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Review of the current state of knowledge in forecasting and searching for gold deposits in the North-Western Balkhash region

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<p>Received: December 20, 2023 Peer-reviewed: January 18, 2024 Accepted: February 28, 2024</p>	<p>ABSTRACT The article provides an assessment of the degree of knowledge of the North-Western Balkhash region based on a priori information from the previously conducted complex of geological and geophysical studies. Today, much is known about the geological, tectonic structure of the North-Eastern Balkhash region, the metallogeny of the region, the main structural elements have been identified; there are characteristics of intrusive formations, the age of the main rock complexes has been determined, several mineralization points, ore occurrences and deposits have been discovered. Based on the results of the earlier work, the Dolinnoye, Pustynnoye, and Karyernoje deposits were discovered. They are characterized by promising gold reserves. The determining role when carrying out prospecting geophysical work is played by the degree of exploration of deposits, which makes it possible to formulate an optimal technology for detecting mineralization points and ore deposits and to reduce the risks of erroneous selection of production facilities to the minimum. The article analyzes the level and provides cartograms of the exploration of the North-Western Balkhash region territory by geological surveying, mining operations, sampling and geophysical methods. The geological and geophysical history of research in the territory of the Dolinnoye, Pustynnoye, and Karyernoje deposits was considered. Conclusions were drawn about the level of exploration of the research area and the need for further geophysical work in this territory, due to the high productivity of the area for copper mineralization.</p>
	<p>Keywords: North-Western Balkhash region; geological survey; geophysical studies; degree of knowledge; copper-pyrite and gold mineralization.</p>
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Introduction

The purpose of the studies presented in the article is to determine the level of knowledge of the North-Western Balkhash region based on the collection, analysis and synthesis of a priori data and to justify the need for further study of the territory based on the use of geophysical methods. To achieve this goal, the following tasks were solved:

1) studying the exploration of the study area with the use of geological methods;

2) the degree of studying the study area by aerial gamma spectrometry, electrical prospecting, gravity prospecting and magnetic prospecting;

3) the effectiveness of geophysical prospecting and justification for the need to continue geophysical studies in searching for gold and copper formations in the North-Western Balkhash region.

The territory of the central part of the North-Western Balkhash region is characterized as inaccessible, which was the reason for the slow study of its geological structure [[1], [2], [3]]. The beginning of extensive geological studies in this area was the

discovery and further establishment of the industrial significance of the Kounrad copper deposit. The studies in 30-40s served as the basis for geological work in subsequent years. Thus, in 1930, N.I. Nakovnik discovered the Shointas magnesite deposit, where geologist F. Dybkov (CNIGRI, 1936) conducted preliminary exploration for magnesite. In the same 1930, N.I. Nakovnik made assumptions about the presence of nickel and platinum in the Kopa tract [[4], [5], [6]].

In 1937-1938, geologists of the Kazakh branch of the USSR Academy of Sciences (Sergievsky V.N., Dmitrievsky V.S., Vakhromeyev V.A., Lignevskaia S.I., Loginova L.I., Novokhatsky N.N.) carried out a huge amount of work to compile a geological map of the entire North-Eastern Balkhash region on a scale of 1:500,000. A wide range of materials was collected, summarized and analyzed, based on which in the North-Eastern Balkhash region it was possible to stratify the marine Devonian, represented by a full set of departments. The research results were ambiguous, therefore, as new material was accumulated, the opinions of scientists underwent significant changes. Among the works of those years, there should be noted the works by V.A. Vakhromeyev, who described in detail the conditionally Lower Silurian (Ordovician) age and divided the jasper-diabase complex into 2 formations: the lower (porphyry) and the upper (jasper-quartzite). He stratified the sandy sequence covering the jasper-quartzite sequence as Gotland.

In 1939, N.L. Bublichenko paid great attention to studying the Silurian and Devonian deposits. Observations were mainly carried out in the Kopa tract and on both sides of the Kenterlau Valley. Generalization of the collected material in 1945 resulted in the compilation of a geological map of sheet D-2-B, as a result of which the geological structure of the territory was significantly corrected. The stratigraphic scheme of the Paleozoic of the North-Eastern Balkhash region compiled by N.L. Bublichenko, remains correct to this day. He conventionally attributed the sequence of basic volcanic rocks and jaspers to the Cambrian. He combined the deposits lying between the Cambrian and terrigenous tellurium sediments into the Diamanshuruk Formation of the Ordovician age. Terrigenous green-coloured formations were dissected by him, distinguishing the Llandoveryan, Wenlock-Ludlovian and Dauconian stages of the Silurian and the Zhudinsky, Sardzhal, Kazakh and Aidarlinian stages of the Silurian to the Devonian [7].

The ultrabasic intrusions of Kazakhstan (Itmurundy, Tyuretai, Tesiktas massifs) were studied

in the publication by I.F. Trusova in 1948. The article was based on her 1937-1940 studies. She defined the age of all the ultrabasic rocks in Kazakhstan as Caledonian.

The studies of the Andasai expedition that were carried out from 1949 to 1951, were dealing with the diamond potential of loose sediments of Lake Balkhash (North Coast). Almost at the same time, Mikhailov N.P. and Moskaleva V.N. began studying the basic and ultrabasic intrusions of this territory. The integration of the studies included a geological and geomorphological report and a geological map on a scale of 1:200,000 (authors Kostenko N.N. and Mastryukova A.A.). Based on the results of these works, the jasper-diabase complex of Kostenko N.N. was attributed to the Upper Proterozoic.

A geological survey on a scale of 1:200,000 in the area of sheet D-2-104 with the participation of Koshkin V.Ya., Nikelev Yu.V. and Aniyatova P.A. was carried out by the North Balkhash SKSU PSP in 1953. That project was accompanied by paleontological studies carried out by palaeontologists Kaplun L.I. and Rukovichnikova T.B. (SKSU), as a result of which Silurian deposits without division were stratified as undivided Gotlandian.

Editing sheet D-2-104B began in 1956 by V.Ya. Koshkin. As a result of research, the rocks of the jasper-diabase complex were divided into the Itmurunda, Kazyk and Tyuretai formations. The Itmurunda and Kazyk formations were conditionally assigned to the Sinian deposits, and the Tyuretai formation was stratified as Cambrian. The deposits lying on the rocks of the jasper-diabase complex are dissected to highlight the Dzhambanshuruk Formation of the Llandoil-Ludlovian Stage. The new edition established a gradual transition from the Upper Silurian to the Devonian, in which stage division was carried out. Rocks of the Carboniferous age were stratified by deposits of the Tournaisian stage and the Sayak formation of the Lower Devonian. In 1958, Koshkin V.Ya. divided the Sayak formation into the Karkala, Keregetas and Arharlin formations [8].

In 1960, when carrying out geological survey work on a scale of 1:50,000, V.Ya. Koshkin for the first-time established gold mineralization in the area of the Pustynnoye deposit. At this time, increased gold contents had already been identified in the local areas of Zapadny, Karierny, and Kopshoky. In 1960-63, the Khantau and North-Balkhash SKSU PSP had a small number of ditches made in these areas. Geologists discovered that elevated gold contents

were confined to zones of intensely pyritized and silicified rocks [9].

In the territory of the Northern Balkhash region, generalization of the data on geology, metallogeny and the implementation of several regional forecasting and metallogenic works to search and explore areas promising for minerals, including gold, were carried out in 1960-1965 by teams of the Ministry of Scientific Research of the Academy of Sciences of the Kazakh SSR and Central Kyiv State University (Shcherba G.N., Alperovich E.V., Kolesnikov V.V.). So, in the intervals of 1961-1962 and 1962-1966, geological surveys of sheets D-45 and D-413 on a scale of 1:50,000 were carried out by V.Ya. Koshkin and Antonyuk R.M., respectively [10].

In April 1981, a new stage of geological survey work began, when, in addition to the Moscow Research Institute of the Academy of Sciences of the Kazakh SSR and the Central Kyiv State University, the Kenterlau Research Station of the Balkhash Geological Survey (Bezuglykh I.V., Akshalov T.).

As a result, geological surveys of a large scale were carried out in the study area. Today, researchers have in their hands the information on the geological, and tectonic structure of the North-Eastern Balkhash region, the metallogeny of the region, and the main structural elements were identified. There are characteristics of intrusive formations, the age of the main rock complexes was determined, several points of mineralization, ore occurrences and deposits were discovered and their genetic relationship with the Late Hercynian magmatism was determined [11].

The stage of studying the Northern Balkhash region by geophysical methods began in 1949. One of the first geophysical methods that were used by employees of the All-Union Aerogeological Trust in 1951 (Yefremova N.N., Preobrazhensky N.A.) was an aeromagnetic survey. It is clear that the results of that survey are practically not used in present-day studies, since the sensitivity of the instruments of that time was low, the survey results were characterized as substandard. An aeromagnetic survey on a scale of 1:25,000 was carried out in the area of sheet D-2-104 by the Volkov expedition in 1955. From 1975 to 1985, the area was actively studied by KAGGE (Zhunussov R.K., Komarov A.M., et al.), ASGE PGO "Kazgeofizika" (Kozlenko O.M., Kuznetsova N.P.). A cartogram of knowledge of sheet L-43 using airborne geophysical methods is presented in Figure 1.

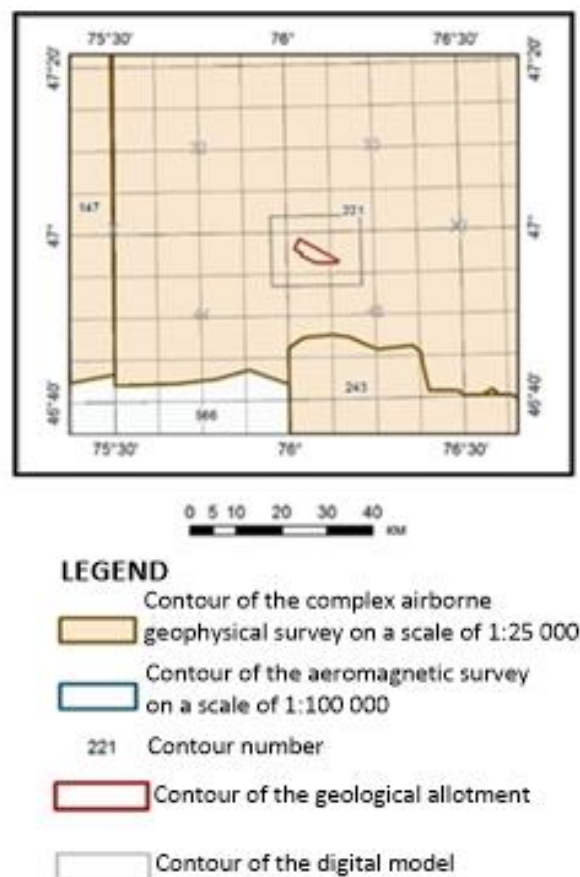


Figure 1 – Airborne geophysical knowledge of sheet L-43

The first magnetic prospecting studies on a scale of 1:50,000 were carried out together with metallometry on the area of sheet D-2-104 in 1952-1954 (the Katbar party of AGFE, Serebryakova I.S.). This territory is confined to the zones of development of ancient strata. Metallometry discovered scattering halos of copper, chromium, nickel, titanium, manganese, and molybdenum here; however, the results of these works also had a significant drawback due to a low sensitivity of spectral analysis and a limited number of elements being determined. In the area of sheets D-410, -413, -412, -415 on a scale of 1:50,000, metallometry was carried out by the Katbar GFP AGFE (Miller S.D., Zhukov M.I.) in 1957. As a result of these works, there was revealed several local scattering halos of Ni, Co, and C_2 that were associated by researchers with hypermafic intrusions.

Promising zones and nodes for sulfide and rare metal mineralization were identified based on a comprehensive interpretation of gravimetric and metallometric research data. On the other hand, gravimetric data made it possible to clarify the

structural and tectonic features of the North-Western Balkhash region [[12], [13], [14]].

When detailing and assessing the copper halos identified during metallometry in 1940-50, in 1961, the employees of the Balkhash State Geographical Enterprise AGFE (Baluta S.V.) discovered the Tesiktas copper pyrite deposit, and in 1962 the Balkhash State Geographic Exploration Company began exploration work. At the same time, the Balkhash State Exploration Survey carried out a metallometric survey on a scale of 1:20,000 of a large area that along its strike covered almost the entire territory of the Tesiktas fault zone. The prospects of several copper halos identified from the results of those studies were assessed by subsequent works as unpromising.

On sheets D-413-B, G, -414-A, B, -415-A, B in the interval of 1968-1969, Yu.P. Moskalev, V.P. Kalinin, V.V. Murashkin carried out a gravimetric survey on a scale of 1:50,000. The purpose of the survey was to trace promising structures for copper mineralization and to clarify the patterns of association of copper mineralization with the deep structures of the area. Detailing the identified gravity anomalies and determining the possibilities of high-precision areal gravity exploration at copper-pyrite deposits in 1967 at the Tesiktas deposit were carried out based on a gravimetric survey on a scale of 1:10,000 (KazKIRG, Gulnitsky V.L., Gubanov M.) [15].

Positive results were not obtained when assessing copper and arsenic copper halos by mining and drilling that were carried out in 1969-1970 at the North-West Tesiktas, East Tesiktas, Tesiktas and Ikkuduk BGRE sites (Safiyulin B.N., et al.). Therefore, in 1972, exploration work was completed due to the unprofitability of areas for industrial development, and the Tesiktas field was mothballed [9].

Deep searches for copper within the Suzyzkara zone (Western Kazyk and Eastern Tesiktas sections) also turned out to be fruitless. The work was carried out in conjunction with VP-SG, VES, MPP (Kashkarskaya GFP, Pokusayev A.V.). Based on the results of the work, it turned out that the IP anomalies were petrogenic, and the identified copper halos and points of visible mineralization were not of practical interest due to the low concentrations and low thickness of the mineralization zones [10].

Thus, the study area was covered by airborne spectrometry (AGS) and gravimetric surveys at 1:100,000 and 1:25,000 scales. A cartogram of gravity exploration knowledge is presented in Figure 2.

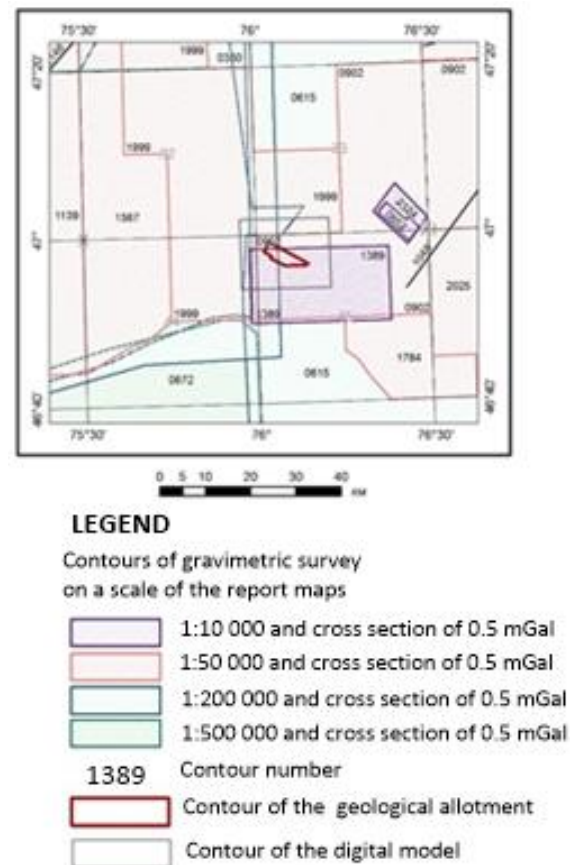


Figure 2 - Gravity exploration knowledge of sheet L-43

Let's consider the level of knowledge of the gold exploration area. In the 1960s, V.Ya. Koshkin discovered several gold-bearing areas (Zapadny, Karierny, etc.). It served as an impetus for prospecting for gold. The gold content and prospects of the listed areas were confirmed by prospecting and assessment work (Karazhalskaya PSP YuKPK, Altybayev A.A., et al.). At the same time, in the area of the Ikkuduk group of manifestations, Grazhdantsev N.G. studied the gold content of the Northern Balkhash region.

In 1967, the Balkhash expedition of the Central Committee of State University began to engage in gold prospecting. From 1967 to 1968, the Ulken party of the Balkhash Exploration Expedition (Bukurov G.Yu., Voloshin V.V.) carried out prospecting and assessment work in the area of the Baktai site and the Ikkuduk group of manifestations. Based on the results of work at the Baktai site, three ore areas with gold content from 1 g/t to 12 g/t were identified among the linearly elongated zone of vein silicification of sandstones. Three promising areas were identified in the Ikkuduk group: Zapadny with a gold content of up to 26.6 g/t; Karyerny (two zones are identified with a content of 2.3 and 2.4 g/t with a layer thickness of 4 and 1 m, respectively); Severny

(a subzone with the content of 2.4 g/t at the thickness of 2 m and several subzones with the content of 1-1.2 g/t were identified). In those areas, work was continued by the Ulken party (Flikop R.M.) in 1970-1973. As a result of mining and testing work at the Baktai ore occurrence, two ore-bearing blocks were identified, and excavation of deep pits with cuts revealed the nest-like and uneven nature of the distribution of metal. In some samples, the gold concentration was up to 80 g/t.

In 1972-1973, specialized prospecting work was carried out (Voloshin V.V.), as a result of which several gold-bearing points were identified in the area of the Itkuduk-Baktay zone, but no industrially interesting objects were identified. Prospecting for gold in the Batykyzyl and Zhalpakkain areas carried out in 1970-1972 by the Akshokinsky party of the Balkhash KGGE (Flikop R.M., Skripchenko A.F.), also turned out to be unsuccessful. At the Batykyzyl site, four IP anomalous zones were identified that were mainly mapping the zones of pyritization of Famennian sandstones. Verification of the anomalies by drilling and testing did not yield positive results for gold and the other elements. At the same time, the Kashkar GFP (Pokusayev A.V., Katrysheva E.I.) carried out prospecting work for copper in the Itbas site, where the prospects for the area in terms of copper gave a negative assessment. Nevertheless, a series of IP anomalies were identified, coinciding with arsenic halos from 0.01 to 0.04% and gravitating towards silicified sandstones and skarn zones at the contact of sedimentary rocks of the Keregetas Formation with the gabbro-granodiorite intrusion. In the exocontact of the intrusions, gold contents of 9.6 g/t were established based on skarns.

Using the data obtained in 1963-1970, comprehensive detailed geological and geophysical prospecting work was carried out in the Zapadny, Karyerny and Kopshoky areas. The complex included excavation of surface and underground mine operations, drilling single wells, magnetic prospecting and electrical prospecting of IP on a scale of 1:10,000 (Altybayev A.A., Permyakov G.N., Flikon R.M.). As a result, in the Zapadny and Karyerny areas, a series of lens-shaped ore bodies, not consistent along the strike, up to a few tens of meters in length, with a thickness of 1.5-10.0 m with a gold content of 3 or more grams per ton, was contoured [16].

In the period from 1972 to 1979, in the area of the ore field and within the Baktai-Itkuduk zone, geological and geophysical work was continued by the Batykyzyl PRP with areal geological and

geophysical work on a scale of 1:50,000 and detailed searches on a scale of 1:10,000 within the Zapadny, Kopshoky and Karyerny areas. As a result, gold-bearing zones were also identified outside the Zapadny, Karyerny and Kopshoky areas. The area under consideration was combined into a field called Pustynnoye [10].

In the Zapadny, Karyerny and Kopshoki sections, the network of ditches was thickened to 10-20 m, old ditches were cleared and retested. As a result, within the Zapadny area, seven ore bodies with gold contents above 2.0 g/t are delineated, extending from 40 to 180 m with a thickness of 1.5 to 75.5 m. The depth of the ore zones was assessed by two wells (C-12, 13) to depths of 200-300 m. Metal reserves - up to 10 tons. In the Karyerny and Kopshoky areas, ditches revealed similar zones of pyritization and silicification but with lower gold contents than those in the Zapadny area. The predicted geological reserves of the field were in general estimated at several tens of tons [17].

In the interval of 1979-1983, detailed prospecting work to study the prospective assessment was carried out by the Itkuduk EP at the Pustynnoye field. Within this period, inter-core drilling, mechanical trenching, manual trenching, drilling pits with a cross-section of 4 m², horizontal workings with a cross-section of 5.1 m², horizontal workings with a cross-section of 2.7 m², core sampling, furrow sampling, magnetic prospecting, electrical prospecting, topographic work, spectral analysis, assay analysis for gold, making thin sections, geophysical research in wells.

From 1973 to the present, the North Balkhash EP and the Eastern GFP specialized for gold, are carrying out geological and geophysical studies in the Baktai-Itkuduk zone [[18], [19], [20]].

Conclusion

The analysis of materials in the geological and geophysical study of the considered area made it possible to draw the following conclusions:

1. The territory of the North-Western Balkhash region was systematically studied through geological survey work from the late 30s of the last century. As a result of carrying out conditional surveys, both of small and large scales, the geology of the area was obtained, the main structural elements were identified, the characteristics of the volcanic activity of the area were given, the age of the main varieties of rocks was clarified, the number of points of mineralization, ore occurrences and deposits were

discovered, as well as their genetic connection with the Late Hercynian magmatism.

2. The entire territory of sheet L-43 is covered by the network of aerial spectrometric, magnetometric, electrical prospecting and gravimetric surveys on a scale of 1:200,000 and larger. What is common to all the studies is that the surveys were carried out in the 50s-80s of the last century using equipment of low sensitivity, quality and accuracy. Due to the low sensitivity of airborne gamma spectrometry instruments, the survey results are characterized as poor quality and now are practically not used.

3. Electrical prospecting work using a complex of VES, IP-MG, MPP, ZSB, and INFAZ-IP methods was carried out to clarify the geological structure and deep searches for copper and gold, without providing a significant increase in information on the structure of the studied areas. Thus, electrical exploration knowledge of the study area is extremely low. At the same time, the results of electrical exploration work and sufficient differentiation of the electrical properties of rocks show the effectiveness of using the IP method both for mapping purposes and for searching for zones of hydrothermal development and associated occurrences of minerals.

4. In general, the magnetic survey materials are of good quality; on their basis, standard maps of the anomalous magnetic field were compiled.

5. Gravimetric studies in the work area were carried out from the late 50s of the last century. Work on a scale of 1:200,000 and larger was carried out in the territory of sheet L-43. It can be considered that the considered area is characterized by satisfactory gravimetric study, but the results of these surveys are morally outdated. Therefore, based on the use of gravimetric results from larger surveys carried out with updated, high-tech equipment of the latest generation, the task is to

detail the structural and tectonic features of the study area.

6. Based on the results of prospecting and assessment work for gold on a scale of 1:50,000, several aureole-anomalous zones were identified, coinciding with both known occurrences of gold (Baktai Yuzhny, Karyerny, Zapadny, Ortosay, etc.), and previously unknown ones. Thus, an areal halo of gold dispersion was recorded in the area of anomaly 4 of the Itbas site, within which the Dolinnoye quartz-vein deposit was identified. It was assessed as a promising one, with significant gold reserves.

7. 20 km west of the Dolinnoye deposit, in recent years there was revealed the Pustynnoye gold deposit of the quartz-gold-pyrite type, which is assessed as a large one based on predicted reserves. Exploration, evaluation, geological and geophysical work in the field began in 1980.

The obtained materials indicate the sufficient effectiveness of the geological and geophysical work performed and the high prospects of the Itkuduk-Baktay zone for searching for large industrial gold deposits. In general, the available airborne geophysical, gravity and magnetometric materials are quite sufficient to solve the problem of developing a modern geophysical basis, but the collected geological and geophysical information needs to be generalized, linked, analyzed and interpreted in light of present-day stratigraphic, geodynamic, metallogenic and the other concepts. Taking into account the high prospectivity of the area, in particular for copper mineralization, this trend is one of the priority tasks of regional research. In certain areas of detailing, it is necessary to state updated high-precision studying methods.

Conflict of interest. On behalf of all the authors, the corresponding author declares that there is no conflict of interest.

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Солтүстік-Батыс Балқаш аймағындағы алтын кендерін болжау және іздеу кезіндегі зерттеудің қазіргі жағдайына шолу

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<p>Мақала келді: 20 желтоқсан 2023 Сараптамадан өтті: 18 қаңтар 2024 Қабылданды: 28 ақпан 2024</p>	<p>ТҮЙІНДЕМЕ Мақалада бұрын жүргізілген геологиялық-геофизикалық зерттеулер кешені бойынша априорлық ақпарат негізінде Солтүстік-Батыс Балқаш аймағының зерттелу дәрежесіне баға берілген. Бүгінгі таңда Солтүстік-Шығыс Балқаш аймағының геологиялық, тектоникалық құрылымы, металлогенезі туралы көп нәрсе белгілі, негізгі құрылымдық элементтер оқшауланған, интрузивті түзілімдердің сипаттамасы бар, тау жыныстарының негізгі кешендерінің жасы анықталған, бірқатар минералдану нүктелері, кенашылымдар мен кен орындары табылған. Бұрын жүргізілген жұмыстардың нәтижелері бойынша перспективалы алтын қорымен сипатталатын Долинное, Пустынное, Карьерное кен орындары ашылды. Іздеу геофизикалық жұмыстарды жүргізуде кен орындарын зерттеу дәрежесі шешуші рөл атқарады, бұл минералдану нүктелерін, кен орындарын анықтаудың оңтайлы технологиясын қалыптастыруға және пайдалану объектілерін қате таңдау қаупін минимумға дейін төмендетуге мүмкіндік береді. Мақалада геологиялық түсірілім, тау-кен жұмыстары, сынау және геофизикалық әдістер арқылы Солтүстік-Батыс Балқаш аумағын зерттеу деңгейі талданып, картограммалар келтірілген. Долинное, Пустынное, Карьерное кен орындарының аумағындағы зерттеулердің геологиялық-геофизикалық тарихы қарастырылды. Зерттеу ауданын зерделеу деңгейі және ауданның мыспен кенденуіне жоғары іздестіру перспективасына байланысты осы аумақта одан әрі геофизикалық жұмыстарды жүргізу қажеттілігі туралы қорытындылар жасалды.</p>
	<p>Түйінді сөздер: Солтүстік-Батыс Балқаш өңірі; геологиялық барлау; геофизикалық зерттеулер; зерделену дәрежесі; мыс колчеданды мен алтынды кендену.</p>
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Обзор современного состояния изученности при прогнозировании и поисках золоторудных месторождений Северо-Западного Прибалхашья

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<p>Поступила: 20 декабря 2023 Рецензирование: 18 января 2024 Принята в печать: 28 февраля 2024</p>	<p>АННОТАЦИЯ В статье дана оценка степени изученности Северо-Западного Прибалхашья на базе априорной информации по ранее проведенному комплексу геолого - геофизических исследований. На сегодняшний день известно многое о геологическом, тектоническом строении Северо-Восточного Прибалхашья, металлогении района, выделены основные структурные элементы, имеется характеристика интрузивных образований, определен возраст основных комплексов горных пород, обнаружен целый ряд точек минерализации, рудопроявлений и месторождений. По результатам проведенных ранее работ были открыты месторождения Долинное, Пустынное, Карьерное, которые характеризуются перспективными запасами золота. Определяющую роль при проведении поисковых геофизических работ играет степень изученности месторождений, которая позволяет сформировать оптимальную технологию обнаружения точек минерализации, рудных залежей, и свести риски ошибочного выбора эксплуатационных объектов до минимума. В статье проанализирован уровень и приведены картограммы изученности территории Северо-Западного Прибалхашья геологической съемкой, горнопроходческими работами, опробованием и геофизическими методами. Рассмотрена геолого-геофизическая история исследований на территории месторождений Долинное, Пустынное, Карьерное. Сделаны выводы об уровне изученности района исследований и необходимости проведения на этой территории дальнейших геофизических работ, в связи с высокой поисковой перспективностью района на медное оруденение.</p>
	<p>Ключевые слова: Северо-Западное Прибалхашье; геологическая съемка; геофизические исследования; степень изученности; медно-колчеданное и золотое оруденение.</p>

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