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AN INVESTIGATION OF QUARTZITIC SANDSTONE FROM MELOCHEVILLE, QUEBEC

by

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MINERAL PROCESSING DIVISION

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SUMMARY OF RESULTS

This investigation, requested by Union Carbide Canada Limited, Toronto, was made to examine the possibility of producing a relatively low-grade glass sand from sandstone and waste fines currently produced by this company at Beauharnois, Quebec.

Following preliminary reduction by jaw crusher, representative portions of a composite sample were reduced to sand by pebble milling and by wet and dry roller milling and the results compared. The products were subjected to vigorous attrition scrubbing and high-intensity magnetic separation.

The resulting products, although approaching the iron content stipulated by Union Carbide (0.07 per cent Fe_2O_3) and falling well below that for alumina (0.25 per cent), would not be acceptable as a first-quality glass sand but undoubtedly would find some application as a "blending" sand for use in coloured glass container manufacture.

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INTRODUCTION

Union Carbide Canada Limited operates a quarry in quartzitic sandstone at Melocheville, Quebec, for the production of lump silica for use in ferrosilicon manufacture at Beauharnois. Large quantities of minus one-inch fines, for which there is only a limited market, are produced. The company requested Mines Branch assistance to determine whether Melocheville rock along with these fines could be reduced to sand and upgraded by relatively simple methods to meet iron and alumina specifications for coloured glass. Specifications were given as 0.07 per cent maximum for iron (Fe_2O_3) and 0.25 per cent maximum for alumina. This silica deposit is of particular interest because of its closeness to the Montreal glass-sand market.

An examination of a 300-pound sample from Melocheville showed this sandstone to be composed of fine grains of silica firmly cemented with a siliceous bond. Because of this, and the fact that the impurities in any sandstone tend to concentrate in the bonding cement, it is desirable to reduce the rock to its natural grain size before attempting beneficiation. Reduction of this particular sandstone could be accomplished by some form of autogenous grinding. Grinding in a chaser-type roller mill, following initial reduction by jaw crusher, might also be applicable. Both these methods were used to reduce this sandstone to its natural grain size prior to beneficiation.

Beneficiation methods included wet scrubbing, water washing and high-intensity magnetic separation.

TEST PROCEDURE AND RESULTS

Pebble Mill Grind Tests

A representative portion of the 300-pound composite sample was separated on a 1 1/2 inch screen. The oversize was reduced to minus 1 1/2 inch by jaw crusher and the combined minus 1 1/2 inch sample was screened on 4 and 28 mesh sieves. The minus 1 1/2 inch plus 4 mesh material, representing 58 per cent of the sample, was used as grinding media and the minus 4 plus 28 mesh, representing 19 per cent, as feed in a series of grinding tests conducted in a 9 x 9 inch McDanel porcelain pebble mill.

About 18 pounds of material, consisting of 80 per cent plus 4 mesh and 20 per cent minus 4 plus 28 mesh was loaded into the mill and ground for 15 minutes. The milled product was then separated on 4 and 28 mesh sieves. The minus 28 mesh sand was removed and the minus 1 1/2 inch plus 4 mesh, and minus 4 plus 28 mesh fractions, made up to the original 18 pounds on a 4 to 1 ratio and returned to the mill. This procedure was repeated for four additional 15-minute grinding periods. A final 1-hour grind was then made to determine the effect of overgrinding. The products from these six grinding tests were designated as 1, 2, 3, 4, 5 and 6 respectively.

The results of these tests follow in Tables 1 and 2.

TABLE 1

Grinding Tests - McDanel Pebble Mill

Test No.	Grinding Time (minutes)	Weight in Pounds				
		Grinding Media (-1 1/2"+4 mesh)		Feed (-4 + 28 mesh)		Product -28 mesh
		Remaining*	Added**	Remaining*	Added**	
Initial charge			14.3		3.6	-
1	15	13.0	1.3	2.8	0.8	2.1
2	15	14.0	0.3	3.0	0.6	0.9
3	15	14.1	0.2	3.2	0.4	0.6
4	15	14.1	0.2	3.2	0.4	0.6
5	15	14.2	0.1	3.2	0.4	0.5
6	60	14.0		2.9		1.0

* Grinding media and/or feed remaining after test.

** Make-up grinding media and/or feed.

TABLE 2

McDanel Pebble Mill - Sieve Analyses

Mesh Size	Samples - Weight, Per Cent				
	Head* -1 1/2 inch	Head** -28 mesh	Product No. 1 -28 mesh	Product No. 2 -28 mesh	Product No. 3 -28 mesh
+4	58.0				
-4 +8	11.0				
-8 +10	2.8				
-10 +14	2.1				
-14 +20	1.5				
-20 +28	1.6				
-28 +35	2.9	12.4	12.9	11.2	8.1
-35 +48	4.4	21.0	21.0	19.6	16.0
-48 +65	5.0	22.8	22.7	22.5	20.2
-65 +100	4.2	17.8	16.2	17.9	15.3
-100 +150	6.5	8.5	6.5	6.9	12.0
-150		17.5	20.7	21.9	28.4
Total	100.0	100.0	100.0	100.0	100.0

*Head sample. The +4 mesh portion was used as grinding media and the -4+28 mesh as mill feed to produce a -28 mesh product.

**Analysis of -28 mesh removed from head sample prior to grinding.

Mix-Muller Grind Tests

A representative portion of the minus 1 1/2 inch sandstone prepared for the pebble mill tests was separated on a 3/8 inch sieve. The plus 3/8 inch material was reduced to minus 3/8 inch by jaw crusher, combined with the remainder of the minus 3/8 inch, and the whole separated into two, 20-pound samples: one for dry reduction, the other for wet reduction in an 18-inch diameter Simpson mix-muller. Each test was for a 30-minute period. The wet test was made at about 70 per cent solids.

Attrition Scrubbing Tests

The products from the wet and dry grinding tests conducted in the Simpson mixer were separately scrubbed in a 10,000-gram Wemco attrition machine for 20 minutes at 70 per cent solids and the scrubbed products thoroughly washed on a 150 mesh sieve. Sieve analyses of these products (No. 7, dry - No. 8, wet) are shown in Table 3.

TABLE 3

Simpson Mix - Muller -- Wemco Attrition Machine
Sieve Analyses

Mesh Size	Weight, Per Cent				
	Feed to Simpson*	Wemco Product (No. 7)**		Wemco Product (No. 8)***	
+8	40.9	13.7		23.3	
-8 +10	7.0	4.4		5.0	
-10 +14	4.0	2.6		4.6	
-14 +20	2.8	1.4		1.0	
-20 +28	3.1	1.7		1.2	
-28 +35	5.7	6.6	8.8	5.7	8.8
-35 +48	8.6	18.9	24.5	15.8	24.3
-48 +65	8.7	24.0	31.5	20.2	31.1
-65 +100	6.5	15.5	20.3	12.3	19.0
-100 +150	6.7	6.1	8.1	5.7	8.8
-150	6.0	5.1	6.8	5.2	8.0
Total	100.0	100.0	100.0	100.0	100.0

*Material formed by reducing -1 1/2 inch sandstone to -3/8 inch by jaw crusher.

**Wemco attrition product, feed used was sand from dry Simpson mix-muller test. Second column represents calculated analysis of -28 mesh portion.

***Wemco attrition product, feed used was sand from wet Simpson mix-muller test. Second column represents calculated analysis of -28 mesh portion.

The minus 28 mesh sand from the pebble mill as well as the minus 28 mesh sand removed prior to pebble milling, because of limited amounts of sample, were scrubbed in a small Hobart mixer at about 70 per cent solids. The scrubbing action of this mixer is not as vigorous as that of the Wemco: the time of scrubbing was therefore extended to 30 minutes to more closely duplicate the action of the Wemco. The products were thoroughly washed on a 150 mesh sieve. Sieve analyses of these products (No. 9, head sample - No. 10, pebble mill product) are shown in Table 4.

TABLE 4

Hobart Mixer - Sieve Analyses

Mesh Size	Weight, Per Cent	
	Product No. 9*	Product No. 10**
-28 +35	14.2	15.0
-35 +48	24.8	27.6
-48 +65	27.0	32.9
-65 +100	19.0	13.2
-100 +150	9.4	7.1
-150	5.6	4.2
Total	100.0	100.0

*Feed was -28 mesh portion of head sample.

**Feed was -28 mesh portion of pebble mill product.

Magnetic Separation

Representative samples of the minus 28 mesh sand portions of the scrubbed products from the Wemco and Hobart units were treated in a Carpco high-intensity magnetic separator to remove any iron introduced during processing, or native to this material itself.

Chemical Analyses

Samples of all products were forwarded to Union Carbide's Beauharnois laboratory for analysis. Results follow in Table 5.

TABLE 5

Chemical Analyses

Product No.	Identification	Analysis - Wt. Per Cent	
		Fe_2O_3	Al_2O_3
7	Dry ground in Simpson, scrubbed in Wemco*	0.19	0.13
7a	Minus 28 mesh portion of 7*	0.09	0.08
8	Wet ground in Simpson, scrubbed in Wemco*	0.12	0.19
8a	Minus 28 mesh portion of 8*	0.13	0.04
9	Minus 28 mesh from jaw, scrubbed in Hobart**	0.13	0.13
10	Minus 28 mesh from pebble mill, scrubbed in Hobart**	0.11	0.06
11	Non-mag portion of 7a	0.08	
12	Non-mag portion of 8a	0.07	
13	Non-mag portion of 9	0.09	
14	Non-mag portion of 10	0.09	

*See Table 3.

**See Table 4.

OBSERVATIONS

An examination of the minus 28 mesh portions of the products from the McDanel pebble mill and Simpson mix-muller revealed few compound grains of quartz, whereas this portion of the jaw crusher product, in particular the plus 48 mesh fraction, mostly consisted of compound grains. Few compound grains were observed in the minus 20 plus 28 mesh portion of the Simpson product, especially the dry-milled product. The next largest fraction, minus 14 plus 20, was mostly composed of compound grains in both the dry- and wet-milled Simpson products.

The quartz grains of the milled products were rounded to sub-angular in shape although the minus 100 mesh portion, being largely composed of interstitial quartz removed from the quartz grain-boundaries during milling, was more angular.

The washed Wemco and Hobart products were superior to the unwashed sands. Some iron staining was observed after drying. This undoubtedly was due to a partial oxidization of the mill iron and pyrite in the samples. Wet magnetic separation prior to drying would, of course, help to eliminate this iron stain although that due to pyrite would persist since pyrite is non-magnetic.

Pyrite, varying from relatively large particles (20 mesh or coarser) to very small particles firmly bonded to the quartz grains, was the chief impurity noted. It was observed in all mesh fractions but tended to be more concentrated in the finer, minus 100 mesh portion of the sand.

The pebble mill grinding test results (Table 1) clearly show that the greatest reduction to minus 28 mesh occurs during the first 15 minutes of grinding. The relative percentage of minus 28 mesh product during subsequent grinding periods is much lower owing to the rounding of the grinding media. The grain size distribution of the pebble mill product closely approaches that of the original sandstone but prolonged grinding results in excessive production of minus 150 mesh fines (compare minus 28 mesh, head, with products 1, 2 and 6, Table 2).

Products 7 and 8 from the dry and wet Simpson mix-muller tests (Table 3) and products 9 and 10 from the Hobart mixer (Table 4) are coarser than those from the pebble mill (Table 2), having had most of the minus 150 mesh fines removed by washing.

Chemical analyses (Table 5) show that the alumina, (Al_2O_3), in all products is less than the 0.25 per cent specified by Union Carbide Canada Limited but that the iron, (Fe_2O_3), in all products except number 12, is greater than the 0.07 per cent specified.

CONCLUSIONS

The results of this work, on the basis of the sample received, show that reduction of quartzitic sandstone from Melocheville to minus 28 mesh, its natural grain size, can be achieved by autogenous grinding techniques or by use of roller-type mills.

Following reduction to grain size this sand can be upgraded, by attrition scrubbing and washing, and high-intensity magnetic separation, to the point at which it approaches the 0.07 per cent iron oxide and is less than the 0.25 per cent alumina stipulated by Union Carbide Canada Limited.

Although the beneficiated sand would perhaps be acceptable as a "blending" sand for coloured container manufacture, it would not be suitable for use in flint (clear) glass manufacture. The chief impurity, pyrite, being uniformly distributed throughout the sand and, in most instances firmly bonded to the quartz grains, is extremely difficult to remove. Effective removal of the pyrite with a resulting reduction of the iron oxide content probably would require the use of such techniques as froth flotation, wet tabling and acid leaching at elevated temperatures.

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