XXIV International Conference on Chemical Reactors CHEMREACTOR-24
September 12 - 17, 2021

MODELING OF SEPARATING REACTORS IN MINERAL PROCESSING TECHNOLOGIES

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BACKGROUND AND AIM OF RESEARCH

In the processing of minerals and the beneficiation of various types of ores, flotation is one of the main methods. It is used to refine about 2 billion tonnes of minerals per every year, of which ores of non-ferrous, rare and precious metals are the most important. The physicochemical separation process is carried out in flotation machines, which can be attributed to separation reactors. Process parameters depend not only on the physical and chemical state of the objects and separation media, but also on the aeration method and hydrodynamic conditions of the separation process, as well as on the design features of the flotation machines and apparatus. According to the principle of organizing the flow of the flotation machine, it is possible to divide into reactors with a predominance of intensive turbulent mixing (mechanical and pneumomechanical types of machines) and reactors with a laminar mode of movement (column flotation machines).

The aim of this work was to study the kinetics of the separation process and simulate the process flow sheet using specialised software packages to justify and select the type of flotation machines in mineral separation.

Technological samples of sulphide gold-bearing ores, which by composition belong to the sulphide, quartz-pyrite-arsenopyrite ore type, were selected for the study. These formations are the products of hydrothermal alteration of volcanogenic-sedimentary rocks: sandstones, siltstones, acidic effusives. Sulphides are represented by individual grains and aggregates with different ratios of pyrite and arsenopyrite.

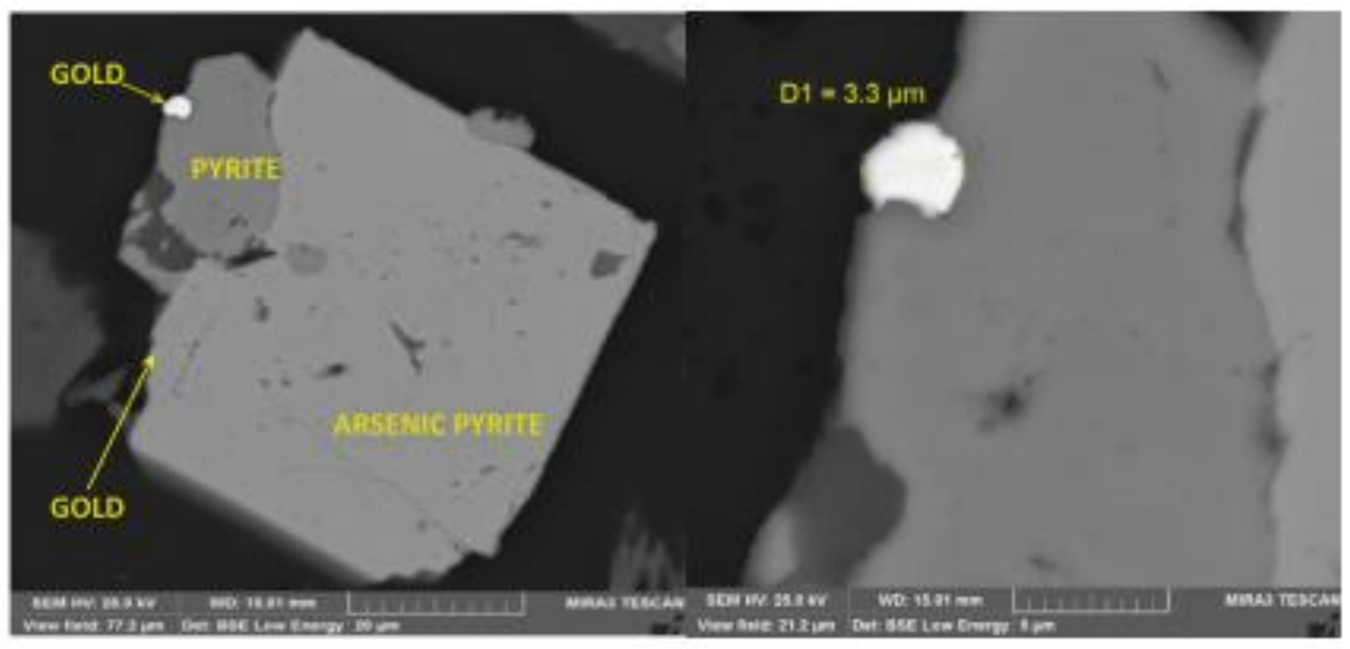

Figure 1. Microphotography of gold disseminated in sulfide minerals

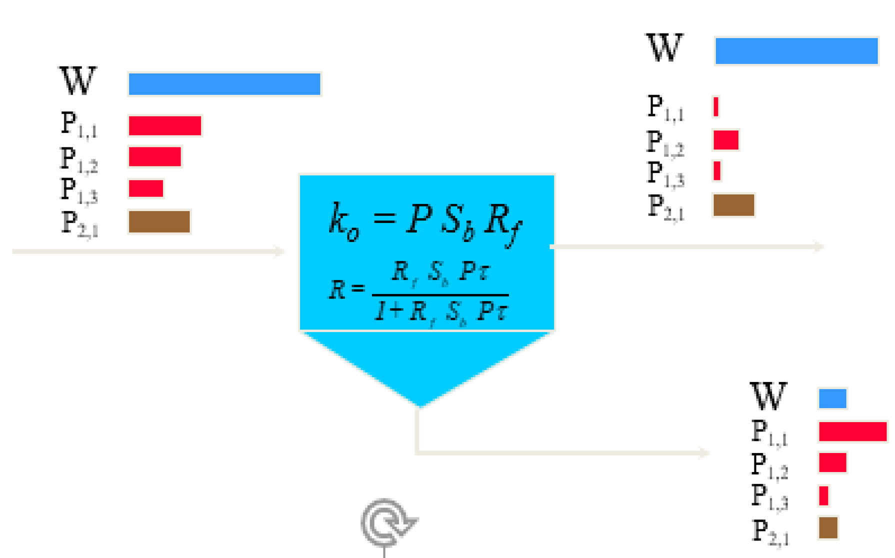

Figure 2. Schematic diagram of separation in a mechanical type flotation machine

R - recovery by true flotation in the pulp, k_o - flotation rate constant, t - flotation process time, S_b - bubble surface area flux, P - ore floatability, R_f - foam product yield

An alternative approach, implemented in JKSimFloat via tthe industrial data distribution model of floatability classes (FCTP), is discussed in this paper. The FCTP model is based on the assertion that the extraction of each class of floatability into a concentrate is a function of several parameters, and it is proposed to determine the kinetic constant by:

$$k = P \cdot R_f \cdot \frac{6 \cdot Q_A \cdot \sum_{i=1}^{n} d_i^2}{A \cdot \sum_{i=1}^{n} d_i^3}.$$

R_f – is the foam product yield, fractions of a unit; Q_A - air flow, m^3/s; d_i– diameter of a single bubble, cm; A – cross-sectional area of the working area of the flotation machine, m^2; P –P is an indicator of floatability, reflecting the probability of a particle fixing on a bubble and its further transfer to the foam product through the act of flotation or mechanical removal.

Analysis of the flotation properties of pyrite and arsenopyrite in their extraction

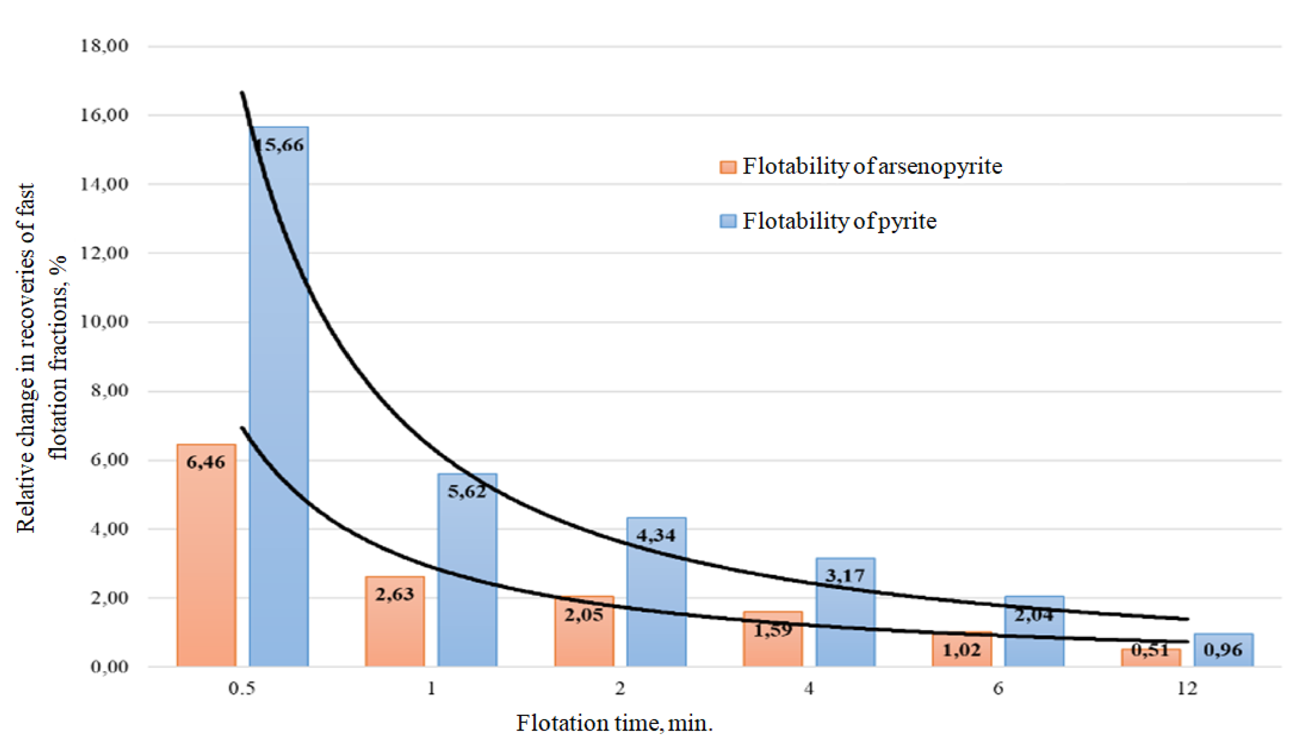

Figure 3. Comparative diagram of the relative changes in the recoveries of the fast flotation fractions

With increasing flotation time the recovery of sulphide minerals decreases for the fast and medium flotation fractions, while for the slow flotation arsenopyrite fractions the recovery remains almost unchanged, which can be explained by the phenomenon of mechanical removal throughout the flotation process.

Data analysis reveals that the maximum rise velocity of bubbles with a high degree of dispersion can be obtained with a machine of the Jameson Cell type. The flotation operation is extremely difficult from the point of view of physico-chemical phenomena. Therefore, special attention is paid to the operating parameters of the flotation machine, which influences the flow of flotation. To study the flotation process and select the optimal mode, as well as further simulation modeling, a process flow diagram was developed in JKSimFloat.

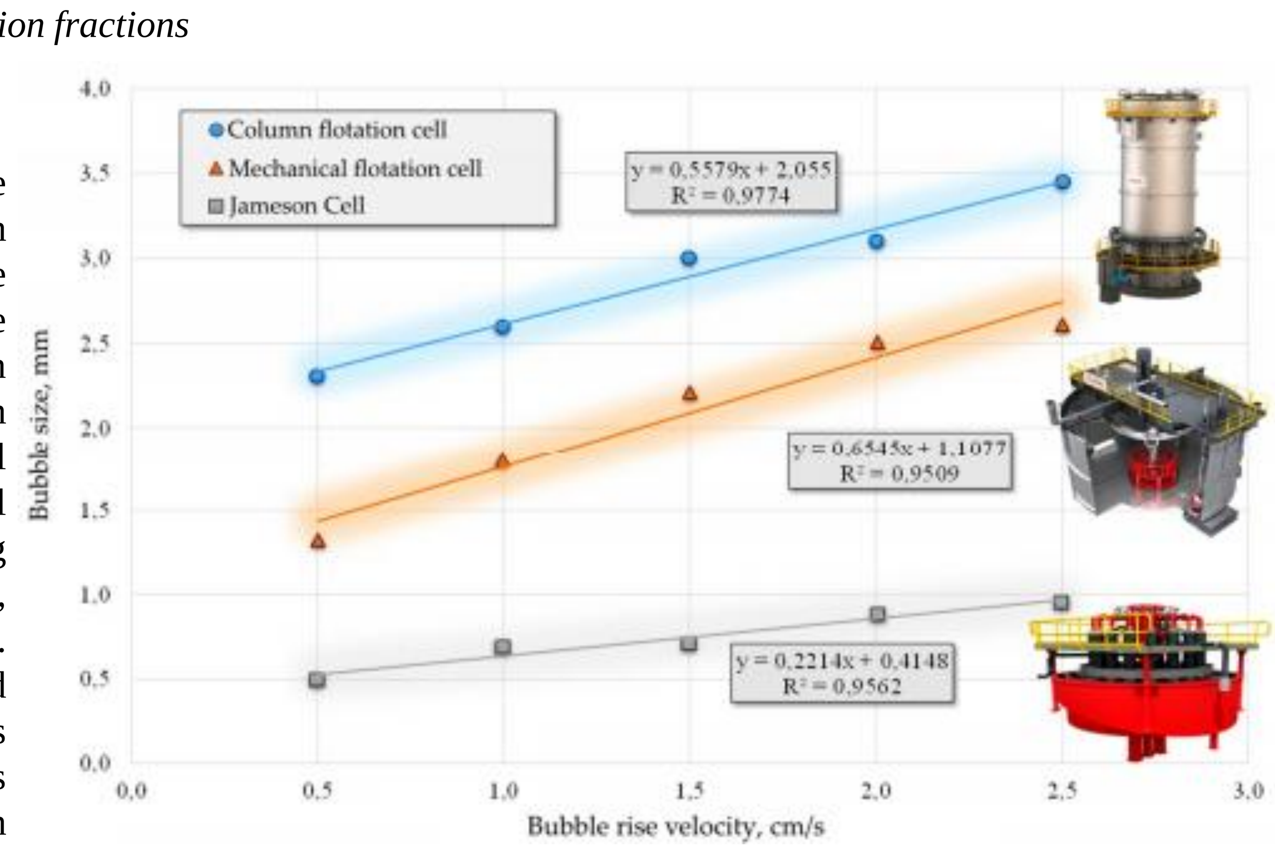

Figure 4. Bubble size as a function of rising velocity for various types of flotation machines

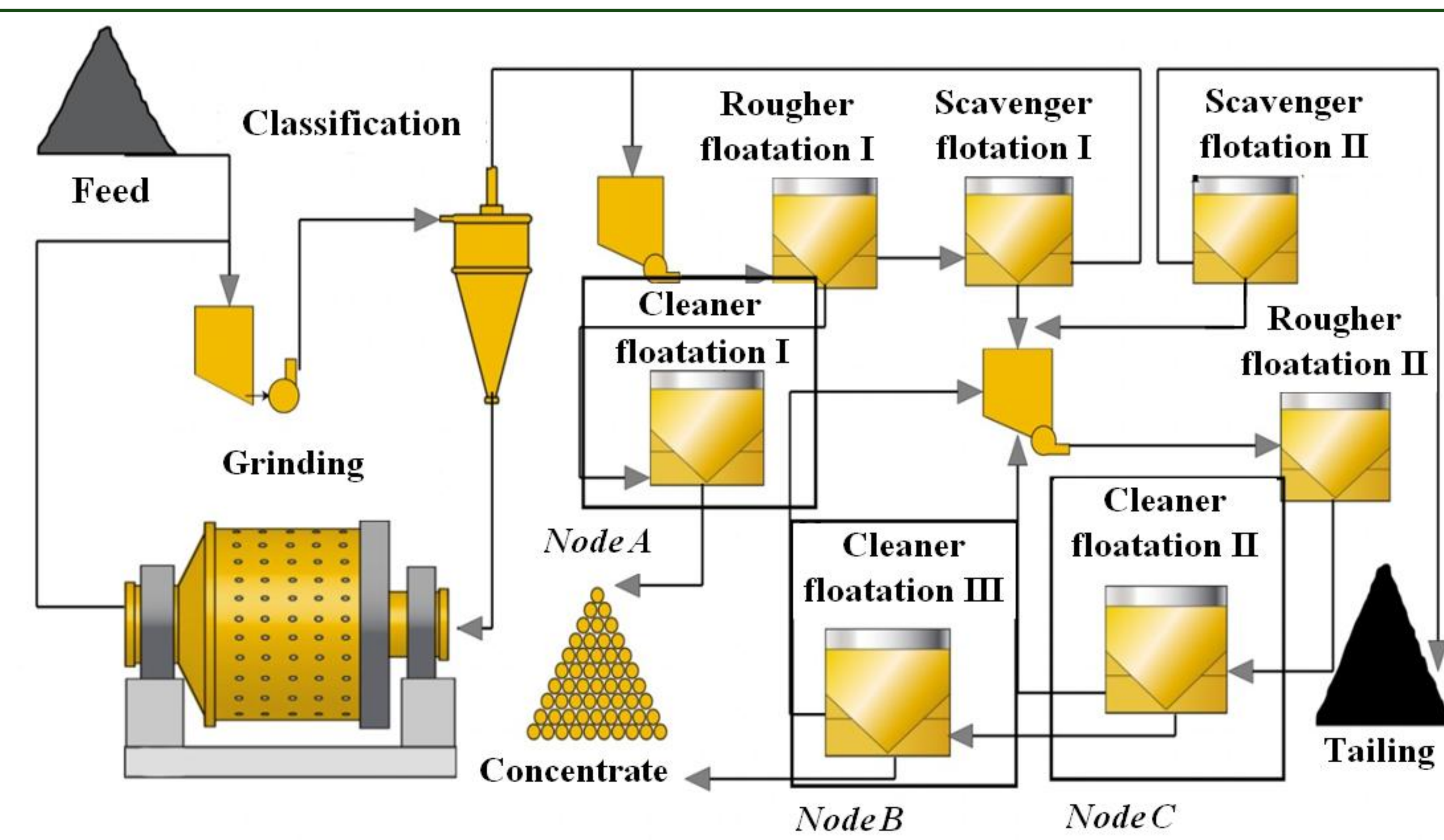

Figure 5. Schematic flowsheet for flotation modelling and experiment

Based on the modelling results, a predictive analysis of the material distribution of the concentrates from the cleaner operations (I-III) by flotation class was performed.

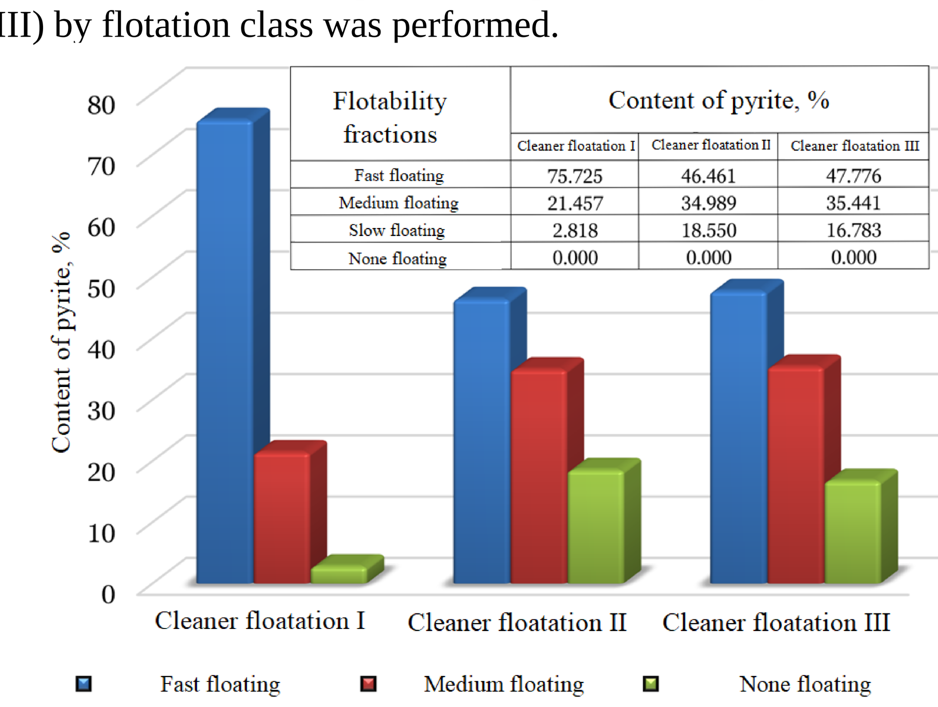

Figure 6. Distribution of pyrite grades by flotation grade in concentrates from the cleaner operations

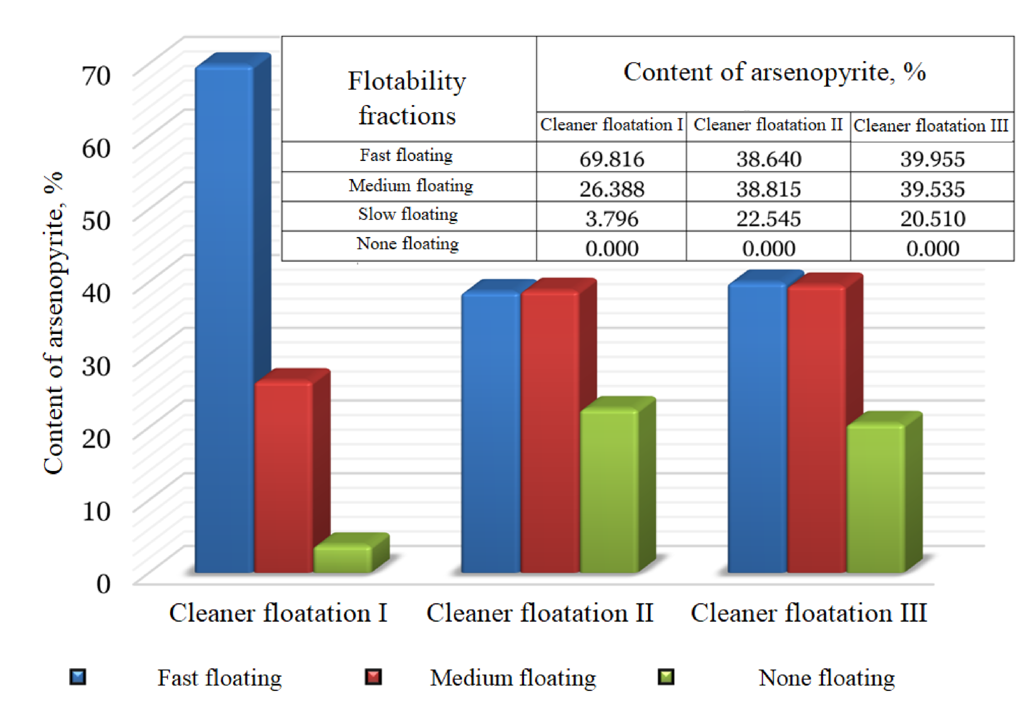

Figure 7. Distribution of arsenopyrite grades by flotation grade in concentrates from the cleaner operations

Based on the analysis of sulphide mineral distribution data by flotation class, high content of fast flotation sulphide mineral fractions in concentrate of cleaner flotation (I) and maintenance of relatively high content of the same fractions in concentrates of cleaner flotations (II and III) are established. The predominance of fast flotation sulphide mineral fractions in cleaner flotations (II and III) is probably due to an insufficient degree of bubble dispersion at a given aeration rate.

Comparison table of technological parametrs

	Content FeS_2,%	Recovery FeS_2, %	Content FeAsS, %	Recovery FeAsS, %
Initial design	19.536	65.561	4.010	60.523
Column flotation machines	19.361	94.562	3.978	88.618
Mechanical machines	18.760	95.817	3.869	90.126

Thus, the simulation of separating rectors (flotation machines) will allow us to justify the optimal technological scheme and equipment for its implementation from the point of view of extracting a valuable component.

This work was supported by the Russian Science Foundation (Project No. 19-17-00096)