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Statistical metallogenic assessment of Gold Mineralization of Kuldzhuktau Mountains (Uzbekistan)

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***Abstract**: This article provides a substantiation of the prospects of the Kuldzhuktau mountain range for precious, rare and other metals with the allocation of promising areas for setting up advanced specialized prospecting works.*

To fulfil the intended purpose, the following tasks were solved: the statistical regularities of the placement of objects of noble, rare and other metals were studied using modern computer geographic information systems, as well as modelling the conditions of formation and regularities of mineralization localization; and in order for quantitative factors identification of localization and forecasting of ore objects, the modules of the computer system were used and promising areas for gold, tungsten, mercury and complex rare earth mineralization were identified with the metallogenic potential assessment.

***Key words**: rare and rare earths, structural-formational, -lithological zone, the Katarmay complex, gold, mercury, graphite, nickel, copper, beresitization, listvenitization, graphitization, pegmatites, greisens.*

Introduction

Modelling of the conditions for formation and localization of industrial mineralization assumes the presence of well-studied objects in Kuldzhuktau. These include the Taushan, Yangikazgan gold objects and the detailed study of the Adilsay ore occurrence with satellites. The study of rare and rare-earth metals is associated with the study of magmatic formations developed in the study area.

Description of the geological development of the region is based on prepared electronic maps - ore load, structural-formational, structural-lithological, geological, topographic, geochemical, and geophysical and others, included in the base of cartographic information, compiled catalogs of the Kuldzhuktau ore minerals.

Metallogenic features of the Kuldzhuktau Mountains. According to the mineragenic zoning of the Pre-Mesozoic formations of Uzbekistan, I.M.Golovanov (2000), R.Kh.Mirkamalova and others (2010), the territory of the Kuldzhuktau Mountains belongs to the Katarmay mineragenic complex of the continental slope with specialization in the gold-sulfide-quartz type of mineralization [1, 2].

Volcanism manifested here with increased potassium content, rare metal content and rare earth content of granitoids, with the presence of alkaline rock massifs and its general metallogenic appearance reflect the block structure of the area and the progressive geological development.

The ore content of the Kuldzhuktau Mountains differs from other parts of the Central Kyzyl Kum with the presence of nickel-graphite occurrences. At the same time, mercury and antimony mineralization are known here.

According to the compiled catalog of endogenous ore objects in the Kuldzhuktau Mountains, 310 ore objects have been identified, including in the rank of deposits, in the rank of ore occurrences and ore points. Diagrams №1 and №2 show the metallogenic potential of the Kuldzhuktau Mountains.

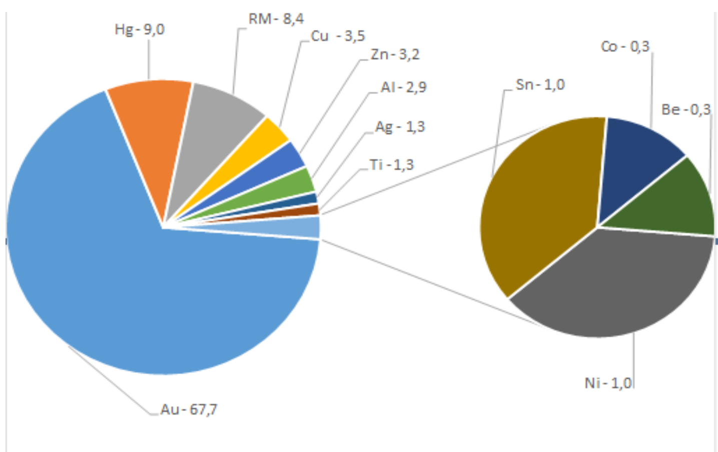

Diagram No. 1 of distribution of ore objects in the Kuldzhuktau Mountains, in % by metals

The Tozbulak block is the most eroded in comparison with the others, and the central part of the Taushan block is more eroded than the Beltau block. As a result of data analysis on the areal distribution of basic rocks (hyperbasites and granites), Kh.R.Rakhmatullaev (1992) found that the former are exposed in the Beltau and Taushan blocks, and the latter are in Tozbulak [4]. In the Beltau and Taushan blocks, only the apical parts of the granitoids are exposed. From this, it can be assumed that magmatites of the Upper Permian porphyrite-dike complex are also located, as well as ore formations genetically or paragenetically related to the above-mentioned plutonic formations. Alkaline rocks of the nephelinesyenite-granite complex are occurred only within the Tozbulak geostructural block, but signs of fenitization of granitoids are also found in the remaining blocks. This indicates the presence of rocks of this complex in deep horizons.

The presence of only individual fragments of the Devonian and Carboniferous sediments also indicates that the Tazbulak block is more eroded and elevated.

Below is the systematics of the ore content of the Kuljuktau Mountains for endogenous minerals (Table 1), obtained as a result of the analysis of the ore load map and the catalog of endogenous minerals of the Kuldzhuktau Mountains.

Gold. 87% of gold ore occurrences, including 2, the Taushan and Yangikazgan deposits, are confined to terrigenous deposits of the Taushan suite (C_2) in the sphere of influence of sublatitudinal and northeastern disturbances. The ore-hosting is the deposits of the Taushan and partly the Kamysta formations, porphyritic and microdiorite dikes of the Late Permian complex.

Gold mineralization is concentrated in quartz veins of the stockwork type, associated with silver, antimony, arsenic, and tungsten. Quartz veins contain dissemination of pyrite, arsenopyrite and chalcopyrite. In siliceous-sericite schists, the maximum gold content is confined to silicified and tourmalinized varieties. In addition to gold, antimony, copper, arsenic, vanadium, lead, zinc, boron, molybdenum, cadmium, and chromium are present in high concentrations.

The ores are low-sulphide. Wallrock alteration is beresitization, listvenization and graphitization. The dikes are transformed into carbonate - quartz-sericite into an aggregate with dissemination of pyrite, graphite, arsenopyrite and chalcopyrite.

In general, the host rocks of the Taushan formation are characterized by increased gold content.

Rocks in disturbance zones are intensely silicified, graphitized, pyritized, limonitized. Small stocks of graphitized, albitized granites and diorite porphyry dikes are indicated. Mineralization is accompanied by vein silicification, graphitization, sericitization, dissemination of pyrite, chalcopyrite, arsenopyrite, wolframite, and scheelite.

Ore mineralization is confined to areas of intense crushing, silicification of carbonaceous-sericite shales, siliceous volcanic rocks, granitoids, as well as breccias, which are traced along the tectonic contact of terrigenous deposits of the Middle Carboniferous with limestones of the Lower Devonian. Elevated gold concentrations are noted in the areas of connection, intersection of differently oriented tectonic zones, as well as in the zone of contact of volcanic sedimentary rocks with graphitized, albitized granitoids.

According to the results of assay analysis, in volcanic sedimentary rocks near the contact with garnitoids, the silver content prevails over gold, and in brecciated zones, crushed, silicified carbonaceous-sericite shales, gold significantly predominates over silver. Other elements found in silicified, graphitized, brecciated shales include arsenic, antimony, lead, yttrium, zirconium, zinc, cadmium, phosphorus, tungsten, and niobium.

Mercury. The main mass of gold and cinnabar (mercury ore) formations is located in the Taushan block area. According to their mineral and chemical compositions, these manifestations belong to the antimonite and polysulfide-gold facies, as well as to the upper arsenopyrite-gold facies according to H.R.Rakhmatullaev [4].

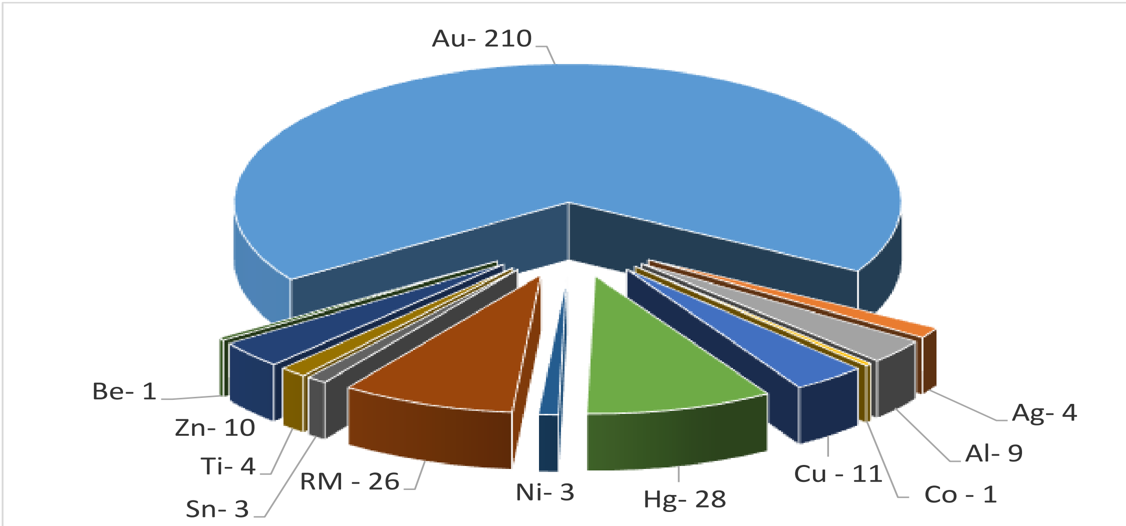

Diagram No. 2 of distribution of the number of various metals ore objects in the Kuldzhuktau Mountains (the total number of objects is 310).

Mercury, located in the eastern and western ends of the Kuldzhuktau Mountains, is found among the Lower Devonian Silurian carbonate deposits and belongs to the crosscutting and partially screened types according to Yu.V.Finkelstein and others. [6]. Mineralization of cinnabar is noted in places of increased fracturing of rocks near disturbances, as well as directly in the zones of crushing of small steeply dipping faults, their junctions and intersections [5]. Cinnabar forms veins, phenocrysts and smears everywhere.

V.P.Fedorchuk (1968) in his works notes that “genetically, mercury-antimony deposits can be subdivided into three groups: 1. proper hydrothermal; 2. typically telethermal; 3. subvolcanic or recent volcanic activity” [7]. Thus, “the overwhelming part of the mercury-antimony deposits of the Tien Shan belongs to the telethermal group, the source of ore matter for which was deep-seated foci [8].

Sources of mercury about sedimentary formation was put forward [9] for the South Ferghana mercury-antimony belt. The formation of mercury and other deposits by sedimentary means is not excluded at all. However, the facts contradict this (in relation to mercury manifestations Altyaul ore field Zirabulak-Ziyatdin mountains.). It is assumed that mercury occurrences of the Altyaul ore fields brought-in from the magma source [10].

The occurrences of graphite-nickel-cobalt formation are located in the area of the Beltau block and, to a lesser extent, in the Taushansky block. It is genetically and spacely related to the basite-ultrabasite complex. In the Tozbulak block, graphite is poorly developed and is spacely confined to the basite formation of the granitoid complex and zones of development of post-magmatism.

The results of the analysis by R. Akhundzhanov and other, petrochemistry of the ultrabasite-basite massifs of Western Uzbekistan give the right to conclude that the magmatic meltings of the ultrabasite-basite intrusions of the Kuldzhuktau Mountains have a separate origin of magma source and distinctive ore content from other such massifs of Western Uzbekistan [11].

The ore is variously graphitized gabbroids consisting of graphite and variable amounts of kaolin, chlorite, and serpentine.

Graphite deposits are found in the Kuldzhuktau Mountains at the contact of gabbroid intrusions with carbonate rocks. Industrial graphite is confined to the contact parts of a fibered gabbroid intrusion with host carbonate rocks and is occasionally observed inside it and forms interstratal bodies.

The Tazkazgan graphite deposits are found in the Kuldzhuktau Mountains at the contact of gabbroid intrusions with carbonate rocks. Industrial graphite is confined to the contact parts of a fibered gabbroid intrusion with host carbonate rocks and is occasionally observed inside it and forms interstratal bodies.

With the Kuldzhuktay penetration rock of the peridotite-norite-gabbro formation, belonging to the belt of basite-ultrabasite rocks of the zone. The Taskazgan graphite-nickel-cobalt deposit is associated with the intrusive of the gabbro-norite formation. Uncovered disseminated pyrrhotite-chalcopyrite-pentlandite ores with a thickness of about 20 m with a nickel content of 0.3-1.5% [12, 13].

Graphite origin is debatable, R.A.Khamidov notes “graphite mineralization within the territory of the republic is distributed very unevenly. The largest number of occurrences (more than 70%) falls on the Kuldzhuktau, Karatyubinsk, Bukantau, Auminzatau and other mineragenic regions and distinguishes magmatic, contact-metasomatic, metamorphic and sedimentary-metamorphic genetic types” [14]. The first two genetic types are usually closely related and, according to the author, the carbonaceous rocks were transformed into shales during metamorphism, and the same shales were repeatedly (pulse-coupled) subjected to high pressure and temperature, while the remains in the carbonaceous rocks of fauna, flora and other elements completely burned out, forming graphite.

Thus, the metallogenic features of the Kuldzhuktau Mountains depend on the specific character of magmatism and the ore content of its individual parts of the block structure.

The Beltau (western) massif is the most stable; here subplatform mafic rocks and ultrabasites by which the Beltau fibered massif is composed, is widely developed. Ore occurrences of mercury, gold (with nickel and copper), rare earths (in carbonatite-like formations), lead and zinc (in fault zones of carbonate rock mass) are known within the block.

In the Tozbulak (central) block, graphite and nickel objects are associated with gabbroids, rare-metal pegmatites, greisens - with granitoids; the occurrences of gold and base metals tend to fault zones in carbonate and terrigenous formations.

In the Taushan (eastern) block the occurrences of gold, mercury, graphite, copper, tungsten and bismuth are developed.

The described geological and metallogenic differences between the identified blocks are one of the important criteria for substantiating of promising areas for some minerals and contribute to the choice of the direction of prospecting and exploration works.

Table 1

ORE CONTENT OF THE KULDZHUKTAU MOUNTAINS

(Compiled by S.T.Maripova, O.T.Razikov, taking into accounts the data of I.Kh.Khamrabaev, B.Ya.Aisanova, Kh.R.Rakhmatullaev, etc.)

Ore Formation; metal	Geological position	Related elements	Distribution area
Cinnabar (mercury); mercury	In carbonate veins and veinlets, in limestones (S_2) and the Lower Carboniferous, in quartz veins in shists. The strike is submeridional, northeastern, sublatitudinal; Wallrock alteration: carbonatization, dolomitization and silicification, weak sulfidization in the screening siliceous rock; Minerals: calcite, quartz, dolomite, cinnabar, metacino-barite (?), Antimonite (rarely).	Au, Sb, As, Mo, Cr, V, Ni, Se	It is developed in the eastern and northeastern part of the Mountains
Antimonite-gold-quartz (medium sulfide); Sb, Ag, Au.	In quartz veins among dolomite limestones of the Silurian and Devonian, less often in carbonaceous-graphite shales of Carbon and Ordovician; Wallrock alteration: silicification, dolomitization, and graphitization. Minerals: quartz, antimonite, pyrite, gold, fahl ores (?).	Pb, Zn, Cu, Se	It is developed in the eastern part of the Mountains
Gold-listvenite-quartz; gold	In granites (Tozbulak and Taushan intrusions), limestones of the Lower Devonian and sandy-shale deposits (Taushan formation). The strike of the veins: sublatitudinal in the eastern part of the mountains; the strike of the veins is meridional and submeridional in the central and eastern parts of the mountains.	As, Ag, Sb, W, Cu, Pb	In the central and eastern part of the mountains
Gold-scheelite; gold, tungsten	In quartz veins and veinlets, at the contact between dolomites and gabbro (Beltau intrusion); The strike of the veins: meridional and submeridional.	Sn	It is developed in the western and central parts of the mountains
Tantalum-niobate; Ta, Nb, Zr and rare earths	In fenitized, greisenized granites; Minerals - tantalum niobates.		In central part of the mountains
Rare earth and rare metal - pegmatite accessory Li,	In pegmatites, skarns at the contact of granites with limestones of the Lower Devonian; Pegmatites: biotite-microcline, muscovite-microcline, microcline-	Ta, Nb	In the eastern and less often in the central

rubidium, cesium, lanthanum; Sn, Mo, Be, Ga, Y, Yb	albite and albite; Minerals: cassiterite, wolframite.		part of the mountains
Graphite - nickel-cobalt	At the contact of gabbroid with Silurian limestones, in garnet-pyroxene-wollastonite skarns; Minerals: graphite-bravoite, nickel pyrite, vialorite, geredorfite, waesite, pentlandite, pyrrhotite, chalcopyrite, etc.	Pt, Pd, Rd, Au и др.	In the western part of the mountains

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