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AN INVESTIGATION OF SAND FROM SOURIS, P.E.I.

by

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MINERAL PROCESSING DIVISION

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SUMMARY

This investigation, undertaken at the request of the Atlantic Development Board, was designed to examine possible methods of upgrading sand from Souris, P.E.I., to meet current specifications for glass sand. Treatment included removal of the impure minus 65 mesh fraction, and high-intensity magnetic separation and acid leaching of the plus 65 mesh sand. Acid treatment tests were made using both sulphuric and hydrochloric acids in concentrations of 100 pounds of acid per ton of sand. Roasting tests followed by acid treatment and magnetic separation were also carried out as well as attrition-scrubbing tests in an acid circuit.

Although numerous tests were made the results, generally, were disappointing. Reduction of the iron content to 0.04 per cent, the iron oxide content specified by many glass container manufacturers, was achieved in only one test. This test involved treatment of the plus 65 mesh, non-magnetic portion of the sand at 300°F with sulphuric acid over a 16-hour period.

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INTRODUCTION

During the latter part of 1963, Dr. G.C. Monture of the Atlantic Development Board, Ottawa, visited the Mines Branch to request assistance in determining whether beach sand from Souris, P.E.I., could be upgraded to glass sand quality. This sand would be of interest as a potential source of silica sand should a glass container plant be built in the Atlantic Provinces. The feasibility of establishing such a plant is being studied jointly by the Atlantic Provinces Economic Council, Halifax, and the Atlantic Development Board.

A 500-pound sample of Souris sand, submitted by Mr. M.J. McQuaid of Souris at the request of Dr. Monture, was received in the Mines Branch Laboratories on October 22, 1963.

DESCRIPTION OF SAMPLE

Most of the quartz grains in this sample were stained with a reddish-brown iron oxide stain. Although the results of previous, unpublished work on Souris sand showed this stain to be strongly resistant to treatment with sulphuric acid, it was decided to further investigate acid leaching using greater concentrations of sulphuric than previously, as well as hydrochloric acid.

Impurities apart from iron staining included small quantities of feldspar, shiny black grains of amphibole (hornblende), and a greyish-green mineral. This greyish-green mineral was predominantly quartz with small amounts of clay and mica*.

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* R.M. Buchanan, Mineralogical Reports MP-MIN-497,-531, Mineral Processing Division, Mines Branch, Ottawa (1964).

TEST PROCEDURE

Preliminary Tests

A sieve analysis of a representative portion showed that over 99 per cent of the sand was plus 65 mesh in size. Also, a definite tendency for the black grains of amphibole to concentrate in the minus 65 mesh fraction was noted. Product recovery from a high-intensity magnetic separation test, made with a Carpco laboratory unit, was over 97 per cent. The magnetic fraction contained a relatively high percentage of black amphibole.

On the basis of these preliminary tests it was decided to conduct all acid leach tests on the plus 65 mesh, non-magnetic portion of the sand. This represented about 97 per cent of the total sample weight.

Acid Leach Tests

A series of acid leach tests using 100 pounds of 98 per cent sulphuric per ton of sand was undertaken on samples of the plus 65 mesh, non-magnetic portion of the Souris sand. Several of these were conducted "dry", that is, by adding the required amount of undiluted acid to sand samples that had been heated to 200, 300 and 400°F respectively. The sand was stirred for 5 minutes following which the acid was diluted in the ratio of 1:4 with hot water (200°F) and stirred for an additional 15 minutes. The sand was then washed and dried. The remaining tests with sulphuric acid were conducted "wet" using 5 and 10 per cent solutions by weight. Most of these latter tests were made at 300°F for periods of 4, 6 and 8 hours. A number of additional leach tests were made at 1, 2 and 16 hours.

Several leach tests based on a U.S. patent** (dilute sulphuric acid in a salt solution--sand in contact with a copper plate) were made but it was evident that this reaction proceeded very slowly. No visible reduction of the iron stain was apparent even after an 8-hour leach period.

Leach tests conducted with hydrochloric acid were made at room temperature and at 150°F using 1 and 5 per cent acid solutions and 30-minute leach periods. Two other tests, using 1 and 5 per cent acid at 150°F were conducted over a 3-hour period.

** U.S. Patent No. 2,891,844, June 23, 1959, assigned to F. W. Adams, Ealing, London, England.

On the assumption that the iron oxide stain on the quartz grains was principally hematite, several roast tests to convert this to magnetite were made. Sand samples were heated to 500 and 1000°F for 30 minutes in a Globar electric furnace. The samples were covered with carbon to ensure reducing conditions. At the end of the roast period the samples were discharged into either water or 10 per cent sulphuric, and then thoroughly washed and dried. The dried products were treated in a Carpco high-intensity magnetic separator.

As a final test a sample of the plus 65 mesh, non-magnetic portion of the sand was treated in a Wemco attrition scrubber for a 20-minute period in a 10 per cent solution of hydrochloric acid maintained at 150°F. Following leaching the sand was thoroughly washed.

CHEMICAL ANALYSIS

Samples of the more promising products from this investigation were submitted to the Mineral Sciences Division for chemical analysis. The results follow in Table 1.

TABLE 1

Chemical Analyses*

Product	Analysis - Wt. %				
	SiO_2	Fe_2O_3	Al_2O_3	MnO	L. O. I.
Head Sample	95.71	0.18	1.50	0.007	0.72
Head sample, +65 mesh		0.18		0.003	
" " , -65 "		4.42		0.77	
" " , +65 mesh, non mag. fraction**		0.12		0.001	
" " , +65 " , mag. fraction		1.74		0.03	
Leached Products (100 lb conc H_2SO_4/ton of sand)					
No. 1 - dry leach, 20 min at 200°F		0.092			
" 6L - " " , 20 " " 300°F		0.083		0.003	
" 2 - " " , 20 " " 400°F		0.067			
" 4 - wet leach, 5% sol, 4 hr at 300°F		0.069			
" 9L - " " , " " , " " "		0.070		0.003	
" 6 - " " , " " , 6 hr " "		0.083			
" 8 - " " , " " , 6 hr " "		0.073			
" 7L - " " , " " , 8 hr " "		0.043		0.003	
" 10L - " " , " " , 16 hr " "		0.037		0.002	
Leached Products (100 lb conc HCl/ton of sand)					
No. 15 - wet leach, 5% sol, 1/2 hr at 150°F		0.126			
" 16 - " " , 1% " , " " " "		0.124			
" 17 - " " , 5% " , 3 hr " "		0.109			
" 18 - " " , 1% " , " " " "		0.119			
" 19 - scrubbed 20 min in Wemco attrition machine in 10% sol at 150°F		0.116			
Globar Products					
No. 9 - roasted 30 min at 500°F, washed in water, non mag. prod.		0.123			
" 10 - " " " " " , washed in 10% H_2SO_4, non mag. prod.		0.112			
" 11 - " " " " 1000°F, washed in water, non mag. prod.		0.124			
" 12 - " " " " " , washed in 10% H_2SO_4, non mag. prod.		0.104			

* Internal Reports MS-AC-63-1475 and 64-658 by Miss E. Mark, Analytical Chemistry Subdivision.

** Head sample for leaching and for furnace treatment.

DISCUSSION OF RESULTS

An examination of the chemical analyses, Table 1, shows that only in two instances was the iron content reduced to a point at which the sand might be considered suitable for glass manufacture. Tests 7L and 10L, conducted over an 8- and 16-hour period, respectively, and at 300°F using 100 pounds of concentrated sulphuric acid per ton of sand, resulted in products containing only 0.043 and 0.037 per cent iron oxide. An iron oxide content of 0.04 per cent would be acceptable for coloured glass containers; however, flint (clear) container manufacturers stipulate that the iron oxide content of sand should not exceed 0.02 per cent.

Removal of the minus 65 mesh portion of the sand and magnetic treatment of the plus 65 mesh portion prior to acid leaching were beneficial in that they reduced the iron oxide content of the sand from 0.18 per cent to 0.12 per cent.

Most leach tests with sulphuric acid were made at 300°F as compared to the 150°F tests made with hydrochloric: the sulphuric acid tests generally resulted in superior products. Possibly a greater reduction of the iron oxide might have been achieved with hydrochloric at higher temperatures.

The Globar furnace tests were disappointing. No significant reduction of the iron oxide content was achieved following acid and magnetic treatment.

CONCLUSIONS

The results of this investigation, on the basis of the work undertaken on the sample submitted, indicate that the iron content of Souris sand can be reduced to 0.04 per cent (Fe_2O_3) by a process involving screening, high-intensity magnetic separation, and leaching with sulphuric acid at 300°F over an 8- to 16-hour period. The beneficiated sand would be suitable for the manufacture of green or amber glass containers but most manufacturers stipulate that the iron oxide content should be less than 0.02 per cent for flint (clear) containers.

A greater reduction of the iron undoubtedly could be achieved at higher temperatures and using acid concentrations in excess of the 100 pounds per ton of sand used in this investigation.

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