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M.V. Ponomareva[1], *Ye.V. Ponomareva[1], A.T. Tungushbayeva[1], D.A. Inkin[2]
[1]Abylkas Saginov Karaganda Technical University (Karaganda, Kazakhstan),
[2]«Qazaq Geophysics» LLP (Karaganda, Kazakhstan)

IDENTIFYING PROMISING AREAS WITHIN THE ZHEZKAZGAN DEPRESSION BY A COMPLEX OF GEOLOGICAL AND GEOPHYSICAL STUDIES

Abstract. The article deals with the possibilities of geological and geophysical methods of studying the northeastern part of the Zhezkazgan depression to determine the boundaries of the studied area, to highlight and to delineate the areas of promising sites and to conduct their further study. The results of magnetometric, gravimetric, radiometric, profile and area electrical prospecting studies are presented, which make it possible to identify promising areas, to clarify the boundaries of geological bodies of different compositions, to select locations for prospecting and mapping wells, and to conduct quantitative geological and geophysical modeling. For all the profiles of the studied area, magnetic and gravitational field graphs, as well as pseudo-sections of resistance and longitudinal conductivity, were constructed and analyzed.

Key words: *Zhezkazgan depression, promising areas, geological structure, geological and geophysical studies, ore deposits, ground geophysical methods, gravity and magnetic prospecting, electrical prospecting.*

Геологиялық-геофизикалық зерттеулер кешенімен Жезқазған ойпаты шегінде перспективалы алаңдарды анықтау

Аңдатпа. Мақалада зерттелетін аумақтың шекарасын анықтау, перспективалық учаскелерді орналастыру алаңдарын бөлу және контурлау және оларды одан әрі зерттеу үшін Жезқазған ойпатының солтүстік-шығыс бөлігін зерттеудің геологиялық-геофизикалық әдістерінің мүмкіндіктері қарастырылады. Перспективалық учаскелерді анықтауға, әртүрлі құрамдағы геологиялық денелердің шекараларын нақтылауға, іздеу-карталау ұңғымаларының орналасу орындарын таңдауға, сандық геологиялық-геофизикалық модельдеуді жүргізуге мүмкіндік беретін магнитометриялық, гравиметриялық, радиометриялық, бейіндік және алаңдық электр барлау зерттеулерінің нәтижелері келтіріледі. Зерттелетін аймақтың барлық бейіндері магниттік және гравитациялық өрістің графиктерін, сондай-ақ қарсылық пен бойлық өткізгіштіктің жалған қималарын құрастырады және талдайды.

Түйінді сөздер: *Жезқазған ойпаты, перспективалық алаңдар, геологиялық құрылым, геологиялық-геофизикалық зерттеулер, кен шоғырлары, жер үстіндегі геофизикалық әдістер, гравибарлау және магнитті барлау жұмыстары, электр барлама.*

Выявление перспективных площадей в пределах Жезказганской впадины комплексом геолого-геофизических исследований

Аннотация. В статье рассматриваются возможности геолого-геофизических методов исследования северо-восточной части Жезказганской впадины для определения границ изучаемой территории, выделения и оконтуривания площадей размещения перспективных участков и проведения их дальнейшего изучения. Приводятся результаты магнитометрических, гравиметрических, радиометрических, профильных и площадных электроразведочных исследований, позволяющие выявить перспективные участки, уточнить границы геологических тел разного состава, выбрать места заложения поисково-картировочных скважин, провести количественное геолого-геофизического моделирование. По всем профилям изучаемой площади построены и проанализированы графики магнитного и гравитационного поля, а также псевдоразрезы сопротивления и продольной проводимости.

Ключевые слова: *Жезказганская впадина, перспективные площади, геологическое строение, геолого-геофизические исследования, рудные залежи, наземные геофизические методы, гравиразведочные и магниторазведочные работы, электроразведка.*

Introduction

At present, sustainable economic development of the country is impossible without reproduction of mineral resources. The main stock of easily accessible near-surface deposits is practically exhausted, and there is observed decreasing the supply of mineral resources to city-forming enterprises. In this regard, identifying promising areas through exploratory geological and geophysical studies within the northeastern part of the Zhezkazgan depression to replenish the mineral resource base of the Zhezkazgan region is an urgent task.

The studied area is located in the Ulytau district of the Ulytau region. In the southern part of the studied area, at the distance of about 2 km from the exploration lines and points, there is the Terecty station; 3 km to the south is the Borsengir village. The relief of the area is a combination of small hills and dissected lowlands, with steep, often rocky slopes separated by flat longitudinal gently undulating valleys. The climate of the area is arid and continental. The vegetation of the territory is steppe and semi-desert. The hydrographic network of the region belongs to the drainage basin of the Kara-Kengir River that collects water from almost the entire area by tributaries.

The geological structure of the studied territory includes the areas of distribution of slightly inclined and horizontally lying, facies-variable Paleogene, Neogene and Quaternary sediments; development of terrigenous, volcanic-terrigenous and carbonate-terrigenous facies-variable deposits of the Middle-Late Devonian, Carboniferous and Permian ages, making up the Sarysu-Teniz branch of the Devonian volcanic-plutonic belt (DVPB), the Sarysu-Teniz zone of rift structures and the Zhezkazgan structural-facies zone (SFZ)); the distribution of highly facies-variable, Lower-Middle Devonian volcanogenic-terrigenous, terrigenous-volcanogenic formations of the Sarysu-Teniz branch of the DVPB, the Devonian intrusive massifs of similar petrographic composition and terrigenous, carbonate-terrigenous facies-variable deposits of the Ordovician, composing the Konskaya SFZ that was subjected to intense folded deformations and complicated by numerous discontinuities; the development of terrigenous, carbonate-terrigenous deposits and terrigenous-volcanogenic formations of the Sarysu-Teniz branch of the DVPB located in the zones of influence of large intrusive massifs [1-3].

The studied area is characterized by a variety of species and genetic types of minerals. All the identified mineral objects in scale are referred to deposits, manifestations and points of mineralization [4].

The purpose of the study consists in identification of promising areas for replenishing the mineral resource base of the Zhezkazgan region by conducting exploratory geological and geophysical studies within the northeastern part of the Zhezkazgan depression.

The tasks of the study include identification, delineation and studying of promising occurrences and mineral deposits in the studied area based on the results of geological and geophysical studies; determining the feasibility of further research to study them.

Research methods

Geological studies involve conducting geological routes; core drilling of prospecting and mapping wells; selecting point and core samples to determine their physical properties and conducting spectral analysis; selecting geochemical samples from cores of prospecting and mapping and prospecting wells; producing thin sections and polished sections for silicate, mineralogical, paleontological and chemical analysis [5].

Carrying out a complex of geophysical studies in the profile version in the studied area, including magnetometric, gravimetric, radiometric studies, as well as profile and area electrical prospecting work, will make it possible to identify promising areas for prospecting work.

When performing gravity exploration work, the Scintrex-CG-5 Autograv gravimeter was used. The studies were carried out along the profiles with a step of 40 meters; control measurements were carried out in the volume of more than 5% to assess the quality of data collection. The shift of the zero point was daily taken into account; the level of interference during shooting was continuously assessed, and the necessary corrections were introduced into the measurement results. When performing measurements, microseisms and lunar-solar disturbances were automatically taken into account. To determine gravity anomalies, corrections were introduced into the results of field measurements for the normal field of the Earth, the height of the observation point, and the influence of the intermediate layer [6].

When performing magnetic exploration work, high-precision GSM-19W magnetometers were used. In order to identify azimuthal errors, all the instruments used to perform routine and control surveys were verified on the verification profile in forward and reverse motion. As a result of the reconciliation, it was found that the difference in levels did not exceed the shooting error. Corrections were also introduced for daily variations in the magnetic field [6, 7].

The walking gamma survey was carried out using a field radiometer SRP-68. Based on the measurement results, gamma activity graphs were constructed for each profile.

Electrical exploration work in the studied area was carried out by sounding the quasi-transient sounding in the near zone (QTS), the «Cycle-7» installation and vertical electrical sounding in the dipole-dipole modification (DOS-IP), using three EIN-209M meters and a GER-5/ generator 1000.

When conducting studies by quasi-transient sounding in the near zone (QTS), to increase reliability of measurements at each picket, at least 2-5 repeated measurements were made, duplicates, which made it possible to improve significantly the accuracy of measurements when processing them. Carrying out experimental and methodological work made it possible to select the size of the installation and the optimal mode of recording the decline in the quasi-transient sounding, which made it possible to carry out field data collection with the necessary accuracy [7, 8].

One of the factors influencing the data recording process is the duration of the current turning off edge. To minimize the effect of the current switch-off front in the generator loop and to increase the dynamic range of the measured transient process, it is recommended to perform sounding with the current pulse amplitude of 1.5-5 A and 10-20 A. Sounding that is performed at the current strength of 1.5-5 A is least distorted by the current switch-off front and contains the information of the upper part of the section. Sounding that is performed at the current of 10-20 A allows for maximum research depth. In this regard, data recording in the studied area was carried out with currents of 5 A and 10 A to monitor the operation of equipment and to analyze the heterogeneity of the medium. During the final processing and interpretation of the data, the curves with currents of 10 A were taken. Control measurements were carried out in the volume of more than 5% to assess the quality of field data collection. The measurement accuracy was ≈ 3% [9, 10].

Results and discussion

As a result of processing, there were obtained pseudo-sections of resistivity and longitudinal conductance for all the profiles (Figure 1).

To identify anomaly-forming objects, to clarify their morphology in detail and to track them to depth, profile electrical prospecting work was carried out using the VES-IP sounding method in the dipole-dipole modification. In order to select the optimal measurement mode, experimental and methodological work was carried out in different areas of the studied territory.

To select the optimal frequency, experimental work was carried out at frequencies from 0.153 Hz to 4.88 Hz. The measurements were carried out in different grounding conditions (dense and loose soils) at near and far distances. Based on the measurement results, the frequency characteristics of the phase parameter were constructed for each AB current line at the measured pickets. The most optimal frequencies for measurements are 0.31, 0.61 and 1.22 Hz.

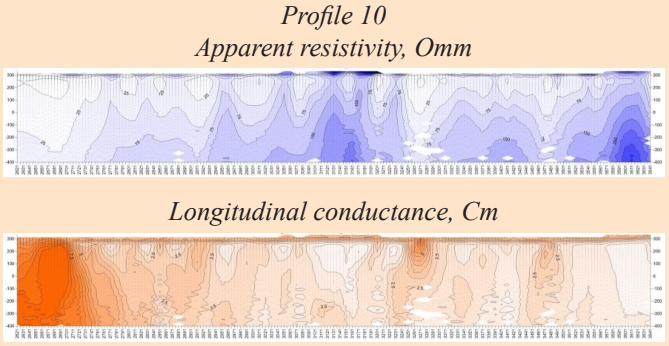


Figure 1. Pseudo-sections of resistivity and longitudinal conductivity.
Сурет 1. Көрінетін қарсылық пен бойлық өткізгіштіктің жалған қималары.
Рис. 1. Псевдоразрезы кажущегося сопротивления и продольной проводимости.

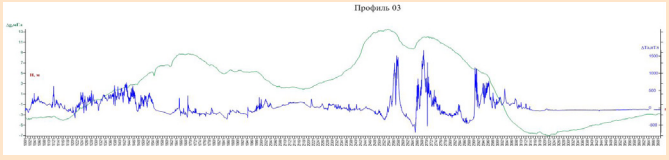
A complex of ground-based geophysical methods, consisting of magnetic prospecting, gravity survey, gamma-ray

survey, was carried out on all profiles of the study area; on a number of profiles (PR03, PR05, PR08) electrical prospecting was carried out using the VES-IP (modified DOS-IP) and QTS methods. Figure 2 shows graphs of the magnetic and gravitational fields for profiles PR03, PR05, PR08.

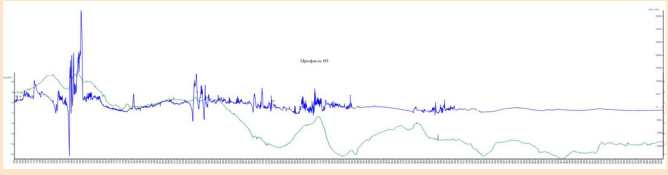
On the PR03 profile (the length is 53.86 km), a differentiated magnetic field is observed, predominantly positive, characteristic of intrusive bodies; extended local anomalies can be traced. The gravitational field changes from negative to positive, has a number of anomalies, and gradually decreases until the end of the profile, going into negative values. According to the VES-IP results, a high-resistivity zone and a polarizability anomaly of up to 1.8% are identified. Based on the results of QTS, a zone of high conductivity is identified.

On the PR05 profile (the length is 90.66 km), the magnetic field is predominantly positive. A sharp field gradient (interval of high values) is observed along the profile. Then the values gradually become negative, mapping the Zhaltyrbulak graben. Afterwards, the field becomes smooth, characteristic of the carbonate strata of the Zhezkazgan depression, with the exception of the interval where the magnetic field becomes more disturbed, along which the Devonian effusive-sedimentary formations of the Birlistyk anticline are distinguished.

Profile 03



Profile 05



Profile 08

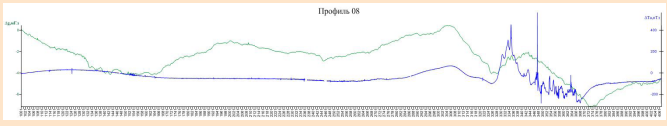


Figure 2. Graphs of the magnetic and gravitation fields for profiles PR03, PR05, PR08.
Сурет 2. ПР03, ПР05, ПР08 бейіндері бойынша магниттік және гравитациялық өріс графиктері.
Рис. 2. Графики магнитного и гравитационного поля по профилям ПР03, ПР05, ПР08.

The gravitational field is initially positive with small local anomalies. Then the field gradually decreases and goes into negative values. The negative field has a number of expressive regional anomalies in some intervals. According to the QTS results, there is a sharp drop in the apparent resistivity to almost zero; this interval was noted above when describing the magnetic field as the Zhaltyrbulak graben. According to the results of VES-IP inversions, the interval is high-resistivity, polarizability is lower than 1%.

Profile PR08 (the length is 61.38 km) completely passes through the Zhezkazgan depression, so the magnetic field here is smooth, except for intervals where a positive anomaly is observed (Birlistyk anticline) similar to PR05.

The gravitational field is completely negative. According to the results of the QTS, the profile is characterized as low-resistance. According to the results of VES-IP inversions, a high-resistivity interval is identified; polarizability does not even reach 1%.

For all the profiles of the studied area, there is a high correlation between the data of gravimetric, magnetometric and electrical surveys. A differentiated, predominantly positive magnetic field is observed for all the profiles; The Zhaltyrbulak graben is mapped with negative values. The gravity field has mainly negative values and characterizes regional anomalies. Electrical prospecting made it possible to identify high-resistivity zones at a number of pickets across all the profiles.

When studying this area, the integration of exploration methods (gravity prospecting, magnetic prospecting, electrical prospecting) based on the proposed physical and geological model, as well as the correlation of the data obtained, made it possible to increase reliability of conclusions when assessing the promising areas within the Zhezkazgan depression.

Conclusions

Gravimagnetic data can serve as the basis for quantitative geological and geophysical modeling with the use of a complex of area field transformations; radiometric survey data to clarify the boundaries of geological bodies of different compositions.

It is necessary to take into account the data from previous geological surveys of the surface and deep geological mapping, as well as the data of the Central Kazakhstan regional structure.

The analysis of geological and geophysical materials shows that for a detailed study of the territory structure, the obtained characteristics of geological objects are not sufficient, therefore it is necessary to involve additional in-depth research methods.

To identify anomalies in induced polarizability and local conductivity of rocks that can be associated with ore deposits, electrical surveys are necessary. Based on the results of ground-based electrical exploration work performed using the VES-IP method, locations for seven prospecting and mapping wells were selected.

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Information of the authors:

Ponomareva M.V. Candidate of Technical Sciences, Associate Professor of the Geology and Exploration of Mineral Deposits Department, «Abylkas Saginov Karaganda Technical University» NJSC (Karaganda, Kazakhstan), *mv_ponomareva18@mail.ru;* https://orcid.org/0000-0001-8652-9607

Ponomareva Ye.V. PhD, acting Associate Professor of the Geology and Exploration of Mineral Deposits Department, «Abylkas Saginov Karaganda Technical University» NJSC (Karaganda, Kazakhstan), *sea_kitten_1@mail.ru;* https://orcid.org/0000-0003-1322-6773

Tungushbayeva A.T. doctoral student of the Geology and Exploration of Mineral Deposits Department, «Abylkas Saginov Karaganda Technical University» NJSC (Karaganda, Kazakhstan), *nur.sa@mail.ru*; https://orcid.org/0000-0002-4749-7785

Inkin D.A. Technical Director of the «Qazaq Geophysics» LLP (Karaganda, Kazakhstan), *idima@yandex.ru;* https://orcid.org/0009-0008-4959-8038

Авторлар туралы мәліметтер:

Пономарева М.В. «Әбілқас Сағынов атындағы Қарағанды техникалық университеті» КеАҚ «Геология және пайдалы қазбалар кен орындарын барлау» кафедрасының доценті, т.ғ.к. (Қарағанды қ., Қазақстан)

Пономарева Е.В. «Әбілқас Сағынов атындағы Қарағанды техникалық университеті» КеАҚ «Геология және пайдалы қазбалар кен орындарын барлау» кафедрасының доцентінің м. а., PhD (Қарағанды қ., Қазақстан)

Тунгушбаева А.Т. «Әбілқас Сағынов атындағы Қарағанды техникалық университеті» КеАҚ «Геология және пайдалы қазбалар кен орындарын барлау» кафедрасының докторанты (Қарағанды қ., Қазақстан)

Инкин Д.А. «Qazaq Geophysics» ЖШС техникалық директор (Қарағанды қ., Қазақстан)

Сведения об авторах:

Пономарева М.В. к.т.н., доцент кафедры «Геология и разведка месторождений полезных ископаемых» НАО «Карагандинский технический университет имени Абылкаса Сагинова» (г. Караганда, Казахстан)

Пономарева Е.В. PhD, и.о. доцента кафедры «Геология и разведка месторождений полезных ископаемых» НАО «Карагандинский технический университет имени Абылкаса Сагинова» (г. Караганда, Казахстан)

Тунгушбаева А.Т. докторант кафедры «Геология и разведка месторождений полезных ископаемых» НАО «Карагандинский технический университет имени Абылкаса Сагинова» (г. Караганда, Казахстан)

Инкин Д.А. технический директор ТОО «Qazaq Geophysics» (г. Караганда, Казахстан)