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CONCENTRATION OF IRON ORE FROM GROS CAP RESERVE NO. 49, ALGOMA DISTRICT, ONTARIO, SUBMITTED BY THE INDIAN AFFAIRS BRANCH

by

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MINERAL PROCESSING DIVISION

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SUMMARY OF RESULTS

The ore sample assayed: 17.83% soluble iron, 3.61% sulphur, 0.06% phosphorus, 0.06% titanium dioxide, and 2.02% arsenic.

Magnetic concentration of the sample produced a concentrate which assayed 66.14% iron, 7.04% insol, 1.20% sulphur, and 0.02% phosphorus pentoxide. The recovery of iron was 53.0% at a ratio of concentration of 5.7:1.

The concentrate was 97% -200 M.

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INTRODUCTION

Shipment

On November 20, 1961, a shipment of 70 lb of iron ore was received at the Mines Branch laboratories, Ottawa, from Mr. A. R. Aquin, Superintendent of the Sault Ste. Marie Agency, Indian Affairs Branch, Department of Citizenship and Immigration, P.O. Box 880, Sault Ste. Marie, Ontario.

Location of the Property

In his letter dated November 9, 1961, Mr. Aquin stated that the shipment originated from the Gros Cap Reserve No. 49 and was obtained by Chief Francis Stone. The ore body on the Reserve was said to be adjacent to a property of the Algoma Ore Properties Ltd., near Michipicoten, Ontario. The samples were taken from an area about one mile long.

Purpose of the Investigation

The purpose of the investigation was to determine if a commercial grade of concentrate could be made from ore represented by the shipment.

ANALYSIS OF SHIPMENT

TABLE 1

Chemical Analysis of the Head Sample

Total iron	-	21.14 %
Soluble iron	-	17.83 "
Arsenic	-	2.02 "
Sulphur	-	3.61 "
Phosphorus	-	0.06 "
Titanium dioxide	-	0.06 "
Silica	-	61.20 "
Insoluble	-	63.48 "

TABLE 2

Semi-Quantitative Spectrographic Analysis of the Head Sample

Major constituents	-	Silicon, iron
Intermediate constituents	-	Aluminium, arsenic
Minor constituents	-	Tungsten, sodium, magnesium, calcium
Trace constituents	-	Manganese, copper, titanium, nickel, barium, chromium, boron, vanadium, zinc, cobalt, tin

MINERALOGICAL EXAMINATION*

One thin section and five polished sections were prepared from the hand specimens, and the minerals present in the samples were identified by means of microscopical and X-ray diffraction studies. Information as to the mineral content of the ore was obtained by means of X-ray diffractometer analysis.

Results of Investigation

The iron ore samples studied are composed of narrow magnetite-rich and wide quartz-rich bands (see Figure 1).

The magnetite-rich bands consist of magnetite, variable amounts of interstitial quartz, apatite and traces of amphibole and hematite. The magnetite grains range between 0.10 mm and 1.0 mm in diameter and the interstitial quartz and apatite grains range between 0.02 mm and 0.1 mm in diameter. The amphibole occurs as fine needle-like laths that are up to 1.0 mm long (see Figure 2), and the hematite occurs as small laths intergrown with magnetite.

The quartz-rich bands contain magnetite, apatite, traces of amphibole and hematite. The magnetite grains range between 0.02 mm and 0.5 mm in diameter and the amphibole and hematite occur as laths in the quartz.

The pyrrhotite sample consists of about 50% pyrrhotite in a quartz and feldspar matrix.

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* Internal Report MS-62-2, Mineral Sciences Division, by W. Petruk, January 9, 1962.

The approximate mineral content of the iron ore as determined by means of the X-ray diffractometer is listed in Table 3.

TABLE 3

Approximate Mineral Content of the Iron Ore

Mineral	Weight %
Quartz	65
Magnetite	25
Apatite	1-5
Hematite	trace
Amphibole	trace
Pyrrhotite	?

Conclusion

The samples studied are specimens of a very low-grade banded iron ore composed of magnetite-rich and quartz-rich bands. Magnetite is the principal iron-bearing mineral and it occurs in both bands. The magnetite in the magnetite-rich band is medium grained and can be separated from the gangue at a grind of 325 mesh, but most of the magnetite in the quartz-rich band is too fine grained to be liberated from quartz by mechanical means.

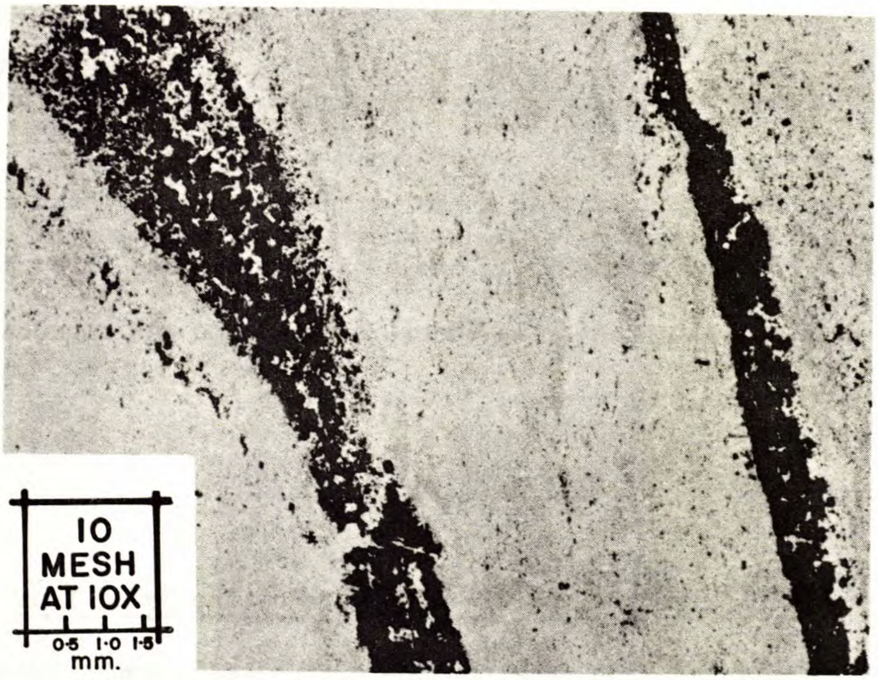

Figure 1. - Photomicrograph of a thin section showing the narrow magnetite-rich bands (black) and the wider quartz-rich bands (white) in the banded iron ore.

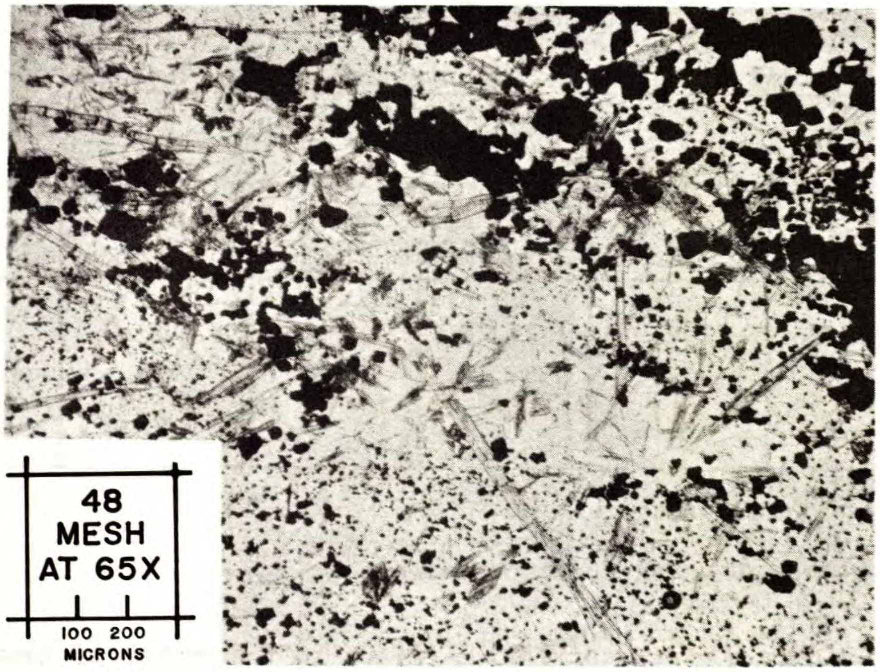

Figure 2. - Photomicrograph of a thin section showing the needle-like amphibole crystals. In this photograph the amphibole crystals occur at the boundary of the magnetite-rich band (black area in upper right) and quartz-rich band (white area with black dots in lower left).

SUMMARY OF TEST PROCEDURE

Magnetic concentration tests were made on ore ground to different degrees of fineness. In one test, the ore was first concentrated at a coarse grind. The coarse concentrate was reground and reconcentrated.

DETAILS OF TESTS

Test 1 - Magnetic Concentration of -200 M Ore by the Davis Tube

The test was made on a portion of the head sample which had been ground to -200 M. The results of the test are shown in Table 4.

TABLE 4

Results of Magnetic Concentration of -200 M Ore by the Davis Tube

Product	Weight %	Analysis %		Distn % Sol Fe	R/C**
		Sol Fe	Insol		
Feed*	100.0	17.79		100.0	
Mag conc	24.4	57.16	18.60	78.4	4.1:1
Tailing	75.6	5.08		21.6	

* calculated

** R/C - Ratio of Concentration

The ratio of concentration refers to the number of tons of ore required to produce one ton of concentrate. This test indicated that 4.1 tons of ore would be required to produce one ton of concentrate, assaying 57.16% soluble iron, 18.6% insoluble and containing 78.4% of the iron in the feed.

Test 2 - Magnetic Concentration by the Jeffrey-Steffensen Separator

A 2000 g sample of -20 M ore was ground in a ball mill to approximately 65% -200 mesh. The ore was concentrated by a Jeffrey-Steffensen separator. The products of the test were a concentrate, a middling and a tailing. A screen-sizing test was made on the magnetic concentrate and the tailing to show the degree of grinding.

TABLE 5

Results of Magnetic Concentration by the Jeffrey-Steffensen Separator

Product	Weight %	Analysis %			Distn % Sol Fe	R/C
		Sol Fe	S	Insol		
Feed*	100.0	18.62	-	-	100.0	
Mag conc	21.3	57.32	1.09	18.9	65.5	4.7:1
Midds	8.5	26.26	-	-	12.0	
Tailing	70.2	5.96	-	-	22.5	

* calculated

TABLE 6

Results of Screen Tests on the Concentrate and Tailing

Mesh	Concentrate Wt %	Tailing Wt %
+65	5.1	1.6
-65 +100	7.5	6.5
-100 +150	9.9	10.4
-150 +200	12.2	13.1
-200 +325	18.2	19.4
-325	47.1	49.0
	100.0	100.0
-200	65.3	68.4

Test 3 - Magnetic Concentration by the Jeffrey-Steffensen Separator

A 2000 g sample of -20 M ore was ground to approximately 80% -200 M in a ball mill and concentrated by the Jeffrey-Steffensen separator, which produced a concentrate, a middling and a tailing. A screen-sizing test was made on the concentrate and tailing.

TABLE 7

Results of Magnetic Concentration

Product	Weight %	Analysis %				Distn % Sol Fe	R/C
		Sol Fe	S	P_2O_5	Insol		
Feed*	100.0	18.47	-	-	-	100.0	
Mag conc	19.1	62.0	1.15	0.02	12.92	64.1	5.24:1
Midds	7.7	31.6	-	-	-	13.2	
Tailing	73.2	5.72	-	-	-	22.7	

* calculated

Titanium dioxide in the mag conc - trace

TABLE 8

Results of Screen Tests on the Concentrate and Tailing

Mesh	Concentrate Wt %	Tailing Wt %
+65	3.3	0.4
-65 +100	3.6	1.9
-100 +150	4.4	5.8
-150 +200	5.2	10.6
-200 +325	10.6	19.5
-325	72.9	61.8
	100.0	100.0
-200	83.5	81.3

Test 4 - Magnetic Cobbing at -48 M, the Concentrate Reground and Concentrated at -100 M

A 2000 g sample of -20 M ore was ground in a ball mill for 15 minutes and concentrated by the Crockett wet separator. A concentrate and a tailing were recovered.

The Crockett concentrate was ground in the ball mill for 30 minutes and concentrated by the Jeffrey-Steffensen separator which produced a concentrate, a middling and a tailing.

Screen-sizing tests were made on the Crockett tailing, and on the Jeffrey-Steffensen concentrate and tailing. These indicated that the Crockett separator feed was 61.6% -200 M and the Jeffrey-Steffensen concentrate was 97.1% -200 M.

The results of the tests are shown in the following tables:

TABLE 9

Results of Magnetic Concentration by the Crockett Separator

Product	Weight %	Analysis % Sol Fe	Distn % Sol Fe	R/C
Feed*	100.0	21.95	100.0	
Mag conc*	40.9	38.01	70.9	2.4:1
Tailing	59.1	10.82	29.1	

* calculated

TABLE 10

Results of Magnetic Concentration of the Reground Crockett Concentrate by the Jeffrey-Steffensen Separator

Product	Weight %		Analysis %				Distribution %		R/C in orig feed
	In test	In orig feed	Sol Fe	S	P_2O_5	Insol	In test Sol Fe	In orig feed Sol Fe	
Feed*	100.0	40.9	38.01				100.0	70.9	
Mag conc	43.0	17.6	66.14	1.20	0.02	7.04	74.8	53.0	5.7:1
Midds	10.4	4.2	46.30	-	-	32.52	12.6	9.0	
Tailing	46.6	19.1	10.24	-	-		12.6	8.9	

Additional analysis of Mag conc, As - 0.038%

Product	Weight % In test	Weight % In orig feed	Sol Fe	S	P_2O_5	Insol	Distribution % In test Sol Fe	Distribution % In orig feed Sol Fe	R/C in orig feed
Crockett Tailing		59.1	10.82					29.1	
Jeff-Steff. Tailing		19.1	10.24					8.9	
Combined Tailing*		78.2	10.67					38.0	

* calculated

TABLE 11

Results of Screen Tests

Mesh	Crockett Tailing Wt %	Jeffrey-Steffensen	
		Concentrate Wt %	Tailing Wt %
+65	2.7	-	-
-65+100	8.6	-	-
-100+150	12.5	1.0	0.5
-150+200	14.6	1.9	1.4
-200+325	18.6	8.7	7.3
-325	43.0	88.4	90.8
	100.0	100.0	100.0
-200	61.6	97.1	98.1

CONCLUSIONS

The iron ore represented by the shipment is amenable to magnetic concentration. The ore contains detrimental elements which include phosphorus, titanium and sulphur. Most of these elements are eliminated by magnetic concentration. The sulphur remaining in the magnetic concentrate would be largely eliminated by agglomeration of the concentrate either by sintering or pelletizing.

The insoluble material, including silica, in the concentrate is rather high at 7.0%.

The ratio of concentration of 5.7:1 is also approaching an economic limit. The recovery of iron in the magnetic concentrate was 53.0% in terms of original feed. Iron is lost in the tailing in the form of very fine-grained magnetite, non-magnetic hematite and pyrite.

ACKNOWLEDGEMENTS

All chemical analyses shown in this report were made in the Analytical Chemistry Sub-division of the Mineral Sciences Division of the Mines Branch.

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