Gold-Silver Natural Alloy of Chromitites from the Kamenushinsky Massif (The Middle Urals)

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Abstract. A detailed study of the chromitites clinopyroxenite Kamenushinsky massif in the middle Urals has allowed to allocate from them the gold-silver alloy. The study of the chemical composition, morphology of gold-silver alloys, peculiarities of their placement allowed not only to determine their genetic relationship with platinum-bearing chromites, but also to make an assumption about the formation of chromitites as a result of a single geological process.

Keywords: Urals Platinum Belt · Kamenushinskiy massif · Chromite-platinum mineralization · Gold

1 Introduction

The history of the development of platinum placers of the Urals dates back nearly a two centuries and a distinctive feature is the permanent presence of gold and its natural alloys along with the extraction of the platinum groups minerals (hereafter - PGM) (Vysotsky 1913). It is known that the main source of the PGM is a process of a zonal massifs erosion of the Ural-Alyaskan type. Nevertheless, the question of a primary source of gold in placers is remained as a controversial issue. Thus, for example, in research works of N. Vysotsky (Vysotsky 1913) was given a support of the idea that the appearance of gold in platinum placers was due to the weathering of an acid rocks, but its absence in some zonal massifs of the Urals Platinum Belt (hereafter - UPB) keeps the matter in abeyance. In the 70s of the 20th century during setting deposit into exploitation, located within the Kachkanar zonal massif UPB, for the first time gold was determined and described from the bed rock (Fominykh et al. 1970). In spite of this fact, further the question of the nature of the appearance of gold in the ores of the UPB massifs was not under active discussion.

Inside the Nysyamsky platinum placer field – one of the main leaders of the platinum mining of the Urals – also the presence of gold was reported (Vysotsky 1913). The source of the placer formations was Kamenushinsky dunite-clinopyroxenite massif which had a potential for of bed chromite-platinum mineralization (Ivanov 1997; Tolstykh et al. 2011, Minibaev et al. 2015). During the study platinum-bearing chromitites were divided into two petrographic types with characteristic features: vein-imbedded and massive (Minibaev 2018). In addition to study of PGM features from the

chromitites of both petrographic types, the scientific observation of the determined Au-Ag alloys is under a great interest

2 Methods and Approaches

A study of morphology and chemical composition of Au-Ag natural alloys and its bearing chromitites was carried out by the scanning electron microscope Carl Zeiss EVO (OPTEC, Moscow), equipped with attachment: EDS (energy dispersive X-ray spectrometer) and BSD (Backscattered Electron Detector).

3 Results and Discussion

Au-Ag natural alloys was determined as impurities of irregular crystallographic habitus in chromspinelides of vein-imbedded (Fig. 1a) and massive (Fig. 1b) chromitites.

The size of the aggregates is around 4–6 microns. The chemical composition of Au-Ag alloys (Table 1) corresponds to the compositions of similar objects founded in the ore chromspinelides of the Konder massif (Pushkarev et al. 2015).

The similar composition of Au-Ag alloys, its presence directly in chromspinelides, also the absence of traces of visible deformations of the mentioned indicates that its formation does not correspond to the processes of serpentization or overlaid hydrothermal processes (as it was known before), it corresponds to the fact that inclusions were gained into chromspinelides during crystallization. Inclusions such as Cr and Fe in Au-Ag alloys are the evidence of inherited condition of mineralization and chemistry features of the ore-forming system.

Table 1. Chemical composition of Au-Ag alloys from the chromitites of the Kamenushinsky massif (mass. %)

№ point	Au	Ag	Cr	Fe	Sum
1	81,45	10,84	3,84	2,02	98,15
2	81,21	10,47	3,55	1,89	97,12

Notes: 1 - from vein-imbedded chromitites; 2 - from massive chromitites.

Fig. 1. Determination of grains Au-Ag natural alloys in chromitites: a - vein-imbedded; b - massiv

4 Conclusions

The obtained results are correlated with the conclusions about the syngenetic nature of the platinum-bearing vein-imbedded and massive chromitites, where the latter are characterized by a later origin relating to the final stage of evolution of the ore-forming system (Minibaev 2018). Also these results can be used not only to confirm the hypothesis about the common substance source of two petrographic types of chromitites, but also allow to make the conclusion that the formation of chromitites is generally resulted from a single geological process.

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