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DEPARTMENT OF MINES AND TECHNICAL SURVEYS

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MINES BRANCH INVESTIGATION REPORT IR 66-11

MAGNETIC CONCENTRATION OF MAGNETICALLY ROASTED ORE FROM STEEP ROCK IRON MINES LIMITED, ATIKOKAN, ONTARIO

by

G. W. RILEY

MINERAL PROCESSING DIVISION

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SUMMARY OF RESULTS

Magnetic concentration at the normal field strength of 350 gauss for the final drum produced concentrates containing 3.7 per cent SiO_2 with 81.9 per cent soluble Fe recovery.

Lowering the field strength to 200 gauss did not reduce the SiO_2 content of the magnetic concentrate but did reduce soluble Fe recovery from 81.9 per cent to 64.1 per cent.

Concentrates which would be produced at 700 gauss were calculated to contain 3.8 per cent SiO_2 with 90.5 per cent soluble Fe recovery.

Mineralogical examination showed that the silica remaining in the concentrate occurred as extremely fine locked grains which could not be liberated even with a grind of 75 per cent minus 25 microns.

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*Technical Officer, Mineral Processing Division, Mines Branch, Department of Mines and Technical Surveys, Ottawa, Canada.

INTRODUCTION

Purpose of Investigation

Mr. J. A. Pursel, Project Metallurgist, Steep Rock Iron Mines Ltd., in his letter of October 2, 1964 requested an investigation of magnetic methods of up-grading magnetically roasted Steep Rock ore to produce a concentrate containing less than 3 per cent SiO_2.

A mineralogical examination of the magnetic concentrate produced was requested also to determine the disposition of the remaining SiO_2.

Shipment

A 100 lb sample of magnetically roasted Steep Rock ore was received on November 6, 1964 from Allis-Chalmers Limited, Milwaukee, Wis. U. S. A. No particulars of the roasting process were provided by Steep Rock.

Procedure and Results

1. Sampling and Head Analysis

Representative samples of the ore as received were riffled out for a screen test and mineralogical examination. The remainder of the sample was crushed to minus 10 mesh and, after a head sample was riffled out for chemical analysis, was split into representative fractions for investigative testing. The chemical analysis of the head sample was

Sol Fe -- 64.6 per cent

SiO_2 -- 6.7 per cent

Results of a screen test on the ore as received are shown in Table I.

TABLE I

Screen Test of Ore as Received

Mesh Tyler		Weight %
	+ ½ in.	1.7
-½ in.	+ 4 mesh	20.0
-4 mesh	+ 8 mesh	21.8
-8 "	+ 14 "	23.1
-14 "	+ 28 "	17.3
-28 "	+ 48 "	9.1
-48 "	+ 100 "	4.4
-100 "	+ 200 "	1.6
-200 "		1.0
Total		100.0

2. Mineralogical Examination*

The sample as received consisted of magnetite, hematite and gangue. The magnetite and hematite are present as masses and contain inclusions of gangue. The gangue is largely quartz and it is present as irregular grains in three distinct sizes. The largest ones range from 70 to 200 microns, the medial ones range from 10 to 50 microns, and the smallest ones range from 1 to 5 microns.

3. General Investigative Procedure

Two thousand gram samples were cobbed at a coarse size in a Sala laboratory permanent-magnet drum type wet separator and the concentrate reground to 98 per cent minus 325 mesh and treated in a three drum Jeffrey-Steffensen wet magnetic separator at various amperages (magnetic intensity), for the different tests. A tailing was produced from the first and second drums with a middling and final concentrate from the third drum. In one test ore was ground to 98 per cent minus 325 mesh and fed directly to the Jeffrey-Steffensen magnetic separator and the magnetic concentrate treated in a hydro-separator.

4. Summary of Results

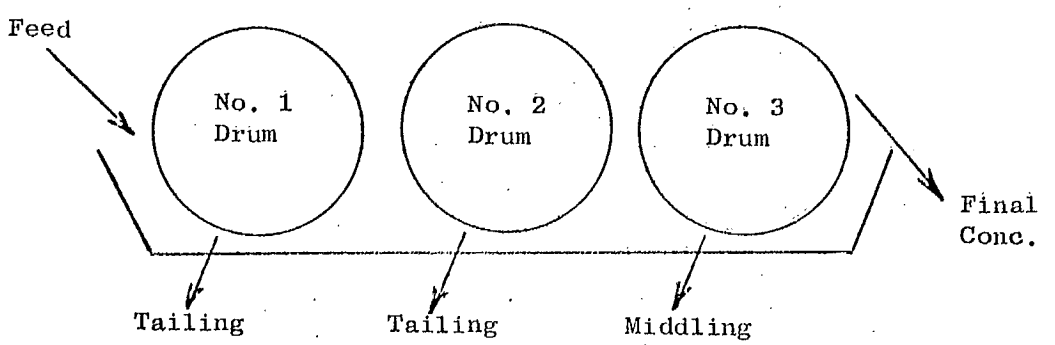
TABLE 2

Results of Test 1, 2, 3 and 4

Test No.	No. 1 and 2 Drums **				No. 3 Drum			
	Gauss*	Recovery % Sol Fe	Analyses % Sol Fe	SiO_2	Gauss*	Recovery % Sol Fe	Analyses % Sol Fe	SiO_2
1	700	90.5	68.1	3.8	350	81.9	68.2	3.7
2	700	89.2	67.1	4.0	200	64.1	68.0	3.6
3	530	81.3	68.0	3.5	350	79.6	68.0	3.5
4	700	92.5	68.2	3.8	350	84.5	68.2	3.8

*Reading taken at surface of the drum

** Calculated



JEFFREY WET MAGNETIC SEPARATOR

*From Mineral Sciences Division, Internal Report MS-65-27 by W. Petruk

DETAILS OF INVESTIGATION

Test 1

A 2000 gram sample of the ore was ground to -48 mesh and treated in a Sala laboratory permanent-magnet drum type wet separator with a field strength of about 500 gauss.

The Sala magnetic concentrate was then stage ground to 98 per cent -325 mesh and treated in a three drum Jeffrey-Steffensen wet magnetic separator with the first and second drums set at 700 gauss and the third drum at 350 gauss.

The non-magnetic products from the first and second drums were combined to produce a non-magnetic tailing. The third drum produced a middling and the final magnetic concentrate.

Results of a screen test of the -48 mesh ore and the magnetic separation tests are shown in Tables 3 and 4.

TABLE 3

Screen Test on Ore Crushed to -48 mesh

Mesh Tyler	Weight %
-48 +65	8.8
-65 +100	21.2
-100 +150	18.3
-150 +200	8.1
-200 +325	9.7
-325	33.9
Total	100.0

TABLE 4

Results of Test 1

Product	Weight % Original	Analyses % Sol Fe	Analyses % SiO_2	Distribution % Sol Fe
-48 mesh				
Non-mag tailing	5.6	41.1	35.4	3.5
98 per cent -325 mesh				
Non-mag tailing	8.1	48.2	19.6	6.0
Middling	8.3	67.3	4.5	8.6
Mag conc	78.0	68.2	3.7	81.9
Feed (calcd)	100.0	65.0	6.8	100.0

Results of a screen analysis of the final magnetic concentrate from Test 1 is shown in Table 5.

TABLE 5

Screen Analysis of Magnetic Concentrate Test 1

Size	Weight %	Analyses % SiO_2	Distribution % SiO_2
+25 microns	23.4	4.1	25.7
-25 microns	76.6	3.6	74.3
Total	100.0	3.7	100.0

Test 2

In an attempt to reject more silica at the cobbing stage a sample of the ore was ground to -65 mesh and treated on the Sala magnetic separator.

The Sala magnetic concentrate was then stage ground to 98 per cent -325 mesh and treated in a three drum Jeffrey-Steffensen magnetic separator. The final cleaning drum was set at 200 gauss, a lower magnetic field strength than Test 1, to obtain a lower SiO_2 content in the final concentrate.

Results of a screen test of the -65 mesh ore and the magnetic separation tests are shown in Tables 6 and 7.

TABLE 6

Screen Test on Ore Crushed to -65 mesh

Mesh Tyler	Weight %
+65	--
-65 +100	16.3
-100 +150	23.0
-150 +200	10.7
-200 +325	12.6
-325	37.4
Total	100.0

TABLE 7

Results of Test 2

Product	Weight % Original	Analyses % Sol Fe	Analyses % SiO_2	Distribution% Sol Fe
-65 mesh				
Non-mag tailing	5.9	38.0	38.5	3.5
98 per cent -325 mesh				
Non-mag tailing	9.6	48.8	14.3	7.3
Middling	24.2	66.2	4.8	25.1
Mag conc	60.3	68.0	3.6	64.1
Feed (calcd)	100.0	64.0	7.0	100.0

Test 3

A sample of the ore was ground to -65 mesh and treated in a Sala laboratory drum type separator.

The Sala magnetic concentrate was then stage ground to 98 per cent -325 mesh and treated in a three drum Jeffrey-Steffensen magnetic separator.

The first two drums were set at 530 gauss to reject more to tailing than Tests 1 and 2. The third drum was set at 350 gauss as for Test 1.

TABLE 8

Results of Magnetic Separation Test 3

Product	Weight % Original	Analyses % Sol Fe	Analyses % SiO_2	Distribution % Sol Fe
-65 mesh				
Non-mag tailing	5.5	36.8	39.5	3.1
98 per cent -325 mesh				
Non-mag tailing	17.0	59.4	12.5	15.6
Middling	1.6	67.0	4.4	1.7
Mag conc	75.9	68.0	3.5	79.6
Feed (calcd)	100.0	64.8	7.0	100.0

Test 4

A sample of the ore was stage ground to 98 per cent -325 mesh and treated in the Jeffrey-Steffensen magnetic separator.

The field strengths were set at 700 gauss for the first and second drums and 350 gauss for the third drum.

The final magnetic concentrate obtained was then treated in a 7 in. hydroseparator at a flow of 6 litres/min (48 ft /hr.) to reduce the SiO_2 content.

Results of the magnetic separation and hydroseparator tests are shown in Table 9.

TABLE 9

Results of Test 4

Product	Weight % Original	Analyses % Sol Fe	Analyses % SiO_2	Distribution % Sol Fe
Jeffrey-Steffensen				
Non-mag tailing	11.6	42.0	33.5	7.5
Middling	7.8	66.7	5.0	8.0
7 in. diam Hydroseparator				
O'flow	0.5	66.6	5.0	0.5
U'flow	80.1	68.2	3.8	84.0
Feed (calcd)	100.0	65.0	7.3	100.0

Concentrates produced from all the tests made contained over 3.0 per cent silica. To determine the disposition of the remaining silica a mineralogical examination was made on the concentrate from Test 1 which was considered as representative of the concentrates produced.

Mineralogical Examination of the Final Magnetic Concentrate from Test 1.*

Microscopic examination of a polished section of a sample of magnetic concentrate showed that the main silicate mineral is quartz and it is present as locked grains (see Figure 1). Some of the grains occur as inclusions in magnetite, and some as separate grains with magnetite inclusions.

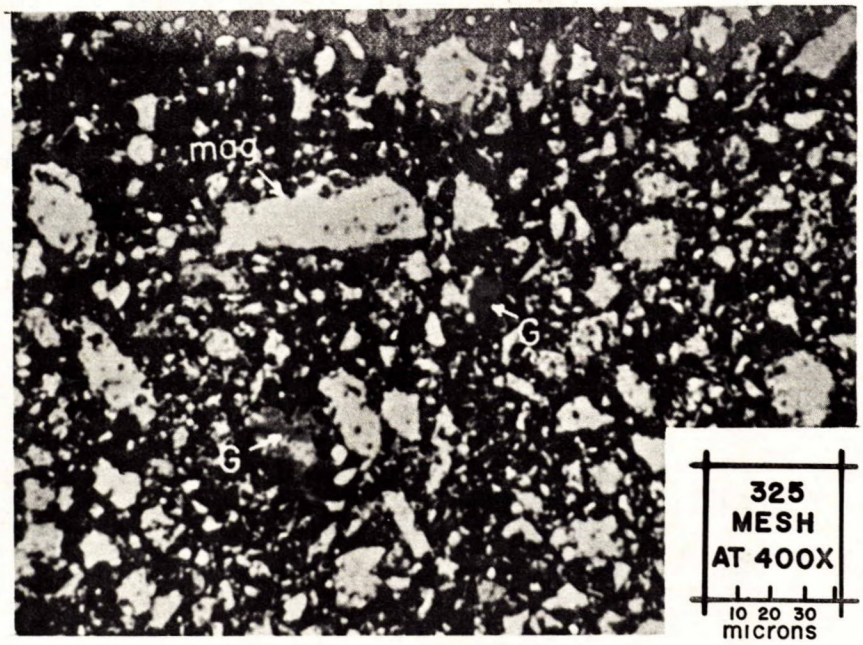


Figure I Photomicrograph of a polished section of the magnetite concentrate showing the locked quartz grains (G) and magnetite (mag).

*Mineral Sciences Division Internal Report MS-65-102 by W. Petruk

CONCLUSION

It appears unlikely because of the extremely fine dissemination of the silica, which cannot be freed within practical grinding limits, that magnetic concentrates containing less than 3.0 per cent SiO_2 can be produced from magnetically roasted ore.

ACKNOWLEDGEMENTS

The chemical analysis, shown in this investigation, was done by the Analytical Chemistry Sub-Division, Mineral Sciences Division Mines Branch.

The magnetic separation tests were conducted by J. Banks, Senior Laboratory Technician, Mineral Processing Division, Mines Branch.