USE OF ATTENUATION OF A GAMMA-RAY BEAM TO DETERMINE THE CHARACTERISTICS OF CRUSHED ORE IN MODELING A SYSTEM OF MINING

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In underground mineral mining, the main indices characterizing the ore mass and the efficiency of a method of breaking down the rock in the working face are the density, the iron content, and the impoverishment.

In laboratory practice, obsolescent methods of determining these indices have recently been replaced by the radiotrace method. In comparison with other methods, this has certain advantages. These include modernity, rapidity, accuracy, and reliability. With the aid of radioactive isotopes, the indices can be determined without breaking up the natural bedding of the particles at any point in the ore mass which may be in a static or a dynamic state. These advantages of the radiotrace method make it practically irreplaceable in laboratory research on the characteristics of an ore mass during cutting and discharge in modeling a system of working.

Despite its undoubted advantages, the use of radioactive isotopes in the laboratory practice of ore mining has not yet achieved the popularity it deserves. One reason for this is the lack of developed, convenient standards, especially for the ores of the Krivoi Rog series. The available information on standards, based on the use of radioactive isotopes, refers mainly to minerals other than ores [1-4, etc.].

In order to fill this gap to some extent, the present authors have attempted to develop standards as mentioned above for various loose ore materials of the Krivoi Rog iron ore field. The problem was solved by the accumulation and appropriate processing of data on the attenuation of gamma rays which have passed through the ore mass, which is made of separate magnetite, martite, and red ores.

Each of the varieties of ore was freely poured at full bulk into three batches each of 10 metal boxes. The boxes were 20.6-21.3 cm long, 12.6-13.5 cm wide, and 10.0-10.1 cm high; the walls were 3 mm thick.

Each of the test materials was carefully mixed with barren rock. The volume of barren rock in each successive box was 10% greater by weight than in the one before.

Table 1 lists the characteristics and grain-size compositions of the impoverishing rock, which we did not model.

<table>
<thead>
<tr>
<th>Fractions, mm</th>
<th>Relative weight, %</th>
<th>Material of model</th>
</tr>
</thead>
<tbody>
<tr>
<td>6-2.5</td>
<td>10</td>
<td>Red-martite ore</td>
</tr>
<tr>
<td>2.5-1.5</td>
<td>7.1</td>
<td>The same</td>
</tr>
<tr>
<td>1.5-1.0</td>
<td>7.7</td>
<td>Martite ore</td>
</tr>
<tr>
<td>1.0-0.6</td>
<td>23.2</td>
<td></td>
</tr>
<tr>
<td>0.5-0.30</td>
<td>44.5</td>
<td></td>
</tr>
<tr>
<td>0.5-0.01</td>
<td>40.2</td>
<td>Sand</td>
</tr>
</tbody>
</table>

From the data in Table 1 it follows that the contents of each cell in the batches had different ratios of the components, distinguished by the density, iron content, and impoverishment. The density of the tested ore materials depends to some extent on the amount of impoverishment by rock and consequently on the iron content. Inasmuch as the attenuation of gamma rays depends on the density of the materials, to each particular value there correspond definite but different values of the indices in question.

The degree of impoverishment was fixed according to the experimental conditions, and the iron content was deter-

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TABLE 2. Coefficients and Characteristics of Equations Expressing Attenuation of
Type of ore | Gamma - ray source | Irradiated thickness, mm | Figure No. | Type of relation | Equation
---|---|---|---|---|---
Marte | 210 130 210 130 210 130 | [a\ d] 2 | Hyperbola | \( \frac{I_f}{I_o} \) \( \propto (\gamma x) \)
 | | [a\ d] 3 | Parabola | \( \frac{I_f}{I_o} = (R) \)
Cs-137 | 210 130 210 130 210 130 | [c\ f] 2 | Hyperbola | \( \frac{I_f}{I_o} \) \( \propto (\gamma x) \)
 | | [c\ f] 3 | Parabola | \( \frac{I_f}{I_o} = (R) \)
Magnetite | 210 130 210 130 210 130 | [b\ e] 2 | Hyperbola | \( \frac{I_f}{I_o} \) \( \propto (\gamma x) \)
 | | [b\ e] 3 | Parabola | \( \frac{I_f}{I_o} = (R) \)
 | 210 130 210 130 210 130 | [c\ b] 2 | Hyperbola | \( \frac{I_f}{I_o} \) \( \propto (\gamma x) \)
 | | [c\ b] 3 | Parabola | \( \frac{I_f}{I_o} = (R) \)
Co-60 | 210 130 210 130 210 130 | [b\ e] 3 | Hyperbola | \( \frac{I_f}{I_o} \) \( \propto (\gamma x) \)
 | | [b\ e] 2 | Parabola | \( \frac{I_f}{I_o} = (R) \)
Red | 210 130 210 130 210 130 | [b\ e] 3 | Parabola | \( \frac{I_f}{I_o} = (R) \)
Magnetite | 210 130 210 130 210 130 | [b\ e] 3 | Parabola | \( \frac{I_f}{I_o} = (R) \)

Note. The hyperbola is represented by the equation \( y = a/x + b + c \); the parabola by...