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CONCENTRATION OF BERYL FROM AMOS, QUEBEC (PROJECT MP-IM-6115)

by

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SUMMARY OF RESULTS

Flotation tests made on a sample of beryl from the Milrot Beryllium property near Amos, Quebec, indicate that concentrates of above 10% BeO can be made with a potential recovery of about 80%, by a simple system employing petroleum sulfonate in an acid circuit with one cleaning step also in an acid circuit.

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INTRODUCTION

A request was received from J.F.B. Davis, Mining Engineer, of Montreal, in regard to the Milrot Beryllium property in Figuery Township, 10 miles south of Amos, Quebec. It was desired to determine the BeO content of a sample reported to be from the "Discovery Pit" on this property. The sample was described as roughly equivalent to hand picked feed for a small mill. Sufficient bench scale laboratory testing was done to demonstrate the feasibility of concentrating the beryl.

DESCRIPTION OF SAMPLE

About 90 lb of lump material were received in a cloth bag. A mineralogical examination was made by R.M. Buchanan*, who reported the material to be a coarse-grained pegmatite, composed of feldspar, quartz, beryl and mica. The beryl content was estimated at 20 to 25%, and this was substantiated by the chemical analysis which gave a BeO content of 3.00%, or approximately 21% beryl. The beryl was described as well-formed, hexagonal, green or greenish-blue crystals, the largest being 1 in. in width. Less than 1% of the sample was represented by garnet, columbite-tantalite and apatite.

TEST WORK

The sample was crushed and screened on 4 mesh with recirculation of oversize until only mica appeared in the +4 mesh fraction. A representative portion of the -4 mesh fraction was riffled out and further reduced to -35 mesh, also with recirculation of oversize until only mica appeared in the +35 mesh fraction. A summary of this operation is given in Table 1.

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TABLE 1

Preparation of Feed

Fraction	Wt(%)	Content
+4m	1.3	mica
-4+35m	2.9	mica
-35m	95.8	all minerals

A preliminary group of tests included magnetic separation and flotation trials. These were not successful in effecting separation of the beryl from other minerals present although tails of less than 1% BeO were obtained. It was, therefore, decided to try a simple type of testing which was being used on a research project in the Division.

This type of testing consists of observing the pick-up by a captive bubble of particles of an individual mineral. The research work had already indicated that flotation should be successful. This had, however, been indicated on beryl from another source. It was thought appropriate to check the beryl from the Milrot property before proceeding further.

About one gram each of beryl, feldspar, quartz and muscovite was carefully separated from the sample. These were reduced by mortar and pestle, and screened to -35 +325 mesh. The research referred to earlier had indicated that beryl could be floated by petroleum sulfonates at low pH, and also that beryl is activated by iron. The Milrot material was therefore tested with petroleum sulfonates as well as a number of other reagents. All the petroleum sulfonates tried floated the beryl well in acid circuits with or without iron activation, but floated little or nothing in neutral circuits. Only one other reagent showed an indication of floating beryl, and then only with iron activation.

The next step was to check flotation of the feldspar, quartz and muscovite with petroleum sulfonates in acid circuit. Very little flotation was observed for any of these. Thus, of 15 reagents tried on the beryl, five were found to be applicable. Table 2 illustrates the type of result obtained from this testing.

TABLE 2

Bubble Attachment Tests

(Figures are approx. No. of particles floated)

Mineral	pH	No. Reagents	Reagent 801	801 +Fe	Petrofloat 462	462 +Fe
Beryl	3	0	20	25	25	25
	0	3	3	0	5	0
Feldspar	3	0	3	0	0	1
	0	0	0	0	1	0
Quartz	3	2	1	0	0	1
	0	0	1	0	1	0
Muscovite	3	0	2	0	2	1
	0	0	0	0	0	0

Table 2 clearly indicates that beryl should be floated away from feldspar, quartz and muscovite, in the Milrot sample, in acid circuit with or without iron activation. A number of bench scale batch tests were applied using this system. Three of these are described to illustrate improvements of technique.

In the first, a comparatively simple system was used. Some -35 mesh feed was deslimed by decantation. H_2SO_4 was used to lower the pH and beryl was floated with Reagent 801 and a little pine oil. When the froth had been completely skimmed, a second application of 801 and pine oil was added and a second float removed. This was followed by a third application of 801 and pine oil and removal of a third float. These three flotation concentrates were separately analyzed. Results are given in Table 3.

TABLE 3

Simple Flotation of Beryl

Fraction	Wt (%)	BeO (%)	Distribution (%)
Slimes	7.9	2.84	8.8
Tails	82.5	1.66	53.5
Conc.1	3.9	10.92	16.7
Conc.2	3.4	9.68	12.9
Conc.3	2.3	9.00	8.1
Feed	100.0	2.56	100.0

Although the three concentrates combined would give a 10.02% BeO product, the recovery, 37.7%, is low. It is apparent that a good deal more would have to be floated to reduce losses to tails sufficiently. It is also apparent that, if additional concentrates were floated, each succeeding one would be of a lower grade. By the time tails were sufficiently low the concentrate would also be too low in grade and cleaning would be necessary.

The next test shows how these facts were used to improve the results obtained. The feed was ground slightly finer, to -48 mesh, and deslimed by decantation as before. The pH was lowered to 3 with H_2SO_4 and a rougher float was made by three successive applications of Reagent 801; the last of these produced very little froth. The combined rougher froth was returned to the cell and refloated in a cleaning step. The froth from the first cleaner was returned to the cell and refloated as a second cleaning step. When the froth had ceased to form in this step, a little more H_2SO_4 and 801 were added and the additional froth was collected as a second concentrate. The results of this test are given in Table 4.

TABLE 4

Flotation With Cleaning Steps

Fraction	Wt (%)	BeO (%)	Distribution (%)
Slimes	9.1	2.84	9.7
R. Tails	57.4	0.18	3.9
Cleaner 1 Tails	14.7	3.83	21.2
Cleaner 2 Tails	5.6	9.00	18.9
Conc. 1	7.4	9.53	26.5
Conc. 2	5.8	9.06	19.8
Feed	100.0	2.67	100.0

As shown in Table 4 this method was successful in stripping the tails of beryl. The two concentrates when combined represent a recovery of 46.3% of the beryl in feed at a grade of 9.35% BeO. It is clear, however, from the grade of the second cleaner tails that in this case the second cleaning step was unnecessary and that the grade after one cleaning was 9.23% BeO for a recovery of 65.2%. In addition, 21.1% of the beryl remained in the first cleaner tails as a middling product for recirculation and additional recovery.

Because beryl concentrates are usually sold with a minimum BeO content of 10%, further work was aimed at improving the grade to this level. The final test to be described used a still finer feed, -65 mesh, with usual desliming. The pH was again lowered to 3 with H_2SO_4 and the rougher float was made in the same way with three steps using Reagent 801. The combined rougher float was cleaned, and the cleaner float re-cleaned, but in both the pH was returned to 3 by additional H_2SO_4. With the pH adjustment in the cleaners it was not found necessary to use more 801 (as in example 2). The results are given in Table 5.

TABLE 5

Flotation with pH Maintained in Cleaners

Fraction	Wt (%)	BeO (%)	Distribution (%)
Slimes	14.5	2.35	13.8
R. Tails	60.1	0.14	3.2
Cleaner 1 Tails	10.0	4.52	18.2
Cleaner 2 Tails	5.2	8.62	18.2
Conc.	10.2	11.13	46.6
Feed	100.0	2.47	100.0

Table 5 shows that maintaining the pH at 3 in the cleaners resulted in better cleaning action and a higher grade of concentrates. In this example, as in example 2, the second cleaning step was unnecessary. If the concentrate and second cleaner tails are combined a grade of 10.4% BeO is obtained at a recovery of 65.8%. In this test 18.2% of the beryl remained in the cleaner 1 tails as a middling for recirculation. The finer grinding produced more material reporting as slimes. With more careful desliming and recirculation of the middling, a potential recovery of close to 80% is indicated, assuming a BeO content in the tails of 0.15% BeO. It is also possible that -48 mesh, or even -35 mesh, would be a sufficiently fine grind if the pH were maintained at 3 in the cleaners.

CONCLUSIONS

(1) Grades of above 10% BeO can be concentrated from the sample provided, with actual recovery of 66% and potential recovery of approximately 80%, by desliming and floating with petroleum sulfonate in an acid circuit. A single cleaning step would probably be sufficient, also in an acid circuit, with recirculation of the cleaner tails.

(2) Simple qualitative tests on individual mineral particles, to show attachment to a captive bubble, are very useful in pointing the way to a practical flotation system.

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