STATE OF IDAHO
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IDAHO BUREAU OF MINES AND GEOLOGY
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BENEFICIATION TESTS ON GYPSUM ROCK
FROM
WASHINGTON COUNTY, IDAHO
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The sample on which these tests have been made was obtained from north
of Weiser, Washington county, Idaho. The deposit is located in T. 13 N.,
R. 7W., sections 7,8,17,18 and 20. In brief the gypsum occurs as lenses in
a gyspite formation overlain by limestone.

INTRODUCTION

A sample of approximately 25 pounds was brought to the laboratory by
Mr. F. W. Handy for testing purposes. In general appearance the rock was white
to light gray in color. Two pieces were a foot or more in the longest dimension,
but the remainder consisted of pieces 3 or 4 inches in diameter. There was
only a small amount of fines and none of this contained any appreciable amount
of clay. Some small but well formed cubes of pyrite were observed in the gypsum.

Qualitative tests showed that the gypsum was the white material. Scattered
through this, but lying in fairly well defined bands, were nodules and irregular
shaped particles of gray material. This proved to be a siliceous limestone.
Its exact mineral composition was not determined. It appeared to be variable
and was apparently a gradation between limestone and gypsum. Specific gravity
determinations were made on hand-picked specimens of the gypsum and of the
gray impurity giving the following results:

Gypsum = 2.32
Impurity = 2.67

The object of the tests outlined below was, first, to determine the separation that might be accomplished by crushing and screening. Two rougher flotation tests were also made.

TESTING PROCEDURE AND DATA

Preparation of Sample

Except for hand specimens of the rock, the entire sample was passed
through the roll jaw crusher, reducing it to approximately one inch. The
crushed product was split in half. One half was reserved, and the other half
was split again. One of these quarter samples was put through the cone crusher
to give a minus 1/4 inch product. Head samples of minus one inch and minus 1/4
inch were, therefore, available for work. It should be noted here that the rock is very soft and produces a large amount of fines in crushing. These
are readily compressed into cakes and tend to clog the crusher when choke fed.

A sample for assaying was cut from the minus 1/4 inch product and pul-
verized to minus 100 mesh. The analysis on this was as follows:

Total ignition loss = 19.9%
Combined Water = 17.5%
Acid Insoluble = 6.0%
\[\text{R}_2\text{O}_3\] = 1.0%
\[\text{CaO}\] = 30.4%
\[\text{SO}_3\] = 41.8%
Assuming that the combined water is present in the gypsum, that the SO3 in excess over this is present as anhydrite, and that the remainder of the lime is present as calcium carbonate, the following mineral composition results:

Gypsum = 83.7%
Anhydrite = 4.8%
Calcite = 2.1%
Insoluble = 6.0%
R2O3 = 1.0%
Others = 2.4%

Screening

To determine the separation that might be made by screening, a sizing-assay test was made on the minus 1/4 inch product. Every other screen in the standard 2 series was used for sizing. The results are summarized below.

Table I

Metallurgical Results of Sizing-Assay Test on -1/4" Feed

<table>
<thead>
<tr>
<th>Size (Mesh)</th>
<th>Weight (Grams)</th>
<th>% Weight</th>
<th>Acid Insol Assay %</th>
<th>Acid Insol Distribution %</th>
<th>CaO Assay %</th>
<th>CaO Distribution %</th>
</tr>
</thead>
<tbody>
<tr>
<td>+8</td>
<td>75.5</td>
<td>10.4</td>
<td>9.3</td>
<td>17.3</td>
<td>29.6</td>
<td>10.0</td>
</tr>
<tr>
<td>8/14</td>
<td>84.5</td>
<td>11.6</td>
<td>10.9</td>
<td>22.7</td>
<td>28.4</td>
<td>10.8</td>
</tr>
<tr>
<td>14/28</td>
<td>70.5</td>
<td>9.7</td>
<td>10.8</td>
<td>18.7</td>
<td>28.5</td>
<td>9.0</td>
</tr>
<tr>
<td>28/48</td>
<td>143.0</td>
<td>19.7</td>
<td>3.8</td>
<td>13.4</td>
<td>31.5</td>
<td>20.2</td>
</tr>
<tr>
<td>48/100</td>
<td>207.0</td>
<td>28.5</td>
<td>2.0</td>
<td>10.2</td>
<td>32.1</td>
<td>29.8</td>
</tr>
<tr>
<td>100/200</td>
<td>101.0</td>
<td>13.9</td>
<td>3.4</td>
<td>8.4</td>
<td>31.5</td>
<td>14.3</td>
</tr>
<tr>
<td>-200</td>
<td>45.0</td>
<td>6.2</td>
<td>8.4</td>
<td>9.3</td>
<td>29.1</td>
<td>5.9</td>
</tr>
<tr>
<td>Composite</td>
<td>726.5</td>
<td>100.0</td>
<td>5.59</td>
<td>100.0</td>
<td>30.7</td>
<td>100.0</td>
</tr>
</tbody>
</table>

From the above tabulation, 28 mesh is indicated as the best splitting size between improved product and waste. The assays for acid insoluble give the most reliable data for calculating metallurgical results. Since the lime is present in at least 3 different minerals, its distribution cannot be accurately determined. However, it should be noted that the lime assays of the minus 28 mesh portions approach very nearly the theoretical (32.5%) CaO content of pure gypsum. A natural division in weight distribution also occurs at 28 mesh. Although including the minus 200 mesh portion in the improved product will lower the grade somewhat, it would not be practicable to eliminate it in a commercial operation.

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Table II
Composite Products Calculated from Table I

<table>
<thead>
<tr>
<th>Product</th>
<th>% Weight</th>
<th>Acid Insol Assay %</th>
<th>Acid Insol Distribution %</th>
<th>CaO Assay %</th>
<th>CaO Distribution %</th>
</tr>
</thead>
<tbody>
<tr>
<td>+28 mesh</td>
<td>31.7</td>
<td>10.3</td>
<td>58.7</td>
<td>28.8</td>
<td>29.8</td>
</tr>
<tr>
<td>-28 mesh</td>
<td>68.3</td>
<td>3.38</td>
<td>41.3</td>
<td>31.5</td>
<td>70.2</td>
</tr>
</tbody>
</table>

Pebble Mill Grinding

In Test No. 2 a charge of 1000 grams of minus 1/4 inch feed was weighed out and screened on 28 mesh. The plus 28 mesh portion was ground 10 minutes in the small laboratory pebble mill and again screened. The results are summarized below.

Table III
Metallurgical Results of Screening and Grinding Test

<table>
<thead>
<tr>
<th>Product</th>
<th>Weight (Grams)</th>
<th>% Weight</th>
<th>Acid Insol Assay %</th>
<th>Acid Insol Distribution %</th>
<th>CaO Assay %</th>
<th>CaO Distribution %</th>
</tr>
</thead>
<tbody>
<tr>
<td>-28 mesh from head</td>
<td>662</td>
<td>66.3</td>
<td>3.6</td>
<td>40.6</td>
<td>30.8</td>
<td>68.0</td>
</tr>
<tr>
<td>-28 mesh after 10 min. grind</td>
<td>314</td>
<td>31.5</td>
<td>8.8</td>
<td>47.1</td>
<td>29.3</td>
<td>30.6</td>
</tr>
<tr>
<td>+28 mesh after 10 min. grind</td>
<td>22</td>
<td>2.2</td>
<td>32.6</td>
<td>12.3</td>
<td>19.5</td>
<td>1.4</td>
</tr>
<tr>
<td>Composite</td>
<td>998</td>
<td>100.0</td>
<td>5.9</td>
<td>100.0</td>
<td>30.1</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Although the remaining plus 28 mesh material is high in acid insoluble, the relatively mild grinding of the pebble mill is too severe to be sufficiently selective.

Tumbling with no Grinding Media

Since the gray impurity is appreciably harder than the gypsum, another test was made to determine the possibility of autogenous grinding. A sample of the coarse feed (minus one inch) was used for this test. Grinding was done by tumbling the rock in a 12-inch rotating steel shell with no grinding media. The testing procedure is diagrammed below.
Undersize (Sample No. 1)  
Oversize  
Tumbling Mill (10 minutes)  
Screen (28 mesh)

Undersize (Sample No. 2)  
Oversize  
Tumbling Mill (10 minutes)  
Screen (28 mesh)

Undersize (Sample No. 3)  
Oversize  
Tumbling Mill (20 minutes)  
Screen (28 mesh)

Undersize (Sample No. 4)  
Oversize  
Screen analysis to 28 mesh  
Samples 5 to 8 incl.

### Table IV

<table>
<thead>
<tr>
<th>Product</th>
<th>Weight (Grams)</th>
<th>% Weight</th>
<th>Acid Insol Assay %</th>
<th>Acid Insol Dist. %</th>
<th>CaO Assay %</th>
<th>CaO Dist. %</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) -28 mesh in feed</td>
<td>615</td>
<td>33.8</td>
<td>3.1</td>
<td>18.8</td>
<td>30.9</td>
<td>34.7</td>
</tr>
<tr>
<td>(2) -28 mesh after 1st grind (10 min.)</td>
<td>262</td>
<td>14.4</td>
<td>4.5</td>
<td>11.6</td>
<td>30.6</td>
<td>14.6</td>
</tr>
<tr>
<td>(3) -28 mesh after 2nd grind (10 min.)</td>
<td>69</td>
<td>3.8</td>
<td>6.1</td>
<td>4.1</td>
<td>29.9</td>
<td>3.8</td>
</tr>
<tr>
<td>(4) -28 mesh after 3rd grind (20 min.)</td>
<td>61</td>
<td>3.3</td>
<td>5.0</td>
<td>3.0</td>
<td>29.9</td>
<td>3.3</td>
</tr>
<tr>
<td>(5) +4 mesh in residue</td>
<td>549</td>
<td>30.2</td>
<td>5.7</td>
<td>30.7</td>
<td>30.3</td>
<td>30.3</td>
</tr>
<tr>
<td>(6) 4/8 mesh in residue</td>
<td>212</td>
<td>11.6</td>
<td>8.7</td>
<td>18.1</td>
<td>29.0</td>
<td>11.2</td>
</tr>
<tr>
<td>(7) 8/14 mesh in residue</td>
<td>34</td>
<td>1.9</td>
<td>21.2</td>
<td>7.1</td>
<td>24.3</td>
<td>1.5</td>
</tr>
<tr>
<td>(8) 14/28 mesh in residue</td>
<td>18</td>
<td>1.0</td>
<td>37.5</td>
<td>6.6</td>
<td>17.4</td>
<td>0.6</td>
</tr>
</tbody>
</table>

Composite                 | 1820           | 100.0    | 5.6                | 100.0              | 30.1        | 100.0       |
The above table indicates that only a small amount of minus 28 mesh is produced in each grind after the first one and also that the grade of the fines from the second and third grinds is no better than the head sample. Even though no segregation is accomplished by the later grinds, the large amount of plus 4 mesh material in the residue shows that grinding was incomplete. The selective grinding accomplished by this method shows only in the 8/14 and 14/28 mesh fractions of the residue. The combined weights of these products is too small to be of economic importance.

Flotation

Although the cost of flotation for producing gypsum for land plaster or building materials would be prohibitive, two tests were made to determine what grade of product might be expected. Only rougher concentrates were made. A 1000-gram sample of the minus 28 mesh material (assaying 3.6% insoluble) saved from the previous screening tests was weighed out and ground 7 minutes in the ball mill with 1000 c.c. of water. The pulp was split into duplicate flotation charges. The test procedures are outlined below.

Test No. 4 - Flotation

<table>
<thead>
<tr>
<th>Product</th>
<th>Weight (Grams)</th>
<th>% Weight</th>
<th>Acid Insoluble Assay %</th>
<th>Acid Insoluble Distribution %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concentrate</td>
<td>366</td>
<td>77.4</td>
<td>1.2</td>
<td>25.0</td>
</tr>
<tr>
<td>Tailing</td>
<td>107</td>
<td>22.6</td>
<td>12.3</td>
<td>75.0</td>
</tr>
<tr>
<td>Composite</td>
<td>473</td>
<td>100.0</td>
<td>3.7</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Test No. 5 - Flotation

<table>
<thead>
<tr>
<th>Product</th>
<th>Weight (Grams)</th>
<th>% Weight</th>
<th>Acid Insoluble Assay %</th>
<th>Acid Insoluble Distribution %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concentrate</td>
<td>285.5</td>
<td>62.8</td>
<td>3.2</td>
<td>56.1</td>
</tr>
<tr>
<td>Tailing</td>
<td>169.5</td>
<td>37.2</td>
<td>4.2</td>
<td>43.9</td>
</tr>
<tr>
<td>Composite</td>
<td>455.0</td>
<td>100.0</td>
<td>3.6</td>
<td>100.0</td>
</tr>
</tbody>
</table>
Reference to the above tables indicate that the acid insoluble content can be appreciably lowered by soap flotation, but that no improvement in grade is made by amine flotation.

CONCLUSIONS

The grade of the product that can be made by crushing and screening will depend somewhat on the method of crushing, but from 3.0% to 3.5% acid insoluble is the best that can be expected from a head sample containing 6.0% insoluble. Crushing gives more selective results than reduction by differential grinding or abrasion.

In these tests it was found necessary to crush to approximately 1/4 inch to obtain satisfactory liberation of the gypsum. Screening the minus 1/4 inch product on 28 mesh gave the best split between a high grade (undersize) and low grade (oversize) product.

A high recovery of gypsum in a product containing 3.5% acid insoluble cannot be expected as approximately 30 percent will be retained in the oversize product. It would probably be necessary to have a market for this as well as for the improved product for the beneficiation to be economically feasible.