5001-9 2718

INDUSTRIAL CONFIDENTIAL

CANADA

DEPARTMENT OF MINES AND TECHNICAL SURVEYS

OTTAWA

MINES BRANCH INVESTIGATION REPORT IR 60-90

FLOTATION OF CHALCOPYRITE FROM ORE OF NEW HOSCO MINES LIMITED, MATTAGAMI LAKE AREA, QUEBEC

DANIEL TWP

by

T. F. BERRY

MINERAL PROCESSING DIVISION

NOTE: THIS REPORT RELATES ESSENTIALLY TO THE SAMPLES AS RECEIVED. THE REPORT AND ANY CORRESPONDENCE CONNECTED THEREWITH SHALL NOT BE USED IN FULL OR IN PART AS PUBLICITY OR ADVERTISING MATTER.

COPY NO. 4

AUGUST 26, 1960

Industrial Confidential

Mines Branch Investigation Report IR 60-90

FLOTATION OF CHALCOPYRITE FROM ORE OF NEW HOSCO MINES LIMITED, MATTAGAMI LAKE AREA, QUEBEC

by

T. F. Berry*

SUMMARY OF RESULTS

Flotation of a bulk sulphide concentrate which required further grinding and one or more cleaning stages was essential for successful metallurgy.

By this means the following grades and recoveries were obtained:

Test No.	Grade % Cu	Recovery % Cu
6	23.07	87.7
7	22.23	88.0
8	24.72	87.3
9	22.24	89.8

There was no consistency in the association of the gold, and an examination of the mill products from several tests indicated that there was little chance of recovering this element in a copper flotation concentrate.

A mineralogical examination of the drill core, and of the infrasizer fractions of the 1st cleaner tailing from test No. 7 showed the intimate association of the chalcopyrite with pyrite . This is undoubtedly the reason for the reduction in concentrate grade as increased recovery was obtained, a trend evident in all of the flotation tests.

* Technical Officer, Mineral Processing Division, Mines Branch, Department of Mines and Technical Surveys, Ottawa, Canada.

CONTENTS

INTRODUCTION

Location of Property

The property is a copper prospect located in Daniel township, Mattagami Lake area, northwestern Quebec.

Shipments

Two samples of drill core were submitted for test work -

1) 325 lb drill core was received on December 28, 1959,
2) 145 lb " " " " " March 31, 1960.

Nature of Investigation Requested

In a letter dated December 14, 1959, Dr. R. Bruce Graham of 54 St. Leonards Avenue, Toronto 12, Ontario, Consulting Geologist for New Hosco Mines Limited, requested test work on the drill core to determine the optimum flotation conditions necessary for the production of a high grade copper concentrate at as high a recovery as possible. Dr. Graham further asked that the association of the gold and silver minerals be determined and, if possible, that these minerals be concentrated.

Sampling and Analysis

Representative samples of each shipment were submitted to the ore mineralogy laboratory for a mineralogical investigation.

The samples of drill core were crushed to -10 mesh and head samples riffled out for spectrographic and chemical analysis.

The spectrographic analysis showed no elements other than copper to be present in economic amounts.

In Table 1 which follows, the results of the chemical analysis of the head samples may be seen.

TABLE 1

Head Analysis - Chemical

Element	Sample No. 1	Sample No. 2
Copper	3.40 %	1.96 %
Zinc	0.72 %	0.14 %
Iron (acid soluble)	31.95 %	32.28 %
Sulphur	18.96 %	17.84 %
Lead	0.01 %	N.D.
Insol	N.D.	27.60
Au	trace oz/t	0.005 oz/t
Ag	0.33 "	0.13 "

N.D. - not determined

MINERALOGICAL INVESTIGATION*

This report is concerned largely with a microscopic study of polished sections of drill core fragments from the two samples. In addition, a description of some mill products produced from the ore is also included.

Mineralogical Composition of Drill Core Samples

Examination of polished sections prepared from diamond drill core fragments reveals that the principal sulphide in both samples is pyrite. Other sulphides present are chalcopyrite and pyrrhotite, and a minor amount of sphalerite. The gangue minerals, as determined by the

---

* Internal Report No. MS-60-74 by Dr. E. H. Nickel, August 16, 1960.

microscopic examination of crushed material in oil immersion, are quartz, chlorite, and a ferruginous carbonate. Some magnetite is also present.

Both samples were analyzed chemically for the principal sulphidic elements. The results are shown in Table 2.

TABLE 2

Partial Chemical Analyses of Head Samples

Element	Sample No.1	Sample No.2
Cu	3.4	1.96
Zn	0.72	0.14
Fe	31.95	32.28
S	18.96	17.84

The values shown in Table 2 were used to calculate the percentages of the sulphide minerals. The calculations were made as follows: All the copper was calculated as chalcopyrite--$CuFeS_2$. All the zinc was calculated as sphalerite. The remaining sulphur was calculated as pyrite and pyrrhotite. The pyrite:pyrrhotite ratios used in the calculations were obtained by X-ray diffraction analysis using a recording diffractometer. The excess iron remaining after the above calculations (14.7% Fe in both samples) can be assumed to be present as magnetite and the iron-bearing gangue-minerals--chlorite and ferruginous carbonate.

The results of the mineralogical calculations are shown in Table 3.

TABLE 3

Calculated Mineral Composition of Samples

Minerals	Sample No.1	Sample No.2
Pyrite	25.7%	23.8%
Chalcopyrite	9.8	5.7
Pyrrhotite	3.7	7.9
Sphalerite	1.1	0.2
Gangue (by difference)	59.7	62.4
	100.0	100.0

According to Table 3, the sulphides comprise about 40% of both samples. This proportion is corroborated by the results of heavy liquid separations of the two samples.

Textural Relationships of Sulphides in Drill Core Samples

The proportion of sulphides to gangue minerals varies greatly from one drill core fragment to the next. Some of the polished sections consist almost entirely of massive sulphides, some contain only sparsely disseminated sulphides, while still others have an intermediate sulphide content. The grain sizes of the sulphides also exhibit wide variations.

Pyrite occurs from relatively coarse aggregates down to tiny grains. The large aggregates are generally irregular in outline, and usually contain inclusions or veinlets of other sulphides or gangue minerals (Figure 1). The smaller pyrite grains are disseminated in gangue and in other sulphides (Figures 2,3,4). Some of the small grains occur as well-formed cubic crystals (Figures 2 and 4).

Chalcopyrite occurs in a wide variety of forms. Some of it is associated with other sulphides, either as fine veinlets (Figure 1) or in irregular intergrowths (Figure 4), while some of the chalcopyrite is enclosed entirely by the gangue as disseminated particles (Figure 5). Figures 2 and 4 show the chalcopyrite interstitial to, and moulded against pyrite grains. The chalcopyrite exhibits wide variations in grain size, from massive aggregates several mm in diameter (Figure 6) down to veinlets and disseminated grains only a few microns in diameter (Figures 1,5). Examination of these sections and those of infrasized tailing products (see page 6) indicate that the great majority of the chalcopyrite is free at a grain size of 10 microns.

Pyrrhotite generally occurs as small irregular grains and aggregates associated with the other sulphide minerals (Figure 4).

Sphalerite occurs mostly as relatively large, irregular masses. It generally contains small inclusions of pyrite and pyrrhotite disseminated throughout (Figure 3).

Association of the Gold

Both samples contain trace amounts of gold. In an effort to determine the association of the gold, duplicate mineral separations were performed on Sample No. 1 by heavy liquids, followed by high intensity magnetic separation of the heavy fractions. Each of the fractions was then assayed for gold. In both cases, only the heavy (sulphide) fractions contained appreciable amounts of gold, which indicates that the gold is preferentially associated with the sulphides. There was no consistency, however, in the association of the gold with any one particular sulphide - in one sample the gold content was highest in the sulphide fraction with the lowest magnetic susceptibility; in the other, the gold was associated with the sulphide fraction with the highest susceptibility.

Microscopic Examination of Mill Products

A number of mill products resulting from the concentration of the copper were examined with the object of determining whether the chalcopyrite in the products was free or attached to other minerals. This was accomplished by preparing polished sections of the mill products for microscopic examination at high magnifications. The results of these examinations are as follows:

Test 5, 1st Cleaner Tailing (0.42% Cu): Largely pyrite. Most of the chalcopyrite is attached to pyrite (est. 10% free).

Test 5, 2nd Cleaner Tailing (4.13% Cu): Largely pyrite. The majority of the chalcopyrite (est. 80%) is free.

Test 6, Scavenger Tailing (2.5% Cu): Largely pyrite. The majority of the chalcopyrite (est. 60%) is free.

Test 6, Cleaner Tailing (0.47% Cu): Largely pyrite. The majority of the chalcopyrite is combined with pyrite (est. 30% free).

Test 7, Flotation Tailing (0.35% Cu): Largely gangue minerals. The majority of the chalcopyrite (est. 75%) is free.

Test 7, 1st Cleaner Tailing (0.64% Cu): Largely pyrite. About one-half of the chalcopyrite appears to be free. Polished sections were prepared from individual infrasized fractions of this product, ranging from +56 microns down to -10 microns to determine the grain size at which liberation is effected. Microscopic examination revealed that, at sizes coarser than 28 microns, practically all the chalcopyrite is attached to other minerals, largely pyrite (Figure 7). Below this size, however, the chalcopyrite is progressively liberated until, in the -10 micron fraction, practically all the chalcopyrite is free.

Chalcopyrite, the principal ore mineral, occurs in a wide range of particle sizes, down to about 10 microns in diameter. Since some of the chalcopyrite is not entirely liberated at sizes above 10 microns, appreciable copper losses or reduced grades may be expected with this ore.

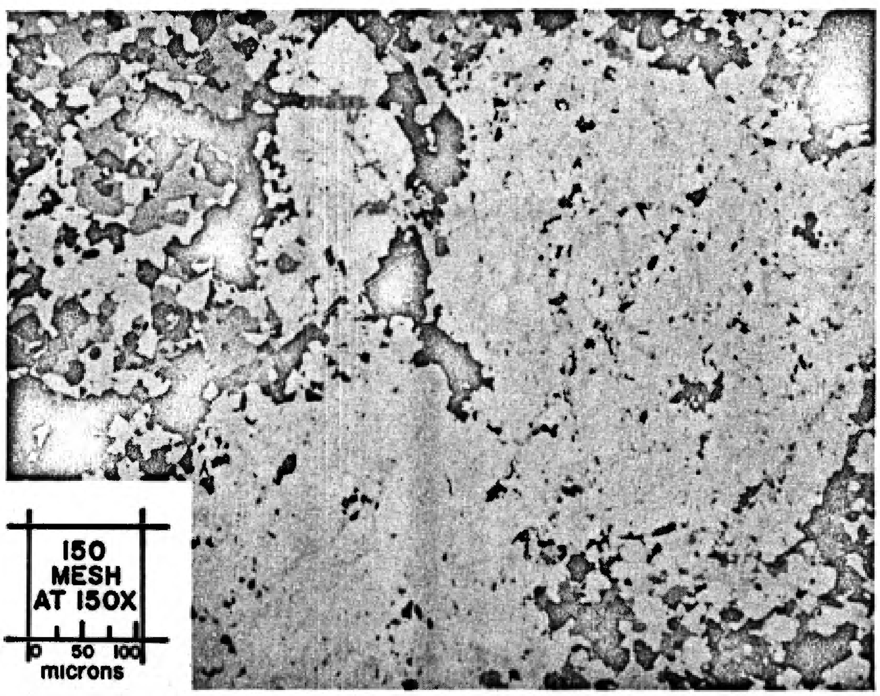

Figure 1. - Polished section of drill core showing irregular pyrite grains (white) cut by numerous tiny veinlets of chalcopyrite (light grey). Sphalerite is dark grey; gangue, black.

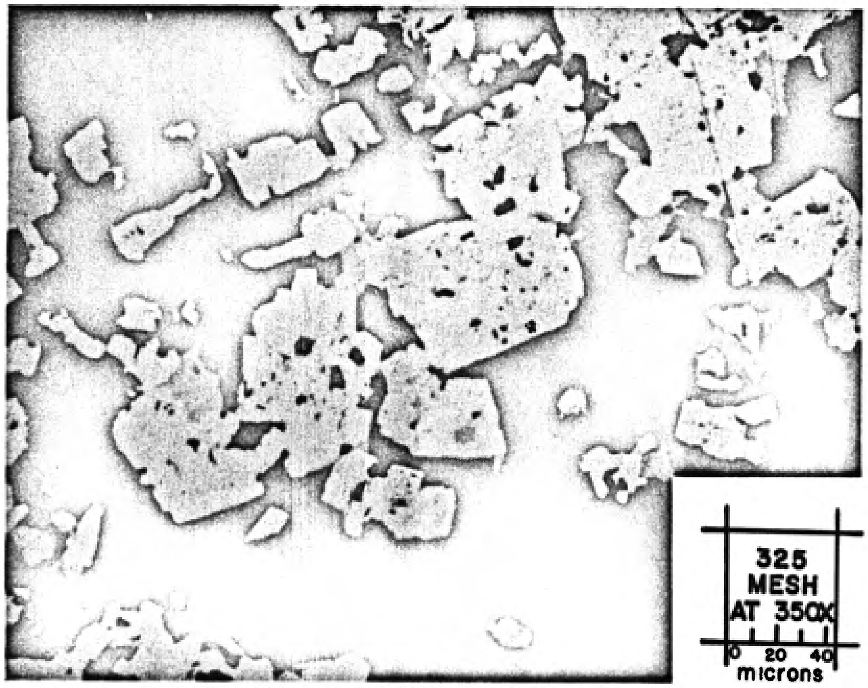

Figure 2. - Polished section of drill core, showing disseminated pyrite grains (white) with some closely associated chalcopyrite (light grey). Gangue is dark grey.

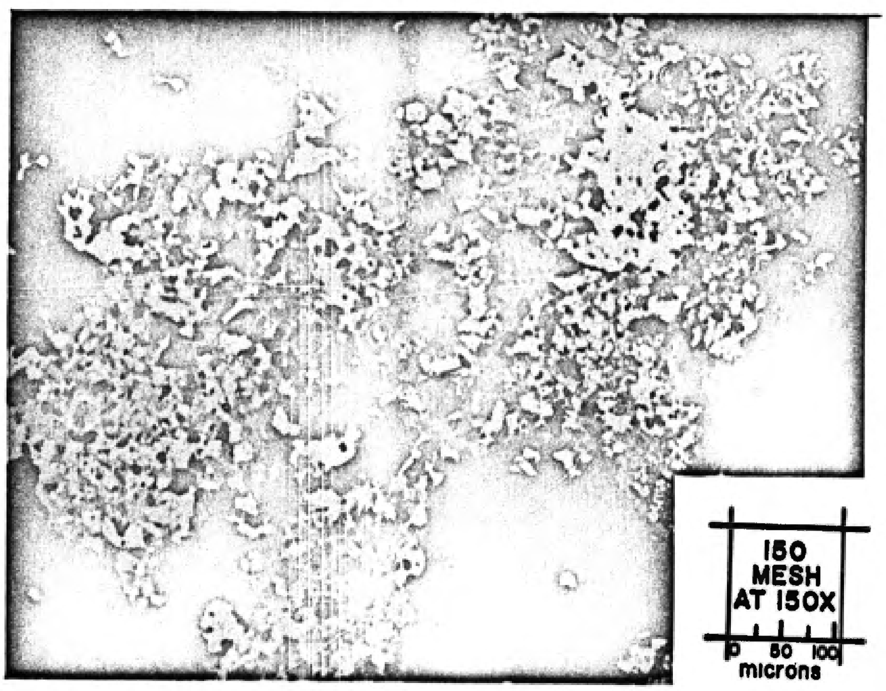

Figure 3. - Polished section of drill core, showing irregular grain of sphalerite (medium grey) with abundant pyrite inclusions (white). Gangue is dark grey.

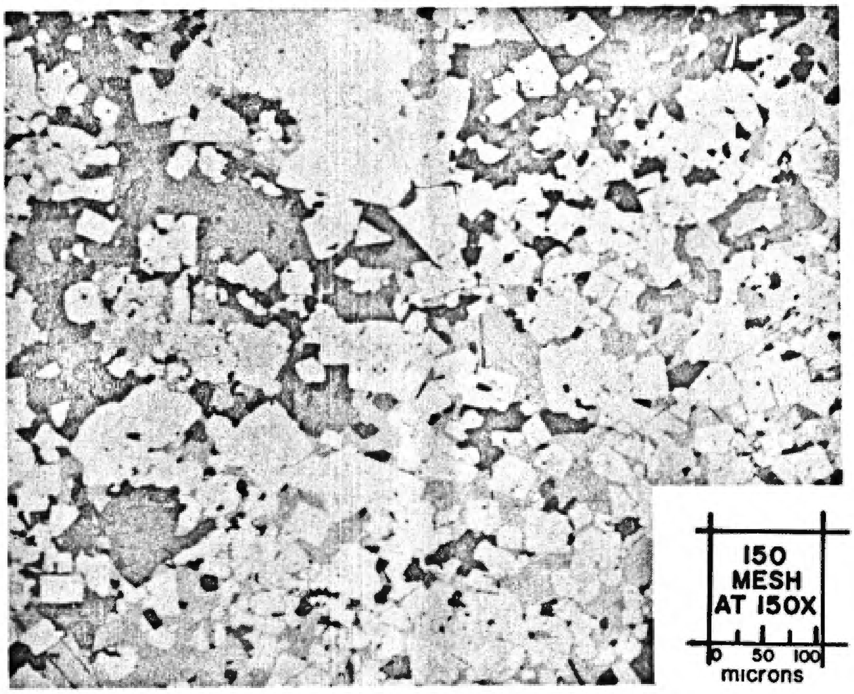

Figure 4. - Polished section of drill core showing pyrite (white) disseminated in a matrix of chalcopyrite (light grey) and pyrrhotite (dark grey). (The pyrrhotite has been lightly etched to increase the contrast.)

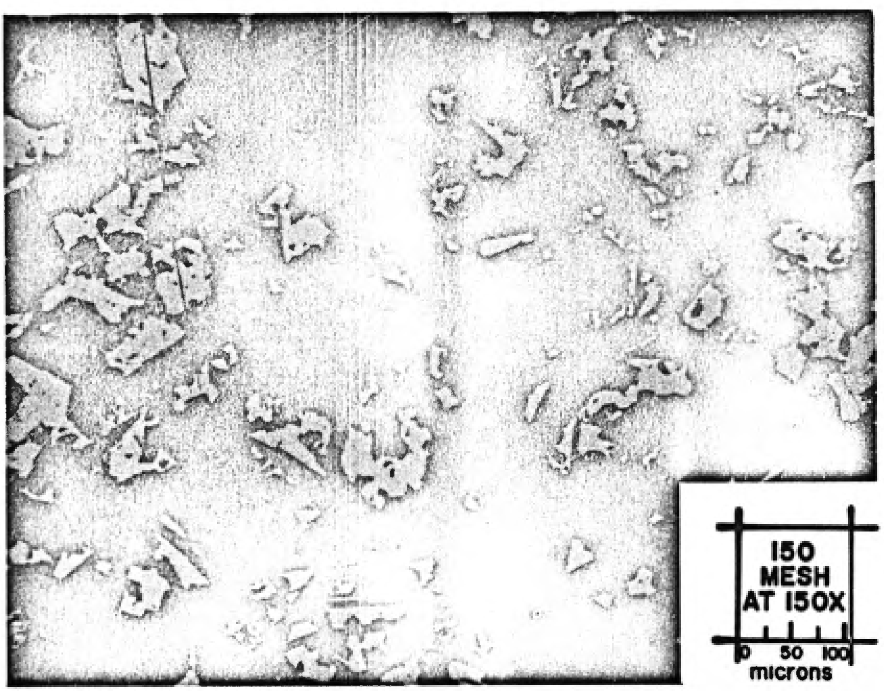

Figure 5. - Polished section of drill core, showing irregular grains of chalcopyrite (light grey) disseminated in gangue (dark grey).

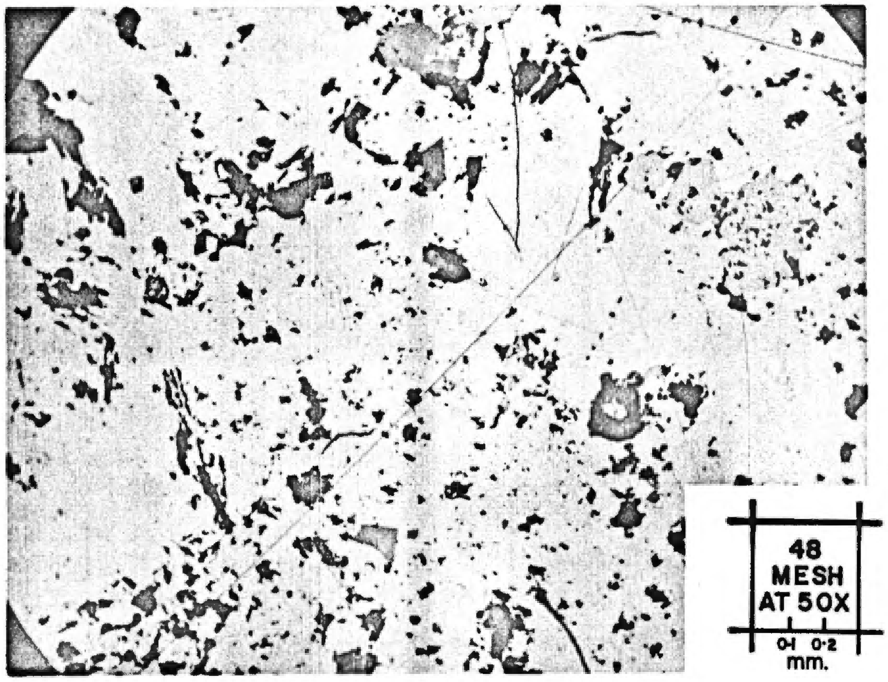

Figure 6. - Polished section of drill core, showing massive chalcopyrite (white) with some scattered inclusions of sphalerite (light grey) and gangue (medium grey). Polishing pits are black.

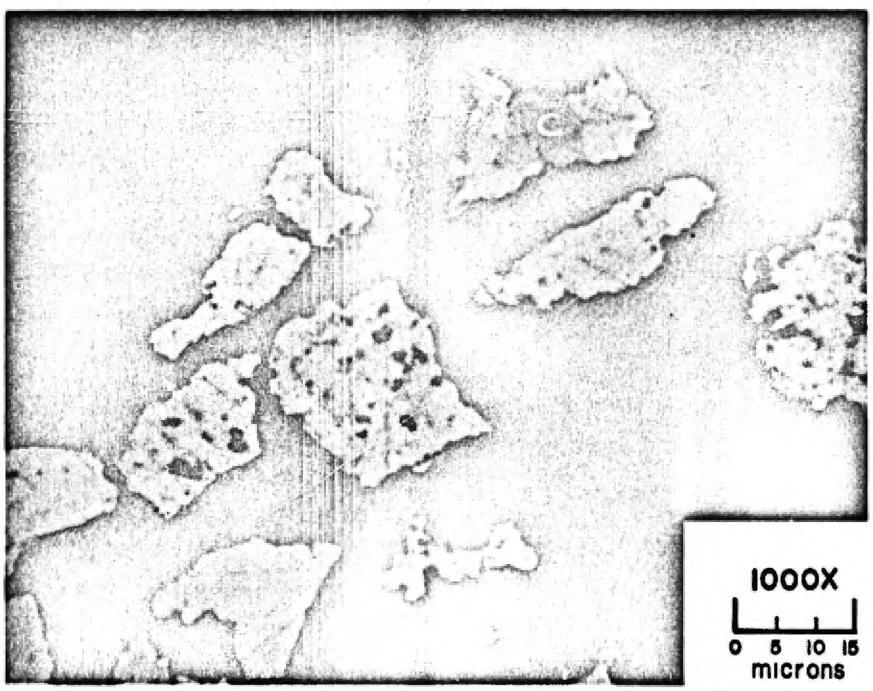

Figure 7. - Polished section of -40+28 micron fraction of Cleaner Tailing No. 1 from Test 7, showing chalcopyrite (C) combined with pyrite (white). The other grains in the photomicrograph are pyrite.

DETAILS OF INVESTIGATION

Of the many tests on the No. 1 and the No. 2 shipments of drill core only those in which the best results were obtained will be included in this report.

After the first few preliminary tests, it was obvious that the intimate association of chalcopyrite with pyrite would present difficulties.

Test No. 1

The -10 mesh ore was ground to 82.7% -200 mesh with lime added to the grind and flotation was carried out under the following conditions:

Reagent	lb/ton	Conditioning (time-min)	Flotation (time-min)	pH
Z-200	0.06	2	4½	9.1
Z-11	0.06	1	-	-
Dowfroth 250	0.02	-	6½	-

The concentrate was ground in a pebble mill using steel balls with 1.0 lb lime per ton of ore. The resulting pH was 10.9. Flotation was carried on for 6 minutes using 0.03 lb Z-200 per ton. This concentrate was recleaned in a 3-minute float at a pH of 11.1.

Results of Test No. 1

Product	Weight %	Assay % Cu	Distribution % Cu
Cu Recl Conc (1)	3.3	29.30	49.3
Cu Recl Tail (2)	4.4	14.25	31.9
Cu Cl Tail	22.8	1.07	12.4
Flot Tail	69.5	0.18	6.4
Head (calcd)	100.0	1.96	100.0

Summary of Test Results at Various Stages

Cu Recl Conc (1)	3.3	29.30	49.3
Cu Cl Conc (1+2)	7.7	20.70	81.2

Test No. 2

The ore, ground to 82.7% -200 mesh with lime and 0.1 lb/ton sodium sulphite added to the grind, was floated according to the following conditions:

Reagent	lb/ton	Conditioning (time-min)	Flotation (time-min)	pH
Z-200	0.06	5	5	9.1
Z-11	0.06	2	-	-
Dowfroth 250	0.03	-	7	-

The concentrate produced was ground in a pebble mill using steel balls to 99.0% -200 mesh with lime and 0.1 lb/ton sodium sulphite added. The resulting pH was 10.5. The ground concentrate was cleaned in a flotation cell for 8 min using 0.06 lb Z-200/t which was stage added. The cleaner concentrate was recleaned for 4 min at a pH of 11.2 using no reagents other than lime and this concentrate was again cleaned for 3 min at a pH of 11.5.

Results of Test No. 2

Product	Weight %	Assays %		Distn. %
		Cu	Zn	Cu
Final Conc (1)	3.3	31.09	0.24	55.4
3rd Cl Tail (2)	2.1	19.11	-	21.7
2nd Cl Tail (3)	4.3	5.69	-	13.2
1st Cl Tail (4)	17.0	0.63	-	5.8
Flot Tail (5)	73.3	0.10	-	3.9
Head (calcd)	100.0	1.85	-	100.0

Summary of Results at Various Stages

Final Conc (1)	3.3	31.09	0.24	55.4
2nd Cl Conc (1+2)	5.4	26.43	-	77.1
1st Cl Conc (1-3)	9.7	17.24	-	90.3

Test No. 3

This test paralleled Test No. 2 in all respects except that the ground rougher concentrate was cleaned for 11 min instead of 8 min and 0.09 lb Z-200 per ton was used instead of 0.06 lb.

Results of Test No. 3

Product	Weight %	Assays %		Distn %
		Cu	Zn	Cu
Final Conc (1)	4.2	29.30	0.24	64.7
3rd Cl Tail (2)	2.9	12.67	-	19.3
2nd Cl Tail (3)	4.7	3.22	-	8.0
1st Cl Tail (4)	14.4	0.45	-	3.4
Flot Tail (5)	73.8	0.12	-	4.6
Head (calcd)	100.0	1.90	-	100.0

Summary of Results at Various Stages

Final Conc (1)	4.2	29.30	0.24	64.7
2nd Cl Conc (1+2)	7.1	22.51	-	84.0
1st Cl Conc (1-3)	11.8	14.82	-	92.0

Test No. 4

The ore was ground to 82.7% -200 mesh with 0.1 lb sodium sulphite per ton and sufficient lime to achieve a pH of 9.2. Flotation was according to the following scheme:

Reagents	lb/ton	Conditioning (time-min)	Flotation (time-min)	pH
Z-200	0.06	5	5	9.2
Z-11	0.06	2	-	-
Dowfroth 250	0.03	-	5	-
Z-11	0.05	1	-	-
Dowfroth 250	0.03	-	2	-

The bulk sulphide concentrate, with lime and 0.1 lb sodium sulphite per ton was ground to 99.0% -200 mesh. The pH of the ground pulp was 10.3. Four cleaner stages now followed.

1st Cleaner stage - condition 2 min 0.03 lb Z-200 per ton
float 9 min 0.06 lb Z-200 per ton stage added.

2nd Cleaner stage - float 4 min pH 11.2 (lime)
3rd " " - " 3 " " 11.1 "
4th " " - " 3 " " 11.5 "

Results of Test No. 4

Product	Weight %	Assay %		Distribution, %	
		Cu	Zn	Cu	Zn
Final Conc (1)	3.0	32.27	0.06	51.5	1.3
4th Cl Tail (2)	1.4	25.25	0.10	18.8	1.0
3rd Cl Tail (3)	1.8	15.15	0.22	14.5	2.9
2nd Cl Tail (4)	3.9	4.46	0.23	9.2	6.6
1st Cl Tail (5)	18.4	0.49	0.46	4.9	61.9
Flot Tail (6)	71.5	0.03	0.05	1.1	26.3
Head (calcd)	100.0	1.88	0.14	100.0	100.0

Summary of Results at Various Stages

Final Conc (1)	3.0	32.27	0.06	51.5	1.3
3rd Cl Conc (1+2)	4.4	30.03	0.07	70.3	2.3
2nd Cl Conc (1-3)	6.2	25.71	0.12	84.8	5.2
1st Cl Conc (1-4)	10.1	17.51	0.16	94.0	11.8
Rougher Conc (1-5)	28.5	6.52	0.35	98.9	73.7

Test No. 5

In this test the grinding and sulphide flotation was a repetition of Test No. 4. The bulk concentrate was ground for 40 min and three cleaning stages followed as in Test No. 4.

Results of Test No. 5

Product	Weight %	Assay % Cu	Distn % Cu
Final Conc (1)	4.2	31.08	67.3
3rd Cl Tail (2)	1.8	16.23	15.0
2nd Cl Tail (3)	3.6	4.13	7.7
1st Cl Tail (4)	26.5	0.42	5.7
Flot Tail (5)	63.9	0.13	4.3
Head (calcd)	100.0	1.94	100.0

Summary of Results at Various Stages

Final Conc (1)	4.2	31.08	67.3
2nd Cl Conc (1+2)	6.0	26.62	82.3
1st Cl Conc (1-3)	9.6	18.19	90.0
Rougher Conc (1-4)	36.1	5.14	95.7

An infrasizer test on the 1st Cl Tailing showed 28.3% in the -10 micron fraction. This fraction contained 54.9% of the copper in the cleaner tail.

Test No. 6

The ore was ground and a bulk sulphide concentrate was floated in accordance with Test No. 4. This concentrate was ground as in Test No. 4 using lime and 0.2 lb sodium sulphite per ton. The ground concentrate was cleaned once as in Test No. 4 and this cleaner concentrate was recleaned once at a pH of 11.5. The recleaner tails were given a scavenger float of 2.5 min at a pH of 11.1 using 0.03 lb Z-200 per ton.

Results of Test No. 6

Product	Weight %	Assays %		Distn %	
		Cu	Zn	Cu	Zn
Recl Conc (1)	5.9	26.73	0.08	81.0	-
Scavenger Conc (2)	1.5	8.66	0.08	6.7	-
Scavenger Tail (3)	2.3	2.50	0.07	3.0	-
Cl Tail (4)	19.2	0.47	0.19	4.6	-
Flot Tail (5)	71.1	0.13	0.05	4.7	-
Head (calcd)	100.0	1.95	-	100.0	-

Summary of Results at Various Stages

Recl Conc (1)	5.9	26.73	0.08	81.0	-
Final Conc (1+2)	7.4	23.07	0.08	87.7	-
Cl Conc (1-3)	9.7	18.17	0.08	90.7	-

An infrasizer test on the cleaner tail showed 27.9% in the -10 micron fraction. This fraction contained 20.3% of the copper in the cleaner tail.

Test No. 7

This test using the No. 1 shipment of drill core (high grade) duplicated Test No. 6 with the exception that an extra cleaning step was installed. The 3rd cleaner tailing was given a scavenger float as in Test No. 6.

Results of Test No. 7

Product	Weight %	Assays %		Distn %	
		Cu	Zn	Cu	Zn
Final Conc (1)	7.7	30.89	0.38	73.6	3.7
Scavenger Conc (2)	1.3	20.44	2.00	8.2	3.3
Scavenger Tail (3)	0.8	6.70	0.63	1.6	6.3
2nd Cl Tail (4)	3.0	4.92	1.28	4.6	4.8
1st Cl Tail (5)	27.2	0.64	0.60	5.4	20.6
Flot Tail (6)	60.0	0.35	0.81	6.6	61.3
Head (calcd)	100.0	3.23	0.79	100.0	100.0

Summary of Results at Various Stages

Final Conc (1)	7.7	30.89	0.38	73.6	3.7
Final + Scav. Conc (1+2)	9.0	29.38	0.61	81.8	7.0
2nd Cl Conc (1-3)	9.8	27.53	1.08	83.4	13.3
1st Cl Conc (1-4)	12.8	22.23	1.12	88.0	18.1
Rougher Conc (1-5)	40.0	7.55	0.77	93.4	38.7

Test No. 8

A sample of the high grade drill core was ground to 82.7% -200 mesh with added lime. The resulting pH was 10.4. Flotation was carried out as follows:

Reagents	lb/ton	Conditioning (time-min)	Flotation (time-min)	pH
Z-200	0.06	5	6	10.4
Z-200	0.03	-	3	-
Z-200	0.03	-	3	-
Z-200	0.03	-	2	-

The concentrate produced was ground to almost all minus 200 mesh with 0.05 lb NaCN per ton, and lime to give a pH of 11.0. A 3-min cleaner float was then made using 0.03 lb Z-200 per ton, and this concentrate was recleaned for 5 min at a pH of 10.0 with 0.05 lb NaCN per ton added. The recleaner concentrate was again cleaned for 5 min using 0.03 lb of Z-200 per ton. The tailing from this last cleaner stage was given a scavenger float using 0.02 lb Z-200 per ton.

Results of Test No. 8

Product	Weight %	Assay %	Distn %
		Cu	Cu
Final Conc (1)	6.3	31.17	61.4
Scavenger Conc (2)	2.0	27.45	17.2
Scavenger Tail (3)	1.3	14.86	6.0
2nd Cl Tail (4)	1.7	5.16	2.7
1st Cl Tail (5)	9.8	1.57	4.8
Flot Tail (6)	78.9	0.32	7.9
Head (calcd)	100.0	3.20	100.0

Summary of Results at Various Stages

Product	Weight %	Assay % Cu	Distn % Cu
Final Conc (1)	6.3	31.17	61.4
Final + Scav. Conc (1+2)	8.3	30.27	78.6
2nd Cl Conc (1-3)	9.6	28.19	84.6
1st Cl Conc (1-4)	11.3	24.72	87.3
Rougher Conc (1-5)	21.1	13.97	92.1

Test No. 9

A sample of the high grade ore (Sample No. 1) was ground to 82.7% -200 mesh. A pH of 10.2 was obtained by adding lime during the grinding.

After conditioning the pulp for 5 min with 0.06 lb Z-200 per ton, a concentrate was floated in 6 min.

A second concentrate was then removed according to the following scheme.

Reagents	lb/ton	Conditioning (time-min)	Flotation (time-min)	pH
Z-11	0.06	1	-	10.1
Dowfroth 250	0.04	1	4	-
Z-11	0.03	-	-	-
Dowfroth 250	0.02	-	1	-

This second concentrate was ground with lime to all -200 mesh. The ground concentrate was combined with the first concentrate and the pH regulated with lime to 10.5.

Three cleaning stages then followed, thus:

1st Cleaner stage	-	0.05 lb NcCN 0.09 lb Z-200 float 9 min	(stage added) pH - 10.5
2nd Cleaner stage	-	0.05 lb NaCN,	float 4 min pH - 10.0
3rd Cleaner stage	-		float 3 min pH - 10.0

Results of Test No. 9

Product	Weight %	Assay %	Distn %
		Cu	Cu
Final Conc (1)	7.4	28.07	67.1
3rd Cl Tail (2)	2.0	19.61	12.7
2nd Cl Tail (3)	3.1	10.00	10.0
1st Cl Tail (4)	13.7	0.90	4.0
Flot Tail (5)	73.8	0.26	6.2
Head (calcd)	100.0	3.09	100.0

Summary of Results at Various Stages

Final Conc (1)	7.4	28.07	67.1
2nd Cl Conc (1+2)	9.4	26.27	79.8
1st Cl Conc (1-3)	12.5	22.24	89.8
Rougher Conc (1-4)	26.2	11.08	93.8

EXAMINATION OF INFRASIZER FRACTIONS

The 1st cleaner tailing from Test No. 7 was infrasized and the fractions were assayed for copper. The following results were obtained.

Size	Weight %	Assay % Cu	Distn % Cu
+150 mesh	-	-	-
-150+200 "	1.0	1.80	3.0
-200+56 microns	5.1	0.87	7.3
-56+40 "	16.7	0.62	17.1
-40+28 "	17.5	0.44	12.7
-28+20 "	15.3	0.36	9.1
-20+14 "	12.4	0.31	6.3
-14+10 "	9.3	0.35	5.4
-10 "	22.7	1.04	39.1
Head (calcd)	100.0	0.60	100.0

Referring to the mineralogical investigation of the mill products on page 6, this 1st cleaner tailing, assaying a calculated 0.60% Cu and representing 5.4% of the total copper (see results of Test No. 7, page 18) contains a large percentage of copper which is almost completely combined with pyrite (ie +28 micron fraction). A further percentage is only partially liberated (ie -28+10 micron fraction). Indeed, it is only when the material has been reduced to -10 microns that virtually free chalcopyrite is obtained. The copper in the -10 micron fraction represents 39.1% of the copper in the cleaner tailing and only 2.1% of the copper in the ore. At this size flotation becomes extremely difficult and it is doubtful if the cost of finer grinding to effect a greater liberation would be offset by any substantial increase in recovery.

DISTRIBUTION OF PRECIOUS METALS

Some of the mill products were assayed for gold in Tests No. 4, 5, 6 and 7 and the results which are shown below indicate that there is little hope of recovering this element in a copper concentrate.

Test No.	Mill Product	Assay Au oz/t
4	Final Conc	0.015
	1st Cl Tail	0.015
	Flot Tail	trace
5	Final Conc	0.02
	1st Cl Tail	0.005
	Flot Tail	0.005
6	Cu Recl Conc	0.015
	Cu Cl Tail	0.0125
	Flot Tail	trace
7	Final Conc	0.02
	1st Cl Tail	0.0175
	Flot Tail	trace

CONCLUSIONS AND DISCUSSIONS

Although a large number of tests were done on the drill core, only those showing the best results were included in this report.

While the chalcopyrite was to a large extent amenable to concentration by flotation, the intimate association of some of this mineral with pyrite as minute veinlets or finely disseminated grains a few microns in size presented a problem in balancing the grade of concentrate with recovery.

Thus, in Test No. 8 the optimum grade and recovery obtained after one cleaning stage was 24.72% Cu and 87.3%, while in Test No. 9 a concentrate assaying 22.24% Cu at a recovery of 89.8% was obtained.

In the treatment of this ore, the production of a bulk sulphide rougher concentrate is essential to obtain a maximum recovery. This must be followed by further grinding plus one or more cleaning stages; or grinding of a cleaner tailing followed by a scavenger flotation step. In any case, additional grinding at some point in the circuit is essential to both grade and recovery.

The gold in the ore did not concentrate with the copper to any appreciable extent. A reason for this was advanced in the mineralogical investigation.

EBM