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An Investigation of
THE RECOVERY OF GOLD AND SILVER
from Rea project samples
submitted by
CORPORATION FALCONBRIDGE COPPER
Progress Report No. 1

Project No. L.R. 2798

NOTE:

This report refers to the samples as received.

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LAKEFIELD RESEARCH
A DIVISION OF FALCONBRIDGE LIMITED
Lakefield, Ontario
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I N T R O D U C T I O N

This report contains the results of testwork conducted on the Rea gold samples on behalf of Falconbridge Copper. The purpose of the testwork was to investigate the recovery of gold and silver in marketable products. The program included flotation testwork and a gravity separation and cyanidation test. The results were discussed in meetings with Mr. S. Fekete of Falconbridge Limited.

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1. Head Analysis

A representative sample of the composite was riffled out and analysed for the elements shown below:

⊗ Gold (Au):	17.8 g/t
⊗ Silver (Ag):	130 g/t
⊗ Copper (Cu):	0.72 %
⊗ Lead (Pb):	4.13 %
⊗ Zinc (Zn):	5.17 %
⊗ Sulphur (S):	22.2 %
⊗ Iron (Fe):	14.5 %
* Arsenic (As):	5.36 %
* Antimony (Sb):	0.090 %

Handwritten notes:
As 5.36
Mn 0.81%
18.1
1.23%
5.05%
7.65%
16.97%
6.45%
0.087
28.047%?
16.37%

2. Mineralogy

The sulphides present in the ore included chalcopyrite, galena, sphalerite, pyrite, arsenopyrite and tennantite. The major gangue mineral was barite. The ore was characterized by fine-grained, complex intergrowths of pyrite and other sulphides and abundant fine-grained inclusions of galena, sphalerite and chalcopyrite in pyrite. Arsenopyrite was commonly associated with sphalerite and galena. Gold was identified in the head sample as an inclusion in pyrite.

3. Flotation Testwork

Flotation tests were conducted to investigate the recovery of gold and silver in marketable products. Preliminary tests revealed the complexity of the ore confirmed by the mineralogical examination. Both bulk and selective flotation procedures were investigated.

Handwritten note:
Beauclerk increased
Zn recovery from 30% - 55%
by adding Philips 80
into float cells.

Summary - Continued

3.1. Bulk Flotation

The sample was ground to 96 % minus 200 mesh. The pH was adjusted to 8.5 with soda ash and the pulp was conditioned with copper sulphate. PAX was applied as collector to recover all sulphides and MIBC as frother. The results are presented in Table No. 1.

Table No. 1

Bulk Flotation

Test No.	Product	Weight %	Assays, g/t, %			% Distribution		
			Au	Ag	S*	Au	Ag	S*
7	Cl. Conc.	41.1	34.3	300	34.4	80.0	94.6	83.6
	Ro. Conc.	54.3	31.5	233	30.2	96.8	97.0	96.8
	Ro. Tail.	45.7	1.22	8.6	1.2	3.2	3.0	3.2
	Head(Calc.)	100.0	17.6	130	16.9	100.0	100.0	100.0

* Sulphide S

Additional analyses on the cleaner concentrate are given below:

Cleaner Concentrate: 1.81 % Cu 2.1
 9.77 % Pb 9.58
 12.0 % Zn 12.0
 9.84 % As 9.84
 0.18 % Sb 0.18
 Ba .75

Essentially in this test, the weight was reduced to 41 % of the original weight and the grades were doubled. Mineralogical examination of the cleaner tailings revealed arsenopyrite and pyrite as the major constituents. Associated with these tailings was 16 % of the gold. The ratio of arsenopyrite to tennantite in the cleaner concentrate was 3.6:1. This indicates that approximately 80 % of the arsenic in this product was in the form of arsenopyrite and 20 % as tennantite.

Handwritten calculations:
 25
 72
 64
 2.5
 103.5
 34.3 g / 1000000

34.3
 1000000

34.3
 1000000
 1030000

Summary - Continued

3.2. Selective Flotation

Two tests were performed to examine the sequential flotation of a copper-lead and zinc concentrates. The samples were ground with sodium sulphite and a zinc sulphate/sodium cyanide mixture to depress sphalerite and pyrite. The pulp was then conditioned with sulphurous acid at pH 7.3. Aerofloat 208 and Aeroxanthate 317 were applied as collectors in the Cu-Pb flotation in test No. 5. In test No. 6, Aerofloat 242 replaced Aerofloat 208. The rougher concentrate was reground and cleaned three times. The pH of the Cu-Pb rougher tailing was adjusted to 11.5 with lime and the pulp was conditioned with copper sulphate to activate sphalerite. A zinc concentrate was recovered with stage additions of Aeroxanthate 343. It was reground and cleaned at pH 12. In test No. 6, a pyrite concentrate was recovered from the zinc tailing. The results of these tests are summarized in Table No. 2.

Summary - Continued

3.2. Selective Flotation - Cont'd

Table No. 2 - Selective Flotation

Test No.	Product	Weight %	Assays, %, g/t						% Distribution					
			Au	Ag	Cu	Pb	Zn	As	Au	Ag	Cu	Pb	Zn	As*
5	Cu-Pb Cl. Conc.	7.5	59.5	1034	5.85	31.5	5.55	8.62	28.6	62.0	61.4	55.0	8.4	12.1
	Cu-Pb Ro. Conc.	17.0	40.5	577	3.45	19.4	7.25	-	44.3	78.9	82.3	77.3	25.0	-
	Zn Cleaner Conc.	5.0	13.6	69.3	0.54	2.10	45.8	5.88	4.4	2.8	3.8	2.5	46.3	5.5
	Zn Rougher Conc.	15.7	21.8	86.0	0.54	3.93	22.8	-	22.1	10.8	11.9	14.8	72.5	-
	Zn Rougher Tail.	67.3	7.74	19.1	0.06	0.50	0.18	3.65	33.6	10.3	5.8	7.9	2.5	45.8
	Head (Calc.)	100.0	15.5	124	0.71	4.27	4.94	5.36	100.0	100.0	100.0	100.0	100.0	100.0
6	Cu-Pb Cl. Conc.	6.5	58.5	1220	6.63	33.4	6.50	8.53	24.8	61.3	59.6	54.5	8.4	10.3
	Cu-Pb Ro. Conc.	14.2	39.5	6.84	3.89	21.6	7.57	-	36.7	75.5	76.7	77.4	21.5	-
	Zn Cleaner Conc.	7.4	16.3	85.3	0.70	2.77	43.1	6.21	7.9	4.9	7.2	5.2	64.0	8.6
	Zn Rougher Conc.	12.6	21.7	108	0.78	3.69	29.5	-	18.0	10.6	13.8	11.8	75.0	-
	Py. Ro. Conc.	25.2	23.8	57.6	0.24	1.48	0.51	10.6	39.4	11.3	8.4	9.4	2.6	49.8
	Py. Ro. Tail.	48.0	1.86	6.9	0.02	0.12	0.09	0.92	5.9	2.6	1.1	1.4	0.9	8.2
Head (Calc.)	100.0	15.2	129	0.72	3.96	4.97	5.36	100.0	100.0	100.0	100.0	100.0	100.0	76.9

* based on direct head

Summary - Continued

3.2. Selective Flotation - Cont'd

The Cu-Pb concentrate was contaminated by arsenopyrite (liberated and associated with galena), pyrite (with inclusions of other sulphides, liberated and as intergrowths with galena), sphalerite and tennantite. The tennantite would contribute an appreciable amount of copper to this product. The mineralogical examination suggested the presence of silver in the tennantite. One piece of gold was identified as fracture-filling in arsenopyrite in an earlier Cu-Pb concentrate (Test No. 4).

The primary contaminants in the zinc concentrate were arsenopyrite (liberated and associated with sphalerite), and pyrite (associated with galena and sphalerite).

The results from test No. 6 indicate some association of gold with the arsenopyrite and pyrite. Almost 40 % of the gold was recovered in the arsenopyrite/pyrite concentrate.

Test No. 8 and 9 were attempts to selectively scalp a copper/tennantite concentrate prior to bulk flotation and thereby produce a high grade silver concentrate. In both tests, the samples were ground with a zinc sulphate/sodium cyanide mixture then conditioned with SO₂ and starch at pH 4.5. Aero 3477 was applied as collector in test No. 8 but was replaced with Aerofloat 208 and Aeroxanthate 325 (SEX) in test No. 9. The pH of the tailing was raised to 8 with soda ash then copper sulphate was added to activate the depressed minerals. The remaining sulphides were recovered with Aeroxanthate 350 (PAX). The results are given in Tables No. 3 and 4.

Summary - Continued

3.2. Selective Flotation - Cont'd

Recovery of a selective copper/tennantite concentrate was unsuccessful. The copper cleaner concentrate produced in test No. 9 was similar to the Cu-Pb concentrate produced in test No. 6 despite the high SO₂ additions, particularly in terms of the gold and silver grades and recoveries.

Due to the complex mineral associations, it was difficult to achieve adequate grades of the flotation products. The presence of tennantite and arsenopyrite led to unacceptably high arsenic levels in any of the concentrates produced. Although the gold and silver content of the ore was high, it was not possible to concentrate their values sufficiently to counteract the problems resulting from the sulphide mineralogy.

Summary - Continued

4. Gravity Separation - Cyanidation Test

A single test was conducted to investigate the recovery of gold and silver in a gravity concentrate and the subsequent cyanide leaching of the tailing. The sample was ground to 87 % minus 200 mesh and fed over a laboratory Wilfley table. The results are tabulated below.

Table No. 5

Gravity Separation Results

Test No.	Product	Weight %	Assays, g/t, %					% Distribution				
			Au	Ag	Cu	Pb	Zn	Au	Ag	Cu	Pb	Zn
3	Table Conc.	2.2	87.9	133	0.52	12.0	3.98	11.6	2.2	1.6	6.6	1.7
	Table Tail.	97.8	15.3	134	0.71	3.85	4.92	88.4	97.8	98.4	93.4	98.3
	Head(Calc.)	100.0	16.9	134	0.71	4.03	4.90	100.0	100.0	100.0	100.0	100.0

The table concentrate was amalgamated and the amalgam was determined to contain 5.5 % of the gold (overall).

A sample of the table tailing was leached in a 1 g/L NaCN solution for 48 hours maintaining the pH at 11. The overall gold and silver extractions were 23.7 % and 10.6 % respectively leaving a residue which assayed 11.3 g/t Au and 117 g/t Ag.

SAMPLE PREPARATION

On February 24, 1984, fourteen samples from the Rea Gold Option were received at Lakefield Research and given our Reference Number 8424421. Another ten samples were received wet in a second shipment received on February 24, 1984 and given our Reference Number 8424426. The wet samples were air-dried then all samples were composited and crushed to minus 10 mesh. A head sample was riffled out and test charges were prepared.

DETAILS OF TESTS

Test No. 1

Purpose: A preliminary test to produce separate Cu-Pb, Zn and pyrite concentrates.

Procedure: Grind and float a Cu-Pb concentrate, a zinc concentrate and a pyrite concentrate. Clean the Cu-Pb concentrate twice.

Feed: 1000 grams minus 10 mesh Composite.

Grind: 15 minutes at 60 % solids in the lab ball mill.

Conditions:

Stage	Reagents Added, grams per tonne						Time, minutes			pH
	Ca-(OH) ₂	ZnSO ₄ / NaCN	A343	MIBC	CuSO ₄	H ₂ SO ₄	Grind	Cond.	Froth	
Grind	500	500	-	-	-	-	15	-	-	-
Cu-Pb Rougher	-	-	20	20	-	-	-	1	3	9.4
Condition	-	-	10	5	-	-	-	1	3	-
Zn Rougher	1000	-	-	-	-	-	-	2	-	-
Condition	-	-	-	-	500	-	-	3	-	11.2
Zn Rougher	-	-	10	-	-	-	-	1	3	-
Condition	-	-	5	5	-	-	-	1	2	-
Pyrite Rougher	-	-	-	-	-	1000	-	2	-	7.4
Condition	-	-	50	-	-	-	-	1	3	-
Cu-Pb 1st Cl.	-	-	50	5	-	-	-	1	3	-
Condition	-	-	50	5	-	-	-	1	2	-
Cu-Pb 1st Cl.	200	200	-	-	-	-	-	2	2	9.8
Condition	-	-	5	5	-	-	-	1	2	-
Cu-Pb 2nd Cl.	100	100	-	-	-	-	-	2	1	9.9
Condition	-	-	2.5	5	-	-	-	1	2	-

Stage	Roughers	Cu-Pb 1st Cl.	Cu-Pb 2nd Cl.
Flotation Cell	500 g D - 1	500 g D - 1	250 g D - 1
Speed: r.p.m.	1400	1300	1200
% Solids	33	-	-

Test No. 1 - Continued

Metallurgical Results

Product	Weight %	Assays, %			% Distribution		
		Cu	Pb	Zn	Cu	Pb	Zn
1. Cu-Pb Cl. Conc.	16.89	2.89	19.6	8.85	64.6	78.9	29.6
2. Cu-Pb 2nd Cl. Tail.	2.40	1.25	5.24	12.0	4.0	3.0	5.7
3. Cu-Pb 1st Cl. Tail.	13.39	0.86	2.71	14.4	15.2	8.6	38.2
4. Zn Rougher Conc.	10.40	0.63	1.84	11.4	8.7	4.6	23.5
5. Pyrite Ro. Conc.	22.59	0.22	0.81	0.57	6.9	4.3	2.6
6. Pyrite Ro. Tail.	34.33	0.014	0.071	0.064	0.6	0.6	0.4
Head (Calculated)	100.00	0.76	4.20	5.05	100.0	100.0	100.0

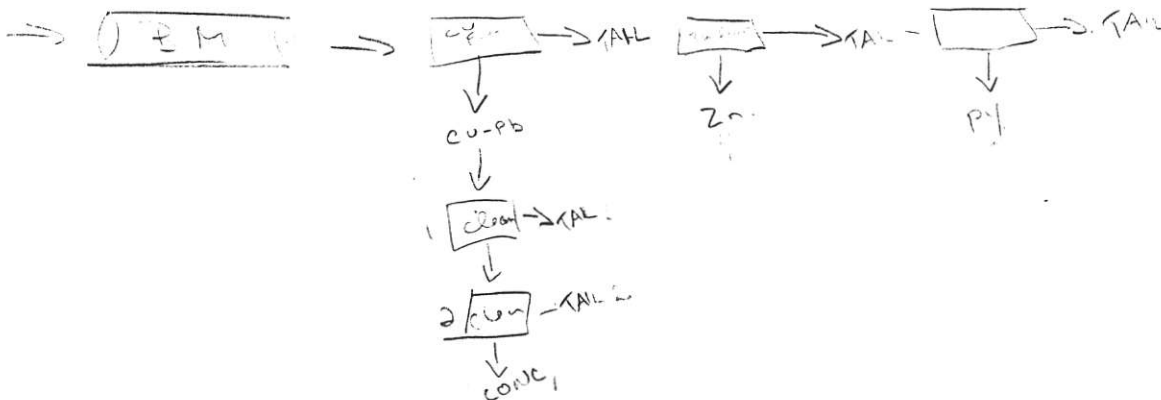
Calculated Grades and Recoveries

Products 1 and 2	19.29	2.69	17.8	9.24	68.6	81.9	35.3
Products 1 to 3	32.68	1.94	11.6	11.4	83.8	90.5	73.5
Products 5 and 6	56.92	0.10	0.36	0.26	7.5	4.9	3.0

Screen Analyses

Combined Products

Mesh Size (Tyler)	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 100	0.1	0.1	99.9
150	0.8	0.9	99.1
200	3.3	4.2	95.8
270	7.9	12.1	87.9
400	10.4	22.5	77.5
- 400	77.5	100.0	-
Total	100.0	-	-



Test No. 2

Purpose: A second preliminary test to produce separate Cu, Pb and Zn concentrate.

Procedure: Grind and float a copper concentrate, a lead concentrate and a zinc concentrate. Clean the copper concentrate twice and the zinc concentrate twice.

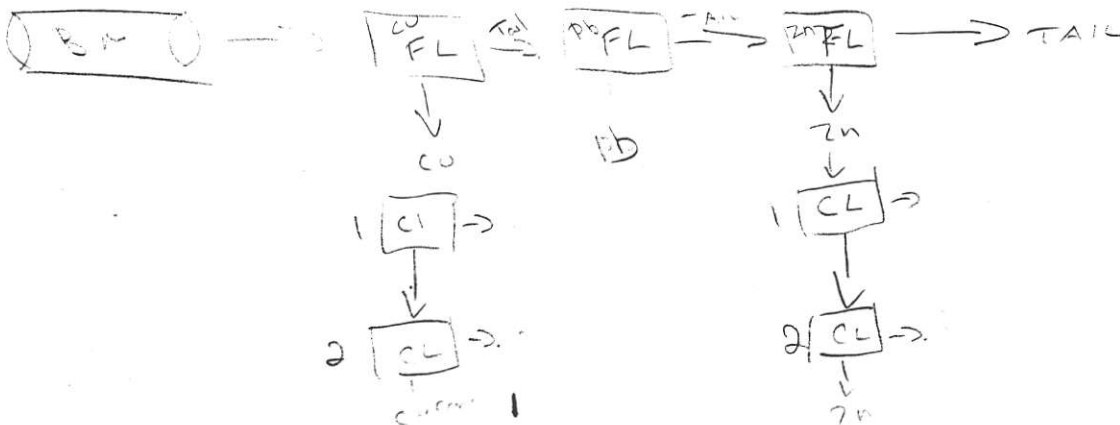
Feed: 1000 grams minus 10 mesh Composite.

Grind: 20 minutes at 60 % solids in the lab ball mill.

Conditions:

Stage	Reagents Added, grams per tonne						Time, minutes			pH
	SO ₂	M2030	Ca-(OH) ₂	ZnSO ₄ /NaCN	A343	CuSO ₄	Grind	Cond.	Froth	
Grind	1000	10	-	-	-	-	-	-	-	6.6
Cu Rougher	100	5	-	-	-	-	-	1	3	6.2
	-	5	-	-	-	-	-	1	2	-
Condition	-	-	1000	500	-	-	-	2	-	9.5
Pb Rougher	-	-	-	-	10	-	-	1	3	-
	-	-	-	-	5	-	-	1	2	-
Condition	-	-	1000	-	-	-	-	2	-	-
Zn Rougher	-	-	-	-	-	250	-	3	-	11.0
	-	5	-	-	5	-	-	1	3	-
	-	5	-	-	5	-	-	1	3	-
Cu 1st Cl.	50	-	-	-	-	-	-	1	2	5.5
	-	5	-	-	-	-	-	1	1	-
Cu 2nd Cl.	30	-	-	-	-	-	-	1	2	5.0
Zn 1st Cl.	-	-	250	-	-	-	-	1	2	11.3
	-	5	-	-	-	-	-	1	1	-
Zn 2nd Cl.	-	-	150	-	-	-	-	-	-	-

Stage	Rougher	1st Cleaners	2nd Cleaners
Flotation Cell	500 g D - 1	500 g D - 1	250 g D - 1
Speed: r.p.m.	1400	1400	1200
% Solids	33	-	-



Test No. 2 - Continued

Metallurgical Results

Product	Weight %	Assays, %			% Distribution		
		Cu	Pb	Zn	Cu	Pb	Zn
1. Cu Cleaner Conc.	1.26	19.1	8.35	10.7	33.2	2.5	2.7
2. Cu 2nd Cl. Tail.	3.41	8.00	7.45	11.5	37.6	6.1	7.9
3. Cu 1st Cl. Tail.	5.01	0.72	5.36	6.98	5.0	6.5	7.0
4. Pb Rougher Conc.	16.66	0.24	16.2	6.16	5.5	65.2	20.7
5. Zn Cleaner Conc.	2.68	0.49	1.95	42.5	1.8	1.3	23.0
6. Zn 2nd Cl. Tail.	2.32	0.50	2.87	17.5	1.6	1.6	8.2
7. Zn 1st Cl. Tail.	12.58	0.35	2.15	8.96	6.0	6.5	22.7
8. Zn Rougher Tail.	56.08	0.12	0.76	0.69	9.3	10.3	7.8
Head (Calculated)	100.00	0.73	4.14	4.96	100.0	100.0	100.0

Saleable →

Calculated Grades and Recoveries

Products 1 and 2 ^{cu}	4.67	11.0	7.69	11.3	70.8	8.6	10.6
Products 1 to 3	9.68	5.68	6.48	9.04	75.8	15.1	17.6
Products 5 and 6 ^{zn}	5.00	0.49	2.38	30.9	3.4	2.9	31.2
Products 5 to 7	17.58	0.39	2.22	15.2	9.4	9.4	53.9

Screen Analyses

Combined Products

Mesh Size (Tyler)	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 65	0.1	0.1	99.9
100	-	-	-
150	0.3	0.4	99.6
200	1.6	2.0	98.0
270	2.5	4.5	95.5
400	8.8	13.3	86.7
- 400	86.7	100.0	-
Total	100.0	-	-

Test No. 3

Purpose: To investigate the recovery of gold and silver in a gravity concentrate and the subsequent extraction of gold and silver by cyanide leaching of the gravity tailing.

1. Gravity Separation

Procedure: The pulp density of the ground sample was adjusted to approximately 50 % solids. The pulp was fed over a laboratory Wilfley table. The table concentrate was amalgamated for 2 hours on rolls. The amalgam was then recovered by elutriation.

Amalgamation Conditions:

10 g Hg
1 g NaOH

Feed: 2 kg of minus 10 mesh composite

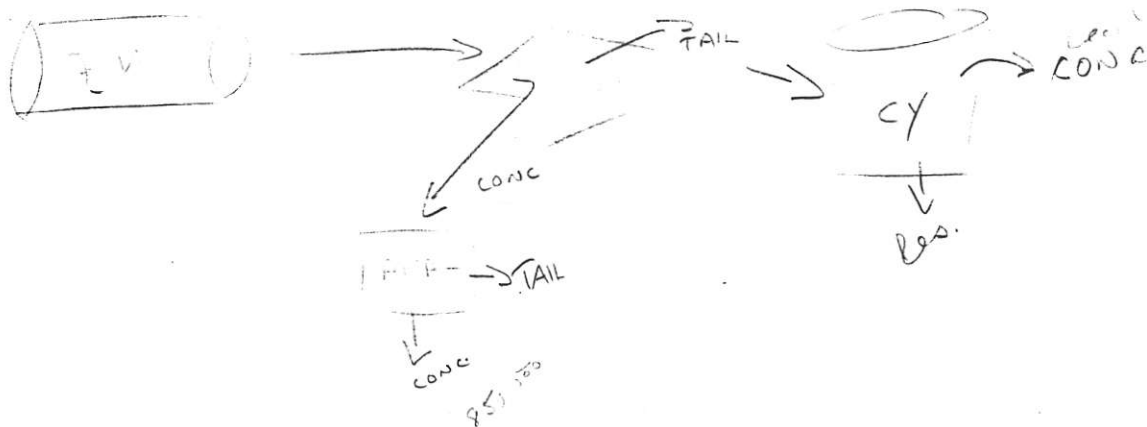
Grind: 15 min/2 kg in the lab ball mill at 65 % solids.

Metallurgical Results

Product	Weight %	Assays, mg, g/t, %					% Distribution				
		Au	Ag	Cu	Pb	Zn	Au	Ag	Cu	Pb	Zn
1. Amalgam	-	1.813	1.06	-	-	-	5.5	0.4	-	-	-
2. Amalgam Tail.	2.2	46.3	109	0.52	12.0	3.98	6.1	1.8	1.6	6.6	1.7
3. Table Tail.	97.8	15.3	134	0.71	3.84	4.92	88.4	97.8	98.4	93.4	98.3
Head(Calc.)	100.0	16.9	134	0.71	4.03	4.90	100.0	100.0	100.0	100.0	100.0

Calculated Grades and Recoveries

Products 1+2	2.2	87.9	133	0.52	12.0	3.98	11.6	2.2	1.6	6.6	1.7
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Test No. 3 - Continued

2. Cyanidation

Procedure: The sample was pulped with water in a two litre bottle. NaCN and lime were added and the cyanidation was carried out on rolls in one 48 hour stage. The pulp was filtered and the residue washed three times with water.

Feed: 500 g table tailing.

Solution Volume: 1000 mL Pulp Density 33 % solids

Solution Composition: 1.0 g/L NaCN

pH Range: 10.5-11 with Ca(OH)₂

Reagent Balance:

Time Hours	Added, Grams				Residual		Consumed		pH
	Actual NaCN	Ca(OH) ₂	Equivalent NaCN	CaO	Grams NaCN	CaO	Grams NaCN	CaO	
0-2.5	1.05	0.50	1.0	0.38	0.65	0.08	0.35	0.30	11.0-11.3
2.5-4	0.37	0	0.35	0	0.98	0.07	0.02	0.01	11.3-11.3
4-6	0.02	0	0.02	0	0.90	0.04	0.10	0.03	11.3-11.2
6-22	0.11	0	0.10	0	0.90	0.03	0.10	0.01	11.2-11.2
22-29	0.11	0	0.10	0	0.90	0.03	0.10	0	11.2-11.3
29-48	0.11	0	0.10	0	0.85	0.02	0.15	0.01	11.4-11.2
Total	1.77	0.50	1.67	0.38	0.85	0.02	0.82	0.36	-

Reagent Consumption (kg/t of cyanide feed) NaCN: 1.62 CaO: 0.71

Test No. 3 - Continued

2. Cyanidation - Cont'd

Metallurgical Results

Product	Amount	Assays, mg/L, g/t		% Distribution			
		Au	Ag	Ind.		O'all	
				Au	Ag	Au	Ag
4 48 h Preg'n+Wash Sol'n	1935 mL	1.08	3.72	26.8	10.8	23.7	10.6
5 48 h Cyanide Residue	506.1 g	11.3	117	73.2	89.2	64.7	87.2
Head (Calculated)	506.1 g	15.4	131	100.0	100.0	88.4	97.8

Overall Recoveries (gravity + cyanidation): 35.3 % Au recovery
 12.8 % Ag recovery

Screen Analyses

48 Hour Cyanide Residue

Mesh Size (Tyler)	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 65	0.2	0.2	99.8
100	0.7	0.9	99.1
150	3.5	4.4	95.6
200	9.0	13.4	86.6
270	11.5	24.9	75.1
400	13.3	38.2	61.8
- 400	61.8	100.0	-
Total	100.0	-	-

$100,000 \times 17.9\% = 17,900,000$
 $17,900,000 \times 11.6 = 206,480,000$
 $206,480,000 \times 23.7 = 4,893,676,000$
 $4,893,676,000 \times 35.3 = 173,226,762,800$
 $173,226,762,800 \times \$300 = 51,968,028,840$

Test No. 4

Purpose: To investigate Na_2S and $\text{Zn}(\text{OH})_2/\text{NaCN}$ for zinc depression in the bulk Cu-Pb flotation and the subsequent Zn flotation.

Procedure: Float a bulk Cu-Pb concentrate. Regrind and clean three times. From the Cu-Pb tailing, float a zinc concentrate and clean twice.

Feed: 1000 grams minus 10 mesh composite.

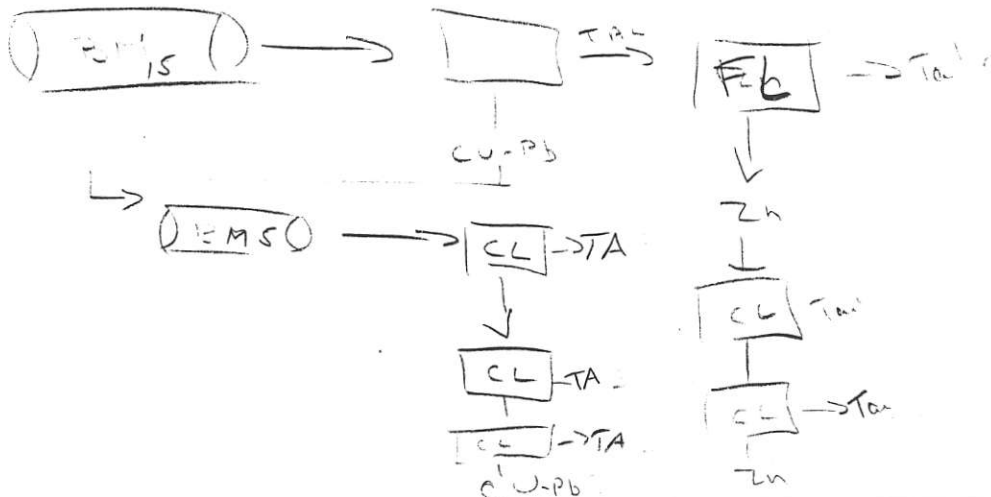
Grind: 15 minutes in the lab ball mill at 60 % solids.

Conditions:

Stage	Reagents Added, grams per tonne								Time, minutes			pH
	Na_2S	$\text{Zn}(\text{OH})_2^*/\text{NaCN}$	SO_2	3477	A343	MIBC	Ca-(OH) ₂	Cu-SO ₄	Grind	Cond.	Froth	
Grind	250	500	-	-	-	-	-	-	15	-	-	-
Cu-Pb Rougher	-	-	100	-	-	-	-	-	-	1	-	-
	-	-	-	10	5	15	-	-	-	1	3	7.0
	-	-	50	5	5	-	-	-	-	-	2	7.0
	-	-	-	5	5	-	-	-	-	1	3	7.0
Regrind	100	200	-	-	-	-	-	-	5	-	-	-
Cu-Pb 1st Cl.	-	-	65	5	10	10	-	-	-	1	2	6.8
	-	-	-	5	5	-	-	-	-	-	3	-
Cu-Pb 2nd Cl.	-	-	20	-	-	5	-	-	-	1	2	6.7
	-	-	-	-	5	5	-	-	-	1	2	-
Cu-Pb 3rd Cl.	-	-	5	-	-	5	-	-	-	1	2	6.6
Condition	-	-	-	-	-	-	850	500	-	3	-	11.5
Zn Rougher	-	-	-	-	20	-	-	-	-	1	2	-
	-	-	-	-	10	5	-	-	-	1	2	-
Zn 1st Cl.	-	-	-	-	-	-	300	-	-	3	5	11.7
Zn 2nd Cl.	-	-	-	-	-	-	150	-	-	1	3	11.6

* 2:1

Stage	Roughers	Cu-Pb 1st Cleaner	Other Cleaners
Flotation Cell	500 g D - 1	500 g D - 1	250 g D - 1
Speed: r.p.m.	1500	1400	1100



Test No. 4 - Continued

Metallurgical Results

Product	Weight %	Assays, %			% Distribution		
		Cu	Pb	Zn	Cu	Pb	Zn
1. Cu-Pb Cl. Conc.	9.07	5.48	25.0	10.4	67.8	57.2	19.4
2. Cu-Pb 3rd Cl. Tail.	4.12	1.45	9.66	20.9	8.1	10.0	17.7
3. Cu-Pb 2nd Cl. Tail.	2.78	1.00	7.90	18.5	3.8	5.5	10.6
4. Cu-Pb 1st Cl. Tail.	8.26	0.58	4.74	10.2	6.5	9.9	17.4
5. Zn Cleaner Conc.	3.53	0.42	1.74	32.6	2.0	1.6	23.7
6. Zn 2nd Cl. Tail.	2.09	0.56	4.01	10.3	1.6	2.1	4.4
7. Zn 1st Cl. Tail.	5.75	0.36	2.71	2.76	2.8	3.9	3.3
8. Zn Rougher Tail.	64.40	0.084	0.60	0.26	7.4	9.8	3.5
Head (Calculated)	100.00	0.73	3.96	4.85	100.0	100.0	100.0

Calculated Grades and Recoveries

Products 1 and 2	13.19	4.22	20.2	13.7	75.9	67.2	37.1
Products 1 to 3	15.97	3.66	18.1	14.5	79.7	72.7	47.7
Products 1 to 4	24.23	2.61	13.5	13.0	86.2	82.6	65.1 ←
Products 5 and 6	5.62	0.47	2.58	24.3	3.6	3.7	28.1
Products 5 to 7	11.37	0.42	2.65	13.4	6.4	7.6	31.4

Screen Analyses

Combined Cu-Pb Cleaner Products

Particle Size	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 30.5 μm	6.7	6.7	93.3
23.7	9.5	16.2	83.8
16.5	17.8	34.0	66.0
11.3	17.4	51.4	48.6
8.8	10.5	61.9	38.1
- 8.8	38.1	100.0	-
Total	100.0	-	-

Specific Gravity 5.00

Test No. 5

Purpose: To investigate the effect of ZnSO₄/NaCN (1:1) and sodium sulphite on zinc depression during Cu-Pb flotation and a higher pH during zinc flotation.

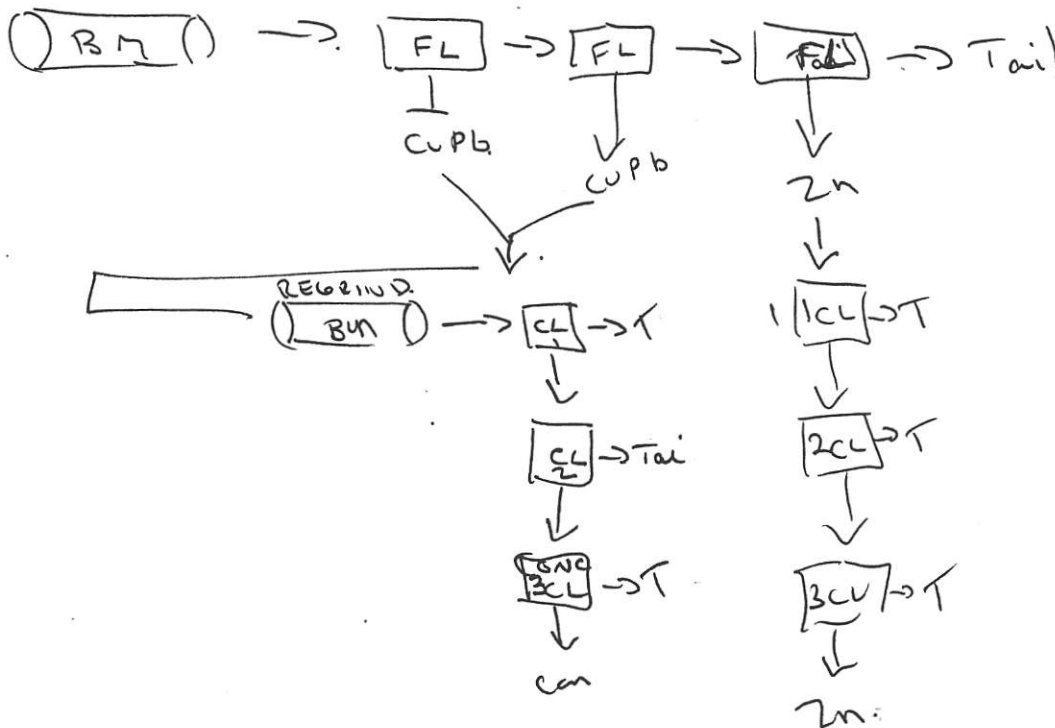
Procedure: As outlined below.

Feed: 1000 g minus 10 mesh Composite.

Grind: 15 minutes in lab ball mill at 60 % solids.

Conditions:

Stage	Reagents Added, grams per tonne						Time, minutes			pH
	ZnSO ₄ / NaCN	Na ₂ - SO ₃	SO ₂	R208	A317	MIBC	Grind	Cond.	Froth	
Grind	600	800	-	-	-	-	15	-	-	9.6
Cu-Pb Rougher	-	-	200	10	20	10	-	1	2	7.3
Cu-Pb Scavenger	300	-	-	-	-	-	-	3	-	9.2
	-	-	125	-	2.5	5	-	1	2	7.3
Combine Cu-Pb rougher and scavenger concentrates.										
Regrind	300	400	-	-	-	-	10	-	-	8.8
Cu-Pb 1st Cl.	-	-	60	5	2.5	5	-	1	2	7.2
	-	-	-	-	2.5	5	-	1	3	-
	-	-	-	-	2.5	-	-	1	3	-
Cu-Pb 2nd Cl.	-	-	20	-	-	5	-	1	5	7.0
	-	-	10	-	-	5	-	1	4	6.8



Test No. 5 - Continued

Conditions:

Stage	Reagents Added, grams per tonne				Time, minutes			pH
	Ca(OH) ₂	CuSO ₄	A343'	MIBC	Grind	Cond.	Froth	
<u>Zn Circuit</u>								
Feed Cu-Pb scavenger tailing								
Condition	800	500	-	-	-	3	-	11.6
Zn Rougher	-	-	20	5	-	1	4	-
	200	-	10	-	-	1	4	11.5
Regrind	500	-	-	-	5	-	-	11.6
Zn 1st Cl.	400	-	10	5	-	1	5	12.1
	-	-	10	5	-	1	5	-
Zn 2nd Cl.	200	-	-	-	-	1	3	12.1
	-	-	-	5	-	1	3	-
Zn 3rd Cl.	150	-	-	5	-	1	3	12.1

Stage	Roughers	1st Cleaners	2nd+3rd Cleaners
Flotation Cell	500 g D - 1	500 g D - 1	250 g D - 1
Speed: r.p.m.	1500	1400	1100

Test No. 5 - Continued

Metallurgical Results

Product	Weight %	Assays, %, g/t					% Distribution				
		Cu	Pb	Zn	Au	Ag	Cu	Pb	Zn	Au	Ag
1. Cu-Pb 3rd Cl. Conc.	7.46	5.85	31.5	5.55	59.5	1034	61.4	55.0	8.4	28.6	62.0
2. Cu-Pb 3rd Cl. Tail.	2.16	1.75	12.7	8.16	32.6	264	5.3	6.4	3.6	4.5	4.6
3. Cu-Pb 2nd Cl. Tail.	1.86	1.74	8.95	9.46	28.4	227	4.5	5.3	3.6	3.4	3.4
4. Cu-Pb 1st Cl. Tail.	5.51	1.44	8.21	8.46	21.9	200	11.1	10.6	9.4	7.8	8.9
<i>saleable</i> 5. Zn 3rd Cl. Conc.	4.99	0.54	2.10	45.8	13.6	69.3	3.8	2.5	46.3	4.4	2.8
6. Zn 3rd Cl. Tail.	1.59	0.62	3.77	28.6	19.3	103	1.4	5.8	9.2	2.0	1.3
7. Zn 2nd Cl. Tail.	2.33	0.63	3.95	16.8	24.3	108	2.1	2.1	7.9	3.6	2.0
8. Zn 1st Cl. Tail.	6.82	0.48	2.73	6.61	27.6	86.8	4.6	4.4	9.1	12.1	4.7
9. Zn Rougher Tail.	67.28	0.061	0.50	0.18	7.74	19.1	5.8	7.9	2.5	33.6	10.3
Head (Calculated)	100.00	0.71	4.27	4.94	15.5	124	100.0	100.0	100.0	100.0	100.0

Calculated Grades and Recoveries

Products 1 and 2	9.62	4.93	27.3	6.14	53.5	861	66.7	61.4	12.0	33.1	66.6
Products 1 to 3	11.48	4.41	24.8	6.67	49.4	758	71.2	66.7	15.6	36.5	70.0
Products 1 to 4	16.99	3.45	19.4	7.25	40.5	577	82.3	77.3	25.0	44.3	78.9
<i>saleable</i> Products 5 and 6	6.58	0.56	5.17	41.6	15.0	77.4	5.2	8.3	55.5	6.4	4.1
Products 5 to 7	8.91	0.58	4.85	35.1	17.4	85.4	7.3	10.4	63.4	10.0	6.1
Products 5 to 8	15.73	0.54	3.93	22.8	21.8	86.0	11.9	14.8	72.5	22.1	10.8
Products 5 to 9	83.01	0.15	1.15	4.46	10.4	31.8	17.7	22.7	75.0	55.7	21.1

Additional Assays:

	% As
Cu-Pb 3rd Cl. Conc.	8.62
Zn 3rd Cl. Conc.	5.88
Zn Rougher Tail.	3.65

Test No. 5 - Continued

Screen Analysis

Combined Cu-Pb Cleaner Products

Particle Size	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 29.6 μ m	3.6	3.6	96.4
22.9	7.7	11.3	88.7
16.0	19.1	30.4	69.6
11.0	20.5	50.9	49.1
8.5	12.1	63.0	37.0
- 8.5	37.0	100.0	-
Total	100.0	-	-

Specific Gravity 5.28

Combined Zn Cleaner Products

+ 31.9 μ m	7.5	7.5	92.5
24.7	8.1	15.6	84.4
17.3	14.3	29.9	70.1
11.9	14.5	44.4	55.6
9.2	9.6	54.0	46.0
- 9.2	46.0	100.0	-
Total	100.0	-	-

Specific Gravity 4.63

Test No. 6

Purpose: To investigate the effect of replacing R208 with R242 in the Cu-Pb circuit and the recovery of gold and silver in a pyrite concentrate following zinc flotation.

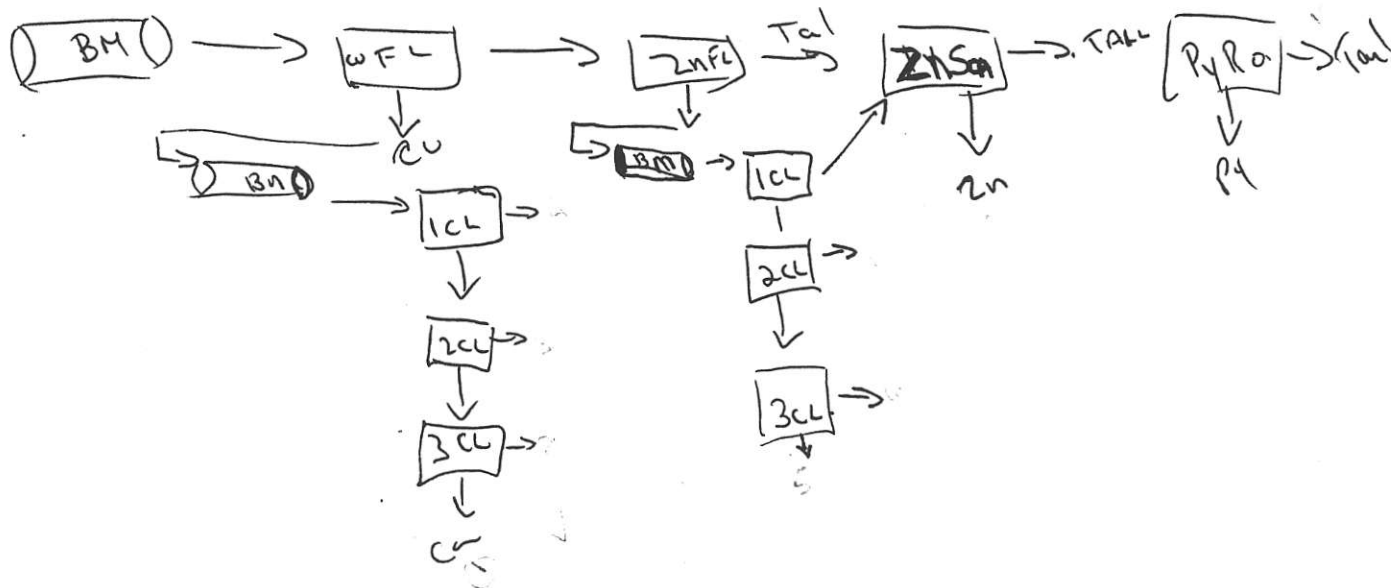
Procedure: As outlined below.

Feed: 1000 g minus 10 mesh Composite.

Grind: 20 minutes in lab ball mill at 60 % solids.

Conditions:

Stage	Reagents Added, grams per tonne									Time, minutes			pH
	ZnSO ₄ / NaCN	Na ₂ - SO ₃	SO ₂	R242	A317	MIBC	A343	Ca- (OH) ₂	Cu- SO ₄	Grind	Cond.	Froth	
Grind	800	800	-	-	-	-	-	-	-	20	-	-	9.6
Cu-Pb Rougher	-	-	300	10	10	12	-	-	-	-	1	2	7.3
	-	-	25	5	5	-	-	-	-	-	1	2	-
Cu-Pb Regrind	400	400	-	-	-	-	-	-	-	10	-	-	9.6
Cu-Pb 1st Cl.	-	-	150	5	5	10	-	-	-	-	1	2	7.2
	-	-	-	5	5	5	-	-	-	-	1	3	-
	-	-	-	5	2.5	5	-	-	-	-	1	3	-
Cu-Pb 2nd Cl.	-	-	-	-	2.5	5	-	-	-	-	1	2	-
	-	-	15	5	2.5	5	-	-	-	-	1	3	6.8
Cu-Pb 3rd Cl.	-	-	-	-	2.5	-	-	-	-	-	1	3	-
	-	-	15	-	2.5	5	-	-	-	-	1	5	6.8
Condition	-	-	-	-	-	-	-	1000	-	-	2	-	11.5
	-	-	-	-	-	-	-	-	500	-	3	-	-
Zn Rougher	-	-	-	-	-	5	20	-	-	-	1	4	11.3
	-	-	-	-	-	-	10	-	-	-	1	4	-
	-	-	-	-	-	5	5	-	-	-	1	-	-
Zn Regrind	-	-	-	-	-	-	-	800	-	10	-	-	-



Test No. 6 - Continued

Conditions:

Stage	Reagents Added, grams per tonne							Time, minutes			pH
	Ca-(OH) ₂	CuSO ₄	A343	MIBC	M200	H ₂ SO ₄	A350	Grind	Cond.	Froth	
Zn 1st Cleaner	-	-	10	5	-	-	-	-	1	5	11.9
	-	-	10	5	-	-	-	-	1	5	-
	-	-	5	-	-	-	-	-	1	5	-
Zn 2nd Cleaner	300	-	-	-	-	-	-	-	1	-	12.0
	-	-	5	5	-	-	-	-	1	6	-
	-	-	2.5	5	-	-	-	-	1	2	-
Zn 3rd Cleaner	300	-	2.5	5	-	-	-	-	1	5	12.0
	-	-	2.5	5	-	-	-	-	1	3	-
Combine Zn 1st cleaner tailing and Zn rougher tailing											
Zn Scavenger	-	100	-	15	10	-	-	-	3	3	10.8
	-	-	-	5	10	-	-	-	1	3	-
Zn Scav. Cl.	250	-	-	5	5	-	-	-	1	3	11.3
Py Rougher	-	-	-	-	-	600	-	-	-	-	9.9-
	-	-	-	10	-	-	30	-	1	1	7.2
	-	-	-	-	-	-	20	-	1	3	-
	-	-	-	5	-	-	20	-	1	4	-
	-	-	-	5	-	-	20	-	1	4	-
	-	-	-	5	-	-	20	-	1	4	-

Test No. 6 - Continued

Metallurgical Results

Product	Weight %	Assays, %, g/t					% Distribution				
		Cu	Pb	Zn	Au	Ag	Cu	Pb	Zn	Au	Ag
1. Cu-Pb Cl. Conc.	6.46	6.63	33.4	6.50	58.5	1220	59.6	54.5	8.4	24.8	61.3
2. Cu-Pb 3rd Cl. Tail.	1.22	2.23	21.7	7.00	32.5	430	3.8	6.7	1.7	2.6	4.1
3. Cu-Pb 2nd Cl. Tail.	0.81	1.62	15.9	7.65	25.5	284	1.8	3.2	1.2	1.3	1.8
4. Cu-Pb 1st Cl. Tail.	5.68	1.46	9.06	8.89	21.4	187	11.5	13.0	10.2	8.0	8.3
5. Zn Cleaner Conc.	7.39	0.70	2.77	43.1	16.3	85.3	7.2	5.2	64.0	7.9	4.9
6. Zn 3rd Cl. Tail.	1.03	0.78	4.99	19.7	22.0	128	1.1	1.3	4.1	1.5	1.0
7. Zn 2nd Cl. Tail.	1.22	0.80	5.09	10.6	25.4	135	1.4	1.6	2.6	2.0	1.3
8. Zn Scav. Cl. Conc.	2.99	0.99	4.93	7.13	33.5	148	4.1	3.7	4.3	6.6	3.4
9. Pyrite Ro. Conc.	25.20	0.24	1.48	0.51	23.8	57.6	8.4	9.4	2.6	39.4	11.3
10. Pyrite Ro. Tail.	48.00	0.016	0.12	0.089	1.86	6.9	1.1	1.4	0.9	5.9	2.6
Head (Calculated)	100.00	0.72	3.96	4.97	15.2	129	100.0	100.0	100.0	100.0	100.0

Calculated Grades and Recoveries

Products 1 and 2	7.68	5.93	31.5	6.58	54.4	1095	63.4	61.2	10.1	27.4	65.4
Products 1 to 3	8.49	5.52	30.0	6.68	51.6	1017	65.2	64.4	11.3	28.7	67.2
Products 1 to 4	14.17	3.89	21.6	7.57	39.5	684	76.7	77.4	21.5	36.7	75.5
Products 5 and 6	8.42	0.71	3.04	40.2	17.0	90.5	8.3	6.5	68.1	9.4	5.9
Products 5 to 7	9.64	0.72	3.30	36.5	18.1	96.2	9.7	8.1	70.7	11.4	7.2
Products 5 to 8	12.63	0.78	3.69	29.5	21.7	108	13.8	11.8	75.0	18.0	10.6
Products 5 to 10	85.83	0.20	1.04	4.55	11.2	36.7	23.3	22.6	78.5	63.3	24.5
Products 9 and 10	73.20	0.093	0.59	0.23	9.41	24.4	9.5	10.8	3.5	45.3	13.9

Additional Assays

	% As	% Distr.*
Cu-Pb Cleaner Concentrate	8.53	10.3
Zn Cleaner Concentrate	6.21	8.6
Zn Scav. Cl. Conc.	17.6	9.8
Pyrite Ro. Conc.	10.6	49.8
Pyrite Ro. Tail.	0.92	8.2

86.7

Test No. 6 - Continued

Screen Analysis

Zn Cleaner Products

Particle Size	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 32.3 μm	3.0	3.0	97.0
25.0	4.8	7.8	92.2
17.5	13.6	21.4	78.6
12.0	17.0	38.4	61.6
9.3	11.8	50.2	49.8
- 9.3	49.8	100.0	-
Total	100.0	-	-

Specific Gravity 4.56

Cu-Pb Cleaner Products

+ 30.0 μm	1.3	1.3	98.7
23.3	3.6	4.9	95.1
16.2	13.8	18.7	81.3
11.2	20.0	38.7	61.3
8.6	13.9	52.6	47.4
- 8.6	47.4	100.0	-
Total	100.0	-	-

Test No. 7

Purpose: To investigate the recovery of gold and silver in a bulk sulphide concentrate.

Procedure: As outlined below.

Feed: 1000 g minus 10 mesh Composite.

Grind: 15 minutes in the lab ball mill at 60% solids.

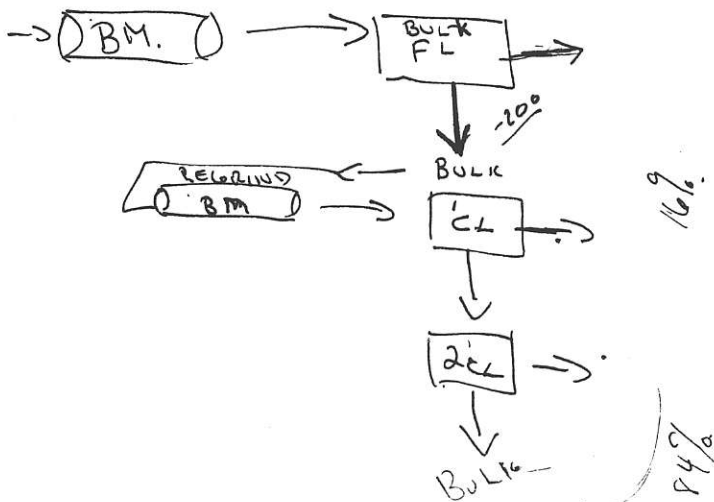
Conditions:

Stage	Reagents Added, grams/tonne				Time, minutes			pH
	Na ₂ CO ₃	CuSO ₄	A-350	MIBC	Grind	Cond.	Froth	
Grind	-	-	-	-	15	-	-	6.5
Condition	800	500	-	-	-	3	-	8.5
Rougher	-	-	30	15	-	1	2	-
	-	-	30	5	-	1	2	-
	-	-	30	10	-	1	3	-
	-	-	30	10	-	1	3	-
	-	-	30	10	-	1	5	8.2
Regrind	-	-	-	-	30	-	-	-
1st Cleaner	-	-	20	10	-	1	2	8.0
	-	-	-	10	-	-	2	-
	-	-	10	10	-	1	4	-
	-	-	10	10	-	1	3	-
	-	100	10	5	-	1	5	-
2nd Cleaner	-	-	-	-	-	1	2	7.9
	-	-	5	10	-	1	2	-
	-	-	5	10	-	1	4	-
	-	-	5	10	-	1	2	-
	-	-	5	5	-	1	2	-

Stage
Flotation Cell
Speed: r.p.m.

Rougher
500 g D-1
1500

Cleaners
500 g D-1
1500



Test No. 7 - Continued

Metallurgical Results

Products	Weight %	Assays, %, g/tonne							% Distribution							
		Au	Ag	Cu	Pb	Zn	S	As	Au	Ag	Cu	Pb	Zn	S	S*	As
1. 2nd Cleaner Concentrate	41.14	34.3	300.	1.81	9.77	12.0	34.4	9.84	80.0	94.6	97.1	95.4	98.3	66.1	83.6	68.3
2. 2nd Cleaner Tailing	3.04	28.6	40.0	0.19	1.31	0.43	20.8	15.4	4.9	1.0	0.8	0.9	0.3	2.9	3.7	7.9
3. 1st Cleaner Tailing	10.09	20.8	18.5	0.094	0.68	0.20	15.9	11.5	11.9	1.4	1.2	1.6	0.4	7.5	9.5	19.6
4. Rougher Tailing	45.73	1.22	8.6	0.016	0.19	0.11	11.0	0.54	3.2	3.0	0.9	2.1	1.0	23.5	3.2	4.2
Head (calculated)	100.00	17.6	120.	0.77	4.21	5.02	21.4	5.92	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Calculated Grades and Recoveries

Products 1 plus 2	44.18	33.9	282.	1.70	9.19	11.2	33.5	10.2	84.9	95.6	97.9	96.3	98.6	69.0	87.3	76.2
Products 1 to 3	54.27	31.5	233.	1.40	7.61	9.16	30.2	10.5	96.8	97.0	99.1	97.9	99.0	76.5	96.8	95.8

* Sulphide S, distribution based on 1.2 % S in the rougher tailing

Additional Assays: 2nd Cl. Conc.: 0.18 % Sb
 Rougher Tailing: 71.4 % BaSO₄ (9.8% S)
 Therefore, 1.2 % sulphide S in the rougher tailing

*What about a
 re-grind ~~and~~ of
 the bulk S conc.
 could be done especially
 if a column flotation
 is used.*

24

Test No. 7 - Continued

Size Analysis

2nd Cleaner Concentrate

Particle Size	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 29.9 μm	2.1	2.1	97.9
23.2	4.8	6.9	93.1
16.2	15.2	22.1	77.9
11.1	20.1	42.2	57.8
8.6	13.5	55.7	44.3
- 8.6 μm	44.3	100.0	-
Total	100.0	-	-

Specific Gravity = 5.11

Test No. 8

Purpose: To investigate the flotation of a copper/silver concentrate prior to the bulk sulphide flotation.

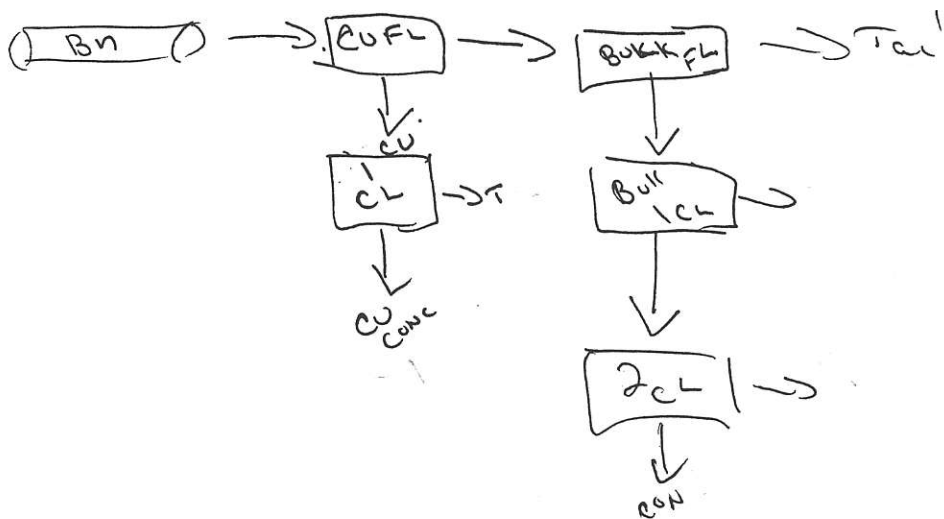
Procedure: Scalp a copper/tennantite concentrate and clean once. From the rougher tailing, float the remaining sulphides and clean.

Feed: 1000 grams minus 10 mesh Composite.

Grind: 15 minutes in the lab ball mill at 60% solids.

Conditions:

Stage	Reagents Added, grams per tonne						Time, minutes			pH
	ZnSO ₄ NaCN	SO ₂	H-31	3477	A350	MIBC	Grind	Cond.	Froth	
Grind	1000	-	-	-	-	-	15	-	-	8.9
Condition	-	2500	250	-	-	-	-	10	-	4.5
Cu Rougher	-	-	-	10	-	10	-	1	3	-
	-	-	-	5	-	-	-	1	2	-
	-	-	-	5	-	-	-	1	2	-
	-	-	-	-	-	25	-	1	2	5.0
Cu Cleaner	Na ₂ CO ₃	CuSO ₄								
	7000	1000	-	-	-	-	-	3	-	8.0
	-	-	-	-	50	10	-	1	2	-
	-	-	-	-	50	-	-	1	3	-
	-	-	-	-	50	10	-	1	5	-
Bulk 1st Cleaner	-	200	-	-	30	10	-	1	5	-
	-	-	-	-	-	-	-	1	2	7.8
	-	-	-	-	10	10	-	1	4	-
	-	-	-	-	20	10	-	1	5	-
Bulk 2nd Cleaner	-	-	-	-	20	10	-	1	5	-
	-	-	-	-	-	-	-	1	2	-
	-	-	-	-	10	10	-	1	4	-
	-	-	-	-	10	10	-	1	2	-



Test No. 8 - Continued

Metallurgical Results

Product	Weight %	Assays, %, g/tonne							% Distribution							
		Au	Ag	Cu	Pb	Zn	S	As	Au	Ag	Cu	Pb	Zn	S	S*	As
1. Cu Cleaner Concentrate	0.65	397.	1690.	11.8	18.6	6.10	25.2	3.45	16.1	8.7	10.1	2.9	0.8	0.8	1.0	0.4
2. Cu Cleaner Tailing	3.15	36.6	361.	1.57	5.41	6.16	19.4	4.92	7.2	9.0	6.5	4.1	3.9	2.8	3.5	2.7
3. Bulk Cleaner Conc.	43.30	24.3	228.	1.41	8.50	10.7	33.8	10.7	65.8	78.2	80.4	88.3	93.9	68.0	84.7	81.0
4. Bulk 2nd Cl. Tailing	3.31	17.8	38.9	0.23	1.47	0.37	17.3	9.78	3.7	1.0	1.0	1.2	0.3	2.6	3.3	5.7
5. Bulk 1st Cl. Tailing	7.55	7.66	15.7	0.085	0.78	0.20	12.2	4.12	3.6	0.9	0.8	1.4	0.3	4.3	5.3	5.4
6. Bulk Rougher Tailing	42.04	1.38	6.5	0.021	0.21	0.097	11.0	0.65	3.6	2.2	1.2	2.1	0.8	21.5	2.2	4.8
Head (calculated)	100.00	16.0	126.	0.76	4.17	4.93	21.5	5.72	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Calculated Grades and Recoveries

Products 1 plus 2	3.80	98.2	588.	3.32	7.67	6.15	20.4	4.67	23.3	17.7	16.6	7.0	4.7	3.6	4.5	3.1
Products 3 plus 4	46.61	23.8	215.	1.33	8.00	9.97	32.6	10.6	69.5	79.2	81.4	89.5	94.2	70.6	88.0	86.7
Products 3 to 5	54.16	21.6	187.	1.15	6.99	8.60	29.8	9.73	73.1	80.1	82.2	90.9	94.5	74.9	93.3	92.1

* Sulphide S

Additional Assay: Bulk Rougher Tailing: 73.5% BaSO₄ (10.1% S)
Therefore, 0.9% sulphide S in the rougher tailing

Test No. 9

Purpose: To investigate the effect of a higher SO₂ addition and replacing 3477 with R208 and A325 during copper flotation.

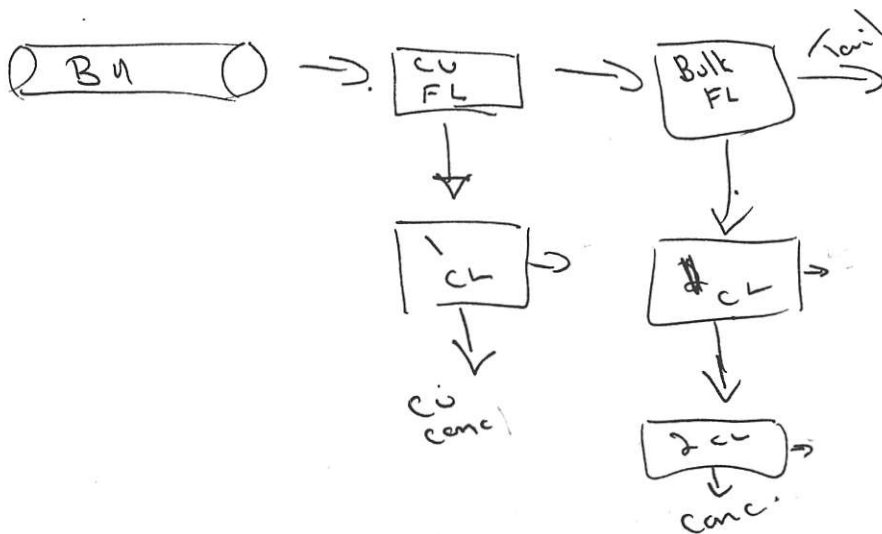
Procedure: As outlined below.

Feed: 1000 grams minus 10 mesh Composite.

Grind: 15 minutes in the lab ball mill at 60% solids.

Conditions:

Stage	Reagents Added, grams/tonne							Time, minutes			pH
	ZnSO ₄ NaCN	SO ₂	H-31	R208	A325	A350	MIBC	Grind	Cond.	Froth	
Grind	1000	-	-	-	-	-	-	15	-	-	-
Condition	-	3750	250	-	-	-	-	-	15	-	4.5
Cu Rougher	-	-	-	10	5	-	10	-	1	2	-
	-	-	-	10	5	-	-	-	1	3	-
	-	-	-	10	5	-	-	-	1	3	-
	-	-	-	10	2.5	-	-	-	1	4	-
	-	-	-	10	2.5	-	-	-	1	3	-
Cu 1st Cleaner	-	75	-	-	-	-	-	-	1	3	4.3
	-	-	-	5	-	-	-	-	1	3	-
Bulk Rougher	Na ₂ CO ₃	CuSO ₄									
	8000	1500	-	-	-	-	-	-	3	-	8.1
	-	-	-	-	-	50	10	-	1	2	-
	-	-	-	-	-	50	10	-	1	2	-
	-	-	-	-	-	50	10	-	1	5	-
	-	-	-	-	-	50	10	-	1	5	-
Bulk 1st Cleaner	-	-	-	-	-	30	10	-	1	5	-
	-	-	-	-	-	-	-	-	1	1	8.0
	-	-	-	-	-	10	10	-	1	3	-
Bulk 2nd Cleaner	-	-	-	-	-	20	10	-	1	5	-
	-	-	-	-	-	-	-	-	1	2	-
	-	-	-	-	-	10	10	-	1	4	-
	-	-	-	-	-	10	10	-	1	2	-



Test No. 9 - Continued

Metallurgical Results

Product	Weight %	Assays, %, g/tonne							% Distribution							
		Au	Ag	Cu	Pb	Zn	S	As	Au	Ag	Cu	Pb	Zn	S	S*	As
1. Cu Cleaner Concentrate	6.60	69.2	1125.	7.31	29.5	7.80	27.7	7.16	27.3	57.1	62.3	46.4	10.2	8.4	10.3	8.2
2. Cu Cleaner Tailing	3.32	23.1	241.	1.08	11.7	8.49	24.6	7.19	4.6	6.2	4.7	9.3	5.6	3.8	4.6	4.1
3. Bulk Cleaner Conc.	41.46	26.4	104.	0.57	4.10	10.1	33.8	11.7	65.4	33.2	30.5	40.6	83.0	64.6	79.2	84.0
4. Bulk 2nd Cl. Tailing	2.99	5.90	31.3	0.21	1.45	0.47	13.8	3.05	1.0	0.7	0.8	1.0	0.3	1.9	2.3	1.6
5. Bulk 1st Cl. Tailing	5.57	2.62	18.2	0.13	0.89	0.26	10.4	1.36	0.9	0.8	0.9	1.2	0.3	2.7	3.3	1.3
6. Bulk Rougher Tailing	40.06	0.35	6.5	0.016	0.16	0.084	10.1	0.12	0.8	2.0	0.8	1.5	0.6	18.6	0.3	0.8
Head (calculated)	100.00	16.7	130.	0.77	4.19	5.05	21.7	5.78	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Calculated Grades and Recoveries

Products 1 plus 2	9.92	53.8	829.	5.23	23.5	8.03	26.7	7.17	31.9	63.3	67.0	55.7	15.8	12.2	14.9	12.3
Products 3 plus 4	44.45	25.0	99.1	0.55	3.92	9.45	32.5	11.1	66.4	33.9	31.3	41.6	83.3	66.5	81.5	85.6
Products 3 to 5	50.02	22.5	90.1	0.50	3.58	8.43	30.0	10.0	67.3	34.7	32.2	42.8	83.6	69.2	84.8	86.9

* Sulphide S

Additional Assay: Rougher Tailing = 73.2 % BaSO₄ (10.0 % S)
Therefore, 0.1% sulphide S in the rougher tailing.

I N T R O D U C T I O N

Three samples were received in the Mineralogy laboratory from Corporation Falconbridge Copper for mineralogical examination. The samples were identified as

- (1) A composite Head Sample
- (2) Test No. 4 Cu-Pb Cleaner Concentrate
- (3) Test No. 4 Zinc Cleaner Concentrate

The purpose of the examination was to determine causes for poor concentrate grades.

Another four samples were received at a later date to determine the relative amounts of arsenopyrite and tennantite and chalcopyrite and tennantite. These samples were

- (1) Test No. 7 2nd Cleaner Concentrate
- (2) Test No. 7 2nd Cleaner Tailing
- (3) Test No. 7 1st Cleaner Tailing
- (4) Test No. 7 Rougher Tailing

A. Head Sample and Test No.4 Concentrates

S U M M A R Y

The Cu-Pb cleaner concentrate was contaminated by

(1) Arsenopyrite, 44 percent of which was liberated and 42 percent associated with galena.

(2) Pyrite, 39 percent of which was liberated, but with inclusions of other sulphides in some grains, and 53 percent associated with galena as intergrowths and inclusions.

(3) Sphalerite, of which 43 percent was liberated and 35 percent associated with galena, and

(4) Tennantite, of which 73 percent by weight was present as liberated/ discrete particles.

The zinc cleaner concentrate was contaminated by

(1) Arsenopyrite, 30 percent of which was liberated, 14 percent was associated with galena and the remainder with sphalerite.

(2) Pyrite, 50 percent of which was associated with galena and 35 percent with sphalerite.

Tennantite represented 12 percent of the Cu-Pb cleaner concentrate and would contribute an appreciable amount of copper to this product.

PREPARATION AND PROCEDURE

A portion of each sample was briquetted and polished for microscopic examination in reflected light. Point counts were made on each briquette, the counts on the two concentrates being made at a magnification of 750X using an oil-immersion objective. As a result, the non-opaque minerals present did not show (were not readily visible) and were not included in the point counting. The point count made on the composite head sample was run at a magnification of 200X and the non-opaques were included in the count.

RESULTS

The grain sizes range from approximately 200 micrometres (for pyrite) to smaller than 10 micrometres. Fine-grained, complex intergrowths between pyrite and the other sulphides, particularly with galena plus the abundant fine-grained inclusions of galena, sphalerite and chalcopyrite in pyrite together with the presence of both arsenopyrite and tennantite bode ill for the production of concentrates acceptable to most smelters. The possible saving grace is the presence of silver - probably in tennantite. Gold also was present and was identified in the head sample as an inclusion in pyrite and in the Cu-Pb cleaner concentrate as a fracture-filling in arsenopyrite (Figure No. 1).

The accompanying tables show the weight percent distribution by association of each mineral in each sample and the weight percent distribution by association for individual species in each sample.

Results - Continued

Table No. 1 - Weight Percent Distribution by Association of Minerals
in the Head Sample

Association	Weight Percent of Sample	Individual Species Weight, %
Arsenopyrite - Liberated	1.8	
" + Chalcopyrite	2.0	
" + Gangue	2.9	
" + Galena	2.9	
" + Pyrite	0.8	
" + Sphalerite	17.0	
" + Tennantite	0.2	<u>27.6</u>
Chalcopyrite - Liberated	0.2	
" + Arsenopyrite	0.5	
" + Sphalerite	0.2	
" + Tennantite	0.1	<u>1.0</u>
Gangue - All Associations	37.1	<u>37.1</u>
Galena - Liberated	0.4	
" + Arsenopyrite	1.1	
" + Pyrite	3.4	
" + Sphalerite	0.2	
" + Tennantite	0.4	<u>5.5</u>
Pyrite - Liberated	2.3	
" + Arsenopyrite	2.9	
" + Gangue	3.8	
" + Galena	2.3	
" + Sphalerite	5.6	
" + Tennantite	0.1	<u>17.0</u>
Sphalerite - Liberated	0.4	
" + Arsenopyrite	6.1	
" + Chalcopyrite	0.1	
" + Gangue	0.6	
" + Galena	0.5	
" + Pyrite	2.8	<u>10.5</u>
Tennantite - Liberated	0.2	
" + Arsenopyrite	0.1	
" + Chalcopyrite	0.1	
" + Gangue	0.2	
" + Sphalerite	0.7	1.3
Total	100.0	100.0

Results - Continued

Table No. 2 - Weight Percent Distribution by Association of Minerals
in Concentrates

Association	Weight Percent of Sample			
	Cu-Pb Cl. Conc.		Zn Cl. Conc.	
	of Sample	of Species	of Sample	of Species
Arsenopyrite - Liberated	5.3		6.3	
" + Chalcopyrite	0.2			
" + Galena	5.1		3.0	
" + Sphalerite	1.0		11.4	
" + Tennantite	0.4	12.0	-	20.7
Chalcopyrite - Liberated	3.8			
" + Arsenopyrite	0.2		0.7	
" + Galena	0.2		-	
" + Pyrite	1.0		0.2	
" + Sphalerite	0.5		0.5	
" + Tennantite	-	5.7	0.2	1.6
Galena - Liberated	27.3			
" + Arsenopyrite	0.5			
" + Chalcopyrite	1.0			
" + Pyrite	4.5			
" + Sphalerite	3.3	36.6		
Pyrite - Liberated	7.1		1.9	
" + Arsenopyrite	-		0.2	
" + Chalcopyrite	0.4		-	
" + Galena	9.5		6.5	
" + Sphalerite	0.8	-	4.6	
" + Tennantite	0.2	18.0	-	13.2
Sphalerite - Liberated	6.6		47.3	
" + Arsenopyrite	1.2		6.5	
" + Chalcopyrite	1.9		0.2	
" + Galena	5.5		3.7	
" + Pyrite	0.3	15.5	4.1	61.8
Tennantite - Liberated	8.9		1.1	
" + Arsenopyrite	0.4			
" + Chalcopyrite	2.2		1.1	
" + Pyrite	0.3		-	
" + Sphalerite	0.4	12.2	0.5	2.7
Total	100.0	100.0	100.0	100.0

Results - Continued

Weight Percent Distribution by Mineral Association for Individual Species in each Sample

Table No. 3 - Arsenopyrite

Mineral Association	Weight Percent Distribution Mineral Species in Sample		
	Head	Cu-Pb Cl. Conc.	Zn Cl. Conc.
Arsenopyrite - Liberated	6.6	44.2	30.4
" + Chalcopyrite	7.3	1.7	-
" + Gangue	10.5	N.C.	N.C.
" + Galena	10.5	42.5	14.5
" + Pyrite	2.7	-	-
" + Sphalerite	61.8	8.3	55.1
" + Tennantite	0.6	3.3	-
Total	100.0	100.0	100.0

Table No. 4 - Chalcopyrite

Mineral Association	Weight Percent Distribution Mineral Species in Sample		
	Head	Cu-Pb Cl. Conc.	Zn Cl. Conc.
Chalcopyrite - Liberated	18.8	66.7	-
" + Arsenopyrite	50.0	3.5	43.8
" + Galena	-	3.5	-
" + Pyrite	-	17.5	12.5
" + Sphalerite	18.8	8.8	31.3
" + Tennantite	12.4	-	12.4
Total	100.0	100.0	100.0

Results - Continued

Weight Percent Distribution by Mineral Association for Individual Species in each Sample

Table No. 5 - Galena

Mineral Association	Weight Percent Distribution Mineral Species in Sample		
	Head	Cu-Pb Cl. Conc.	Zn Cl. Conc.
Galena - Liberated	6.9	74.6	-
" + Arsenopyrite	20.7	1.4	-
" + Chalcopyrite	-	2.7	-
" + Pyrite	62.1	12.3	-
" + Sphalerite	3.4	9.0	-
" + Tennantite	6.9	-	-
Total	100.0	100.0	100.0

Table No. 6 - Pyrite

Mineral Association	Weight Percent Distribution Mineral Species in Sample		
	Head	Cu-Pb Cl. Conc.	Zn Cl. Conc.
Pyrite - Liberated	13.4	39.4	14.4
" + Arsenopyrite	17.2	-	1.5
" + Chalcopyrite	-	2.2	-
" + Gangue	22.4	N.C.	N.C.
" + Galena	13.4	52.8	49.2
" + Sphalerite	32.8	4.4	34.9
" + Tennantite	0.8	1.2	-
Total	100.0	100.0	100.0

Table No. 7 - Sphalerite

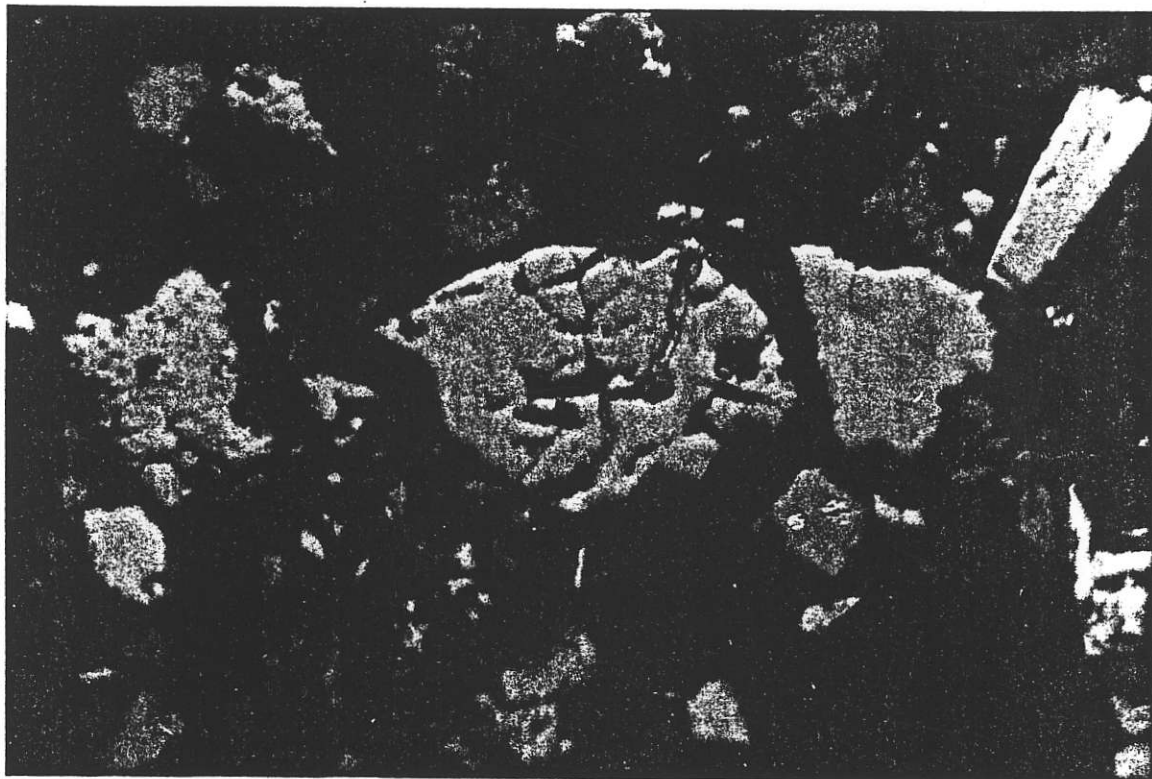
Mineral Association	Weight Percent Distribution Mineral Species in Sample		
	Head	Cu-Pb Cl. Conc.	Zn Cl. Conc.
Sphalerite - Liberated	3.6	42.6	76.0
" + Arsenopyrite	57.5	7.7	10.5
" + Chalcopyrite	1.2	12.3	0.4
" + Gangue	6.0	N.C.	N.C.
" + Galena	4.8	35.5	5.9
" + Pyrite	26.9	1.9	6.6
" + Tennantite	-	-	0.6
Total	100.0	100.0	100.0

Results - Continued

Weight Percent Distribution by Mineral Association for Individual Species in each Sample

Table No. 8 - Tennantite

Mineral Association	Weight Percent Distribution Mineral Species in Sample		
	Head	Cu-Pb Cl. Conc.	Zn Cl. Conc.
Tennantite - Liberated	15.4	73.0	40.7
" + Arsenopyrite	7.7	3.3	-
" + Chalcopyrite	7.7	18.0	40.7
" + Gangue	15.4	-	-
" + Pyrite	-	2.5	-
" + Sphalerite	53.8	3.2	18.6
Total	100.0	100.0	100.0



50 μ m

Figure No. 1: Test No. 4 Cu-Pb Cleaner Concentrate
Gold Fracture-Filling in Arsenopyrite.
Width: 12 μ m

B. Test No. 7 Products

2nd Cleaner Concentrate

The ratio of tennantite to arsenopyrite was approximately 1 : 3.6 and that of tennantite to chalcopyrite approximately 1 : 1. Particles smaller than 5 micrometres were not counted.

1st Cleaner Tailing

The sample contained arsenopyrite and pyrite as readily identifiable phases. The remainder of the sample was too fine-grained for clear distinction between mineral species except for occasional sphalerite, non-opaque, chalcopyrite and tennantite. The ratio of tennantite to arsenopyrite was approximately 1 : 100 and that of tennantite to chalcopyrite could not be determined.

2nd Cleaner Tailing

Similar to the above

Rougher Tailing

This sample had been pulverized and so was too fine-grained for microscopic (normal at 750X) examination.

LAKEFIELD RESEARCH
Lakefield, Ontario
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