IR/1962

O T T A W A December 1, 1945.

R E P O R T

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1962.

Concentration of Specular Hematite from the Ore of the New Telluride Gold Mines of Canada Limited, Telluride, Ontario.

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Note:
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Shipments:

Two shipments of ore were received from the New Telluride Gold Mines of Canada Limited.

The first, consisting of 3 samples, total weight 25 pounds, was received on September 6, 1945. As these were made up of fairly fine material, a second sample of the ore in larger pieces was requested. This lot, weighing 78 pounds, was received on October 1, 1945.

Location:

The mine is located in Skead township, in the Larder Lake area of northern Ontario. The mine office is at Telluride, Ontario.

Purpose of the Investigation:

Mr. D. M. Gilpin, President of the company, requested that an investigation be carried out with the object of obtaining from the ore an iron concentrate substantially free from all impurities.

Sampling and Analysis:

As no distinguishing marks were found on the three samples submitted in the first shipment, they were numbered 1, 2 and 3 in order of their weights. All samples were finely broken when received. Sample No. 1 weighed 14½ pounds and had been crushed to approximately minus 80 mesh. Sample No. 2, weight 8½ pounds, and Sample No. 3, weight 2 pounds, had been crushed to approximately minus 14 mesh.

The analysis of the three samples was:

	Iron	Sulphur	Insoluble
	-	Per	Cent -
No. 1	31.18	10.82	32.30
No. 2	29.40	10.98	35.06
No. 3	17.64	11.85	51.60

Shipment No. 2 was received in lump form and was crushed and sampled by standard methods. The results were as follows:

Gold, oz./ton	Copper, per cent	Iron, per cent	Sulphur, per cent	Insol., per cent
0.295	6.54	38.68	13.93	21.78

Results of Experimental Tests:

The results of the experimental tests which have been completed to date indicate that it will be difficult to recover a hematite concentrate free of sulphur and insoluble gangue material. The lowest analysis obtained indicated 7.5 per cent of insoluble, and microscopic examination disclosed that even after two cleaning operations silica particles were

(Results of Experimental Tests, cont'd) -

present in sizes from coarse to fine.

Flotation of the sulphides from the ore did not present any difficulty in the second shipment. High-grade copper and pyrite concentrates could be obtained by selective flotation. However, sufficient sulphides remained in the sulphide flotation tailing to contaminate any second concentrate made from the residues.

Character of the Ore:

The description of the ore applies only to that represented by Shipment No. 2.

Polished sections were prepared from selected specimens of the ore and were examined microscopically.

Gangue -

Gangue is abundant and consists essentially of hard, greenish grey rock with numerous small, scattered grains of soft material. A few narrow veinlets of glassy quartz cut the assemblage of rock mineral which appears to represent a highly silicified greenstone.

Metallic Minerals -

Metallic mineralization is fairly heavy in the sections and is represented by hematite, pyrite, chalcopyrite and magnetite, listed in their approximate order of abundance. The first three minerals named above occur in gangue, chiefly as mixed granular masses with hematite predominating in some places and sulphide(s) in others. A more detailed description of their modes of occurrence follows:

Needles, platy aggregates and narrow veinlets of specular hematite are visible in gangue alone and closely associated with chalcopyrite and/or pyrite. While the greater portion of the iron oxide in the polished surfaces is free of sulphides, in some places it is rather intimately associated with them, especially with chalcopyrite. The polished surfaces

(Character of the Ore, cont'd) -

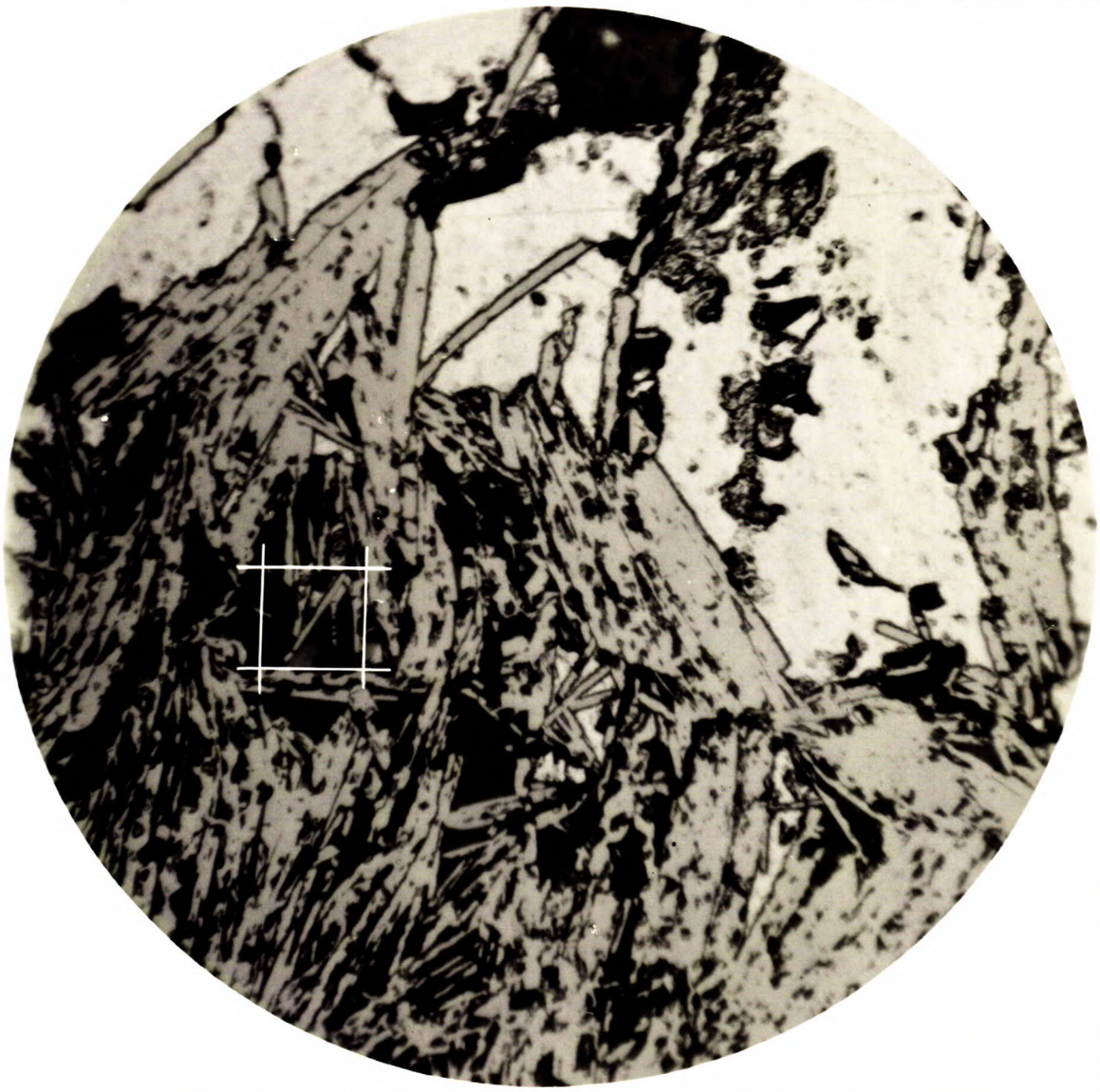
of the hematite are rather badly pitted and, while it is impossible to say whether or not every pit originally contained gangue which pulled out during the polishing, many of these pits definitely contained gangue. The majority of such inclusions, however, appear to be along cleavage lines in the micaceous specularite and hence probably can be freed by grinding (see Figure 1).

While pyrite and chalcopyrite occur alone in gangue, they are usually together as intimately mixed granular masses in which the chalcopyrite veins pyrite. A small amount of magnetite is visible in one section as occasional, tiny, equidimensional grains in gangue.

(Figure 1 follows,
on Page 5.)

(Character of the Ore, cont'd) -

Figure 1.



X200.

PHOTOMICROGRAPH OF POLISHED SECTION, SHOWING THE CHARACTER OF THE HEMATITE AND ITS RELATION TO SULPHIDE, HERE CHALCOPYRITE.

A 200-mesh Tyler screen opening is outlined in white.

Chalcopyrite - light grey, almost white.
Hematite - medium grey.
Gangue - dark grey.
Pits - black.

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Investigative Procedure:

To obtain a concentration of hematite free from impurities it first was necessary to remove sulphides. This was done by bulk and selective flotation processes followed by a second flotation of the hematite from the sulphide flotation tailing. In some tests, attempts were made by flotation to remove siliceous minerals, leaving the hematite as a tailing.

EXPERIMENTAL TESTS:

Test No. 1, Shipment No. 1, Sample No. 1 - Bulk Flotation of Sulphide.

This test was made using the ore received in the sample designated No. 1 in this report.

A sample of the ore was crushed to approximately minus 100 mesh by grinding in a ball mill with water. The pulp was placed in a flotation machine, and soda ash was added in stages until alkalinity was obtained. This required 10 pounds of soda ash per ton of ore. After conditioning for 10 minutes, 0.2 pound of potassium amyl xanthate was added and conditioned for 3 minutes. Pine oil was used as a frother (0.1 pound per ton). After floating the resulting concentrate for 7 minutes, the following reagents were added to the cell:

Na_2CO_3	-	2.0 lb./ton
Copper sulphate	-	1.0 "
Potassium amyl xanthate	-	0.2 "
Pine oil	-	0.05 "

A further concentrate was recovered. The rougher concentrate was recleaned without reagents.

Results of Flotation:

Products	Weight, per cent	ASSAYS Au oz./ton	Percent Cu	Fe	S	Insol.	Distribution, per cent Fe	S	Insol.
Feed	100.0	-	-	31.2	10.8	32.2	100.0	100.0	100.0
Flot. conc.	26.5	1.08	17.13	36.0	35.2	4.6	29.1	91.7	4.1
" midd.	3.2	-	6.14	25.1	9.7	34.4	2.4	3.0	3.7
" tailing	70.3	-	0.52	31.9	0.76	38.5	68.5	5.3	92.2

Ratio of concentration, 3.77:1.

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(Experimental Tests, cont'd) -

Test No. 2, Shipment No. 1, Sample No. 2.
- Bulk Flotation of Sulphide.

A sample of the ore was prepared for flotation by grinding in water to approximately 84 per cent minus 200 mesh with 10 pounds of soda ash per ton. The flotation reagents were potassium amyl xanthate, 0.2 pound per ton, and pine oil, 0.1 pound per ton. Flotation was for 7 minutes.

A further addition of 0.2 pound per ton of amyl xanthate was used and the resulting concentrate was recovered. No copper sulphate was used. This rougher concentrate was recleaned without reagents.

Results of Flotation:

Products	Weight, per cent	ASSAYS Au oz./ton	Per cent Cu	Fe	S	Insol.	Distribution, per cent Fe	S	Insol
Feed	100.0	-	-	29.4	11.0	35.1	100.0	100.0	100.0
Flot. conc.	27.1	0.86	17.5	36.6	35.8	3.5	31.4	92.4	3.0
" midd.	3.8	-	4.8	28.2	8.3	33.4	3.3	3.0	4.0
" tailing	69.1	-	0.4	29.9	0.71	41.9	65.3	4.6	93.0

Ratio of concentration, 3.7:1.

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Test No. 3, Shipment No. 2.

This test included flotation of the sulphides and gangue separately.

The sulphides were recovered by using the same reagents as in Test No. 2.

The pulp was then conditioned with 1.0 pound sodium silicate per ton, and 0.5 pound of reconstructed oleic acid per ton was added. These reagents floated the slimed hematite and left the coarser particles of hematite in the flotation tailing.

An analysis of the flotation tailing showed it to contain:

Iron, 41.35 per cent.
Sulphur, 0.03 "
Insol., 15.40 "

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(Experimental Tests, cont'd) -

Test No. 4, Shipment No. 2.

After recovering the sulphides, oleic acid was used to try to recover the hematite. Using the same reagents as in Test No. 3, the sulphides were removed from the pulp.

The pulp was conditioned with 1.0 pound of sodium silicate per ton. Oleic acid was used as a collector for the hematite. The froth appeared quite black and well mineralized. This concentrate was recleaned with 1.0 pound of sodium silicate.

Microscopic examination showed that the cleaner concentrate still contained a considerable amount of coarse particles of gangue (silicates). It was found to contain:

Iron,	45.78	per cent
Sulphur,	0.14	"
Insoluble,	14.28	"

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Test No. 5, Shipment No. 2.

After recovering the sulphides, sodium oleate was used to recover hematite.

The sulphides were removed by means of the same reagents as in the previous test. The pulp was then conditioned with 1.0 pound of sodium silicate. Sodium oleate was stage-fed until 0.5 pound was added. This resulted in a satisfactory-appearing froth which was well mineralized with hematite.

The rougher concentrate was cleaned with 1.0 pound of sodium silicate. The microscope showed that the cleaner concentrate contained much free gangue. On analysis it was found to contain:

Iron,	43.04	per cent
Sulphur,	0.16	"
Insoluble,	10.36	"

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Test No. 6, Shipment No. 2. - Selective Flotation of Sulphides.

In this test the pulp was ground to approximately 84 per cent minus 200 mesh. The reagents added to the grind

(Experimental Tests, Test No. 6, cont'd) -

were 10 pounds of soda ash per ton and 0.2 pound of Barretts No. 4 reagent per ton.

The pulp was put in the flotation machine and it was noted that the chalcopyrite contained in the ore appeared to be activated in preference to the pyrite. The addition of 0.1 pound of cresylic acid resulted in a strong, well-mineralized froth which was recovered. This concentrate appeared to consist mainly of chalcopyrite. It was recleaned with 2.0 pounds of lime and 0.2 pound of sodium cyanide per ton, giving a cleaner copper concentrate and a middling.

The pyrite was activated using potassium amyl xanthate (stage-fed, 0.4 pound per ton) as the collector. This pyrite concentrate was also recleaned, without the use of any reagents, giving a cleaner pyrite concentrate and a middling.

The pulp was then dumped from the flotation machine and was deslimed.

A portion of the coarse tailing was repulped in a flotation machine and conditioned with oleic acid at a pH of 9.0. A concentrate of specularite was recovered which was recleaned twice.

The copper concentrate contained:

Gold,	0.50	oz./ton
Copper,	25.6	per cent
Iron,	33.9	"
Insoluble,	1.0	"

The pyrite concentrate contained:

Gold,	1.44	oz./ton
Copper,	1.43	per cent
Iron,	42.4	"
Insoluble,	3.5	"

The hematite concentrate contained:

Iron,	54.1	per cent
Sulphur,	0.21	"
Insoluble,	7.36	"

The slimes contained iron, 25.8 per cent.

(Experimental Tests, Test No. 6, cont'd) -

The hematite middlings contained considerable specularite and gangue, some of which was free. Several products of the test were not analysed, as the microscopic examination showed that the gangue minerals had not been eliminated.

Results of Test No. 6.

Product	Weight, per cent	Assays: Au oz./ton	Assays, per cent: Cu	Fe	S	Insol.	Distribution, per cent: Au	Cu	Fe	S	Insol.	Ratio of Conc.
Feed	100.0	0.295	6.54	38.68	13.93	21.78	100.0	100.0	100.0	100.0	100.0	
Copper conc.	24.4	0.50	25.6	33.9	-	1.0	41.4	95.5	21.4	-	1.12	4.1:1
" midd.	3.0	-	-	-	-	-	-	-	-	-	-	-
Pyrite conc.	10.7	1.44	1.43	42.4	-	3.5	52.5	2.4	11.8	-	1.73	9.3:1
" midd.	1.7	-	-	-	-	-	-	-	-	-	-	-
Slimes	16.2	-	-	25.83	-	-	-	-	10.8	-	-	6.2:1
Hem. conc.	18.9	-	-	54.1	0.21	7.4	-	-	26.4	0.28	6.4	5.3:1
Hem. midling No. 1	6.1	-	-	-	-	-	-	-	-	-	-	-
Hem. midling No. 2	7.1	-	-	-	-	-	-	-	-	-	-	-
Flot. tailing	11.9	-	-	18.3	-	-	-	-	5.6	-	-	-

(Experimental Tests, Test No. 6, cont'd) -

A portion of the deslimed tailing was treated by the Hydrated Lime method. Lime was added to give a pH of 11 to 12. The lime was used to inhibit the hematite and activate its quartz. An anionic collecter (sodium oleate) was used to try to float the siliceous gangue minerals. The result of this test was not successful in that a considerable number of coarse particles of gangue remained in the hematite tailing.

A further test, using the caustic metaphosphate method, was tried. The pulp was made alkaline with sodium hydroxide (pH 12.0). Calgon (sodium metaphosphate) and oleic acid were used to activate the gangue minerals.

Microscopic examination of the hematite concentrates disclosed considerable gangue particles. No analysis of the products was made.

Test No. 7, Shipment No. 2.

This test was made to determine the effect of low alkalinity on the flotation of hematite.

After removing the sulphides and desliming the flotation tailing, the pulp containing the coarse hematite was returned to a flotation machine and repulped with water. The pH of the pulp was 9.3. Sulphuric acid was added to the pulp to hold it at pH 7.5 as nearly as possible. It is suggested that the acid (H_2SO_4) has a depressing action on silica gangue.

Oleic acid was stage-fed and about 0.5 pound was used to float practically all of the hematite in a rougher concentrate. Considerable gangue floated with the hematite and was not eliminated after two recleanings.

(Continued on next page)

(Experimental Tests, Test No. 7, cont'd) -

Products	Weight, per cent	Assays, per cent			Distribution, per cent			Ratio of Conc.
		Fe	S	Insol.	Fe	S	Insol.	
Feed	100.0	38.68	13.93	21.78	100.0	100.0	100.0	
Sulphide conc.	38.6	39.63	-	-	39.5	-	-	2.6:1
Slimes	17.0	23.80	-	-	10.5	-		5.9:1
Iron conc.	29.8	49.98	0.15	15.08	38.5	0.32	20.6	3.4:1
Iron middling No. 1	4.2	35.70	-	40.88	3.9	-	7.9	-
Iron middling No. 2	5.7	38.01	-	37.78	5.6	-	9.9	
Flotation tailing	4.7	16.38	-	-	2.0	-	-	

CONCLUSIONS:

It is apparent from the above that it will be impossible, practically, to produce an iron concentrate free from impurities from an ore of this character. Any concentrate obtained would have to compete with iron ore from producing localities. The grade and impurities in the concentrate will render it unacceptable for such special use as the production of iron powder.

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