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MINES BRANCH INVESTIGATION REPORT

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RECOVERY OF BARITE FROM TAILINGS, BUCHANS, NEWFOUNDLAND

(PROJECT MP-IM-7007)

by

F. H. Hartman and R. A. Wyman

Mineral Processing Division

Mines Branch Investigation Report IR 74-17

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SUMMARY

At the request of International Drilling Fluids, Calgary, a project was initiated to find and develop drilling mud on the East Coast. Barite was floated from ASARCO's Buchans tailings after grinding to freshen surfaces and free middling particles. A single reagent, Igepon T-33, was used to recover 75% of the barite at 91% $BaSO_4$. The highest grade obtained was 93% $BaSO_4$.

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INTRODUCTION

In June, 1970, Mr. M. Charles MacDonald, International Drilling Fluids, Calgary, Alberta, visited the Mineral Processing Division accompanied by Dr. W. Graham, National Research Council, Ottawa. They were interested in recovering barite from tailings of the American Smelting and Refining Company's (ASARCO) mine, Buchans Unit, Buchans, Newfoundland.

In 1957, Buchans Mining Company, Limited, a subsidiary of ASARCO, ran a 9-day pilot plant test on final mill tailings to produce barite concentrates. In 1968, Baroid Division, National Lead Company, attempted recovery of barite from tailings for use in drilling mud. Neither trial proved sufficiently economical to warrant implementation.

The Mines Branch was asked to try its process[1] to recover barite with the objective, if successful, of setting up a small scale operation at the Buchans' location to produce 10 tons per day of barite for use in drilling muds. International Drilling Fluids had an agreement with ASARCO to cover such an arrangement.

SAMPLE

A 100-lb tailing sample (MPD 70/66) was shipped from Buchans to Ottawa in July, 1970. Final assay as reported by ASARCO was:

Copper	0.08%	
Lead	0.44%	
Zinc	1.08%	
$BaSO_4$	33.6%	(barite)

PROCEDURE AND RESULTS

Analytical Methods

Barium was determined by X-ray fluorescence and calculated as $BaSO_4$. The accuracy of this method is reported only to the nearest 0.1%.

Semi-quantitative spectrochemical analyses were run of the barite concentrates submitted to International Drilling Fluids.

Methylene iodide, a heavy liquid, (specific gravity 3.33), was used in some tests to separate certain products into "sink and float" fractions. The sink fraction from the heavy liquid separation was analysed by X-ray diffraction; magnetic products were checked the same way.

Grinding

Results of three wet grinding tests run at 50% solids in a medium-size, (8.75-inch diameter x 9.60-inch long) Abbe mill, are given in Table 1 and compared with the sample as-received. The grinding media comprised 3000 grams of half-inch burundum "cylpebs". The mill was operated at 80 rpm for times indicated for each test.

Magnetic Separation

The head sample, as-received, was passed once through the Jones wet magnetic mineral separator equipped with salient pole plates, at 25 amperes. Products were analysed for $BaSO_4$. The results are shown in Table 2.

Flotation

Test work was done at 20-25% solids in a 500-gram Denver Sub-A laboratory flotation cell.

Test 1 was carried out with material as-received. In Test 2, the magnetic fraction was removed before flotation. The pulp was conditioned with a small amount of sodium silicate (dispersant) and the barite was floated

TABLE 1

Grinding Data

Head Sample: MPD 70/66

Screen Test No.			1	2	3
Duration of Grind		as received	10 min	15 min	20 min
Tyler Screen Fraction		weight	weight	weight	weight
Minus	Plus	%	%	%	%
-	48	0.3	-	-	-
48	65	2.2	0.7	0.5	0.2
65	100	6.6	2.1	1.4	0.9
100	150	9.0	5.1	3.5	2.7
150	200	9.5	9.0	7.2	3.6
200	325	12.2	13.9	13.4	11.6
325		60.2	69.2	74.0	81.0
Total		100.0	100.0	100.0	100.0

TABLE 2

Magnetic Separation Head Sample

Jones Test 1, 25 amperes, salient pole plates

Fraction*	Wt %	$BaSO_4$ %	
		Analysis	Distribution
Magnetic	8.6	4.7	1.2
Middling	41.2	38.0	46.3
Non-magnetic	50.2	35.3	52.5
Head (calc)	100.0	33.78	100.0
Head (assay)	-	33.9	-

*X-ray diffraction analysis indicated that the non-magnetic and middling fractions were identical to the head sample. The magnetic fraction had less barite, but had increased amounts of chlorite, quartz and mica. (Mineral Processing Division Mineralogical Report Sample MP-MIN-1415).

with the collector Igepon T-33, added with conditioning, in seven steps.

The product was cleaned twice. Results are given in Tables 3 and 3A.

TABLE 3

Flotation Tests 1 and 2, Tailings "as-received"
No grind, with and without magnetic separation

Test No.	1			2		
CONDITIONS						
Magnetic Separation, Jones	-			25 amp*		
Reagents, lb/ton:						
Sodium silicate	0.25			0.25		
Igepon T-33	0.4x7 = 2.8 (roughers)			0.4x7 = 2.8 (roughers)		
RESULTS						
	Wt	$BaSO_4$ %		Wt	$BaSO_4$ %	
Fraction	%	Anal	Dist	%	Anal	Dist
Magnetic	-	-	-	8.6	4.7	1.1
Barite Concentrate	24.4	84.6	60.0	33.4	88.0	82.3
Cleaner 2 Tailings	6.9	49.5	9.9	6.1	37.4	6.4
Cleaner 1 Tailings	15.7	33.9	15.4	13.3	17.2	6.4
Rougher Tailings	53.0	9.5	14.7	38.6	3.5	3.8
Head (calc)	100.0	34.5	100.0	100.0	35.72	100.0

*Combined middling and non-magnetic fractions from Jones Test 1 (Table 2) used as feed.

TABLE 3A

Sink Fractions, S.G. 3.33, Tests 1 and 2

Test	1*		2	
Fraction	Wt %	Colour	Wt %	Colour
Barite Concentrate	97.22	light grey-white	95.64	not recorded
Cleaner 2 Tailings	93.46	dark grey	74.66	"
Cleaner 1 Tailings	26.48	dark grey	12.27	"
Rougher Tailings	9.79	dark grey	4.56	"

*X-ray diffraction analysis indicated that the pyrite content decreased progressively from rougher tailings through 1st and 2nd cleaner tailings. In the barite concentrate, only barite and a trace of pyrite were identified. (Mineral Processing Division, Mineralogical Report, Sample MP-MIN-1415).

Flotation test 3 was done with pulp ground for 10 minutes, using only Igepon T-33 at the natural pH of the sample in Ottawa tap water. Cleaning was carried one stage further than in Tests 1 and 2; the amount of collector used was the same. Some barite concentrate from this test was sent to International Drilling Fluids for evaluation.

Test 4 was similar to Test 3, except that a fourth cleaning was added and more Igepon T-33 was used in the roughers; additional collector was necessary in Cleaner 1.

Test 5 was similar to Test 4 in the rougher float. The rougher concentrate was then filtered, re-ground for 20 minutes, re-floated with more Igepon T-33, and cleaned a total of four times.

Results are shown in Tables 4 and 4A.

TABLE 4

Flotation Tests 3, 4, and 5: Ground Tailings
Reagent: Igepon T-33 only

Test No.	3			4			5		
CONDITIONS Reagents, lb/ton Igepon T-33	0.4x7 = 2.8			0.8x4 = 3.2(roughers) 0.4x1 = 0.4(Cleaner 1)			0.8x4 = 3.2(roughers) 0.4x2 = 0.8(Cleaner 1)		
REMARKS	Head sample ground for 10 min			Head sample ground for 10 min			Head sample ground for 10 min, rougher concentrate filtered and re-ground for 20 min		
RESULTS Fraction	Wt %	$BaSO_4$ % Anal	$BaSO_4$ % Dist	Wt %	$BaSO_4$ % Anal	$BaSO_4$ % Dist	Wt %	$BaSO_4$ % Anal	$BaSO_4$ % Dist
Barite Concentrate	19.8*	91.0	50.8	22.1	93.0	58.5	16.8	92.0	43.8
Cleaner 4 Tailings	-	-	-	2.8	77.0	6.1	2.8	80.6	6.4
Cleaner 3 Tailings	3.5	68.0	6.7	4.3	62.5	7.6	5.5	69.5	10.8
Cleaner 2 Tailings	6.0	51.6	8.8	8.9	42.5	10.8	11.3	55.2	17.7
Cleaner 1 Tailings	21.4	39.8	24.0	16.7	23.4	11.1	17.1	28.8	13.9
Rougher Tailings	49.3	7.0	9.7	45.2	4.6	5.9	46.5	5.65	7.4
Head (calc)	100.0	35.5	100.0	100.0	35.2	100.0	100.0	35.3	100.0

*Semi-quantitative spectrochemical analysis indicated Ba - Principal constituent, Si - 0.7% Al - 0.2%, Mg - 0.2%, Pb - 0.6%, Mn - 0.01%, Fe - 0.7%, Ca - 0.4%, Na - 0.3%, Cu - 0.05%, Ag - 0.06%, Zn - 1.3%;
not detected - Zr, Ni, Ti, Mo, V, Cr, Nb, As, Bi, Sb, Co, P, Be, W. In, Ge, Li.
(Mineral Sciences Division, Spectrochemistry Section, Internal Report MS-SC-71-73).

TABLE 4A

Sink Fraction, S.G. 3.33, Test 3

Fraction	Wt %
Barite Concentrate	97.00
Cleaner 3 Tailings	98.22
Cleaner 2 Tailings	96.45
Cleaner 1 Tailings	55.25
Rougher Tailings	6.16

In Tests 6 and 7 the grinding time was increased to 15 and 20 minutes. More Igepon T-33 was used. No heavy media separations were done. Results are shown in Table 5.

TABLE 5

Flotation Tests 6 and 7: Ground Tailings

Grind increased, reagent:Igepon T-33 alone

Test No.	6			7		
CONDITIONS Duration of grind Reagents, lb/ton Igepon T-33	Head sample ground 15 min 0.8x5 = 4.0 (roughers) 0.4x2 = 0.8 (cleaner 1)			Head sample ground 20 min 0.8x5 = 4.0 (roughers) 0.4x2 = 0.8 (cleaner 1)		
RESULTS Fraction	Wt %	$BaSO_4$ % Anal	$BaSO_4$ % Dist	Wt %	$BaSO_4$ % Anal	$BaSO_4$ % Dist
Barite Concentrate	27.4	92.3	71.5	29.4	91.3	75.5
Cleaner 4 Tailings	1.9	56.2	3.0	1.8	54.1	2.7
Cleaner 3 Tailings	4.0	53.6	6.1	3.9	45.5	5.0
Cleaner 2 Tailings	9.8	33.6	9.4	8.9	30.3	7.6
Cleaner 1 Tailings	17.5	13.7	6.8	14.5	12.0	4.9
Rougher Tailings	39.4	2.84	3.2	41.5	3.72	4.3
Head (calc)	100.0	35.24	100.0	100.0	35.58	100.0

DISCUSSION

A short history of the development of milling at Buchans, Newfoundland, and a description of the operation has been published[2].

The sample responded well to the Mines Branch method of floating barite with sodium taurates (Igepon T-33). There was little indication that removal of the magnetic fraction before flotation was necessary or economical for the production of drilling-mud grade barite.

Grinding to freshen or polish surfaces gave improved results. Higher recoveries were obtained with longer grinding time, indicating that some barite is present as combined particles.

The results from bench-scale, batch tests 3 to 7 (Tables 4, 4A and 5) warranted testing on a continuous basis on a pilot-plant scale. Such an approach should decrease reagent consumption, increase recovery, establish final grade, and show if middling problems are present.

At the time the above program was completed, work on the flotation of barite with Igepon T-33 was being done by Professor Michael A. K. Grice at Atlantic Industrial Research Foundation, Nova Scotia Technical College, Halifax, in conjunction with the Mines Branch. It was suggested that he be requested to undertake pilot plant tests with Buchans tailings. At the same time, International Drilling Fluids expressed a desire to do some experimental flotation work in Calgary.

The Foundation at Halifax was contacted from Calgary and Ottawa and a sample from the mine sent for testing. However, the writers believe this work was never authorized or done.

Igepon T-33 is a biodegradable reagent that acts as a selective collector for barite and celestite in many beneficiation applications. As

shipped, it contains some residual oleic acid from feed-stocks, and isopropyl alcohol. Igepon T-33 used alone as a frother/collector tends to produce a voluminous froth. This can be modified; further addition of isopropyl alcohol is suggested. Tall oils or other fatty acids modify the froth but introduce their individual collecting properties.

CONCLUSIONS

Ground tailings from Buchans were beneficiated with the single reagent Igepon T-33 to recover:

(1) 75.5% barite assaying 91.3% $BaSO_4$ (Test 7, Table 5),

(2) 58.5% barite assaying 93.0% $BaSO_4$ (Test 4, Table 4).

Indications are a market exists for drilling mud which is economical for this location. The system developed should be tested at pilot-plant scale.

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J. L. Dalton, Chemist, Spectrochemistry Section, Mineral Sciences Division, carried out X-ray fluorescence and spectrochemical analyses.

R. M. Buchanan, Head, and C.H.J. Childe, Technician, Ore Mineralogy Section, Mineral Processing Division, analysed various products by X-ray diffraction. J. H. Colborne and P. R. Lachapelle, Technicians, provided support in carrying out the test program.

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2. Maher, W. H. and Powell, C.R., "Milling Practice at Buchans, Newfoundland", C.I.M.M. Transactions, Vol LX1X, 1966, pp 273-280.

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