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CHARACTERISTICS OF THE SEISMOMAGNETIC EFFECT (SME) VARIATION IN THE GOYCHAY EARTHQUAKE IN THE MIDDLE KURA DEPRESSION

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Annotation

The article studies data on anomalous changes in the geomagnetic field voltage near the earthquake epicenter. The nature of the seismomagnetic effect is determined by the geomagnetic regime prevailing in the epicenter. The spatial-temporal distribution of the geomagnetic field voltage gradient reflects the geomagnetic regime prevailing in the Middle Kura Depression.

Keywords: SME – seismomagnetic effect, ntl-nanotesla, earthquake source mechanism, geomagnetic regime, geomagnetic field strength, ml – magnitude.

ORTA KÜR ÇÖKƏKLİYİNDƏ BAŞ VERMİŞ GÖYÇAY ZƏLZƏLƏSİNDƏ SEYSMOMAQNİT EFFEKTİN (SME) DƏYİŞMƏ XÜSUSİYYƏTLƏRİ

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Annotasiya

Məqalədə zəlzələ ocağının yaxınlığında geomaqnit sahə gərginliyinin anomal dəyişmələri haqqında məlumatlar öyrənilir. Seysmomaqnit effektin yaranma xarakteri ocaqda gedən geomaqnit rejimlə təyin olunur. Geomaqnit sahəsinin gərginlik qradientinin məkan –zamana görə paylanması Orta Kür Çökəkliyində gedən geomaqnit rejimini əks etdirir.

Açar sözlər: SME – seysmomaqnit effekt, ntl- nanotesla , zəlzələ ocağının mexanizmi, geomaqnit rejim, geomaqnit sahə gərginliyi, ml – maqnituda

ХАРАКТЕРИСТИКИ ИЗМЕНЕНИЯ СЕЙСМОМАГНИТНОГО ЭФФЕКТА (SME) В СРЕДНЕ-КУРИНСКОЙ ВПАДИНЕ ВО ВРЕМЯ ЗЕМЛЕТРЯСЕНИЯ В ГЁЙЧАЕ

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Аннотация

Рассматривается аномальное изменение геомагнитного поля вблизи очага землетрясения. Показано соответствие характера сейсмомагнитного эффекта динамике механизма очага. Отмечается отражение текущего геодинамического режима в Нижнекуринских отложениях в пространственно – временных приращениях градиента напряженности геомагнитного поля.

Ключевые слова: сейсмомагнитный эффект (SME), ntl - нанотесла, механизм источника землетрясения, геомагнитный режим, напряженность геомагнитного поля, ml - магнитуда.

The Republican Seismic Survey Center under the Azerbaijan National Academy of Sciences has been studying the time-dependent variations of the seismomagnetic effect in separate local areas in Azerbaijan for more than 45 years. Anomalous changes caused by strong earthquakes occurring in areas assessed as having high seismic risk and geodynamic activity are observed from time to time.

The accumulation of stress-strain energy at different depths of the Earth is related to intra-terrestrial and cosmogenic factors. The Middle and Lower Kura depressions, where anomalous stress-

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strain energy accumulates, and the northern and southern foothills of the Greater Caucasus, also change the mechanical, physical-chemical and other properties of the environment in the earthquake foci occurring in the Azerbaijani sector of the Caspian Sea with characteristic indicators.

The description of such active processes on the Earth's surface is studied in seismically active regions of the world as gravitational, electrical, magnetic and geochemical anomalous changes in geophysical fields, as well as as warning factors of earthquakes.

The magnetometric method not only allows for the effective implementation of geological mapping, tectonics, the state of fault zones, and the clarification of the boundaries of geological complexes, but is also successfully applied in seismological research, as well as in the study of geodynamic regimes in earthquake hotspots.

This is due to the unique property of the main geomagnetic field to record and remember the entire transformation process of the earth's crust. It is precisely this that explains the cause-and-effect relationships of many geophysical processes occurring in conditions of excessive elastic accumulation of depths. Since the seismogenic zone is a zone of excessive accumulation of elastic energy and frequent changes in the stress state, it is reflected in the formation of the seismomagnetic effect (SME). Therefore, SME can be considered an indicator of the seismotectonic process consisting of horizontal and vertical movements of the earth's crust in seismogenic zones as components of the general geodynamic regime.

The results of long-term studies conducted at the Sheki-Shamakhi polygon in Azerbaijan allowed us to determine a number of characteristic features of the seismomagnetic effect and its dependence on the earthquake source mechanism. [Rzayev 2016].

Thus, in the case of compression of the earthquake source and the formation of reverse fault deformation, the seismomagnetic effect is mainly manifested with a positive sign.

When a tension mechanism is formed in the earthquake source and, as a result, a collapse-slip deformation occurs, the seismomagnetic effect is manifested with a negative sign before this seismotectonic process [Rzayev 2016].

Below is a map of the epicenters of earthquakes that occurred in the Middle Kura depression and adjacent areas during 2004-2024 (Fig. 1).

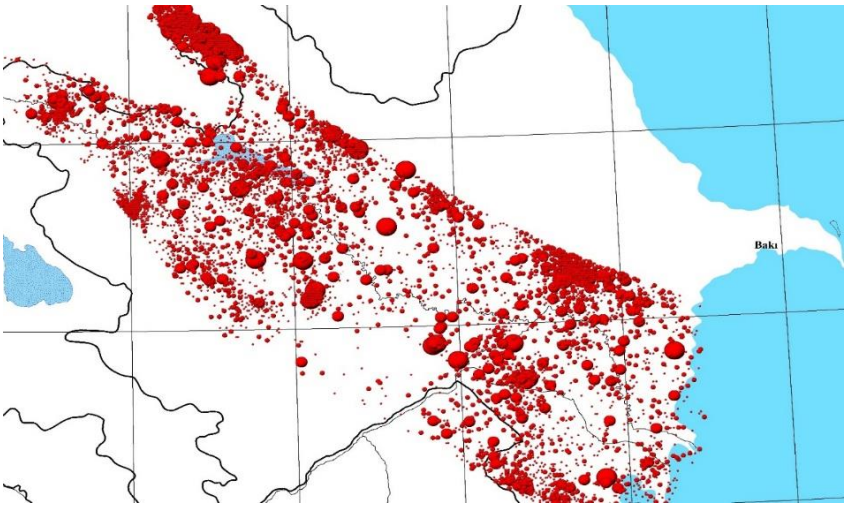

Fig. 1. Map of epicenters of earthquakes that occurred in the Middle Kura Depression and nearby areas during 2004-2024 (Kazimova S. E.)

In the Middle Kura Depression, seismicity was higher than the background level in the quarters. The epicenters of the Goychay earthquake auto shocks are located in the Kura-Pan-Caucasus Gabala-Chakhirly intercalary zone. [Rzayev A.G. 2013].

In these parts of the Middle Kura Depression, Sabirabad earthquake sources are known. In 2024, the geodynamic activity of the Sabirabad zone was higher than in other regions. [Yetirmishli G.J., Rzayev A.G. 2018].

If we look at Figure 2, which reflects the change in the increase in geomagnetic field voltage $\Delta T \sim f(t)$, we see that the ΔT level decreased slightly up to two weeks before the earthquake, apparently due to the loosening of mountain rocks under the influence of tensile stresses in the earthquake sources. This process is replaced by a sharp accumulation of compressive stresses 8 days before the seismic shock, which leads to an increase in the ΔT stress.

At this time, the seismomagnetic effect (SME) formed at a value of 20 nTl precedes the main seismic shock dated 09.08.2025, followed by a relaxation of the stress to the background level ΔT.

As can be seen, the "fault-rise" mechanism of the earthquake source is fully reflected in the formation of the SME over time and is confirmed by the nature of the transformations of the geomagnetic field stress.

On August 9, 2025 (ML=4.0, H= 16 km), an earthquake occurred in the Goychay area.

The mechanism of the earthquake source is of a fault-rise (Fault), displacement-tension nature (the data of the RSSC ANAS). The seismomagnetic effect was observed in the curves constructed based on the indications of magnetometers operating at the Ismayilli and Sheki stations (Fig.2).

09.08.2025 Lat=40.61 Lon=47.85 H=16 Ml=4.0 (Goychay)

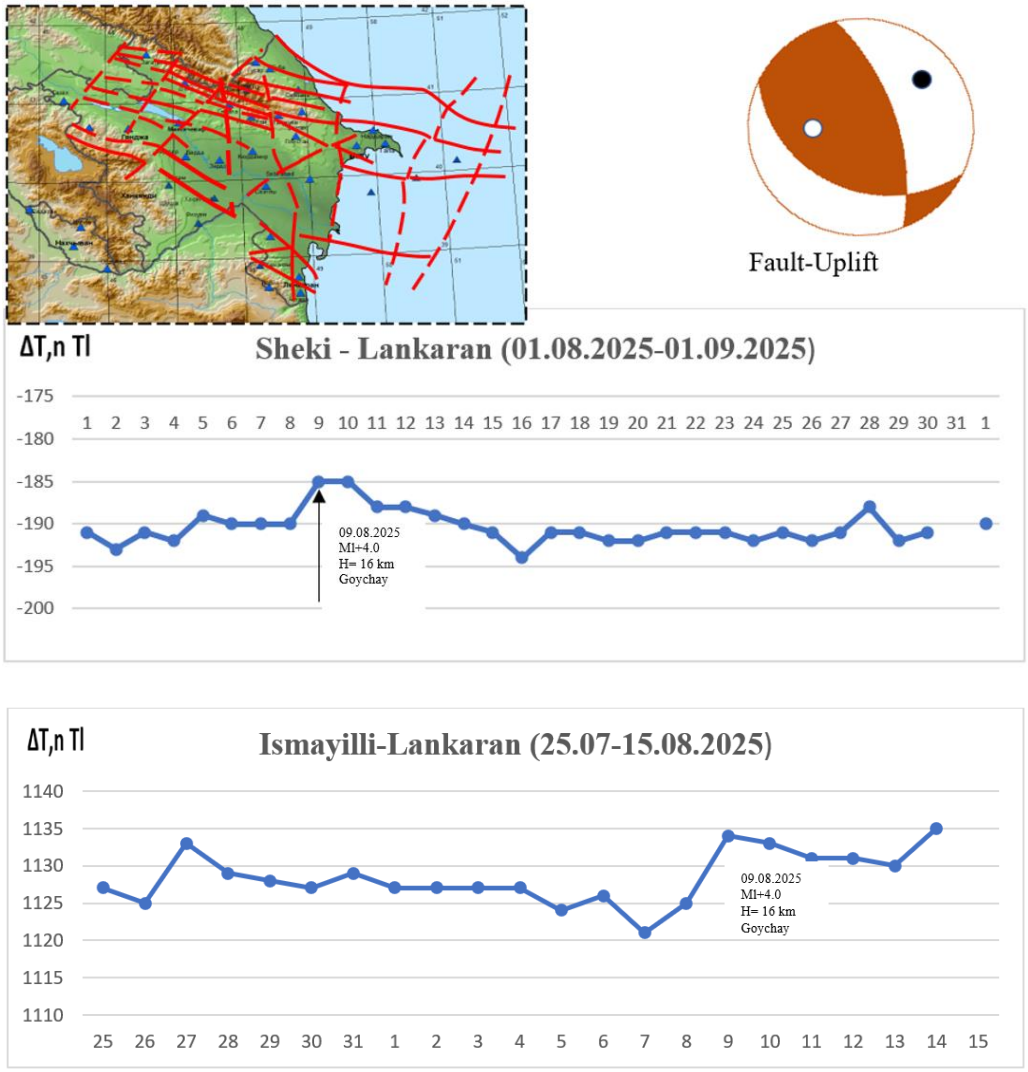

Fig. 2. Seismomagnetic effect felt at Ismayilli and Sheki stations during the Goychay earthquake

The increase gradient of the geomagnetic field stress detected as a result of geomagnetic observations during fieldwork in 2025 provides information about the stress state in the seismogenic zones in the polygons. Analysis of the variations of geomagnetic field stresses and gradient increases allowed us to detect stress-deformation zones in the Middle Kura Depression and adjacent areas. These are Saatli, Barda, Agdam, Ujar, Zardab long-term stress-deformation zones. Strong earthquakes do not always occur in these areas, but they are assessed as seismic risk zones and the seismomagnetic effect is observed with anomalous changes.

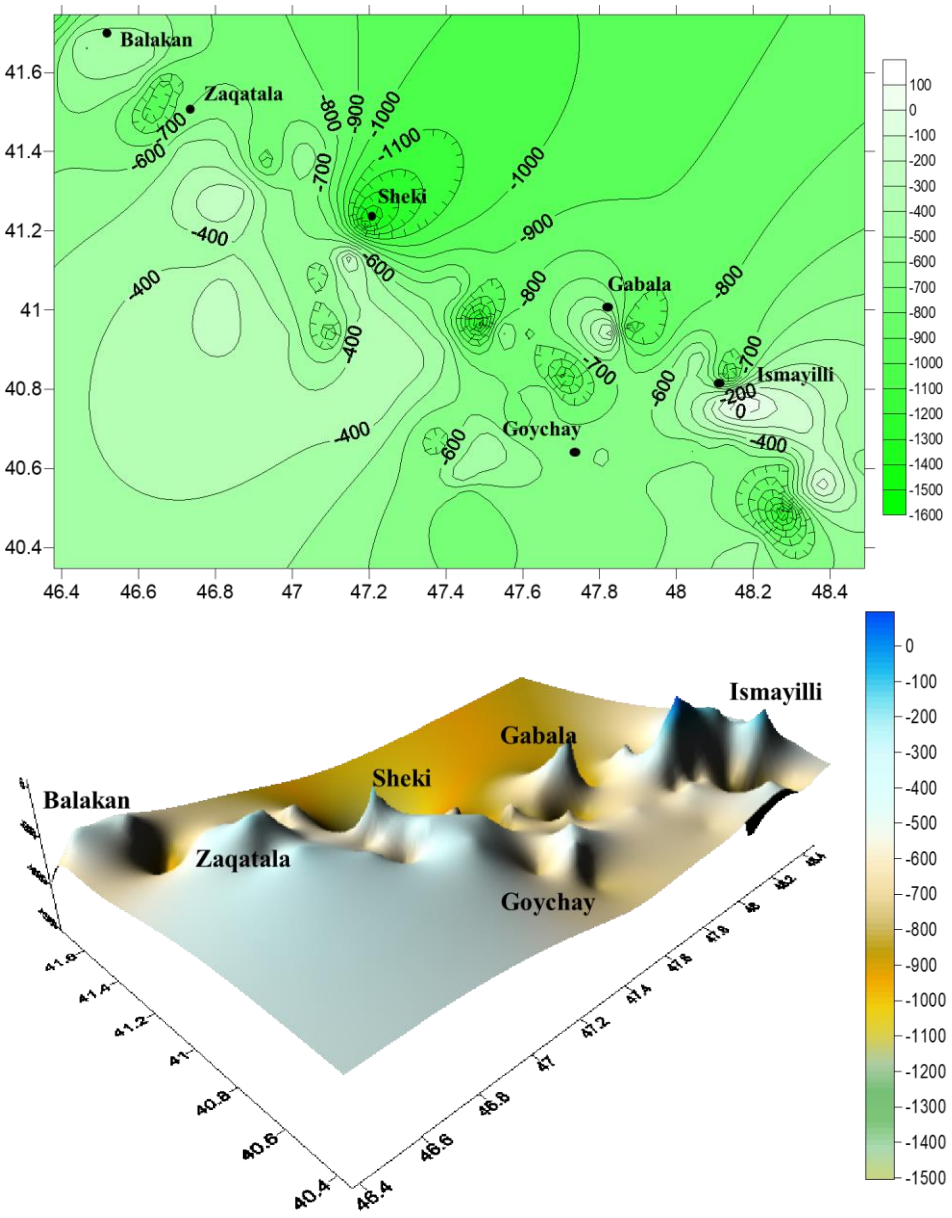

Fig. 3. Stressed deformation state of the geological environment based on magnetic data at the Kura – Talysh landfill (in 2D, 3D formats)

If we look at the map constructed in 2D and 3D format reflecting the stress-deformation state of the geological environment based on magnetic data in the Kura-Talysh geodynamic polygon in 2025, magnetic maxima are noted in the Jalilabad-Imishli-Kurdamir zone in the regional plan (Fig. 3).

It is noted that the geodynamic regime of the Middle Kura depression is mainly related to the movement of the Kura depression blocks under the Greater Caucasus structures.

The formation of a positive seismomagnetic effect in the source zone of the earthquake that occurred in the Goychay area once again confirms the above-mentioned facts.

Conclusion

The spatial-temporal variation of the geomagnetic field voltage gradient reflects the geodynamic regime of the Azerbaijani territory. The article studies and analyzes in detail the anomalous variations of the geomagnetic field in and near earthquake sources.

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