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Barite Flotation
El Cuervo Butte

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Abstract

Barite ($BaSO_4$) is an essential industrial mineral used for both its chemical and physical characteristics. Specifications for the various end uses of barite usually require a higher barite content than is found in the raw ore. Therefore, the ore must be beneficiated to increase the barite content to match the specifications. Samples of barite ore from El Cuervo Butte were beneficiated by flotation and by gravity concentration to determine if these materials might be successfully upgraded. Results showed that flotation achieved better results than did gravity concentration.

<u>Introduction</u>

Barite is an essential industrial mineral used both for its physical and chemical properties. Barite can be characterized as: a soft (hardness $\cong$ 3.5), heavy (specific gravity $\cong$ 4.5) mineral, primarily used as a major component in drilling muds. This accounts for well over 90% of the barite used in the United States on an annual basis. Other uses for barite depend on the purity of the barite and its physical appearance. These uses include: as a filler and extender in rubber and plastics, in the manufacture of glass, as a pigment, and as the only source of barium for chemical manufacturing. Many of the uses have stringent specifications based on minimum $BaSO_4$ content, maximum contents of various impurities, and particle size distributions. Therefore, many barite ores must be beneficiated in order to meet the desired specifications for a particular end use. (Sources 1,2,3)

Uses and Specifications

Drilling Mud: Chemically nonreactive, heavy and finely ground. Therefore, typical specifications include, free of soluble salts, specific gravity minimum of 4.2, with a minimum of 90 percent passing 325 mesh.

Chemical Manufacturing: Minimum 94 percent $BaSO_4$, with less than 1 percent Fe_2O_3 and $SrSO_4$, particle size is typically between 4 and 20 mesh.

Glass Manufacturing: Minimum 95 percent $BaSO_4$, with a maximum of

2.5 percent SiO_2 and 0.15 percent Fe_2O_3, with a particle size range of 30 to 140 mesh.

Barite Occurrences in New Mexico

There are at least 60 known barite deposits in New Mexico, with more than a score of other miscellaneous occurrences. Production of barite ores through the early 1960's has been reported as being over 36,000 tons with more than 95 percent of that production coming from the Mex-Tex mine in Socorro county.

Processing Methods

There are two processes which are typically used to beneficiate barite ores. The first process, flotation, depends on a combination of physical and chemical characteristics to separate the barite from the gangue components . The second process, gravity concentration, depends on the high specific gravity of the barite to separate it from the gangue components found in the ore. Both of these methods were tested in the metallurgy laboratory of the New Mexico Bureau of Mines and Mineral Resources, using barite samples taken from El Cuervo Butte.

Sample Description and Preparation

Five samples of barite containing materials were taken from El Cuervo Butte. The samples consisted of pieces and chips with the largest pieces being approximately 4 inches in diameter. The sample weights varied from 14 to 30 kilograms. Mineralogical examination showed that the primary components of the samples were barite, calcite and quartz. Note that the composition of the samples varied from 21 percent to 77 percent barite.

Sample Number	$BaSO_4$	$CaCO_3$	SiO_2	Total
1	39.4	50.5	3.08	93.0
2	77.7	11.5	3.91	93.1
3	75.6	14.6	5.97	96.1
4	21.2	0.53	76.1	97.8
5	68.4	6.08	21.7	96.2

Each of the samples was ground to a nominal 10 mesh and blended in preparation for the test work. Sample Nos. 2 and 5 which had substantially more bulk were split into halves and one half was further reduced to quarters. One quarter of each sample was ground to 65 mesh and the second quarter was ground to 100 mesh. Each of these samples were then reserved for further test work. Typical size distribution of the crushed and ground products are shown below:

Size Distributions for Crushed and Ground Samples of El Cuervo Butte Sample Number 5

Cumulative Passing (Tyler Mesh)	Crushed to 100% 10 mesh	Ground to 65 mesh	Ground to 100 mesh
28	62.0	----	----
35	52.5	----	----
48	44.0	----	----
65	37.3	97.8	98.9
100	31.8	78.9	89.7
150	26.2	62.3	69.7
200	21.8	51.1	64.0

Experimental Work

The various samples of El Cuervo Butte barite were all subjected to flotation testing to produce an upgraded barite product. In addition, portions of sample 2 and 5 were subjected to gravity concentration testing to produce an upgraded barite product.

Flotation Testing -- Preliminary flotation testing was carried out under the following general conditions:

collectors: Aero 845, Fatty Acid #2
frother: Aero 65,
pH: around 9 with NaOH
modifiers: sodium silicate as a dispersant

A total of 15 flotation tests were carried out to investigate the effects of flotation on the concentration and recovery of barite. Ten tests were performed to examine rougher flotation under two sets of conditions for the five ore types. An additional five tests were carried out to examine the effect of multiple recleaning steps on the recovery of the barite.

General Test Procedure

A one kilogram sample of barite ore was ground in a laboratory sized rod mill for five minutes at 50 percent solids. This produced a product which was approximately 65 percent passing 200 mesh. The flotation testing was carried out using a Denver model D1 laboratory flotation machine and the "one kilogram" cell. The ground ore was slurried in the cell and all flotation reagents were then added to the slurry.

Five tests were carried out to examine the effect of using Areo 845 as the collector. Five more tests were carried out to examine the effect of using fatty acid #2 as the collector. The test results are summarized below, complete results are presented in the appendix.

Table I

Comparison of two different collectors on the flotatior concentration of Barite samples from El Cuervo Butte.

Collector:
Tests Nos. 1 - 5 Aero 845
Tests Nos. 6 -10 FA #2

Sample	Product	$BaSO_4$ %		$BaSO_4$ Dist.	
		Test 1	Test 6	Test 1	Test 6
1	Concentrate	48.3	23.7	91.1	87.2
	Tail	9.2	33.2	8.9	12.8
	Head(assayed)	39.4	39.4	100.0	100.0

Sample	Product	$BaSO_4$ %		$BaSO_4$ Dist.	
		Test 2	Test 7	Test 2	Test 7
2	Concentrate	67.3	65.8	???	97.8
	Tail	0??	20.4	???	2.2
	Head(assayed)	77.7	77.7	100.0	100.0
		Test 3	Test 8	Test 3	Test 8
3	Concentrate	71.9	66.3	75.2	99.0
	Tail	34.5	7.6	24.8	1.0
	Head(assayed)	75.5	75.5	100.0	100.0
		Test 4	Test 9	Test 4	Test 9
4	Concentrate	46.4	44.4	90.9	97.4
	Tail	1.6	4.7	9.1	2.6
	Head(assayed)	21.2	21.2	100.0	100.0
		Test 5	Test 10	Test 5	Test 10
5	Concentrate	65.9	61.5	38.2	98.3
	Tail	43.3	4.4	61.8	1.7
	Head(assayed)	68.4	68.4	100.0	100.0

As can be seen in these results, the Aero 845 collector always gave a higher grade of $BaSO_4$ in the concentrate, then was obtained with the Fatty Acid collector. Conversely, the Fatty Acid gave substantially higher recoveries then did the Aero 845. It appears that the Aero 845 is more selective for barite then is the fatty acid. Making any further conclusions based on these results is difficult since the products do not balance well with the assayed heads.

Following this initial test work it was decided to try, one series of tests to investigate the effects of recleaning the rougher flotation concentrate to improve the final grade of barite contained in the concentrate. For this test work the Fatty Acid #2 was used as the collector since it gave much higher recoveries in the rougher flotation, which if they could be successfully cleaned would yield the best over all performance. These test results are summarized below, and presented in detail in the appendix.

Table II
Effects of Recleaning on the Final Concentration of Barite
(Tests Nos. 11 - 15 Fatty Acid # 2)

Test No.	Sample	Product	Wt %	$BaSO_4$ %	$BaSO_4$ Dist.
11	1	Cln Conc.	49.1	68.1	72.8
6	1	Concentrate	90.5	23.7	87.2
12	2	Cln Conc.	80.8	92.9	91.9
7	2	Concentrate	93.3	65.8	97.8
13	3	Cln Conc.	39.5	98.4	48.1
8	3	Concentrate	91.8	66.3	99.0
14	4	Cln Conc.	14.6	80.6	41.4
9	4	Concentrate	80.1	44.4	97.4
15	5	Cln Conc.	28.7	94.9	39.2
10	5	Concentrate	80.7	61.5	98.3

As seen in this comparison, recleaning the rougher concentrate produced substantially higher grades in the cleaner concentrate product, at the expense of lower recoveries. Based on these results it would be expected that the flow sheet for treating this material would consist of multiple stages of flotation with the intermediate tailings being recycled to earlier stages of flotation. This would seem to be the only way to ensure a high grade in the final product, while limiting the loss of barite to the final tailings.

Gravity Concentration

Two gravity concentration tests were performed using a laboratory sized shaking table to produce four products, two concentrates, a middling and a tailing. Feed material for these tests were taken from El Cuervo Butte sample #2 and sample #5.

Sample Preparation: Each sample was ground to 65 mesh prior to being concentrated on the shaking table.

Discussion: The test products were collected and analyzed for barite content with the results summarized below:

Gravity Test #1
Sample: El Cuervo Butte #2

Test Product	Wt %	% $BaSO_4$	$BaSO_4$ % Distributior
Conc I	15.0	80.4	21.1
Conc II	45.1	59.8	47.1
Middling	18.3	39.3	12.6
Tailing	21.6	51.0	19.2
Head (analyzed)		77.7	
Head (computed)		57.2	

Gravity Test #2
Sample: El Cuervo Butte #5

Test Product	Wt %	% $BaSO_4$	$BaSO_4$ % Distribution
Conc I	24.2	70.4	36.0
Conc II	35.5	46.9	35.1
Middling	16.7	31.8	11.2
Tailing	23.6	35.5	17.7
Head (analyzed)		68.4	
Head (computed)		47.4	

As seen in these results the barite was successfully concentrated using gravity techniques. However a significant fraction of the barite also reported to the tailings, in fact in both tests the barite grade in the tailing product was higher than the grade of the middling product. Further conclusions are again hampered by the poor agreement in the metallurgical balances of these tests.

Conclusions

1. The El Cuervo Butte samples were successfully upgraded by both flotation and gravity concentration.

2. High grade flotation products can be achieved but only with multiple stages of recleaning which decreases the overall recovery in the final concentrate. Therefore, any flow sheet using flotation to treat the material from El Cuervo Butte, will almost certainly include multiple recycling of intermediate tailing products to previous stages of flotation.

3. While the barite was upgraded by gravity concentration the loss of barite to the tailings (finer sizes) was significant. Tight control on particle size distribution should improve the overall recovery of the barite and minimize the losses to the final tailings.

References

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Mineral Facts and Problems, U.S. Bureau of Mines Bulletin 675, U.S. Government Printing Office, 1985, pp 65 - 75.

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APPENDIX

Summary of Flotation Test Results

Tests Nos. 1 - 5
Collector: Aero 845

Test No.	Sample	Product	Wt %	$BaSO_4$ %	$BaSO_4$ Dist.
1	1	Concentrate	66.0	48.3	91.1
		Tail	34.0	9.2	8.9
		Head(assayed)		39.4	
		Head(computed)		35.0	
2	2	Concentrate	85.7	67.3	???
		Tail	14.3	0??	???
		Head(assayed)		77.7	
		Head(computed)		57.7	
3	3	Concentrate	59.3	71.9	75.2
		Tail	40.7	34.5	24.8
		Head(assayed)		75.5	
		Head(computed)		56.7	
4	4	Concentrate	25.5	46.4	90.9
		Tail	74.5	1.6	9.1
		Head(assayed)		21.2	
		Head(computed)		13.0	
5	5	Concentrate	28.9	65.9	38.2
		Tail	71.1	43.3	61.8
		Head(assayed)		68.4	
		Head(computed)		49.8	

Tests Nos. 6 - 10
Collector: Fatty Acid # 2

Test No.	Sample	Product	Wt %	$BaSO_4$ %	$BaSO_4$ Dist.
6	1	Concentrate	90.5	23.7	87.2
		Tail	9.5	33.2	12.8
		Head(assayed)		39.4	
		Head(computed)		24.6	
7	2	Concentrate	93.3	65.8	97.8
		Tail	6.7	20.4	2.2
		Head(assayed)		77.7	
		Head(computed)		62.7	
8	3	Concentrate	91.8	66.3	99.0
		Tail	8.2	7.6	1.0
		Head(assayed)		75.5	
		Head(computed)		61.5	
9	4	Concentrate	80.1	44.4	97.4
		Tail	19.9	4.7	2.6
		Head(assayed)		21.2	
		Head(computed)		36.5	
10	5	Concentrate	80.7	61.5	98.3
		Tail	19.3	4.4	1.7
		Head(assayed)		68.4	
		Head(computed)		50.5	

Tests Nos. 11 - 15 Fatty Acid # 2

Test No.	Sample	Product	Wt %	$BaSO_4$ %	$BaSO_4$ Dist.
11	1	Concentrate	49.1	68.1	72.8
		Cln Tail	11.2	32.1	7.8
		Ro Tail	39.7	22.5	19.4
		Head(assayed)		39.4	
		Head(computed)		45.9	
12	2	Concentrate	80.8	92.9	91.9
		Cln Tail	13.2	29.5	4.8
		Ro Tail	6.0	44.3	3.3
		Head(assayed)		77.7	
		Head(computed)		81.0	
13	3	Concentrate	39.5	98.4	48.1
		Cln Tail	16.4	72.5	14.7
		Ro Tail	44.1	67.9	37.1
		Head(assayed)		75.5	
		Head(computed)		80.7	
14	4	Concentrate	14.6	80.6	41.4
		Cln Tail	13.7	20.9	10.1
		Ro Tail	71.1	19.2	48.5
		Head(assayed)		21.2	
		Head(computed)		28.4	
15	5	Concentrate	28.7	94.9	39.2
		Cln Tail	4.0	32.0	1.9
		Ro Tail	68.3	60.0	58.9
		Head(assayed)		68.4	
		Head(computed)		69.5	