Research and technological testing of ores with dispersed gold of the Yellow Jacket Deposit

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Abstract. The article discusses the mineral and geochemical features of the yellow Jacket ore Deposit located in Clark County, Nevada. The Deposit differs significantly in many mineral and geochemical features from the deposits of dispersed gold ores belonging to the so-called Karlin formation type in compacted and locally weakly metamorphosed strata of carbonate rocks, mudstones and carbonated shales (carbonated turbidites). Positive results of analyses, including those with a cupellation (gravimetric) termination, were obtained in laboratories using non-standard approaches to sample preparation. Based on the working hypothesis of finding chemically bound dispersed gold in hematite-goethite films on the surface of quartz-chalcedony particles and internal microcracks, it was proposed to use active metastable chlorine-oxygen compounds to break the chemical bonds between iron atoms and clustered dispersed gold atoms and transfer it to a solution. In the liquid phase of the ore pulp with reagents added to it , after its activation treatment, the gold content, depending on its duration and intensity, varied in the range from 1.2 to 30 mg/l(at W:T=1:1).
Keywords: Yellow Jacket Deposit, mineral and geochemical features of ores, ore testing, dispersed, chemically bound gold, assay and atomic absorption analysis, chloride-hypochlorite leaching, preparation of ores for leaching, active leaching solutions, peroxide-carbonate solution, chloride-carbonat solution

1 Introduction

Yellow Jacket is a Deposit of dispersed gold ores and, presumably, platinoids, is located in the southern part of the state of Nevada(Clark County).This Deposit differs significantly in many mineral and geochemical features from the deposits of dispersed gold ores belonging to the so-called Karlin formation type in compacted and locally weakly metamorphosed strata of carbonate rocks, mudstones and carbonated shales (carbonated turbidites).The Deposit is composed exclusively of sedimentary rocks of silicate-alumino-silicate composition (siltstones) locally carbonated and sulfated. Its uniqueness lies in the fact that no visible or encapsulated gold is found in the ores, even with the use of modern electron microscopy tools. Geological exploration of this object was carried out by boreholes, trenches and furrows (on the surface) to a depth of 80 m (the lower part of the ore-bearing layer is not cut by a borehole drilled to a depth of 200 m). The samples were analyzed by assay (with various variants of its termination), atomic absorption and inductively coupled plasma (ICP-MS) methods, as well as cyanide testing, including non-standard testing in several laboratories in

Nevada, Arizona, and Texas. Assay analysis conducted with the standard composition of the flakes-soda, borax, gleta and temperature (time mode of melting 1300°C -1 hour), did not allow to detect noble metals in the samples. Positive result analyses, including those with a cupellation(gravimetric) end, were obtained in laboratories using non-standard approaches to sample preparation. Analysts using non-standard methods, such as treatment of the worn mineral mass with special solutions, stage melting, cyanide technological testing with precipitation of gold from the filtrate with zinc dust in the presence of lead salts, revealed industrial concentrations of gold in the ore– about 5 g/t (0.2 oz per 1 t). At the same time, not only high values of the content of gold and silver, but also platinum and some other platinoids have been established. The most important analytical and geological and technological studies at the field were conducted in 1985. under the guidance of experienced canadian geologist J. T. Burton. After averaging and reduction, the samples of drilling material were divided into 4 parts: two reserve samples, one was passed to the analyst White (Aurum Smelting and Refining) and another one- to A. J. Cristensen. In the first case, the samples were subjected to step-by-step melting (the slags were melted several times) under the assumption that the output of gold in the lead "button" – verkbley is prevented by sulfates of alkaline and alkaline earth metals and most of it remains in the slag. The gold content in this case really increased sharply by step 3-4, after which it significantly decreased. Usually, the order of gold content at step 3-4 was 0.5-0.7 ounces per 1 ton (14-19 g/t). In addition, White used direct electrodeposition of gold, apparently on a lead cathode, obtaining 12 mg of gold from 5 l of cyanide solution (T: W in his report is not specified). A. J.Cristensen used a special solution of reagents, which processed the crushed sample. After drying, the sample was analyzed using the assay method. At the same time, an interesting effect was shown: when the standard sample was crushed to 200 meshs, the gold content in it was 2 times lower than for its duplicate attachments, crushed to 400 meshs.

2 Research materials and methods

For analytical and experimental studies, the authors, together with employees of MGRI (Moscow and the University of Las Vegas, directly at the Deposit from small pits and ditches were selected ore samples. A series of assay analyses of the initial ore samples, conducted by the authors using a non-standard method based on a step-by-step scheme of sample preparation and melting, resulted in a positive result: the gold content after intensive pre-photoelectrochemical oxidation of the ore sample was 5-7.5 g/t (Fig.1).

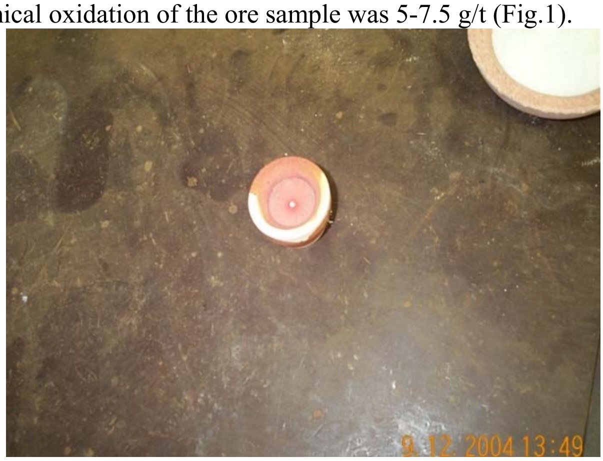

Fig. 1. Photo of a crown in a drop obtained after step-by-step melting of the processed ore and kupelation of the werkbley (lead collector)

Thus, the results of non-standard assay methods confirmed the conclusions of colleagues about the presence of chemically related dispersed forms of gold in the ores of the Deposit. Based on the obtained results and fractional analysis data, we can draw a definite conclusion that the dispersed gold on the "Yellow Jacket" is associated with iron oxide-hydroxide minerals (hematite, goethite, hydrogetite, to a lesser extent, magnetite). To a much lesser extent, dispersed gold is present in aluminum-silicon-magnesium and oxide-hydroxide complexes of clay and mica minerals. Based on the working hypothesis of finding chemically bound dispersed gold in hematite-goethite films on the surface of quartz-chalcedony particles and internal microcracks, proposed in connection with the close mineral-geochemical connection of gold and iron oxide established for this object, it was proposed to use active metastable chlorine-oxygen compounds to destroy the chemical bonds between iron atoms and clustered atoms of dispersed gold and further transfer it to a solution [1,2].

At the first time, a chloride-hypochlorite solution prepared by 2-stage electrochemical treatment of pulps was used for sample processing (the first stage is direct (membrane-free) electrolysis, the second stage is conditioning the pulp with hydrochloric acid and electric discharge).

For technological testing of ores using this method, MGRI developed a special laboratory apparatus for electric pulp processing.

A distinctive feature of the developed device (Fig. 2) was the possibility of implementing two modes of operation: standard electrolysis with the production of an active complex of initial reagents and pulse-plasma (with U-shaped and sawtooth forms of pulses), which provides the formation of local plasma channels in the pulp.

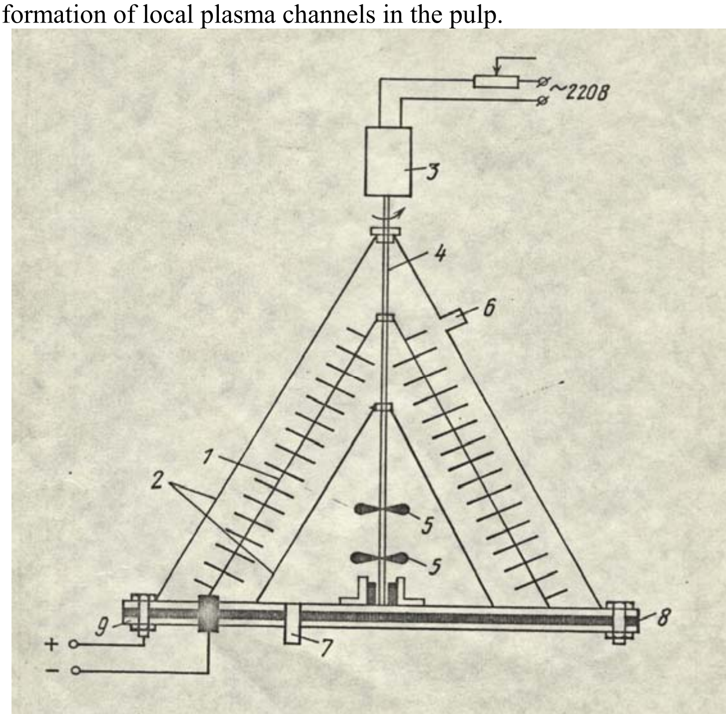

Fig. 2. Diagram of a laboratory installation for technological equipment testing samples

The anode was the inner conical surface of the device, and the cathodes were a system of rods with pointed heads. Thus, after the electrolysis of sodium chloride to hypochlorite producing, a jump-like voltage increase to 220V, spark discharge channels appeared between the cathode heads and the corresponding sections of the anode surface, which was visually noticeable through the viewing window.

3 Results and discussion.

After processing the pulp formed from the charge of two available types of ores in the apparatus, liquid and solid samples were taken, which were analyzed in the TsNIGRI (Moscow). The obtained values of the gold content for solid tailings-leaching cakes of the order of 0.7-0.8 g / t significantly exceeded those for input samples (0.2-0.3 g / t), despite the fact that its output to the liquid phase after activation leaching (according to atomic absorption analysis) it was 2.1-2.5 g / t of ore. It should be particularly noted, that according to the input atomic absorption analysis carried out according to the standard method, the initial gold content was one hundredth of a gram per ton. Even if we do not take into account the data on the liquid phase, it is obvious that the activation treatment of ores provides, at least, a change in the shape of the gold in the matrix or the weakening of interatomic bonds, which allows it to be more fully detected in the analysis process.

The main testing work was then carried out by us directly at the field and in the research laboratory of Advanced Recovery, Cal. USA. After processing the sample, converted to a pulp form and feeding it with sodium chloride and at a certain stage of hydrochloric acid, its solid and liquid phases were analyzed. Samples were sent to 2 independent analytical laboratories: ATLAS assay analysis (source ore and cakes) and D. Bauer atomic absorption analysis (all products). In the first case, gold and silver were not found in either the initial or processed ore (evaporated sample). In the second case, the gold content in the untreated ore was 0.1-0.2 oz per 1 ton (2.8-5.6 g/t), in the processed, under the most intensive conditions – up to 15 g/t. In the liquid phase of the ore pulp with reagents added to it , after its activation treatment, the gold content, depending on the duration and intensity, varied in the range from 1.2 to 30 mg/l(at W:T=1:1).The results of the analysis, on the one hand, confirmed the high industrial potential of the Deposit, on the other – predetermined the need to develop a non-standard technological scheme for processing ores, since the conclusions of American geologists and metallurgists confirmed that a significant part of the gold remained in the slag during melting and in the mineral matrix during leaching. The methods of preparing samples with photoelectroactivated solutions and conducting assay and assay-atomic adsorption analyses tested on the ores of the yellow Jacket Deposit allow us to recommend them for evaluating the gold content of the mineralized mineral mass of similar objects. Altynsay (Uzbekistan, Navoi villoyat), as well as numerous so-called "yellow sections" in the Russian Federation, can be attributed to the analogs of this Deposit in terms of the General geological situation, the material composition of ores and, most importantly, the form of finding gold. The term "yellow sections" was proposed by Siberian geologists (Shelkovnikov et al.) in the mid-70s of the 20th century, in connection with the establishment of the gold content of fine alluvial deposits with an increased content of clays and the presence of limonite, which gives them a yellowish hue. Such sedimentary rocks have a significant thickness (sometimes more than 100 m) and an area of distribution (tens of square kilometers), lie in the valleys formed in the Mesozoic-Cenozoic. Such valleys, in particular, are located in the Bauntovsky ore-placer district of Buryatia, Darasunsky ore-placer district in the North-Eastern part of the TRANS-Baikal territory. Experts who have studied these objects suggest that gold in such deposits is not only in the form of small (up to the submicron level) free particles, but also mineral-sorbed clay complexes. We can also assume that in such formations, gold is present in the form of dispersed inclusions in quartz, chalcedony, limonite particles, as well as in minerals of concentrates. At the same time, the main condition for the industrial development of these unusual gold-containing formations is the development of effective technologies for extracting precious metals. In our opinion, such a technology can be considered in the article activation chloride-hypochlorite leaching, including in heap and/or cuvette implementation options.

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