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ASSESSMENT OF INDUSTRIAL SIGNIFICANCE OF THE SHEKTAS AND SURDZHAR SITES IN THE NORTH-EASTERN PART OF THE ZHEKAZGAN DEPRESSION

Abstract. The article deals with the issues of prospecting, exploration and assessment of industrial significance of promising areas within the north-eastern part of the Zhezkazgan Depression. The main attention is paid to detailed geological and geophysical studies that were carried out at the Shektas and Surdzhar sites. During the prospecting work, a complex was used, including ground geological exploration studies, drilling of prospecting and mapping wells, laboratory studies and quantitative analysis of samples. As a result of the work carried out at the Surdzhar site, an increased content of lead and silver was revealed, gold-silver mineralization was revealed, points of mineralization of gallium and rare earth metals were identified. Based on the results of the studies, an assessment of the prospects of the sites for solid minerals was given.

Key words: Zhezkazgan Depression, mineral resources, exploration work, geological and geophysical research, exploration and mapping wells, laboratory research, sample analysis, mineralization points, gallium, rare earth metals.

Жезқазған ойпатының солтүстік-шығыс бөлігіндегі «Шектас» және «Сурджар» учаскелерінің өндірістік маңыздылығын бағалау

Аңдатпа. Мақалада Жезқазған ойпатының солтүстік-шығыс бөлігіндегі перспективалық учаскелерді іздеу, барлау және өнеркәсіптік маңызын бағалау мәселелері қарастырылған. «Шектас» және «Сурджар» учаскелерінде жүргізілген егжей-тегжейлі геологиялық-геофизикалық зерттеулерге басты назар аударылды. Іздестіру жұмыстарын жүргізу кезінде жерүсті геологиялық барлау, іздеу-карталау ұңғымаларын бұрғылау, зертханалық зерттеулер мен сынамалардың сандық талдауын қамтитын кешен пайдаланылды. Сурджар учаскесінде жүргізілген жұмыстардың нәтижесінде қорғасын мен күмістің жоғарылауы анықталды, алтын-күміс минералдануы анықталды, галлий мен сирекжер металдарының минералдану жерлері анықталды. Жүргізілген зерттеулердің нәтижелері бойынша қатты пайдалы қазбалар бойынша аумақтардың перспективасына баға беріліп.

Түйінді сөздер: Жезқазған ойпаты, пайдалы қазбалар, іздеу жұмыстары, геологиялық-геофизикалық зерттеулер, іздеу-карталау ұңғымалар, зертханалық зерттеулер, үлгілерді талдау, галлий, сирекжер металдар.

Оценка промышленной значимости участков «Шектас» и «Сурджар» северо-восточной части Жезказганской впадины

Аннотация. В статье рассматриваются вопросы поиска, разведки и оценки промышленной значимости перспективных площадей в пределах северо-восточной части Жезказганской впадины. Основное внимание уделяется детальным геолого-геофизическим исследованиям, которые проводились на участках «Шектас» и «Сурджар». При проведении поисковых работ применялся комплекс, включающий наземные геологоразведочные исследования, бурение поисковых и картировочных скважин, лабораторные исследования и количественный анализ проб. В результате проведенных работ на участке «Сурджар» выявлено повышенное содержание свинца и серебра, вскрыто золото-серебряное оруденение, выявлены пункты минерализации галлия и редкоземельных металлов. По результатам проведенных исследований дана оценка перспективности участков на твердые полезные ископаемые.

Ключевые слова: Жезказганская впадина, полезные ископаемые, поисковые работы, геолого-геофизические исследования, поисково-картировочные скважины, лабораторные исследования, анализ проб, пункты минерализации, галлий, редкоземельные металлы.

Introduction

In terms of quantity and diversity of resources, the mineral resource base of the Republic of Kazakhstan occupies one of the leading places in the world. The Republic is among the top ten countries in the world in terms of reserves of such solid minerals as lead, zinc, copper, chromium, iron, manganese, tin, gold, phosphorites, boron and potassium salts.

At the same time, some of the reserves of mineral raw materials are uncompetitive due to the decreasing of their quality. In addition, there is an insufficient replenishment of mined minerals that ensure the operation of the existing mining and metallurgical enterprises. In view of this, searching, exploration and assessment of the industrial significance of promising areas within the north-eastern part of the Zhezkazgan Depression is an urgent task. The area of the study territory is characterized by various genetic types of minerals. The group of ferrous metals is represented by mineralization points of iron and manganese; the group of non-ferrous metals by copper mineralization points, manifestations and mineralization points of lead and zinc; noble metals by gold ore and gold-silver mineralization. In addition, there are rare metals, trace and rare earth elements and the other non-metallic minerals [1, 2, 3].

Detailed geological and geophysical studies were carried out at the Shektas and Surdzhar sites. The studies within these

sites were justified by geological and geophysical features, as well as by the results of previous work [4, 5].

The area of the Shektas site is 18.7 km². Within the site, stratified formations of the Upper Tournaisian-Lower Viséan stages of the Lower Carboniferous, the Pavlodar Formation of the Miocene-Pliocene, deposits of the Quaternary system and granitoids of the Early Devonian Karamendy and Middle Devonian Terekty complexes are developed from the surface.

From bottom to top along the section, stratified formations of different ages in the area are represented by carbonate deposits of the Upper Tournaisian-Lower Viséan stages of the Lower Carboniferous ($C_{1t_2-v_1}$), the Pavlodar Formation (N_{1-2pv}), the middle-upper link (Q_{II-III}) and the upper link-Holocene of the Quaternary (Q_{III-IV}) system.

The Upper Tournaisian-Lower Viséan deposits of the Lower Carboniferous are exposed as narrow ridges of sublatitudinal strike in the central part of the site over a small area and are represented by organogenic silicified cavernous limestones and marls.

The Pavlodar Formation is mapped in the eastern part of the site and is represented by red-brown clays with iron-manganese concretions.

The Quaternary deposits occupy the main area of the site and are represented by proluvial-deluvial deposits of trains (Q_{II-III}) composed of loams with granitoid and terrigenous

rock gruss and alluvial-proluvial deposits composed of sandy loams, loams with granitoid and terrigenous rock gruss (Q_{III-IV}).

Intrusive rocks are mapped in the northern part of the site. They are represented by granodiorites of the Early Devonian Karamendy complex and leucogranites of the Middle Devonian Terekty complex.

The area of the Surdzhar site is 22.9 km². Within the site, stratified formations of the Upper Ordovician, Lower Devonian, Neogene and Quaternary systems are developed. Intrusions are represented by granodiorites of the Early Devonian Karamendy complex.

From bottom to top along the section, stratified formations of different ages in the area are represented by: conglomerate-sandstone sequence of the Upper Ordovician (O_3kp), upper subformation of the Utzhan Formation of the Lower Devonian (D_1ut_3), lower subformation of the Taranshi Formation of the Lower Devonian (D_1tr_1), upper subformation of the Taranshi Formation of the Lower Devonian (D_1tr_2), Zheltymes Formation of the Lower Devonian (D_1zl), Zhamansarysu Formation of the Neogene (N_1zs), middle-upper link of the Quaternary system (Q_{II-III}) and the modern link of the Quaternary system (Q_{IV}).

Conglomerate-sandstone (O_3kp) is exposed in the south-western corner of the area. The sequence is composed of conglomerates with interlayers of gravelstones and sandstones.

The upper subformation of the Utzhan Formation (D_1ut_3) is mapped in the northwestern corner of the area. The structure of the formation includes inequigranular polymictic sandstones with conglomerate interlayers.

The lower subformation of the Taranshi Formation (D_1tr_1) is exposed in the northwestern and southwestern parts of the area. The subformation is mainly composed of conglomerates and tuff conglomerates of andesitic composition. The upper subformation of the Taranshi Formation (D_1tr_2) is developed in the central part of the area and is mainly composed of andesites.

The Zheltymes Formation (D_1zl) is mapped in the western part of the area and is mainly composed of large-porphyry dacites.

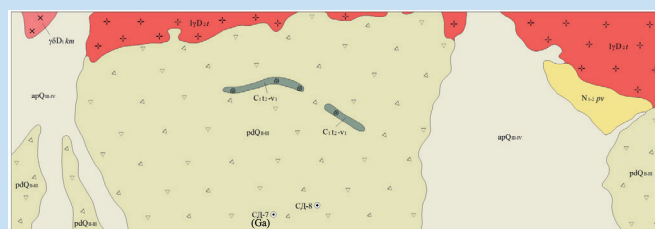
The Zhamansarysu Formation (N_1zs) is exposed as a narrow strip in the northwestern part of the area. The formation consists of greenish-gray clays with gypsum inclusions.

The Quaternary deposits (Q_{II-III}) are developed within the entire area of the site and are represented by proluvial-deluvial loams, sandy loams with volcanic rubble and granitoid gruss. The Quaternary deposits (Q_{IV}) form a lake basin in the south-western part of the site. Lake deposits are represented by clays, sandy loams, and sands with gruss.

Geological maps of the sites (Tarasov I.A., Glukhov A.M., 2022) with additions from the authors are presented in Figures 1, 2.

The purpose of the study. Assessment of the prospects of areas for solid minerals, studying geological patterns of their location.

Objectives of the study. Conducting detailed exploration work on the Shektas and Surdzhar sites of the north-eastern part of the Zhezkazgan Depression, identifying increased con-



Legend

apQIII-IV	Quaternary system. Upper link - Holocene. Alluvial-proluvial deposits. Sandy loams, loams, gruss, crushed stone	▽ ▽	Granitoid rubble. Crushed siliceous rocks
pdQII-III	Quaternary system. Middle-upper links. Proluvial-deluvial deposits of trains. Loams, gruss, crushed stone	+ +	Leucogranites
N _{1zpv}	Neogene system. Pavlodar formation. Miocene-Pliocene. Red-brown clays with iron-manganese concretions	× ×	Granodiorites
C _{1t2-v1}	Carboniferous system. Upper Tournaisian-Lower Viséan stages. Silicified marls, silicified and porous limestones	—	Geological boundaries
l _{7D2t}	Terekty complex. Leucocratic medium-grained and medium-coarse-grained granites	CD-7	Exploration boreholes and their numbers
78D _{1km}	Karamendy complex. Medium-grained granodiorites	⊙	Places of collection of fossil fauna

Figure 1. Geological map of the Shektas site with minerals.

Сурет 1. «Шектес» учаскесінің пайдалы қазбалары бар геологиялық картасы.

Рис. 1. Геологическая карта участка «Шектас» с полезными ископаемыми.

tents of ore elements and mineralization points, assessing their industrial significance.

Research methods

Within the north-eastern part of the Zhezkazgan Depression, the following exploration works were performed: deep geochemical exploration with core and cuttings collection from blastholes was carried out along the lines of seismic profiles; exploration and mapping drilling was carried out along the lines of seismic profiles and within the detailed areas; exploration works were carried out using a geological and geophysical complex at two detailed areas: Shektas and Surdzhar.

In the course of exploration works at the Shektas and Surdzhar areas, the following complex of geological and geophysical works was performed: topographic and geodetic breakdown of profiles; electrical exploration; exploration drilling; GIS (inclinometry, calipermetry, gamma logging, SP log, self-potential, MS log, MPE); charge method; sampling (collection of core and geochemical samples, collection of samples for determination of physical properties, collection of thin sections); sample preparation; laboratory studies (semi-quantitative spectral analysis, description of thin sections, determination of density and magnetic susceptibility) [6, 7, 8].

In the course of studying the Surdzhar site, additional prospecting and mapping drilling and atomic absorption analysis of samples for Au and Ag were carried out [9].

Research results and discussion

At the Shektas site, as a result of the ground geological exploration work (search routes, NFS electrical exploration), the locations for two exploration wells SD-7 and SD-8 were selected.

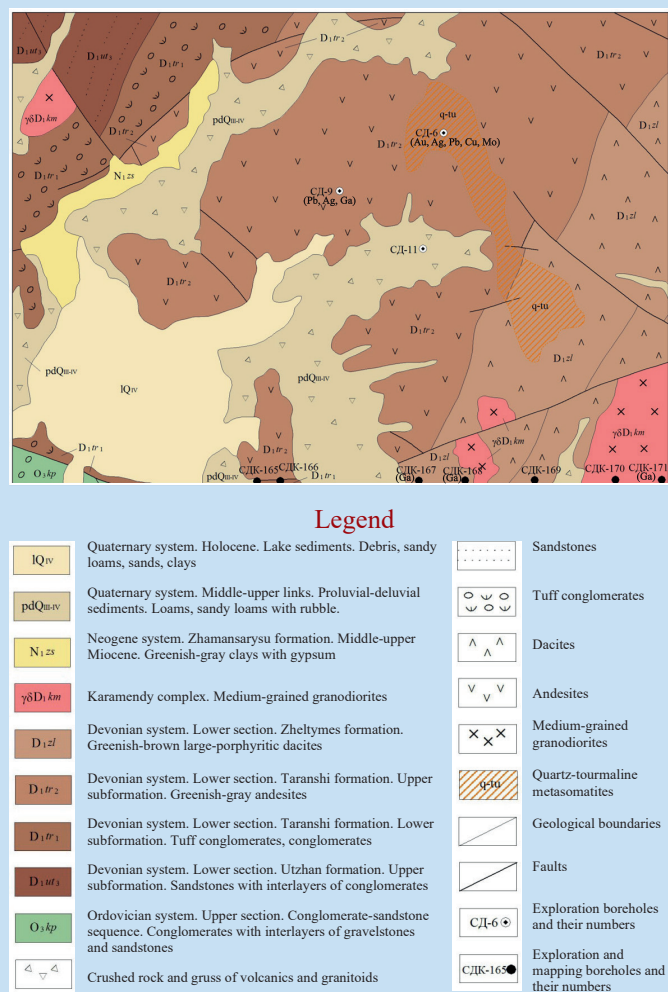


Figure 2. Geological map of the Surdzhar site with minerals.

Сурет 2. «Сұрджар» учакесінің пайдалы қазбалары бар геологиялық картасы.

Рис. 2. Геологическая карта участка «Сурджар» с полезными ископаемыми.

When drilling those wells, sections of the Cenozoic deposits and the Upper Viscean substage of the Lower Carboniferous were opened. They are represented by loams, clays, as well as siltstones, sandstones, argillites and limestones with calcite veins and rare pyrite mineralization. In brownish-brown clays (well SD-7), the increased gallium content of 0.01% was noted. This is shown on the geological map of the Shektas site (Figure 1).

The locations of seven exploration and mapping wells (SDK-165, SDK-166, SDK-167, SDK-168, SDK-169, SDK-170, SDK-171) and three exploration wells (SD-6, SD-9, SD-11) in the Surdzhar area were selected at points where, as a result of ground electrical exploration work performed using the IPEVS method, polarizability anomalies with the intensity of 1-2% were observed.

According to the results of laboratory studies of samples taken from wells SDK-166, SDK-169, SDK-170, SD-11, elevated contents of useful elements were not revealed. According to the results of quantitative analysis of samples taken from prospecting and mapping well SDK-167, in beresitoid-type metasomatites on medium-composition tuffs of the Zheltymes

Formation of the Lower Devonian, the gallium content reaches values of 0.005-0.006%; in well SDK-168, in clays of the Zhamansarysu formation (*N_{1,23}*), the gallium content reaches is 0.006%; in metasomatites on medium-composition tuffs of the Zheltymes Formation of the Lower Devonian (*D_{1.zf}*), the gallium content reaches values of 0.005-0.007%; In borehole SDK-171, in the clayey-rubble weathering crust on hornfels, the gallium content reaches – 0.006%; in hornfels on volcanics of the Zheltymes Formation of the Lower Devonian, the gallium content reaches values of 0.005-0.007%.

According to the results of laboratory studies in the SD-6 exploration borehole, increased gold contents were found in the volcanic rocks of the Taranshi Formation and in the metasomatites on them. Silver mineralization is observed practically along the entire borehole. In addition, isolated intervals with the increased lead content of up to 0.15%, copper up to 0.26%, and molybdenum up to 0.02% are noted in the borehole.

According to the results of semi-quantitative spectral analysis of samples taken from borehole SD-9, elevated lead and silver content was revealed in rhyolite (rhyodacites) tuffs. In some intervals along the borehole, elevated gallium contents were noted in volcanics up to 0.007-0.008%. This is shown on the geological map of the Surdzhar site (Figure 2).

Gallium mineralization was noted in metasomatites on the Lower Devonian volcanics (4 mineralization points); in clayey-rubble weathering crust on Lower Devonian volcanics and granitoids of the Karamendy complex (2 mineralization points); in sandy-clayey sediments of the Paleogene-Neogene age (8 mineralization points).

As a result of deep geochemical prospecting, buried halos of rare earth metals (the sum of *Ce, La* and *Y*), gallium, lithium and mercury were revealed. Mineralization of rare earth metals has been noted in the clayey-gravelly weathering crust of sedimentary deposits of the Beleuta Formation of the Lower-Middle Carboniferous, the Zhidelisai Formation of the Lower Permian, and marls of the Kengir Formation of the Lower-Upper Permian (4 mineralization points); in sandy-clayey deposits of the Paleogene-Neogene age (8 mineralization points) [10].

Conclusions

Detailed geological and geophysical studies were carried out at the Shektas and Surdzhar sites.

According to the results of semi-quantitative spectral analysis in two exploration wells SD-7 and SD-8 at the Shektas site, no increased contents of ore elements were detected. As a result of the complex of geological and geophysical works carried out at the Shektas site, it can be concluded that it is unpromising.

At the Surdzhar site (well SD-9), an increased content of lead and silver was detected in the rhyolite (rhyodacites) tuffs of the Upper Taranshi subformation of the Lower Devonian. During the testing of electric field anomalies by drilling operations at the Surdzhar site, gold-silver mineralization (Surdzhar ore occurrence) was discovered and its resources were estimated according to the *P₃* category, using the results of geophysical work by the charge method carried out in the well. According to the results of prospecting and mapping drilling, 14 points of gallium mineralization and 12 points of rare earth metals (according to the sum of *Ce, La* and *Y*), gallium, lithium and mercury were identified.

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