Ottawa, June 29, 1928

REPORT
of the
ORE DRESSING AND METALLURGICAL LABORATORIES

Report No. 211

Concentration of a complex Copper-Zinc ore from the Sherritt-Gordon mine, N.Manitoba

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Shipments: Two shipments were received, designated in this report as No. 4 and No. 5. Shipment No. 4 consisted of 115 bags of ore weighing about 3 tons and was received in March 1928. Shipment No. 5 consisted of a car load of ore weighing about 20 tons, and was received in April. The shipments were made by the Sherritt-Gordon Mines Ltd. of Toronto and were from the Sherritt-Gordon mine in northern Manitoba.

Characteristics and Analysis of the ore: The two shipments consisted of a complex copper-zinc-iron sulphide ore containing low values in gold and silver. The analysis of the two shipment was as follows:

	No. 4	No. 5
Copper	1.24 %	3.08 %
Zinc	8.94 %	6.49 %
Gold	0.02 oz/ton	0.05 oz/ton
Silver	0.26 "	0.90 "
Iron		17.92 %

Purpose of Experimental work: These shipments were made for the purpose of having concentration tests made on the ore to determine what economic results could be expected from concentrating the ore. A high grade copper concentrate was desired with a minimum of zinc in it, and a high grade zinc concentrate with a minimum of copper and iron. Information as to the control of the conditions which would produce these products was also desired. Special tests were requested to determine whether the pyrrhotite carried an appreciable amount of gold.

Experimental Tests: The work on shipment 4 was divided into tree sections. The first section consists of selective flotation tests made in a small continuous flotation unit having a capacity of 100 pounds of ore per hour. Second section consists of bulk flotation tests made in the same unit, and the third section of special work done to isolate the pyrrhotite for the determination of its gold content.

The work on shipment 5 was also divided into three sections. The first section consists of bulk flotation tests made on a one-ton sample taken at random from the shipment and run in the small flotation unit, and the second section of selective tests made in this unit. The third section consists of large scale tonnage tests made on the large flotation unit treating the ore at the rate of 1000 pounds an hour

Lot No. 4 - Section 1 (Selective Flotation)

The ore was crushed to 10 mesh and fed to an 18x24 inch rod mill in closed circuit with a 12 inch Akins classifier. The overflow of the classifier passed to a mechanically agitated conditioning tank giving from 20 to 30 minutes contact to the pulp and reagents before entering an 8-cell standard Minerals Separation type of flotation cells for the flotation of the copper. The first two cells were used as mixers, the other six as flotation cells. A rougher concentrate was made which was cleaned in a 3-cell Denver Sub-A machine, the cleaner tailing being returned to the head of the rougher. The rougher tailing passed to the zinc flotation circuit. The feed to the zinc circuit was conditioned for 20-30 minutes in a conditioning tank the overflow from which passed to a 6-cell Denver Sub-A machine where a rougher zinc concentrate was made which was cleaned in a small Callow cell. The cleaner tailing was returned to the head of the rougher cell. Results:

Test No. 1:

Product	Weight %	Assays Cu %	Zn %	Au oz	Ag oz	% of values Cu	Zn	Au	Ag
Cu conc	5.25	20.46	7.57	0.10	3.82	86.99	4.47	90+	66.66
Zn "	15.07	0.46	52.93	0.01	0.29	5.69	89.26		15.33
Cu tail		0.19	8.54	tr	0.10				
Zn "	79.68	0.12	0.71	tr	0.08	7.32	6.27		
Test No. 2:									
1st. sample (9.30am-2.00 pm)									
Cu conc	5.86	18.49	5.97	0.10	3.30	87.10	3.91	81.08	65.51
Zn "	11.96	0.42	49.78	tr	0.11	4.03	66.55	13.55	3.45
Zn tail	82.18	0.13	3.21	tr	0.12	8.87	29.54	5.37	31.04
2nd. sample (2.00-4.30 pm)									
Cu conc	5.33	20.93	6.27	0.10	3.63	90.24	3.69	71.43	65.52
Zn "	14.41	0.36	51.41	tr	0.17	4.07	82.89	14.28	6.89
Zn tail	80.26	0.09	1.49	tr	0.10	5.69	13.42	14.29	27.59

Reagents: (in lbs/ton)

Time	Rod mill Na2CO3	Conditioner NaCN	Zn cells Cu SO4	Rod mill Thio	Cu cell Cresylic	Rod ml ZnSO3	Conditioner NaCN	Class. o'flw
Test No. 1								
9.30				0.14	0.14	1		
10.00	2.3	0.51			0.70	1	0.32	1:2.8
10.30		0.58		"				
10.40		0.25	0.80			1	"	
10.50				"		1	"	
11.00	2.3	0.25	0.80		0.56	1	"	1:2.4
11.30	2.3			"	"			1:2.5
12.00	2.3	0.24	"		"	1	"	1:2.2
12.30		0.29	"	"	"	1	"	1:2.5
1.15	2.3	"	"	"	"	1	"	1:4.2
1.45	2.3	0.43	"	"	"	1	"	1:3.7
2.00	2.3	"	"	"	"	1	"	1:3.3
2.30	2.3	"	"	"	"	1	0.31	1:4.8
2.40		0.29	"	"				1:3.1
3.00	2.5	"	"		"	1	"	1:3.0
3.30	2.5	0.43	"	"	"	1	"	1:2.8
4.00	2.5	"	"	"	"	1	0.30	1:2.7
4.30	2.5	"	"	"	"	1	"	1:2.7
Test No. 2								
9.45	2.37	0.44	1.18	0.07	0.56	1	0.24	1:5.2
10.00	"	"	"	"	"	1	"	
10.30	"	0.45	"	"	"	1	"	
11.30	"	"	"	"	"	1	"	1:2.5
12.00	"	"	"	"	"	1	"	"
12.30	"	"	"	"	"	1	0.20	1:2.7
1.00	"	"	"	"	"	1	0.30	1:3.3
1.30	"	"	"	"	"	1	"	"
2.00	2.18	0.40	1.09	"	"	1	0.31	"
2.30	2.32	0.43	1.16	"	"	1	0.33	1:3.5
3.00	"	"	"	"	"	1	"	1:3.1
3.30	"	"	"	"	"	1	"	1:3.3

Lot 4 Section 2 (Bulk Flotation)

The crushing circuit was the same as that used in the selective tests. The standard Minerals Separation cells were used to make the bulk float. The pulp was conditioned in the #1 conditioner for 5 minutes. The rougher concentrate was cleaned as in the selective tests. Results:

Test No. 3 -

Product	Weight %	Assays Cu %	Zn %	Au oz	Ag oz	% of values Cu	Zn	Au	Ag
Conc. #1	19.15	6.06	42.84	0.04	1.36	92.06	91.72	50.00	81.25
Conc. #2		1.78	40.49	0.02	0.44				
Tailing	80.85	0.12	0.91	tr	0.07	7.94	8.28	50.00	18.75
Head		1.24	8.94	0.02	0.26				

Reagents: (in lb/ton)

Time	To rod mill CaO	NaCN	Thio	To head of cells CuSO4	Cresylic	Xanthate	Feed lb/hr	Class. o'flow
9.30	5	0.44	0.07	1.18	0.56		101.5	1:4.0
10.00	5	"	"	"	"			
10.30	5	"	"	"	"	0.04		1:3.0
11.00	5	"	"	"	"	"		1:2.8
11.30	5	"	"	"	"	"		1:3.0
12.00	5	0.32	"	1.21	"	"		1:2.7
12.30	5	"	"	1.18	"	"		1:3.5
1.00	5	"	"	"	"	"		1:3.3
1.30	5	0.44	"	"	"	"		1:3.5
2.00	5	0.32	"	"	"	"		1:3.7
2.30	5	0.30	"	"	"	"	108	1:4.0
3.00	5	"	"	"	"	"		1:6.1
3.30	5	"	Blas mill plugged					

Lot 4 - Section 3 (Isolation of Pyrrhotite)

The tailings from the selective flotation tests were tabled. The table concentrate containing the sulphides was passed through a laboratory magnetic separator, which is designed to thoroughly wash out any entangled non-magnetic particles. The results are as follow:

No.1 Pyrrhotite product (magnetic)	Fe 57.87 % S 36.47 % Au 0.004 oz/ton
No.2 Pyrite product (non-magnetic)	Fe 20.52 % As tr Cu 0.22 % Au 0.01 oz/ton

This definitely indicates that the gold is not associated with the pyrrhotite. In this connection we find a little free gold present in the ore, probably due to oxidation of the ore taken from near the surface.

Conclusions & Remarks on Lot 4: The head analysis was Cu 1.24% Zn 8.94 % Gold 0.02 oz/ton Silver 0.26 oz/ton.

Selective tests: There was no particular difficulty in making the separation outside of the control of the operation of so small a unit. The tests show that exceptionally sharp separations can be expected if this sample is representative of the type of ore to be mined.

Bulk Tests: This test was run for the information of the Base Metal Extraction Co. As can be seen from the results a very excellent recovery and grade of concentrate was made. No difficulty of importance was encountered.

Lot 5 - Section 1 (Bulk Flotation)

The flow sheet was the same as that used on Lot 4, section 2.

Test No. 4

Product	Weight %	Assays				% of values			
		Cu %	Zn %	Au oz	Ag oz	Cu	Zn	Au	Ag
Conc #1	13.45	13.78	27.95	0.09	2.69	92.50	73.29	52.63	69.23
" #2		2.68	45.68	0.03	0.70				
Tailing	86.55	0.17	1.58	0.01	0.19	7.50	26.71	47.37	30.77
Sample 2									
Conc #1	16.67	11.10	28.05	0.08	2.24	92.50	82.83	43.33	71.15
" #2		1.92	38.25	0.03	0.63				
Tailing	83.33	0.18	1.17	0.02	0.18	7.50	17.17	56.67	28.85

Reagents: (in lb/ton) Test 4

Time	Rod mill CaO	NaCN	Thio	Head of cells $CuSO_4$	Cresylic	Xanthate	Feed lb/ton	Class. o'flow
10.15	5.0	0.28	0.07	1.17	0.56	0.03	114	
10.30	"	"	"	"	"	"		1:4.2
11.00	"	"	"	"	"	"		1:2.5
11.30	"	"	"	"	"	"		1:2.5
12.00		"	"	"	"	"		1:2.8
12.30	"	"		"	"	"		1:2.1
1.00		"	"	"	"	"		
1.30		"		"	"	"		
	Sample 2							
2.00	5.0	"	"	"	0.84	0.04		1:3.0
2.30		"		"	"	"		1:2.0
3.00	"	0.34	"	1.22	"	"	98	1:3.3
3.30	"	0.34		"	"	"		1:4.0
4.00	"	0.34	"	"	"	"		1:3.1

Lot 5 - Section 2 - (Selective Flotation)

The flow sheet was the same as that used for Lot 4 Section 1.

Results: Head - Cu 2.00% Zn 5.51 % Au 0.04 oz Ag 0.48 oz

Test No	Product	Weight %	Assays Cu %	Zn %	Au oz	Ag oz	% of values Cu	Zn	Au	Ag
5	Cu conc.	10.83	17.06	4.64	0.20	3.44	92.50	9.07	66.67	75.51
	Zn "	10.67	0.70	43.55	0.02	0.36	3.50	84.39	6.67	8.16
	Cu tail		0.14	4.64	0.01	0.12				
	Zn "	78.50	0.10	0.46	tr	0.10	4.00	6.54	26.66	16.33
6	Sample 1									
	Cu conc	8.46	20.04	3.52	0.21	3.63	86.00	5.44	54.05	70.45
	Zn "	18.83	1.19	24.28	0.015	0.37	11.00	82.94	27.00	15.90
	Cu tail		0.34	5.40	0.01	0.15				
	Zn "	72.71	0.11	0.88	0.01	0.09	4.00	11.62	18.95	13.65
	Sample 2									
	Cu conc	10.44	17.75	3.62	0.16	3.50	92.50	6.90	64.00	80.00
	Zn conc	13.44	0.63	36.31	0.01	0.27	4.00	88.57	4.00	8.89
	Cu tail		0.16	5.76	0.01	0.15	3.50	4.53	32.00	11.11
	Zn tail	76.12	0.08	0.33	0.01	0.07				

Reagents: (in lb/ton) Tests 5 & 6

Time	Rod mill Na_2CO_3	Thio	NaCN	$ZnSO_4$	Cond. tanks #1 NaCN	#2 NaCN	Head of cells Cu Cresyl	Zn $CuSO_4$	Zn Xanthate	Feed lb/ ton	Classifier Overflow
	Test No. 5										
9.20	4.44	0.14		0.92	0.30		0.42			108	
10.00	4.72	"		"	0.29		"				
10.30	"	"		"	0.30		0.70				
11.00	"	"		"	0.33		0.28				1:7.3
11.15	"	"		"		0.22	0.56				1:3.3
11.30	4.85	0.142		0.95	0.40	"	"			105	1:3.7
12.00	"	"		"	0.31	"	"	1.19			1:4.0
12.60	"	"		"	"	"	"	"	0.04		1:2.0
1.00	"	"		"	"	"	"	"	"		1:2.2
1.30	4.71	"		"	0.30	"	"	"	"		1:3.6
2.00	4.85	0.147		0.90	"	0.23	"	1.26	"	102	1:3.6
2.30	"	"		"	0.32	"	0.42	"	"		1:3.3
3.00	"	"		"	0.29	"	0.56	1.20	"		1:2.8
	Test No. 6										
9.30	4.6	0.14	0.27	0.95		0.28	0.56	1.28	0.075		1:1.8
10.00			0.23					1.14	"		1:3.5
10.30	4.8	"	0.31	"		"	"	"	"	105	1:2.2
11.00	4.6	"	0.27	"		"	"	"	"		1:2.2
11.30	4.7	"	0.31	"		"	"	"	"		1:2.8
12.00	"	"	"	"		"	"	1.06	"		1:2.3
12.30	"	"	"	off		"	"	"	0.05		1:3.0
1.00	"	"	"			"	"	"	"		1:3.0 Sample
2.00	"	"	0.23			"	"	"	"		1:3.0 #2
2.30	4.3	"	0.33			"	"	1.37	"		1:3.5
3.00		"	0.38			"	"	"	"		1:3.5
3.30	4.6	"	0.43			"	"	"	"		1:3.0

Lot 5 - Section 3 - (Large scale tests)

The ore was crushed to ½" and fed to a 6 x 3 ft. Marcy rod mill in closed circuit with a 14" x 12' Dorr classifier. The feed rate was from 800 to 1000 pounds of ore an hour. The overflow of the classifier passed directly to an 8-cell Greenawalt flotation machine; finished copper concentrate was taken from the first two cells, the remaining cell concentrates being returned to the head of the machine. The concentrate was not cleaned. The tailing from this operation was then elevated by an air lift to a four-cell Callow flat bottom type unit consisting of two rougher cells in series and two cleaner cells in series. The tailing from both cleaner cells was returned to the head of the machine. Results of tests 7, 8, 9, 10 and 11 follow:-

Test Run No. 5

Product	Weight %	Assays Cu %	Zn %	Au oz	Ag oz	% of values Cu	Zn	Au	Ag
Head		5.36	3.71	0.04	2.93				
1st.sample									
Cu conc.	25.87	20.30	6.00	0.08	11.52	98.50	41.89	99.00	88.43
Zn "	4.66	0.46	36.78	0.02	1.90	0.37	46.22		2.67
Cu tailg		0.10	4.42	tr.	0.62				
Zn "	69.47	0.09	0.84	tr.	0.44	1.13	11.89		8.90
2nd. sample									
Cu conc.	20.91	25.16	3.76	0.08	12.08	98.13	21.29	99.00	87.54
Zn "	5.60	0.60	45.52	0.02	1.46	0.56	68.73		2.77
Cu tailg.		0.16	3.71	tr.	0.46				
Zn tailg.	73.49	0.09	0.51	tr.	0.38	1.31	9.98		9.69

Reagents:

Time	Copper Na_2CO_3 lb/ton	NaCN lb/tn	$ZnSO_4$ lb/tn	$CuSO_4$ lb/tn	Cresyl.Thio lb/ton	lb/tn	Zinc Aero lb/tn	NaCN lb/tn	Feed	Class O'Flow
9.30	5.1	0.20	1.06		0.22	0.15			105¾	1:3.7
10.00	5.1	0.23	1.06		0.33	0.15				1:4.2
10.30	5.1	0.28	1.08	0.83	0.33	"		0.11	107.8	1:3.5
11.00	5.1	0.28	1.08	0.83	0.44	"		0.11		1:3.7
11.30	5.1	0.28	1.08	0.83	0.44	"		0.11		1:3.7
12.00	5.1	0.28	1.08	0.83	0.44	"		0.11		1:3.7
12.30	5.1	0.28	1.08	0.83	0.44	"		0.11		1:3.3
1.00	5.1	0.28	1.08	0.83	0.44	"		0.11		1:3.3
1.30	5.1	0.28	1.08	0.83	0.44	"		0.11		1:3.3
2.00	5.1	0.41	1.08	0.83	0.44	"		0.11		1:3.1
2.30	5.1	0.41	1.03	0.88	0.44	"		0.11	103½	1:2.8
3.00	5.1	0.41	1.03	0.88	0.44	"		0.11		1:3.0
3.30	5.1	0.41	1.03	0.88	0.44	"	0.22	0.11		1:3.1

Test Run No. 6 - Bulk concentration

Product	Assay Cu %	Zn %	Au oz	Ag oz	% recovery Cu	Zn	Au	Ag
Cu+Zn conc	21.58	15.06	0.06	8.71	96.30	90.57	99.00	
Tailing	0.26	0.45	tr	0.78				

Reagents

Time	CaO lb/tn	NaCn lb/tn	$CuSO_4$ lb/tn	Xanthate lb/ton	Cresylic lb/ton	Feed	Water to bm	Class O'flow
9.30	5.0	0.40	0.85					
10.00	5.0	0.40	0.85	0.13	0.28	96	2000	
10.30	5.0	0.40	0.85	0.13	0.28			1:3.1
11.00	5.0	0.40	0.85	0.13	0.28	103¼		1:3.5
11.30	5.0	0.40	0.85	0.17	0.28			1:3.1
12.00	5.0	0.40	0.85	0.17	0.28			
12.30	5.0	0.40	0.85	0.17	0.28		2000	1:2.7
1.00	5.0	0.40	0.85	0.17	0.28			1:2.5
1.30	5.0	0.40	0.85	0.17	0.28		2000	1:2.5
2.00	5.0	0.40	0.85	0.17	0.28			1:3.0
2.30	5.0	0.40	0.85	0.21	0.28	100.9		1:3.0
3.00	5.0	0.40	0.85	0.21	0.28		2000	1:3.0
3.30	5.0	0.40	0.85	0.21	0.28			1:3.1
4.00	5.0	0.40	0.85	0.21	0.28			1:2.8

Tabling flotation tailings for Tin -

18 bags (wet) were tabled on Wilfley slime deck and the concentrates sampled and assayed for tin.

Results: Sample No. 1 0.04% Sn
2 0.06% Sn
3 0.05% Sn

Test No	Product	Weight %	Assays Cu %	Zn %	Au oz	Ag oz	% of values Cu	Zn	Au	Ag
7	Head		3.08	7.11	0.06	0.95				
	Sample 1									
	Cu conc	16.62	18.07	6.71	0.16	4.64	97.40	15.75	66.66	83.69
	Cu tail		0.08	6.68	0.01	0.30				
	Zn conc	10.54	0.26	44.79	0.01	0.30	0.97	66.38	2.22	3.26
	Zn tail	72.84	0.06	1.75	0.02	0.16	1.63	17.87	31.11	13.05
	Sample 2									
	Cu conc	13.27	22.06	5.01	0.12	3.24	95.13	9.28	61.54	72.88
	Zn "	9.96	0.74	52.40	0.02	0.27	2.27	73.42	7.69	5.08
	Cu tail		0.18	7.51	0.02	0.12				
	Zn "	76.77	0.11	1.60	0.01	0.17	2.60	17.30	30.77	22.04
8	Head		3.08	7.11	0.06	0.95				
	Sample 1 (10 am - 2.50 pm)									
	Cu conc	10.57	26.41	3.81	0.27	5.05	90.88	5.63	56.60	81.54
	Cu tail		0.36	7.26	0.01	0.13				
	Zn conc	13.12	1.54	45.00	0.02	0.45	6.51	83.10	5.66	9.23
	Zn tail	76.31	0.10	1.05	0.02	0.19	2.61	11.27	37.74	9.23
	Sample 2									
	Cu conc	13.28	22.04	3.91	0.20	4.52	95.13	7.31	63.83	77.92
	Cu tail		0.17	7.31	0.02	0.18				
	Zn conc	13.45	0.64	46.29	0.02	0.38	2.92	87.62	6.38	6.49
	Zn tail	73.29	0.09	0.50	0.02	0.16	1.95	5.07	29.79	15.59
9	Head		3.10	5.91	0.045	0.61				
	Sample 1 (10.30 am - 12.10 pm)									
	Cu conc	17.03	17.18	4.40	0.20	3.80	94.52	12.69	71.43	81.25
	Cu tail		0.20	7.11	0.02	0.23				
	Zn conc	10.58	0.83	44.89	0.02	0.39	2.90	80.37	4.76	5.00
	Zn tail	72.39	0.12	0.57	0.02	0.16	2.58	6.94	23.81	13.75
	Sample 2									
	Cu conc	14.51	19.81	3.00	0.15	4.01	92.58	7.29	64.52	72.50
	Cu tail		0.36	6.96	0.03	0.33				
	Zn conc	11.83	1.04	43.48	0.01	0.45	4.19	87.12	3.23	6.25
	Zn tail	73.66	0.14	0.45	0.02	0.23	3.23	5.59	32.25	21.25
10	Head		3.10	5.91	0.045	0.81				
	Sample 1 (10.10 am - 4.00 pm)									
	Cu conc	15.48	18.25	3.20	0.16	3.94	91.29	8.29	62.50	76.25
	Cu tail		0.31	5.81	0.015	0.25				
	Zn conc	11.72	1.47	43.08	0.01	0.48	5.48	85.45	2.50	7.50
	Zn tail	72.80	0.14	0.50	0.02	0.18	3.23	6.26	35.00	16.25
	Sample 2								68.96	
	Cu conc	11.78	22.97	3.71	0.20	5.00	87.42	7.43	68.86	79.73
	Cu tail		0.45	6.71	0.01	0.39				
	Zn conc	16.61	1.55	27.35	0.01	0.25	8.39	77.03	6.90	5.40
	Zn tail	71.61	0.17	1.30	0.01	0.15	4.19	15.54	24.14	14.87
11	Head		3.10	5.91	0.045	0.81				
	Sample 1 (10.35am - 12.00)									
	Cu conc	14.92	19.07	4.41	0.22	4.12	91.61	11.17	78.57	80.26
	Cu tail		0.23	6.71	0.02	0.17				
	Zn conc	10.67	1 .48	35.97	0.02	0.46	5.16	64.97	4.76	6.58
	Zn tail	74.41	0.13	1.90	0.01	0.14	3.23	23.86	16.67	13.16
	Sample 2 (12.00 - 1.55pm)									
	Cu conc	15.57	19.07	5.21	0.18	3.96	95.81	13.71	75.68	82.67
	Cu tail		0.15	6.66	0.02	0.16				
	Zn conc	10.76	0.52	35.75	0.02	0.32	1.93	65.14	5.41	4.00
	Zn tail	73.67	0.10	1.70	0.01	0.14	2.26	21.15	18.91	13.33
	Sample 3									
	Cu conc	14.85	19.86	5.11	0.24	4.30	95.16	12.86	81.82	81.01
	Cu tail		0.17	6.66	0.01	0.15				
	Zn conc	10.57	0.52	39.57	0.015	0.34	1.61	70.73	2.27	5.06
	Zn tail	74.58	0.13	1.30	0.01	0.15	3.23	16.41	15.91	13.93

Reagents: (in lb/ton)

Test No	Time	Rod Mill Na_2CO_3	Rod Mill NaCN	Rod Mill $ZnSO_4$	Rod Mill Thio	Rod Mill ~~Cresyl acid~~	Head of cells Copper Cresyl	Head of cells Copper ~~Aerofit~~	Head of cells Zinc Cresyl.	Head of cells Zinc $CuSO_4$	Head of cells Zinc TT	Head of cells Zinc Xantht	Air lift Xantht	Air lift NaCN	Feed lb/ hour	% solids R.M. disch	% solids Class o'flow	pH
7	9.30	2.7	0.27	0.92	0.09	0.13	0.13							0.36	3100			
	10.00	"	"	"	"					0.46				"	776	34		
	10.30	"	"	"	"		0.10			1.13			0.06	"	1060	43	31	
	11.00	"	"	"	"					"			"	"	880	40	33	
	11.30	"	"	"	"		0.11			"			"	"	870	49	37	
	12.00	"	"	"	"		0.08		0.13	1.08			0.19	"	870	52		7.2
	12.30	3.0	"	"	"		0.06		0.27	1.16			"	0.18	870		27	
	1.00	"	"	"	"										870	56	23	7.6
	1.30	"	0.33	"	"		0.08		0.31	"			0.21	0.09	870	55	14	
	2.00	"	"	"	"					"					870	51	29	
	2.30	"	"	"	"		0.11		"	"			"	"	870	46	24	8.6
	3.00	"	"	"	"				"	"			"	"	870	58	28	8.6
	3.30	"	"	"	"		"		"	"			"	"	870	50	29	
	4.00	"	"	"	"		"		"	"			"	"	870	55	28	
8	9.00	2.3	0 26	1.20	.079		0.15		0.05	0.92			0.18	0.07				
	9.15	2.8	0.30	"	"		"		"	"			"	"	1020			
	9.30	"	"	"	"		"		"	"			"	"	1020	48	43	
	10.00	3.07	0.32	"	"		"		"	"			"	"		51	18	
	10.30	"	"	"	"		"		off	"	0.15		"	"		53	28	
	11.00	"	"	"	"		"			"	"		"	"		53	33	
	11.30	"	"	"	"		"			"	"		"	"		54	29	
	11.45	"	"	"	off		"			"	0.05		"	0.14				
	12.00	"	"	"			0.20			0.97	"		"	"		55	26	
	12.30	"	"	"			"			"	"		"	"		55	29	
	1.00	"	"	"			"			1.00	"		"	"		57	31	
	1.30	"	0.36	"	.065		"			"	"		"	"		58	23	
	2.00	"	"	"	"		"			"	"		"	"		54	24	
	2.15	"	0.26	"	"		"			"	0.10		0.20	"				
	2.30	"	"	"	.09		"			"	"		"	"		59	24	
	3.00	"	"	"	"		"			"	"		"	"		59	23	
	3.30	"	"	"	"		"			"	"		"	"		59	22	
	4.00	"	"	"	"		"			"	"		"	"		59	21	
	4.30	"	"	"	"		"			"	"		"	"				

Reagents: (in lb/ton)

Test No.	Time	Rod Mill Na_2CO_3	Rod Mill NaCN	Rod Mill $ZnSO_4$	Rod Mill Thio	Head of cells: Copper Cresyl.	Head of cells: Copper Aeroflt	Head of cells: Zinc Cresyl	Head of cells: Zinc $CuSO_4$	Head of cells: Zinc TT	Head of cells: Zinc Xantht	Air lift Xantht	Air lift NaCN	Feed lb/ hour	% solids R.M. disch	% solids Class o'flow	pH
9	9.45	3.42	0.28	1.3	0.11	0.06			1.09	0.03		0.24	0.17				
	10.00													926			
	10.30	3.20	0.27	1.2	0.10	"			1.02	"		0.23	0.16	990	43	16	
	11.00					"			"	"		"	"		64	27	
	11.30	"	0.33	"	"	"			"	0.05		"	"		56	46	
	12.00	3.23	"	1.25	"	"			1.03	"		"	"	980	59	38	
	12.30	"	"	"	"	"			"	"		"	"		59	38	
	1.00	"	"	"	"	"			"	"		"	"		63	36	
	1.30	"	"	"	"	"			"	0.02		"	"		64	43	
	2.00	"	"	"	"	"			"	"		"	"		66	42	
	2.30	"	"	"	"	"			"	"		"	"		65	41	
	3.00	"	"	"	"	"			"	"		"	"		65	41	
	3.15	2.8	0.23	1.23	0.09	0.05			0.90	"		0.21	0.14	1125			
	3.30									"							
	4.00	"	"	"	"	"			"	"		"	"		67	40	
10	9.15	3.0	0.31	1.16			0.06		1.06	0.02		0.27	0.15				
	9.30													1050			
	10.00	"	"	"			"		"	"		"	0.21		47	24	
	10.30	"	"	"			"		"	"		"	"		52	23	
	11.00	"	"	"			"		"	"		"	"		46	36	
	11.30	"	"	"			"		"	off		"	"		45	29	
	12.00	"	"	"			"		"			"	"		47	28	
	12.30	"	"	"			"		"			"	"		47	26	
	1.00	"	"	"			"		"			"	"		47	26	
	1.30	"	"	"			"		"			"	"		46	30	
	2.00	"	0.35	"			"		"			0.11	0.25		45	29	
	2.30	3.23	0.38	1.25			"		1.03			off	0.26	980	47	25	
	3.00	"	0.34	"			"		"	Aeroflt			Off		50	29	
	3.30						"		"	0.13							
	4.00	5.12	"	"			"		"	off					52	29	
	4.35																
11	10.00	5.0	0.33		0.08	0.06		0.02	1.0		0.08		0.22				
	10.15	"	"		"	"		"	"		"		"				
	10.30	"	"		"	"		"	"		"		"	1005	55	36	
	11.00	"	"		"	"		"	"		"		"		50	41	
	11.30	"	"		"	"		"	"		"		"		53	33	
	12.00	"	"		"	"		"	"		"		"		50	33	
	12.30	"	0.37		"	"		"	"		"		0.26		56	36	
	1.00	"	"		"	"		"	"		"		"		56	31	
	1.30	"	"		"	"		"	"		"		"		58	33	
	2.30	"	"		"	"		"	"		"		"		58	33	
	3.00	"	"		"	"		"	"		"		"		58	34	
	3.20	"	"		"	"		"	"		"		"		58	34	

Conclusions & Remarks Lot 5: The head sample for tests 7 & 8 was Cu 3.08% Zn 7.11 %, Gold 0.05 oz/ton, Silver 0.90 oz/ton, Fe 17.92%, and for tests 9, 10, & 11 it was - Cu 3.10 %, Zn 5.91 %, Gold 0.045 oz/ton, Silver 0.81 oz/ton. The reason for this variation was that the ore was crushed and sampled in two separate lots.

The small scale tests in sections 1 and 2 are not as good as those on lot 4. This is chiefly due to manipulation of the small unit, although the poor grade of the concentrate may be partly due to over oiling. The large scale tests are exceptionally good and give a very excellent idea of what can be expected from the operation of a mill.

Summary & Conclusions:

1. It will be possible to make a 20% copper concentrate with over 90% recovery.
2. A 45-50% zinc concentrate with over 80% recovery
3. The gold recovery will vary with the grade of the copper concentrate and for a concentrate of 20% copper will be over 60%
4. The silver recovery will also vary, but will be over 70%
5. The zinc in the copper concentrate can be kept between 3 and 4 % without much difficulty.
6. The use of zinc sulphate was found to lower the zinc in the copper concentrate but it also interfered with the subsequent flotation of the zinc, making it difficult to obtain a high grade zinc concentrate and low tailing at the same time.
7. The alkalinity of the pulp during flotation was found to effect the results. A pH of about 8-9 was found to give the best results in these tests.
8. It was found necessary to reclean the zinc concentrate twice, that is to use two cleaners in series.
9. Although no conditioning tanks were used in the large scale tests there was evidence to indicate that better and more uniform conditions would be obtained by adding the cyanide to a conditioning tank instead of to the rod mill, and conditioning for about 30 mins.
10. Conditioning was found to be important between the copper and zinc separations. The well of the air lift gave a short period of contact for additional cyanide before the zinc was floated. This was found to be an important feature of the separation. If sufficient cyanide was added before the flotation of the copper to inhibit the iron during both the flotation of the copper and zinc, the copper was decidedly acted on by the cyanide, resulting in a poor recovery

and high copper in the zinc concentrate. From our experience we strongly recommend conditioning and the use of additional cyanide between the copper and zinc sections.

Recommendations: Although the results of our tests indicate that the ore can be readily concentrated, we recommend that a pilot plant be built at the mine and operated for a sufficient time to obtain the necessary data on crushing, grinding, conditioning, uniformity of the milling action of the ore, and the seasonal effect, if any, of the water supply. After obtaining this data the mill can be designed and erected with the assurance that no extensive alterations will be found to be necessary after it is put into operation. We believe that in the long run, a pilot plant will pay for the cost of construction and operation many times over.