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Investigation of the possibility of the biodestruction of the stale waste of hydrometallurgical plants

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ABSTRACT: The paper presents the results of using bacteria in the tailings of gold producing factories. From the tailings and fresh tail pulp, 2 strains of Bacillussubtilis and 2 Pseudomonassp. Strains with different degrees of resistance to metal ions and cyanides in the medium were isolated and determined according to the species. Studies have been carried out on the adaptation of microorganisms to metal ions in solution (pulp) and methods for their intensification have been developed. The possibility of increasing the through-extraction of gold by contacting bacterial solutions for two months has been shown experimentally.

KEYWORDS: tailing dumps, biodestruction, biochemical transformation, microbiocenose, microflora, biodegradation, adaptation of microorganisms, gold extraction.

I.INTRODUCTION

Studies devoted to the study of the distribution of valuable metals in the stale waste, their production and to assess the economic feasibility of their recovery are an actual area of hydrometallurgy with a view to rational use of raw materials. As is known [1-5], the gold content in tailings of concentrating mills and hydrometallurgical plants depends on its initial content, the form of finding and the degree of through gold extraction, taking into account the specific technology used.

The gold content in the tailing dumps of HMP-2 is 0.2-0.4 gram per ton In the tailing dump of the Marjanbulak gold recovery section of NMMC, the gold content is 0.3-0.4 g / t in the upper layers of the tailing dump (1-3 m) and 0.8-1.2 gram per ton the lower layers of the tailing dump.

II. SIGNIFICANCE OF THE SYSTEM

In this paper, we present the results of a study on the determination of the spatial-volume distribution of gold in the tailing dump of the hydrometallurgical plant No. 3 of the NMMC, the methods for finding gold in the tailing dump, the location of the cyanidized gold, the microbiological studies of stagnant tailings, the possibility of biodestruction of the rocks, which increased the cyanated form of gold.

III. LITERATURE SURVEY

The gold content in the stale tails of HMP-3 is 0.6-1.0 gram per ton The content and forms of finding gold in the stale tailings of the tailing dumps of hydrometallurgical plants, where the refractory (sulphide, carbon-sulfide) ores are processed also directly depends on the initial gold content and the degree of its through extraction. Gold content sent to the tailings can be reduced by using a combined technology (biooxidation and firing tailings of biocake sorption) processing of resistant ores, but the implementation of this technology will require additional investment. With the purpose of rational use of natural resources, it is considered expedient to store separate tailings of biocake sorption, where the gold content is 6.0-8.0 gram per ton, for the purpose of further processing. The costs for the construction of a

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new tailing dump are justified in the future, due to the development and application of a highly efficient gold recovery technology.

IV. METHODOLOGY

Based on the conducted studies on the frequency of occurrence of gold in the stale tails of hydrometallurgy with a content of more than 0.8 gram per ton, it is possible to classify the tailings of HMP-3 as a technogenic raw material, in contrast to the tailing dumps of HMP-1, HMP-2 and HMP-4.

Table 1.
The frequency of occurrence of gold in the tailing dump with a content of more than 0.8 gram per ton (in rel.%), Depending on the depth of the waste

	Selection side (pos.)	Total number of samples, pcs.	Depth of selection, m			
			1	2	3	average
1	Northwest Side (I)	157	12	11	57	26
2	Northwest Side (II)	143	27.	27	21	22
3	North Side (III)	355	52	64	58	58
4	Northeast (IV)	64	87	100	100	96
5	Western (V)	482	41	47	58	49
6	West (XI)	266	27	17	59	34
7	South (VI)	153	38	40	59	46
8	Southern (VII, IX)	189	45	46	40	44
9	South addition. Selection (X)	70	43	23	50	39
	Total	**1879**				**46**

A rather high content of organic carbon is found in the northwestern and western parts of the tailing dump. In the northern (northeastern) and southern (southeastern) parts-sulfide; in the north-eastern and south-western parts-gold.

A. **MICROBIOLOGICAL DESTRUCTION**. It is known [7-13] that the habitat and functioning of naturally active microorganisms perform the function of rock destructors in neutral and alkaline environments. These include microscopic fungi belonging to the genus Aspergillus, Fuzarium, Mucor, Penicillium, Trichoderma, getrotrophic bacteria (Aspergillus niger, Bacillus, Pseudomonas, Proteus Mycobacterium and others), getrotrophic bacteria that destroy cyanides (Bacillus brevis, Pseudomonas fluorescens, Bact album, Bacterium liguefaciens). Analysis of literature data shows that the issue of destruction of rocks (rock-forming minerals) in neutral and alkaline media at elevated concentrations of cyanides and thiocyanates has not been studied in detail.

To clarify the nature of biochemical transformations, a comprehensive study of the geochemical environment and the development of a population of microorganisms in it is necessary. It should be understood that the identification of regularities and causal relationships in such a complex heterogeneous environment is possible only with deep complex studies, including a detailed study of microbiocenoses, not only natural, but also in technogenic deposits.

It is known [6-13] that various microorganisms take part in microbiological processes occurring in ore deposits and tailings. However, a key role in really occurring processes belongs to a limited number of bacteria. The main and leading role in these processes belongs, of course, to geochemically active microorganisms. Until recently, little attention has been paid to the association of organotrophs entering into the biocenosis of ore microorganisms and most often detected in tailing dumps. At present, their role in the destruction of ore and nonmetallic minerals is shown, many of them take part in the concentration and oxidation of certain metals, the destruction of cyanides in the tail pulp of gold industries

The study of the microflora of various deposits in Uzbekistan showed a variety of species composition in each of them, but the general prevalence of representatives of the genera Bacillus and Pseudomonas was $2.5 \cdot 10^4$-$7 \cdot 10^5$ quantyty per gram. The presence of Actinomyces, Myxobacterium, Mycococcus, Mycobacterium, Bakterium, Saccharomices, Micrococcus and Sarcina was detected, the abundance of which in the investigated deposits fluctuated significantly.

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Investigations of the microflora of the black shale component of sulphide ores of the Kokpatas and Daugyztau deposits revealed that the number of isolated heterotrophic bacteria varies between $2.5 \cdot 10^1$-$6.0 \cdot 10^4$quantyty per gram. Heterotrophic bacteria are attributed to the genera Bacillus and Rhodococcus.

A significant role of heterotrophic microorganisms in the processes of destruction of cyanides. In laboratory and large-scale experiments, the ability of destruction of free (up to 98.7%) and bound cyanides (up to 75%) in the tail pulp of both oxidized and sulphide ores, using adapted in cyanide mediums of Pseudomonasfluorescens VKPM -5040 [13, 14]. The tests carried out on the destruction of cyanide tail pulp have established the possibility of destruction of cyanides by Bacilluscereus microorganisms, as well as resistant strains of Bacillusubtilis 22M and Pseudomonasaeruginosa 11M for 18-24 hours under aeration conditions [15, 16].

In connection with this, the purpose of these studies is: the study of the microflora of tail pulp and stale tails of HMP-3; investigation of the dynamics of development of spontaneous microflora of tail pulp; establishing the characteristics of the allocated active destructors; study of factors affecting the biological activity of bacteria.

The following nutrient media were used to isolate and cultivate microorganisms from the technogenesis zones: To identify microorganisms, elective nutrient media were used: meat nutrient agar, for detection of heterotrophic microorganisms growing on meat or fish extract, Giltay and Baalsrud environment, for isolating heterotrophic and autotrophic denitrification agents, Waxman's medium, for the isolation of sulfur-oxidizing microorganisms, London's medium for thionexmixotrophs, Czapek's medium for the isolation of microscopic (g / l): Peptone-1.5 (can be substituted for the waste of the sausage industry of belkosin, or for any waste containing meat extracts). The microorganisms are cultivated on a medium of the following composition: ; K_2HPO_4 0.6; $MgSO_4$– 0.5, as well as media for the cultivation of certain types of geochemically active microorganisms.

The generic affiliation of the isolated bacteria was determined using morphological and cultural characteristics, respectively [.21 Bergeyetall 1980]. The total number of microorganisms was determined by the method of serial dilutions with sowing on liquid and dense nutrient media.

Tailings microflora. Tail pulp is a technogenic formation and is a product obtained as a result of ore processing, and in particular, sulfide ores. In this regard, the study of the development of microbiocenoses under such conditions is of interest not only from the point of view of ecology, but also to an awareness of the processes of destruction occurring in the tail pulp, involving spontaneous microflora and bacteria-destructors. A study of the biocenosis of the tailing dump revealed the development of a variety of physiological groups of microorganisms. The presence of various bacteria associations in such complex and toxic waste streams indicates that they are favorable substrates for development.

Lying tails are characterized by the presence of such associations of microorganisms as ammonifiers, denitrifiers and oligonitrophils, which indicates that favorable conditions for the development of microorganisms are created in the tailing ponds, as a result of which various transformations of the metal compounds occur, their dispersion and concentration. In the dormant tails, one can note the similar, when examining deposits, the relationship between the material composition of ores and the physiological groups of microorganisms

Microbiocenoses of the tail pulp of the Kemix apparatus and fresh factory tail pulp have been studied. It is shown that during the destruction of cyanides a change occurs both in the number of microorganisms detected and qualitative changes in the composition of the aboriginal microflora of the tail pulp. The greatest number of microorganisms is noted in the fresh factory tail pulp (Fig. 1).

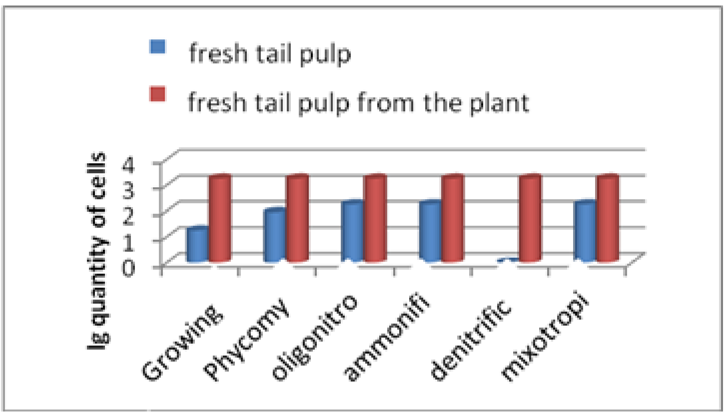

Fig.1. Microbiocenosis of tail pulp

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B. ISOLATION AND CHARACTERIZATION OF ACTIVE DESTRUCTORS. From the averaged samples of the stale, isolates, previously assigned to the genus Bacillus and Pseudomonas, were obtained. As a result of microbiological actions to determine the morphological and cultural features (determining the nature of sporulation, the size and nature of the movement of vegetative cells, the presence of capsules, features of intracellular structure, Gram stain, oxygen, temperature, the ability to synthesize lytic enzymes, the splitting of important macromolecules), we selected 2 strains classified as genus Bacillus and 2 strains assigned to the genus Pseudomonas.

The genus Bacillus unites mobile rod-shaped cells, the sizes of which fluctuate within rather wide limits. Flagellum is peritrichic. Gram staining is positive. The strains isolated by us are attributed to Bacillussubtilis. In stems, the cells are rod-shaped 0.7-0.9 x 2-4 mkm, The spores are elliptical, the location of the spores is central. Gram positive, there are intracellular granules that are not stained with fuchsin. When glucose is split, acid and acetone form, no gas is formed. The acid is formed from xylose arabinose and mannitol, chemo-organotrophs, the metabolism is strictly respiratory. Catalase-positive, hydrolyze starch. Bacillussubtilis strains differ in cell size. In addition, in strain Bacillussubtilis C-2, the cells are stained by Gram only in the early stages of growth.

Representatives of the genus Pseudomonas unfortunately were not identified by us to the species affiliation and are now defined as Pseudomonassp.

To determine the stability of Bacillusubtilis to thiocyanates in the medium, we studied the effect of different concentrations of KCNS on the growth of bacteria and the content of extracellular protein. It is known that 100 mg / l of rhodanides is the maximum allowable concentration. Due to the fact that in the effluent of hydrometallurgical enterprises higher concentrations of thiocyanates occur, we were interested to see the effect of both the maximum permissible and the higher concentrations of these on the vital activity of microorganisms. It has been shown experimentally that a concentration of 100 mg / l and higher concentrations of thiocyanates stimulate the development of the culture.

V. EXPERIMENTAL RESULTS

The protein accumulation and the number of viable cells were studied during the day, at the initial concentration of thiocyanates in the medium 400 mg / dm^3. The obtained results indicate that during the first hours the number of viable bacterial cells decreases, and, accordingly, the content of exometabolites decreases. However, after 9 hours of cultivation, there is an equalization in comparison with the control of cell growth and protein content, and then, on medium with thiocyanate, the microorganisms develop more intensively than on the medium without it.

Thus, the natural association of Bacillusubtilis C-2 adapts to thiocyanates in the first 9 hours of cultivation. Then residual concentrations of rhodanides begin to stimulate the growth of cells and in 24 hours of cultivation the number of cells on the medium with rhodanides are 2 times higher than in the control sample (Fig. 2).

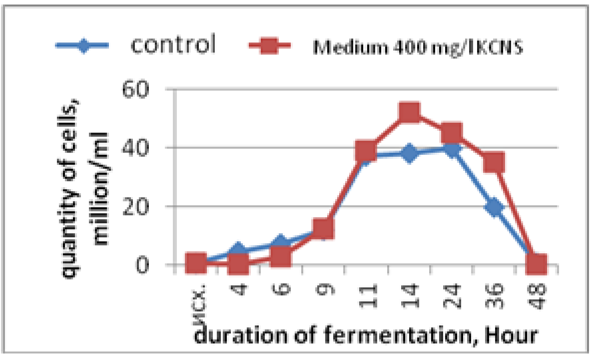

Fig.2. Kinetic Influence Curves thiocyanates on the growth of Bacillus subtilis C-2 cells

The presence in the environment, along with thiocyanates and more toxic substances, such as cyanide, complicates the vital activity of microorganisms-destructors on one side and promotes the adaptation of microorganisms during fractional crossings.

Using this adaptation mechanism, stable forms of microorganisms have been obtained, which are used in further series of laboratory experiments to study the vital activity and biological activity of specially isolated strains of bacteria for the destruction of dead waste.

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A.RATIONAL ANALYSIS OF SAMPLES BEFORE AND AFTER BIODEGRADATION.. After the biodegradation of samples taken from the north-western and northern parts of the tailing dump (averaged result), the shape of the gold: in the free state and in the form of intergrowths (cyanated) increases from 17.75 to 38.2 rel. %; coated with films, associated with antimonite and amorphous silica remains unchanged in the order of 11.8 rel. %; associated with oxides, iron hydroxides, carbonates, chlorites, antimonite and amorphous silica – decreases twofold (from 18.3 to 9.1 rel.%); associated with sulfides is doubled (from 14.9 to 30.9 rel.%) due to the reduction of other forms of gold; associated with the carbonaceous matter is reduced by 7 times (from 13.3 to 1.8 rel.%); Thin-clad gold in rock-forming minerals decreases 3-fold (from 24.9 to 7.3 rel.%).

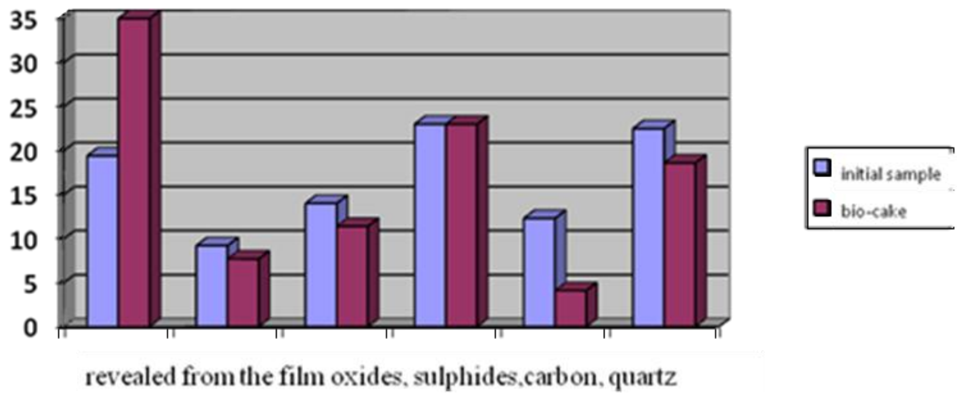

Fig. 3. Comparison of the form of gold in technogenic raw materials before and after biodestruction

After biooxidation of samples, the western and southern parts of the tailing dump (the average result) of the form of gold finding: in the free state and in the form of intergrowths (cyanated) increases from 19.1 to 31.8 rel. %; coated with films, associated with antimonite and amorphous silica decreases from 7.6 to 1.9 rel. %; associated with oxides, iron hydroxides, carbonates, chlorites, antimonite and amorphous silica – remains unchanged in the order of 12.0 rel.%); associated with sulphides is doubled (from 14.9 to 30.9 rel.%) (error of analysis); associated with the carbonaceous matter decreases from 11.2 to 6.4 rel.%); Fine-grained gold in rock-forming minerals increases from 20.2 to 30.0 rel.% (error of analysis).

By the method of sorption cyanidation, an average of 18.1% (cyanated form 19%) of gold is extracted from the raw material (1525 samples) of the tailings from the raw material, including 16.5% in the northwestern part, 21.8% in the northern part %, in the western part – 14%, in the southern part – 20% of tailings. Given that the cyanated form during biodegradation of raw materials increases two-fold for two months, the value of the degree of sorption extraction is similarly expected.

VI.CONCLUSION AND FUTURE WORK

Thus, from the tailings and fresh tail pulp, 2 strains of Bacillusubtilis and 2 Pseudomonassp. Strains with different degrees of resistance to metal ions and cyanides in the medium were isolated and determined according to the species. Studies have been carried out on the adaptation of microorganisms to metal ions in solution (pulp) and methods for their intensification have been developed.

The possibility of increasing the through-extraction of gold by contacting bacterial solutions for two months has been shown experimentally. At present, a detailed study is underway to establish a biodegradation regime from the HMF-3's stale tails with the goal of achieving a through-extraction of at least 50%.

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