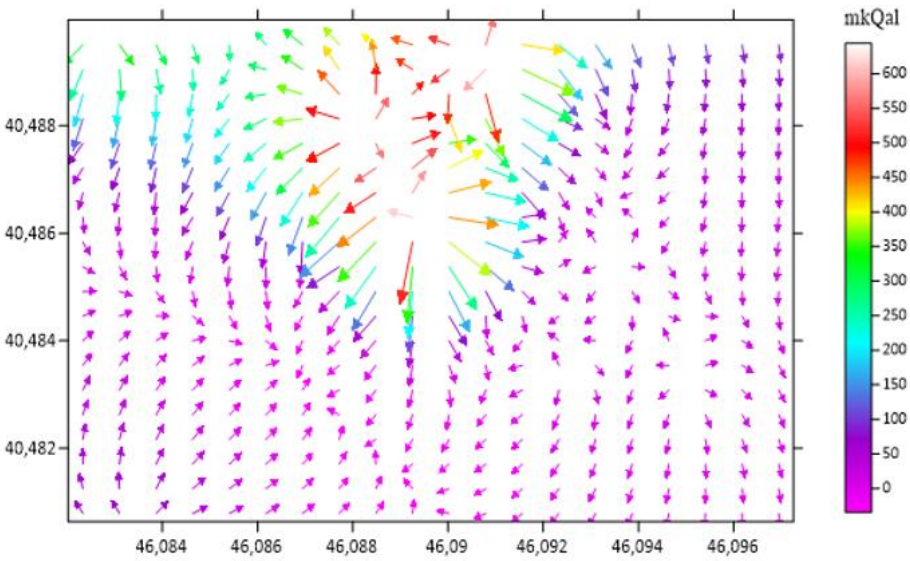

Figure 15. Vector map of the gravity field reflecting the stress-strain condition in the waste and landslide area of Dashkasan skarn - iron ore group beds.

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