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MINES BRANCH INVESTIGATION REPORT

IR 73-53 September 1973

CONCENTRATION OF SPODUMENE FROM VAL D'OR, QUEBEC

(PROJECT MP-IM-7105)

by

F. H. Hartman and R. A. Wyman

Mineral Processing Division

Mines Branch Investigation Report IR 73-53

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RESUME

The concentration of spodumene (removing feldspar, quartz, mica, and other iron-bearing minerals by "reverse flotation", as patented by Mines Branch) was tried on ore from Val d'Or, Quebec, supplied by Groupe Minier/SULLIVAN/Mining Group Ltd. who desired a low-iron spodumene concentrate.

Tests run with the original method were not promising. However, a simplified process, using only Armac L-10 (0.4 lb per ton) recovered, without cleaning,

(a) 55% material analysing 5.76% Li_2O; 0.68% Fe_2O_3; 23.73% Al_2O_3

(b) 49% material analysing 5.75% Li_2O; 0.60% Fe_2O_3; 24.00% Al_2O_3

Cleaning would increase recovery.

* Research Scientist, and ** Head, Industrial Minerals Milling Section, Mineral Processing Division, Mines Branch, Department of Energy, Mines and Resources, Ottawa, Canada.

Direction des Mines Rapport d'Investigation IR 73-53

CONCENTRATION DE SPODUMENE DE VAL D'OR, QUEBEC
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RESUME

La concentration du spodumène (par une méthode de "flottation inverse" développée par la Direction des Mines impliquant le déplacement du feldspath, du quartz, du mica ainsi que d'autres minéraux contenant du fer) a été tentée sur un minerai de Val D'Or, Québec, lequel fut soumis par le Groupe Minier Sullivan qui désirait obtenir un concentré de spodumène à basse teneur en fer.

Des essais effectués avec la méthode originale n'ont toutefois pas donné de très bons résultats. Cependant, un procédé simplifié, comportant l'utilisation d'Armac L-10 seulement (0.4 lb/tonne), a permit, sans nettoyage, de récupérer:

(a) 55% de matériel montrant à l'analyse, 5.76% de Li_2O, 0.68% de Fe_2O_3 et 23.73% de Al_2O_3;

(b) 49% de matériel montrant à l'analyse, 5.75% de Li_2O, 0.60% de Fe_2O_3 et 24.00% de Al_2O_3.

Un nettoyage ultérieur permettrait d'accroître la récupération.

*Rechercheur Scientifique et ** Chef, Section de Préparation des Minéraux Industriels, Division du Traitement des Minerais, Direction des Mines, Départment de l'Energie, des Mines et des Ressources, Ottawa, Canada.

CONTENTS

TABLES

INTRODUCTION

Wyman found (1), patented (2), and published (3) information using a new series of reagents to float quartz, feldspar, and iron-bearing minerals from spodumene ore.

The Mines Branch was asked in July, 1971, by Groupe Minier/SULLIVAN/ Mining Group Ltd. to try this "reverse flotation" approach on spodumene ore from their Quebec Lithium property. An objective was to produce a low-iron spodumene product. Previous work had indicated that (1) a low-iron material was not easily obtainable (4,5) and (2) some iron was present in the spodumene molecule (6).

The results of the initial test program in this case were not encouraging, so the original process was simplified. After new results had been confirmed, the simple method was tried on the Quebec Lithium sample.

SAMPLES

A cwt of spodumene ore (MPD 71/38) was received, July 29, 1971, from the Quebec Lithium property, in a drum that was either greasy or oily inside the lid; this was replaced with a 110-pound ore sample (MPD 71/45), received August 23, 1971.

A head sample was prepared by jaw and roll crushing about half the ore to pass 28 mesh. This minimized the production of fines; see the screen analysis in Table 1.

TABLE 1

Screen Analysis of Minus 28-Mesh Head Sample (MPD 71/45)

Tyler Screen Fraction Minus	Tyler Screen Fraction Plus	Weight %	Li_2O % Analysis	Li_2O % Distribution	Fe_2O_3 %	Al_2O_3 %
28	35	8.8	1.88	10.5		
35	48	28.3	1.84	32.9		
48	65	15.8	1.63	16.3		
65	100	12.6	1.39	11.1		
100	150	9.3	1.40	8.3		
150	200	6.6	1.28	5.4		
200		18.6	1.32	15.5		
Heads (calc)		100.0	1.57	100.0		
Heads (assay)			1.59		0.25	16.67

EXPERIMENTAL WORK

Magnetic Separation

The minus 28-mesh head sample was run through the Jones wet magnetic separator, equipped with high-intensity plates, at 25 amperes (Table 2).

TABLE 2

Wet Magnetic Separation of Minus 28-Mesh Head Sample (MPD 71/45)
Jones Test 1

Fraction	Weight %	Li_2O % Analysis	Li_2O % Distribution	Fe_2O_3 % Analysis	Fe_2O_3 % Distribution
Magnetics	7.1	3.95	17.7	0.93	30.6
Middlings	41.6	1.71	45.0	0.20	38.5
Non-Magnetics	51.3	1.15	37.3	0.13	30.9
Heads (calc)	100.0	1.58	100.0	0.21	100.0
Heads, Assay		1.59		0.25	

Grinding

The minus 28-mesh head sample was ground wet (50% solids) in a medium-size 8.75 x 9.60-inch-long Abbe mill, the media being 3000 g half-inch burundum "cylpebs". For some tests, the plus 48-mesh fraction in the feed was reduced to minus 48 mesh.

Results of the two grinds are given in Table 3.

TABLE 3

Grinding Data
Head Sample (MPD 71/45)

Screen Test		2			3
Duration of Grind		15 minutes			40 minutes
Feed		minus 48-mesh			minus 28-mesh
Tyler Screen Fractions		Weight %	Li_2O % Analysis	Li_2O % Distribution	Weight %
Minus	Plus				
28	35	-			0.8
35	48	-			1.2
48	65	2.2	3.47	5.2	1.7
65	100	9.2	2.50	15.8	3.6
100	150	21.8	1.28	19.2	9.2
150	200	14.3	1.30	12.8	14.2
200	325	18.6	1.32	16.9	24.5
325		33.9	1.29	30.1	44.8
Heads, Calculated		100.0	1.45	100.0	100.0

Flotation

Original Reverse Flotation

Freshly ground ore was conditioned for one minute in a NaOH-alkaline pulp. The pulp was conditioned with soluble starch for one minute to depress spodumene. A collector, the commercially available acetate salt of B-amine, Armac L-10, was added in one-minute conditioning stages and pine oil was tried as a frother. Several concentrates were cut, and rougher tails were deslimed before filtering.

In some cases before flotation, the ground ore was deslimed by treating with caustic soda, swirling in a pail, settling, and decanting the fines; for some tests it was passed at 25 amperes through the Jones wet magnetic separator equipped with high-intensity plates.

Mica, quartz, and feldspar floats were attempted.

Flotation was done in a 500-gram Denver Sub-A cell.

Table 4 gives results of four tests on minus 28- and minus 48-mesh feed that had been ground 15 minutes.

Test 4 indicated that in the rougher tails higher-grade spodumene was in the finer sizes. Time of grinding was increased.

Grinding for 20 minutes and screening the rougher tails (Test 5) showed a concentration of Li_2O in the plus 48-mesh fraction.

In Test 6, after a 20-minute grind, plus 65-mesh material was removed by wet screening.

Test 7 was a repeat of Test 6 with grinding time increased to 30 minutes.

Results are shown in Table 5. Only the rougher tails were deslimed.

TABLE 4

Flotation Tests 1 - 4

15-minute grind and one-minute conditioning*

Test	1			2			3			4		
CONDITIONS												
Feed mesh	-28			-48			-48			-48		
Magnetic Separation												
Jones High-Intensity plates	-			-			-			25 amp x 2		
Desliming												
Caustic soda lb/ton	1			1			1			-		
Flotation - Mica												
Caustic soda lb/ton	-			-			1			1		
Armac L-10 lb/ton	-			-			0.8			0.4**		
Flotation - Other												
Caustic soda lb/ton	1			1			-			-		
Soluble starch lb/ton	1.2			1.2			1.2			1.2		
Armac L-10 lb/ton	1.2; 0.4; 0.4			1.2; 0.4; 0.4; 0.4; 0.4			0.4			0.4; 0.4; 0.4; 0.4		
Pine oil lb/ton	-			-			0.1			0.1		
REMARKS	all slimes combined			Slimes 2-Rougher Tails			Conc 1 - Mica fraction Conc 2,3,&4 - Pine oil All slimes combined			Conc 1 - Mica Conc 2 - Pine oil only Rougher Tailsonly deslimed		
RESULTS Fractions	Wt %	Anal	Dist	Wt %	Anal	Dist	Wt %	Anal	Dist	Wt %	Anal	Dist
Magnetics	-	-	-	-	-	-	-	-	-	1.8	3.72	4.3
Slimes 1	20.3	1.08	14.8	16.8	0.27	3.2	28.0	1.16	22.9	-	-	-
Slimes 2 Rougher Tails	-	-	-	1.1	2.44	1.9	-	-	-	1.0	3.16	2.0
Conc 1	14.9	0.24	2.4	0.9	0.38	0.2	0.6	0.52	0.2	2.6	1.30	2.2
Conc 2	17.1	0.27	3.1	8.0	0.21	1.2	31.3	0.17	3.8	2.7	0.94	1.6
Conc 3	8.6	0.74	4.3	23.0	0.23	3.8	8.7	0.28	1.7	31.0	0.25	4.9
Conc 4	-	-	-	11.9	0.59	4.9	4.4	0.50	1.6	33.4	0.55	11.7
Conc 5	-	-	-	3.9	1.84	5.1	-	-	-	10.1	3.83	24.4
Conc 6	-	-	-	-	-	-	-	-	-	1.4	3.79	3.4
Rougher Tails (deslimed)	38.9	2.88	73.4	34.4	3.27	79.7	27.0	3.67	69.8	16.0	4.47	45.5
Heads (calcd)	100.0	1.48	100.0	100.0	1.41	100.0	100.0	1.41	100.0	100.0	1.57	100.0
Rougher Tails, plus 65-mesh	-	-	-	-	-	-	-	-	-	11.1	3.75	9.6
65 to 100-mesh	-	-	-	-	-	-	-	-	-	34.2	3.91	30.9
100 to 150 "	-	-	-	-	-	-	-	-	-	30.6	3.84	27.0
minus 150-mesh	-	-	-	-	-	-	-	-	-	24.1	5.82	32.5
Rougher Tails (calcd)										100.0	4.33	100.0

* Each addition of reagent

** Plus 0.1 lb/ton Pine oil

TABLE 5

Flotation Tests 5 to 7
Minus 28-mesh feed, varied grind, one-minute conditioning and no desliming

Test	5			6			7		
CONDITONS									
Duration of grind, minutes	20			20			30		
Magnetic Separation									
Jones Hi-Intensity Plates	25 amp x 2			-					
Flotation									
Caustic soda lb/ton	1			1			1		
Soluble starch lb/ton	1.2			1.2			1.2		
Armac L-10 lb/ton	0.8; 0.4; 0.4; 0.4			0.8; 0.4; 0.4			0.8; 0.4; 0.4		
Pine oil lb/ton	0.1 0.1			0.1 0.1			0.1 0.1		
RESULTS Fractions	Wt %	Li_2O % Anal	 Dist	Wt %	Li_2O % Anal	 Dist	Wt %	Li_2O % Anal	 Dist
Magnetics	3.5	4.40	10.6	-	-	-	-	-	-
Plus 65-Mesh	-			21.2	2.88	41.7	9.2	4.34	26.6
Slimes	1.2	2.48	1.9	1.8	3.44	4.2	0.6	3.66	1.6
Conc 1	5.6	0.38	1.4	4.9	0.23	0.8	9.4	0.27	1.7
Conc 2	37.2	0.31	7.8	42.3	0.28	8.0	45.9	0.31	9.4
Conc 3	25.0	0.78	13.2	20.8	1.25	17.7	23.7	1.42	22.3
Conc 4	2.7	2.80	5.2	-	-	-	-	-	-
Rougher Tails (deslimed)	24.8	3.57	59.9	9.0	4.51	27.6	11.2	5.15	38.4
Heads, Calculated	100.0	1.48	100.0	100.0	1.47	100.0	100.0	1.50	100.0
Rougher Tails, Plus 48-Mesh	24.7	3.87	28.3						
48 to 65-Mesh	25.0	2.96	21.9						
65 to 100-Mesh	23.0	2.83	19.3						
100 to 150-Mesh	17.3	2.92	15.0						
Minus 150-Mesh	10.0	5.23	15.5						
Rougher Tails, Calculated	100.0	3.37	100.0						

In Tests 9, 10, and 11, minus 28-mesh feed was ground for 35 minutes, the concentrate was cleaned twice, all tails were deslimed and the products combined.

In order to try and float feldspar from quartz in Test 10, the pH of the cleaned concentrate was reduced to about 3 and refloated. Mineralogical examination of the products indicated some separation of spar.

Beneficiation of feldspar was carried a step further in Test 11, in that spar, after flotation from quartz, was cleaned once. All products were deslimed before filtering and the slimes were combined; see Table 6.

TABLE 6

Flotation Tests 9 to 11

Minus 28-mesh feed, 35-minute grind, one-minute conditioning, and no desliming

Test	9			10			11		
CONDITIONS									
Flotation									
Caustic soda lb/ton	1			1			1		
Soluble starch lb/ton	1.2			1.2			1.2		
Armac L-10 lb/ton	0.8 + 0.4 + 0.4			0.8 + 0.4 + 0.4			0.8 + 0.4 + 0.4		
Pine oil lb/ton	0.1 + 0.1			0.1 + 0.1			0.1 + 0.1		
REMARKS				Spar/Quartz float H_2SO_4 to pH-3			Spar/Quartz float H_2SO_4 to pH-3		
RESULTS	Wt	Li_2O %		Wt	Li_2O %		Wt	Li_2O %	
Fractions	%	Anal	Dist	%	Anal	Dist	%	Anal	Dist
Slimes	3.0	3.51	8.0	4.1	2.99	9.3	13.9	1.79	16.6
Spar Conc				43.5	0.35	11.7	26.5	0.25	4.4
Spar Cl 1 Tails				–	–	–	19.1	0.18	2.3
Quartz Conc				20.2	0.41	6.4	9.7	0.35	2.3
Conc	65.0	0.32	15.2	–	–	–	–	–	–
Cl 2 Tails	4.7	0.65	2.2	6.6	0.90	4.6	4.4	0.98	2.9
Cl 1 Tails	5.3	1.90	7.3	6.3	1.90	9.2	5.3	1.98	7.0
Rougher Tails(deslimed)	22.0	4.19	67.3	19.3	3.97	58.8	21.1	4.58	64.5
Heads, Calculated	100.0	1.36	100.0	100.0	1.30	100.0	100.0	1.49	100.0

Test 12, 13, and 14 used minus 28-mesh head material and varied the time of grind.

Test 12 was the same as Test 11 but with a 40-minute grind.

In Test 13 a second concentrate was cut after adding more NaOH, soluble starch, Armac L-10, and pine oil; this was not deslimed before filtering. Conditioning time was increased to 2 minutes.

Test 14 repeated the conditons of Test 13 but the time of grind was increased from 30 to 35 minutes.

Results are given in Table 7.

Rougher tails from Tests 13 and 14 were separated by tetrabromoethane (TBE) specific gravity 2.96. Sink fractions were analysed chemically for Li_2O and Fe_2O_3 and they were then examined mineralogically (see Table 8).

Modified Concept of Reverse Flotation

In a natural pH circuit, L-10 appears to be a highly selective reagent to float feldspar, quartz, and iron-bearing minerals from spodumene. The material must be ground fine for liberation and to allow the collector to lift the gangue. Spodumene that may come over with the froth from excess grinding drops off in early stages of cleaning. The amount of L-10 used is less than in an alkaline circuit. Desliming is not necessary.

In Test 15, the ore was ground for 35 minutes in Ottawa tap water, L-10 was added once, and the froth was cleaned twice. Slimes from all samples were combined before filtering.

In Test 16, time of grind was increased to 40 minutes, and some L-10 added to the first cleaning stage. The rougher tails were passed through the Jones magnetic separator, equipped with high-intensity plates, at 25 amperes. All samples, except the magnetics were deslimed before filtering, and all slimes were combined; see Tables 9 and 10.

TABLE 7

Flotation Tests 12 to 14

Minus 28-mesh feed, varied grind and conditioning, and no desliming

Test	12	13	14
CONDITIONS			
Duration of Grind (minutes)	40	30	35
Flotation			
Conditioning Time min	1	2	2
Caustic soda lb/ton	1	1	1
Soluble starch lb/ton	1.2	1.2	1.2
Armac L-10 lb/ton	0.8 + 0.4 + 0.4	0.8 + 0.4	0.8 + 0.4
Pine oil lb/ton	0.1 + 0.1	0.1	0.1
REMARKS		Concentrate 2: NaOH - 1 lb/ton, soluble starch - 1.2 lb/ton, Armac L-10 - 0.4 + 0.4 + 0.4 lb/ton, Pine oil - 0.1 lb/ton. Spar/Quartz float: H_2SO_4 to pH - 3	

RESULTS Fractions	12 Wt %	12 Li_2O% Anal	12 Li_2O% Dist	12 Al_2O_3 %	13 Wt %	13 Li_2O % Anal	13 Li_2O % Dist	13 Al_2O_3 %	14 Wt %	14 Li_2O % Anal	14 Li_2O % Dist	14 Al_2O_3 %
Slimes	13.2	1.66	15.8		18.2	1.02	12.5		10.4	1.55	11.2	-
Spar Conc	22.9	0.32	5.3	16.60	8.9	0.21	1.3	17.10	17.5	0.26	3.2	16.47
Spar Cleaner 1 Tails	25.5	0.28	5.1	14.32	13.3	0.15	1.3	14.17	16.4	0.20	2.3	14.04
Quartz Conc	12.0	0.52	4.5	15.79	16.9	0.13	1.5	13.01	15.1	0.23	2.4	13.78
Cl 2 Tails	6.3	1.78	8.0		4.4	0.41	2.0		4.3	0.74	2.2	15.91
Cl 1 Tails	6.3	3.27	14.8		1.6	1.86	1.2		1.0	2.84	2.0	21.58
Conc 2					9.1	1.26	7.7		5.4	1.92	7.2	-
Rougher Tails (deslimed)	13.8	4.67	46.5		27.6	3.91	72.5		29.9	3.35	69.5	-
Heads, Calculated	100.0	1.39	100.0	-	100.0	1.48	100.0	-	100.0	1.43	100.0	-

TABLE 8

Sink Fractions - Rougher Tails
Flotation Tests 13 and 14
T.B.E. (Specific Gravity - 2.96)

Test	% Sinks	Li_2O % Rougher Tails			Fe_2O_3 %
		Sinks	Calcd	Analysis	
13	54.4	6.68	3.62	3.91	0.76
14	49.0	6.63	3.24	3.35	0.76

X-Ray diffraction indicated spodumene to be the major constituent of each sample with quartz, K-spar, and garnet present in minor amounts. No iron minerals were identified.

TABLE 9

Flotation Test 15 (Modified Method)
Minus 28-mesh feed, 35 minute grind, one-minute conditioning, and no desliming

CONDITIONS							
Flotation							
Armac L-10 lb/ton	0.4						
Time of float min	5.5						
REMARKS	All fractions were deslimed before filtering and slimes were combined						
RESULTS	Wt	Li_2O %		Fe_2O_3 %		Al_2O_3 %	
Fractions	%	Anal	Dist	Anal	Dist	Anal	Dist
Slimes	11.6	1.50	11.3	0.50	22.1	18.16	12.6
Concentrate	8.0	0.48	2.5	0.31	9.5	16.95	8.1
Cleaner 2 Tails	25.4	0.36	5.9	0.12	11.6	14.49	22.0
Cleaner 1 Tails	40.2	0.96	25.1	0.12	18.4	15.17	36.4
Rougher Tails	14.8	5.76	55.2	0.68	38.4	23.73	20.9
Heads, Calculated	100.0	1.54	100.0	0.26	100.0	16.75	100.0

TABLE 10

Flotation Test 16 (Modified Method)
Minus 28-mesh feed, 40 minute grind, one minute conditioning, and no desliming

CONDITIONS	
Flotation: Rougher	
Armac L-10 lb/ton	0.2 + 0.2
Minutes of float:	2 3
: Cleaner 1	
Armac L-10 lb/ton	0 + 0.2
Minutes of float	2.5 2.5
Magnetic Separation	
Jones, Hi-Intensity Plates	25 amp x 1
REMARKS	Rougher Tails magnetically separated. All fractions, except magnetics, deslimed before filtering. Slimes combined.

RESULTS Fractions	Wt %	Li_2O % Anal	Li_2O % Dist	Fe_2O_3 % Anal	Fe_2O_3 % Dist	Al_2O_3% Anal	Al_2O_3% Dist
Slimes	6.6	1.46	6.4	0.70	19.6	18.93	7.6
Concentrate	27.9	0.44	8.2	0.16	19.1	15.28	26.2
Cleaner 2 Tails	47.4	0.74	23.3	0.10	20.2	14.15	41.0
Cleaner 1 Tails	5.2	3.63	12.7	0.37	8.3	20.73	6.7
Rougher Tails, magnetics	1.3	6.64	5.5	1.56	8.3	25.32	1.9
" " , middlings	7.4	5.35	26.5	0.46	14.6	22.84	10.4
" " , non-magnetics	4.2	6.24	17.4	0.55	9.9	24.08	6.2
Rougher Tails, Combined	12.9	5.75	49.4	0.60	32.8	24.00	18.5
Heads, Calculated	100.0	1.50	100.0	0.23	100.0	16.32	100.0

DISCUSSION

Low-Iron Spodumene

The possibility of economically producing a low-iron spodumene by physical beneficiation is not promising.

Nickel (6) concluded that iron is in chemical combination with spodumene, probably as a replacement for aluminum. He also suggested that magnetic susceptibility can generally be related to iron content. This is confirmed in Table 10 where the highest-grade product was the magnetic fraction of the rougher tails that ran 6.64% Li_2O. Minus 28-mesh feed before grinding, when separated magnetically (Table 2), gave a magnetic fraction assaying 3.95% Li_2O, much higher in Li_2O and Fe_2O_3 than the non-magnetic material. In Test 4 (Table 4) and Test 5 (Table 5), the magnetics removed after grinding but before flotation ran 3.72% Li_2O and 4.40% Li_2O.

The sink fractions of the heavy liquid separation of rougher tails from Tests 13 and 14 (Table 8) assayed the same in Fe_2O_3, 0.76%, although the 30-minute time of grind in Test 13 gave a weight recovery of 27.6% containing 3.91% Li_2O versus a weight recovery of 29.9% containing 3.35% Li_2O in Test 14 with a 35-minute grind. Mineralogical examination identified no iron minerals as such.

Previous work (4,5) with magnetic separation of spodumene concentrate produced non-magnetic fractions containing between 0.61 and 0.72% Fe_2O_3; concentrate head sample submitted (5) was 6.10% Li_2O; 2.15% Fe_2O_3.

Current work, with the modified concept, in Test 15 (Table 9), gave a product with 0.68% Fe_2O_3. Magnetic treatment of the rougher tails in Test 16 (Table 10) only reduced Fe_2O_3 content to 0.46% in middlings (5.35% Li_2O, 22.84% Al_2O_3), and 0.55% in non-magnetics (6.24% Li_2O; 24.08% Al_2O_3); the Fe_2O_3 : Li_2O

ratio suggests iron to be present in the crystal lattice of spodumene.

Other Aspects

The modified concept (Tables 9 and 10) in which reverse flotation of feldspar, quartz, mica, and iron-bearing minerals in a natural pH circuit, using Armac L-10, appears to leave behind high-grade spodumene. Selectivity without desliming is sharp, as in Test 15, where a recovery of 55% material, assaying 5.76% Li_2O, is achieved with cleaner 1 tails running 0.96% Li_2O. More careful addition of reagent and using some Armac L-10 in the cleaning operation gave a 49.4% recovery at 5.75% Li_2O and a cleaner 1 product with 12% of the Li_2O present at 3.63%. The economics are good because only 0.4 to 0.6 lb/ton Armac L-10 is required to float the large amount of gangue in a relatively low-grade head sample.

The possibility of a simple separation of feldspar and quartz would require more test work. In Table 7, calculating and allowing for Al_2O_3 combined with Li_2O present as spodumene, the spar concentrate contained 15.58% Al_2O_3 versus 13.00% Al_2O_3in the quartz concentrate (Test 14); 16.38% Al_2O_3 to 12.57% Al_2O_3 in quartz (Test 13); 15.51 % Al_2O_3 to 14.02% Al_2O_3 in quartz (Test 12).

The primary objective to recover a low-Fe_2O_3, high-Li_2O concentrate was not achieved. Results, however, indicated that a simple, low-cost flotation method is available to upgrade the spodumene. This combined with magnetic separation gave some ore fractions lower in Fe_2O_3 than were obtained in earlier work on magnetic separation of concentrates (4,5).

By-products consisting of high-feldspar and possibly quartz can probably be recovered at little extra cost.

SUMMARY

By a simple reverse flotation system, without magnetic separation, typical spodumene recoveries were:

(a) 55% at 5.76% Li_2O, 0.68% Fe_2O_3, and 23.73% Al_2O_3;

(b) 49% at 5.75% Li_2O, 0.60% Fe_2O_3, and 24.00% Al_2O_3.

The feed contained 1.59% Li_2O, 0.25% Fe_2O_3, and 16.67 Al_2O_3, and the reagent used was 0.4 lb per ton Armac L-10.

Magnetic fractionation of spodumene products gave high Li_2O values with high Fe_2O_3 content. This supports previous suppositions (6) that iron is present in the crystal lattice of the spodumene.

ACKNOWLEDGEMENTS

R. M. Buchanan (Head) and C.H.J. Childe (Technician) analyzed various products by X-ray diffraction. A. D. Kent (Chemist) and S. T. Lepage and G. R. Harrison (Technicians) did chemical analyses and J. H. Colborne (Technician) did the heavy-liquid separations. The excellent test work that checks well throughout and with previous programmes was done by P. R. Lachapelle (Technician).

FHH/RAW/am

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