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Research of Material Content on Drop Layout Waste of Marjanbulak Gold Extracting Factory

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Annotation

The article presents the results of the analysis of the material composition of a technological sample obtained from industrial waste at the Marjanbulak gold recovery plant. The material composition of the waste samples was studied using spectral, chemical, rational, optical emission spectral, mineralogical, particle size distribution and other types of analyzes. The main industrial components of the sample are gold and silver. According to the results of laboratory studies, the content of gold in the waste of MGRP is 0, 61 conventional units, silver – 11, 61 conventional units. The waste contains an additional rare earth element, the total amount of which is 169,2 g/t. The investigated technological sample belongs to the mixed type, in which gold is found in pure form and in the form of an electrode. It is not visible in gold sulfides and in terms of size refers mainly to fine and dusty classes. The size of gold micro particles is 0,001-0, 05 mm. According to the results of laboratory analysis, the minerals and minerals of gold in the waste are slightly lower in quality and quantity than in the original ore, which negatively affects the enrichment of the waste and leads to low enrichment ratios.

Keywords: industrial waste, wasting, sample, element, metal, mineral, component, gold, silver, content, analysis, spectral, full chemical, optical emission spectral, rational, mineralogical, particle size distribution, grindability, cyanidation.

Introduction

Over the years of activity of the Marjanbulak Gold recovery plant, more than 15 million tons of man-made waste has accumulated at the wasting dump. In the near future, these technogenic wastes can be considered as a raw material resource of the Marjanbulak gold extraction workshop. The development of a rational technology for processing these man-made wastes is relevant, which will make it possible to solve the economic, environmental and technological problems of the relevant area, as well as increase the economic indicators of the Ministry of Health, and in general of Uzbekistan

Taking into account the fact that the content of valuable components in man-made waste is low in it and is modified in comparison with the initial ores, research requires a dewasteed study of the material composition of waste and the characteristics of valuable components using effective methods and modern analytical equipment.

The material composition of the initial samples was studied using spectral, chemical, assay, rational, optical-emission spectral, mineralogical, etc. types of analyses.

Spectral analysis

Semi-quantitative spectral analysis was performed in the laboratory "Center for Analytical study of the material composition of mineral raw materials" of the State Institution "Institute of Mineral Resources", the results of which are given in Table 1

Table 2. Results of spectral analysis of the average sample of waste

Name of the elements	Content, 10^{-3}%	Name of the elements	Content, 10^{-3}%
Ba	30	Ni	2
Be	0,7	Sn	0,7
V	100	Pb	100
Bi	<0,2	Ag	10
W	7	Sb	30
Ga	3	Ti	700
Ge	1	Cr	100
Cd	<0,1	Zn	100
Co	5	Au	0,07
Mn	100	Nb	5
Cu	20	Ta	10
Mo	5	Li	<3
As	<1,1		

Complete chemical analysis

A complete chemical analysis was performed in the laboratory "Analytical Center for the study of the material composition of mineral raw materials" of the State Institution "Institute of Mineral Resources", the results of which are given in Table 2

Table 2. Results of chemical analysis of the average sample of waste

Components	Content, %	Components	Content, %
SiO_2	65,7	Na_2O	0,46
Fe_2O_3	5,9	K_2O	2,96
FeO	2,27	$S_{totaly.}$	2,04
TiO_2	0,59	SO_3	2,32
MnO	0,09	$S_{sulfide}$	1,11
Al_2O_3	14,2	CO_2	3,74
CaO	1,95	H_2O	0,16
MgO	1,60	l.d.c.	4,58

Optical emission spectral analysis

Table 2. Results of optical emission spectral analysis of the initial wastes

№	Elements	Content, g/t	№	Elements	Content, g/t
1	Ag	3,42	31	Na	8290
2	Al	65600	32	Nb	14,1
3	As	546	33	Nd	26,4
4	Au	0,663	34	Ni	51,2
5	Ba	914	35	P	503
6	Be	2,39	36	Pb	13,3
7	Bi	1,64	37	Pr	6,15
8	Ca	5090	38	Rb	63,5
9	Cd	0,1	39	S	19900
10	Ce	62,5	40	Sb	0,674
11	Co	17,2	41	Sc	12,5
12	Cr	178	42	Se	12,5
13	Cs	7,95	43	Sm	4,19
14	Cu	24,3	44	Sn	4,96
15	Dy	3,44	45	Sr	152
16	Er	2,61	46	Ta	0,375
17	Eu	1,04	47	Tb	0,1
18	Fe	48300	48	Te	0,129
19	Gd	19,9	49	Th	9,2
20	Ga	19,9	50	Ti	3220
21	Hf	1,85	51	Tl	0,469
22	Ho	0,527	52	Tm	0,292
23	In	0,221	53	U	3,68
24	K	28700	54	V	148
25	La	28,8	55	W	3,1
26	Li	15,5	56	Y	18,4
27	Lu	0,323	57	Yb	2,1
28	Mg	6550	58	Zn	265
29	Mn	743	59	Zr	86,2
30	Mo	22,9	60	∑REE	169,2

According to the results of optical emission spectral analysis of the initial wastes, the content of the total REE was 169.2 g/t, the main part of which falls on the light REE group.

Rational analysis for gold and silver

The forms of finding precious metals in the ore sample were studied using rational analysis, which was carried out according to a standard technique based on sequential leaching of the crushed sample (size 85% cl. -0.074 mm) with cyanide solution after preliminary release of gold and silver from association with other ore and rock-forming components. The following operations were included in the analysis scheme: cyanidation of the sample, alkaline treatment of the wasting of the I cyanidation followed by another cyanidation, hydrochloric acid treatment of the wasting of the II cyanidation and then III cyanidation, nitric acid treatment of the wasting of the III cyanidation followed by cyanidation of the insoluble residue.

The results of the rational analysis of the sample are shown in Table 4.

Table 4. Results of rational analysis of the gold and silver samples

The form of finding gold, silver and the nature of their connection with ore components	Distribution of metals			
	Au		Ag	
	c.u	%	c.u	%
Gold and silver are native, in accretions with other minerals: chlorides, sulfates, simple silver sulfides (cyanide)	0,17	27,87	3,79	32,64
Gold and silver associated with minerals and chemical compounds of antimony and arsenic (except arsenopyrite and compounds of pentavalent antimony; silver sulfosols, pyrgyrite, prustite, etc.), (cyanized after NaOH treatment)	0	0	0,02	0,17
Gold and silver associated with acid–soluble minerals, oxides, hydroxides and carbonates of iron and manganese (cyanized after HCl treatment)	0,08	13,11	1,76	15,16
Gold and silver finely interspersed in sulfides (pyrite and arsenopyrite) (cyanized after HNO_3 treatment)	0,16	26,23	2,5	21,54
Gold and silver in quartz, aluminosilicates and other acid-insoluble minerals	0,200	32,79	3,54	30,49
Total:	**0,61**	**100**	**11,61**	**100**

As can be seen from the data in Table 4, the content of cyanized free gold in the wasting sample is 27.87% and 32.64% silver; 0.17% silver is associated with minerals and chemical compounds of antimony and arsenic; 13.11% gold, 15.16% silver is associated with carbonates, iron and manganese hydroxides; sulfides (pyrite, arsenopyrite) is bound with 26.23% gold and 26.54% silver; 32.79% gold and 30.49% silver is found in quartz, aluminosilicates and other acid-insoluble minerals.

Technical analysis

The tests of the sample were carried out according to standard methods used in determining the technical characteristics of the quality of raw materials. (GOST 31436-2011, GOST 11014-2011 or 11056-77).

Specific gravity (true density) is a physical constant for an individual substance. It is defined as the ratio of the resting mass of the material to its volume without pores by the pycnometric method. The specific gravity is calculated by the formula:

$$\gamma = \frac{m \cdot \gamma_t}{m - (m_1 - m_2)}, \text{ g/cm}^3, \text{ which}$$

γ – the specific gravity of the studied rock, g/cm^3;

m - is the weight of the sample of the rock, g;

m_1 - and m_2 are the mass of the pycnometer, respectively, with rock and liquid and

only with liquid, g;

γ_t - is the density of the liquid (H2O = 0.998), g/cm^3.

As a result of the technical analysis, it was determined that the specific gravity of the ore sample under study was 2.68 g/cm^3.

Sample shreddability

The shreddability of the material of the technological sample under study was studied according to the methodology developed by the MECHANOBR Institute (St. Petersburg, Russia).

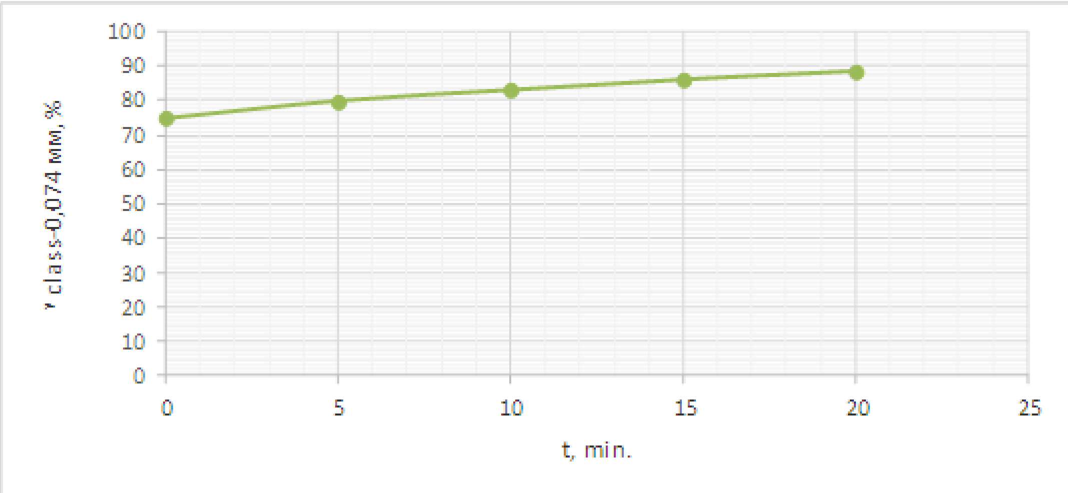
The samples of the material weighing 1 kg were crushed in a laboratory mill of the 40ML brand for various times. Grinding was carried out at a constant ball loading and the ratio T: W: W = 1:0.5:8. The crushed product is sieved through a sieve with holes of 0.074 mm (200mesh).

The results of the experiments are shown in Table 5.

Table 5. Dependence of the output of the class -0.074 mm on the grinding time source wastes

Name	**The output of the class is -0.074 mm, % at the grinding time, min.**					
	min	0	5	10	15	20
Initial samples	%	74,8	79,9	83,1	86,1	88,6

Granulometric analysis



To determine the distribution of the main valuable components by size classes, the initial wastes of size -0.315+0 mm were subjected to a sieve analysis. The results of the sieve analysis are shown in Table 6.

Table 6. The results of the sieve analysis of the ore sample

Size class, mm	**Exit, %**	**Content, c.u.**		**Distribution by class, %**	
		Au	**Ag**	**Au**	**Ag**
+0,2	1,8	0,61	8,69	1,8	1,3
-0,2+0,08	21,6	0,69	10,42	24,4	19,4
-0,08+0,044	23,4	0,95	10,48	36,4	21,1
-0,044+0	53,2	0,43	12,68	37,4	58,1
Initial samples	100	0,61	11,61	100	100

The results of the sieve analysis of the average sample of the initial wastes showed that in larger classes of waste fineness, the gold content is slightly high, and an inverse correlation is observed with silver. With a decrease in the size class, the silver content increases to 12.68 y.e.

Mineralogical research

Mineralogical analysis of the initial wasting and processed products was carried out using chemical atomic absorption, spectral, rational, assay analyses, on the basis of which a list of minerals of the above-described samples was compiled.

In order to determine the material content of the initial wasting and processed products, the behavior of gold and gold-containing sulfides, as well as, most importantly, negatively influencing factors on wasting enrichment, in addition to microscopic observation, others were required. Auxiliary types of research described above:

a) Study of the mineral composition (ore and non-metallic minerals) of processed products, including:

- ✓ study of processed products under a binocular microscope (magnification 16-56 times);
- ✓ production of polished briquettes;
- ✓ Study of ore minerals under the ore microscope "ORTOLUX" at a magnification of 100-1250 times. Search for gold coins with the use of immersion liquids.

b) Recalculation of silicate chemical analysis of processed products from wasting to mineral composition, taking into account all the materials of the study.

c) Photographing polished briquettes of processed products with a digital camera (morphology of minerals and their associations) and obtaining color images.

Mineralogical studies were also carried out on the products of gravity and flotation enrichment, cyanidation and autoclave oxidation cakes, and the ends of gravio and flotation concentrates. Briquettes were made from processed products to study the characteristics of precious metals and ore minerals.

The contents of valuable components and harmful impurities in the initial sample are shown in Table 7

Table 7. The content of valuable components in the source wastes

Name of samples	Content				
	c.u.		%		
	Au	Ag	As	Sb	$S_{общ.}$
Initial samples	0,61	11,61	0,16	0,002	2,04

Mineralogical analysis of the initial wastes

According to the results of mineralogical analysis, ore and non-metallic minerals were identified in the initial sample. Ore minerals consist mainly of sulfides, which are replaced by secondary minerals of the oxidation zone, from partial to complete pseudomorphosis.

The conversion to the material composition was carried out according to the results of a complete chemical analysis of the initial sample Table 8

Table 8. Approximate quantitative ratios of minerals of the initial sample

Name of minerals	Content, %
Native gold	sin. sign
Sulfides	
Pyrite	~1,9-2
Arsenopyrite	~0,3-0,4

Name of minerals	Content, %
Chalcopyrite	sin. sign
Sphalerite	sin. sign
Pyrrhotite	sin. sign
Faded ore	
Tetrahedrite+freibergite	sin. sign
Antimonite	sin. sign
Minor ore minerals	
Chalcosine + covellin	sin. sign
Iron hydroxides	~2,5
Rock - forming minerals	
Quartz	~43-43,5
Plagioclase	par. signs
Orthoclase	
Sericite	~37
Chlorite	~1,3
Carbonates	~6,2-6,3
Clay substances	~6,5-7
Accessory minerals	
Rutile+ilmenite	~0,6
Apatite	~0,2
Epidote	ra. signs.

Conclusion

The material composition of the sample was analyzed by spectral, chemical atomic absorption, assay, mineralogical, rational, granulometric and other methods of analysis.

According to the results of chemical analyses, the average gold content in the sample was 0.61 c.u and silver 11.61 c.u.

According to the results of rational analysis, the content of cyanized free gold in the wasting sample is 27.87% and 32.64% silver; 0.17% silver is associated with minerals and chemical compounds of antimony and arsenic; 13.11% gold, 15.16% silver are associated with carbonates, iron and manganese hydroxides; 26.23% gold and arsenopyrite are associated with sulfides (pyrite, arsenopyrite). 21.54% silver; 32.79% gold and 30.49% silver are found in quartz, aluminosilicates and other acid-insoluble minerals.

The technological sample belongs to the mixed (oxidized and sulfide-quartz) type. Valuable components of the wastes are gold and silver.

The form of finding gold is native and in the form of electrum in goethite (the oxidized part). Perhaps the isolated native gold is in quartz, and in sulfides it is invisible. The shape of the secretions is isometric, rounded, oval, elongated, lenticular, etc., in terms of dimension, gold belongs mainly to the finely dispersed and pulverized classes with a microparticle size of 0.001–0.05 mm. In terms of reflectivity, gold is medium- and low-grade. No visible gold wastes were found in the initial sample.

The main non-metallic minerals are quartz, feldspar, carbonates, sericite and chlorites. Accessory minerals are represented by apatite, rutile+ilmenite and epidote.

By their characteristic properties, quality, as well as the amount of ore minerals and precious metals in the stale wasting of processing is much inferior to the original ore, which complicates the process of wasting enrichment and predetermines low technological indicators. Based on the results of the study of the material composition, both gravity and flotation methods and combined enrichment schemes can be used to enrich the wastes of Marjanbulak Gold recovery plant.

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