71-31-P

BALL MILLING AND FLOTATION OF SPRUCE PINE FELDSPAR ORE PRELIMINARY REPORT

by
Immo H. Redeker

BALL MILLING AND FLOTATION OF SPRUCE PINE FELDSPAR ORE
PRELIMINARY REPORT

Project No. 19, Book 280
Minerals Research Laboratory December 1971 Progress Report

by
Immo H. Redeker

INTRODUCTION

Approximately 2500 to 3000 tons of alaskite-feldspar ore are mined and milled daily in the Spruce Pine area of North Carolina to produce glass-, ceramic-, and filler-grade feldspar, and some mica and quartz. All of the ore is crushed and ground to basically minus 20 mesh and then sized on 200 mesh. Until two years ago, all of the minus 200 mesh material was being wasted. One company in the area recovers now 3000 tons per month of additional feldspar, without mining of extra fresh ore, from the formerly wasted material by a special secondary feldspar flotation step. This secondary flotation step was put into production after an intensive feldspar tailings study at the Asheville Minerals Research Laboratory showed that appreciable amounts of fine feldspar could be recovered from the wasted fines.

Grinding to minus 20 mesh is done by all Spruce Pine feldspar producers in rod mills, usually 5' x 10' in size, in closed circuit with screens. The object is minimum production of minus 200 mesh material which formerly could not be treated by flotation. A large part of the minus 20 mesh plus 200 mesh feldspar recovered is ground later in ceramic-lined pebble mills of relatively low efficiency to minus 200 mesh and minus 325 mesh for sale to ceramic and filler industries. It is suggested to increase grinding efficiency and to increase feldspar

recovery from the ore by grinding in steel ball mills to all minus 20 or 35 mesh without regard to the amount of minus 200 mesh material produced. Sizing at a finer size of around 10 microns before flotation recovery of feldspar, instead of sizing at 200 mesh, is suggested for higher overall recovery from the ore. The recovered feldspar could, after flotation, be sized to produce glass-grade plus 200 mesh feldspar, and, with minimum further grinding, ceramic- and filler-grade fine feldspar. Since steel ball milling is a more effective way of grinding to 20 or 35 mesh than rod milling, and also much more efficient than pebble milling, grinding costs are reduced. Also ball milling delaminates the bookey mica better, and thereby improves the removal of mica and iron minerals before feldspar-quartz separation. Desliming, when accomplished at 10 microns instead of 200 mesh, reduces wasted ore. Preliminary test work indicated that ball milling might be successfully applied to Spruce Pine feldspar ore, and some results are reported here.

ORE SAMPLE

The ore sample was a composite of Lawson-United rod mill feed taken over a period of one month. The ore had the following chemical and mineral composition.

Chemical Composition, Ore 3112

K_2O	= 3.36 percent
Na_2O	= 5.06 percent
CaO	= 0.91 percent
Al_2O_3	= 15.43 percent
SiO_2	= 74.04 percent
Fe_2O_3	= 0.42 percent
Ignition Loss	= 0.40 percent

Mineral Composition, Ore 3112 (Calculated)

Potash Feldspar	=	16.8 percent
Soda Feldspar	=	42.9 percent
Lime Feldspar	=	4.5 percent
Total Feldspar	=	64.2 percent
Muscovite	=	4.4 percent
Kaolinite	=	2.5 percent
Quartz	=	28.5 percent
Others (Garnet)	=	0.4 percent

PRELIMINARY GRINDING AND FLOTATION TEST WORK

The alaskite-feldspar ore was crushed in stages to minus 8 mesh. After intensive mixing, 500-gram samples were split out. To obtain complete liberation of feldspar minerals from quartz, mica and garnet, the ore was ground in one stage in the laboratory steel ball mill at 70 percent solids to essentially 35 mesh. Any plus 35 mesh material remaining was clean mica. The ground material was diluted with water to about 8% solids and deslimed two times by syphoning after 14 minutes settling time. The deslimed material was then conditioned at 60% solids for 5 minutes with H_2SO_4, tallow amine acetate (Armac-T), fuel oil, and frother (Hunticol H-25). The mica was removed by flotation in the laboratory Denver Flotation Cell. A very clean mica float was obtained with complete mica removal. The machine discharge was dewatered and conditioned for 5 minutes at 65% solids with sulfuric acid, sulfonated petroleum oil (Morco-70), fuel oil, and frother (Hunticol H-25). Iron and garnet minerals were removed by flotation. The dewatered machine

discharge was then conditioned at 55-60% solids for 5 minutes with hydrofluoric acid and amine acetate (Armac-T). The feldspar was removed by flotation. No cleaner step was employed. In Test 101, a 10-minute ball mill grind was used, and the feldspar product was treated in the Frantz Ferrofilter before drying and screening. In Test 103, where an 8-minute ball mill grind was employed, the feldspar product was dried and screened without use of the Ferrofilter. In Test 101, 56.1% of the feldspar was plus 200 mesh with glass-grade analysis; the minus 200 mesh fraction, 43.9% by weight, had a slightly higher potash analysis than the plus 200 mesh fraction. In Test 103, 64.4% of the feldspar reported as plus 200 mesh glass-grade material with low iron analysis. Thirty-five and six-tenths percent of the feldspar was minus 200 mesh with a higher potash analysis than the plus 200 mesh fraction. Pertinent data of two feldspar flotation tests after steel ball milling are presented on Table I and Table II.

PRELIMINARY RESULTS

Batch flotation test work, after ball milling and desliming at about 10 microns, showed that acceptable coarse glass-grade feldspar and fine ceramic- or filler-grade feldspar could be obtained simultaneously with high recoveries. About 55 to 65% of the feldspar concentrate was in the minus 35 plus 200 mesh size fraction, 35 to 45% was minus 200 mesh. The minus 200 mesh feldspar was slightly higher in potash content than the plus 200 mesh feldspar. Future test work will study important parameters of feldspar flotation after steel ball milling.

NORTH CAROLINA STATE MINERALS RESEARCH LABORATORY

Table I

ORE DRESSING TEST DATA

Lab. No. 3112 Test No. 101

Operator I. H. Redeker Date 10/28/70

Object of Test Ball Milling of Feldspar Ore, 10-Minute Grind

	Wt	% Wt	% Wt	K_2O	Na_2O	Fe_2O_3	Ign. Loss				
+35 Mica		1.9									
Slime 1		6.9	9.4								
Slime 2		2.5									
Mica		6.3									
Fe Flot		2.5									
Spar		53.6		4.02	7.15	0.080	0.38				
Quartz		25.6		0.17	0.26	0.035	0.05				
Ferrofilter		0.7									
Spar +100 Mesh		21.5	56.1	3.72	7.15	0.066	0.06				
-100+200		34.6		4.02	7.15	0.058	0.13				
-200+325		18.7	43.9	4.32	7.15	0.058	0.12				
-325		25.2		4.32	7.15	0.074	0.07				

	Conditions				Reagents (lbs per ton)					
Process	Time	% Solids	pH	rpm	H_2SO_4	Ar-T	F.O.	H-25	M-70	HF
Grind ball mill	10	70	-	54	-	-	-	-	-	-
Deslime 2 X	14	8	-	-	-	-	-	-	-	-
Mica Cond.	5	60	3.8	700	2.5	0.15	0.33	0.05	-	-
Mica Flot	-	-	-	1200	-	-	-	-	-	-
Fe Cond.	5	70	3.8	700	2.0	-	0.50	0.10	0.70	-
Fe Flot	-	-	-	1200	-	-	-	-	-	-
Spar Cond.	5	60	-	700	-	0.25	-	-	-	1.4
Spar Flot	-	-	4.0	1200	-	-	-	-	-	-

Remarks:

Grind.
Deslime 2 times by syphoning after 14 min. settling.
Mica Cond.

NORTH CAROLINA STATE MINERALS RESEARCH LABORATORY

Table II

ORE DRESSING TEST DATA

Lab. No. 3112 Test No. 103

Operator I. H. Redeker Date 10/29/70

Object of Test Ball Milling of Feldspar Ore, 8-Minute Grind

	Wt	% Wt	% Wt	K_2O	Na_2O	Fe_2O_3	Ign. Loss				
+35 Mica		1.2									
Slime 1		5.0	6.6								
Slime 2		1.6									
Mica		6.2									
Fe Flot		1.4									
Spar		55.6		4.21	7.17	0.056	0.20				
Quartz		28.8		0.36	0.71	0.034	0.05				
Spar +100 Mesh		31.7	64.4	3.90	7.17	0.070	0.05				
-100+200		32.7		3.91	7.15	0.049	0.22				
-200+325		15.4	35.6	4.25	7.15	0.058	0.08				
-325		20.2		4.04	6.90	0.080	0.22				

Conditions / Reagents (lbs per ton)

Process	Time	% Solids	pH	rpm	H_2SO_4	Ar-T	F.O.	H-25	M-70	HF
Grind ball mill	8	70	-	54	-	-	-	-	-	-
Deslime 2 X	14	8	-	-	-	-	-	-	-	-
Mica Cond.	5	60	4.1	700	3.5	0.15	0.17	0.05	-	-
Mica Flot	-	-	-	1200	-	-	-	-	-	-
Fe Cond.	5	70	4.2	700	3.5	-	0.33	0.10	0.70	-
Fe Flot	-	-	-	1200	-	-	-	-	-	-
Spar Cond.	5	60	-	700	-	0.25	-	-	-	1.4
Spar Flot	-	-	-	1200	-	-	-	-	-	-

Remarks:

Grind.
Deslime 2 times by syphoning after 14 min. settling.
Mica Cond.