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An Investigation of  
**THE RECOVERY OF ZINC AND SILVER**  
from Logan Project Samples  
submitted by  
**STRATHCONA MINERAL SERVICES LTD.**  
Progress Report No.1

Project No. L.R. 3654

NOTE:

This report refers to the samples as received.

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LAKEFIELD RESEARCH  
A DIVISION OF FALCONBRIDGE LIMITED  
March 1st, 1989

## TABLE OF CONTENTS

	<u>Page No.</u>
ABSTRACT.....	3
INTRODUCTION.....	4
SUMMARY.....	5 - 14
1.0 Head Analysis.....	5
2.0 Bond Work Index.....	7
3.0 Effect of Fineness of Grind on Composites A and B.....	7
4.0 Copper Prefloat.....	10
4.1 Copper Prefloat on Overall Composite.....	10
4.2 Effect of Copper Prefloat on Composite B.....	11
5.0 Effect of pH on Zinc Cleaning.....	12
6.0 Additional Analysis.....	12
7.0 Gravity Concentration of Sn from the Flotation Tailing.....	14
SAMPLE PREPARATION.....	15
DETAILS OF TESTWORK.....	16 - 48
APPENDIX 1 - Mineralogy Report.....	49 - 56

## ABSTRACT

Both the low grade, fine grained zinc and the high grade, coarse grained zinc respond similarly to the flotation conditions investigated. The best results on the individual composites were obtained at a primary grind of 74.5% -80.5% minus 150 mesh with a regrind of 80.8% - 82.9% minus 30  $\mu\text{m}$ . Zinc cleaner concentrates of approximately 50% Zn with 98% recovery of zinc and 80% recovery of silver should be obtained under optimized conditions.

Incorporating a copper-prefloat into the flowsheet, a high grade silver concentrate of 1800-2500 g/t Ag containing 40-50% of the silver can be produced without adversely affecting the zinc circuit.

An attempt to recover tin from the flotation tailing which assays 0.042% Sn and represents 85% of the Sn in the sample was unsuccessful.

## INTRODUCTION

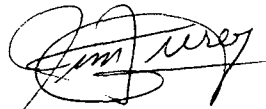
This report contains results of testwork conducted on Composite A and B and an Overall Composite of these submitted by Mr. Ken Rawling of Strathcona Mineral Services Ltd. The testwork investigated flotation at various fineness of grind, flotation with and without the recovery of a separate copper concentrate and the possibility of recovering a tin concentrate from the flotation tailing.

The test details and results were discussed frequently with Mr. Ken Rawling of Strathcona Mineral Services.

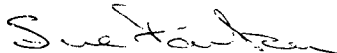
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## S U M M A R Y

### 1.0 Head Analysis

Composites A and B were submitted for head analysis and semi-quantitative analysis. The results are contained in Table No. 1 and Table No. 2.

Table No. 1 - Head Analysis

Assay	Composite A	Compsite B
Zinc, Zn %	3.65	13.3
Lead, Pb %	0.023	0.10
Copper, Cu %	0.050	0.11
Antimony, Sb %	<0.002	0.002
Arsenic, As %	0.052	0.44
Mercury, Hg %	<0.00003	<0.00003
Tin, Sn %	0.023	0.064
Gold, Au g/t	Trace	Trace
Silver, Ag g/t	12.3	60.8

**Table No. 2 - XRF Semi-Quantitative Analysis**

	<u>Comp. "A"</u>	<u>Comp. "B"</u>
Titanium	ND	ND
Chromium	ND	ND
Manganese	L	LM
Iron	LM	LM
Cobalt	ND	ND
Nickel	ND	ND
Copper	T	T
Zinc	LM	MH
Arsenic	FT	T
Bismuth	ND	ND
Lead	T	T
Uranium	ND	ND
Thorium	ND	ND
Yttrium	FT	ND
Columbium	ND	ND
Molybdenum	ND	ND
Silver	ND	ND
Cadmium	ND	T
Tin	FT	T
Antimony	ND	ND

Code: H	-	10% plus	L	-	.1 - 1.%
MH	-	5 - 15%	TL	-	.05 - .5%
M	-	1 - 10%	T	-	.01 - .1%
LM	-	.5 - 5%	FT	-	Less than .01%
			ND	-	Not Detected

Mineralogical examination of Composite A and B identified the silver minerals as metallic silver, proustite and pearceite. The metallic silver was identified only in galena and Pb-sulfosalts. The complete mineralogical report is contained in Appendix No.1 of this report.

## **2.0 Bond Work Index**

Bond Ball mill closed circuit grindability tests were conducted on Composites A and B. The work indices are 15.6 and 11.6 respectively.

## **3.0 Effect of Fineness of Grind on Composite A and B**

Flotation was investigated at two fineness of primary grind, with and without regrinding the rougher concentrate prior to cleaning. The results are summarized in Table No. 3.

**Table No. 3 - Effect of Fineness of Grind**

Test No.	Comp	Grind		Sec. % -30µm	Product	Wgt %	Assays % g/t			% Distribution		
		Primary % -150 mesh	% -270 µm				Zn	S	Ag	Zn	S	Ag
1	A	74.5	45.8	-	Zn Cleaner Conc.	4.9	53.9	34.0	79.3	72.6	51.0	29.7
					Zn Rougher Conc.	11.9	29.6	26.0	90.4	97.7	95.4	83.0
					Zn Rougher Tail	88.1	0.096	0.17	2.50	2.3	4.6	17.0
					Head (Calc)	100.0	3.60	3.24	12.9	100.0	100.0	100.0
3	A	74.5	45.8	80.8	Zn Cleaner Conc.	7.3	48.6	32.9	15.9	98.3	78.5	81.6
					Zn Rougher Conc.	14.6	24.6	20.4	87.3	99.1	96.9	89.2
					Zn Rougher Tail	85.4	0.037	0.11	1.80	0.9	3.1	10.8
					Head (Calc)	100.0	3.62	3.07	14.3	100.0	100.0	100.0
5	A	36.1	29.1	N.A.*	Zn Cleaner Conc.	6.7	51.1	36.4	135	92.7	74.0	72.1
					Zn Rougher Conc.	14.3	24.3	21.6	71.7	93.7	93.5	81.5
					Zn Rougher Tail	85.7	0.27	0.25	2.70	6.3	6.5	18.5
					Head (Calc)	100.0	3.69	3.29	12.5	100.0	100.0	100.0
2	B	80.5	52.7	-	Zn Cleaner Conc.	25.1	51.2	32.7	130	90.6	74.5	57.8
					Zn Rougher Conc.	39.7	35.5	27.5	134	99.4	99.0	94.3
					Zn Rougher Tail	60.3	0.15	0.18	5.30	0.6	1.0	5.7
					Head (Calc)	100.0	14.2	11.0	56.4	100.0	100.0	100.0
4	B	80.5	52.7	82.9	Zn Cleaner Conc.	27.5	50.5	33.4	190	98.5	82.5	83.1
					Zn Rougher Conc.	41.3	33.9	26.8	133	99.3	99.1	87.6
					Zn Rougher Tail	58.7	0.18	0.17	13.3	0.7	0.9	12.4
					Head (Calc)	100.0	14.1	11.1	62.9	100.0	100.0	100.0
6	B	27.1	16.9	N.A.*	Zn Cleaner Conc.	23.0	47.6	35.3	220	78.9	71.7	82.6
					Zn Rougher Conc.	35.4	31.1	26.1	149	79.3	81.5	85.8
					Zn Rougher Tail	64.6	4.45	3.24	13.5	20.7	18.5	14.2
					Head (Calc)	100.0	13.9	11.3	61.4	100.0	100.0	100.0

\* Not available

Figure No. 1 illustrates the effect of grind fineness on zinc grade and recovery. Figure No. 2 illustrates the relationship between zinc grade and silver recovery. The best results were obtained using the finer primary grind with a regrind prior to cleaning.

Fig. No. 1: Effect of Grinding Fineness on Zinc Grades and Recoveries

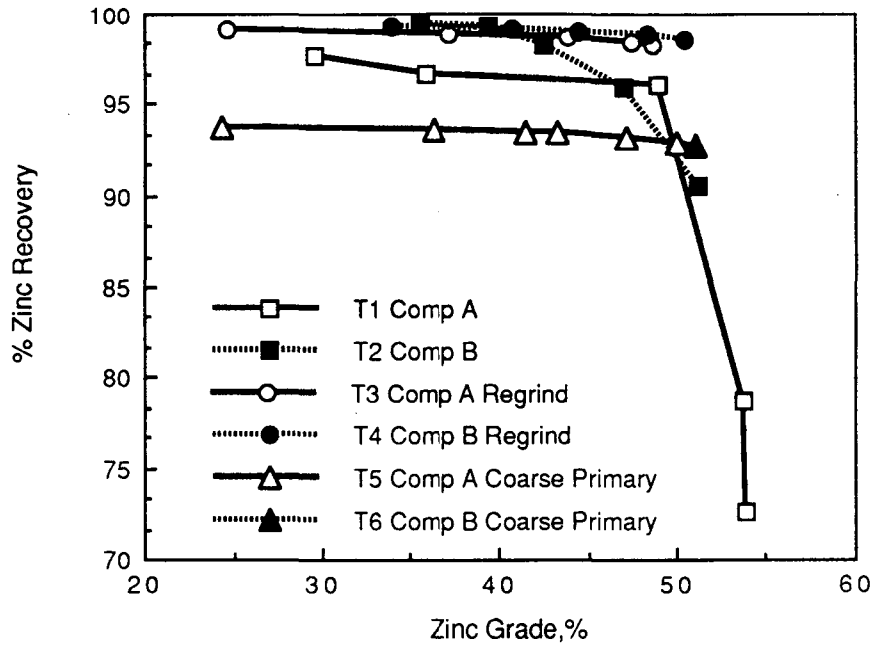
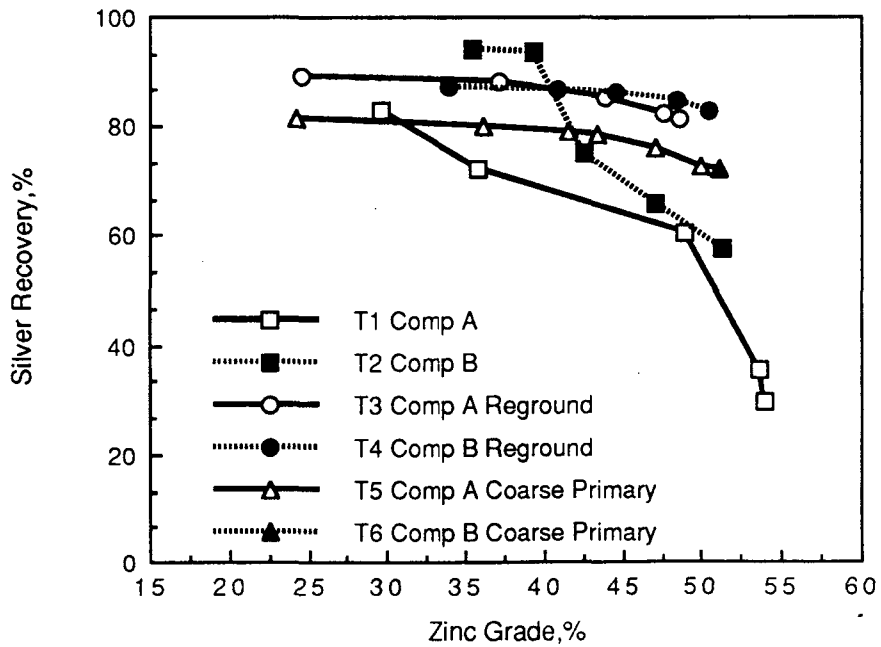


Fig. No. 2: Relationship between Zinc Grade and Silver Recovery



The coarser primary grind was unfortunately well below the target of 80% minus 65 mesh as Composite A was 56.7% minus 65 mesh and Composite B was 47.6% minus 65 mesh.

#### 4.0 Copper Prefloat

##### 4.1 Copper Prefloat on Overall Composite

The overall composite was ground to 93.9% minus 65 mesh and a copper prefloat concentrate removed using Minerac 2030 as collector at pH 11 (Test 7) and at pH 8.5 (Test 11). The zinc circuit was then conducted similar to Test No. 3.

**Table No. 4 - Copper Prefloat from Overall Composite**

Test No.	Comp	Grind % -65 mesh	Product	Wt %	Assays %, g/t				% Distribution			
					Zn	Cu	S	Ag	Zn	Cu	S	Ag
7	O.C.	93.9	Prefloat Conc.	2.0	16.8	1.42	32.8	653	4.4	32.9	10.9	40.6
			Zn Cleaner Conc.	12.8	54.3	0.37	31.8	90.2	93.0	55.4	68.3	36.2
			Zn Rougher Conc.	23.3	30.4	0.25	22.4	69.5	94.8	67.1	87.6	50.7
			Zn Rougher Tail	74.7	0.076	0.008	0.12	3.7	0.8	0.01	1.5	8.7
			Head (Calc)	100.0	7.47	0.085	5.96	31.8	100.0	100.0	100.0	100.0
11	O.C.	-	Prefloat Cl. Conc.	0.7	18.6	4.11	40.9	1892	1.7	33.8	4.3	40.1
			Pref. Ro. Conc.	3.5	16.0	0.92	26.0	567	7.7	40.5	14.6	64.1
			Zn Cl. Conc.	12.5	54.0	0.34	34.9	64.3	90.5	51.7	67.8	25.2
			Zn Rougher Conc.	20.1	34.1	0.24	26.7	51.6	91.5	59.5	83.0	32.3
			Zn Rougher Tail	76.3	0.07	0.008	0.21	1.5	0.7	0.01	2.5	3.6
Head (Calc)	100.0	7.48	0.083	6.45	31.0	100.0	100.0	100.0	100.0			

The silver recovery to the copper rougher prefloat concentrate was improved by flotation at the natural pH of 8.5.

#### 4.2 Effect of Prefloat of Composite B

Testwork was conducted on Composite B with and without a copper prefloat. The conditions of the prefloat were modified by the addition of ZnSO<sub>4</sub> to attempt to depress the zinc in the prefloat concentrate. The prefloat rougher concentrate generally assays 17-20% Zn representing 5-8% Zn recovery. The zinc sulfate did not appear to effect flotation of the prefloat concentrate. The results are summarized in Table No. 5.

**Table No. 5 - Effect of Copper Prefloat on Composite B**

Test No.	Product	Weight %	Assays, % g/t				% Distribution			
			Zn	Cu	S	Ag	Zn	Cu	S	Ag
13	Zn Cleaner Conc.	23.0	53.4	0.42	34.7	160	88.7	86.2	70.7	58.5
	Zn Rougher Conc.	34.5	37.4	0.33	30.6	159	93.0	99.9	93.2	87.5
	Zn Rougher Tail	65.5	1.49	0.009	1.17	12.0	7.0	0.1	6.8	12.5
	Head (Calc)	100.0	13.9	0.11	11.3	62.8	100.0	100.0	100.0	100.0
14	Pref. Cl. Conc.	1.4	14.6	2.58	40.1	2545	1.5	31.1	4.9	49.8
	Pref. Ro. Conc.	3.0	19.6	1.39	32.4	1340	4.2	35.6	8.5	55.7
	Zn Cleaner Conc.	23.6	52.5	0.29	34.0	111	90.3	59.6	71.1	36.9
	Zn Rougher Conc.	32.3	38.7	0.23	30.2	88.4	91.0	64.3	86.4	40.2
	Zn Rougher Tail	64.7	1.02	0.005	0.90	4.5	4.8	0.04	5.1	4.1
	Head (Calc)	100.0	13.8	0.12	11.3	71.1	100.0	100.0	100.0	100.0

Overall the zinc grade and recovery is not affected by the copper prefloat. Silver which was lost to the zinc rougher tailing appears to float with the prefloat concentrate as well as silver which previously floated in the zinc circuit. Approximately 50% of the silver may be recovered in the prefloat concentrate assaying 2545 g/t Ag.

The copper assay in the zinc cleaner concentrate was reduced to 0.29% Cu from 0.42% copper.

### 5.0 Effect of pH on Zinc Cleaning

Three tests were conducted with copper prefloats at pH 11, zinc rougher flotation at pH 10.5 followed by 4 stages of zinc cleaning at pH 11.0, 11.5 and 12.0. The results are summarized in Table No. 5.

**Table No. 6 - Effect of pH on Zinc Cleaning**

Test No.	pH in Zn Cl.	Product	Wgt %	Assays %, g/t				% Distribution			
				Zn	Cu	S	Ag	Zn	Cu	S	Ag
8	11.0	Prefloat Concentrate	1.6	19.8	2.16	29.6	1360	4.4	42.6	7.7	39.5
		Zn Cleaner Concentrate	13.1	53.2	0.30	33.6	124	93.6	47.1	69.5	28.7
		Zn Rougher Concentrate	20.9	33.8	0.23	27.2	151	94.8	57.4	89.9	55.5
		Zn Rougher Tail	77.5	0.076	0.011	0.20	3.6	0.08	0.01	2.4	4.9
		Head (Calc)	100.0	7.43	0.083	6.33	56.6	100.0	100.0	100.0	100.0
9	11.5	Prefloat Concentrate	2.0	21.7	1.99	23.4	782	5.8	46.4	7.5	34.9
		Zn Cleaner Conc.	12.3	53.4	0.27	32.8	157	90.1	39.6	66.2	44.2
		Zn Rougher Concentrate	20.2	33.6	0.22	26.7	132	93.0	53.6	88.2	60.7
		Zn Rougher Tail	77.8	0.11	0.013	0.34	2.5	1.2	0.02	4.3	4.4
		Head (Calc)	100.0	7.31	0.084	6.12	43.9	100.0	100.0	100.0	100.0
10	12.0	Prefloat Concentrate	2.6	19.4	1.38	35.7	763	6.8	41.6	14.6	52.5
		Zn Cleaner Conc.	13.0	52.8	0.33	34.0	102	91.7	49.0	68.8	34.6
		Zn Rougher Concentrate	20.4	33.8	0.25	26.3	81.0	92.5	58.4	83.7	43.1
		Zn Rougher Tail	76.9	0.064	0.008	0.14	2.2	0.7	0.01	1.7	4.4
		Head (Calc)	100.0	7.48	0.087	6.42	38.3	100.0	100.0	100.0	100.0

The pH in cleaning had negligible effect on zinc grade and recovery. Silver losses during zinc cleaner appear to decrease as the pH is increased.

### 6.0 Additional Analysis

The zinc cleaner concentrates from Tests 4 and 5 were submitted for impurity analysis. These results are contained in Table No. 7

**Table No. 7 - Concentrate Impurities**

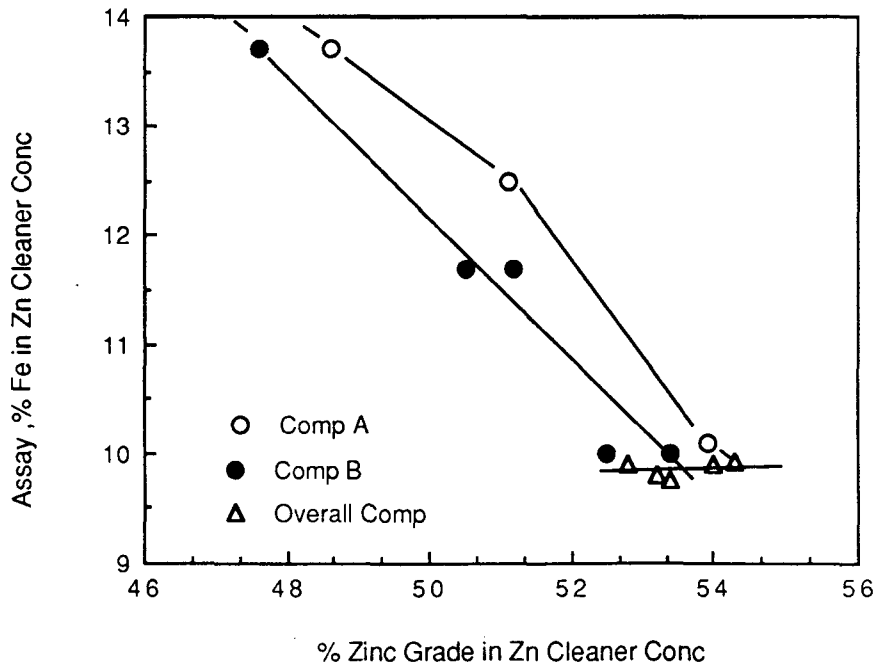
Test No.	Comp.	Assays, %, g/t										
		Zn	Cu	S	Ag	Au	As	Sn	Hg	Cd	Sb	Ge
4	B	50.5	0.46	33.4	190	1.23	0.16	0.013	<0.00003	0.11	0.003	<0.001
5	A	51.1	0.75	36.4	135	1.62	0.17	0.012	0.00006	0.10	0.003	<0.001

Zinc concentrates in all flotation tests were monitored for iron content. These results are contained in Table No. 8. Figure No. 3 illustrates the relationship between zinc grade and iron content.

**Table No. 8 - Iron Analysis of Zinc Concentrates**

Test No.	Comp	Assays, %		Test No.	Comp	Assays %	
		Zn	Fe			Zn	Fe
7	OC	54.3	9.92	2	B	51.2	11.7
8	OC	53.2	9.80	4	B	50.5	11.7
9	OC	53.4	9.76	6	B	47.6	13.7
10	OC	52.8	9.90	13	B	53.4	10.0
11	OC	54.0	9.89	14	B	52.5	10.0
1	A	53.9	10.1				
3	A	48.6	13.7				
5	A	51.1	12.5				

**Figure No.3: Relationship between Zinc Grade and Iron Content of Zn Cleaner Conc**



**7.0 Gravity Concentrate of Sn from the Flotation Tailing**

Initial testwork on Composites A and B, Tests 1 and 2, respectively, show that 89.9% and 82.0% of the Sn remains in the flotation tailing. Flotation tailing from Tests 8, 9 and 10 on the Overall Composite were combined and passed over the Wilfley table. Only 19.6% of the Sn in the flotation tailing was concentrated in the table concentrate. The results are summarized in Table No. 9

**Table No. 9 - Gravity Concentration of Sn**

Test No.	Product	Weight %	Assays, % Sn	% Distribution Sn
12	Table Concentrate	2.96	0.28	19.6
	Table Tail	97.04	0.035	80.4
	Head (Calc)	100.00	0.042	100.0

**SAMPLE PREPARATION**

Two sets of samples, labelled A and B were received at Lakefield on January 2, 1989 and given our reference No. LR 8931110. Each set of samples was composited separately, crushed to minus 10 mesh and samples removed for screen analysis, mineralogy and head analysis. The remainder was prepared as 2 kilogram test charges.

An Overall Composite was prepared on January 25, 1989 by combining 8 kilograms of Composite A and 4.8 kilograms of Composite B.

**DETAILS OF TESTWORK****BOND BALL MILL CLOSED CIRCUIT GRINDABILITY TEST**

Sample: Comp. A

Mesh of Grind: 100 Mesh

Feed: 25.0 % Passing 100 Mesh

Cycle	New Feed g	Number of Revolutions	grams of minus 10 mesh			
			In Mill Product	In Mill Feed	Net Product	Net Per Revolution
1	1233	100	432	308	124	1.24
2	432	197	440	108	332	1.69
3	440	143	358	110	248	1.73
4	358	151	359	90	269	1.78
5	359	147	348	90	258	1.76
6	348	151	355	87	268	1.77

Unit Volume (700 ml) = 1233 g in mill : Equivalent to 1761 kg/m<sup>3</sup> at minus -10 mesh

Ideal potential product = 352 g

Average of last 2 periods: 352 g : 250 % circulating load

1.76 Net g minus 100 mesh per revolution

**Bonds Formula**

$$W_i = \frac{44.5}{S^{0.23} \times N^{0.82} \times \left\{ \frac{10}{\sqrt{P}} - \frac{10}{\sqrt{F}} \right\}}$$

where:	W	=	Work Index (Bond)	=	15.6
	S	=	Screen size, in $\mu\text{m}$	=	147
	N	=	Net grams of undersize produced per revolution of test mill	=	1.76
	P	=	Size in $\mu\text{m}$ , 80% passing in product	=	123
	F	=	Size in $\mu\text{m}$ , 80% passing in feed	=	910

**Screen Analysis - Composite A**

Mesh Size (Tyler)	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 10	1.0	1.0	99.0
14	10.5	11.5	88.5
20	11.5	23.0	77.0
28	14.7	37.7	62.3
35	12.2	49.9	50.1
48	10.9	60.8	39.2
65	8.0	68.8	31.2
100	6.2	75.0	25.0
150	5.3	80.3	19.7
200	4.2	84.5	15.5
270	2.9	87.4	12.6
400	2.4	89.8	10.2
- 400	10.2	100.0	-
Total	100.0	-	-

**Screen Analysis - Composite A Cycles 5, 6**

Mesh Size (Tyler)	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 100	4.2	4.2	95.8
150	26.8	31.0	69.0
200	18.9	49.9	50.1
270	10.9	60.8	39.2
400	8.4	69.2	30.8
- 400	30.8	100.0	-
Total	100.0	-	-

**BOND BALL MILL CLOSED CIRCUIT GRINDABILITY TEST**

Sample: Comp. B

Mesh of Grind: 100 Mesh

Feed: 20.7 % Passing 100 Mesh

Cycle	New Feed g	Number of Revolutions	grams of minus 10 mesh			
			In Mill Product	In Mill Feed	Net Product	Net Per Revolution
1	1393	100	463	288	175	1.75
2	463	173	453	96	357	2.06
3	453	174	459	94	365	2.10
4	459	144	412	95	317	2.20
5	412	142	393	85	308	2.17
6	393	146	401	81	320	2.19

Unit Volume (700 ml) = 1393 g in mill : Equivalent to 1990 kg/m<sup>3</sup> at minus -10 mesh

Ideal potential product = 398 g

Average of last 2 periods: 397 g : 251 % circulating load

2.18 Net g minus 100 mesh per revolution

**Bonds Formula**

$$W_i = \frac{44.5}{S^{0.23} \times N^{0.82} \times \left\{ \frac{10}{\sqrt{P}} - \frac{10}{\sqrt{F}} \right\}}$$

where:

W	=	Work Index (Bond)	=	11.6
S	=	Screen size, in $\mu\text{m}$	=	147
N	=	Net grams of undersize produced per revolution of test mill	=	2.18
P	=	Size in $\mu\text{m}$ , 80% passing in product	=	116
F	=	Size in $\mu\text{m}$ , 80% passing in feed	=	1210

**Screen Analysis - Composite B**

Mesh Size (Tyler)	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 10	2.6	2.6	97.4
14	19.7	22.3	77.7
20	15.0	37.3	62.7
28	14.1	51.4	48.6
35	9.9	61.3	38.7
48	7.1	68.4	31.6
65	5.9	74.3	25.7
100	5.0	79.3	20.7
150	4.5	83.8	16.2
200	3.3	87.1	12.9
270	2.6	89.7	10.3
400	2.0	91.7	8.3
- 400	8.3	100.0	-
Total	100.0	-	-

**Screen Analysis - Composite "B", # 5, 6 Cycle Undersize**

Mesh Size (Tyler)	% Retained		% Passing Cumulative
	Individual	Cumulative	
+ 100	2.1	2.1	97.9
150	25.7	27.8	72.2
200	20.2	48.0	52.0
270	11.5	59.5	40.5
400	8.8	68.3	31.7
- 400	31.7	100.0	-
Total	100.0	-	-

**Test No. 1**

Purpose: To investigate flotation of Zn-Ag from the low grade fine grained sample Composite A

Procedure: As outlined below.

Feed: 2000 grams minus 10 mesh Composite A

Grind: 20 minutes at 65 percent solids in the laboratory ball mill

Conditions:

	Reagents Added, grams per tonne					Time, minutes			pH
	Ca(OH) <sub>2</sub>	CuSO <sub>4</sub>	Hoechst PAX	M2030	MIBC	Grind	Cond.	Froth	
Grind	-	-	-	-	-	20	-	-	-
Condition 1	500	-	-	-	-	-	5	-	11.3
Condition 2	-	400	-	10	-	-	5	-	10.5
Zn Rougher	-	-	-	-	-	-	-	2	-
Scavenger	-	-	5	10	10	-	1	4	-
Zn 1st Cl.	200	-	10	-	10	-	1	3	-
	-	-	-	5	5	-	2	2	11.7
Zn 2nd Cl.	900	-	-	-	-	-	1	2	-
	-	-	-	5	-	-	2	2	>12
Zn 3rd Cl.	500	-	-	5	-	-	1	3	-
	-	-	-	5	-	-	1	2	>12
	-	-	-	-	5	-	1	2	-

## Test 1

Product	Weight		Assays,%gt					% Distribution				
	g	%	Zn	Sn	S	Au	Ag	Zn	Sn	S	Au	Ag
1 Cleaner Conc	95.7	4.9	53.9	0.013	34.0	0.13	79.3	72.6	2.7	51.0	7.6	29.7
2 3rd Cl Tail	8.7	0.4	50.9	0.023	31.2	0.43	165	6.2	0.4	4.3	2.3	5.6
3 2nd Cl Tail	35.1	1.8	34.9	0.023	32.4	0.20	186	17.2	1.7	17.8	4.3	25.6
4 1st Cl Tail	52.8	2.7	0.96	0.025	12.2	0.22	54.4	0.7	2.8	10.1	7.1	11.2
5 Scav Conc.	42.0	2.1	1.54	0.027	18.6	0.19	65.7	0.9	2.4	12.2	4.9	10.8
6 Scav. Tail	1738.8	88.1	0.096	0.024	0.17	0.070	2.50	2.3	89.9	4.6	74.0	17.0
Head(calc)	1973.1	100.0	3.60	0.024	3.24	0.083	12.9	100.0	100.0	100.0	100.0	100.0
Combined Products												
1 + 2		5.3	53.7	0.014	33.8	0.16	86.4	78.8	3.1	55.2	9.8	35.3
1 to 3		7.1	48.9	0.016	33.4	0.17	111	96.0	4.8	73.0	14.1	60.9
1 to 4		9.7	35.8	0.019	27.6	0.18	95.8	96.7	7.7	83.1	21.2	72.2
1 to 5		11.9	29.6	0.020	26.0	0.18	90.4	97.7	10.1	95.4	26.0	83.0

## Screen Analysis

Mesh Size (Tyler)	% Retained		% Pass
	Ind	Cum	Cum
65	3.5	3.5	96.5
100	8.0	11.5	88.5
150	14.0	25.5	74.5
200	17.1	42.6	57.4
270	11.6	54.2	45.8
400	9.5	63.7	36.3
-400	36.3	100.0	-
Total	100.0	-	-

**Test No. 2**

Purpose: To investigate flotation of Zn-Ag from the high grade coarse grained Sample B

Procedure: As outlined below.

Feed: 2000 grams minus 10 mesh Composite B

Grind: 20 minutes at 65 percent solids in the laboratory ball mill

Conditions:

	Reagents Added, grams per tonne					Time, minutes			pH
	Ca(OH) <sub>2</sub>	CuSO <sub>4</sub>	M2030	Hoechst PAX	MIBC	Grind	Cond.	Froth	
Grind	-	-	-	-	-	20	-	-	-
Condition 1	1000	-	-	-	-	-	5	-	11.5
Condition 2	-	600	20	-	-	-	5	-	-
Zn Rougher	-	-	-	-	-	-	1	3	-
	-	-	10	10	-	-	1	4	-
	-	-	5	10	-	-	1	4	-
	-	-	-	20	10	-	1	4	-
Zn 1st Cl.	500	-	-	-	-	-	2	4	11.5
	-	-	-	5	5	-	1	2	-
Zn 2nd Cl.	300	-	-	-	-	-	2	4	>12
	-	-	2.5	-	-	-	1	2	-
	-	-	2.5	-	-	-	1	2	-
Zn 3rd Cl.	500	-	-	-	-	-	2	6	>12
Zn 4th Cl.	500	-	-	-	-	-	2	5	>12

## Test 2

Product	Weight		Assays,%gt					% Distribution				
	g	%	Zn	Sn	S	Au	Ag	Zn	Sn	S	Au	Ag
1 Cleaner Conc	497.0	25.1	51.2	0.012	32.7	0.11	130	90.6	4.4	74.5	26.9	57.8
2 4th Cl Tail	76.3	3.9	19.5	0.026	32.1	0.11	122	5.3	1.5	11.2	4.1	8.3
3 3rd Cl Tail	74.8	3.8	8.33	0.042	28.1	0.22	138	2.2	2.3	9.6	8.1	9.2
4 2nd Cl Tail	59.3	3.0	4.81	0.092	11.7	0.07	345	1.0	4.0	3.2	2.0	18.3
5 1st Cl Tail	78.9	4.0	0.64	0.099	1.17	0.15	9.90	0.2	5.8	0.4	5.8	0.7
6 Rougher Tail Head(calc)	1195.3 1981.6	60.3 100.0	0.15 14.17	0.093 0.068	0.18 11.0	0.09 0.10	5.30 56.4	0.6 100.0	82.0 100.0	1.0 100.0	53.0 100.0	5.7 100.0
Combined Products												
1 + 2		28.9	47.0	0.014	32.6	0.11	129	95.9	5.9	85.8	31.1	66.1
1 to 3		32.7	42.5	0.017	32.1	0.12	130	98.2	8.2	95.4	39.2	75.3
1 to 4		35.7	39.4	0.023	30.4	0.12	148	99.2	12.2	98.6	41.2	93.6
1 to 5		39.7	35.5	0.031	27.5	0.12	134	99.4	18.0	99.0	47.0	94.3

## Screen Analysis

Mesh Size (Tyler)	% Retained		% Pass
	Ind	Cum	Cum
65	1.7	1.7	98.3
100	5.3	7.0	93.0
150	12.5	19.5	80.5
200	14.6	34.1	65.9
270	13.2	47.3	52.7
400	10.8	58.1	41.9
-400	41.9	100.0	-
Total	100.0	-	-

**Test No. 3**

Purpose: To investigate the effect of regrinding on Ag recovery in the cleaner circuit.

Procedure: As outlined below.

Feed: 2000 grams minus 10 mesh Composite A

Grind: 20 minutes at 65 percent solids in the laboratory ball mill

Conditions:

Stage	Reagents Added, grams per tonne						Time, minutes			pH
	Ca(OH) <sub>2</sub>	CuSO <sub>4</sub>	M2030	Hoechst	MIBC	DF	Grind	Cond.	Froth	
Grind	-	-	-	-	-	-	20	-	-	-
Condition 1	500	-	-	-	-	-	-	5	-	11.0
Condition 2	-	-	10	5	10	-	-	5	-	10.5
Zn Rougher	-	-	10	5	10	-	-	1	4	-
Zn Re grind (PM)	200	200	-	-	-	-	10	-	-	-
Zn 1st Cleaner	-	-	2.5	2.5	-	-	-	1	3	10.4
	-	-	2.5	2.5	10	2.5	-	1	3	-
Zn 2nd Cleaner	125	100	-	-	-	-	-	2	2	10.5
	-	-	-	-	-	2.5	-	1	4	-
	-	-	2.5	-	-	-	-	1	2	-
Zn 3rd Cleaner	75	50	-	-	-	-	-	2	2	10.5
	-	-	2.5	-	2.5	-	-	1	3	-
Zn 4th Cleaner	75	-	-	-	-	5	-	1	5	11.0

## Test 3

Product	Weight		Assays,%g/t			% Distribution		
	g	%	Zn	S	Ag	Zn	S	Ag
1 Cleaner Conc	145.8	7.3	48.6	32.9	159	98.3	78.5	81.6
2 4th CI Tail	3.6	0.2	3.03	37.8	82.6	0.2	2.2	1.0
3 3rd CI Tail	12.9	0.6	1.67	31.8	65.8	0.3	6.7	3.0
4 2nd CI Tail	29.3	1.5	0.43	15.3	24.6	0.2	7.3	2.5
5 1st CI Tail	99.1	5.0	0.15	1.36	3.10	0.2	2.2	1.1
6 Rougher Tail	1700.0	85.4	0.037	0.11	1.80	0.9	3.1	10.8
Head(calc)	1990.7	100.0	3.62	3.07	14.3	100.0	100.0	100.0

## Combined Products

1 + 2	7.5	47.5	33.0	157	98.4	80.7	82.6
1 to 3	8.2	43.9	32.9	150	98.7	87.4	85.6
1 to 4	9.6	37.2	30.2	131	98.9	94.7	88.2
1 to 5	14.6	24.6	20.4	87.3	99.1	96.9	89.2

## Screen Analysis

## Primary Grind

## Regrind

Mesh Size (Tyler)	% Retained			% Pass	Part. Size	% Retained			% Pass
	Ind	Cum	Cum	Ind		Cum	Cum		
65	3.5	3.5	96.5	150m	1.0	1.0	99.0		
100	8.0	11.5	88.5	200	3.2	4.2	95.8		
150	14.0	25.5	74.5	270	6.5	10.7	89.3		
200	17.1	42.6	57.4	32.3µm	8.5	19.2	80.8		
270	11.6	54.2	45.8	25.0	9.0	28.2	71.8		
400	9.5	63.7	36.3	17.4	15.9	44.1	55.9		
-400	36.3	100.0	-	12.0	12.6	56.7	43.3		
Total	100.0	-	-	9.3	7.6	64.3	35.7		
				-9.3	35.7	100.0	-		
				Total	100.0	-	-		

**Test No. 4**

Purpose: To investigate the effect of regrinding on Ag recovery in the cleaner circuit

Procedure: As outlined below.

Feed: 2000 grams minus 10 mesh Composite B

Grind: 20 minutes at 65 percent solids in the laboratory ball mill

Conditions:

	Reagents Added, grams per tonne					Time, minutes			pH
	Ca(OH) <sub>2</sub>	CuSO <sub>4</sub>	M2030	Hoechst PAX	MIBC	Grind	Cond.	Froth	
Grind	-	-	-	-	-	20	-	-	-
Condition	1000	-	-	-	-	-	5	-	11.5
Zn Rougher	-	600	20	-	-	-	5	-	11.0
	-	-	-	-	-	-	-	4	-
	-	-	10	10	5	-	1	4	-
	-	-	5	5	-	-	1	4	-
Zn Re grind	500	300	-	-	-	30	-	-	-
Zn 1st Cl.	-	-	-	-	-	-	1	4	10.3
	-	-	5	-	-	-	1	4	-
	-	-	2.5	2.5	-	-	1	2	-
Zn 2nd Cl.	-	-	-	-	-	-	1	4	11.0
	-	-	2.5	2.5	-	-	1	3	-
Zn 3rd Cl.	-	-	-	-	5	-	1	4	10.2
	-	-	2.5	-	-	-	1	3	-
Zn 4th Cl.	-	-	-	-	-	-	1	6	10.0

## Test 4

Product	Weight		Assays, %g/t			% Distribution		
	g	%	Zn	S	Ag	Zn	S	Ag
1 Cleaner Conc	547.4	27.5	50.5	33.4	190	98.5	82.5	83.1
2 4th Cl Tail	25.2	1.3	3.46	27.9	80.1	0.3	3.2	1.6
3 3rd Cl Tail	51.5	2.6	1.08	29.6	35.7	0.2	6.9	1.5
4 2nd Cl Tail	58.1	2.9	0.61	9.12	13.3	0.1	2.4	0.6
5 1st Cl Tail	138.8	7.0	0.32	6.64	6.70	0.2	4.2	0.7
6 Rougher Tail	1168.1	58.7	0.18	0.17	13.3	0.7	0.9	12.4
Head(calc)	1989.1	100.0	14.1	11.1	62.9	100.0	100.0	100.0
Combined Products								
1 + 2		28.8	48.4	33.2	185	98.8	85.7	84.8
1 to 3		31.4	44.5	32.9	173	99.0	92.6	86.2
1 to 4		34.3	40.8	30.8	159	99.1	94.9	86.8
1 to 5		41.3	33.9	26.8	133	99.3	99.1	87.6
Additional Assays								
Zn Cl Conc	Cu, %	Au, g/t	As, %	Sn, %	Hg, %	Cd, %	Sb, %	Ge, %
	0.46	1.23	0.16	0.013	<0.00003	0.11	0.003	<0.001
Screen Analysis								
Mesh Size (Tyler)	Primary Grind			Regrind				
	% Retained Ind	% Retained Cum	% Pass Cum	Part. Size	% Retained Ind	% Retained Cum	% Pass Cum	
65	1.7	1.7	98.3	150m	0.4	0.4	99.6	
100	5.3	7.0	93.0	200	2.0	2.4	97.6	
150	12.5	19.5	80.5	270	5.6	8.0	92.0	
200	14.6	34.1	65.9	32.3µm	9.1	17.1	82.9	
270	13.2	47.3	52.7	25.0	9.9	27.0	73.0	
400	10.8	58.1	41.9	17.4	18.4	45.4	54.6	
-400	41.9	100.0	-	12.0	13.7	59.1	40.9	
Total	100.0	-	-	9.3	7.7	66.8	33.2	
				-9.3	33.2	100.0	-	
				Total	100.0	-	-	

**Test No. 5**

Purpose: To investigate flotation of Zn and Ag from Comp. A at a coarser primary grind.

Procedure: As outlined below.

Feed: 2000 grams minus 10 mesh Composite A

Grind: 10 minutes at 65 percent solids in the laboratory rod mill

Conditions:

	Reagents Added, grams per tonne					Time, minutes			pH
	Ca(OH) <sub>2</sub>	CuSO <sub>4</sub>	M2030	PAX	DF 250	Grind	Cond.	Froth	
Grind	-	-	-	-	-	10	-	-	-
Condition	500	-	-	-	-	-	5	-	11.0
Zn Rougher	-	400	10	-	-	-	5	-	10.5
	-	-	10	5	5	-	1	4	-
	-	-	5	5	5	-	1	4	-
	-	-	-	10	-	-	1	4	-
	-	-	-	10	5	-	1	4	-
	-	-	-	10	5	-	1	4	-
Zn Re grind	200	200	-	-	-	15	-	-	-
Zn 1st Cl.	-	-	2.5	2.5	-	-	1	8	10.8
	-	-	2.5	2.5	5	-	1	6	-
Zn 2nd Cl.	125	100	-	-	2.5	-	2	6	10.4
	-	-	5	5	2.5	-	1	4	-
Zn 3rd Cl.	75	50	-	-	-	-	2	4	10.5
	-	-	2.5	2.5	5	-	1	3	-
Zn 4th Cl.	-	-	-	-	-	-	1	7	10.5
Zn 5th Cl.	50	-	-	-	5	-	1	8	10.5
Zn 6th Cl.	-	-	-	-	5	-	1	6	10.0

## Test 5

Product	Weight		Assays, %g/t			% Distribution		
	g	%	Zn	S	Ag	Zn	S	Ag
1 Cleaner Conc	133.4	6.7	51.1	36.4	135	92.7	74.0	72.1
2 6th Cl Tail	3.1	0.2	2.77	45.5	58.1	0.1	2.2	0.7
3 5th Cl Tail	9.0	0.5	3.11	43.7	99.4	0.4	6.0	3.6
4 4th Cl Tail	13.2	0.7	1.08	37.6	45.6	0.2	7.6	2.4
5 3rd Cl Tail	6.9	0.3	0.72	9.58	18.1	0.1	1.0	0.5
6 2nd Cl Tail	24.3	1.2	0.34	2.97	6.50	0.1	1.1	0.6
7 1st Cl Tail	94.3	4.7	0.15	1.15	4.30	0.2	1.7	1.6
8 Rougher Tail	1708.3	85.7	0.27	0.25	2.70	6.3	6.5	18.5
Head(calc)	1992.5	100.0	3.69	3.29	12.5	100.0	100.0	100.0
Combined Products								
1 + 2		6.9	50.0	36.6	133	92.8	76.2	72.8
1 to 3		7.3	47.1	37.0	131	93.2	82.2	76.4
1 to 4		8.0	43.3	37.1	124	93.4	89.7	78.8
1 to 5		8.3	41.5	35.9	120	93.4	90.7	79.3
1 to 6		9.5	36.2	31.7	105	93.5	91.8	79.9
1 to 7		14.3	24.3	21.6	71.7	93.7	93.5	81.5
Additional Assays								
Zn Cl Conc	Cu, %	Au, g/t	As, %	Sn, %	Hg, %	Cd, %	Sb, %	Ge, %
	0.75	1.62	0.17	0.012	0.00006	0.10	0.003	<0.001

## Screen Analysis Primary Grind

Mesh Size (Tyler)	% Retained		% Pass
	Ind	Cum	Cum
28	0.6	0.6	99.4
35	10.2	10.8	89.2
48	20.2	31.0	69.0
65	12.3	43.3	56.7
100	11.8	55.1	44.9
150	8.8	63.9	36.1
200	7.0	70.9	29.1
270	4.7	75.6	24.4
400	3.8	79.4	20.6
-400	20.6	100.0	-
Total	100.0	-	-

**Test No. 6**

Purpose: To investigate flotation of Zn and Ag from Comp. B at a coarser primary grind

Procedure: As outlined below.

Feed: 2000 grams minus 10 mesh Composite B

Grind: 10 minutes at 65 percent solids in the laboratory rod mill

Conditions:

	Reagents Added, grams per tonne					Time, minutes			pH
	Ca(OH) <sub>2</sub>	CuSO <sub>4</sub>	M2030	PAX	DF 250	Grind	Cond.	Froth	
Grind	-	-	-	-	-	10	-	-	-
Condition	1000	-	-	-	-	-	5	-	11.5
Zn Rougher	-	600	20	20	-	-	5	-	-
	-	-	5	-	15	-	1	4	-
	-	-	5	10	10	-	1	4	-
	-	-	5	10	10	-	1	4	-
	-	-	5	10	5	-	1	4	-
	-	-	10	20	10	-	1	8	-
Zn Regrind	300	300	-	-	-	30	-	-	-
Zn 1st Cl.	-	-	5	5	-	-	1	4	10.0
	-	-	2.5	2.5	-	-	1	6	-
Zn 2nd Cl.	50	50	-	-	-	-	1	4	10.0
	-	-	2.5	2.5	-	-	1	-	-
Zn 3rd Cl.	25	-	-	-	-	-	1	6	10.2
Zn 4th Cl.	25	-	-	-	-	-	1	5	10.2
Zn 5th Cl.	25	-	-	-	-	-	1	5	10.2

## Test 6

Product	Weight		Assays,%g/t			% Distribution		
	g	%	Zn	S	Ag	Zn	S	Ag
1 Cleaner Conc	457.1	23.0	47.6	35.3	220	78.9	71.7	82.6
2 5th Cl Tail	16.7	0.8	1.82	33.2	72.7	0.1	2.5	1.0
3 4th Cl Tail	15.1	0.8	0.95	22.7	37.6	0.1	1.5	0.5
4 3rd Cl Tail	32.0	1.6	0.57	17.3	22.3	0.1	2.5	0.6
5 2nd Cl Tail	54.2	2.7	0.46	7.14	10.3	0.1	1.7	0.5
6 1st Cl Tail	127.4	6.4	0.29	2.95	6.70	0.1	1.7	0.7
7 Rougher Tail	1282.4	64.6	4.45	3.24	13.5	20.7	18.5	14.2
Head(calc)	1984.9	100.0	13.9	11.3	61.4	100.0	100.0	100.0

## Combined Products

1 + 2	23.9	46.0	35.2	215	79.0	74.2	83.6
1 to 3	24.6	44.6	34.8	210	79.0	75.7	84.1
1 to 4	26.2	41.9	33.8	198	79.1	78.1	84.6
1 to 5	29.0	38.0	31.3	180	79.2	79.9	85.1
1 to 6	35.4	31.1	26.1	149	79.3	81.5	85.8

## Screen Analysis Primary Grind

Mesh Size (Tyler)	% Retained		% Pass
	Ind	Cum	Cum
28	1.3	1.3	98.7
35	15.3	16.6	83.4
48	20.7	37.3	62.7
65	15.1	52.4	47.6
100	11.7	64.1	35.9
150	8.8	72.9	27.1
200	5.7	78.6	21.4
270	4.5	83.1	16.9
400	3.4	86.5	13.5
-400	13.5	100.0	-
Total	100.0	-	-

**Test No. 7**

Purpose: To repeat conditions of Test 3 with the Overall Composite at a slightly coarser grind and use a Cu prefloat.

Procedure: As outlined below.

Feed: 2000 grams minus 10 mesh Overall Composite

Grind: 17 minutes at 65 percent solids in the laboratory ball mill

Conditions:

Stage	Reagents Added, grams per tonne						Time, minutes			pH
	Ca(OH) <sub>2</sub>	M2030	CuSO <sub>4</sub>	PAX	MIBC	DF 250	Grind	Cond.	Froth	
Grind	-	-	-	-	-	-	17	-	-	-
Condition	500	-	-	-	-	-	-	2	-	11.0
Prefloat	-	10	-	-	-	-	-	1	4	-
Condition	500	-	450	-	-	-	-	5	2	11.4
Zn Rougher	-	10	-	5	10	5	-	1	3	-
Scavenger	-	10	-	10	-	5	-	1	3	-
Reg. Zn Rougher	200	-	200	-	-	-	10	-	-	-
Zn 1st Cleaner	-	2.5	-	2.5	-	-	-	1	3	10.4
	-	2.5	-	2.5	5	2.5	-	1	2	-
Zn 2nd Cleaner	125	-	100	-	-	-	-	2	3	10.5
	-	2.5	-	-	-	-	-	1	1	-
Zn 3rd Cleaner	75	-	50	-	-	-	-	2	3	10.6
Zn 4th Cleaner	30	-	-	-	-	-	-	2	3	10.5

## Test 7

Product	Weight		Assays,%g/t					% Distribution				
	g	%	Zn	Cu	S	Ag	Fe	Zn	Cu	S	Ag	Fe
1 Cleaner Conc	254.2	12.8	54.3	0.37	31.8	90.2	9.92	93.0	55.4	68.3	36.2	20.0
2 4th Cl Tail	2.8	0.1	13.6	0.46	18.7	291	19.9	0.3	0.8	0.4	1.3	0.4
3 3rd Cl Tail	9.4	0.5	6.86	0.48	19.7	148	26.4	0.4	2.7	1.6	2.2	2.0
4 2nd Cl Tail	20.2	1.0	1.07	0.21	16.1	20.2	21.8	0.1	2.5	2.7	0.6	3.5
5 1st Cl Tail	85.7	4.3	0.33	0.050	3.81	7.7	8.80	0.2	2.5	2.8	1.0	6.0
6 Scav Conc	90.0	4.5	1.23	0.061	15.5	65.7	20.7	0.7	3.2	11.8	9.3	14.7
7 Prefloat Conc	39.3	2.0	16.8	1.42	32.8	653	27.4	4.4	32.9	10.9	40.6	8.5
8 Scavenger Tail	1485.6	74.8	0.076	0.008	0.12	3.7	3.82	0.8	0.01	1.5	8.7	44.9
Head(calc)	1987.2	100.0	7.47	0.085	5.96	31.8	6.36	100.0	100.0	100.0	100.0	100.0
Combined Products												
1 + 2		12.9	53.9	0.37	31.7	92.4	10.0	93.3	56.2	68.7	37.5	20.4
1 to 3		13.4	52.2	0.37	31.2	94.4	10.6	93.7	58.8	70.3	39.7	22.4
1 to 4		14.4	48.6	0.36	30.2	89.1	11.4	93.9	61.3	73.1	40.4	25.8
1 to 5		18.7	37.5	0.29	24.1	70.4	10.8	94.0	63.9	75.8	41.4	31.8
1 to 6		23.3	30.4	0.25	22.4	69.5	12.7	94.8	67.1	87.6	50.7	46.6

## Screen Analysis Primary Grind

Mesh Size (Tyler)	% Retained		% Pass
	Ind	Cum	Cum
28	0.1	0.1	99.9
35	0.2	0.3	99.7
48	1.3	1.6	98.4
65	4.5	6.1	93.9
100	12.6	18.7	81.3
150	17.6	36.3	63.7
200	15.9	52.2	47.8
270	10.6	62.8	37.2
400	8.0	70.8	29.2
-400	29.2	100.0	-
Total	100.0	-	-

**Test No. 8**

**Purpose:** To investigate effect of pH in cleaning on zinc grade and Ag recovery in the cleaner concentrate

**Procedure:** As outlined below

**Feed:** 2000 g of minus 10 mesh Overall Composite

**Grind:** 20 minutes at 65% solids in a lab ball mill

**Conditions:**

Stage	Reagents Added, grams per tonne							Time, minutes			pH
	Ca(OH) <sub>2</sub>	R208	CuSO <sub>4</sub>	PAX	MIBC	DF 250	R241	Grind	Cond.	Froth	
Grind	-	-	-	-	-	-	-	20	-	-	7.2
Condition	500	-	-	-	-	-	-	-	5	-	11.0
Prefloat	-	10	-	-	10	-	5	-	1	4	-
		<b>M2030</b>									
Condition	250	-	450	-	-	-	-	-	5	-	10.5
Zn Rougher	-	10	-	-	-	5	-	-	1	4	-
	-	5	-	5	-	2.5	-	-	1	3	-
	-	5	-	10	-	-	-	-	1	2	-
Zn Regrind	200	-	200	-	-	-	-	10	-	-	-
Zn 1st Cleaner	50	-	-	-	-	-	-	-	1	4	11.0
	-	2.5	-	-	-	2.5	-	-	1	2	-
Zn 2nd Cleaner	125	-	100	-	-	-	-	-	1	3	11.0
	-	2.5	-	-	2.5	-	-	-	1	2	-
Zn 3rd Cleaner	125	-	50	-	-	-	-	-	1	2	11.0
	-	-	-	-	2.5	-	-	-	1	2	-
Zn 4th Cleaner	125	-	-	-	-	-	-	-	1	3	11.0

## Test 8

Product	Weight		Assays,%g/t				Fe	% Distribution			
	g	%	Zn	Cu	S	Ag		Zn	Cu	S	Ag
1 Cleaner Conc	260.0	13.1	53.2	0.30	33.6	124	9.80	93.6	47.1	69.5	28.7
2 4th CI Tail	2.9	0.1	9.80	0.28	19.7	1002		0.2	0.5	0.5	2.6
3 3rd CI Tail	9.9	0.5	6.22	0.27	21.1	381		0.4	1.6	1.7	3.4
4 2nd CI Tail	19.2	1.0	1.64	0.25	17.2	146		0.2	2.9	2.6	2.5
5 1st CI Tail	122.8	6.2	0.44	0.071	16.0	169		0.4	5.3	15.6	18.4
6 Prefloat Conc	32.7	1.6	19.8	2.16	29.6	1360		4.4	42.6	7.7	39.5
7 Zn Rougher Tail	1540.0	77.5	0.076	0.011	0.20	3.6		0.8	0.01	2.4	4.9
Head(calc)	1987.5	100.0	7.43	0.083	6.33	56.6	100.0	100.0	100.0	100.0	
Combined Products											
1 + 2		13.2	52.7	0.30	33.4	134		93.8	47.6	69.9	31.2
1 to 3		13.7	51.0	0.30	33.0	143		94.2	49.2	71.6	34.6
1 to 4		14.7	47.8	0.30	32.0	143		94.5	52.1	74.2	37.1
1 to 5		20.9	33.8	0.23	27.2	151		94.8	57.4	89.9	55.5
1 + 6		14.7	49.5	0.51	33.2	262		98.0	89.7	77.2	68.2

**Test No. 9**

Purpose: To repeat Test 8 at pH 11.5 in cleaning and use CMC in the prefloat.

Procedure: As outlined below

Feed: 2000 g of minus 10 mesh Overall Composite

Grind: 20 minutes at 65% solids in a lab ball mill

Conditions:

Stage	Reagents Added, grams per tonne							Time, minutes			pH
	Ca(OH) <sub>2</sub>	R208	CuSO <sub>4</sub>	CMC 7LT	MIBC	DF 250	R241	Grind	Cond.	Froth	
Grind	-	-	-	-	-	-	-	20	-	-	-
Condition	500	-	-	200	-	-	-	-	5	-	11.0
Prefloat	-	10	-	-	10	-	5	-	1	4	-
		<b>M2030</b>		<b>PAX</b>							
Condition	250	-	450	-	-	-	-	-	5	-	10.5
Zn Rougher	-	10	-	-	-	5	-	-	1	4	-
	-	5	-	5	-	2.5	-	-	1	3	-
	-	5	-	10	-	-	-	-	1	2	-
Zn Regrind	300	-	200	-	-	-	-	10	-	-	-
Zn 1st Cleaner	50	-	-	-	-	-	-	-	1	4	11.5
	-	2.5	-	-	-	2.5	-	-	1	2	-
Zn 2nd Cleaner	125	-	100	-	-	-	-	-	1	3	11.5
	-	2.5	-	-	2.5	-	-	-	1	2	-
Zn 3rd Cleaner	125	-	50	-	-	2.5	-	-	1	2	11.5
	-	-	-	-	2.5	-	-	-	1	2	-
Zn 4th Cleaner	125	-	-	-	-	-	-	-	1	2	11.5
	-	-	-	-	-	2.5	-	-	1	2	-

## Test 9

Product	Weight		Assays,%g/t					% Distribution			
	g	%	Zn	Cu	S	Ag	Fe	Zn	Cu	S	Ag
1 Cleaner Conc	245.1	12.3	53.4	0.27	32.8	157	9.76	90.1	39.6	66.2	44.2
2 4th Cl Tail	4.1	0.2	15.7	0.36	17.0	458		0.4	0.9	0.6	2.2
3 3rd Cl Tail	9.7	0.5	9.10	0.38	16.5	297		0.6	2.2	1.3	3.3
4 2nd Cl Tail	35.5	1.8	4.13	0.24	15.3	76.3		1.0	5.1	4.5	3.1
5 1st Cl Tail	107.0	5.4	1.10	0.090	17.8	64.7		0.8	5.8	15.7	7.9
6 Prefloat Conc	38.9	2.0	21.7	1.99	23.4	782		5.8	46.4	7.5	34.9
7 Zn Rougher Tail	1547.0	77.8	0.11	0.013	0.34	2.5		1.2	0.02	4.3	4.4
Head(calc)	1987.3	100.0	7.31	0.084	6.12	43.9		100.0	100.0	100.0	100.0
Combined Products											
1 + 2		12.5	52.8	0.27	32.5	162		90.6	40.5	66.7	46.3
1 to 3		13.0	51.1	0.28	31.9	167		91.2	42.7	68.0	49.6
1 to 4		14.8	45.5	0.27	29.9	156		92.2	47.8	72.5	52.7
1 to 5		20.2	33.6	0.22	26.7	132		93.0	53.6	88.2	60.7
1 +6		14.3	49.1	0.51	31.5	243		96.0	86.0	73.6	79.1

**Test No. 10**

Purpose: To repeat conditions of Test 8 at pH 12.0 in the cleaning

Procedure: As outlined below

Feed: 2000 g of minus 10 mesh Overall Composite

Grind: 20 minutes at 65% solids in a lab ball mill

Conditions:

Stage	Reagents Added, grams per tonne							Time, minutes			pH
	Ca(OH) <sub>2</sub>	R208	CuSO <sub>4</sub>	PAX	MIBC	DF 250	R241	Grind	Cond.	Froth	
Grind	-	-	-	-	-	-	-	20	-	-	-
Condition	500	-	-	-	-	-	-	-	5	-	-
Prefloat	-	10	-	-	5	-	5	-	1	4	-
		<b>M2030</b>									
Condition	250	-	450	-	-	-	-	-	5	-	10.5
Zn Rougher	-	10	-	-	-	15	-	-	1	4	-
	-	5	-	5	-	10	-	-	1	3	-
	-	5	-	10	-	-	-	-	1	2	-
Zn Re grind	350	-	200	-	-	-	-	10	-	-	-
Zn 1st Cleaner	-	-	-	-	-	-	-	-	1	4	12.0
	-	2.5	-	-	-	2.5	-	-	1	2	-
Zn 2nd Cleaner	150	-	100	-	-	-	-	-	1	3	12.0
	-	2.5	-	-	-	-	-	-	1	1	-
Zn 3rd Cleaner	150	-	50	-	2.5	-	-	-	1	3	12.0
Zn 4th Cleaner	150	-	-	-	-	-	-	-	1	3	12.0

## Test 10

Product	Weight		Assays,%g/t				Fe	% Distribution			
	g	%	Zn	Cu	S	Ag		Zn	Cu	S	Ag
1 Cleaner Conc	258.8	13.0	52.8	0.33	34.0	102	9.90	91.7	49.0	68.8	34.6
2 4th Cl Tail	3.4	0.2	10.0	0.42	15.8	331		0.2	0.8	0.4	1.5
3 3rd Cl Tail	5.7	0.3	5.09	0.46	16.3	231		0.2	1.5	0.7	1.7
4 2nd Cl Tail	13.2	0.7	1.27	0.30	11.2	68.4		0.1	2.3	1.2	1.2
5 1st Cl Tail	126.2	6.3	0.33	0.067	12.8	25.1		0.3	4.9	12.6	4.1
6 Prefloat Conc	52.5	2.6	19.4	1.38	35.7	763		6.8	41.6	14.6	52.5
7 Zn Rougher Tail	1533.4	76.9	0.064	0.008	0.14	2.2		0.7	0.01	1.7	4.4
Head(calc)	1993.2	100.0	7.48	0.087	6.42	38.3		100.0	100.0	100.0	100.0
Combined Products											
1 + 2		13.2	52.2	0.33	33.8	105		91.9	49.8	69.2	36.1
1 to 3		13.4	51.2	0.33	33.4	108		92.1	51.3	69.9	37.8
1 to 4		14.1	48.9	0.33	32.4	106		92.2	53.6	71.1	39.0
1 to 5		20.4	33.8	0.25	26.3	81		92.5	58.4	83.7	43.1
1 +6		15.6	47.2	0.51	34.3	213		98.5	90.5	83.4	87.1

**Test No. 11**

Purpose: To float Cu concentrate at pH 8 - 9 and clean twice

Procedure: As outlined below

Feed: 2 x 2 kg grams minus 10 mesh Overall Comp.

Grind: 2 x 20 minutes at 65% solids in a lab ball mill

Conditions:

Stage	Reagents Added, grams per tonne						Time, minutes			pH
	Ca(OH) <sub>2</sub>	R208	R241	MIBC	CuSO <sub>4</sub>	PAX	Grind	Cond.	Froth	
Grind	-	-	-	-	-	-	20	-	-	-
Condition	300	10	54	-	-	-	-	5	-	8.5
Prefloat	-	-	-	2.5	-	-	-	1	4	-
		<b>M2030</b>								
Condition	30	-	-	-	450	-	-	5	-	11.0
Zn Rougher	-	10	-	10	-	-	-	1	4	-
	-	5	-	-	-	5	-	1	3	-
	-	5	-	-	-	10	-	1	2	-
		<b>R208</b>								
Cu 1st Cleaner	100	-	-	-	-	-	-	1	2	9.0
	-	5	-	5	-	-	-	1	2	-
	180	2.5	-	-	-	-	-	1	3	11.2
		<b>M2030</b>								
Zn Re grind	350	-	-	-	200	-	10	-	-	-
Zn 1st Cleaner	-	-	-	-	-	-	-	1	4	11.5
	-	2.5	-	2.5	-	-	-	1	2	-
Zn 2nd Cleaner	150	-	-	-	100	-	-	1	3	11.2
	-	5	-	5	-	-	-	1	2	-
Zn 3rd Cleaner	100	-	-	-	50	-	-	1	3	11.3
	-	5	-	-	-	-	-	1	1	-
Zn 4th Cleaner	50	-	-	-	-	-	-	1	3	11.2

## Test 11

Product	Weight		Assays,%g/t				Fe	% Distribution			
	g	%	Zn	Cu	S	Ag		Zn	Cu	S	Ag
1 Cleaner Conc	499.4	12.5	54.0	0.34	34.9	64.3	9.89	90.5	51.7	67.8	25.2
2 4th Cl Tail	6.0	0.2	8.90	0.32	12.0	207		0.2	0.6	0.3	1.0
3 3rd Cl Tail	13.1	0.3	3.18	0.34	10.3	51.4		0.1	1.4	0.5	0.5
4 2nd Cl Tail	52.2	1.3	1.72	0.17	10.6	31.4		0.3	2.7	2.2	1.3
5 1st Cl Tail	228.2	5.7	0.48	0.046	13.7	24.2		0.4	3.2	12.2	4.3
6 Prefloat Conc	27.0	0.7	18.6	4.11	40.9	1892		1.7	33.8	4.3	40.1
7 2nd Cl Tail	27.7	0.7	16.1	0.28	39.7	788		1.5	2.4	4.3	17.1
8 1st Cl Tail	89.4	2.2	15.2	0.16	17.2	98.5		4.6	4.4	6.0	6.9
9 Zn Rougher Tail	3038.2	76.3	0.07	0.008	0.21	1.5		0.7	0.01	2.5	3.6
Head(calc)	3981.2	100.0	7.48	0.083	6.45	32.0		100.0	100.0	100.0	100.0
Combined Products											
1 + 2		12.7	53.5	0.34	34.6	66.0		90.7	52.3	68.1	26.2
1 to 3		13.0	52.2	0.34	34.0	65.6		90.9	53.6	68.6	26.7
1 to 4		14.3	47.6	0.32	31.9	62.5		91.2	56.3	70.8	28.0
1 to 5		20.1	34.1	0.24	26.7	51.6		91.5	59.5	83.0	32.3
6 + 7		1.4	17.3	2.17	40.3	1333		3.2	36.1	8.6	57.2
6 to 8		3.6	16.0	0.92	26.0	567		7.7	40.5	14.6	64.1
1 +6		13.2	52.2	0.53	35.2	158		92.2	85.4	72.1	65.3

**TEST NO. 12**

**Purpose:** To determine the recovery of Sn by gravity separation on a Wilfley table.

**Feed:** 1000 g each of Zn Rougher Tail from Tests 8, 9 and 10.

**Procedure:** The feed was pulped with water to aid in feeding it to the table. The feed was then passed across the table and the table middlings and concentrate were recirculated until all the feed was in the table circuit. The circulation pump was then disconnected and the table concentrate was collected. The table middlings and tailings were combined. The products were then dried and weighed and assayed for Sn.

**Data:**

Product	Weight %	Assays,% Sn	% Distribution Sn
Table Conc.	2.96	0.28	19.6
Table Tails	97.04	0.035	80.4
Head (Calc.)	100.0	0.042	100.0



## Test 13

Product	Weight		Assays, %g/t					% Distribution			
	g	%	Zn	Cu	S	Ag	Fe	Zn	Cu	S	Ag
1 Cleaner Conc	453.3	23.0	53.4	0.42	34.7	160	10.0	88.7	86.2	70.7	58.5
2 4th Cl Tail	9.6	0.5	26.6	0.54	26.2	880	18.3	0.9	2.3	1.1	6.8
3 3rd Cl Tail	17.8	0.9	15.5	0.40	23.8	551	23.8	1.0	3.2	1.9	7.9
4 2nd Cl Tail	22.1	1.1	8.15	0.24	21.3	115	23.8	0.7	2.4	2.1	2.1
5 1st Cl Tail	175.7	8.9	2.57	0.072	22.0	85.3	25.5	1.7	5.7	17.4	12.1
7 Zn Rougher Tail	1290.7	65.5	1.49	0.009	1.17	12.0	7.30	7.0	0.12	6.8	12.5
Head(calc)	1969.2	100.0	13.9	0.112	11.3	62.8	9.93	100.0	100.0	100.0	100.0
<b>Combined Products</b>											
1 + 2		23.5	52.8	0.42	34.5	175	10.2	89.6	88.5	71.8	65.4
1 to 3		24.4	51.5	0.42	34.1	189	10.7	90.6	91.8	73.7	73.3
1 to 4		25.5	49.6	0.41	33.6	185	11.3	91.3	94.2	75.8	75.4
1 to 5		34.5	37.4	0.33	30.6	159	14.9	93.0	99.9	93.2	87.5

**Test No. 14**

Purpose: To repeat conditions of Test 11 on Composite B

Procedure: As outlined below

Feed: 2 x 2 kg minus 10 mesh Comp. B

Grind: 2 x 20 minutes at 65% solids in a lab ball mill

Conditions:

Stage	Reagents Added, grams per tonne							Time, minutes			pH
	Ca(OH) <sub>2</sub>	R208	R241	MIBC	CuSO <sub>4</sub>	PAX	ZnSO <sub>4</sub>	Grind	Cond.	Froth	
Grind	-	-	-	-	-	-	-	20	-	-	-
Condition	300	-	-	-	-	-	400	-	5	-	8.0
Prefloat	-	10	5	2.5	-	-	-	-	2	4	-
		<b>M2030</b>									
Condition	300	-	-	-	450	-	-	-	5	-	-
Zn Rougher	-	10	-	10	-	-	-	-	1	4	11.0
	-	5	-	-	-	5	-	-	1	3	-
	-	5	-	-	-	10	-	-	1	2	-
		<b>R208</b>									
Cu 1st Cleaner	100	-	-	-	-	-	50	-	1	1	9.0
	-	2.5	-	2.5	-	-	-	-	1	2	-
Cu 2nd Cleaner	150	-	-	-	-	-	25	-	1	3	11.2
		<b>M2030</b>									
Zn Re grind	350	-	-	-	200	-	-	10	-	-	-
Zn 1st Cleaner	-	-	-	-	-	-	-	-	1	4	11.5
	-	2.5	-	2.5	-	-	-	-	1	2	-
Zn 2nd Cleaner	150	-	-	-	100	-	-	-	1	3	11.2
	-	2.5	-	2.5	-	-	-	-	1	2	-
Zn 3rd Cleaner	100	-	-	-	50	-	-	-	1	3	-
	-	5	-	-	-	-	-	-	1	1	-
Zn 4th Cleaner	50	-	-	-	-	-	-	-	1	3	11.2

## Test 14

Product	Weight		Assays,%g/t				Fe	% Distribution			
	g	%	Zn	Cu	S	Ag		Zn	Cu	S	Ag
1 Cleaner Conc	943.6	23.6	52.5	0.29	34.0	111	10.0	90.3	59.6	71.1	36.9
2 4th Cl Tail	12.5	0.3	8.50	0.26	14.4	76.6		0.2	0.7	0.4	0.3
3 3rd Cl Tail	19.3	0.5	2.42	0.21	12.8	80.3		0.1	0.9	0.5	0.5
4 2nd Cl Tail	50.4	1.3	1.26	0.14	14.0	31.7		0.1	1.5	1.6	0.6
5 1st Cl Tail	264.1	6.6	0.66	0.028	21.9	19.8		0.3	1.6	12.8	1.8
6 Prefloat Conc	10.0	0.3	14.9	8.66	35.9	3166		0.3	18.9	0.8	11.2
7 2nd Cl Tail	45.5	1.1	14.5	1.24	41.0	2409		1.2	12.3	4.1	38.6
8 1st Cl Tail	62.5	1.6	24.0	0.33	25.5	270		2.7	4.5	3.5	6.0
9 Zn Rougher Tail	2582.8	64.7	1.02	0.005	0.90	4.5		4.8	0.04	5.1	4.1
Head(calc)	3990.7	100.0	13.8	0.12	11.3	71.1		100.0	100.0	100.0	100.0
Combined Products											
1 + 2		24.0	51.9	0.29	33.7	111		90.5	60.3	71.5	37.2
1 to 3		24.4	50.9	0.29	33.3	110		90.6	61.2	72.0	37.8
1 to 4		25.7	48.5	0.28	32.4	106		90.7	62.7	73.6	38.3
1 to 5		32.3	38.7	0.23	30.2	88.4		91.0	64.3	86.4	40.2
6 + 7		1.4	14.6	2.58	40.1	2545		1.5	31.1	4.9	49.8
6 to 8		3.0	19.6	1.39	32.4	1340		4.2	35.6	8.5	55.7
1 + 6		23.9	52.1	0.38	34.0	143		90.6	78.4	71.9	48.1
1+6+7		25.0	50.4	0.42	34.3	246		91.8	90.7	76.0	86.7

**APPENDIX 1**

Mineralogical Examination of  
**STRATHCONA MINERALS**  
Logan Project Samples

Project No. L.R. 3654

NOTE:

This report refers to the samples as received.

The practice of this Company in issuing reports of this nature is to require the recipient not to publish the report or any part thereof without the written consent of Lakefield Research.

LAKEFIELD RESEARCH  
A DIVISION OF FALCONBRIDGE LIMITED  
March 1st, 1989


## INTRODUCTION

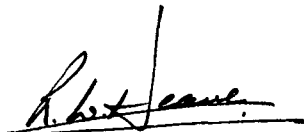
Two samples of minus 10 mesh material and one tailings sample were received in the Mineralogy laboratory for examination. These samples were identified as

1. Composite A
2. Composite B
3. Test No. 2 - Zinc 2nd Cleaner Tailing

and were submitted for identification of the silver minerals and determination of their association and grain-size.

LAKEFIELD RESEARCH

  
for R.S. Salter  
General Manager

  
R.W. Deane  
Chief Mineralogist

S U M M A R Y

Silver minerals identified and the weight percent of each as silver host were:

Metallic silver	-	Ag	80%
Proustite	-	$\text{Ag}_3\text{As S}_3$	10%
Pearceite	-	$(\text{Ag-Cu})_{16} (\text{As, Sb})_2 \text{S}_{11}$	<u>10%</u>
		Total	100%

Silver may have been present in minerals other than those listed above.

Metallic silver was identified only in galena and Pb sulfo-salt such as bournonite. Proustite was identified as three grains all less than 15 micrometres in size and the pearceite as one free grain plus 2 inclusions in bournonite all of which were small than 15 micrometres.

Other opaque minerals present in the samples were in decreasing order of abundance.

Sphalerite	ZnS
pyrite	FeS <sub>2</sub>
pyrrhotite	FeS
marcasite	FeS <sub>2</sub>
chalcopyrite	Cu Fe S <sub>2</sub>
Fe arsenide	Fe As (?)
bournonite	Cu Pb Sb S <sub>3</sub>
boulangerite	Pb <sub>5</sub> Sb <sub>4</sub> S
galena	Pb S
silver	Ag
proustite	Ag <sub>3</sub> As S <sub>3</sub>
pearceite	(Ag, Cu) <sub>16</sub> (As, Sb) <sub>2</sub> , S <sub>11</sub>
magnetite	Fe <sub>2</sub> O <sub>3</sub> .FeO

The non-opaque gangue minerals identified were

Quartz	SiO <sub>2</sub>
siderite	FeCO <sub>3</sub>
mica	K <sub>2</sub> (Fe, Mg) <sub>6</sub> (Al, Si) O <sub>20</sub> (OH) <sub>4</sub>
calcite	CaCO <sub>3</sub>

The silver minerals were identified in zinc Cl. tailing and not with certainty in either of the composite samples.

**PREPARATION AND PROCEDURE**

A portion of each of the composite samples was briquetted then prepared as a polished thin-section for microscopic examination in combined reflected and transmitted light. A portion of the cleaner tailing was briquetted and polished for microscopic examination in reflected light.

## RESULTS

Silver occurs in the Logan Project samples in three, perhaps more, species. These minerals identified were

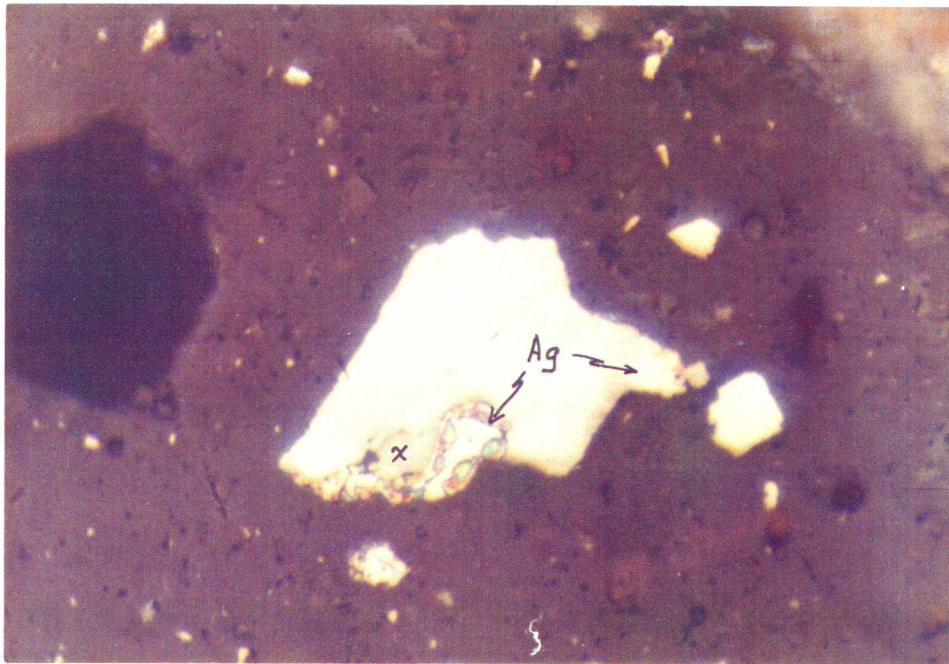
1. Metallic silver as inclusions in sulfosalts
2. proustite occurring as liberated grains
3. pearceite as inclusions in other sulfosalt.

The maximum grain-size for any of these silver minerals was 15 micrometres. Metallic silver represented an estimated 80 percent of the silver in the zinc Cleaner Tail and the other two silver minerals represented equal parts of the remaining 20 percent of the silver. Silver or other silver minerals were not identified in either of the composite samples.

The major opaque minerals were sphalerite, pyrite, pyrrhotite and marcasite. These were present in amount 5 percent by weight or more of the total minerals. Present in minor to accessory amount, i.e. approximately 1 to less than 5 percent by weight were chalcopyrite and an Fe arsenide similar to lollingite. Present in amount less than 1 percent were bournonite, boulangerite, galena, magnetite and at least two sulfo-salts minerals which would have to be submitted for electron-probe analysis for identification.

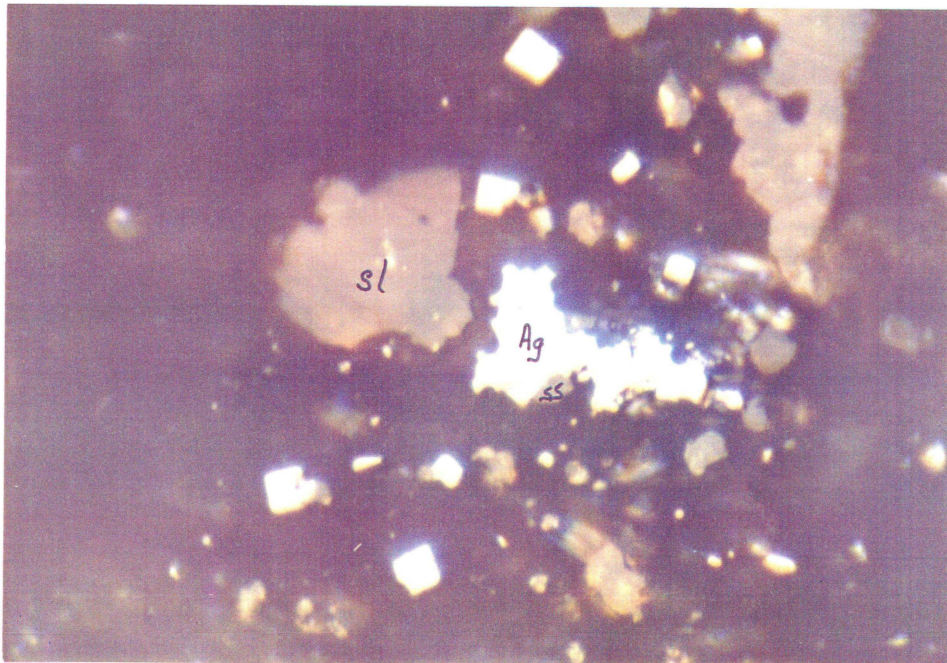
The non-opaque host rock minerals were quartz, siderite, mica and minor calcite. Accessory and lesser non-opaque minerals were not identified.

The particle size of the silver minerals and that 90 percent of them occur as inclusions in sulfo-salt minerals is an indication that guarded optimism is required with respect to grades and recovery. The sphalerite is Fe-rich with an Fe content in excess of 5 percent.



26  $\mu\text{m}$

Illustration 1  
Silver (Ag) in Pb sulfo-salt. Brown mineral (x) was similar to pyrrhotite but isotropic. 450 X



20  $\mu\text{m}$

Illustration 2  
Silver (Ag) with sulfo-salt (S) and sphalerite (sl). 600 X

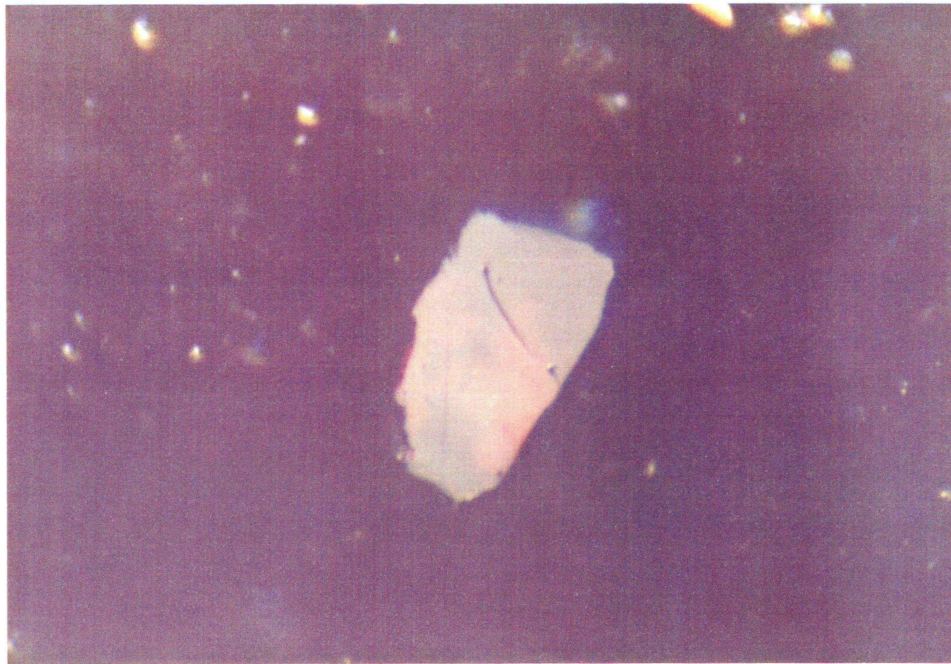


Illustration 3  
Grain of proustite  
600 X

20  $\mu\text{m}$

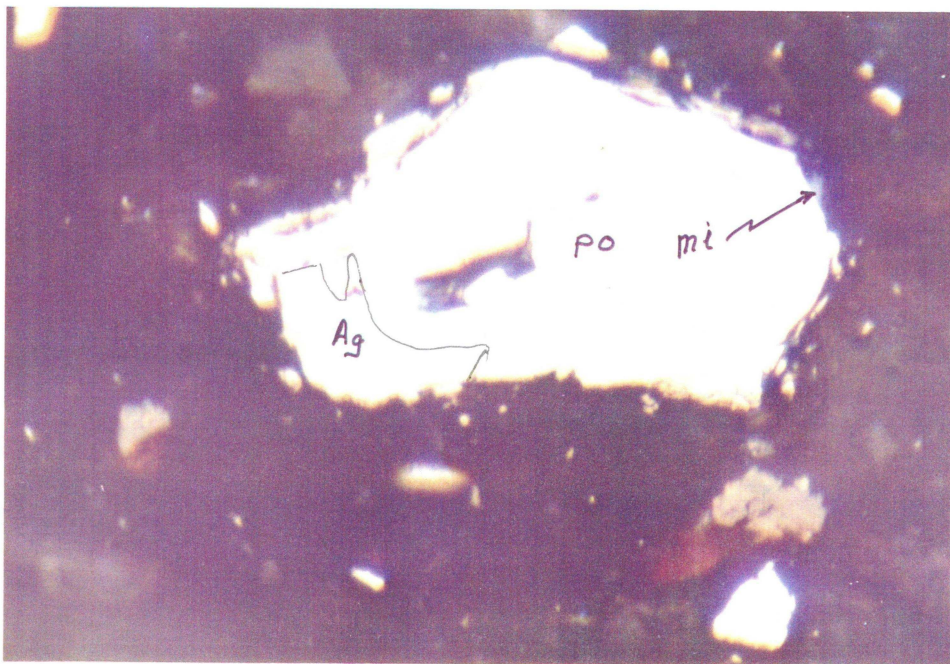


Illustration 4  
Silver (Ag) and miargyrite (mi) on  
pyrrhotite (po)  
600 X

20  $\mu\text{m}$