DEVELOPMENT OF AN INTEGRATED TECHNOLOGY FOR RECOVERY OF PRECIOUS AND PLATINUM GROUP METALS FROM OFF-BALANCE OXIDIZED COPPER ORES

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Uzbekistan's copper industry expansion is a pressing issue in the mining and metallurgical sector. NMMC and AMMC focus on producing copper, zinc, lead, selenium, tellurium, gold, silver, and other valuable metals from waste materials while improving metallurgical technologies through research. Expanding the raw material base, particularly through studying out-of-balance sulfide and oxidized copper ores of the Kalmakkir Mine and Yoshlik-I Mine, will support copper production growth and the development of new technologies for complex metal extraction [1].

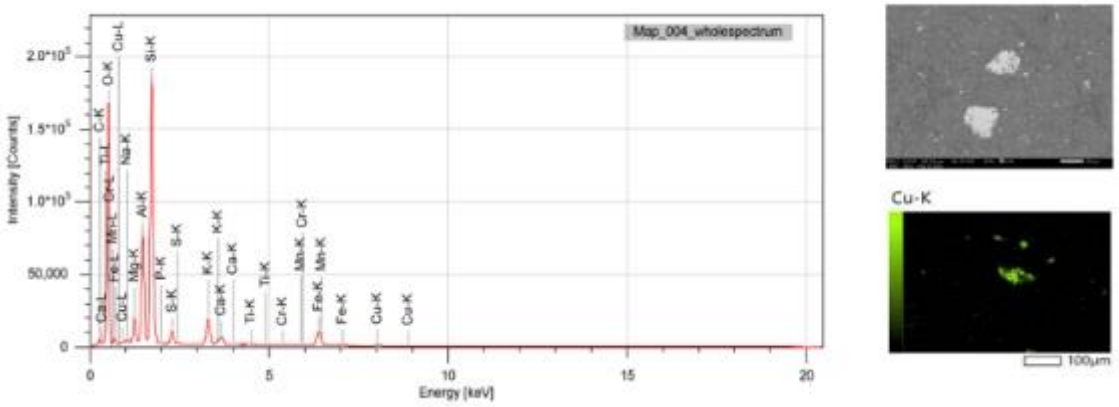
The research focused on sulfide and oxidized off-balance copper ores of AMMC, particularly from the Kalmakkir Mine. Their chemical and material composition was analyzed using X-ray fluorescence and mass spectrometric methods, including the NEX CGI RIGA analyzer . Results showed that dumps a-7 and a-8 contain 7 million tons of ore with 0.424% copper, 74.5 g/t gold, and 31.6 g/t silver, totaling 1.77 t gold and 132.2 t silver . Other oxidized ore dumps (No. 39, 9, 10, 8, a-4) contain 63.8 million tons of ore with 31.1 t gold and 144.5 t silver, confirming their significant resource potential.

Table 1. Kalmakkir the average amount of waste that have been in metal mining.

№	Metals	The total amount of metals in ore okside, t	The total amount of metals from sulfide ore, t	The total amount, t
1	Au (gold)	to 31.1	31,6	62,7
2	Ag (silver)	144,5	132,2	276,7
3	Se (selenium)	74	86,42	160,42
4	Pt (platinum)	143,55	167,625	311,175
5	Pd (Palladium)	194,59	227,225	421,815
6	Re (Rhenium)	16,97	19,817	36,787
7	Os (Osmium)	4,568	5,3342	9,9022
8	In (Indium)	0,1276	0,149	0,2766
9	Ru (Ruthenium)	1,0846	1,2665	2,3511

The study improved methods for separating precious metals from waste by analyzing their chemical composition. Energy-dispersive spectroscopy (EDS) and chemical analysis identified the main components across sample surfaces. Copper particles were mostly about 10 microns in size and mainly associated with sulfides [5]. The samples

were characterized by copper, iron sulfide minerals, and a high quartz content (4.0×10^5 intensity peak). Spectrum 005 analysis showed 0.15% copper with oxygen-bound inclusions of iron sulfide, quartz, alumina, and calcite. Samples from site 10 also contained an average of 0.15% copper, with copper mineral sizes averaging 100 microns, confirming the potential for metal recovery.



Picture 1. Results of the analysis of the 10 division sample of the off-balance oxide ore of the Kalmokkir mine.

From Figure 1, it can be seen that copper also occurs in oxidized ores, with the peak of Cu equal to the peak of O_2. The mineralogical composition and the results of experiments show that the out-of-balance ores of the A8 site are sulphide, but the results of flotation beneficiation and beneficiation analysis showed a low concentration of copper and precious metals (gold, silver, platinum and palladium), and such flotation beneficiation was carried out by AKMK JSC It was found that it does not meet the requirements of MEZ. Gravity beneficiation tests on ore samples from A4 and 9 dumps showed high recovery results for precious metals such as gold, silver, platinum, and palladium, but low copper recovery. Therefore, ore from the A7 dump was further tested, with the concentrate additionally analyzed for selenium and tellurium. The remaining oxidized ore residues were selectively smelted with sulfide off-balance ores to produce copper, confirming the effectiveness of this комплекс processing approach.

After gravity enrichment of off-balance oxidized copper ores (A4, A7, and 9), a concentrate rich in precious metals is obtained: gold 28–46 g/t, silver 52–58 g/t, platinum 80–96 g/t, and palladium 100–170 g/t. The processing technology involves calcining the concentrate at 350–400°C, sulfuric acid washing, and two-stage selective leaching: silver and palladium are removed with nitric acid, while platinum and gold are dissolved using arginine solution. Using optimized precipitation reagents, the developed process produces 99.9% pure precious metals with over 90% recovery.

Reference:

1. Vokhidov B.R., Khasanov A.S. Researching the technology of extracting platinum and palladium from man-made wastes of the copper industry // Tashkent 2021. December 6. 2021 p.56-68.

2. B..R. Vokhidov New horizons processing of technogenic waste of the copper industry // (№23 The American Journal of Applied sciences) // Volume 04 issue 05 Pages: 42-51. SJIF Impact factor (2021: 5. 634) (2022: 6. 176).