COMPREHENSIVE STUDY OF THE MATERIAL COMPOSITION AND DISTRIBUTION FORMS OF PRECIOUS METALS IN THE TAILINGS OF HMP-1

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As a result of mineral resource processing, more than 25 billion tons of technogenic waste are generated annually worldwide, of which over 10 billion tons originate from the mining and metallurgical industry. A significant portion of these wastes is formed during mineral beneficiation and hydrometallurgical processing, where the extraction of valuable components remains incomplete, resulting in the retention of precious metals in tailings. More than 70% of such wastes are accumulated in tailings storage facilities, which represent complex technogenic objects exerting considerable environmental impact. At present, intensive efforts are being directed toward the development of technologies aimed at the more complete recovery of valuable components, implementation of waste-free solutions, utilization of cyanide-containing and solid wastes, as well as the reprocessing of technogenic dumps for the extraction of precious, rare, and non-ferrous metals. The tailings storage facility of Hydrometallurgical Plant No. 1 (HMP-1) is located 5 km east of the plant and consists of seven sections with a total area of 10.2 km². This flat-type facility was commissioned in 1964 for the disposal of uranium ore processing wastes. Its total area is 630 ha. Since 1995, the facility has additionally received tailings from the processing of gold-bearing raw materials and wastes from underground leaching operations, which significantly altered the material composition of the accumulated wastes and increased interest in their secondary processing. Currently, the tailings storage facility is regarded as a potential source of secondary mineral resources.

The sanitary protection zone of the facility extends over 700 m. To investigate the material composition and granulometric characteristics, averaged tailings samples from JSC “NMMC” were examined using scanning electron microscopy (JEOL JSM-IT200). The analysis was conducted under low-vacuum conditions, enabling the study of carbon-containing particles without additional sample preparation. In addition, energy-dispersive spectroscopy (EDS) was employed to determine the elemental composition of the samples, which is essential for evaluating the potential recovery of precious metals.

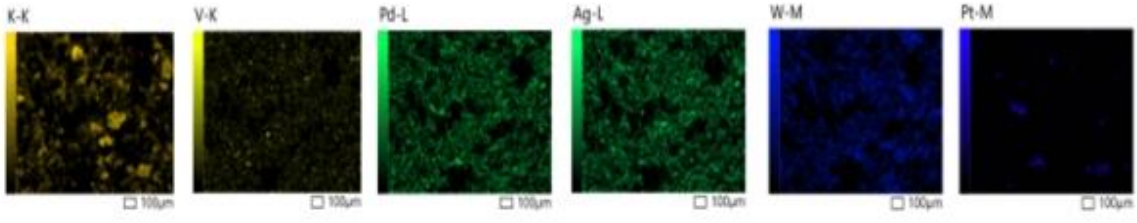


Fig. 1. Results and discussion of electron microscopy scanning of tailings samples from the HMP-1 tailings storage facility

A multi-element surface map of the sample at 150× magnification revealed particles approximately 100 μm in size enriched in silicon and iron. Green-colored areas on the image indicate the presence of palladium, silver, iron, and copper. Palladium in metallic form was found to be associated with silver, and its content in the sample amounted to 0.02%.The occurrence forms of precious metals in the samples were investigated by rational analysis according to the method of V.I. Zelenov (1978). The procedure involved sequential leaching of ground material (90% passing −0.074 mm) with cyanide solutions combined with alternating acidic and alkaline treatments. The stages included primary cyanidation, alkaline treatment of tailings, repeated cyanidation stages, hydrochloric and nitric acid treatments, oxidative roasting followed by leaching of the residue. The obtained results of the rational analysis are presented in Table 1.

Table 1.

Results of Rational Analysis of Samples for Gold and Silver

Forms of occurrence of precious metals and nature of their association with ore minerals	Metal Distribution			
	Au		Ag	
	g/t	%	g/t	%
HMP-1 Tailings				
Native Au and Ag intergrown with other minerals: chlorides, sulfates, and simple silver sulfides (cyanidable)	0,22	37,93	0,09	7,89
Au and Ag associated with minerals and chemical compounds of Sb and As (except arsenopyrite and pentavalent Sb compounds), silver sulfosalts (cyanidable after alkaline treatment)	0,09	15,52	0,16	14,04
Au and Ag associated with acid-soluble minerals, iron and manganese oxides (carbonates, oxides, and hydroxides) (cyanidable after HCl treatment)	0,16	27,59	0,2	17,54
Au and Ag finely disseminated in sulfides (pyrite and arsenopyrite) (cyanidable after HNO_3 treatment)	0,05	8,62	0,19	16,67
Au and Ag associated with carbonaceous matter (cyanidable after oxidative roasting)	0,05	8,62	0,12	10,53
Gold and silver contained in quartz, aluminosilicates, and other acid-insoluble minerals	0,01	1,72	0,38	33,33
Total in the sample	0,58	100	1,14	100

The studies demonstrated that the HMP-1 tailings contain significant amounts of precious metals occurring in various mineral forms. The largest proportion of gold is associated with carbonates and iron-manganese hydroxides (27.59%), whereas silver is predominantly bound to acid-insoluble minerals (33.33%). The obtained results confirm the prospects for involving the tailings in further processing aimed at the additional recovery of gold and silver, thereby creating opportunities for improving the integrated utilization of mineral resources and reducing the technogenic environmental burden.

References:

[1] Zelenov V.I.// Rational methods for the analysis of gold occurrence forms in ores//. – M.: Nedra, 1978. – 184 p.

[2] B.R.Voxidov, M Sh.Babaev // Research chemical technology of processing manmade waste JSC “NMMC” // The International Conference on Energy-Earth-Environment Engineering, 5 December 2023,Tashkent,Uzbekistan. 61-62 p