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MINERALOGICAL EXAMINATION OF A TITANIUM ORE FROM THE GAUTHIER PROPERTY IN QUEBEC

by

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MINERAL SCIENCES DIVISION

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SUMMARY OF REULSTS

Drill core and mill products from an ilmenite ore, Gauthier property, St. Urbain, Quebec, were studied mineralogically. The ilmenite occurs in complex ilmenite-hematite grains disseminated in gangue, and the ilmenite-hematite grains are more plentiful in samples from the tops of the drill holes than in samples from the bottoms. The complex ilmenite-hematite grains are composed of ilmenite with hematite lamellae. The ilmenite-hematite grains from the tops of drill holes contain wide and narrow hematite lamellae and consist of about 65% ilmenite and 35% hamatite. Grains from the bottoms contain only narrow hematite lamellae and consist of about 80% ilmenite and 20% hematite but the grains are associated with magnetite and some are partly altered to rutile and goethite.

Mill products from the tops of drill holes show that the ilmenite-hematite grains are concentrated in the 5-amp magnetic fraction (with some hornblende), that pyroxene is concentrated in the 10-amp magnetic fraction (with some ilmenite hematite grains), and that feldspar is concentrated in the 10-amp non-magnetic fraction.

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INTRODUCTION

Nine drill core specimens and four mill products of an ilmenite ore from the Gauthier property, St. Urbain, Quebec, were received from Mr. G. Riley, Mineral Processing Division, Mines Branch on November 17, 1972. Mr. Riley stated that the drill core specimens were taken from 300 pounds of split drill core which was submitted to the Mines Branch by Mr. Paul E. Dumont, Consulting Engineer, 812 Boulevard St. Croix, Room 305, Montreal 249, Quebec, for mineral beneficiation tests. The mill products were from preliminary ore dressing tests. Mr. Riley requested that the samples be examined mineralogically.

The core specimens are from drill holes H_1 and H_4 and were labelled H_1 50-60, H_1 110-160, H_1 180-190, H_1 240-260, H_1 290-300, H_4 30-40, H_4 80-90, H_4 120-130 and H_4 160-170. The mill products were labelled D_1-5 amps mag., D_1-10 amps mag., D_1-10 amps midds., and D_1-10 amps non-mag.

METHOD OF INVESTIGATION

Polished and thin sections were prepared from the drill core specimens and mill products and the minerals were identified by microscopical and X-ray diffraction studies. The textures were determined by microscopical studies, and the relative quantities and size distributions of the minerals were measured with quantitative image analysis equipment.

GENERAL CHARACTERISTICS OF THE ORE

The drill core specimens consist of disseminated oxides and sulphides in a relatively coarse-grained rock (Figure 1). The oxides are ilmenite, hematite, magnetite, rutile, and goethite; the sulphides are pyrite, chalcopyrite, pyrrhotite, and sphalerite; and the rock-forming minerals are anorthite, hornblende, pyroxene, apatite, biotite, chlorite, quartz, zircon, and clay minerals.

The approximate mineralogical compositions of some of the core specimens, as determined by means of quantitative image analysis equipment are given in Table 1.

Samples from the tops of the drill holes (Sample Nos. H_1 50-60, H_1 110-120, H_4 30-40 and H_4 80-90) are different from those at the bottom in that:

(1) They contain more ilmenite, but the ilmenite grains in samples from the tops contain more hematite (Figure 2) than the samples from the bottoms (Figure 3).

(2) magnetite is present only in samples from the bottoms of the drill holes;

(3) the minerals in samples from the upper parts of the drill holes are relatively fresh, whereas those from the bottoms are partly altered to secondary minerals along fractures. For example, the ilmenite is partly altered to rutile and goethite, hematite to goethite, feldspar to clay minerals and quartz, and hornblende to chlorite.

DETAILED MINERALOGY OF ORE SPECIMENS

Ilmenite and Hematite

Ilmenite is the main mineral of economic interest and it occurs as a constituent of complex ilmenite-hematite grains disseminated in gangue.

TABLE 1

Approximate Mineralogical Compositions of Drill Core Samples
(in volume per cent)

Sample No.	Anorthite + Apatite + Zircon	Hornblende + Pyroxene + Chlorite + Biotite	Ilmenite + Hematite	Magnetite	Sulphides
H_4 30-40	42	31	26.4	nil	0.6
H_4 80-90	NA*	NA*	27.9	nil	1.1
H_4 120-130	60	29.8	7.1	2.9	0.2
H_4 160-170	NA*	NA*	5.4	3.5	0.5

*NA = Not analyzed.

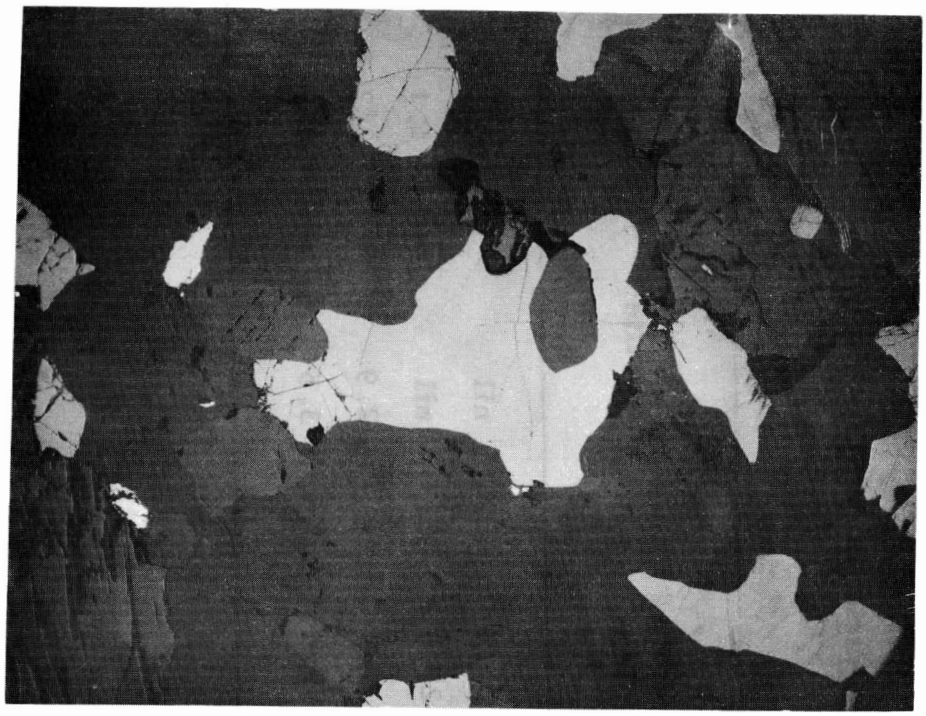

Figure 1. - Photomicrograph of the ilmenite ore showing disseminated ilmenite and magnetite (grey, not resolved in this photograph) and pyrite (white) (X 80).

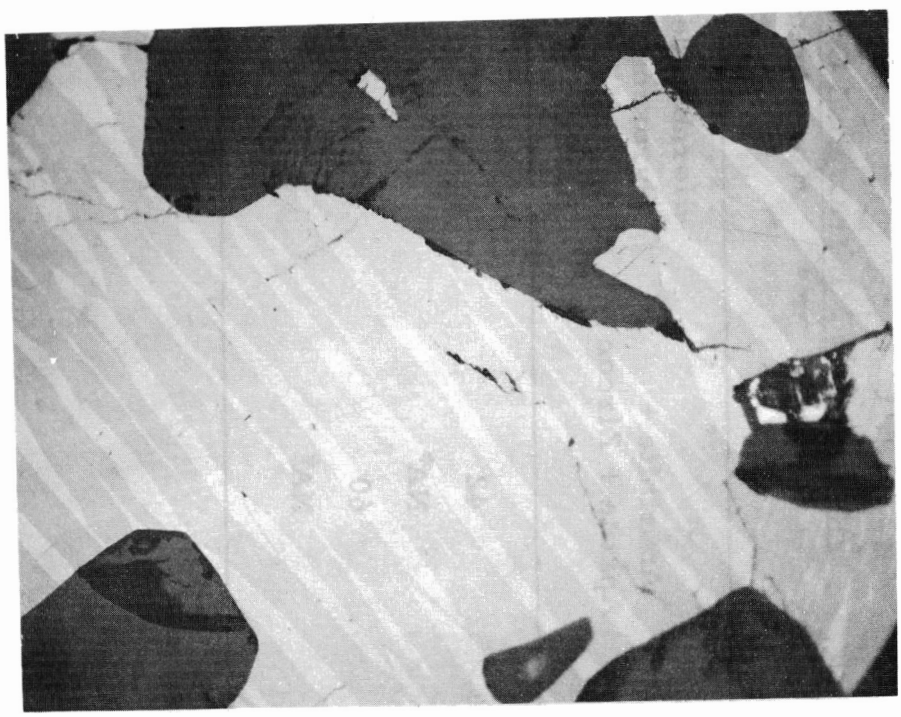

Figure 2. - Photomicrograph showing the wide and narrow hematite lamellae (white) in ilmenite (grey) (X 110).

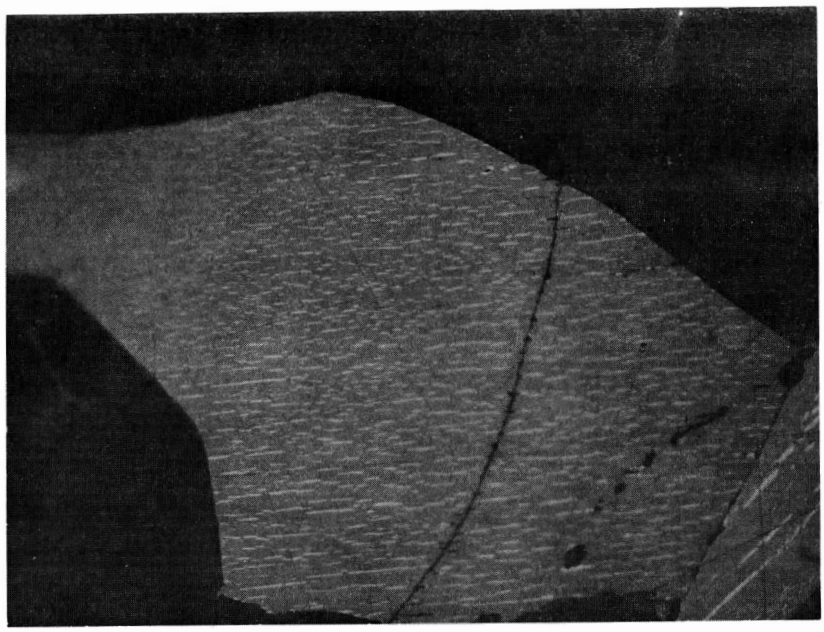

Figure 3. - Photomicrograph showing the narrow hematite lamellae (white) in ilmenite (grey). The black area and lines in the grain represent alteration products (goethite and rutile). (X 40).

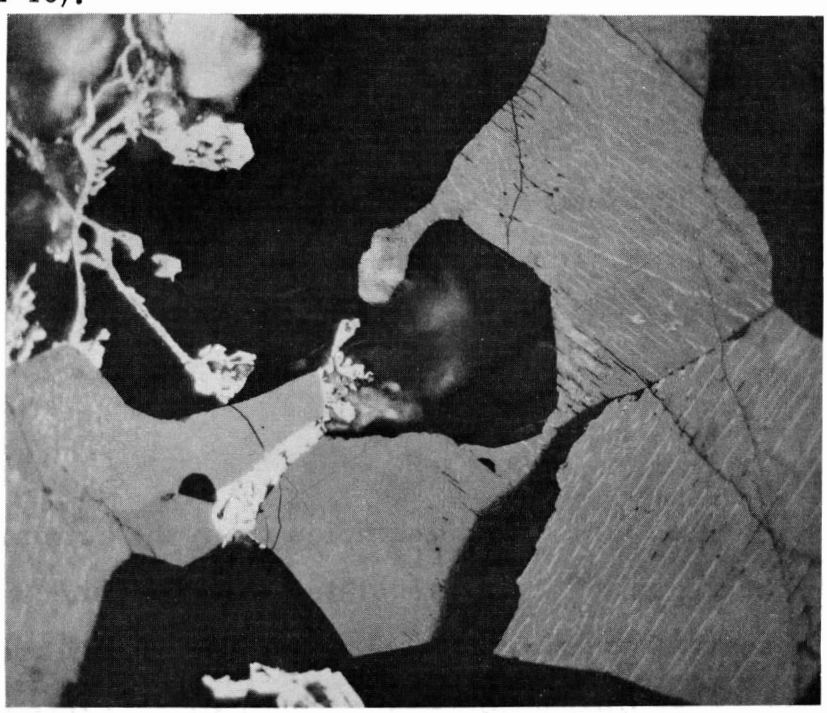

Figure 4. - Photomicrograph showing pyrite (white) in gangue and ilmenite. The light grey diffuse area on the end of the ilmenite grain in the centre of the photograph, above pyrite, represents rutile. (X 420).

The ilmenite-hematite grains in the upper parts of the drill holes consist of ilmenite with wide and narrow hematite lamellae (Figure 2). The wide hematite lamellae are 10 to 17 microns wide, contain a few minute ilmenite lamellae, and account for about 20% of the ilmenite-hematite grains. The narrow hematite lamellae occur in the ilmenite matrix between the wide lamellae, are up to 1 micron wide, and account for about 20% of the matrix. Therefore it can be calculated that the ilmenite-hematite grains from the upper parts of the drill holes contains about 35% hematite and 65% ilmenite.

The ilmenite-hematite grains from the bottoms of the drill holes consist of ilmenite with narrow hematite lamellae (up to 3 microns wide) (Figure 3) and contain about 20% hematite. Some of the grains in samples from the bottom of drill holes are partly altered along fractures and grain boundaries to rutile and goethite (Figure 4). The size distribution of the ilmenite-hematite grains in samples from the tops and bottoms of drill hole H_4 are given in Table 2.

Rutile

Rutile was found only as an alteration product of ilmenite in association with goethite in samples from the bottom parts of the drill holes. In a few places, small ilmenite grains have been completely altered to rutile.

Magnetite

Magnetite was found only in samples from the bottom of drill holes. It occurs as irregular grain associated with the ilmenite-hematite grains. Polished sections show that some magnetite grains are bleached along fractures but X-ray diffraction studies indicate that this bleached material is still magnetite.

Pyrite

Pyrite is the main sulphide mineral. It occurs as irregular grains and as inclusion and veinlets in the ilmenite-hematite and magnetite

TABLE 2

Size Analyses of Ilmenite-Hematite Grains in Drill Hole H_4
(in volume per cent)

Size Range (in microns)		Top of drill hole Sample H_4 30-40 %	Bottom of drill hole Sample H_4 160-170 %
plus	minus		
0	15	0.6	0.5
15	30	0.5	0.5
30	60	2.3	3.5
60	90	2.6	4.5
90	120	4.8	3.8
120	150	4.0	3.5
150	180	1.1	plus 150 83.7
180	210	5.3	
210	240	7.3	
240		71.5	
Total		100.0	100.0

grains (Figure 4). The pyrite grains are up to 100 microns in diameter and the veinlets are up to 10 microns wide.

Chalcopyrite

Small amounts of chalcopyrite were found as intergrowths with and as minute inclusions in pyrite.

Pyrrhotite and sphalerite

Small amounts of pyrrhotite and sphalerite were found as minute grains in gangue. The pyrrhotite was found only in the upper parts of the drill holes.

Silicate Minerals

The main silicates are anorthite, hornblende, and pyroxene, but some zircon, biotite, clay minerals, chlorite, and quartz, and present. The chlorite occurs as veinlets, but the clay minerals and quartz are alteration products of feldspar and are largely in samples from depth.

MILL PRODUCTS

The approximate mineralogical compositions of some products of magnetic separation as determined by means of the quantitative image analysis equipment are given in Table 3.

The results show that the ilmenite-hematite grains (35% hematite, 65% ilmenite) are concentrated in the 5-amp magnetic fraction; hornblende and pyroxene, in the 10-amp magnetic fraction; and non-magnetic silicates (feldspar) in the 10-amp non-magnetic fraction, some hornblende and pyroxene, however, were drawn into the 5-amp magnetic fraction and some ilmenite-hematite grains into the 10-amp magnetic fraction. This suggests an overlap in the magnetic susceptibilities of these two mineral groups. It is considered significant that most of the ilmenite-hematite grains in the 5- and 10-amp magnetic fraction are free whereas all of those in the 10-amp middling and magnetic fractions are present as inclusions in gangue.

A size analysis of the ilmenite-hematite grains in the 5- and 10-amp magnetic fraction is given in Table 4.

TABLE 3

Approximate Mineralogical Composition of Mill Products from Test D_1 on Ore from Upper Part of Hole H_4

Mineral	5-amp mag Vol %	10-amp mag Vol %	10-amp midds Vol %	10-amp non-mag Vol %
Ilmenite-Hematite	83.7	9.3	low	very low
Sulphides	0.3	0.7	low	very low
Hornblende + Pyroxene	16.0	90.0	high	nil
Feldspar			high	very high
Apatite			low	low
Total	100.0	100.0		
Ilmenite-Hematite: Sulphides ratio	310:1	14:1	1.5:1	1:1

TABLE 4

Size Analyses of Mill Products

Size range (in microns)		5-amp magnetic	10-amp magnetic
plus	minus		
0	15	1.2	0.5
15	30	0.8	2.3
30	60	13.6	13.7
60	90	24.4	10.7
90	120	30.0	17.7
120	150	21.6	16.4
150	180	6.1	27.9
180	210	2.3	10.8
Total		100.0	100.0

CONCLUSIONS

The main ore mineral is ilmenite and it occurs as a constituent of ilmenite-hematite grains. The ilmenite-hematite grains at the tops of the orebodies contain both wide and narrow hematite lamellae and consist of about 35% hematite and 65% ilmenite. Those at the bottoms of orebodies contain only narrow hematite lamellae and consist of about 20% hematite and 80% ilmenite, are associated with magnetite, and some are partly altered to rutile. This suggests that it may be possible to produce a higher-grade ilmenite concentrate from the bottom of the orebody than from the top. However, the bottom of the orebody contains more impurities which may interfere with recoveries.

Preliminary tests on the mill products suggest that the magnetic susceptibility of the hornblende is similar to that of the ilmenite-hematite grains and that hornblende would interfere with magnetic separation of ilmenite-hematite.

This ore is similar in many respects to that of Continental Iron and Titanium Mines (1),(2),(3),(4) and (5).

ACKNOWLEDGEMENTS

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