

TR18, 214-220

R.672. Fluorite recovery tests, cassiterite grain size determinations, Khaki Lode, Cleveland Tin N.L.

P.L. James
H.K. Wellington

Five samples were obtained by the Chief Chemist and Metallurgist from the Cleveland Tin N.L. works at Luina. The samples were as follows:

Reg. No.	Description
735696	Khaki lode - grab sample underground ore.
735697	Table tailing w/e 21/8/73
735698	Vanner tailing w/e 21/8/73
735699	Six-inch cyclone P15
735700	Flotation feed P15

The aim of this investigation was to determine the fluorite content of the Khaki lode sample (735696) and the mill products, and to do preliminary tests aimed at concentrating the fluorite in the Khaki lode material.

As there were doubts about the mill recovery when treating Khaki lode ore, a cassiterite grain size determination was done on the grab sample to give an indication of the recovery to be expected.

		ASSAYS							
		Per cent							
		C.Sn	S.Sn	T.Sn	CaF ₂	Cu	Fe	S	CO ₂
735696	Khaki ore*	0.7	0.2	0.9	7.8	0.4	21.9	5.8	10.0
735697	T/T				4.9				
735698	V/T				6.9				
735699	6-inch cyclone P15				9.3				
735700	F.F/D P15				4.1				

* This analysis indicates approximately the major constituents to be:

Pyrrhotite	11%	Fluorite	8%
Stannite	} 2%	Cassiterite	0.9%
Chalcopyrite			
Siderite	25%	Insoluble	50%

Mill samples

There is a concentration of CaF₂ in Sample 735699 and to a lesser extent in Sample 735698.

TEST WORK, KHAKI LODE ORE SAMPLE

Cassiterite grain size analysis

Sample preparation. The total sample was jaw crushed to approximately -5 mm. A sample was cut out by riffing and this sample stage roll crushed to -1 mm. Two hundred grams of the -1 mm material was treated with HCl/HNO₃/HF/H₂SO₄ and the acid treatment residue used for sizing.

Sizing. The residue was sized by elutriation in a Bardwell tube with screen sizing of the Bardwell tube residue.

Result

SnO ₂ Particle Size	Sn Distribution	
	%	% Cumulative
-1 mm +150 μm	7.1	7.1
-150 μm +75 μm	21.8	28.9
-75 μm +38 μm	23.1	52.0
-38 μm +28 μm	20.2	72.2
-28 μm +20 μm	9.7	81.9
-20 μm +13 μm	6.0	87.9
-13 μm +10 μm	5.0	92.9
-10 μm	7.1	100.0
Total	100.0	

Fluorite flotation

Preparation of flotation feed. Minus 5 mm ore was stage pulverized (dry) to -300 μm. Sulphides were removed from a 10 kg charge of -300 μm ore by cleaner batch flotation using copper sulphate, sodium ethyl and potassium amyl xanthates, and MIBC.

Metallic iron from the pulverizer was removed from the flotation tailing pulp with a hand magnet. The tailing was then divided into eight charges of approximately one kilogram for batch fluorite flotation tests.

Pulverizer grinding was used instead of the better, but very time consuming, stage ball mill grinding.

Sulphide flotation results

Product	% Mass
F2C	12.1
FT	87.9
Total	100.0

The sulphides recovered in this operation agrees closely with the approximate total sulphides calculated from the head sample analysis.

Batch fluorite flotation tests. Several preliminary tests were undertaken, with and without desliming to test the effect of a number of collectors. The results of these tests and the flotation conditions are as follow:

Preliminary rougher test results.

Test N1. Flotation conditions

Na ₂ CO ₃	2.2 kg/t (pH=10)
Tannic acid	0.11 kg/t
Oleic acid	0.45 kg/t
Desliming	No desliming
Conditioning time	4 minutes
Flotation time	4 minutes
Temperature	Room temperature

Result

Product	% Mass	% CaF ₂	% CaF ₂ Distn
FC	28.4	17.1	55.7
FT	71.6	5.4	44.3
<hr/>			
H	100.0	8.7	100.0

Test N2. Flotation conditions

Reagents As for Test N1.
 Desliming Deslimed by decantation from cell.
 Temperature FC1 at room temperature.
 FC2 at 42°C.

Result

Product	% Mass	% CaF ₂	% CaF ₂ Distn
FC1	2.0	27.7	6.1
FC2	10.6	25.7	30.2
FT	41.0	1.9	8.7
Slime	46.4	10.7	55.0
<hr/>			
H	100.0	9.0	100.0

Notes: Improved selectivity because of desliming.
 Heating of pulp improved recovery, but there was no improvement in concentrate grade over Test N1.
 Recovery in FC1 + FC2 from deslimed material was 80.6% at an approximate grade of 26% CaF₂.

Test N3. Flotation conditions

Na₂CO₃ 2.2 kg/t (pH 9.8)
 Tannic acid 0.11 kg/t
 Cyanamid 0.45 kg/t
 Light fuel oil 0.18 kg/t
 Deslimed No desliming
 Conditioning time 4 minutes
 Flotation time 6 minutes
 Temperature Room temperature

Result

Product	% Mass	% CaF ₂	% CaF ₂ Distn
FC	22.9	12.5	29.2
FT	77.1	9.0	70.8
<hr/>			
H	100.0	9.8	100.0

Note: The result is not as good as oleic acid treatment under similar conditions, however some selectivity was obtained.

Test N4. Flotation conditions

Reagent As for Test N3
 Desliming Deslimed
 Temperature 44°C

Result

No improvement on Test N3.

Test N5. Flotation conditions

FC1

Desliming Deslimed
 Temperature Room temperature
 Aeromine 3035 0.18 kg/t H₂SO₄ (pH 6)
 Conditioning time 3 minutes
 Flotation time 4

FC2

Aeromine 3035 Further 0.09 kg/t H₂SO₄ (pH 3.5)
 Conditioning time 3 minutes
 Flotation time 3 minutes

FC3

Na₂CO₃ pH 11
 Flotation time 3 minutes

FC4

Sulphonated castor oil 0.09 kg/t
 Conditioning time 2 minutes
 Flotation time 2 minutes

FC5

H₂SO₄ pH 3
 Flotation time 2 minutes

Result

Product	% Mass	% CaF ₂	% CaF ₂ Distr
FC1	11.4	2.7	3.5
FC2	12.4	11.5	16.4
FC3	0.3	5.2	0.2
FC4	2.1	22.8	5.5
FC5	0.4	1.9	0.1
FT	37.3	7.2	30.8
Slime	36.1	10.5	43.5
<hr/>			
H	100.0	8.7	100.0
<hr/>			

Notes: Amine in acid pulp shows some selectivity*.
 Sulphonated castor oil in alkaline pulp shows some selectivity†.
 Recoveries are low with each reagent.
 Heating of the pulp could possibly improve the recoveries.

*Recovery of CaF₂ in the feed at this stage is 29% at a grade of 11.5%.

†Recovery of CaF₂ in the feed at this stage is 14% at a grade of 22.8%.

Cleaner flotation test results.

Test N6. Flotation conditions

	Rougher	Cleaner	Recleaner (F3C1)	Scavenger (F3C2)
Na ₂ CO ₃ (kg/t)	2.2			
pH	9.5	9	9	9
Oleic acid (kg/t)	1.34			
	(0.45 + 0.89)			
Tannic acid (kg/t)		0.09	0.09	
Conditioning time (minutes)	5	3	3	
Flotation time (minutes)	12 (7+5)	5	5	
Temperature	Room	45°C	30°C	30°C
Desliming	None			

Result

Product	% Mass	% CaF ₂	% CaF ₂ Distn
F3C1*	23.0	25.3	77.6
F3C2	4.8	6.1	3.9
F3T	6.5	0.8	0.7
F2T	8.6	2.9	3.3
F1T	57.1	1.9	14.5
<hr/>			
H	100.0	7.5	100.0

* The approximate mineral composition of this concentrate is:

Fluorite	25%	Calcite	26%
Siderite	23%	Acid insoluble	23%

Test N7. Flotation conditions

	Rougher	Cleaner (F2C1)	Scavenger (F2C2)
H ₂ SO ₄ to pH	3.5	3.9	3.9
Primary amine (Alamac 26) (kg/t)	0.67		
Aeromine 3035	0.22	0.89	
Conditioning time (minutes)	5		
Flotation time (minutes)	10	8	4
Desliming	Deslimed		
Temperature	35°C	50°C	40°C

Result

Product	% Mass	% CaF ₂	% CaF ₂ Distn
F2C1	13.9	13.7	18.2
F2C2	7.1	14.5	9.9
F2T	5.8	12.4	6.9
F1T	31.4	7.0	21.0
Slime	41.8	11.0	44.0

H	100.0	10.4	100.0
---	-------	------	-------

Note: The cleaning stage has not improved the grade.
 Rougher concentrate recovery from deslimed
 feed was 62.5% at an average grade of 13.6% CaF₂.

Test N8. Flotation conditions

	Deslime	Rougher	Cleaner	Recleaner
Na ₂ CO ₃ (0.89 kg/t)	Two decants			
Na ₂ SiO ₃ (0.45 kg/t)	From cell			
pH	10	10	9.8	9.5
Oleic adic (kg/t)		0.18		
Sulphonated castor oil (kg/t)		0.09		
Tannic acid (kg/t)		0.05	0.09	
Conditioning time (50% solids) (minutes)		10		
Flotation time (after dilution to 25% solids) (minutes)		6		

Result

Product	% Mass	% CaF ₂	% CaF ₂ Distn
F3C	8.7	28.8	31.6
F3T	1.1	11.3	1.6
F2T	8.0	14.6	14.7
F1T	52.3	1.2	7.9
Slime	29.9	11.7	44.2

H	100.0	7.9	100.0
---	-------	-----	-------

Notes: Recovery from the deslimed feed was 56.6% at
 28.8% CaF₂.
 Reagent addition may be low; compare with N6
 in which 0.89 kg/t of oleic acid was used (with-
 out desliming).

SUMMARY

Mill samples. Assays indicate that there is a concentration of fluorite in the slime products of Samples 735698 and 735699. It is of interest to note that in the batch tests reported here, there is also a concentration of fluorite in the slime decants. Some degree of preferential grinding is perhaps indicated.

Cassiterite grain size analysis. This analysis indicates that tin recovery of the order of 65% should be possible although the presence of a large amount of siderite may pose problems in recovery.

Fluorite flotation tests. Some encouraging results have been obtained so far, particularly using oleic acid as a collector in alkaline pulps. The tests should be regarded as of a preliminary nature only, but have considerable value in showing that some degree of selectivity is obtainable in fluorite flotation from this ore.

Any further test work on fluorite recovery should be done on samples obtained from the mill and taken over an extended period of time. Such samples would then represent a meaningful tonnage of ore which the grab sample 735696 does not.

Note: The cleaning stage has not improved the grade.
Rougher concentrate recovery from deslimed feed was 81.2% at an average grade of 13.5% CaF₂.

[27 November 1973]

Test No. 1 Fluorite conditions

Product	Fluorite	Siderite	CaF ₂	CaO	SiO ₂	Fe	Al ₂ O ₃	Other
Fluorite	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Siderite	0.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0
CaF ₂	0.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0
CaO	0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0
SiO ₂	0.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0
Fe	0.0	0.0	0.0	0.0	0.0	100.0	0.0	0.0
Al ₂ O ₃	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0
Other	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0

Recovery from the deslimed feed was 81.2% at an average grade of 13.5% CaF₂.
Reagent addition may be low; compare with test in which 0.82 kg/t of oleic acid was used with 0.2% desliming.

SUMMARY

Mill samples. Always assume that there is a concentration of fluorite in the fine product of samples 735698 and 735699. It is of interest to note that in the batch tests reported here, there is also a concentration of fluorite in the slime fraction. Some degree of preferential grinding is perhaps indicated.