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MINES BRANCH INVESTIGATION REPORT IR 59-109

INVESTIGATION OF IRON ORE FROM CALVIN TOWNSHIP, ONTARIO, SUBMITTED BY PEERLESS CANADIAN EXPLORATIONS LTD., TORONTO

by

W. S. JENKINS

MINERAL PROCESSING DIVISION

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SUMMARY OF RESULTS

The head sample assayed:

Total iron	-	24.03 %
Soluble iron	-	12.22 %
Titanium dioxide	-	5.58 %
Phosphorus	-	1.65 %
Sulphur	-	2.99 %

The recovery of iron in the concentrate was 8.4% and in the combined concentrate and middling was only 20%.

The best grade of magnetic concentrate was obtained from ore ground to 80.5% -200 mesh. The concentrate assayed Fe, 59.9%; TiO_2, 2.83%; Silica, 7.70%. The middling assayed Fe, 46.3%; TiO_2, 2.83%. The concentrate weighed 2.19% of the feed, with a ratio of concentration of 45.7:1.

The non-magnetic tailing assayed: Fe, 13.4%; TiO_2, 5.99%.

A high intensity magnetic concentrate from the tailing assayed, TiO_2, 12.17%. This concentrate contained weakly magnetic gangue minerals.

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INTRODUCTION

Shipment

A shipment of 6 bags of diamond drill cores, net weight 161 lb, was delivered to the Mines Branch laboratories on November 12, 1959, by Mr. Sadowski for the Peerless Canadian Explorations Limited, Room 906, 357 Bay Street, Toronto, Ontario.

Location of the Property

Part of lot 24, 4th concession, lots 23 and 24, 5th concession and part of lot 24, 6th concession, all in the township of Calvin, district of Nipissing, Ontario, was said to be the property from which the shipment originated.

Purpose of the Investigation

In his letter, dated November 17, 1959, Mr. A. B. Whitelaw, Director, Peerless Canadian Explorations Limited, confirmed Mr. Sadowski's conversation and requested an investigation of the sample of iron ore and a report of the results as soon as possible.

Description of the Property

Mr. Whitelaw stated that the development of the property included 2000 feet of diamond drilling. It was also estimated that the property had a potential tonnage of 100 million tons.

Table 1

Sampling and Analysis of the Shipment

Chemical Analysis of the Head Sample:

Total iron	-	24.03 %
Soluble iron	-	12.22 %
Titanium dioxide	-	5.58 %
Manganese	-	0.43 %
Phosphorus	-	1.65 %
Sulphur	-	0.299 %

Semi-Quantitative Spectrographic Analysis of Head Sample

Major constituents: Fe, Si, Al, Ca
Intermediate constituents: Mg, Ti, Na
Minor constituents: Mn, Ba
Trace constituents: Cu, V, Ni, Co, Zn

MINERALOGICAL EXAMINATION

Sample, Purpose and Method

A small sample of iron-bearing rock was brought to this laboratory on November 13, 1959, by W. S. Jenkins, Mineral Processing Division, for a mineralogical examination. For this purpose, the sample was examined megascopically and under a binocular microscope before the polished sections were studied under an ore microscope. Mineral identifications were corroborated by means of X-ray powder patterns.

Hand Samples

As received, the sample consisted of thirteen fragments of split diamond drill core, the longest measuring about three inches. All pieces but one are quite dark in colour, due largely to the abundance of pyroxene and mica, together with a minor quantity of hard black metallic mineral. With the aid of the binocular microscope, small particles of green olivine and brownish red garnet are seen to be scattered here and there in some pieces; the lightest coloured piece contains a relatively large amount of plagioclase feldspar. Although some pieces are slightly attracted by a small magnet, none will cling to it, and other pieces are unaffected by it.

Polished Sections

Metallic minerals are quite subordinate to gangue in four polished sections, two of which are attracted by the magnet and the other two are not. When examined under the ore microscope, magnetite proves to be the most abundant metallic mineral in the two magnetic pieces while ilmenite predominates almost exclusively in the other two.

Magnetite and ilmenite occur alone and associated with each other as coarse to fine disseminated grains and small granular aggregates up to about 3 mm (-6 +8 Tyler mesh) in size. The coarser grain sizes predominate in both minerals but small proportions of each are present also in very fine sizes. However, no tiny, oriented, exsolved lenses of one in the other were seen in the polished sections but tiny parallel plates or rods of ilmenite occur in gangue (see Figures 1 and 2).

Minor quantities of sulphide minerals are present as small, erratically scattered particles of marcasite, pyrrhotite, and chalcopyrite. The last named mineral is negligible in amount, only one small grain being observed. The largest particle of sulphide in the four sections measures 0.375 mm (-35 +48 mesh) across its greatest dimension and from that they range down to 0.052 mm (280 mesh) or less in size. It is interesting to note that marcasite particles, usually containing numerous small inclusions of gangue, predominate in the dark magnetic specimens and pyrrhotite particles, usually free of such inclusions, predominate in the lighter non-magnetic specimens (see Figures 1 and 2).

Gangue consists essentially of a medium grained assemblage of pyroxene, plagioclase, phlogopite and calcite transected by rare narrow veinlets of quartz and siderite. The numerous tiny inclusions of gangue in marcasite are apatite.

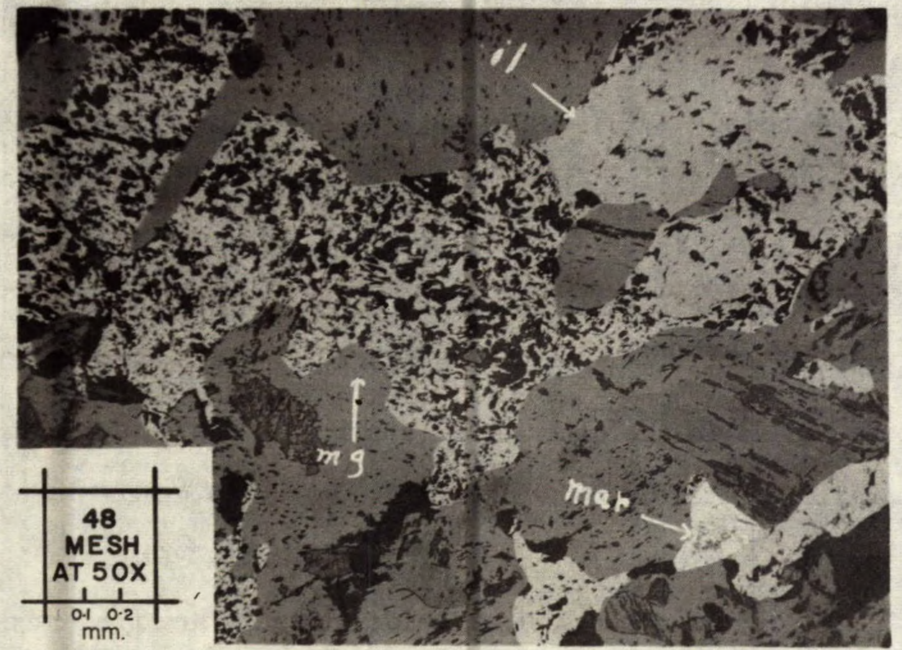

Figure 1 - Typical field in magnetic sections showing magnetite (mg), medium grey pitted surface; ilmenite (il), medium grey smooth surface; marcasite (mar), triangular white grain with tiny dark grey inclusions; gangue, various shades of dark grey; polishing pits, black.

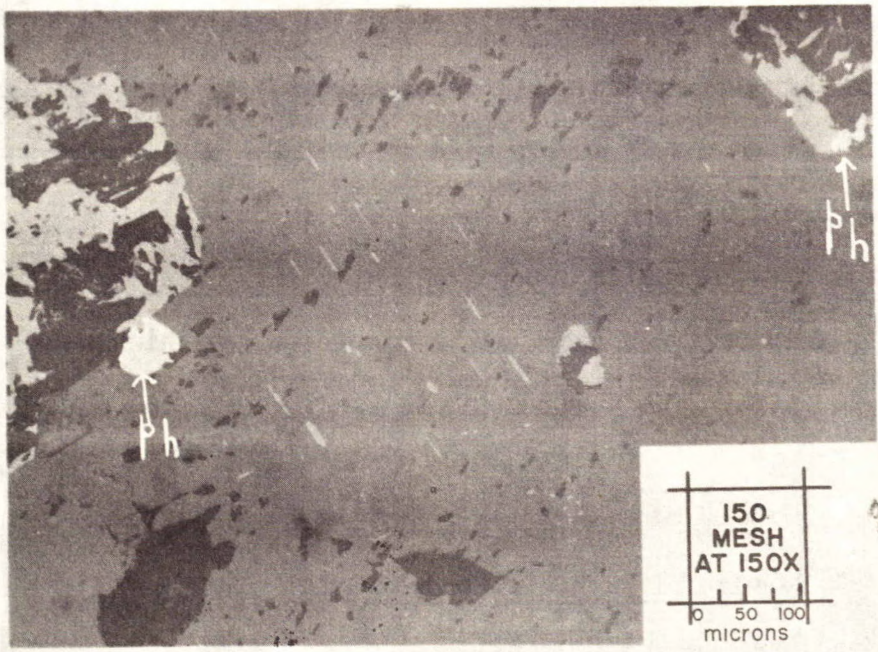

Figure 2 - Photomicrograph of non-magnetic section: ilmenite, grey, and pyrrhotite (ph), white, in gangue, dark grey; note tiny dots and dashes of ilmenite evidently following a crystallographic direction in the gangue mineral; pits are black.

DETAILS OF THE TESTS

Samples of the ore were crushed to various degrees of fineness and concentrated by low and high intensity separators of both wet and dry types.

The magnetite was recovered in concentrates from low intensity separators. In some tests the non-magnetic tailings from the low intensity separators were re-concentrated by high intensity separators to determine if an ilmenite concentrate of suitable commercial grade could be recovered.

Test No. 1 - Magnetic Concentration by the Davis Tube

This test was made with a sample of ore which had been ground to -200 mesh. The products of the test were a concentrate and a tailing.

Table 2

Results of Magnetic Concentration (Test No. 1)

Feed -200 Mesh Ore

Product	Weight, %	Analysis, %			Distn, %		Ratio of concentration
		Fe	TiO_2	SiO_2	Fe	TiO_2	
Feed*	100.0	15.9	5.76		100.0	100.0	
Mag. conc.	7.3	58.2	2.83	11.0	26.7	3.6	13.7:1
Tailing	92.7	12.6	5.99	--	73.3	96.4	

* calculated

Tests Nos. 2 and 3 - Wet Magnetic Concentration by the Jeffrey-Steffensen 3-drum Separator

Test No. 2: A 2000 g sample of -20 mesh ore was ground in a ball mill to 68.9% -200 mesh. The ground ore was concentrated by the Jeffrey-Steffensen separator which produced a concentrate, a middling and a tailing.

Test No. 3: The sample of 2000 g of ore was ground to 80.5% -200 mesh and concentrated as in Test No. 2.

Table 3 (Results of Test No. 2)

Results of Magnetic Concentration

Test No. 2
Feed, 68.9% -200 Mesh Ore

Product	Weight, %	Analysis, %			Distn, %		Ratio of concen-tration
		Fe	TiO_2	SiO_2	Fe	TiO_2	
Feed*	100.0	15.6	5.86		100.0	100.0	
Mag. conc.	2.45	58.3	2.62	8.62	9.1	1.1	40.8:1
Midds.	2.97	47.7	2.73	-	9.1	1.4	
Tailing	94.58	13.5	6.04	-	81.8	97.5	
Combined* Conc + Midds	5.42	52.5	2.68		18.2	2.5	18.5:1

Table 4 (Results of Test No. 3)

Test No. 3
Feed, 80.5% -200 Mesh Ore

Feed*	100.0	15.7	5.80		100.0	100.0	
Mag. conc.	2.19	59.9	2.83	7.70	8.4	1.1	45.7:1
Midds.	3.95	46.3	2.83	-	11.6	1.9	
Tailing	93.86	13.4	5.99	-	80.0	97.0	
Combined* Conc + Midds	6.14	51.2	2.83	-	20.0	3.0	16.3:1

*calculated

A screen test was made on the tailing of Tests Nos. 2 and 3.

Table 5

Results of Screen Tests

Mesh	Weight	%
	Test No. 2	Test No. 3
+65	0.7	0.5
+100	3.6	1.4
+150	11.2	5.8
+200	15.6	11.8
+325	24.0	25.2
-325	44.9	55.3
	100.0	100.0
-200	68.9	80.5

Test No. 4 - Concentration of the Tailings of Tests Nos. 2 and 3 by the Jones High Intensity Wet Magnetic Separator

A portion of each of the tailings from Tests Nos. 2 and 3 was concentrated by the Jones Separator, using current strengths of 0, 3, 10 and 25 amperes.

The products were four concentrates and a non-magnetic tailing from the 25 amp fraction.

Test No. 4(a):

The tailing of Test No. 2 was concentrated into the following fractions and the weight of each was calculated in terms of the original feed.

These products were sent to the mineralogical laboratory to determine the minerals present in each. The products were not analysed.

Table 6

Results of High Intensity Magnetic Concentration (Test No. 4(a))

Feed - Tailing from Test No. 2

Product	Weight, %		Amps. on Separator	Minerals seen in the Products
	In test	In orig. feed		
Feed	100.0	94.58		
Conc 1	5.54	5.24	0	Magnetite
Conc 2	33.25	31.45	3	Ilmenite pyroxene garnet, biotite
Conc 3	44.11	41.72	10	No ilmenite) In each) pyroxene) garnet) biotite
Conc 4	1.90	1.80	25	No ilmenite)
Non-mag. tailing	15.20	14.37		Feldspar, apatite

Test No. 4(b):

The tailing of Test No. 3 was concentrated at 0, 3 and 10 amperes.

The concentrates resulting from 0 and 3 amp were analysed. The remaining products, a concentrate at 10 amp and the non-magnetic tailing from 10 amp were not analysed.

Table 7

Results of High Intensity Magnetic Concentration (Test No. 4(b)

Feed - Tailing from Test No. 3

Product	Weight, %		Amp on Separator	Analysis, %		
	In test	In Orig. Feed		Fe	TiO_2	SiO_2
Feed	100.0	93.86				
Conc 1	4.27	4.01	0	26.56	3.88	26.84
Conc 2	28.84	27.07	3	-	12.17	-
Conc 3	44.66	41.92	10	-	-	-
Non-mag. tailing	22.23	20.86	from 10 amp setting	-	-	-

The concentrates containing magnetite and ilmenite were too low grade for commercial use.

The gangue minerals, pyroxene, garnet and biotite, although of low magnetic susceptibility, were drawn into the concentrate, resulting in a considerable dilution of the ilmenite concentrate.

Test No. 5 - Magnetic concentration by a low intensity separator to recover magnetite, followed by concentration of the tailing by a high intensity dry belt separator to recover ilmenite

This test was made with ore crushed to -20 mesh. The magnetite was removed by a low intensity dry belt separator, Ball-Norton type.

The Ball-Norton tailing was concentrated by a Stearns high intensity dry belt type separator. The Stearns concentrate was screened on 48 mesh.

Table 8

Results of Magnetic Concentration (Test No. 5)

Ball-Norton Separator

Product	Weight, %		Analysis, %			Distribution, %				Ratio of concentration in orig. feed
	In test	In orig. feed	Fe	TiO_2	SiO_2	In test Fe	In test TiO_2	In orig. feed Fe	In orig. feed TiO_2	
Feed*	100.0		16.0	5.80		100.0	100.0			
Mag. conc.	9.0		43.3	4.76	21.7	24.4	7.4			11 : 1
Tailing	91.0		13.3	5.91	--	75.6	92.6			

Stearns Separator

Stearns Feed*	100.0	91.0	13.3	5.91		100.0	100.0	75.6	92.6	
+48 mesh conc	44.7	40.7	13.2	4.60	36.9	44.6	34.9	33.7	32.3	2.5 : 1
-48 " "	47.0	42.8	15.0	8.08	34.2	53.2	64.3	40.2	59.6	2.3 : 1
Combined conc*	91.7	83.5	14.1	6.38	35.5	97.8	99.2	73.9	91.9	1.2 : 1
Tailing	8.3	7.5	3.61	0.60	--	2.2	0.8	1.7	0.7	

*calculated

CONCLUSIONS

The ore represented by this shipment is too low grade for an economic recovery of a suitable grade of concentrate, and in addition has ilmenite associated with the magnetite which cannot be eliminated to an accepted amount by fine grinding.

The magnetic concentrate obtained appears to be unsuitable as blast furnace feed on account of the contained ilmenite.

After removing the magnetite the ilmenite remaining in the tailing could not be recovered as a suitable ilmenite concentrate.

This is largely due to the sparse amount of ilmenite in the ore and to the presence of minerals of weak magnetic susceptibility which were concentrated with the ilmenite.

If higher grade ore should be found, further tests should be made on representative samples to determine the grade of concentrate to be expected from this property.

An ore of this type should contain at least 25% soluble iron to be economic under present conditions.

WSJ:EBM