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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 gypsite 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 pulverized to minus 100 mesh. The analysis on this was as follows:

Total ingition loss	= 19.9%
Combined Water	= 17.5%
Acid Insoluble	= 6.0%
R_2O_3	= 1.0%
CaO	= 30.4%
SO_3	= 41.8%

Assuming that the combined water is present in the gypsum, that the SO_3 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%
R_2O_3	=	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

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

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.

Table II

Composite Products Calculated from Table I

Product	% Weight	Acid Insol Assay %	Acid Insol Distri-bution %	CaO Assay %	CaO Distri-bution %
+28 mesh	31.7	10.3	58.7	28.8	29.8
-28 mesh	68.3	3.38	41.3	31.5	70.2

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

Product	Weight (Grams)	% Weight	Acid Insol Assay %	Acid Insol Distribu-tion %	CaO Assay %	CaO Distribu-tion %
- 28 mesh from head	662	66.3	3.6	40.6	30.8	68.0
- 28 mesh after 10 min. grind	314	31.5	8.8	47.1	29.3	30.6
+ 28 mesh after 10 min. grind	22	2.2	32.6	12.3	19.5	1.4
Composite	998	100.0	5.9	100.0	30.1	100.0

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.

Sample

Screen (28 mesh)

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

Metallurgical Results of Autogenous Grinding Test

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

Cre	=	1/2 of 1000 gram grind
Na_2CO_3	=	1 gram (4.0 lb./ton)
Na_2SiO_3	=	0.1 gram (0.4 lb./ton)
S-37	=	0.25 gram (1.0 lb./ton)
Oleic Acid	=	0.17 gram (0.7 lb./ton) - added in 3 stages
Pine Oil	=	0.027 gram (0.1 lb./ton)
Frothing time	=	8 minutes

Metallurgical Results

Product	Weight (Grams)	% Weight	Acid Insoluble Assay %	Acid Insoluble Distribution %
Concentrate	366	77.4	1.2	25.0
Tailing	107	22.6	12.3	75.0
Composite	473	100.0	3.7	100.0

Test No. 5 - Flotation

Ore	=	1/2 of 1000 gram grind
CaO	=	1.0 gram (4.0 lb./ton)
Na_2SiO_3	=	0.1 gram (0.4 lb./ton)
D.P.243	=	0.125 gram (0.5 lb./ton) added in 2 stages
Frothing time	=	7 minutes

Metallurgical Results

Product	Weight (Grams)	%Weight	Acid Insoluble Assay %	Acid Insoluble Distribution %
Concentrate	285.5	62.8	3.2	56.1
Tailing	169.5	37.2	4.2	43.9
Composite	455.0	100.0	3.6	100.0

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.