ABSTRACT

of the dissertation for the degree of Doctor of Philosophy PhD
in the specialty 6D070700 – "Mining"

KAUMETOVA DINARA SUYUNDIKOVNA

TECHNOLOGY OF MINING OF PRIMARY GOLD-BEARING ORES OF THE VASILKOVSKOYE DEPOSIT BY THE METHOD OF CONTROLLED FLOWS DURING HEAP LEACHING

The relevance of research. The use of the resource potential of man-made formations of spent gold deposits, tailings dumps and dumps can significantly increase the mineral resource base of gold mining enterprises and replenish the reserve of gold-containing raw materials. One of the methods of economically and technologically efficient processing of such depleted raw materials is heap leaching. Since the main disadvantages of KV are the low extraction coefficient and the duration of the leaching process, optimization of technological parameters and design solutions will allow to extract the target valuable component, increasing the profitability of production as a whole. One of the possible solutions to this issue is the development of models for the management of the heap leaching process, which will make it possible to carry out a time forecast of processes with its appropriate adjustment, will allow for rational processing of raw materials and reduction of environmental pollution.

The purpose of the study is to increase the efficiency of heap leaching using material flow management methods in conditions of different densities of mineral raw materials.

The object of research is the gold-bearing ore of the Vasilkovskoye deposit.

Research objectives

- analysis of mining and geological conditions of the dumps of the Vasilkovskoye deposit and heap leaching technology;
- development of laboratory research methodology.
- studies of the effect of the density of mineral raw materials on the indicators of heap leaching;
- carrying out laboratory work to establish the effect of the rate of solution supply and dispersion on the extraction of gold into a productive solution;
- processing of laboratory results;
- development of a recommendation.

Research methods

Both traditional and new scientific research methods were used in the dissertation. Traditional methods: analysis of scientific and patent literature, derivation of various mathematical formulas, experiment planning and processing of experimental data.

Preparation and sampling was carried out according to GOST. Chemical analysis of all initial gold–containing materials and obtained metal samples were carried out in a certified laboratory of the testing center accredited in the accreditation system of the Republic of Kazakhstan for compliance with the requirements of the ST RK ISO/IEC 17025 - 2007, provided with modern certified methods of chemical and physical analysis (GOST) and appropriate standardized instruments, certified testing equipment and measuring instruments.

The study of the structure and phase composition of gold-containing materials was carried out in modern electronic devices.

In order to conduct laboratory studies and the principal possibility of percolation heap leaching of ore with the determination of the parameters and indicators of the process, percolators were designed, which are a plastic cylinder with a diameter of 150 mm and a height of 3000 mm, with a conical perforated bottom, with a layer easily permeable to the solution. The ore was placed in a plastic column, arranging it in the following order: the largest pieces were located in the lower part of the column, smaller ore particles were placed in the upper part. At the beginning of percolation leaching, moisture saturation of the ore was carried out by soaking with ordinary water for 24 hours to increase the efficiency of the process. A series of experiments and the development of technology by the method of controlled flows during heap leaching and the establishment of technological modes were carried out in the ZIF research laboratory.

The main methods of research and analysis used in the performance of the dissertation work include:

– X-ray experimental data obtained on the BRUKER D8 ADVANCE apparatus on copper radiation at an accelerating voltage of 36 kV, a current of 25 mA;

– X–ray fluorescence analysis was performed on a Venus 200 PANalyical B.V. wave dispersion spectrometer (Holland);

- chemical analysis of samples was performed on an optical emission spectrometer with inductively coupled plasma Optima 200 DV (USA, Perkin Elmer);

– mapping of the elemental and phase composition of the samples was carried out on an electron probe microanalyzer JXA - 8230 by JEOL (Japan);

– energy dispersive X-ray fluorescence analysis was performed on the ORBIS MICRO-XRF device of EDAX company (Japan);

- laser diffraction particle size analyzer Mastersizer 3000 (Russia);

- optical microscope ZEISS Scope. A1 (Russia);

– calculation of mathematical modeling in heap leaching processes of possible reactions of interaction of the main components of gold-bearing ore with cyanide solution, performed using the thermodynamic calculation program HSC Chemistry 8.0 of Outokumpu Technology Engineering Research.

The following laboratory and enlarged laboratory equipment were also used: polypropylene percolators for heap leaching; drying cabinet for drying, continuous heating, calcination of bulk materials up to 350 ° C; laboratory top-drive agitator ES-8300, pH meter CONSORT-C931, for measuring pH and ORP.

While studying and analyzing the phase compositions and structure of the raw materials, part of the work was carried out during an internship at the Kyrgyz State University of Geology, Mining and Natural Resources Development named after Academician U.A. Asanaliev (Bishkek, Kyrgyzstan) on an XRD 7000C X-ray diffractometer (Shimadza, Japan). In the course of the internship, specialization with methods of conducting cost-effective technologies of the open method of developing deposits of solid minerals; including methods of geological and industrial evaluation of mineral deposits; computer technologies for modeling and designing drilling and blasting operations.

All studies were carried out in accredited laboratories using various instruments and measuring instruments that have passed the state metrological verification.

The main scientific provisions submitted for defense

- the use of water during heap leaching increases gold production by 24%;
- increasing the concentration of cyanide to 1-1.2 g / l leads to the maximum extraction of gold in solution;
- the use of controlled flow methods allows you to achieve gold recovery of up to 60%.

Description of the main results of the study.

- the composition of gold-bearing ores has been studied using physico-chemical research methods.
- the estimation of reserves and gold content in ore stacks of the heap leaching site has been studied.
- the influence of the main parameters of the cyanide leaching process of gold-bearing ores, such as the ratio T: W, duration, on the degree of gold extraction has been studied.
- the construction of a mathematical model of percolation tests with dubbing has been studied and the optimal modes of gold leaching have been calculated.
- large-scale laboratory tests were carried out according to the developed technology for processing primary gold-bearing ores by the method of controlled flows during heap leaching.

Substantiation of the novelty and importance of the results obtained.

The novelty of the topic lies in the development of technology for processing primary gold-bearing ores of the Vasilkovskoye deposit by the method of controlled flows during heap leaching. In a complex of measures aimed at controlling the components of the process and increasing the efficiency of heap leaching by modeling the parameters of separation and supply of the working solution, creating flows with different speeds of movement depending on the density of raw materials.

The main results obtained:

- for the first time, the process of heap leaching by the method of controlled flows was used in the development of primary gold-bearing ores;

- assessment of reserves and gold content in ore stacks of the heap leaching site

- the regularities of the application of mathematical models to determine the effective parameters of the heap leaching regime are revealed;

- results of enlarged tests of heap leaching technology with the method of controlled flows based on mathematical models.

Together, this will allow us to develop a technology for mining primary gold-bearing ores, as well as an increase in the production of gold-bearing deposits previously used only in the national economic sector of the Republic of Kazakhstan.

Description of the doctoral student's contribution to the preparation of each publication

The author's personal contribution consists in carrying out the main volume of theoretical and experimental research presented in the dissertation work, including the development of theoretical models, experimental research methods, research, analysis and presentation of results in the form of publications and scientific reports.

5 scientific papers have been published on the topic of the dissertation, including: 3 (three) articles in peer-reviewed scientific publications on the scientific direction of the dissertation topic, indexed in the Science Citation Index Expanded database of Web of Science (Clarivate Analytics) and CiteScore in the Scopus database (Elsevier), 1 (one) article in the domestic edition, recommended by COXON, and 4 (four) articles in collections of International and Republican scientific and practical conferences.

Information about the main publications indexed in the Science Citation Index Expanded of the Web of Science database (Clarivate Analytics), in a peer-reviewed scientific publication with a CiteScore percentile in the Scopus database (Elsevier) on the topic of the dissertation:

1. Dinara Kaumetova, Ibatolla Arystan, Khasen Absalyamov, Karlygash Zhusupova, Didar Zhanienov. Reprocessing of ore heap leach tailings at the Vasilkovsky GOK, Kazakhstan// Mining mineral deposits. 2022. 16(1).- P.77-83. ISSN 2415-3443, 63 percentile, Q2.

2. Kaumetova, D.S., Koizhanova, A.K., Toktar, G., Magomedov, D.R., Abdyldaev, N.N. Study of the finely-dispersed gold recovery parameters// News of the National Academy of Sciences of the Republic of Kazakhstan, Series of Geology and Technical Sciencesthis link is disabled. 2022. 2022(1). -P. 69–75. ISSN: 2224-5278, E-ISSN: 2518-170X. 47 percentile, Q3.

3. Kaumetova D.S., Arystan I.D., Absalyamov H.K., Zhusupova K.K, Zhukenova A.D., Abisheva G.S. Research into heap leaching technology of gold-bearing ores at the vasilkovsky gold ore deposit (Kazakhstan)// Naukovyi Visnyk Natsionalnoho Hirnychoho Universytetu. 2022.2. - P. 017 – 022. ISSN 2071-2227, E-ISSN 2223-2362, 50 percentile, Q2.

In publications recommended by the Committee for Control in the Field of Education and Science of the Ministry of Education and Science of the Republic of Kazakhstan:

1. Kaumetova D.S., Koizhanova A.K., Absalyamov Kh.K., Magomedov D.R., Banks C.E. Studies of the rate of gold sorption by the am-2b anionite from cyanidealkaline solutions// Complex Use of Mineral Resources. 2022.320(1).

Information about the reports reported and discussed on the results of the dissertation work at International and Republican scientific and practical conferences:

1. Arystan I.D., Absalyamov H.K., Kaumetova D.S., Mukanova A.K. Selection and justification of initial data to ensure completeness of extraction of primary gold-bearing ores//International Scientific and Practical Conference "Rational use of mineral and man-made raw materials in the conditions of industry 4.0", Almaty, March 14-15, 2019. - pp.299-303. ISBN 978-601-323-168-6.

2. Kaumetova D.S., Karelin V.A., Absalyamov Kh.K. The current state of bio-purification of waste from gold-extracting industries//Materials of the international scientific and practical conference "Science and business: innovations in production". Kokshetau 2022. pp.61-65. ISBN 978-601-261-519-7 2022.

3. Kaumetova D.S., Solozhenkin P.M., Arystan I.D., Mukanova A.K. Increasing the extraction of free fine gold// Materials of the international scientific and practical conference "Problems of development of scientific competition in the field of high technologies". Taganrog, Russia October 10, 2022.

4. Magomedov D.R., Koizhanova A.K., Kaumetova D.S., Bakraeva A.N. Investigation of the processes of electroflotation enrichment of low-sulfide and persistent gold-containing raw materials //V International Symposium "Fundamental issues of geology, extraction, separation of rare, rare-earth, precious metals and the creation of modern materials based on them". Almaty.2022.