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COMBINED PROCESSING OF ERDENET ORE-DRESSING PLANT PYRITE CONCENTRATES

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On the basis of studying pyrite concentrate substance composition, obtained at the same time during flotation of copper-porphyry ores of the Erdenetiin Ovoo deposit, the possibility is considered of extracting valuable components from it.

Keywords: *pyrite concentrate, substance composition, processing technology.*

Extraction of nonferrous metals is accompanied by processing a considerable volume ore raw material. For example, in order to produce one ton of copper on average it is necessary to process up to 20 tons of rock mass, whose dumping creates technogenic formations that are main sources of contamination of water bodies, the air basin, and adjacent earth. For the Erdenet Ore-Dressing Plant this index approaches 60 tons, and in future it will increase due to a reduction copper content in ore as the deposit is worked out. In view of this for concentration production an important problem is extraction at the same time of valuable components (in particular precious metals) from pyrite concentrates, obtained in considerable amounts in processing copper-porphyry ores.

The Mongolian and Russian Erdenet Joint Mining and Concentration Enterprise processes in a year on average 26 million tons of sulfide ore of complex mineralogical composition, which contains about 0.420 million tons copper and 3500 tons of molybdenum concentrates. Enrichment tailings (about 25.5 million tons per year) together with pyrite concentrate (0.5–1.5 million tons per year) are accumulated in the combines tailing ponds, creating technogenic formations that are on one hand of significant danger for ecology of the region, and on the other hand a significant raw material resource for extracting precious metals, copper, iron, and other valuable components. Recently laboratory research has been carried out for processing pyrite concentrates by a simplified scheme with the aim of obtaining valuable metals; the first encouraging results have been obtained.

Pyrite concentrate, obtained in the stage of basic selection of pyrite, contains on average 0.35% copper, 39.12% iron, 42.41% sulfur, 3.21% quartzite, 0.42% lead, up to 10 g/ton gold, 24 g/ton silver, and 220 g/ton cobalt (Table 1).

It is well known that in the Erdenetiin Ovoo deposit the pyrite content is on average 3–5%. It is represented mainly in the form of disseminations and veinlets in quartz; vein-like accumulations with thickness up to 30–40 cm are rarely encountered. For the pyrite deposit there is a typical higher concentration of a number of scarce elements: selenium, cobalt, copper, nickel, gold, silver, with the absence of bismuth and mercury. The high content in pyrites of copper, silver, cobalt, may be explained by presence of micro- and submicro-inclusions of natural minerals of these elements. The average chemical composition of the main ore minerals with isomorphous impurities of the Erdenetiin Ovoo deposit are presented in Table 1.

The aim of this work is to determine the possibility of extracting valuable components from pyrite concentrates and select technology for comprehensive processing taking account of the mineralogical and chemical composition.

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TABLE 1. Average Chemical Composition of Main Ore Minerals of the Erdenetiin Ovoo Deposit (according to data of Zh. Baatarkhuu)

Mineral	Content, %						Content, g/ton				
	Cu	Fe	S	Zn	Pb	As	Sb	Au	Ag	Re	Co
Chalcopyrite	35.1	30.1	34.8	0.07	0.63	0.02	353	0.36	55	0.97	87.7
Chalcocite	76.62	1.50	22.0	0.07	0.02	0.15	75	0.1	130	–	–
Covellite	67.51	1.13	31.12	0.05	0.25	0.25	100	0.05	100	–	–
Sphalerite	0.62	0.57	32.6	65.02	0.06	0.01	100	–	1500	–	–
Pyrite	0.11	46.34	63.51	0.03	0.31	0.02	51.7	0.18	28	0.46	230.2

TABLE 2. Regime and Results of Cyanide Leaching of Precious Metals from Pyrite Concentrates

Cyaniding conditions*		Concentration in solution, mg/liter		Content in cake, mg/kg		Extraction, %	
NaCN consumption, kg/kg	C_{NaCN}, g/liter	Au	Ag	Au	Ag	Au	Ag
0.01	3.0	0.04	0.86	1.1	24	87.2	96.3
0.02	3.0	0.03	0.71	0.9	18	86.8	95.5
0.03	3.0	0.01	0.76	0.5	22	87.1	96.1

* L:S = 2:1, duration 72 h.

Samples of pyrite concentrate were studied in the plant central research laboratory and this demonstrated the presence within it (on average) of 80% pyrite, 4.7% chalcopyrite, 1.5% molybdenite, and 9.8% quartz. Pyrite is mainly in the form of disseminations in quartz and chalcopyrite, and rarely encountered veinlet accumulations with a size of up to 0.6 mm. Molybdenite is encountered mainly in association with pyrite and quartz, and is rarely observed in paragenesis with chalcopyrite and forms pocket accumulations, striated deposits, and scattered disseminations.

Gold confined to pyrite is encountered in insignificant amount in native form, but is mainly in the form of tellurides. Cobalt is concentrated in pyrite in the form of an isomorphous admixture and is not encountered in natural minerals.

The chemical composition of a sample of pyrite concentrate (34.8% Fe; 1.66% Cu; 0.78% Mo; 39.6% S) was obtained by averaging the results of current analyses carried out by the plant laboratory at all main points of flotation. Analysis for gold and silver content (10 and 28 g/ton, respectively) in samples was carried in the Solid Physics laboratory of the Mongolian Academy of Sciences.

Tests were carried out by a scheme: firing–leaching–cyaniding–extraction of gold into solution. The concentrate was given oxidation firing with the aim of uncovering dispersed gold and removing sulfur, arsenic, and other volatile impurities. Firing was carried out in a muffle furnace in the temperature range 650–700°C for 6 h. The sinter obtained was ground to fineness class +0.2 mm and subjected to sulfuric acid leaching with aim of transferring copper and other precious metals into solution, and the cake obtained was treated with cyanide. The cyaniding regime and results of three tests are provided in Table 2. It may be concluded from the results obtained that the Erdenet Ore Dressing Plant pyrite concentrate obtained may be specified as a gold-containing technogenic raw material that is difficult to process, and with respect to gold it is related to the category of highly-rusty gold-containing sulfide raw material.

The production scheme proposed for processing pyrite concentrate (see Fig. 1) includes operations of oxidation firing, sulfuric acid leaching, and two-stage cyaniding with intermediate washing of cakes. The processing products are: rich with

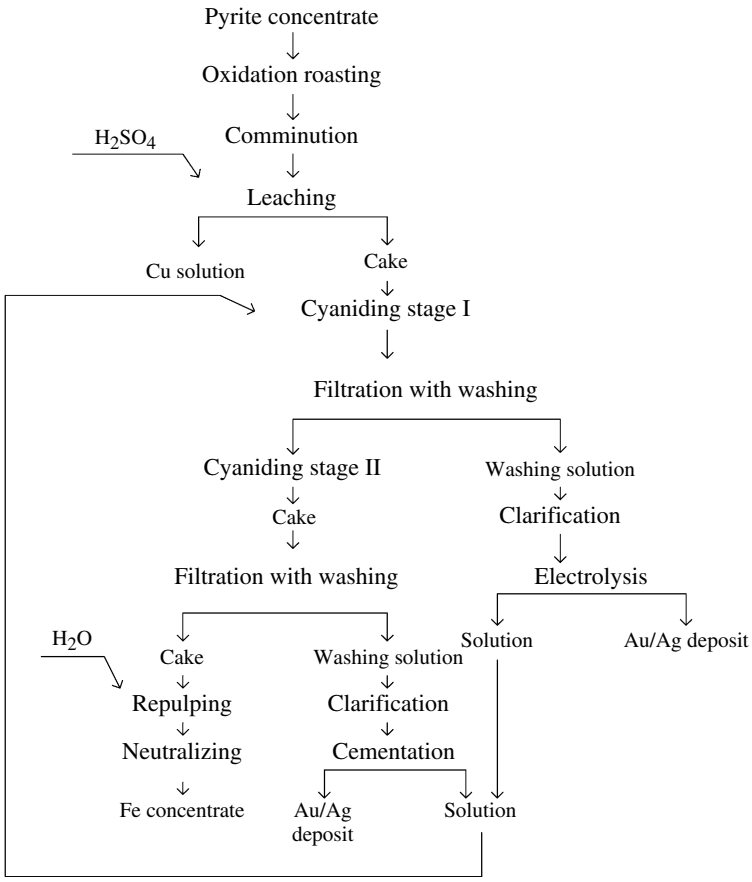

Fig. 1. Production scheme for combined processing of pyrite concentrates.

respect to content of precious metals, copper-containing sulphate solution, suitable for utilizing by an extraction – electrolysis with insoluble anodes scheme (Erdmin enterprise, Erdenet), and iron concentrate for a ferrous metallurgy enterprise.

Conclusion. Research has been carried out on combined processing of flotation pyrite concentrates, obtained during ore enrichment of the Erdenetiin Ovoo ore deposit. It shows that a production scheme including two-stage cyaniding with intermediate filtration and washing out dissolved gold and silver, as well as electrolytic deposition of metals with pre-extraction of them by cementation, and use of solutions in rotation, provides preparation of quite high production indices with respect to gold and silver extraction. This points to the efficiency of this technology for processing accumulated and current pyrite concentrates.