

DEPARTMENT OF MINES AND RESOURCES

BUREAU OF MINES

CANADA

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Ottawa, January 12, 1947.

R E P O R T

of the

MINERAL DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 2158.

Flotation Tests on Three Samples of Copper-Zinc-
Gold Ore from the Quamont Mining Corporation Limited,
Noranda, Quebec.

(Copy No. 13.)

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Bureau of Mines

Mineral Dressing and
Metallurgy Division

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OF
MINES AND RESOURCES

Mines and Geology Branch

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Gold Ore from the Queмонт Mining Corporation Limited,
Noranda, Quebec.

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Shipments:

Three shipments of ore were received, on March 22,
August 29, and November 20, 1946, weighing respectively 111
pounds, 220 pounds and 162 pounds. The samples, designated
as Queмонт ore, were submitted by D. E. Bourke, Mill Super-
intendent, Normetal Mining Corporation Limited, Normetal, Quebec.

Location of Property:

The property from which this ore was taken is
located in Rouyn township, northwestern Quebec, adjacent to
the property of Noranda Mines Limited.

Sampling and Assaying:

The shipments were sampled, assayed and reported as follows: (In this instance the samples are numbered 1, 2 and 3 in the chronological order of the dates on which they were received here.)

	<u>Sample No. 1.</u>	<u>Sample No. 2.</u>	<u>Sample No. 3.</u>
Gold, oz./ton	0.155	0.24	0.19
Silver, "	1.16	1.00	1.12
Copper, per cent	1.56	1.60	1.00
Lead, "	--	None detected.	None detected.
Zinc, "	3.78	3.18	4.37
Iron, "	42.84	34.73	35.10
Arsenic, "	Trace.	--	--
Tellurium, "	None detected.	--	--
Sulphur, "	34.72	19.40	25.93
Insoluble, "	6.80	17.42	15.29

Purpose of the Test:

This series of tests was conducted to find out whether or not copper and zinc concentrates of marketable grades could be produced by flotation methods and also to determine where the gold and silver would report under these conditions.

Summary of Results:

This ore presents an acute problem in preventing flotation of pyrite with the copper and zinc minerals. When xanthates were used low-grade copper and zinc concentrates were produced. They would assay from 10 to 20 per cent in copper and from 15 to 40 per cent zinc, with recovery falling off as grade improves. By leaving xanthates out of the circuit and using more selective collectors such as diphenylguanidine or thiocarbanilide good grade concentrates can be produced with good recoveries while the ore is fresh. However, after it has been standing for a week or more a

(Summary of Results, cont'd) -

decided falling off in grade and recovery is noticed. This may be due to oxidation of the pyrrhotite.

Conclusions:

The results obtained from the tests reported in detail are fairly satisfactory but there is still room for improvement. Owing to the fact that the ore oxidizes readily and that, furthermore, reagent control will be delicate, it will not be possible to reach any definite conclusions until some of the details have been worked out on tonnage check tests.

The problem of producing good grade concentrates is almost entirely one of keeping the pyrite from floating with the copper and zinc minerals. Once the pyrite has been in contact with xanthates it seems impossible to depress all of it again, considerable quantities staying with the copper and zinc concentrates no matter how much lime may be added to depress it.

From 50 to 70 per cent of the gold is recovered in the copper concentrate and the flotation tailing usually assays 0.05 ounce per ton or less. The gold content of the tailing can be reduced to 0.015 ounce per ton by cyanidation but reagent cost is excessive, about 7.0 pounds or more of sodium cyanide being consumed per ton of tailing.

While no free gold was isolated in any of the test products, the microscopic examination of the ore revealed the presence of six grains of gold, five of which were in pyrrhotite and the other in pyrite. An amalgamation test on a jig concentrate resulted in the recovery of about 10 per cent of the total gold; so it would therefore seem wise to make some provision for collecting free gold.

(Conclusions, cont'd) -

CHARACTER OF THE ORE AND MILL PRODUCTS:

Polished sections were prepared from the first two shipments of ore and from samples of mill products for examination under a reflecting microscope. Another set of polished sections (18 sections), prepared elsewhere from Gremont diamond drill cores, was also submitted for microscopic examination.

Ore

The first shipment of ore was a composite sample of 236 diamond drill core samples and was received here crushed to approximately $\frac{1}{4}$ inch. The whole sample was screened on a 3-mesh screen and about a dozen pieces in all were retained on the screen. With the aid of a hand magnet these pieces were divided into magnetic and non-magnetic fractions, and polished sections were made of each. The microscope revealed that the characteristics of the magnetic and non-magnetic sections were essentially the same except for the amount of pyrrhotite present. For this reason the sections are not described separately. The second shipment received was ore taken from underground. It was considered unnecessary to make a microscopic examination of Shipment No. 3 as this apparently was the same as preceding lots.

Metallie Minerals -

Metallization is very strong in some of the polished sections and sparse in others. Listed in their approximate order of decreasing abundance, the metallic minerals visible in the sections are: pyrite, pyrrhotite, magnetite, chalcopyrite, sphalerite, galena (?), and native gold. The first five minerals named are relatively abundant and are very

(Character of the Ore and Mill Products, cont'd) -

intimately associated in many places.

Pyrite occurs largely as medium-coarse disseminated crystals and grains which, in some places, are aggregated and form small masses. It appears to be the oldest sulphide in the ore, since the polished surfaces often exhibit a granular mosaic with pyrrhotite, chalcopyrite and sphalerite filling the irregular spaces between well-crystallized grains of pyrite. This mode of occurrence is well illustrated in Figures 1 and 3. In some places the pyrite is almost free of inclusions but in other places it contains occasional to numerous small grains of gangue and other metallic minerals.

Pyrrhotite is almost as abundant as pyrite, and in one section it preponderates as a moderately coarse granular mass in which scattered grains of gangue and metallics are embedded. This type of occurrence is depicted in Figure 2. As already mentioned, this mineral is often associated with chalcopyrite and/or sphalerite as coarse to fine irregular particles and small patches which fill interstitial spaces between grains of pyrite. A small quantity of pyrrhotite also occurs as inclusions in pyrite, chalcopyrite and sphalerite.

In two or three polished sections, massive magnetite forms the groundmass for scattered grains of chalcopyrite, pyrite and gangue; in other sections the magnetic iron oxide is present as tiny irregular grains disseminated unevenly through gangue and metallics.

Chalcopyrite and sphalerite in almost equal amounts, and often in close association, occur as small masses and coarse to fine irregular grains in gangue, in each other, and in other metallic minerals. The average grain sizes of the

(Character of the Ore and Mill Products, cont'd) -

copper and zinc sulphides are smaller than those of pyrite and pyrrhotite. In some places where chalcopyrite is enclosed within sphalerite it is present as tiny dots or blebs which are too small to be economically released by grinding. The percentage of copper tied up with zinc in this manner, however, is very small (see Figure 1).

Rare, tiny, irregular grains of a soft, white mineral occurs in pyrrhotite and pyrite. An attempt was made to drill out a little powder, for qualitative micro-chemical tests, from a few of the larger grains. While this operation was not entirely satisfactory, a positive test for lead was obtained and it seems probable that this mineral is galena since no tellurium was detected in the head sample. In any case it is present in very small, practically negligible amount.

A few tiny crystals of arsenopyrite, the largest about 14 microns in size, are associated with sphalerite and pyrrhotite in one section but its total quantity is negligible.

Six grains of native gold were observed in the sections. Five occur in pyrrhotite and one in dense pyrite, all of them associated with other minerals. With the five grains in pyrrhotite, the most common associates are chalcopyrite and gangue, each of which occurs with gold in three places. Three of the grains are irregular or elongated in shape and are between grains of sulphides; the other two grains are more or less equidimensional in shape but appear to be occupying interstitial spaces. With the grain in dense pyrite, the associates are sphalerite and chalcopyrite. The largest particle of gold seen measures 144 x 36 microns

(Character of the Ore and Mill Products, cont'd) -

and is associated with chalcopyrite, magnetite (?) and gangue (see Figure 2); the smallest is 10 microns in diameter and is associated with gangue.

Gangue -

Gangue material predominates in some of the polished surfaces and forms the matrix in which metallic minerals are embedded. It is subordinate in amount in other sections where it occurs as scattered grains and small patches within and between sulphides. In those sections in which gangue is predominant it consists of soft, dark greenish grey rock which contains abundant finely disseminated carbonate but in those sections in which it is subordinate many of the grains scattered through sulphides appear to be quartz.

Conclusions -

The microscopic examination of six polished sections prepared at these Laboratories from the sample of underground ore received shows that it is essentially the same in character as the eighteen drill core sections prepared elsewhere and previously examined in the mineralogical laboratory. The relative abundance of the ore minerals varies somewhat, of course; as, for example, magnetite is more abundant in the sections made from underground ore than in those from the drill cores. In this connection, too, it might be well to record here that the colours of both the iron oxide and the sphalerite were found to be very similar in the polished surfaces and difficult to distinguish in places.

Mill Products

Zinc Concentrate (Test No. 2) -

The polished surfaces exhibit numerous particles of metallic minerals, ranging from about 150 microns

(Character of the Ore and Mill Products, cont'd) -

(-65 +100 mesh) down to only a few microns in size, set in the mounting medium (bakelite). Particles of sphalerite preponderate but grains of chalcopyrite, pyrite and pyrrhotite are common, are comparatively large, and are predominantly free but a few are combined with sphalerite or each other.

In order to obtain a rough idea of how much of the copper sulphide is combined with the zinc sulphide, several traverses were made across the two polished sections. Over sixty grains of chalcopyrite were encountered and measured. The measurements were then calculated into percentages by volume, with the following result: approximately 90 per cent of the chalcopyrite is apparently free in bakelite and only 10 per cent of the copper mineral is combined with sphalerite.

Copper Concentrate (Test No. 2) -

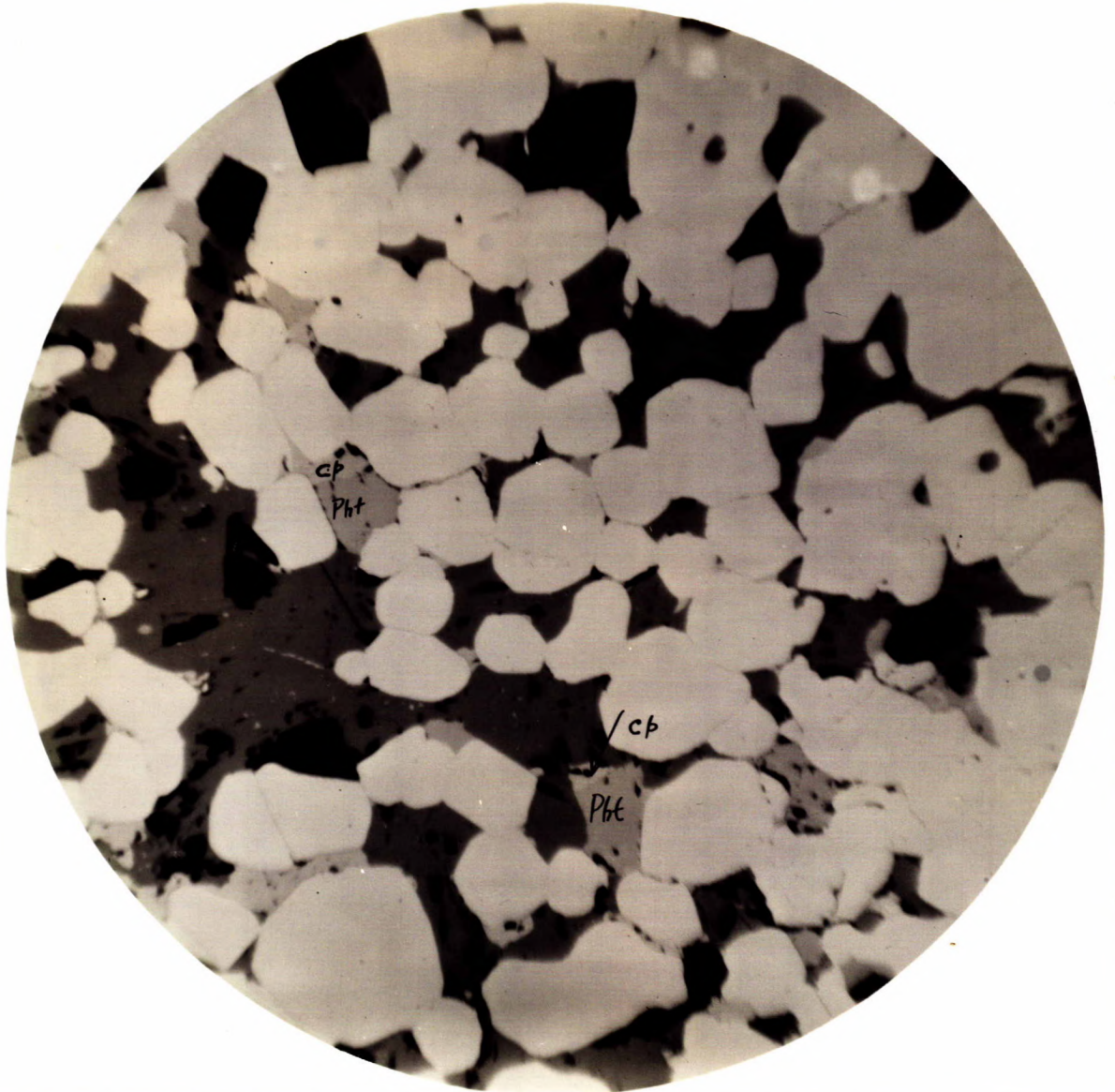
The two polished sections are, in general, very similar to those made from the zinc concentrate. The same metallic minerals are present in approximately the same size range, the only difference being that chalcopyrite is the preponderant mineral in place of sphalerite, which is now a deleterious constituent along with pyrite and pyrrhotite. As in the zinc concentrate, particles of all the unwanted minerals (sphalerite, pyrite and pyrrhotite) are common and the great majority of them are free in bakelite.

Following the same procedure of traversing and measuring grains of sphalerite, approximately 75 per cent of the zinc sulphide is free and 25 per cent is combined with chalcopyrite.

(Figures 1, 2
{ and 3 follow,
{ on Pages 9 to 11.)

(Character of the Ore and
Mill Products, cont'd) -

Figure 1.

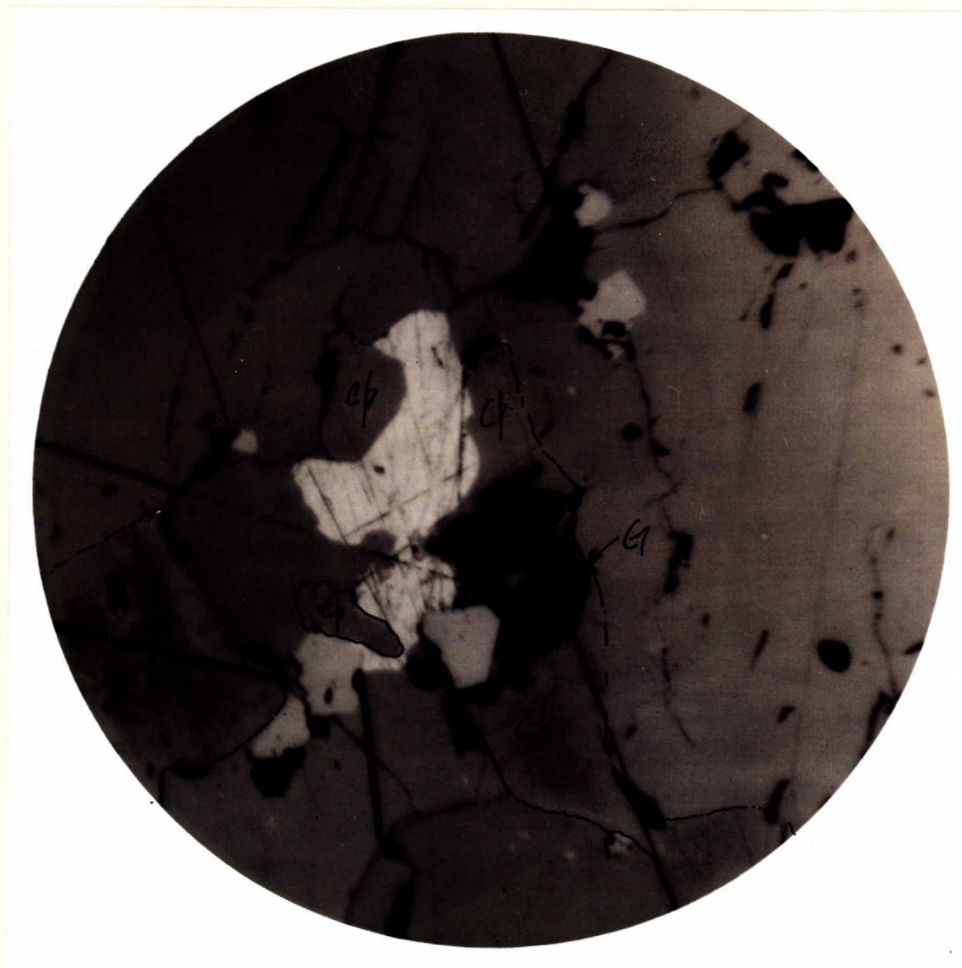


Photomicrograph of polished section showing pyrite (white) mosaic with other sulphides, here largely sphalerite (dark grey), filling interstitial spaces. Chalcopyrite (light grey, almost white) and pyrrhotite (light grey) are comparatively sparse in the field of the microscope and a grain of each of these two minerals is lettered (cp and pht respectively) to aid in their identification. Note the tiny dots and dashes of chalcopyrite in the large area of sphalerite (centre left).

Magnification, X80.

(Character of the Ore and
Mill Products, cont'd) -

Figure 2.



Photomicrograph of section showing native gold (white) in pyrrhotite (grey) associated with chalcopyrite (cp), magnetite(?) (light grey), and grain of gangue (black, indicated with G). The grains of chalcopyrite are difficult to distinguish from those of pyrrhotite and are outlined with a broken line. The grain of gangue contains tiny elongated inclusions of chalcopyrite; all other black areas are pits.

Magnification, X350.

(Character of the Ore and
Mill Products, cont'd) -

Figure 3.



Photomicrograph of a polished section showing typical modes of occurrence of the chief sulphides. Note the sphalerite inclusions in the pyrite grains at the top.

Pyrite - white, coarse crystals.
Chalcopyrite (cp) - white, smaller grains.
Pyrrhotite (pht) - light grey.
Sphalerite - dark grey.
Pits - black.

Magnification, X80.

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

DETAILS OF INVESTIGATIONS:

Test No. 1. - Jig Concentration, Amalgamation,
Flotation, and Cyanidation.

This test was conducted on the first shipment of ore. Two thousand grams of the ore at minus 20 mesh was concentrated in a small jig. The jig concentrate was reground and amalgamated with new mercury for one hour. The amalgam was assayed and the amalgamation tailing reunited with the jig tailing for regrinding and flotation. This tailing mixture was ground about 86 per cent finer than 200 mesh with the following reagents:

	<u>Lb./ton</u>
Lime -	1.0
Sodium cyanide -	0.10
Zinc sulphate -	1.0

Reagents to Cell:

Copper Circuit -

Butyl xanthate	0.10
Cresylic acid	0.10
pH -	8.50.

The concentrate was cleaned without additional reagents.

	<u>Lb./ton</u>
<u>Zinc Circuit -</u>	
Copper sulphate -	1.0
Lime -	4.0
Sodium ethyl xanthate -	0.10
Pine oil	0.05
pH -	11.10.

The concentrate was cleaned once without additional reagents.

(Continued on next page)

RESULTS OF TEST NO. 1:

Product	Weight, per cent	A s s a y s						D i s t r i b u t i o n,				
		Oz./ton		Per Cent				p e r c e n t				
		Au	Ag	Cu	Zn	Fe	Insol.	Au	Cu	Zn	Fe	Insol.
Cu conc.	5.54	1.30	9.16	21.06	4.62	32.80	2.00	44.50	76.33	6.82	4.32	1.45
Cu cleaner tailing	2.36	0.64	4.88	4.18	3.62	39.25	5.35	9.33	6.45	2.28	2.20	1.65
Zn conc.	19.48	0.14	1.24	0.93	15.83	38.51	1.70	16.85	11.85	82.16	17.84	4.33
Zn cleaner tailing	2.35	0.10	1.22	0.50	1.10	40.80	11.10	1.45	0.77	0.69	2.29	3.41
Flotation tailing	70.27	0.04	0.44	0.10	0.45	43.90	9.70	17.37	4.60	8.05	73.36	89.16
Amal. tailing (cal.)	100.00	0.145	1.20	1.53	3.75	42.05	7.65	89.50	100.00	100.00	100.00	100.00
Amalgam		0.017	⊙					10.50				
Feed (calc.)	100.00	0.162		1.53	3.75	42.05	7.65	100.00	100.00	100.00	100.00	100.00
Cyanide tailing	70.27	0.015	0.31					6.51				

Gold extraction by cyanidation was 17.37-6.51 = 10.86 per cent.
 Reagent consumed, lb./ton tailing: NaCN, 15.79; CaO, 26.44.

⊙ The amalgam was dissolved in acid to determine the gold in it and this made impossible the determination of the silver content. For this reason no distribution has been calculated for the silver.

(Details of investigation, cont'd.)

(Details of Investigation, cont'd) -

The presence of excess pyrite is responsible for the low grade of both copper and zinc concentrates.

Test No. 2.

This test was conducted on the second shipment of ore. The sample was ground about 85 per cent finer than 200 mesh and floated.

Charge to Ball Mill:

Ore	-	1,000 grams at -20 mesh
Water	-	750 grams
Lime	-	2.0 lb./ton
Diphenylguanidine	-	0.10 lb./ton
Sodium cyanide	-	0.10 "

Reagents to Cell:

Copper Circuit -

Butyl xanthate	-	0.10 lb./ton
Pine oil	-	0.05 "

pH - 9.10.

The concentrate was cleaned without additional reagents.

Zinc Circuit -

Copper sulphate	-	1.0 lb./ton
Lime	-	4.0 "
Sodium aerofloat	-	0.10 "
Pine oil	-	0.10 "

pH - 11.70.

The concentrate was cleaned twice with the addition of some lime.

Polished sections were made from samples of the final copper and zinc concentrates for examination under the reflecting microscope.

The microscope revealed the presence in each of the concentrates of considerable quantities of contaminating minerals, such as pyrite, pyrrhotite and chalcopyrite in the zinc concentrate, as well as sphalerite in the copper concentrate. While small amounts of the contaminating mineral were combined, the greater part was free and should normally have been eliminated in the flotation circuit. (See "Character of Ore" section.)

RESULTS OF TEST NO. 2:

Product	Weight, per cent	Assays						Distribution, per cent				
		Oz./ton		Per Cent				Au	Ag	Cu	Zn	Fe
		Au	Ag	Cu	Zn	Fe	Insol.					
Cu conc.	4.91	2.40	10.10	23.85	3.60	31.91	2.14	54.58	45.44	82.89	6.74	4.37
Cu cleaner tailing	2.05	2.09	6.11	2.49	1.78	32.91	20.50	19.85	11.48	3.61	1.39	1.88
Zn conc.	4.07	0.14	1.70	1.25	43.87	13.29	1.12	2.64	6.34	3.60	68.10	1.51
1st Zn cleaner tailing	6.25	0.09	1.25	0.55	2.02	34.14	19.94	2.61	7.16	2.45	4.82	5.95
2nd Zn cleaner tailing	1.69	0.20	2.32	1.44	11.66	35.92	9.18	1.56	3.59	1.72	7.52	1.69
Flotation tailing	81.03	0.05	0.35	0.10	0.37	37.42	19.18	18.76	25.99	5.75	11.43	84.60
Feed (calc.)	100.00	0.22	1.09	1.41	2.62	35.84	17.51	100.00	100.00	100.00	100.00	100.00

(Details of Investigation, cont'd)

(Details of Investigation, cont'd) -

Test No. 3.

This test was also conducted on No. 2 ore shipment. The grinding was the same as in Tests Nos. 1 and 2.

Charge to Ball Mill:

Ore - 1,000 grams at -20 mesh
 Water - 750 grams
 Thiocarbamide - 0.10 lb./ton

 Sodium cyanide - 0.10 "
 Zinc sulphate - 2.0 "
 Lime - 2.0 "

Reagents to Cell:

Copper Circuit -

Cresylic acid - 0.25 lb./ton
 pH - 9.20.

The concentrate was cleaned without additional reagents.

Zinc Circuit -

Lime - 4.0 lb./ton
 Copper sulphate - 1.0 "
 Sodium aerofloat - 0.10 "
 Pine oil - 0.10 "
 pH - 11.85.

The concentrate was cleaned without additional reagents. The absence of xanthates seemed to improve conditions in the zinc circuit in so much as the pyrite did not float so persistently.

RESULTS OF TEST NO. 3:

Product	Weight, per cent	Assays				Distribution, per cent			
		Oz./ton		Per Cent					
		Au	Ag	Cu	Zn	Au	Ag	Cu	Zn
Cu conc.	5.67	2.56	9.52	23.60	4.10	60.64	50.24	86.35	7.49
Cu cleaner tailing	4.85	0.75	3.91	2.36	5.68	15.20	17.65	7.39	8.07
Zn conc.	3.08	0.32	1.14	0.35	52.22	4.12	3.27	0.70	51.79
Zn cleaner tailing	2.66	0.23	0.95	0.41	12.32	2.56	2.35	0.70	10.55
Flotation tailing	83.74	0.05	0.54	0.09	0.79	17.48	26.49	4.86	21.30
Feed (calc.)	100.00	0.24	1.07	1.55	3.11	100.00	100.00	100.00	100.00

(Details of Investigation, cont'd) -

The above procedure leaves a high zinc tailing and a high-grade zinc cleaner tailing to be treated. This would suggest a scavenging operation following the zinc roughers with, possibly, regrinding of the scavenger concentrate along with the zinc cleaner tailing. The following test was conducted along these lines although none of the products was reground.

Test No. 4.

This test was done on the third shipment of ore with the same grind as has been used in the foregoing tests.

Charge to Ball Mill:

Ore	-	1,000 grams at -20 mesh
Water	-	750 grams
Lime	-	2.0 lb./ton
Sodium cyanide	-	0.10 "
Zinc sulphate	-	2.0 "
Diphenylguanidine	-	0.10 "
Thiocarb nêlide	-	0.06 "

Reagents to Cell:

Copper Circuit -

Pine oil - 0.05 lb./ton

The concentrate was cleaned twice without additional reagents.

Zinc Rougher Circuit -

Copper sulphate - 2.0 lb./ton
Lime - 4.0 "
Conditioning time - 20 minutes.

The concentrate was cleaned with the addition of extra pine oil and lime.

Zinc Scavenger Circuit -

Sodium aerofloat - 0.10 lb./ton
Pine oil - 0.05 "

(Details of Investigation, cont'd) -

RESULTS OF TEST NO. 4:

Product	Weight, per cent	A s s a y s					Distribution, per cent			
		oz./ton		Per Cent			Au	Ag	Cu	Zn
		Au	Ag	Cu	Zn	Fe				
Cu conc.	2.81	2.61	11.89	22.88	3.92	33.34	41.94	33.66	68.97	2.29
Cu cleaner tailing	5.13	0.75	3.84	2.68	6.13	-	22.00	19.85	14.75	6.53
Zn conc.	6.32	0.08	1.14	0.51	54.07	10.29	2.89	7.26	3.46	70.93
Zn cleaner tailing	4.43	0.10	1.58	0.88	11.66	-	2.53	7.05	4.18	10.72
Zn scavenger conc.	5.17	0.30	1.32	0.38	4.02	-	8.87	6.87	2.11	4.31
Flotation tailing	76.14	0.05	0.33	0.08	0.33	-	21.77	25.31	6.53	5.22
Feed (calc.)	100.00	0.17	0.99	0.93	4.82		100.00	100.00	100.00	100.00

This test was conducted while the ore was still fresh, but after a few days it did not seem to react quite so well when an attempt was made to duplicate the test.

The results, however, indicate that a reasonably good separation can be made under favourable conditions and that operating technique will be an important factor in making the separation. Subsequent tests indicate that one of the important conditions is that the ore should be fresh.

Observations from Unreported Preliminary Tests.

The following points appear to have been established by a large number of tests that have been conducted but not reported in detail:

Cyanide is apparently helpful and gives best results when added to the grinding circuit. It helps to depress some of the more readily floatable pyrite and gives a better

(Observations from Unreported Preliminary Tests, cont'd) -

grade of copper concentrate than would otherwise be obtained. It also reduces the amount of sphalerite that floats with the copper minerals.

A number of tests were conducted in which various xanthates were used in varying amounts as collectors for the copper and zinc minerals. They did not in any case show enough selectivity between pyrite on the one hand and either chalcopyrite or sphalerite on the other, and it made no difference how much lime may have been added. In one such test lime was added to the zinc circuit at the rate of 20 pounds per ton and the concentrate after two cleanings assayed more than 20 per cent iron, the majority of which was present as pyrite. Reagent 208 was used in the copper circuit in one test, in the hope of increasing gold recovery, but it floated altogether too much pyrite.

Attempts were also made to selectively activate the sphalerite by careful control of the copper sulphate but this proved a failure when zinc in the flotation tailing went up to more than one per cent and the pyrite was still floating.

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