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PECULIARITIES OF GOLD MINERALIZATION IN THE DEVONIAN CARBONATES OF THE ALMALYK ORE DISTRICT (BY THE EXAMPLE OF THE KARATAGATINSKY AREA)

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Abstract

The expansion of the mineral resource potential of the Republic of Uzbekistan is a problem of high relevance, the conceptual solution of which is largely associated with the discovery of new, unconventional types of ore deposits.

Despite a significant share of the increase in gold reserves, which fall on large and unique deposits, an increase in gold reserves in the Almalyk ore region with a developed infrastructure of the mining industry is possible due to the discovery of small, compact deposits for small-volume production with an open pit mining in terrigenous-carbonate deposits.

Keywords: gold, sedimentary and volcanogenic rocks, structural floor, mineralization, native gold, skarning.

Introduction

Almalyk ore region is the most important region of non-ferrous metallurgy in Uzbekistan. There are stockwork copper-molybdenum, as well as polymetallic, gold and other deposits.

New, non-traditional for Uzbekistan types of gold ore (lower structural stage), also known in the western United States, in Russia and other regions of the world, are represented by ores of hard-to-diagnose disseminated gold in terrigenous-carbonate deposits.

It is known that with the use of modern technologies from such ores (Nevada, USA) over the past decades, gold has been mined with a grade of 0.8-1.0 g/t, the cost of 1 gram of which is significantly lower than the corresponding average world costs. The geological and economic attractiveness of this type of deposits lies in the considerable cheapness of their industrial development: easy dressing, suitability for open mining, manufacturability, from which gold is extracted up to 65-68%.

The Almalyk ore district is located on the northern slope of the Kuraminsky Range. In the scheme of tectonic zoning of Central Asia, developed by Nalivkin D.A. and Popov V.I. The Kuraminsky mountains are part of the Kuraminsky subzone of the middle zone of the Tien Shan, which is characterized by an extremely complex geological structure. Sedimentary, volcanic and intrusive formations are developed. The latter are the most widely represented.

Methods

Sedimentary and volcanic rocks that make up the Almalyk region are subdivided into three structural levels. In each of them, structural tiers are distinguished, separated by breaks.

II (middle) structural floor - D_2 - C_3

The rocks of this structural stage are widely developed in the central part of the Almalyk region and are divided into two structural stages: lower and upper.

The lower structural stage - O-S - D_1 is represented by metamorphic and effusive-igneous rocks.

The lower structural stage - D_2 - C_1 is represented by sandy-carbonate deposits, the preserved area in the form of isolated massifs-remnants of a once single stratum lying on the eroded surface of the Lower Devonian effusives.

Devonian system - D_2 - D_3. Stratigraphically, the Devonian deposits are divided into three stages: Givetian, Frasnian, Famennian.

The Givetian stage- (D_2gv) is represented by two horizons: Arkozovo - conglomerate - (D_2gv_1); Sandy-conglomerate horizon - (D_2 gv_2). The thickness of the sandy-carbonate horizon is 230m. The Frasnian stage - (D_3 fr) is represented in the area by three horizons: calcareous-marly - D_3fr_1; massive dolomites - D_3fr_2; ribbon dolomites - D_3fr_3. Its thickness reaches 510 m.

The Famenskaya rhythmic sequence (RT) is divided into the Karatagata (Lower-Upper Devonian) and Kulata (Upper Famennian) rhythmic formations.

The Karatagata rhythmic suite (D_3 fm kr) represents the beginning of a new major rhythm in the sedimentation of the region. The Nizhnekaratagata rhythmic suite (lower famen) ($D_3fm_1kr_1$) is composed of thin interbedding of light gray, dark gray, sometimes pelitic dolomites, green mudstones with sandstone interlayers with rare anhydrite interlayers. The thickness of the rhythm subsuite is up to 110 m. The Verkhnekaratagata rhythmic suite (D_3fm_2 kr_2) is represented by dark gray, black dolomites with fine and fine-grained, thick-layered and massive, less often medium-layered structure, with the smell of hydrogen sulfide and with rare siliceous nodules. In the section of rocks in the Karatagata area and on the left bank of the Karakiyasay, in separate layers, an accumulation of stromatoporoid fauna, small corals, and thin-walled brachiopods is noted. The lower horizon is characterized by elevated contents of gold, lead and zinc. The thickness of the rhythmic subformation is up to 84 m

The Kulata Rhythm Formation (D_3fmkl) is subdivided into the Lower Kulata and Upper Kulata Rhythm Subformations.

Lower Kulata rhythmic subformation ($D_3fm_2kl_1$). At the base of this rhythmic suite lie dolomites of light gray, greenish gray color. Above lie sandy and pelitic, thin and sheet-layered rocks with mudstone interlayers 1-10 mm thick, with lenses and lenticular interlayers of sandstones 0,01-0,1 m thick. The thickness of this pack ranges from 10 to 40 m. The Upper Kulata rhythmic subformation ($D_3fm_2kl_2$) is an alternation of greenish-gray, dark gray, black dolomites, up to 10-20 m thick. At the end of rhythm packs, black and dark gray dolomites with the highest contents of gold, lead, and zinc are common. The thickness of the Kul'atinskaya rhythmic suite is up to 552 m. The thickness of the Devonian sedimentary formations in the section of the Karatagatinsky area is 850 m.

Lower Carboniferous - C_1 According to lithological features, fauna and microfauna, the Lower Carboniferous deposits are divided into two stages: Tournaisian and Visean.

The Tournaisian Stage (C_1t) is composed of the Tournaisian Stage in the lower section of gray and light gray massive limestones with crinoid segments, and the upper part of the section is represented by thinly bedded limestones with siliceous nodules and interlayers. The thickness of the Tournaisian stage is assumed to be 250 m. The Visean stage - (C_1v) is represented by dark gray massive limestones with siliceous nodules. From Tournaisian limestones, these rocks are separated very indistinctly - by an increase in the content of siliceous inclusions in limestones. Here its thickness does not exceed 130 m.

Results and Discussion

Features of localization of gold and polymetallic mineralization of the Karatagatinsky area. Gold-bearing skarn polymetallic and copper-porphyry formations, composed of terrigenous-carbonate rocks, as well as at contact with them, bearing the main polymetallic, copper mineralization, in turn, had a number of ore-localizing properties. K.K.Shamgunov believes that carbonate rocks are, firstly,

intensively enriched in organic material, which creates favorable physical and chemical conditions for the precipitation of sulfides; secondly, carbonate rocks are composed of the most granular, and hence more porous varieties of dolomites, in which cell partitions are composed of organic matter and near clarke contents of chalcophile elements were catalysts for the precipitation of sulfides.

Thus, it becomes obvious that the concentration of polymetallic ores in the area involved lead compounds dispersed in carbonates, possibly gold, and to a large extent the material brought under the influence of igneous rocks. Depending on the geological development of the area, and the territorial distribution of polymetallic, copper and other mineralization, after the completion of the carbonate sedimentation cycle, the area experienced the impact of the strongest magmatic activity, manifested in the introduction of intrusions and outpouring of effusions. During this period, sedimentary rocks underwent processes of all-round skarning, later, as magmatic activity subsided, the redistribution of ore material continued, and gold-bearing polymetallic and gold-bearing porphyry copper formations probably formed.

As a result of mineralogical, lithological-stratigraphic and geological-structural studies, gold occurrences in terrigenous-carbonate rocks of the Karatagatinsky area are confined to certain stratified horizons. Gold occurrences are widely developed in the form of quartz veins consistent with layering, secant veinlets, and zones of metasomatic alteration in interformational (contact) and intraformational zones. Structural and lithological control manifested itself in their distribution. Structural control is expressed in the confinement of the bulk of manifestations to faults of sublatitudinal and submeridial strike, to the base of Upper Paleozoic volcanic rocks. Lithological control - all subconformities are associated with lenses of calcareous quartz sandstones, dolomites and mudstones. Taking into account the stratiform nature of the gold occurrences of the Almalyk ore region, the main factor in the prediction and search for such objects, regardless of the points of view on the genesis of these deposits, should be considered the lithological and stratigraphic control of mineralization, its confinement to certain formations and facies. Several exploratory and mapping wells were drilled in the Karatagatinsky area, in addition, ditches and pits were drilled, which completely or partially crossed the carbonate strata. Gold concentrations were found in ditches, pits and mapping wells; they are associated with terrigenous-carbonate formations, with manifestations of polymetallic, pyrite mineralization, with zones of crushing, silicification, silicification, hematization, recrystallization of carbonates.

The intensity of near-ore metasomatism is manifested from insignificant to intense within and between deposits, ore formations, which indicates the predominance of lithological control of mineralization. In some areas, the primary lithological composition has been altered by silicification, dolomitization, argillitization, and sulfidization. Silicification is more pronounced and is directly related to gold, thus, the maximum number of recorded concentrations tends to the Karatagata and Kulata rhythmic suites, dolomites, to areas of intercalation of greenish-gray, black, thinly and medium-layered dolomites and to altered limestones.

Morphotypes of gold ore bodies and their distribution. Carbonate rocks D3 of the Karatagatinsky ore field are represented by three suites - Almalyk, Karatagatinsky and Kulatinskaya, the deposits of which are developed as on the day surface, the ore bodies are represented by three main morphotypes - intraformation, interformation (contact) and secant.

When surveying the carbonate deposits of the Karatagatinsky ore field, the subject of their gold content was involved in data from more than 200 wells and about 5 ore occurrences and ore points. The gold content of individual suites, morphotypes and ore-formation types (geological - industrial types) was calculated from the total "reduced" productivity. The sum of productivity for a particular type was divided by the total capacity. The result was an average productivity per 1 m of power.

The composition and zoning of ore bodies of different morphotypes differ significantly. The intraformational type is characterized by partial or almost complete silicified carbonate rocks with the formation of a quartzite-like rock with a significant admixture of primary carbonate minerals. This aggregate is broken by a network of microcracks, along which later veinlets of columnar medium-grained quartz (with an admixture of newly formed carbonate) and proper carbonate veinlets develop.

The newly formed carbonate differs from the primary one by the absence of impurities and ferruginization, which is typical for rock-forming carbonate minerals. The present ore minerals, as a rule, gravitate towards the selvage parts of veinlets of quartz and quartz-carbonate composition, less often carbonate. The entire mass of silicified rock is weakly sericitized. Ores of interformational type are represented by zones of microquartzites broken by microcracks filled with medium- and coarse-grained columnar quartz. The ore mineral segregations gravitate to the veinlets of the newly formed columnar quartz, sometimes up to 5% of fine-grained acicular, almost transparent tourmaline is noted in their selvages.

The thicknesses of bodies of interformation type vary from 1–2 to 15–20 m in bulges. When approaching the contact, the number of veinlets increases and a continuous calcitization zone is formed in the direct contact, composed of pure white newly formed calcite. At the contact with effusives, the latter show strong ferrugination (up to 20%), crushing and mylonitization of rocks, intense sericitization (up to 25%), which gradually fade away at a distance of 5–20 m from the contact (depending on the thickness of the quartzite zone).

This morphotype has an asymmetric zonality due to the heterogeneity of host rocks (carbonate rocks in the footwall of the zones and effusive rocks of intermediate composition in the hanging wall of the metasomatite zones).

The thickness of metasomatite zones of this morphotype does not exceed 3-7 m. Their zoning is generally similar to the contact type.

Mineralogical features of gold occurrences. In order to study the peculiarities of the placement of gold mineralization and the allocation of areas of increased gold content, the material composition of ores was studied. The main ore and vein minerals of paragenetic mineral associations are described according to poor low-sulfide manifestations: Karasai, the studied gold-bearing carbonate rocks belong to the poor-sulfide gold-quartz-carbonate ore-formation type and are characterized by a relatively simple composition of ore minerals, mainly iron, copper, less often lead, zinc and products of their modification. Minerals-concentrators of gold are quartz, pyrite, carbonates, goethite, sericite. Productive paragenetic associations for gold are: pyrite - arsenopyrite with gold, low content of antimony and arsenic sulfides and almost complete absence of mercury.

Native gold is found quite often in the studied ore occurrences. These are single and frequent signs, 0,01-0,2 mm in size in polished sections and 0,5-1 mm in elongation in cut samples. According to the classification of N.V. Petrovskaya and A.I. Fostolovich, such gold belongs to the class of very fine and fine (gold size is from 0,05 to 0,005 mm). The shape of the grains in the cut is often close to isometric, in the volume, mainly dendritic, thin-lamellar with serrated edges, lump-shaped aggregates are characteristic. The color of gold is rich yellow. Three varieties of gold have been identified at the Gray Rock site: 1) gold containing an admixture of silver 10,69-15,49% and arsenic 0,04-0,45% has a fineness of 840-860 ppm, 2) high-grade gold (990 ppm lei) with an admixture of silver 0,07-0,46% and arsenic 0,06-0,22%, 3) high-grade gold (980-990 ppm) with an admixture of silver 0,13-0,56% and antimony 0,10-0,27%.

Conclusions

1. The location of gold mineralization is controlled by large regional faults, the localization of ore bodies is confined to cleavage faults; gold mineralization in the deposits is concentrated in hydrothermally altered (to a quartzite-like appearance) carbonate rocks in silicification zones and in overlying volcanic rocks.
2. For terrigenous-carbonate deposits of the Upper Devonian and Lower Carboniferous in the Almalyk ore region, an increased gold content is characteristic. Gold concentrations are confined to stagnant facies zones enriched in organic matter. A characteristic feature of the distribution of primary gold and mineralization in terrigenous-carbonate rocks is its finely dispersed organometallic character. Organic matter is a precipitator of gold and other elements.

3. Gold has the characteristics referred to as microscopic gold "or invisible finely dispersed".
4. Visually in the field it is difficult to identify areas favorable for the localization of gold mineralization without sampling. Gold in carbonate deposits is finely dispersed.

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