

FEATURES OF THE COMPOSITION OF MINERALS AND THE STRUCTURE OF CERTAIN FACIES OF NEAR-ORE METASOMATITES

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ABSTRACT

The Republic of Uzbekistan has a large complex of ore minerals, including various types of metals, widely used in all sectors of the national economy. The Zarmitan gold field includes the Guzhumsay, Promezhutochnoye and Charmitan deposits, known under the common name of Zarmitan.

Keywords: *Gold Ore, Pluton, Kvarz, Gold, Deposit, Intrusive, Syenite, Suite, Phase, Metasomatite*

INTRODUCTION

The Charmitan deposit is located on the southern slopes of the central part of the Northern Nuratau ridge, confined to the southeastern exo- and endocontact part of the Koshrabad multiphase intrusive massif (C₂m) on the southern wing of the North Nuratau anticlinorium. The ore-bearing rocks at the deposit are the volcanogenic-terrigenous formations of the Dzhazbulak suite of the early Silurian and the granitoid (granosyenite) rocks of the Koshrabad pluton.

The Jazbulak suite is composed of clay shales, siltstones, sandstones with lenses of limestone, tuff sandstones, tuff siltstones and interstratal sill-like bodies of diabase porphyrites and gabbro-diabases. The deposits of the suite are crumpled into isoclinal folds of west-northwest strike and have undergone regional (sericite-chlorite stage of greenschist facies) metamorphism and thermal impact of the intruded Koshrabad intrusion. Endogenous gold deposits of Uzbekistan are divided into five geological and industrial types. Of these, three are gold-quartz, gold-sulfide-quartz and gold-sulfide. The geological and structural position of the ore bodies at the deposit is characterized by their confinement to shear faults of west-northwest strike with a steep northern dip.

Industrial ore bodies are divided into three types by morphology: vein (strongly predominate); linear stockworks (ore bodies 10 and 10a); plate-like mineralized deposits belong to the actual gold types. The other two – gold-silver and gold-copper-porphyry – belong to gold-complex geological-industrial types of deposits (described in silver and copper deposits, respectively). The first – gold-quartz – type includes the Murantau, Charmitan, Pirmirab, Guzaksay deposits. The second – gold-sulfide-quartz – includes Kyzylalmasai, Kochbulak, Kauldy, Marjanbulak, Sarmich, Adzhibugut. The third – gold-sulfide – includes Kokpatas, Daugyztau, Amantaytau. The gold placer type belongs to exogenous deposits.

MATERIALS AND METHODS

At the Murantau, Kokpatas, Charmitan, Kochbulak, Kyzylalmasai, Chadak and other deposits, the issues of geology and material composition of ores, wallrock metasomatites, morphology of ore bodies, mineralization distribution patterns were studied in detail, ore-controlling factors were established, variants of volumetric geological and geophysical models were developed, which gave an output for a detailed mineralization forecast with its operational verification. Practical implementation of the results of scientific and thematic studies was expressed in the involvement of promising areas in the geological

exploration process. Integration of efforts made it possible to significantly increase the prospects in the Karatau gold-bearing zone of the Charmitan ore field.

The Zarmitan ore field is located on the southern slope of the Nuratau ridge, in the Kyzylkum-Nurata gold-bearing province of the South Tien Shan Hercynian folded belt (Fig. 1). The Zarmitan gold field includes the Gujumsay, Promezhutochnoye and Charmitan deposits, collectively known as Zarmitan. The total reserves of Zarmitan are more than 400 tons of gold with an average grade of 9.8 g / t.

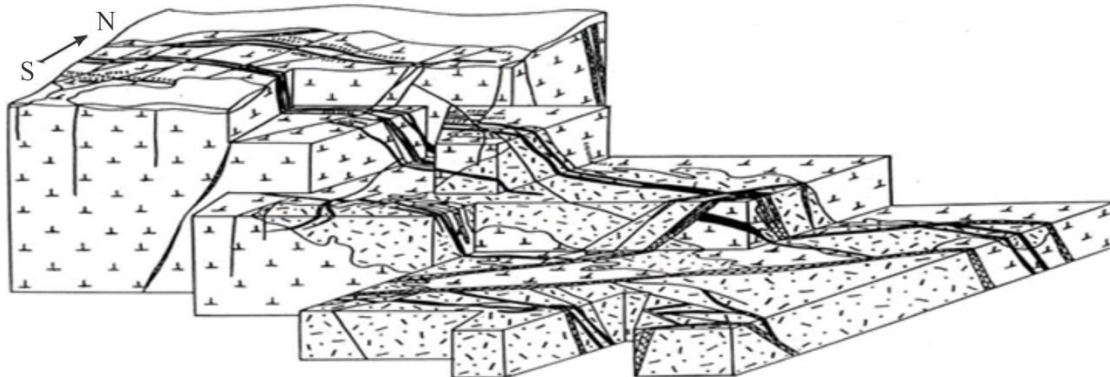


Fig. 1. Charmitan deposit. Block diagram

The main ore-bearing unit for these deposits is the multiphase Koshrabad intrusion with an area of 196 km², which has a wedge shape, elongated in the sublatitudinal direction. The most studied deposits are Zarmitan (Charmitan, Gujumsay), which was considered as "gold-quartz", "gold-tungsten" or as located in an intrusion. The deposit is considered a large world-class object.

The deposits are located in the southern endocontact of the Koshrabad granitoid intrusion and partly in the sandy-shale deposits of the Dzhazbulak suite (S1). Intrusive rocks are classified as biotite-amphibole granosyenites or mafic and quartz monzonites and granites with a rapakivi structure. The age of the intrusion (U-Pb) and the age of mineralization by pyrite (Os-Re) are 283-286 million years. Ore bodies form vein systems, linear stockworks, and plate-like mineralized deposits. Samples of gold-quartz ores. Andalusite schists, hornfels, marmorization, and skarnification are developed in the exocontact of the intrusion. The wallrock alterations are represented by feldspar-quartz metasomatites.

The ores of the Charmitan deposit are divided by composition into poor, low and moderate sulphide. In the endocontact of the intrusion, poor and low sulphide varieties predominate, in the exocontact – low and sometimes moderate sulphide varieties. The degree of sulphide increases in the eastern direction.

The ores are localized in the form of stockwork and stockwork-vein bodies, in which the vein components gravitate towards the upper parts of ore zones or individual tiers, while stockwork bodies are more typical of the lower levels of ore zones.

The mineralogy of the Charmitan ore field was studied by R.P. Badalova, E.B. Bertman, N.S. Bortnikov, A.I. Glotov, E.I. Gromova, N.V. Kotov, V.A. Horvat, G.M. Chebotarev, T.E. Eshimov, S.M. Koloskova, V.D. Soy, I.V. Koroleva, M.A. Kim, T. Graupner, R. Seltmann and others.

SYSTEM ANALYSIS

The position of the Charmitan ore field in the structure of the region is due to the transverse bending of the layered Lower Paleozoic strata, possibly under the influence of the Zirabulak-Koshrabad hidden deep fault of submeridional orientation. The Kosrabad granitoid massif is confined to the bend, in the

southeastern endo- and exocontact of which, along with the Guzhumsai and Promezhutochnoye (Urtalik) deposits, the Charmitan deposit is located (Fig. 2).

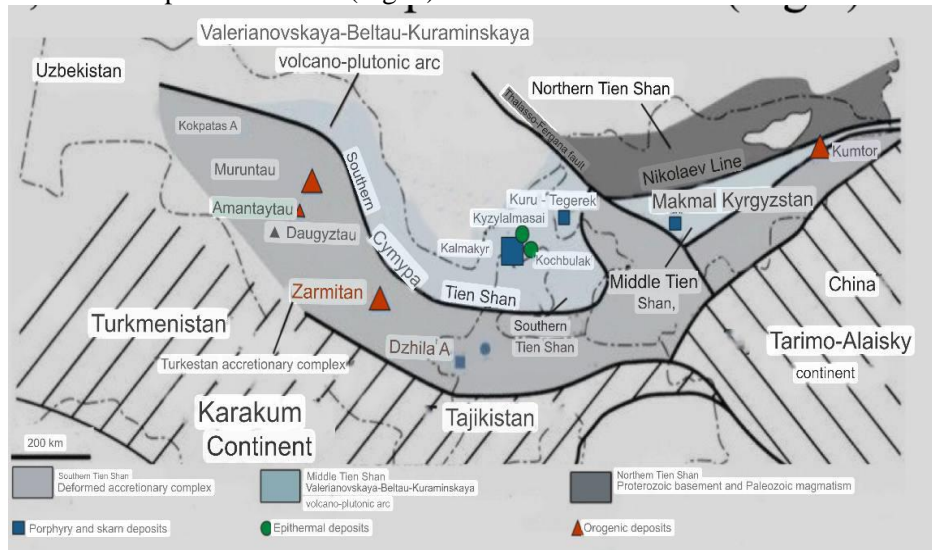


Fig. 2. Geodynamic settings and key gold deposits in Tien Shan

The ore-bearing rocks at the deposit are volcanogenic-terrigenous formations of the Dzhazbulak suite of the Early Silurian and the granitoid (granosyenites) rocks of the Kosrabad Late Silurian pluton.

The Dzhazbulak suite is composed of clay shales, siltstones, sandstones with lenses of limestones, tuff sandstones, tuff siltstones and interstratal sill-like bodies of diabase porphyrites and gabbro-diabases. The sediments of the suite are folded into isoclinal folds of west-northwest strike and have undergone regional (sericite-chlorite facies of the greenschist formation) metamorphism and thermal action of the intruded Kosrabad intrusion.

In the exocontact zone, regionally metamorphosed sedimentary rocks are subject to contact thermal andalusite and cordierite, which are replaced by muscovite and sericite with distance from the contact. Siltstones with carbonate cement are transformed into calcareous-quartz hornfelses with actinolite.

Within the exocontact in sedimentary-volcanogenic rocks of the Dzhazbulak suite metasomatic processes are manifested, formed as a result of hydrothermal processing. The appearance of such minerals as albite, microcline, tourmaline, sericite, early chlorite, quartz, expressed by the processes of sericitization, albitization, microclinization, beresitization, silicification and chloritization can be associated with metasomatism.

The process of beresitization-listvenitization is most clearly manifested along the contact of the intrusive massif and in hornfelses. Intensively transformed under the influence of hydrothermal solutions, enriched with CO₂ rocks are distinguished by yellowish and apple-green colors, complete loss of primary structural and textural features. Listvenites consist of Mg and Fe carbonates, to a lesser extent Ca (most often ankerite), quartz and chlorite.

Listvenites contain various minerals as impurities: talc, actinolite, albite, microcline, tourmaline, rutile, sphene, pyrite, arsenopyrite, hematite. Iron hydroxides appear due to the decomposition of sulfides and carbonates, giving listvenites brown hues. Morphologically, beresites and listvenites are characterized by a complex shape, to a certain extent subordinated to fault tectonics and rock contacts.

The process of listvenitization is a typical vein-like change. It develops along cracks, tectonic zones, shear zones, and also along dike contacts. The thickness of listvenitization zones at the Charmitan deposit does not exceed 0.5-1.0 m.

Chlorites are present as products of alteration of higher-temperature Mg-Fe silicates in the listvenitized hornfelses of the Charmitan deposit. They form pseudomorphoses on biotite, sometimes develop on sericite, and also fill veins in quartz or are scattered in the main mass of the metamorphic rock and transformed into hornfelses of various, mainly biotite-feldspar composition, nodular and spotted andalusite schists.

The thickness of the contact metamorphic aureole reaches 2 km. As can be seen from the diagram, the lowest iron content is found in chlorites from the apophyses of the Koshrabat intrusion. The formation of these chlorites is associated with regional metamorphism of granosyenites (Fig. 3).

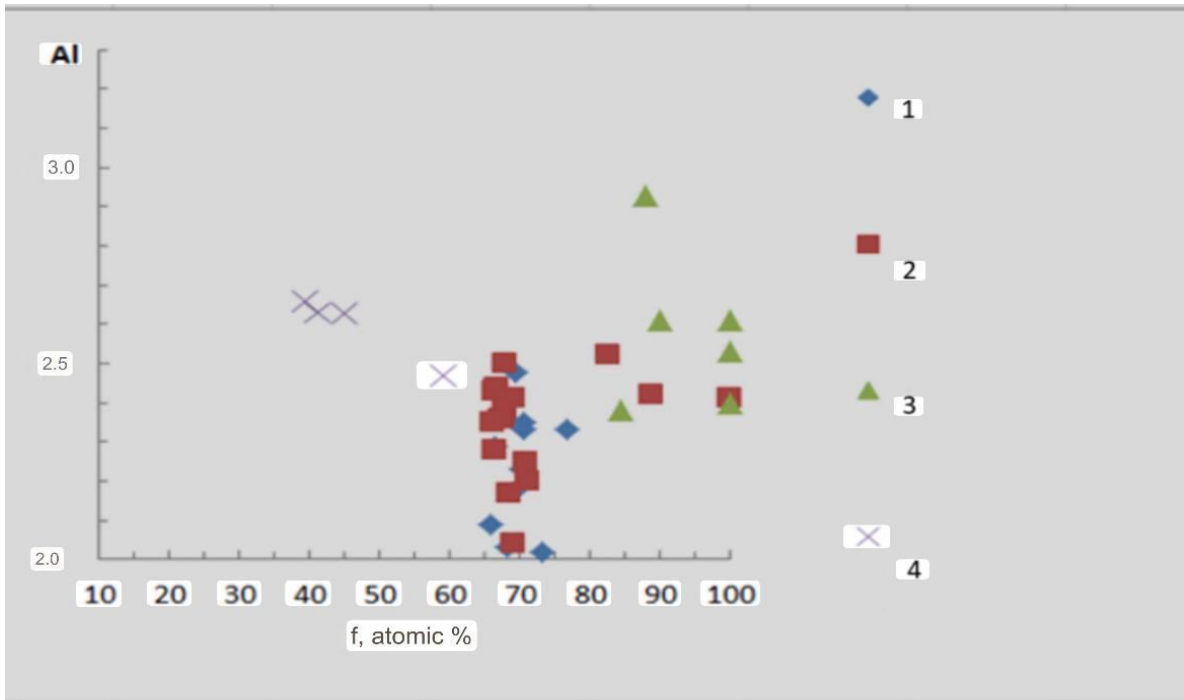


Fig. 3. Composition of chlorites of the Charmitan deposit. Granitized cornea, 2- Epidotized albitized granosyenite, 3- Keratinized clay shale, 4- Fine-grained granosyenite from the apophysis.

The mineral associations of hornfels at the studied deposit are determined by the composition of the original rocks. Hornfels consisting of quartz, plagioclase, biotite, muscovite, and chlorite develop along sandy-shale varieties. In the case of prevalence of clay material, hornfels contain a significant admixture of aluminous minerals.

RESULTS AND DISCUSSION

Chlorites are a group of widespread minerals - hydrous meta-aluminosilicates of Mg and Fe with a layered mica-like crystalline structure. The general formula is $(\text{Mg}, \text{Fe})_3[(\text{Al}, \text{Si})_4\text{O}_{10}(\text{OH})_2] \cdot 3(\text{Mg}, \text{Fe})(\text{OH})_2$.

Mg can be partially or completely replaced by Fe^{3+} or Fe^{2+} . According to the ratio of Fe^{3+} and Fe^{2+} orthochlorites (non-oxidized; contain less than 4% Fe_2O_3) and lepto-chlorites (rich in Fe_2O_3) are distinguished. Orthochlorites are a large group of minerals that differ in total iron content, i.e. the $\text{Fe}/(\text{Fe}+\text{Mg})$ ratio in octahedral layers and the Si/Al ratio in tetrahedrons. According to iron content, all chlorites are divided into magnesian (up to 25%), magnesian-ferrous (25-75%) and ferrous (over 75%).

Chlorites are characterized by a mica-like appearance of crystals (plate, tabular, barrel-shaped), perfect cleavage in one direction (along the basis), low hardness (1.5-2.5). Chlorite leaflets, unlike micas, are flexible but not elastic. Chlorites of the Charmitan deposit often form spherulites, rosettes, scaly and earthy aggregates, pseudomorphoses after various rock-forming minerals. The color of chlorites is usually green of various shades. Luster is glassy, on cleavage planes - up to pearly; sometimes dull.

The earliest products of pre-ore secondary processes at the Charmitan deposit are represented by propylites. The leading mineral is chlorite. Ore mineralization is represented by numerous veins and veinlets, which are superimposed on propylitized granosyenites and volcanogenic-sedimentary formations.

They, in turn, are accompanied by halos of vein wallrock alterations with the formation of chlorite in association with quartz, albite and calcite. Thus, chlorite is a typomorphic mineral of both pre-ore and syn-ore stages.

This work characterizes some features of the distribution of chlorite varieties in metasomatites and an attempt to assess the physicochemical conditions of the formation of chlorites of the Charmitan deposit by their chemical compositions.

CONCLUSION

Chlorites were studied by classical methods of petrography and microprobe analysis at the Institute of Geology and Mineralogy of the Academy of Sciences of the Republic of Uzbekistan.

The structural formulas of chlorites are calculated based on the following:

1. The number of OH groups in chlorites is constant and equal to 8; the deficiency of OH is caused by the presence of micaceous layers, the excess is caused by the presence of adsorption water or iron hydroxides, as a result of which the calculation of chlorite formulas is made based on 18 constant oxygens.
2. Ti in chlorites is mainly caused by impurities, especially since with an increase in the amount of TiO₂ there is always clear mineralogical evidence of the presence of impurities. Therefore, analyzes containing TiO₂ are included in further consideration, but TiO₂ is not taken into account.
3. Ca and alkalis are not included in the structure of chlorites, since there is no room in the structure for such large cations as Na, K and Ca. These elements are in the form of impurities. Therefore, CaO, Na₂O and K₂O, included in the analyzes, are not included in the calculation of formulas.
4. S is excluded together with half the molecular amount of FeO.

The points of chlorite compositions are shown in Fig. 3. The alumina content varies from 1.98 to 2.93 units in the crystallochemical formula, the iron content – from 39 to 100 atomic. %. Considering the easy extraction of rare earths from carbonates, this may be of independent industrial interest. The high demand and high price of rare earth elements on the world market make it possible to consider the possibility of extracting ytterbium as a by-product of gold ore bodies of the Charmitan ore field.

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