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THE PROCESSING OF CERTAIN LIMESTONES FOR USE AS WHITING SUBSTITUTE

by

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MINERAL PROCESSING DIVISION

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SUMMARY OF RESULTS

To determine the properties and the method of processing certain limestones for use as whiting substitute, King Paving Company Limited, Oakville, Ontario, submitted seven samples for investigation. One was a standard commodity produced in the United States, and the others, labelled Bonter, Bolender #1 and #2, Shatraw #1 and #2, and Whitney, were from deposits in southern Ontario.

The Bolender and Shatraw samples were unsuitable chemically for use as whiting substitute. To use a processing method that would cause the least contamination to the remaining samples, a combination of jaw crushing, hammer milling and pebble milling was investigated. In addition, part of the Bonter sample was subjected to ball milling after reduction by jaw crusher and hammer mill to determine and to compare the effect of the less costly method of ball milling with pebble milling.

By employing pebble milling in the grinding stage, the Bonter and Whitney products would be suitable as whiting substitute for at least some consumers. The degree of suitability would depend on the relative cost and on the quality of competitive products. The Bonter product was essentially purer chemically than the standard sample and had a light reflectivity of 93 per cent as compared to 100 per cent for the latter sample.

With the batch type of grinding employed in this investigation, pebble milling decreased the light reflectivity by about 2 1/2 per cent whereas ball milling reduced it about 8 per cent, and thereby made the Bonter product generally unacceptable as whiting substitute.

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INTRODUCTION

In an attempt to establish the feasibility of producing whiting substitute in southern Ontario, King Paving Company Limited, Oakville, Ontario, submitted seven limestone samples for processing and investigation. One sample, labelled Camelcarb, was a product of the firm's parent United States Company and was used as a chemical standard. Five of the samples were labelled Bonter, #1 Bolender, #2 Bolender, #1 Shatraw and #2 Shatraw, and each weighed 100 pounds.

The purpose of the investigation was to establish a dry-grinding method of producing the best possible whiting product from the five limestone samples. Upon the completion of this investigation, a 46-pound sample of "Whitney" limestone was submitted for processing and testing by the method that produced the best product.

The Bonter sample was from the Malone, Ontario, quarry of W.F. Bonter & Co. Ltd.; the Bolender samples originated from the Eagle Lake, Ontario, quarry of Bolender's Limited; the Shatraw samples came from near Bancroft, Ontario; and the Whitney limestone was from near Havelock, Ontario.

MACROSCOPIC EXAMINATION

The Camelcarb sample was white and 100 per cent minus 325 mesh in particle size.

The Bonter sample consisted of pieces of limestone up to 12 inches in size. It was an off-white, fine-grained, recrystallized rock averaging 1/32 to 1/16 inch in grain size. Minor amounts of light green minerals and a moderate number of slips and joints were present. Both Bolender samples were dolomitic and were comprised of pieces under 12 inches in size. These recrystallized limestones were light grey, massive, averaged 1/4 inch in grain size and were uniform in colour and texture. The Shatraw dolomitic limestone samples consisted of fragments under 12 inches in size. This rock was light buff, massive, and averaged 1/4 inch in grain size. An occasional fragment of light grey limestone was intermixed with the #1 Shatraw sample.

The Whitney recrystallized limestone was off-white in colour, 1/8 to 1/4 inch in average grain size, and contained minor amounts of light green silicate minerals. The fragments were up to 12 inches and a few were faintly banded.

PROCEDURE

The chemical content, particle size, and light reflectivity were determined for the Camelcarb sample. For all light reflectivity determinations in this investigation, a Densichron reflectivity meter was used without a filter, and the reflectivity was determined as a percentage of that obtained with basic magnesium carbonate. At least three determinations were made on each sample.

When it was realized that the particle size and the light reflectivity of the Camelcarb sample were 100 per cent minus 325 mesh, and 100 per cent respectively, the milling process therefore was resolved to one that would produce, from the other five samples, a minus 325-mesh product that would have as high a reflectivity as possible. Ball milling using ceramic liners and non-metallic grinding media would produce the best results. Because of the relatively high expense for this type of grinding over other types, it was decided that the results of ball-milling tests using metallic liners and media should be investigated as well.

The Bonter, Bolender and Shatraw samples were crushed to minus 1/4 inch in a jaw crusher. From each jaw-crusher product, a 200-gram sample was riffled and reduced by a ceramic pestle and mortar to minus 325 mesh. Twenty grams were submitted for chemical analysis and the remainder was tested for its light reflectivity. Results indicated that the Bonter limestone was far superior as a source of whiting substitute to the other four samples. As a result, test work was continued only on the Bonter sample.

Ten pounds of minus 1/4-inch rock were riffled from the Bonter jaw-crusher product. The 10-pound sample was reduced to the smallest particle size possible with the hammer mill on hand, with one pass. A 1/16-inch grate opening was used. Two samples were split from the hammer-mill product. One was analysed for iron and manganese, and the other for particle size. The remaining portion was split in half. One portion was dry-ground to essentially minus 325 mesh in a ceramic-lined mill using flint pebbles and the other portion was dry-ground to the same size in a steel ball mill using stainless steel balls. Samples were split from the mill products for chemical analysis and for light reflectivity tests. The latter tests were determined on the minus 325-mesh fractions.

After the completion of the foregoing investigation, a sample of Whitney limestone was submitted for the purpose of determining the properties of the product of this rock after it was crushed, pulverized, and then ground in a ceramic-lined pebble mill with alundum grinding media. Details of this processing were similar to those of the previous group of samples.

OBSERVATIONS AND RESULTS

The following tables contain the results of this investigation.

TABLE 1

Chemical Analyses and Light Reflectivites
of Jaw-Crusher Products (per cent)

Tested For	Camelcarb (Original Sample)	Bonter	#1 Bolender	#2 Bolender	#1 Shatraw	#2 Shatraw	Whitney
Acid Insol.	2.42	0.80	6.78	5.74	7.29	0.46	2.96
CaO	53.0	54.2	30.3	30.5	31.0	30.2	54.13
SiO_2	1.80	0.58	4.31	3.93	4.43	0.33	2.58
MgO	1.31	1.66	20.3	19.5	20.2	20.8	0.31
L.O.I.	42.8	43.6	42.4	42.5	41.8	45.2	41.89
Fe_2O_3	0.16	0.12	0.23	0.24	0.10	0.19	
Mn	$<$0.01	0.018	0.037	0.030	0.030	0.052	
Cu	0.024	0.080	0.025	0.025	0.024	0.021	Nil
Al_2O_3	0.401	0.106	0.261	0.187	0.168	0.091	0.20
Light reflectivity at -325 M	100	96.3	90.0	94.8	93.7	92.0	93.5

TABLE 2

Light Reflectivities and Screen and Partial Chemical Analyses of Hammer-Mill Products (per cent)

Tested For	Bonter	#1 Bolender	#2 Bolender	#1 Shatraw	#2 Shatraw	Whitney
+35 M	23.7	28.0	31.6	23.8	19.5	
-35 +48	12.0	14.2	14.8	12.6	12.2	
- 48+65	12.0	13.6	13.6	13.0	13.2	
- 65+100	11.8	12.4	12.0	13.0	13.4	
-100+200	16.0	14.3	5.6	16.3	17.2	
-200	24.5	17.5	22.4	21.3	24.5	
Fe_2O_3	0.11	0.22	0.27	0.09	0.30	0.28
Mn	0.012	0.038	0.030	0.030	0.054	0.006
Light reflectivity at -325 M	95.3	90.3		90.0		

TABLE 3

Light Reflectivities and Partial Chemical Analyses of Ground Products (per cent)

Tested for	Bonter		Whitney
	Steel liners and media	Ceramic liners and media	Ceramic liners and media
Fe_2O_3	0.15	0.12	
Mn	0.008	0.016	
Light reflectivity at -325 M	87.7	93.0	91.0

TABLE 4

Summary of Results

Sample	Tested For	Jaw Crusher Product	Hammer Mill Product	Dry-ground to essentially -325M: Steel liners and media	Dry-ground to essentially -325M: Ceramic liners and media
Camelcarb	% CaO	53.0			
	% Fe_2O_3	0.16			
	% Mn	< 0.01			
	% Light reflectivity	100			
Bonter	% CaO	54.2			
	% Fe_2O_3	0.12	0.11	0.15	0.12
	% Mn	0.018	0.012	0.008	0.016
	% Light reflectivity	96.3	95.3	87.7	93.0
#1 Bolender	% CaO	30.3			
	% Fe_2O_3	0.23	0.22		
	% Mn	0.037	0.038		
	% Light reflectivity	90.0	90.3		
#2 Bolender	% CaO	30.5			
	% Fe_2O_3	0.24	0.27		
	% Mn	0.030	0.030		
	% Light reflectivity	94.8			
#1 Shatraw	% CaO	31.0			
	% Fe_2O_3	0.10	0.09		
	% Mn	0.030	0.030		
	% Light reflectivity	93.7	90.0		
#2 Shatraw	% CaO	30.2			
	% Fe_2O_3	0.19	0.30		
	% Mn	0.052	0.054		
	% Light reflectivity	92.0			
Whitney	% CaO	54.13			
	% Fe_2O_3		0.28		
	% Mn		0.006		
	% Light reflectivity	93.5			91.0

DISCUSSION AND CONCLUSIONS

Although the specifications for whiting substitute vary depending on the consumer and on the type of use, many consumers require a minimum of 95 per cent calcium carbonate and a light reflectivity of at least 90 per cent as compared with that of basic magnesium carbonate. Some consumers will tolerate a minimum calcium carbonate content of 90 per cent. Others have limits on the copper and manganese contents.

The Bolender and Shatraw limestones could not normally compete as whiting substitute. By reduction by jaw crusher, hammer mill, and ceramic-lined pebble mill, both the Bonter and Whitney products would be suitable as whiting substitute for at least some consumers. The light reflectivity of the Bonter product was 2 per cent greater than that of the Whitney material. Chemically, the Bonter and Whitney products compared favourably with the Camelcarb sample. However, both had significantly lower light reflectivities, as can be expected when a natural product is compared with a chemical precipitate.

This investigation has been of additional value in that it has indicated the extent of contamination of near-white limestone during reduction by steel ball milling and by ceramic pebble milling. Under the conditions of this investigation, ceramic pebble milling reduced the light reflectivity by about 2 1/2 per cent, whereas steel ball milling reduced it by about 8 per cent. Even with the high quality of the Bonter limestone, the reduction of 8 per cent in light reflectivity by steel ball milling, rendered this limestone of no value for most uses as whiting substitute. The noteworthy reductions in light reflectivity owing to ball and pebble milling were probably more severe in these laboratory batch runs than they would be in a continuous process in actual practice.

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