



Comparative Gold Department Study on Direct Leaching and Hybrid Process Tails of Oxide Ores from Mayskoye Au Deposit (Chukotka, Russia)

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Abstract. Mayskoye gold deposit is located in Chukotka, Russia. Ore bodies are mineralized brecciation zones composed of vein-quartz, argillic altered rocks (siltstone and carbonaceous silts) with fine disseminated and veinlet gold-bearing arsenopyrite and pyrite. Two main technological types of ores were distinguished at the deposit: primary and oxide. The main reserves were represented by primary ores, which are classified as refractory. Oxide ore had a quartz-micaceous composition with minor feldspars, kaolinite and sulfides. Beside native visible and colloidal gold, other main carriers of gold in oxide ore are arsenopyrite, pyrite, minerals of scorodite group and stibnite. Tested oxide ore sample showed low recoveries, according to the existing flow sheet in the CIL plant. Cyanidation tests showed some preg-robbing effect on organic matter. Flotation of carbonaceous matter with consecutive leaching of flotation tails proved to have better recoveries than direct leaching by reducing preg-robbing on carbon three times.

Keywords: Refractory gold · Preg-robbing · Invisible gold · Surface contamination

1 Introduction

Mayskoye Au deposit is located in Chaunsky region in Chukotka, Russia. The ore was formed by quartz-pyrite-arsenopyrite shear opening veins in terrigenous sequence of carbonaceous siltstone and sandy-siltstones. Ore bearing sequence altered to micaceous-carbonate-albite rocks (of beresite formation). Thus, the ore had quartz-micaceous composition with minor feldspars and sulphide material. Major part of gold was refractory and concentrated in arsenopyrite and partially pyrite. Thus primary ores are treated with flotation recovering around 90% of gold with sulfide concentrate, which was shipped to Amursky POX plant for oxidation and cyanide tank leaching.

Part of the carbonaceous matter is preg-robbing gold. Upper part of the deposit contains oxide ore, which mostly was not refractory and free leaching. The carbon in pulp plant treats oxide ore during the warm season.

The studied oxidized ore sample had low gold recovery in CIL plant, thus directed to gold department analysis and lab test work. The sample mineral composition was quartz-micaceous with minor kaolinite and secondary minerals scorodite, jarosite, tripuhyite and others. Natural coal content was 1,4%. Sulfides were represented by pyrite, marcasite, arsenopyrite and stibnite. Oxidized ore appeared to be partially refractory. Most of the refractory gold was represented by “invisible” gold. It was contained both in the native form, and was dispersed in liberated ore minerals: pyrite, arsenopyrite, stibnite and scorodite, and their binaries with gangue. The form of occurrence of gold in the ore and its connection with mineral carrier was important to determine effective methods for metal extraction. Such study in plant products was necessary to chase the issue and find optimization in reagent scheme or the flow-sheet.

2 Samples and Methods of Study

Two samples of initial oxidized ores from 1st and 2nd ore zones of Mayskoe gold deposit and four plant products: direct cyanidation tails, flotation tails and combined leach tails of flotation tails leaching product. The examination methodology included the following stages: classification of samples into narrow size classes, separation of material in heavy liquids with density of 2,90 g/cm³ and 2,5 g/cm³. Gold concentrate was panned from the heavy concentrate. The following separation products were obtained: gold gravity concentrate, heavy concentrate, rock-forming lights and carbonaceous fraction. Bulk mineral composition of the initial size classes and lights was studied by powder X-ray phase analysis using the Rietveld refinement. The mineral composition of the gold concentrates and heavy concentrates were studied by optical microscopy and the mineral identification of the carbonaceous fraction was done with stereo microscope.

Gold content in the products was analyzed by fire assays; arsenic, antimony and other elements by XRF in all products, except for gold concentrates. In the gold tips, the quantitative finding of gold was carried out by optical and electron microscopy.

Chemical composition of minerals-carrier of gold and other ore minerals was studied with SEM-EDX.

3 Results and Discussion

Quartz and phyllosilicates (muscovite, illite, smectite, kaolinite, dickite) were the main minerals in the samples; scorodite, jarosite, sulfides and other minerals were accessories. The main minerals-carrier of gold are represented by arsenopyrite, pyrite, marcasite and stibnite, oxidized forms of arsenic - scorodite, and antimony - tripuhyite, stibiconite, cervantite and valentinite. Native carbon content in the ore was 0,1–1,4%.

Visible native gold in samples had high fineness (902–914‰). The distribution pattern of visible native gold particles in ore zone 1 and 2 were slightly different. 70% of the visible native gold from head sample from the first ore zone was larger than 90 μm. 65% of the visible native gold from the second ore zone head sample was coarser than 70 μm. All visible gold particles in the cyanidation tails of first ore zone

were less than 45 μm . Gold particles coarser than 45 μm dominated in cyanidation tails of the sample from the second ore zone. Native gold observed in the samples of direct leach tails were found in free particles with the surface shielded or in binaries with oxidized antimony forms. Rarely binaries of gold with pyrite, stibnite and gangue minerals were observed. Fineness of visible gold in cyanidation tails was 10–15% lower than in initial products with higher silver content. Besides natural gold the metal was in dispersed form in the mineral-carriers: pyrite, arsenopyrite, stibnite, scorodite, antimony oxidized forms and bound with carbon (Fig. 1).

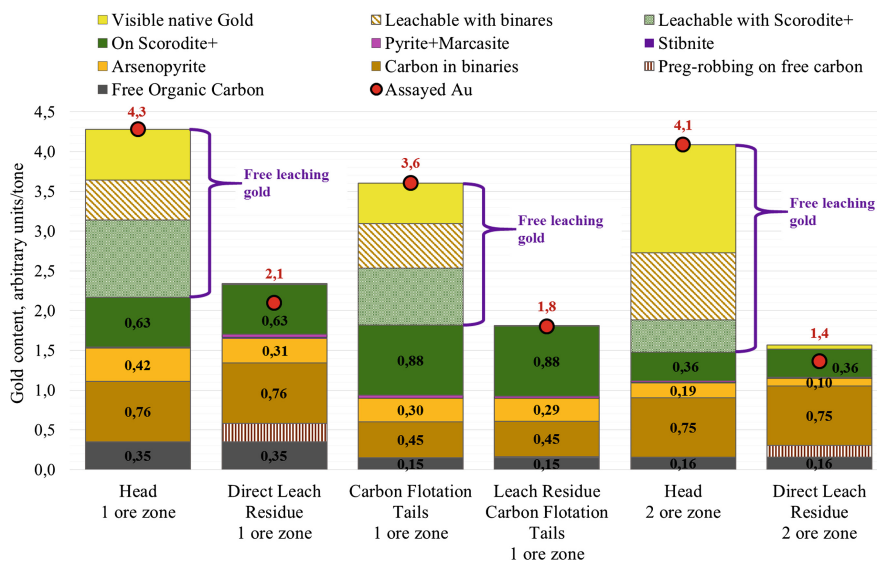


Fig. 1. Gold department in the plant feed, direct leach tailings, flotation tails and flotation tails leach residues of oxidized ores from 1st and 2nd ore zones of Mayskoe gold deposit

Free leaching gold accounted for 49% in head sample from the first ore zone and 64% in head sample from the second ore zone. The rest of the gold was on carbon (about 22–26%), in sulfides (about 5–10%) and scorodite (about 9–15%). Visible gold extraction by direct cyanidation was in range of 96–99% and gold from scorodite only 53–61%. The losses of visible gold in leaching occurred due to the blocking of the surface with compounds of oxidized antimony, as well as the slower cyanidation of gold with lower fineness. Coal flotation reduced gold losses by 22%.

4 Conclusions

Gold in the head samples was represented by both visible high-grade gold, most of which was a of gravity size and invisible/colloidal gold (<0,5 micron), forming more than half of the metal of the original ore. Lower grade gold particles leached slower.

The oxide ore of zones 1 and 2 of Mayskoye deposit was partially refractory, since most of the gold was invisible and dispersed in arsenopyrite, scorodite and with carbon.

The main gold losses during cyanidation were associated with invisible gold enclosed in sulfides, scorodite and organic carbon.

Based on gold deportment results obtained, the following suggestions were made:

1. Introduction of gravity in the grinding cycle would help reduce the loss of coarse gold and extract some of the refractory gold with large particles of arsenopyrite and stibnite. Increase in recovery can vary as coarse gold content and be as much as 2–5%.
2. Addition of lead nitrate in cyanidation process may increase the dissolution of low-grade gold particles.
3. Flotation of carbon with consecutive tails leaching proved to have better recoveries than direct leaching. Partial coal removing reduced preg-robbing on carbon for three times and reduced gold losses by 22% from zone 1 ore.
4. The most effective objective to recovery would be liberation of minerals-carriers of gold (mainly scorodite and arsenopyrite) from binaries with rock forming minerals.
5. Leaching of gold from scorodite can be enhanced by NaOH pretreatment with recovery increase of 10–15% for ore zone 1 and lesser effect for ore zone 2.

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