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DEVELOPMENT OF AN ALGORITHM FOR IDENTIFYING ORE DISSEMINATION FUNCTION

Annatation. The work is devoted to one of the mineral exploration field for processing - identification of disseminated function. The purpose of the work is to develop a methodology for determining the impregnation function according to the known size classes and the distribution of grains according to the content of valuable mineral in the size classes.

An algorithm for determining of the impregnation distribution function by size classes is proposed. Having performed the classification of the crushed product according to size classes the content analysis of the valuable component in each size class is further analyzed, which allows determining the intergrowths distribution function in each size class. It is shown that the dependence of the impregnation distribution function on the size distribution function of the product is nonlinear.

Keywords: testing, impregnation, intergrowths, distribution function.

Introduction. Most metal-bearing ores and industrial minerals contain valuable mineral or metal in a small amount, the valuable mineral being embedded in a host rock as a multitude of intergrowths or disseminated throughout it as impregnations. So most raw ores require treatment of some kind to produce a salable product. Any processing process begins with testing, which consists in isolating part of the array (sample), preparing it and measuring controlled properties. The main purpose of testing is to obtain the necessary information about the test product [1]. The patterns of testing depend on the values of mineral processing characteristics and on its texture and structural features. Thus, the object of dressing study is the processing features. To search for these patterns, it is necessary to know the mineral textural and structural features and the most probable value of the content of a valuable mineral. Therefore, the urgent task is to determine the dependence of the processing characteristic variability in the size classes.

The study of minerals for processing involves the identification of the impregnation function [2]. Usually this is hard work with a microscope. If a scanning microscope with computer signal processing is available, then such work is not difficult [3]. However, in this case, it is necessary to perform several scans of various sections and then perform averaging of the calculations. Not every laboratory has such scanners, since these devices are expensive ones.

More operative method for determining the impregnation function is proposed based on the determination of the size classes and the distribution of grains according to the content of a valuable mineral in each size class.

The purpose of the work is to develop a methodology for determining the impregnation function according to known particle size classes and grain distribution by the content of valuable mineral in the particle size classes.

Formulation of the problem. Prediction of mineral processing indicators is associated with a large preliminary experimental work to determine the texture and structural features of ore. For deep processing it connected with a dissemination of a valuable component, which is characterized by the size distribution function. The identification of this function is associated with a labor intensive process of thin section examination with a microscope. There are scanning microscopes for this purpose, but they are still very expensive and justify the costs only for the study of polymetallic ores. For this reason, in enterprises where one type of mineral is being dressed, an indirect value is used, which largely depends on dissemination. This is the so-called dressability or processing. The study of ore varieties for dressability involves a test for grinding, which is carried out in laboratory mills. For this, a sample of a certain mass is placed in a mill and crushed until an obtained product gets a given grinding size, for example, 95 % of the class 0.05 mm. Then this crushed product is subjected to separation on the analyzer and then the enriched product is analyzed for the content of the valuable component. The value of the valuable component content in the ready product is got, which serves as a guide for the expected indicator of the concentrate quality. Thus, one integral value is obtained. The task is to obtain the function of the growths distribution in the crushed product. However, it is possible to extract intermediate indicators from the obtained results, which directly characterize the processing ore properties, for example, impregnation dim, the distribution intergrowths function and open grains of the ore and nonmetallic phases.

Research results. A preliminary visual examination of the thin section of the ore piece makes it possible to determine the maximum impregnation size dim_{max}. In accordance with this value, grinding is performed to a given boundary maximum particle size, for example, to medium particle size $\overline{d} = \frac{d_{BK\max}}{3}$, or 100 % particle size – dim_{max}. In the last case, the largest class has open ore grains, and the smaller classes – even more so. Thus, it is necessary to grind so that each size class has an open fraction.

Having completed the classification of the crushed product by size classes (d_i), then we coduct the fractional analysis in each size class. Thus we have distribution functions of the intergrowths in each size class $F(dim_i)=F(\alpha_i^j/d_i)$. As a result, the content of the open ore fraction in each size class becomes a known quantity.

In [4], it was shown that it is theoretically possible to determine the content of an open ore fraction in a certain *i* class of particle size using the relation:

$$Cor(d_i) = \alpha_{in}(1 - \frac{d_i}{dim_i})\Delta F(d_i)\Delta F(dim_i) \qquad (1)$$

where d_i – the size class; α_{in} – the content of valuable mineral in the initial product; $\Delta F(d_i)$, $\Delta F(dim_i)$ – increments of the particle size distribution function and dissemination distribution function, accordingly.

The distribution functions are determined by analyzing the crushed product. In this relation (1), in the simplest form and in the explicit form, the relationship between the values of the size and dissemination classes is visible.

The value $Cor(d_i)$ is determined by the analysis and represents an open fraction in each size class: $Cor(d_i) = \Delta F(\alpha = 1/d_i)$.

During grinding small open ore grains are also formed from large impregnations. As a result they move into a smaller class according to particle size analysis. On this basis, the method of successive approximations begins the analysis with a large class, from which small fragments of the newly formed class leave.

Based on theoretical assumptions in the largest sized class (which size is dn) the amount of open ore phase is following

$$Cor(d_i) = \alpha_{in}(1 - \frac{d_n}{dim_n})\Delta F(d_n)\Delta F(dim_n), \qquad (2)$$

where $\Delta F(d_n)$ – the content of n size class in the sample; $\Delta F(dim_n)$ – the content of the impregnation class in the ore; α_{in} – the content of a valuable mineral in the initial ore.

In this (2) equation the unknown quantity is $\Delta F(dim_n)$, which can be determined as follows

$$\Delta F(dim_n) = \frac{Cor_n / \alpha_{in}}{(1 - \frac{d_n}{dim_{\max}})\Delta F(d_n)}, \qquad (3)$$

where Cor_n is the content of ore grains in class of size n (ore grain). However, since the value of Cor_n is less than expected, it also $\Delta F(dim_n)$ turns out to be less than the actual value. Since in small classes the Cor_i value is overestimated for the above reasons, the calculated result is to be adjusted. This is a systematic error, a method error.

The neighboring lower class *n-1* consists of an open fraction obtained from neighboring large inclusions and from inclusions belonging to this class:

$$Cor(d_i) = \alpha_{in}(1 - \frac{d_{n-1}}{dim_n})\Delta F(d_{n-1})\Delta F(dim_{n-1}) + \alpha_{in}(1 - \frac{d_{n-1}}{dim_{\max}})\Delta F(d_n)\Delta F(dim_n)$$

Then

$$\Delta F(dim_{(n-1)}) = \frac{Cor_{(n-1)} / \alpha_{in} - (1 - \frac{d_{n-1}}{\dim_{\max}})\Delta F(d_n)\Delta F(dim_n)}{(1 - \frac{d_n}{dim_{\max}})\Delta F(d_n)} \qquad (4)$$

The next smaller class, i.e. the second from the end of size classes, gives the ratio

$$Cor_{(n-2)} = \alpha_{in}(1 - \frac{d_{n-2}}{d_{im(n-1)}})\Delta F(d_{n-2})\Delta F(dim_{(n-2)}) +$$

$$+\alpha_{in}(1-\frac{d_{n-2}}{dim_{(n-1)}})\Delta F(d_{n-1})\Delta F(dim_{(n-1)}) +$$

$$+\alpha_{in}(1-\frac{d_{n-2}}{dim_{\max}})\Delta F(d_n)\Delta F(dim_n).$$

Thus,

$$\Delta F(dim_{(n-2)}) = \frac{Cor_{(n-2)}/\alpha_{in} - (1-\frac{d_{n-2}}{dim_{(n-1)}})\Delta F(d_{n-1})\Delta F(dim_{(n-1)})}{(1-\frac{d_{n-2}}{dim_{(n-1)}})\Delta F(d_{n-1})} -$$

$$-\frac{(1-\frac{d_{n-2}}{dim_{\max}})\Delta F(d_n)\Delta F(dim_n)}{(1-\frac{d_{n-2}}{dim_{(n-1)}})\Delta F(d_{n-1})}.$$

In general, the content of the *j*-th impregnation class is

$$\Delta F(dim_j) = \frac{Cor_j/\alpha_{in} - \sum_{i=n}^{j-1}(1-\frac{d_j}{dim_i})\Delta F(d_i)\Delta F(dim_i)}{(1-\frac{d_j}{dim_{(j-1)}})\Delta F(d_j)}.\ j = n, n-1, n-2,..1. \quad (5)$$

As a result, the dissemination distribution function will be obtained.

Let us evaluate the impregnation function for the initial data shown in table 1. As a result of the calculation, we obtain the function shown in Fig.1.

Table 1

The initial data for the calculation of the impregnation function

d_i, mm	1	0,5	0,25	0,12	0,06	0,03
d_{im}, mm	0,1	0,08	0,06	0,055	0,05	0,03

It was found that the disclosure indicators (in particular, the dissemination function) have clearly nonlinear relationships with particle size and depend on many more parameters that must be set during testing. In particular, it was shown in [1] that the impregnation appearance of valuable components depends on the structure type: rare grains, vein, layered and other texture formations. In addition, it should also be considered the distribution type of the ore grains. All this imposes its features on the of indicator analysis of a valuable component disclosure.

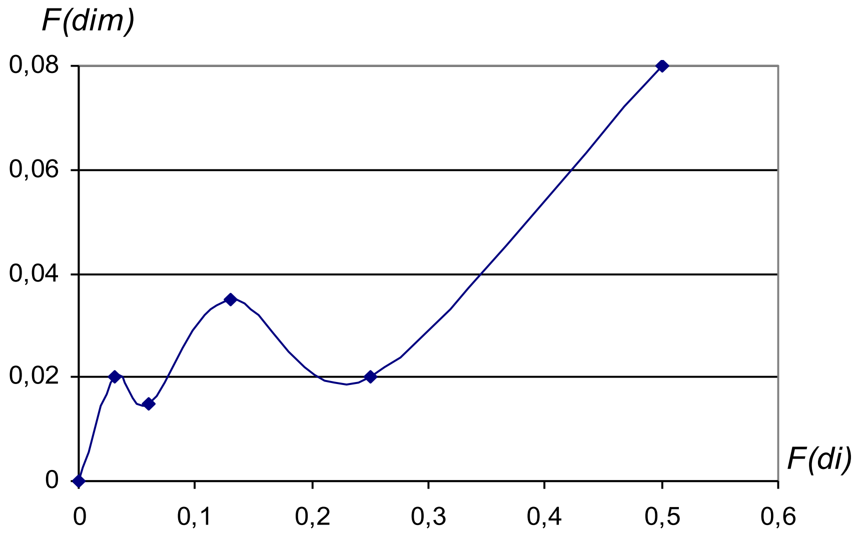

Figure 1 – Dependence of the impregnation function on the size distribution function of the product

Conclusions. An algorithm for determining the impregnation distribution function according to size classes is proposed. Having performed the classification of the crushed product by size classes, we analyze the contents of the valuable component in each size class, which allows determining the intergrowths distribution function in each size class. Then, according to the established formula, the dissemination function is calculated by the size classes. It is shown that the dependence of the dissemination function on the size distribution function of the product is nonlinear.

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Розробка алгоритму ідентифікації функції вкраплення руди

Робота присвячена одному з напрямків дослідження корисних копалин на збагачуваність – ідентифікації функції вкраплення.

Актуальність тематики даної роботи визначається необхідністю вдосконалення методики прогнозування показників збагачення корисних копалин. Це пов'язано з великою попередньої експериментальною роботою з визначення текстурно-структурних ознак руди. Отримана первинно величина вмісту цінного компонента в готовому продукті служить орієнтиром для очікуваного показника якості концентрату. При глибокому збагаченні це є вкрапленням цінного компонента, яке пов'язана з функцією розподілу за крупністю. Мета роботи – розробка методики визначення функції вкраплення за відомими класами крупності і розподілу зерен за змістом в них цінного мінералу в класах крупності.

Запропоновано алгоритм визначення функції розподілу вкраплення за класами крупності. Виконавши класифікування подрібненого продукту за класами крупності, далі проводять аналіз вмісту цінного компонента в кожному класі крупності, що дозволяє визначити функцію розподілу зростків в кожному класі крупності. Потім за встановленою формулою обчислюють функцію вкрапленності за класами крупності. Показано, що залежність функції вкраплення від функції розподілу продукту за крупністю має нелінійний характер. Розроблений алгоритм відрізняється простотою і дозволяє контролювати якість продуктів збагачення: з одного боку – керувати якістю вхідної сировини, а з іншого боку – керувати якістю продукції, що випускається, визначати вибір режимів переробки, усередненням концентрату. Результати дослідження можуть бути використані при оцінці збагачуваності руд нових родовищ, при зміні показників якості концентрату і хвостів на збагачувальних фабриках при незмінних параметрах сепарації.

Development of an algorithm for identifying ore dissemination function

Most metal-bearing ores and industrial minerals contain valuable mineral or metal in a small amount, the valuable mineral being embedded in a host rock as a multitude of intergrowths or disseminated throughout it as impregnations. So most raw ores require treatment of some kind to produce a salable product. The work is devoted to one of the mineral exploration field for processing - identification of disseminated function. The subject relevance of this work is determined by the need to improve the methodology for predicting mineral processing indicators. This is due to the large preliminary experimental work to determine the texture and structural features of ore. The primary value of the valuable component content obtained in the ready product provides a guideline for the expected indicator of the concentrate quality. At deep processing, this is a dissemination of a valuable component, which is associated with the size distribution function.

The purpose of the work is to develop a methodology for determining the impregnation function according to the known size classes and the distribution of grains according to the content of valuable mineral in the size classes.

An algorithm for determining the distribution function of impregnation by size classes is proposed. Having performed the classification of the crushed product by size classes, we analyze the contents of the valuable component in each size class, which allows determining the intergrowths distribution function in each size class. Then, according to the established formula, the dissemination function is calculated by the size classes. It is shown that the dependence of the dissemination function on the size distribution function of the product is nonlinear. The developed algorithm is simple and allows controlling the quality of processing products: on one hand to control the quality of input raw materials, and on the other hand, to control the quality of ready products, to determine the choice of processing modes and averaging the concentrate. The results of the study can be used to assess the dressability of new ore deposits for changing

the quality indicators of the concentrate and tailings at the processing plants with constant separation.

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