ALROSA GROUP
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BOUREVESTNIK
RESEARCH ✦ DESIGN ✦ PRODUCTION

# Application of X-ray absorption method (XRT) for estimation of gold ore concentration

## INTRODUCTION

Gold mining is a process that is not one hundred or even one thousand years old. People have been mining gold veins since time immemorial, using the precious metal for a variety of purposes - from jewelry and household items to the creation of monetary reserves of states.

Gold rarely loses value, and its stability in the financial market makes buying the yellow metal an optimal way to protect assets. Despite crises and epidemics, it is gold that remains the most sought-after currency, not paper money.

The basic methods of gold mining are quite simple. With their help people have been mining gold for centuries and in our modern time the recovery methods have not changed, but improved. If earlier people did all the work manually, now a lot of work is done by machines.

There are not many ways to mine the precious metal, but the main ones are only two:

- washing gold-bearing sand from a body of water;
- mining from mines for rock that contains small amounts of precious metal.

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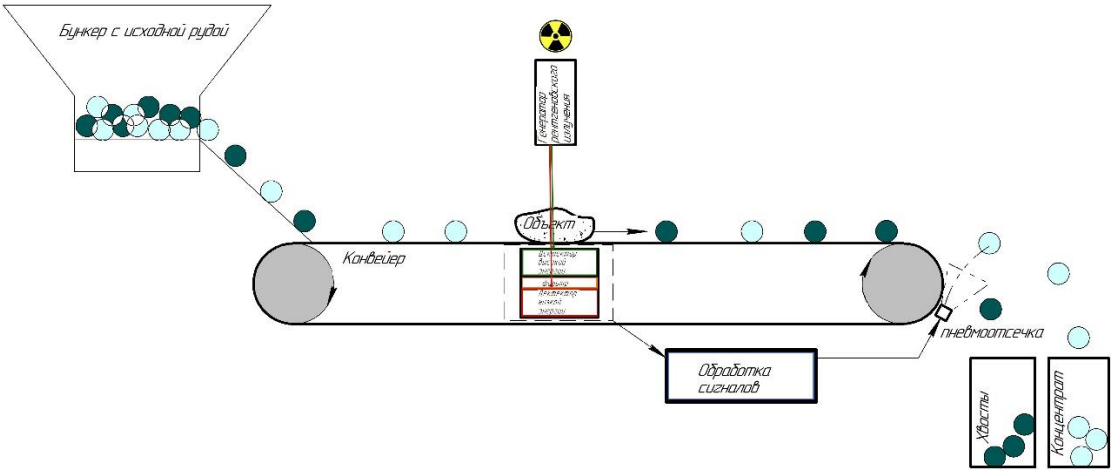
## METHODS AND PRINCIPLES

The search for an effective method of raw mineral concentration is an important strategic task for the development of mining companies. A special place among the methods used for preconcentration is occupied by a group of information methods. Among them the most widespread are X-ray absorption for primary concentration of mineral ores. For this purpose X-ray absorption separation or X-Ray Transmission method (XRT method) is used with high efficiency.

This method does not require special preparation of raw materials in the form of washing operations and cleaning the surface of rocks from dirt, dust, sludge films. X-ray absorption method is a penetrating method, and allows to recognize hidden mineralization in the rock.




General principle of operation of the X-ray absorption sorting

In general, the principle of operation of the X-ray absorption method can be presented as follows: the higher the atomic number of the elements that make up minerals and rocks, the smaller the number of X-rays will pass through this material. The amount of attenuation of X-ray intensity by the material depends on the atomic number of the object substance, the thickness of the piece and the energy of X-ray quanta.

## STUDY

Bourevestnik carried out work to assess the enrichability of gold-bearing ores of Verninskoye deposit by X-ray absorption method. According to the results of the research, high efficiency of the developed MD separation feature was established. Two process samples were received for research:

- Sample No. 1 potential concentrate of poor gold-bearing ore of size class -60 +40 mm weighing 250-350 kg;
- Sample No. 2 potential tailings of poor gold-bearing ore of size class -60 +40 mm weighing 250-350 kg.

The principle of recording and evaluation in X-ray absorption analysis is that X-rays passed through pieces of minerals and rocks are recorded on a scintillation detector. The detector converts the energy of the X-rays that have passed through the pieces of ore into current pulses, which are amplified and recorded by a recording system. The obtained results are digitized, converted into graphic form in the form of raster graphic images and processed by the software of the automated control system according to a special algorithm developed in Bourevestnik. Then they are compared with the values of the specified separation threshold, after which the ratio of the area of the useful component to the total area of the ore piece in the X-ray image was analyzed and calculated. In the

study the sought components were accepted as the main ore mineral in the sample material - pyrite, the secondary role is played by arsenopyrite, limonite group minerals, chalcopyrite and sphalerite, with which numerous nugget gold concretions were also diagnosed.

To determine the contrast and enrichment by X-ray absorption separation method, two representative samples of 200 and 100 pieces (main sample and duplicate) were taken from both samples to determine the technological parameters of enrichment by X-ray absorption separation method.

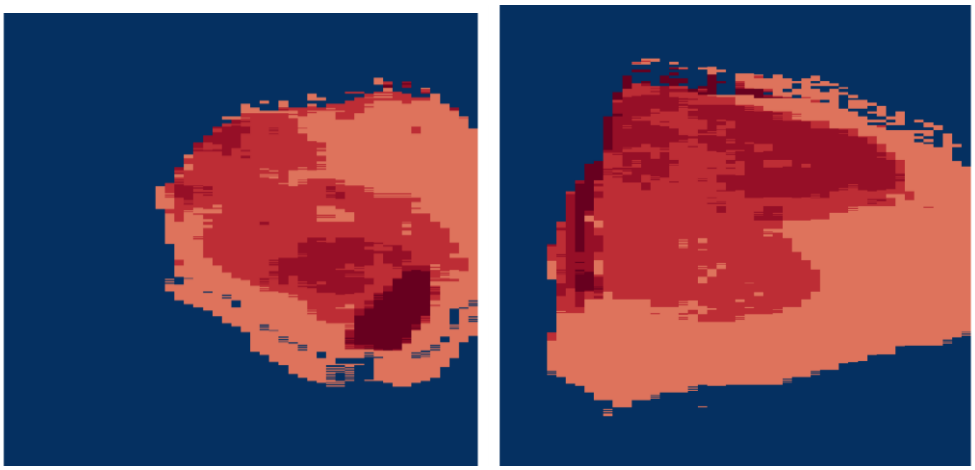
Each piece of sample was washed, labeled, weighed and sent for X-ray absorption measurements to obtain X-ray radiographs. The radiographs were processed to obtain 2 signs of separation.

## RESULTS AND DISCUSSIONS

After assaying the pieces, it was determined from visual examination that the gold in the sample was associated with sulphide minerals. Due to the presence in the main sample of pieces with hurricane gold grades, an additional composite sample was formed.

XRT sorting quality analysis using the two developed MD1 and MD2 traits showed that the MD1 trait performs better due to the fact that fewer gold-rich pieces end up in the tailings and more in the concentrate.

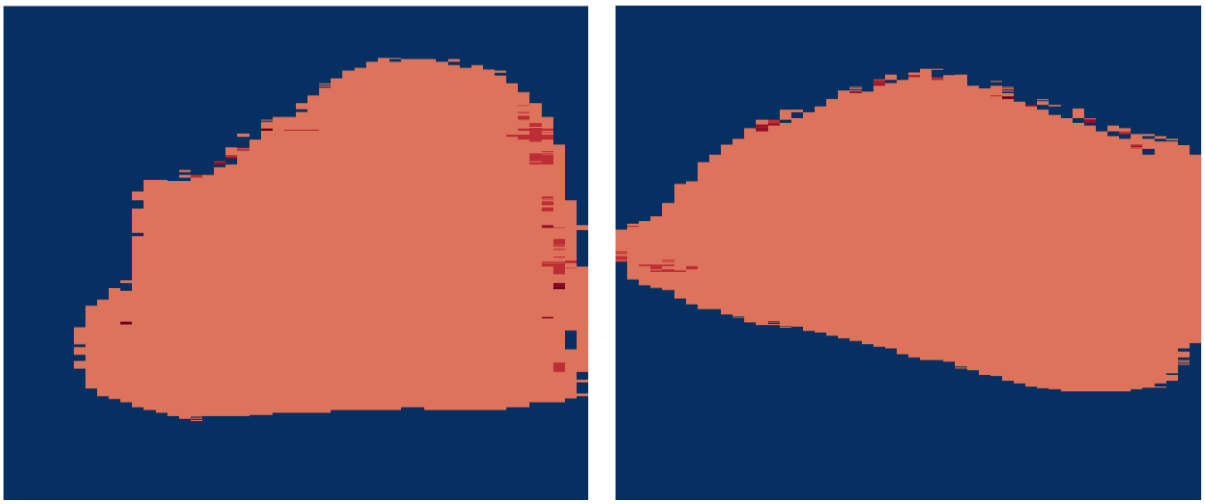
The figure below shows X-ray images of stones with large sulfides graded by X-ray intensity, their content of sulfides (pyrite) and the results of assay analysis on these stones, confirming their "gold content".



pyrite 38,63% $C_{Au}$= 9,18g/t pyrite 45,54% $C_{Au}$= 2,92g/t

Images of stones from the group of large sulfides and sulfides graded by intensity.

The figure below shows radiographic images of the "waste" stones, showing the accurate determination of zero pyrite content and the zero-gold assay results confirming this fact.



pyrite 0,11 % $C_{Au}$=0,03g/t pyrite 0,85% $C_{Au}$=0,05g/t

Radiographic images of "hollow" stones.

The control of the layout and the processing and output of results are performed from one computer using a single program, including the control part, calculation and output of results.

As a result of the assessment of contrast in gold content, all samples were found to be highly contrasting. The values of the contrast index amounted to 1.3-1.4.

Evaluation of the maximum technological parameters on samples showed the possibility of obtaining tailings with a yield of 74-82 % with losses of 9-10 % of gold.

When separating samples by MD1 feature, the possibility of obtaining 50-55 % of tailings containing 0.2-0.3 g/t gold with losses with them at the level of 10 % was shown. The value of the separation efficiency of the trait in this case amounted to 0.68-0.74.

When separating samples by MD2 feature, the possibility of obtaining 36-48 % of tailings containing 0.3-0.4 g/t gold at a loss with them at the level of 10 % was shown. The value of the separation efficiency of the trait in this case amounted to 0.57-0.69

## CONCLUSIONS

Thus, in the course of the project implementation the software and methodological support was used, which allows to carry out XRT studies of mineral raw materials, while establishing various criteria for product separation.

Fractionation of a sample of 200 pieces by the MD1 separation feature parameter determined the possibility of obtaining 55.3% of tailings with Au = 0.3 g/t with losses of up to 8.5% Au. The concentrate contains 3.6 g/t Au. Optimal separation feature MD1= 5.8, separation feature index=1, separation feature efficiency =0.68.

Fractionation of a sample of 200 pieces by the MD2 separation feature parameter determined the possibility of obtaining 49.6% of tailings with Au=0.3g/t with a loss of up to 9.5% Au. At the same time the concentrate contains 3.1 g/t Au. Optimal separation feature MD2=4.1, separation feature index=0.95, separation feature efficiency=0.65.

As a result of estimation of contrast of samples by gold content their high contrast at the level of 1.3-1.4 was established

Thus, taking into account the obtained results of research of gold-bearing ore of Verninskoye deposit, the X-ray absorption separation method realized on the XRT mineral sorter RGS-6A with capacity up to 160 t/h with the possibility of loading ore range from 10 to 100 mm, produced by Bourevestnik, allows to significantly increase the recovery rates of useful component at the stage of preliminary enrichment of initial ore due to its inclusion in the technological process chain.