WESTERN CANADA STEEL LTD

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TESTS ON

QUEEN CHARLOTTE SANDS

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WESTERN CANADA STEEL LTD.
450 S.E. Marine
Vancouver, B.C.

TESTING OF QUEEN CHARLOTTE SANDS

Vancouver, B.C.
March 2, 1957

Dr. R.M. Thompson
Henry M. Howard.

HENRY M. HOWARD
1962 WESTERN PARKWAY
VANCOUVER, B.C.

March 2, 1957

Western Canada Steel Ltd.,
450 S.E. Marine,
Vancouver, B.C.

Gentlemen:

The accompanying report summarizes tests carried out on a sample of Queen Charlotte Sands as submitted by Coast Laboratories Limited.

The recoverable Magnetite content was found to be only 1.6%. Dr. R.M. Thompson has determined that the so-called "Ilmenite" is actually Hematite, with an appreciable Ilmenite content. The Ilmenite is partly in solid solution and partly as exsolved particles. This product would not be a source of Titanium.

The nature of the sands is such that no concentration of Magnetite may be found. No recoverable gold was present in the sample. The sands are considered to be worthless.

Yours very truly,

Henry M. Howard

Henry M. Howard.

HMH/gh
Encl.

TESTING OF QUEEN CHARLOTTE SANDS

Summary

A sample of Queen Charlotte Sands was submitted by Coast Laboratories Limited for test purposes.

Using table concentration, followed by magnetic separation of the table concentrate, the sample was found to contain 1.6% recoverable Magnetite and 2.5% recoverable "Ilmenite". The Magnetite assayed 64.4% Fe and 7.33% TiO_2. The "Ilmenite" fraction assayed 55.5% Fe and 22.3% TiO_2.

Dr. R.M. Thompson has shown that the "Ilmenite" fraction is mainly Hematite containing some Ilmenite in solid solution, plus exsolved particles of Ilmenite. This material cannot be considered as a source of Titanium.

Magnetite grains are present mainly in the 65 to 150 mesh size range. Prolonged concentration would decrease, rather than increase, the Magnetite content. It is therefore most unlikely that any Magnetite-rich areas will be found.

No Gold was seen on the table and Gold could not be detected under the microscope. It can be assumed that the sample contained no recoverable Gold.

The deposits are considered to be worthless as a source of iron ore.

Henry M. Howard

Henry M. Howard

Vancouver, B.C.
March 2, 1957.

TESTING OF QUEEN CHARLOTTE SANDS

Introduction

A sample of sands was received on Feb. 25 for test purposes. The sample was submitted by Coast Laboratories Limited and was said to have been taken by Noranda Explorations Limited from Rose Point, Graham Island. It was stated that the sample was a composite which included field samples 851-864 and 791-800.

Purpose of Tests

The chief purpose of the tests was to determine the yield of recoverable Magnetite and Ilmenite which could be obtained from the sands, and to see what type of concentrates could be produced. Mineral identification was also desired where necessary.

Description of Sample.

The material submitted was rather light in color. The sands were mainly in the 28 to 65 mesh size range.

The sample was first put through a 10-mesh screen to remove any pebbles and trash. The pebble content was small, representing about 1% of the total sample. Some pieces of hardpan, about 1/2 inch thick, were present. There was some fine wood trash and only minor traces of marine shells.

Pebbles were all worn very smooth and tended to be flattened, some very severely. No angular material was present and no coarse Magnetite was seen.

Testing Procedure.

The sands were tabled on the laboratory Wilfley table to make a rough concentrate and a tailing. The split between these products was made so as to include most of the Garnet in the rough concentrate. This was necessary to ensure a high recovery of the free Magnetite and Ilmenite, which tended to merge into the Garnet band on the table.

No Gold, nor any other high-specific gravity minerals could be seen on the table. Samples of all products were taken for reference, for assay, and for further work as described below. Results are as follows:

Sample No.		Wt.%	Fe %	TiO_2%
A2	Rough conct.	7.4	39.8	8.08
A3	Rougher tails	92.6	4.41	0.61
A1	Table feed	100.0	7.95	0.98
Table feed (calculated)			7.02	1.17

While the material balance is not all that could be desired, the above data show that assays on material "as received" cannot be used to evaluate these sands. The rougher tailings contained only traces of fine free Magnetite and "Ilmenite", but many middling particles were present.

The rough concentrate represented a ratio of concentration of 13.5. When operating on a large scale it would be possible to produce rough concentrates similar to the above. Recoveries would probably be somewhat lower than obtained in the laboratory. To increase the ratio of concentration, producing higher grade rough concentrates, would likely result in sharply reduced recoveries.

The rough concentrate was further treated by magnetic separation. Magnetite was removed by a hand magnet, while other fractions were obtained in the Isodynamic Separator. At very low current strengths a small amount of material was removed. All of this product was found to respond to the hand magnet and it was therefore combined with the Magnetite which had previously been removed. (Sample No. A4).

Two "Ilmenite" fractions were then removed (Samples A5 and A6). The current was increased to remove Garnet (Sample No. A7) and Epidote (Sample A8). Results are tabulated on following page.

Magnetic Separation of Rough Concentrate.

Sample No.	Description	Wt.%	Fe %	TiO_2%
A4	Magnetite	21.5	64.4	7.33
A5	"Ilmenite" No.1	27.0	55.2	22.0
A6	"Ilmenite" No.2	6.6	55.6	23.3
A7	Garnet	32.5	22.4	1.77
A8	Epidote	5.5	not assayed	
A9	Non-magnetic Remainder	6.9	not assayed	
A2	Rough conct.	100.0	39.8	8.08
Rough conct. (calculated from above)			39.8	9.64
A5 + A6 "Ilmenite" fraction (calculated)		33.6	55.5	22.3

The above results show magnetic products with a satisfactory Iron content, but very high in TiO_2. The two "Ilmenite" products are identical for all practical purposes and should be combined in making calculations.

The Iron balance is very good. The TiO_2, as calculated from the magnetic fractions, is appreciably higher than indicated by the assay of the rough concentrate. The discrepancy is somewhat greater than given above, due to the presence of some Rutile in Samples A8 and A9.

It will be noted that the discrepancies in the calculated TiO_2 values, in the results presented for table concentration and for magnetic separation, are of the same order, about 20% high. There is a possibility that the Fe + TiO_2 for samples A4, A5 and A6 in particular may be rather high. While these were relatively clean products they did contain some middling particles.

The Titanium assay is rather difficult, but results on the higher grade products usually tend to be low rather than high. While it would be desirable to establish the accuracy of the assays, the question in this instance is of academic interest only.

It will be noted that the rough concentrates contained 21.5% recoverable Magnetite and 33.6% "Ilmenite". At a ratio of concentration of 13.5 this would represent 1.6% Magnetite and 2.6% "Ilmenite" which could be recovered from the sands as received. These values are obviously too low for a commercial operation.

These recoveries are probably upper limits, since large scale roughing operations would reject some of the finer Magnetite and Ilmenite which was recovered on the laboratory table. On the other hand, recovery of magnetic minerals from the rough concentrates by magnetic separation should be almost exactly the same as that obtained in the laboratory. Also, assuming assays to be correct, the analyses of the products obtained in a magnetic separation plant should be similar to the analyses of the laboratory products.

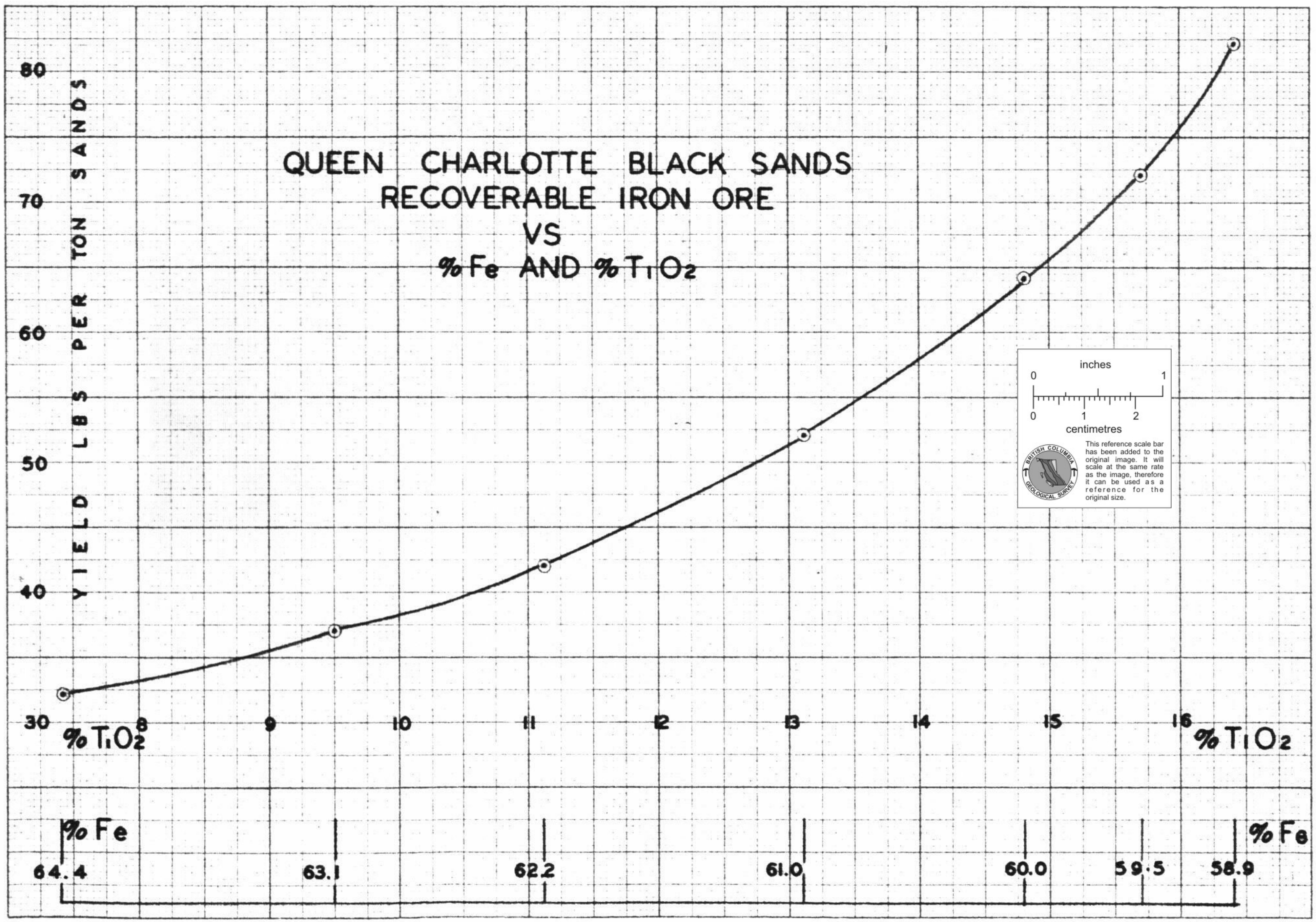
The "Ilmenite" fractions are made up of material which looks exactly like Ilmenite under the microscope and has the magnetic behavior of Ilmenite. The composition as indicated by the assays is not that of Ilmenite, nor does any known Titaniferous Magnetite fall into this category. The material is not a Magnetite-Ilmenite middling, since under the test conditions such middlings would either report as Magnetite or would have come off somewhere between Magnetite and Ilmenite.

X-ray determinations made by Dr. R.M. Thompson show that the so-called Ilmenite is actually Hematite, containing some Ilmenite. Photographs show clearly the presence of exsolved Ilmenite in Hematite. Details are given by Dr. Thompson at the end of this report. His findings are obviously of the utmost importance.

The "Ilmenite" fraction is useless as a source of Titanium. Although the Iron content is interesting, the high percentage of TiO_2 makes the material very undesirable for steel making. To be used at all, it would have to be diluted with large amounts of Titanium-free Iron ore.

If the recoverable Magnetite <u>only</u> is utilized, it would be necessary to ship and process 4.65 tons of rough concentrate for each ton of Magnetite recovered. This would not pay under any circumstances.

If the Magnetite plus the "Ilmenite" could be utilized each ton of Magnetite plus "Ilmenite" recovered by magnetic separation would entail the handling of 1.82 tons of rough concentrate.


QUEEN CHARLOTTE BLACK SANDS
RECOVERABLE IRON ORE
VS
%Fe AND %TiO2
YIELD LBS PER TON SANDS
80
70
60
50
40
30
%TiO2
8
9
10
11
12
13
14
15
16
%TiO2
%Fe
64.4
63.1
62.2
61.0
60.0
59.5
58.9
%Fe
inches
0
1
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1
2
centimetres
This reference scale bar has been added to the original image. It will scale at the same rate as the image, therefore it can be used as a reference for the original size.
BRITISH COLUMBIA
GEOLOGICAL SURVEY

The effect of mixing together the Magnetite and "Ilmenite" products is indicated on the accompanying graph. The "yield", in pounds per ton recovered from sands as received, is plotted against the Fe and TiO_2 content of the various mixtures which could be made. It will be noted that the high TiO_2 content of the Magnetite fraction, based on the assays obtained, makes any program of mixing rather impractical from the start. Even if it could be possible to start with a Titanium-free Magnetite there could be included only a small amount of the "Ilmenite" fraction before the TiO_2 content of the mixture would exceed the 5-7% range which is probably a practical limit.

It is interesting to note that the Iron content of any mixture of the Magnetite and "Ilmenite" products is always quite high. Even when the entire "Ilmenite" product is included, the resulting mixture would contain 58.9% Fe. Per ton of sands, there would then be recovered 82 lbs. of "Iron Ore", but this would unfortunately contain 16.4% TiO_2.

Screen Analysis of Table Feed.

To study the sands further a screen analysis was made of the minus 10-mesh table feed. The purpose was to study the size distribution of the sands and to determine at what sizes the mineral was free. Results are tabulated on the following page.

Screen Fraction	Wt.%	Magnetite %	Magnetite % distr.	
-10+14	0.8	middlings only		
-14+20	2.5	"	"	
-20+28	6.8	2.9	6.0	mostly middlings
-28+35	16.4	2.9	14.5	mostly middlings
-35+48	37.7	1.5	17.1	25% free Mag.
-48+65	24.0	2.7	19.6	50% free Mag.
-65+100	8.0	11.3	27.2	90% free Mag.
-100+150	2.0	21.7	12.9	99% free Mag.
-150+200	0.7	7.5	1.5	99% free Mag.
-200	1.1	3.3	1.2	99% free Mag.
Original sample	100.0	3.32	100.0	

Sample No. A10 was the combined Magnetite fractions from the above. This sample assayed 2.66% TiO_2 and 30.9% Fe. The low assay is due to the high middling content in the coarser sizes. The middlings are also responsible for the high calculated value of 3.32% Magnetite. Most of these middlings were rejected in the rougher tailings.

The nature of the Magnetite grains makes it impossible to recover the middlings. If recovered, the Iron content of the middlings would be too low to justify grinding and subsequent magnetic separation.

Most of the free Magnetite occurs in the 100 and 150-mesh sizes. Very few Magnetite grains are coarser than 48 mesh, and no Magnetite grains coarser than 28 mesh could be seen.

The type of rocks from which these sands have originated do not contain coarse Magnetite or Ilmenite.

It will be seen that the screen analysis is that of a typical classified product, containing particles of roughly equal settling rates. The sands have been subject to rather mild water concentration, sufficient to wash away the finer sands only, leaving behind the fine Magnetite grains and the coarser sands.

Conclusions

Since no coarse Magnetite or Ilmenite was originally present in the source rocks, more extensive concentration will serve only to wash away the medium-sized sands and the finer Magnetite and "Ilmenite". There is therefore no possibility of finding any rich concentrations of Magnetite and "Ilmenite" in sands of this nature. Prolonged concentration will yield a product which is actually depleted in Magnetite and "Ilmenite".

The opinions expressed in this report have been based on the testing of one sample only. Although carefully done, the work was rushed on a day and night basis in order to meet a Government deadline. There was no time to check the assays nor to repeat any part of the work after the assays were received.

In spite of these handicaps it is still possible to draw important conclusions from this work. The nature of the sands indicates that no concentration of Magnetite may be found, other than on the surface at the water's edge. The recoverable

Magnetite content is too low to permit commercial operation. The nature of the "Ilmenite" fraction is such that these sands cannot be assumed to be a source of Titanium. Shipping and processing the rough concentrates would be an expensive item. No Gold has been found in the sample. The deposits are therefore considered to be worthless as a source of Iron ore.

Henry M. Howard

Vancouver, B.C.
March 2, 1957

Henry M. Howard.

MINERALOGY OF THE SAMPLE

A 100 gram sample of table concentrate was received from Prof. Howard for magnetic separation and mineral identification. The procedure was as follows: The magnetite was removed by means of a number of Al-Ni magnets and the product cleaned twice. The remainder was put through a Frantz Isodynamic Separator at various current strengths and eight products were obtained and examined.

Current strengths of 0.05, 0.10, and 0.15 amperes each produced small quantities of material which would adhere to a magnet. Some of this material is magnetite, and some, magnetite middlings. A polished briquette of the magnetite fraction shows that the grains are largely free and clean.

At 0.20 amperes, a black granular product in greater amount than the magnetite was obtained. Because some of this material was still present in the remainder, the amperage was increased to 0.225 which effectively removed almost all of the black granular material. This black material was thought to be ilmenite but x-ray powder photographs made on a number of grains selected at random from the 0.20 amp. and the 0.225 amp. fractions both gave the pattern of hematite plus a very weak pattern of ilmenite. A polished briquette of these two fractions shows grains of hematite with exsolved laths and /or blebs of ilmenite.

Hematite and ilmenite form a continuous solid solution series above 600°C. If rapidly cooled, the solid solution is preserved in a metastable state but with moderately slow cooling it unmixes into two solid solutions - a ferriferous ilmenite and a titaniferous hematite. The final products of unmixing are ilmenite containing about 6% Fe_2O_3 (4.2% Fe^{3+}) still in solid solution, and "titan-hematite" or hematite containing about 10% TiO_2 (7.5% Ti^{3+}) in solid solution. Typical microtextures resulting from the unmixing of this ilmenite-hematite solid solution are shown in Figs. 1-3.

Fig. 1 shows a groundmass of "titanhematite" with exsolved blades and blebs of ilmenite. Fig. 2 shows a groundmass of ferriferous ilmenite with exsolved laths of "titanhematite". Fig. 3 shows a coarse lath of ilmenite (with exsolved "titanhematite") in a grain of "titanhematite" (with exsolved ilmenite). Fig. 1 is typical of the great majority of the grains. Free ilmenite grains are rare. The above explains the low titanium assays on the "ilmenite" fraction.

The 0.45 amp. fraction consists principally of red garnet and black prismatic hornblende.

The 1.45 amp. (magnetic fraction) consists of a number of minerals including epidote, olivine, titanite, monazite etc.

The 1.45 amp. (maximum obtainable amperage) non-magnetic fraction consists of light coloured minerals including quartz, feldspar, zircon, and unimportant amounts of black rutile and other minerals. Gold, which is occasionally present in this fraction , was not observed.

R.M. Thompson
R. M. Thompson
February 28, 1957.

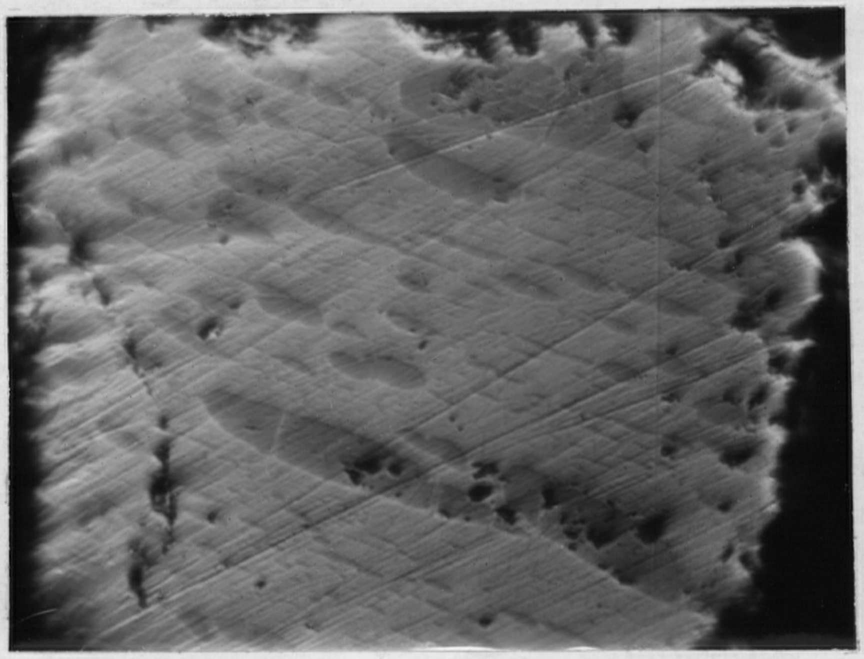
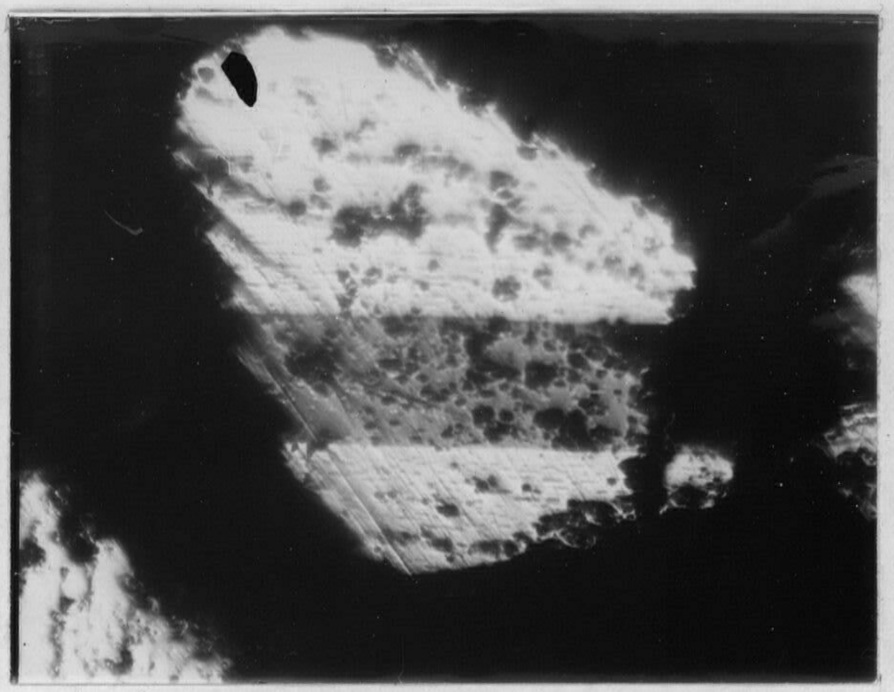


Fig. 1 A groundmass of "titanhematite" with exsolved blebs and blades of ilmenite. x 570.



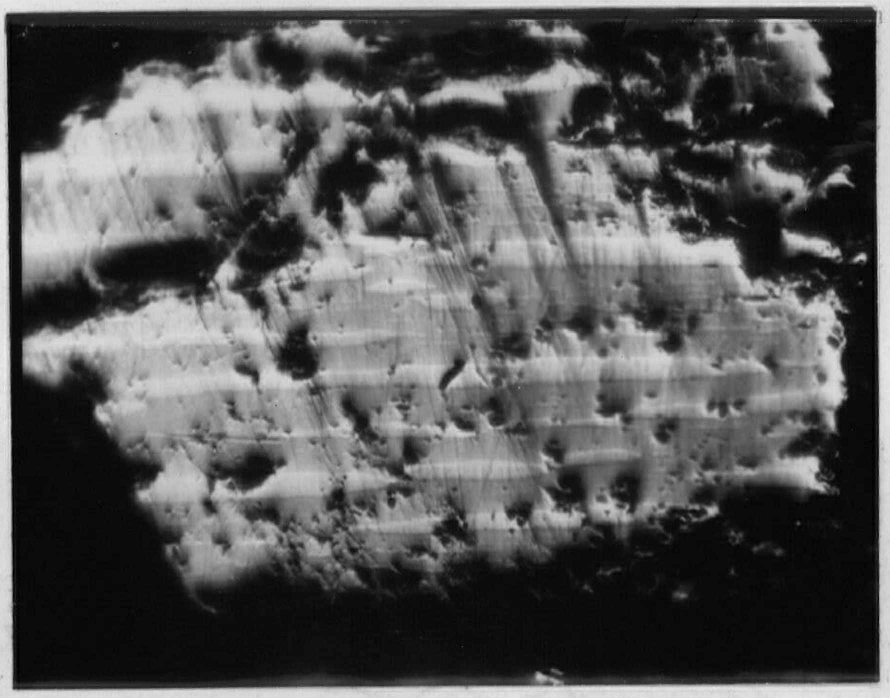


Fig. 2 A groundmass of ferriferous ilmenite with exsolved laths of "titanhematite". x 570.

Fig. 3 A coarse lath of ilmenite (with exsolved "titanhematite") in a grain of "titanhematite" (with exsolved ilmenite). Oil immersion lense x 327.