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A STUDY OF SELECTIVE FLOTATION TECHNIQUES FOR CONCENTRATING A Cu-Pb-Zn-Ag ORE FROM MATTABI MINES LIMITED, STURGEON LAKE AREA, ONTARIO

by

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MINERAL PROCESSING DIVISION

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SUMMARY OF RESULTS

The three ore samples investigated assayed as follows:

Sample No.	% Cu	% Pb	% Zn	oz/ton Ag
F-1	0.7	1.1	9.3	4.0
F-2	1.4	0.8	9.0	3.6
F-7	0.6	2.5	8.5	3.0

Sulphide mineralization consisted of pyrite, sphalerite, pyrrhotite, chalcopyrite and galena. Silver was present as silver-bearing tetrahedrite.

Flotation of a bulk copper-lead concentrate and zinc concentrate at a grind of 83% minus 200 mesh followed by copper-lead separation of the bulk concentrate gave the following range of results:

	% Cu	% Pb	% Zn	oz/ton Ag
Cu conc	22 - 29	1.2 - 2.4	3.2 - 5.2	27 - 83
Pb conc	0.3 - 0.9	37 - 55	3.2 - 5.3	15 - 150
Zn conc	0.1 - 0.15	0.1 - 0.2	58 - 59	0.9 - 1.3
Rougher flotation recovery, %	89 - 95	81 - 90	85 - 89	78 - 81

Similar grades of copper and lead concentrates were also produced by selective flotation directly on the ore but recoveries were lower.

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INTRODUCTION

Location of Property

The ore deposit is located within the Abitibi Paper Company Block No. 7 near Sturgeon Lake, about 50 miles northeast of Ignace, Ontario. Recently a new company, Mattabi Mines Limited, has been formed to put the property into production. It is jointly owned by Mattagami Lake Mines Limited (60%) and Abitibi Paper Company Limited (40%).

Shipment

Three shipments of coarsely crushed diamond drill core (about 3/8 in) were received as follows:

Sample No.	Date received	Weight, lbs
F-1	January 9, 1970	115
F-2	March 31, 1970	110
F-7	August 6, 1970	106

Nature of Investigation Requested

In his letter of December 4, 1969, Mr. M. W. Airth, Manager, Mattagami Lake Mines Limited, requested assistance in carrying out a metallurgical investigation on representative diamond-drill core. It was also stated that tests would be carried out at the Mattagami laboratories and those of associated companies. In subsequent discussions with Mr. M.J.S. Bennett and Mr. K.V. Konigsmann, metallurgical consultant and mill superintendent respectively, it was agreed that the cyanide method for copper-lead separation of a bulk copper-lead concentrate was to be investigated thoroughly in preference to other methods. This was to avoid duplication of effort by the other laboratories who would concentrate on the sulphur dioxide-starch and dichromate methods.

Sampling and Analysis

Each of the samples was first riffled into halves. One of the halves was crushed to minus 10 mesh and riffled into 16 portions, while the other half was stored for future use. One of the portions was chosen at random as a head sample; the weights of the remaining portions were adjusted to make up 2000-gram lots. In order to minimize possible oxidation of sulphides, the practice was adopted of storing both the coarsely crushed and finely crushed material in a freezer. Chemical analyses of the head samples are given in Table 1, followed by a semi-quantitative spectrographic analysis of the F-1 head sample in Table 2.

TABLE 1

Chemical Analyses of Head Samples

		F-1	F-2	F-7
Copper	(Cu)	0.72 %	1.41 %	0.59 %
Lead	(Pb)	1.11 "	0.79 "	2.50 "
Zinc	(Zn)	9.25 "	9.02 "	8.46 "
Soluble Iron	(Fe)	23.2 "	25.1 "	27.8 "
Sulphur	(S)	25.6 "	28.8 "	27.5 "
Insolubles	(Insol)	30.7 "	26.5 "	15.2 "
Silver	(Ag)	4.01 oz/ton	3.59 oz/ton	2.99 oz/ton
Gold	(Au)	0.02 " "	0.014 " "	0.012 " "
Ratio, chalcopyrite: galena		1.6:1	4.5:1	0.6:1

TABLE 2

Semi-Quantitative Spectrographic Analysis* of F-1 Head Sample

Range - %	Elements
Principal constituent	Si, Fe, Zn
1.0 to 0.1	Pb, Mg, Al, Cu
0.1 to 0.01	Ni, Mo, Ca, Cr, Mn, Ti, Zr, Ag
Not detected	Ba, Be, B, Sb, As, W, Sn, Nb, Ta Ge, Bi, V, Sr, In, Na, Co.

*From Internal Report MS-AC-70-4.

Mineralogical Examination*

Fragments from the F-1 sample and also a representative portion of the minus 10-mesh head sample were submitted to the Mineral Sciences Division for mineralogical examination.

Four polished sections for microscopic study were prepared from the diamond-drill core fragments. The -48 + 100 and the -100 +.200-mesh fractions of the minus 10-mesh head sample were separated using heavy liquids with specific gravities of 2.96, 3.3 and 3.7; the sink products at 3.7 were further separated into sub-fractions magnetically using a hand magnet and the Frantz magnetic separator. Polished sections were then prepared from several of these sub-fractions. The hand magnetic fraction was subjected to X-ray diffractometery to determine the ratio of monoclinic to hexagonal pyrrhotite. The minerals were identified by microscopy, X-ray diffraction analysis and electron-probe microanalysis.

The diamond-drill core samples consisted principally of sulphides with minor gangue; a few of the core fragments were attracted to a hand magnet and contained mainly pyrrhotite and magnetite, while a few others contained mainly gangue minerals.

Pyrite, sphalerite, pyrrhotite and magnetite all occur in major amounts. Much of the pyrite is massive, but some also occurs as grains varying in size** down to about 10 microns. The pyrite appears to be associated with all the other ore minerals***.

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* From Mines Branch Investigation Report IR 70-15 "Mineralogical Examination of a Cu-Pb-Zn-Ag Ore Submitted by Mattagami Lake Mines Ltd., from the Sturgeon Lake, NW, Ontario Deposit" by R. G. Pinard.

** The word "size" as used in this report refers to the greatest dimension of the grain.

***The term "ore mineral" as used in this report does not necessarily have an economic connotation.

The great majority of sphalerite occurs in massive form (Figure 1), but a relatively minor amount is also present as disseminated grains, which vary in size from several millimeters to less than 5 microns. It occurs as inclusions in pyrite, as isolated grains, and in veins associated with the gangue minerals (Figure 2). Electron-probe analyses showed the sphalerite to vary in Fe content from a high of about 8.1% to a low of about 6.3%. The majority of the pyrrhotite is relatively coarse, with grains up to about 1 millimetre in size; it is frequently found associated with magnetite. The pyrrhotite appears to be mainly of the magnetic monoclinic variety. The magnetite grains vary in size from 1 mm down to very fine-grained inclusions of about 5 microns in size.

The next most common ore mineral is chalcopyrite, most of which is relatively coarse, but some of which occurs as fine-grained inclusions down to about 10 microns. It appears to be associated with all other ore minerals. The galena is more fine grained, (Figure 3), with a maximum grain size of about 800 microns. It is generally associated with pyrite, chalcopyrite, and sphalerite. Marcasite was found in a few of the polished sections with grain size varying from 300 microns to less than 10 microns.

The major gangue mineral is quartz, although minor amounts of mica and chlorite were also observed. Other minerals occurring in small amounts and found in a few of the samples are tetrahedrite, siderite, ilmenite, rutile and arsenopyrite.

Tetrahedrite (freibergite) was the only silver-bearing mineral identified, and was found only in the polished section prepared from the heavy liquid concentrate of the head sample. Electron micro-probe analysis showed it to contain a relatively high silver content of 15.4%, a copper content of 27.4% and an antimony content of 24.5%.

The liberation of the ore minerals was estimated by microscopic examination of the heavy-liquid fractions of the head sample. A rough assessment is that the ore minerals occur mostly as combined grains at -48+100 mesh but mostly as free grains at -100+200 mesh.

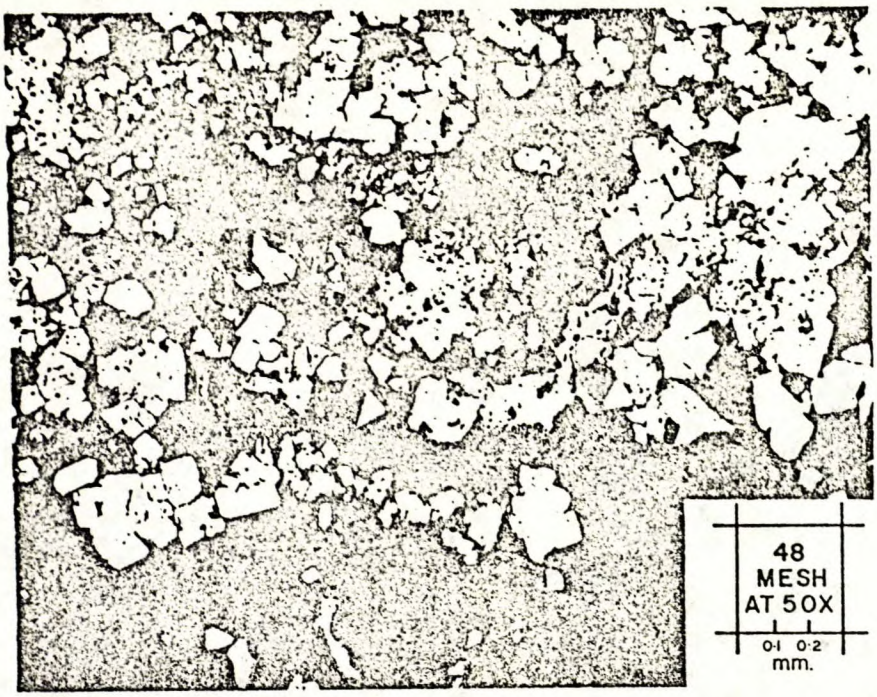

Figure 1.

Sphalerite matrix (dark grey) with inclusions of pyrite (white) and chalcopyrite (light grey). The black areas are gangue and polishing pits.

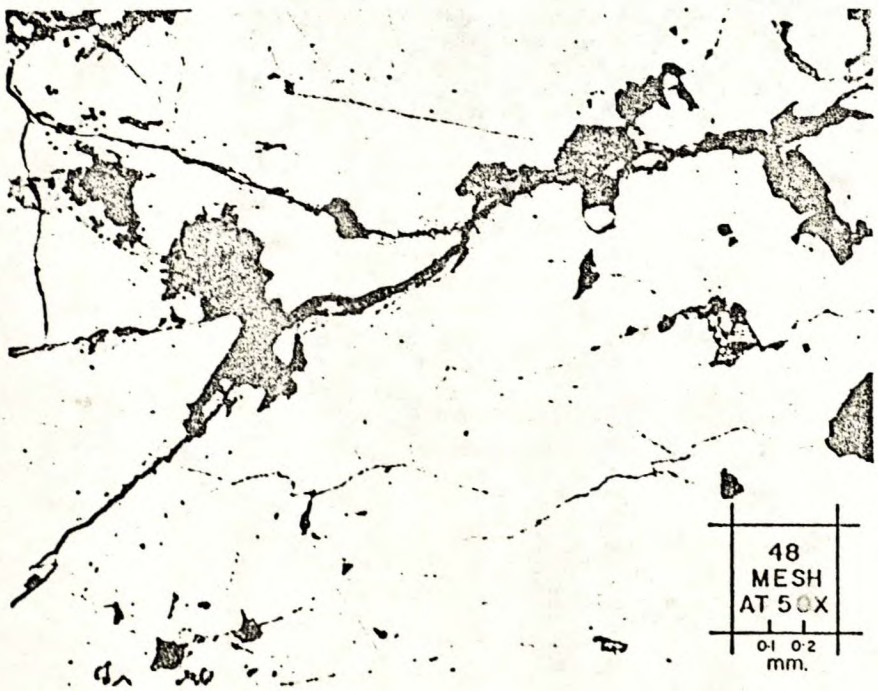

Figure 2.

Massive pyrite (white) with veins consisting of gangue (dark grey) and sphalerite (light grey). The black areas are polishing pits.

Figure 3.

Galena (light grey) with inclusions of pyrite (white) in gangue (dark grey); the black triangular areas are polishing pits.

The samples examined indicate a complex base metal ore, with sphalerite, galena and chalcopyrite as the principle sources of base metals. The other metal that would probably add to the value of the ore is the silver in the tetrahedrite.

The mineralogical examination did not reveal any factors that are likely to have a serious adverse affect on the beneficiation of the ore..

OUTLINE OF INVESTIGATION

The object of the investigation was to produce copper, lead and zinc concentrates from the ore by flotation with as much of the silver as possible to be recovered in the copper and lead concentrates.

Three schemes for the production of separate copper and lead concentrates were tried, as follows:

(1) Flotation of a bulk copper-lead concentrate followed by copper-lead separation of the bulk concentrate.

(2) Selective flotation of copper and lead concentrates directly from the ore.

(3) Selective flotation as in (2) augmented by copper-lead separation on one of the products.

After flotation of the copper and lead minerals, a zinc concentrate was floated from the tailing using standard procedure.

Where possible, the above three schemes were tried on each of the samples submitted. When the supply of F-1 sample was exhausted it was necessary to substitute a composite made up of equal parts of the F-2 and F-7 samples the copper:lead ratio of which was approximately equal to that of the F-1 sample.

Flowsheets for the various schemes are given in Figures 4, 5, 6 and 7.

Grinding

A primary grind of approximately 83% minus 200 mesh was employed in all tests except one (Test 34) in which a coarser grind of 75% minus 200 mesh was tried.

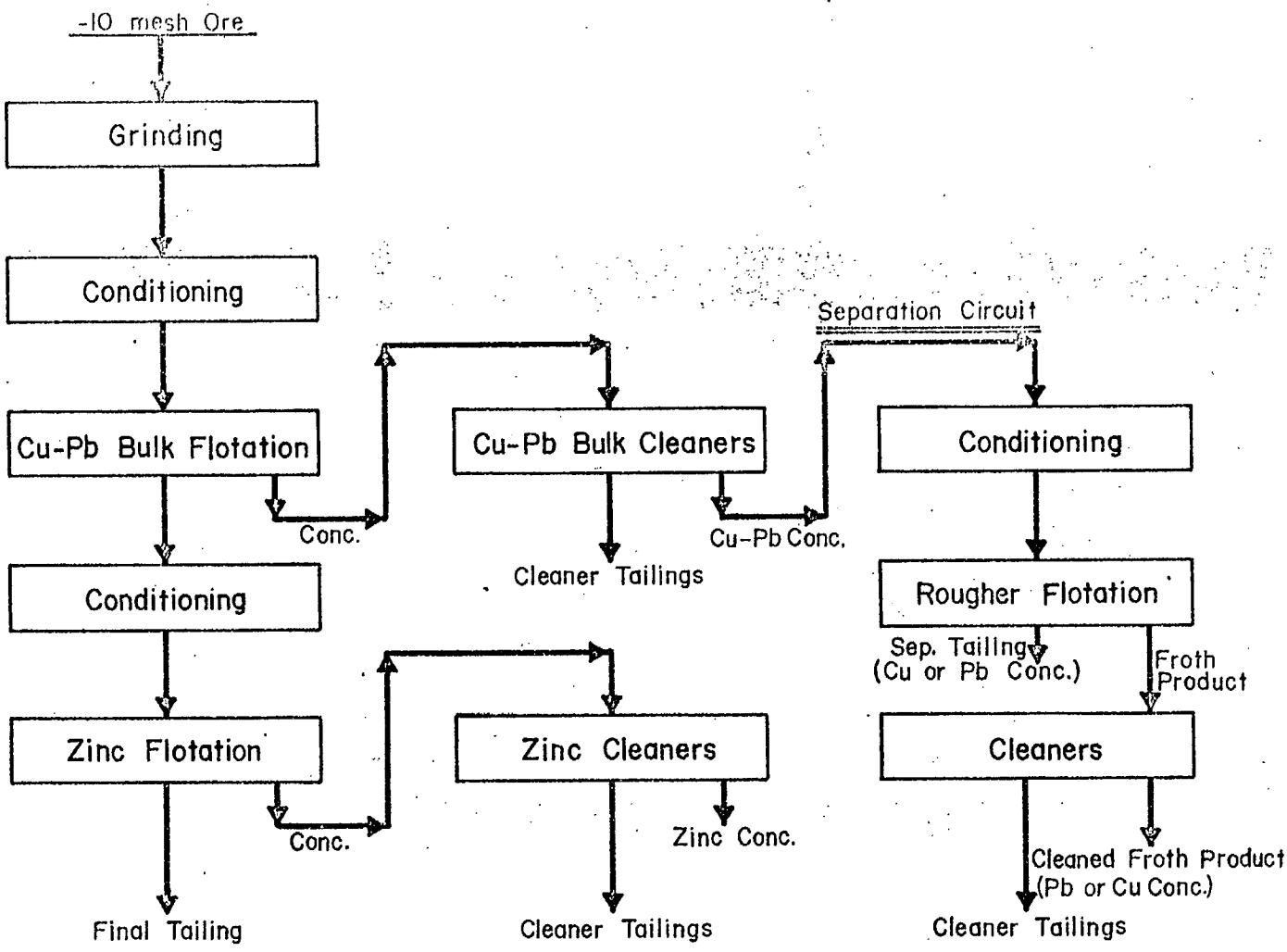

Figure 4 FLOWSHEET No.I — BULK FLOTATION FOLLOWED BY COPPER LEAD SEPARATION OF BULK CONCENTRATE

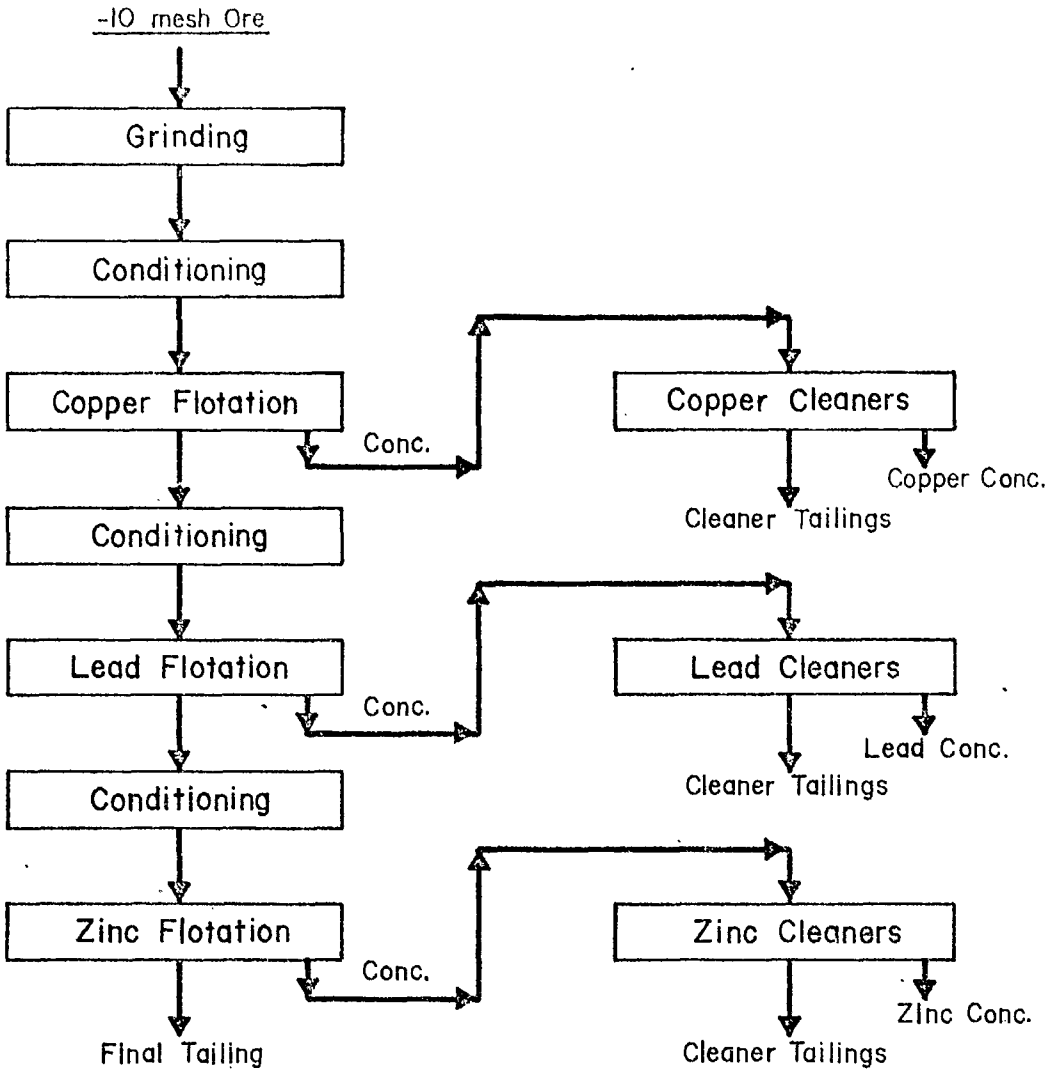

Figure 5 FLOWSHEET No. 2 — SELECTIVE FLOTATION OF COPPER AND LEAD CONCENTRATES DIRECTLY FROM THE ORE

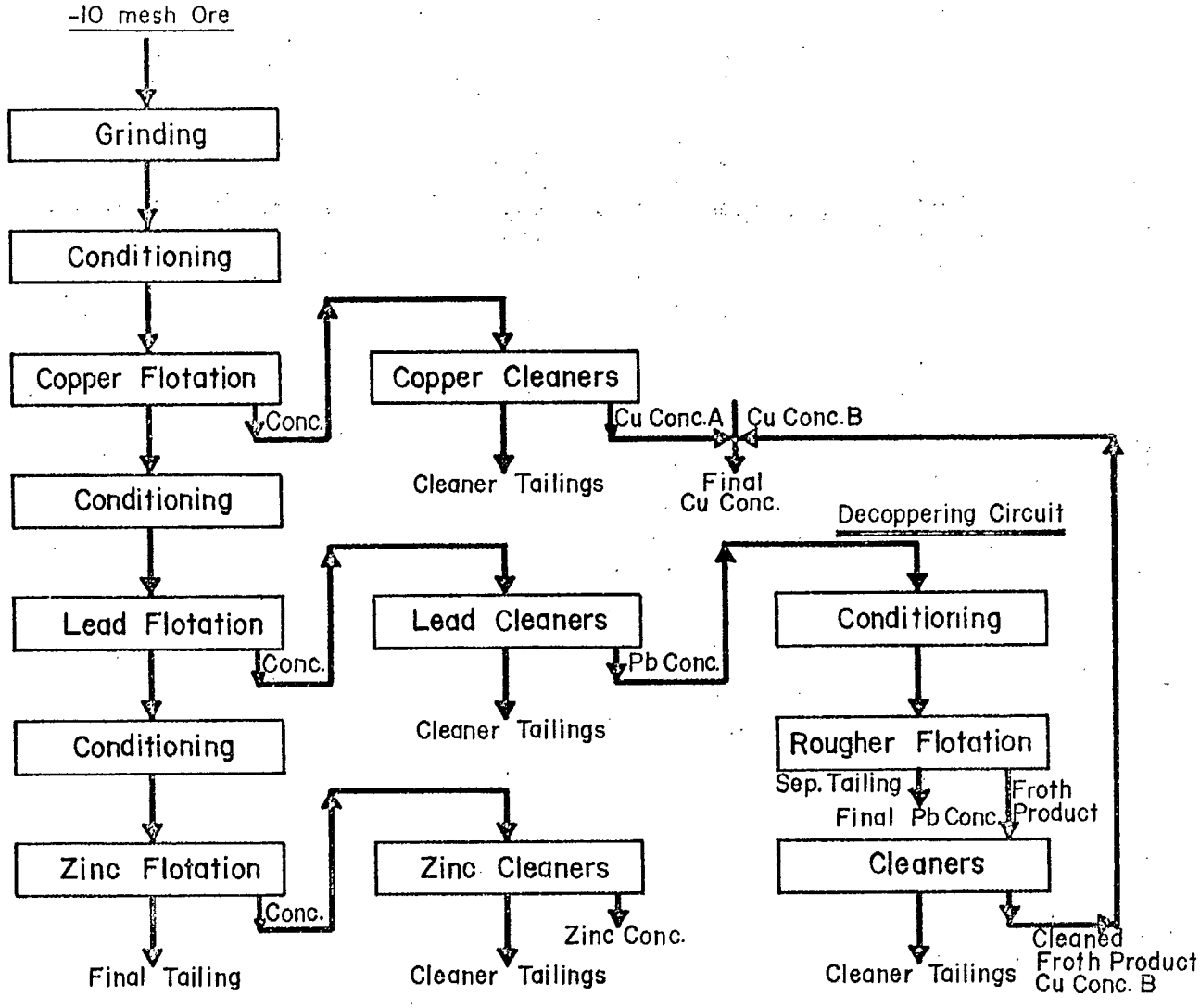

Figure 6 FLOWSHEET No.3A—SELECTIVE FLOTATION OF COPPER AND LEAD CONCENTRATES DIRECTLY FROM THE ORE AUGMENTED BY DECOPPERING OF LEAD CONCENTRATE

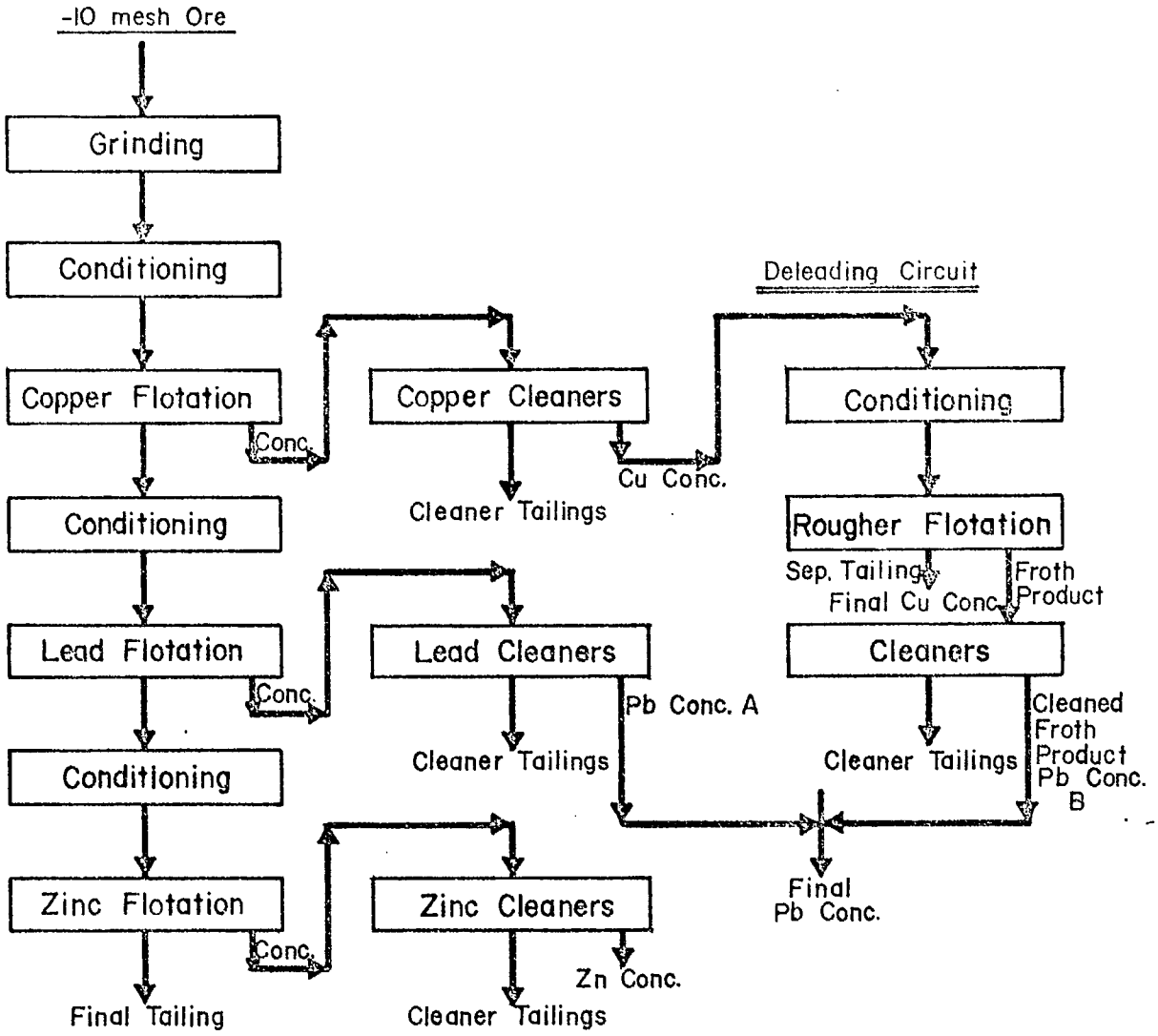

Figure 7 FLOWSHEET No. 3B—SELECTIVE FLOTATION OF COPPER AND LEAD CONCENTRATES DIRECTLY FROM THE ORE AUGMENTED BY DELEADING OF COPPER CONCENTRATE

Bulk Flotation Followed by Copper-Lead Separation of Bulk Concentrate (Flowsheet No. 1, Figure 4)

Bulk Flotation

Two combinations of alkalinity regulators and depressants were employed for bulk flotation viz; lime with zinc sulphate and cyanide, and soda ash with sodium sulphite and cyanide. Both combinations were tried with and without aeration of the pulp prior to flotation.

Combinations of Aerofloat Promoters 208 and 242 were employed as collectors for bulk flotation except in the initial tests on the F-1 sample in which amyl xanthate was used.

Generally, the bulk rougher concentrate was cleaned without additional reagents except for small amounts of frother. In two tests on the F-7 sample (39, 40) cyanide was added to the cleaners for pyrite depression.

Copper-Lead Separation

As was agreed, the cyanide method for copper-lead separation of the bulk concentrate was investigated in preference to other methods. However, the dichromate and sulphur dioxide-starch methods were tried in a few tests on the F-7 sample, the bulk concentrate from which was not amenable to separation by the cyanide method because of the high ratio of galena to chalcopyrite.

The compound $Na_2Zn(CN)_4$ was used as the chalcopyrite depressant in place of NaCN. This compound, which was prepared by adding NaCN to a dilute zinc oxide slurry, is reported to be as effective as NaCN and has the advantage of having no dissolving effect on cyanide-soluble minerals such as tetrahedrite*. It was found that high additions of the compound were required to effect a separation (10 to 20 lb/ton separation feed). This resulted in an increase in pH of the pulp to 11.5. When a lower pH was desired the required amount of NaCN was first added to the pulp followed by

*See "Flotation of Complex Copper-Lead-Zinc Ores" by F. W. McQuiston Jr., Transactions, International Mineral Dressing Congress, Stockholm 1957, page 513.

the addition of $ZnSO_4$ which was employed as the pH modifier. Presumably, the cyanide and zinc sulphate would react in the pulp to form the zinc-cyanide compound.

In efforts to improve separation efficiency, test conditions were varied as follows:

(1) Bulk concentrate slurry was boiled for a short time prior to the separation step; this was done to remove collector coatings from mineral surfaces.

(2) The pH was reduced from 11.5 to 9.5.

(3) Soda ash was added along with the zinc-cyanide compound

(4) Primary grind was coarsened to 75% minus 200 mesh from the standard 83% minus 200 mesh.

Selective Flotation of Copper and Lead Concentrates Directly from the Ore (Flowsheet No. 2, Figure 5)

In this scheme, the pulp was first conditioned with sufficient sulphur dioxide to bring the pH to the acid range. Sulphur dioxide has a depressing effect on galena, sphalerite, and the iron sulphides but does not affect chalcopyrite. After floating off a copper concentrate, the galena was reactivated by adjusting the pH of the pulp to the alkaline range with lime or soda ash. Sodium cyanide was also added to ensure depression of the iron sulphides and sphalerite. A lead concentrate was then floated off with Aerofloat 242.

The scheme was tried with and without aerative conditioning prior to copper flotation. A number of copper collectors were tested viz; amyl xanthate, Minerec A, Aerofloat 194 and Z-200.

Generally, the copper rougher concentrates were cleaned without depressants but in some tests lime or sulphur dioxide was added to depress galena and pyrite. Cyanide or a combination of lime and cyanide was added to the lead cleaners for pyrite depression.

Selective Flotation Augmented by Copper-Lead Separation

Two variations of this scheme were tried, as follows:

(1) Decoppering of Lead Concentrate (Flowsheet 3A, Figure 6)

A copper concentrate was selectively floated from the ore containing most, but not all of the recoverable copper. The balance of the copper was recovered in the subsequent lead flotation step. The lead concentrate was then subjected to copper-lead separation using the dichromate method and the copper concentrate from this operation was combined with the copper concentrate initially floated from the ore to give the final product.

(2) Deleading of Copper Concentrate (Flowsheet 3B, Figure 7)

Copper and lead concentrates were selectively floated as in (1) with the exception that all of the copper was recovered in the copper concentrate. The copper concentrate was subjected to copper-lead separation to reduce the lead content, and the lead concentrate from this operation was combined with the lead concentrate floated from the ore to give the final product.

In both cases above, selectivity was achieved by employing a selective promoter for copper flotation such as Z-200 or Aerofloat 238. In (1) lime, zinc sulphate and cyanide were added to the grind for pyrite and sphalerite depression, while in (2) the same purpose was served by adding sodium sulphite to the grind. In (1), lead flotation was achieved simply by adding Aerofloat 242 and Aero float 238 as collectors; in (2), the copper tailing was conditioned with soda ash and cyanide before collector addition.

Zinc Flotation

No difficulty was encountered in floating a high-grade zinc concentrate from the ore with good recovery. For this reason, zinc flotation was omitted from the procedure in many of the tests. High-lime alkalinity

(pH 11-5) was used in both roughers and cleaners to ensure maximum depression of pyrite. Sodium aerofloat along with smaller amounts of amyl xanthate were employed as zinc collectors.

Test Data

Details of test procedure and metallurgical balances are given in the flotation test reports, which are appended.

Except as noted, analyses of test products were done by the Mattagami Lake mine assay laboratory.

In addition to the total iron as determined by chemical analysis, the iron present as iron sulphides (pyrite and pyrrhotite) has been calculated for most of the test products by subtracting the iron present in the chalcopyrite and in the sphalerite (assumed to be 7 %) from the total iron. Because the ore contains the soluble iron minerals magnetite and siderite, the calculated value for iron as iron sulphides can be considered to be an approximation only. Despite this limitation, it has been found to be useful when evaluating results.

EVALUATION AND DISCUSSION OF RESULTS

Best Results for Copper and Lead Flotation

The best copper and lead results achieved using the three schemes are summarized and compared in Tables 3, 4 and 5. In order to simplify comparison, all the various cleaner tailings have been lumped together with only the metal distribution shown.

TABLE 3

Comparison of Results for Copper and Lead Flotation
Using the Three Schemes on F-1 and Composite Samples

Test No	Scheme	Product	Wt %	Assays*				Distribution %			
				Cu	Pb	Zn	Ag	Cu	Pb	Zn	Ag
36 (Comp)	Cu-Pb Separation of Bulk Conc, (Cyanide method)	Cu conc	2.79	21.70	2.11	5.24	27.02	63.5	4.0	1.7	24.7
		Pb conc	1.52	0.86	55.50	5.32	49.62	1.4	58.0	0.9	24.7
		Cl tail	7.79					30.6	28.4	8.0	31.9
		Cu-Pb ro tail	87.90	0.05	0.16	8.84	0.65	4.5	9.6	89.4	18.7
		Feed (calcd)	100.00	0.95	1.46	8.69	3.06	100.0	100.0	100.0	100.0
15 (F-1)	Selective Flotation	Cu conc	2.08	23.15	1.08	4.38	89.20	62.5	1.9	1.0	45.8
		Pb conc	1.82	0.64	38.40	8.73	23.67	1.5	60.3	1.7	10.6
		Cl tail	3.86					22.8	13.9	5.0	22.2
		Pb ro tail	92.24	0.11	0.30	9.09	0.94	13.2	23.9	92.3	21.4
		Feed (calcd)	100.00	0.77	1.16	9.10	4.05	100.0	100.0	100.0	100.0
38 (Comp)	Selective Flotation + Cu-Pb Separation (Flowsheet 3B)	Cu conc	2.99	23.15	1.14	2.00	20.84	69.3	2.2	0.7	18.3
		Pb conc	2.53	0.65	32.33	6.25	32.62	1.7	53.4	1.8	24.2
		Cl tail	4.97					16.4	30.9	5.7	30.0
		Pb ro tail	89.51	0.14	0.23	8.92	1.05	12.6	13.5	91.8	27.5
		Feed (calcd)	100.00	1.00	1.53	8.70	3.41	100.0	100.0	100.0	100.0

*Assays in this and all subsequent tables are in per cent, except Ag which is in oz per ton.

TABLE 4

Comparison of Results for Copper and Lead Flotation
Using the Three Schemes on F-2 Samples

Test No	Scheme	Product	Wt %	Assays				Distribution %			
				Cu	Pb	Zn	Ag	Cu	Pb	Zn	Ag
35	Cu-Pb Separation of Bulk Conc, (Cyanide method)	Cu conc	3.51	27.41	1.18	3.22	23.02	72.4	6.6	1.3	22.9
		Pb conc	0.60	0.26	47.72	5.26	154.60	0.1	45.3	0.4	26.3
		Cl tail	5.16					22.6	29.4	4.6	30.3
		Cu-Pb ro tail	90.73	0.07	0.13	8.96	0.79	4.9	18.7	93.7	20.5
		Feed (calcd)	100.00	1.33	0.63	8.68	3.52	100.0	100.0	100.0	100.0
22	Selective Flotation	Cu conc	3.77	27.24	1.07	3.64	33.15	72.4	6.4	1.6	34.7
		Pb conc	0.69	0.42	39.07	7.55	30.56	0.2	42.6	0.6	5.9
		Cl tail	4.72					17.6	24.3	3.6	31.6
		Pb ro tail	90.82	0.15	0.19	8.66	1.10	9.8	26.7	94.2	27.8
		Feed (calcd)	100.00	1.42	0.63	8.35	3.60	100.0	100.0	100.0	100.0
30	Selective Flotation + Cu-Pb Separation (Flowsheet 3A)	Cu conc	2.87	30.13	1.40	1.93	55.46	63.3	5.9	0.6	43.3
		Pb conc	1.31	0.32	23.24	6.56	18.48	0.3	44.8	1.0	6.6
		Cl tail	3.75					27.9	22.8	3.5	26.3
		Pb ro tail	92.07	0.13	0.20	8.83	0.95	8.5	26.5	94.9	23.8
		Feed (calcd)	100.00	1.36	0.68	8.56	3.68	100.0	100.0	100.0	100.0

TABLE 5

Comparison of Results for Copper and Lead Flotation
Using the Three Schemes on F-7 Sample

Test No	Scheme	Product	Wt %	Assays				Distribution %			
				Cu	Pb	Zn	Ag	Cu	Pb	Zn	Ag
39	Cu-Pb Separation of Bulk Conc, (Dichromate method)	Cu conc	0.81	29.06	2.44	5.04	83.19	42.8	0.9	0.5	25.2
		Pb conc	4.34	0.35	36.83	3.24	14.80	2.7	70.5	1.6	24.1
		Cl tail	5.43					43.7	18.5	6.0	28.2
		Cu-Pb ro tail	89.42	0.07	0.26	8.79	0.67	10.8	10.1	91.9	22.5
		Feed (calcd)	100.00	0.55	2.27	8.56	2.67	100.0	100.0	100.0	100.0
37	Selective Flotation	Cu conc	1.44	25.04	4.33	2.16	40.88	60.8	2.7	0.4	20.5
		Pb conc	3.15	0.09	50.17	5.84	21.68	0.5	68.0	2.1	23.7
		Cl tail	2.49					10.5	15.0	2.9	18.3
		Pb ro tail	92.92	0.18	0.36	8.78	1.16	28.2	14.3	94.6	37.5
		Feed (calcd)	100.00	0.59	2.32	8.62	2.88	100.0	100.0	100.0	100.0
31	Selective Flotation + Cu-Pb Separation (Flowsheet 3A)	Cu conc	1.58	24.94	13.95	2.59	54.45	64.1	9.7	0.5	28.6
		Pb conc	2.49	0.20	45.04	5.96	16.32	0.8	49.4	1.7	13.5
		Cl tail	4.03					23.4	27.2	4.7	26.3
		Pb ro tail	91.90	0.08	0.34	8.85	1.04	11.7	13.7	93.1	31.6
		Feed (calcd)	100.00	0.61	2.27	8.74	3.01	100.0	100.0	100.0	100.0

With the exception of Test 30 on the F-2 sample and Test 31 on the F-7 Sample, acceptable grades of copper and lead concentrates were made using each of the three schemes. In Test 30, lead concentrate grade was low because of a high pyrite content, while in Test 31, the lead content of the copper concentrate was too high. If Flowsheet 3B(initial flotation of all the copper with deleading of the copper concentrate) had been used in Test 31 instead of Flowsheet3A, it is believed that the lead content in the copper concentrate would have been reduced to an acceptable level.

The main difference in results was the lower losses of copper, silver and lead in the tailing when bulk flotation was employed.

Results of Zinc Flotation

Zinc results obtained on the various samples are summarized in Table 6.

TABLE 6

Summary of Zinc Flotation Results

Sample No.	Test No and Flowsheet	Zinc Rougher Flotation			Zinc Cleaning		
		Conc grade % Zn	Tailing % Zn	Zn Recovery %	Conc grade % Zn	Zn Distn, %	Cleaner Stages
F-1	3-1	51.44	0.55	87.1	57.83	54.0	2
	4-1	53.64	0.58	89.8	58.32	37.4	2
	14-2	52.73	0.48	88.6			
	15-2	54.27	0.48	88.1			
F-2	19-1	55.89	0.81	85.9	59.86	63.3	1
	34-1	53.48	0.69	87.8			
	22-2	51.70	0.35	90.9			
	23-2	53.24	0.43	89.9			
F-7	39-1	54.05	0.76	85.1	58.77	77.5	1
	33-2	50.36	0.39	91.1			
	31-3A	51.45	0.54	88.3			

Generally, the zinc results obtained were fairly consistent and did not depend on either the ore sample or scheme used for the preceding copper-lead flotation step. Only one or at most two stages of cleaning was required to produce a high-grade zinc concentrate in the 58-59% zinc range.

In the initial tests using the selective flotation scheme, zinc loss in the tailing was high probably because of the severe depressing action of sulphur dioxide on sphalerite but this problem was overcome by the simple expedient of increasing copper sulphate addition from 1.0 to 2.0 lb per ton.

Copper-Lead Bulk Flotation

A comparison of results for copper-lead bulk flotation employing various schemes is shown in Table 7, while Table 8 gives reagents and conditions for these tests along with the separation efficiencies achieved. Separation efficiency,* which is a quantitative measure of the extent of separation between the various minerals, is calculated by subtracting the per cent recovery of the unwanted constituents in the concentrate from the per cent recovery of the metals or minerals concentrated.

Conclusions as to the effectiveness of the various flotation schemes are as follows:

(1) Alkalinity Regulator and Depressants

The combination of soda ash along with sodium sulphite and cyanide as zinc and pyrite depressants gave the best results (Tests 4, 35 and 40). Lime in combination with zinc sulphate and cyanide gave inferior selectivity towards zinc and pyrite, as evidenced by the lower separation efficiencies obtained (Test 8, 18 and 32). In some tests it had an adverse effect on lead and silver recoveries (Tests 18, 20 and 32).

Optimum cyanide addition appears to be about 0.1 lb/ton. In the initial tests (1 and 3), cyanide addition was only 0.05 lb/ton. This resulted in poorer zinc depression than was obtained in subsequent tests in which cyanide was increased to 0.1 lb/ton. An increase to 0.15 lb/ton (Test 40), however, did not result in any appreciable changes in results.

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*"Separation Efficiency" by N. F. Schultz, SME Transactions, Vol. 247, March 1970.

TABLE 7

Comparison of Results for Copper-Lead Bulk Flotation

Sample No.	Test No.	Wt %	Assays of copper-lead rougher conc						Distribution in copper-lead rougher conc %					
			Cu	Pb	Cu FeS_2 +PbS	Zn	Fe/FeS	Ag	Cu	Pb	$CuFeS_2$ + PbS	Zn	Fe/FeS	Ag
F-1	1	6.66	9.61	13.83	43.7	11.88	14.4	47.74	86.4	88.1	87.1	8.6	4.5	80.0
	3	8.27	7.87	10.97	35.4	9.43	18.0	38.05	87.5	88.1	87.9	8.5	6.9	81.1
	4	5.75	11.74	16.13	52.6	8.55	11.0	57.60	90.9	85.5	89.0	5.3	2.9	81.5
	8	5.36	11.38	16.10	51.5	6.23	13.6	55.53	86.5	82.8	85.2	3.9	3.4	79.2
F-2	18	6.74	18.48	7.56	62.1	4.71	11.4	38.96	89.1	76.7	87.2	3.8	3.4	72.8
	19	9.05	14.50	6.37	49.3	6.12	16.0	33.07	94.0	84.8	92.6	6.7	6.3	81.6
	20	5.96	19.67	7.27	65.2	7.13	8.1	40.56	83.9	67.1	81.3	5.4	2.1	69.6
	21	8.75	14.95	5.73	49.8	5.51	16.3	30.68	94.2	80.3	91.9	5.7	6.2	77.5
	34	8.94	14.29	5.94	48.2	5.96	15.5	30.71	93.3	80.8	91.3	6.2	6.1	81.1
	35	9.27	13.64	5.54	45.8	5.90	17.0	30.26	95.1	81.3	93.0	6.3	6.9	79.5
F-7	32	7.86	5.24	25.22	44.3	7.30	15.1	24.38	70.2	88.4	80.9	6.5	4.5	65.8
	39	10.58	4.64	19.28	35.7	6.62	20.3	19.57	89.2	89.9	89.7	8.1	8.2	77.5
	40	9.93	4.95	21.21	38.8	7.64	19.6	20.28	90.1	90.1	89.8	8.6	7.4	76.3
F-2+F-7 Comp	36	12.10	7.52	10.86	34.3	7.62	20.0	20.54	95.5	90.4	93.5	10.6	9.8	81.3

TABLE 8

Comparison of Separation Efficiencies
Achieved Using Various Copper-Lead Bulk Flotation Schemes

Sample No.	Test No.	Reagents to Grind lb/ton			Conditioning		Promoter	Separation Efficiencies $CuFeS_2$+PbS from		
					Aeration	pH		Zn	Fe/FeS	All of Feed
F-1	1	2.0 lime	0.5 $ZnSO_4$	0.05 NaCN	No	10.8	C x 51	78.5	82.6	83.2
	3	3.0 lime	" "	" "	Yes	10.3	"	79.4	81.0	82.4
	4	3.0 Na_2CO_3	1.0 Na_2SO_3	0.10 NaCN	"	9.5	"	83.7	86.1	86.2
	8	1.5 lime	0.5 $ZnSO_4$	" "	No	10.1	"	81.3	81.8	82.5
F-2	18	" "	" "	" "	"	"	"	83.4	83.8	84.5
	19	4.0 Na_2CO_3	1.0 Na_2SO_3	" "	Yes	9.5	208 + 242	85.9	86.3	87.8
	20	2.0 lime	0.5 $ZnSO_4$	" "	No	10.4	C x 51	75.9	79.2	79.1
	21	4.0 Na_2CO_3	1.0 Na_2SO_3	" "	"	9.7	208 + 242	86.2	85.7	87.3
	34*	" "	" "	" "	"	"	" "	85.1	85.2	86.4
	35	" "	" "	" "	"	"	" "	88.8	88.2	87.7
F-7	32	1.5 lime	0.5 $ZnSO_4$	" "	"	9.2	" "	74.4	76.4	76.3
	39	4.0 Na_2CO_3	1.0 Na_2CO_3	" "	"	9.8	" "	81.6	81.5	82.6
	40	3.0 Na_2CO_3	" "	0.15 NaCN	"	9.6	" "	81.2	82.4	83.5
	36	4.0 Na_2CO_3	" "	0.10 NaCN	"	9.7	" "	82.9	83.7	85.2

*30 min grind vs 45 min grind in all other tests.

(2) Aeration

Intense aeration of the pulp in a lab aerator prior to bulk flotation did not offer any advantages over conditioning in a lab flotation cell without air. (Compare separation efficiencies in Test 3 and 8 and Tests 19 and 21.)

(3) Promoters

None of the tests were specifically designed to compare the effectiveness of amyl xanthate or a combination of Aerofloat 208 and Aerofloat 242 as copper-lead promoters. Amyl xanthate gave satisfactory results when used on the F-1 sample (Test 4), while results equally as good were obtained with a combination of Aerofloat 208 and Aerofloat 242 on the other samples investigated.

Copper-Lead Bulk Concentrate Cleaning

Generally, the bulk rougher concentrate could be upgraded satisfactorily by multi-stage cleaning without the addition of depressants. In tests on the F-7 sample, however, it was found difficult to reject pyrite during the cleaning operation. Sodium cyanide was tried as a pyrite depressant in the first cleaner in Tests 39 and 40, but its use resulted in severe depression of chalcopyrite.

In two tests (18 and 20) in which lime was used as an alkalinity regulator in copper-lead bulk flotation the depressing effect of lime on galena was carried over into the cleaners. As a result, the rejection of galena to the cleaner tailings was such that the lead content in the cleaner concentrate was lower than in the rougher concentrate.

Copper-Lead Separation

Tables 9 and 10 summarize results of copper-lead separation using the cyanide method on bulk concentrate produced from the F-1 and F-2 samples, while Table 11 gives a comparison of results obtained using the dichromate and sulphur dioxide-starch methods on bulk concentrate produced from the F-7 sample.

In these tables the separation efficiency of the initial roughing operation (% recovery of metal floated minus % recovery of other metal in rougher concentrate) is used as the criterion in comparing the effectiveness of the separation methods employed.

TABLE 9

Summary of Results of Copper-Lead Separation Using Cyanide Method
On Bulk Concentrate Produced from F-1 Sample

Test No. and Remarks	Product	Wt %	Assays			Distribution %			Rougher Sep Eff. %
			Cu	Pb	Ag	Cu	Pb	Ag	
8 Initial test, pH 11.7	Cu conc	46.1	23.20	8.42	60.25	73.8	19.4	39.8	
	Pb conc	17.4	0.37	56.98	44.90	0.4	49.5	11.2	
	Pb cl tail	36.5	10.22	17.06	93.91	25.8	31.1	49.0	54.4
	Feed	100.0	14.49	20.06	69.80	100.0	100.0	100.0	
	Pb ro conc	53.9	7.02	30.03	77.99	26.2	80.6	60.2	
9 Repeat of Test 8 but boiled Cu-Pb conc slurry prior to separation	Cu conc	63.9	22.90	6.98	73.65	92.2	20.1	60.4	
	Pb conc	17.9	0.55	65.68	56.15	0.6	53.0	12.9	
	Pb cl tail	18.2	6.24	32.76	114.27	7.2	26.9	26.7	72.1
	Feed	100.0	15.83	22.26	77.93	100.0	100.0	100.0	
	Pb ro conc	36.1	3.42	49.08	85.45	7.8	79.9	39.6	
10 Similar to Test 9 but floated a greater weight of lead conc	Cu conc	39.4	22.00	2.46	42.50	69.6	5.7	30.3	
	Pb ro conc*	60.6	6.25	26.66	63.44	30.4	94.3	69.7	63.9
	Feed	100.0	12.46	17.13	55.19	100.0	100.0	100.0	
36** Added soda ash to separation, pH 11.3 also added NaCN to lead cleaners	Cu conc	49.3	21.70	2.11	27.02	74.0	5.2	36.3	
	Pb conc	26.8	0.86	55.50	49.62	1.6	75.2	36.3	
	Pb cl tail	23.9	14.77	16.24	41.88	24.4	19.6	27.4	68.8
	Feed	100.0	14.45	19.81	36.64	100.0	100.0	100.0	
	Pb ro conc	50.7	7.42	36.99	45.97	26.0	94.8	63.7	

* Not cleaned

** Feed to this test was a 1:1 composite of F-2 and F-7 samples.

TABLE 10

Summary of Copper-Lead Separation Results Using Cyanide Method
On Bulk Concentrate Produced from F-2 Sample

Test No. and Remarks	Product	Wt %	Assays			Distribution %			Sep Eff. %
			Cu	Pb	Ag	Cu	Pb	Ag	
Test 21	Cu conc	66.8	27.92	1.60	27.20	79.7	13.1	40.0	
Standard test, i.e. with	Pb conc	9.5	1.62	46.61	98.80	0.7	54.7	20.7	66.6
ZnCN compound, pH 11.5+	Pb cl tail	23.7	19.49	11.07	75.42	19.6	32.2	39.3	
and Cu-Pb conc slurry	Feed	100.0	23.42	8.13	45.43	100.0	100.0	100.0	
boiled prior to separation	Pb ro conc	33.2	14.35	21.29	82.15	20.3	86.9	60.0	
Test 29	Cu conc	67.5	26.60	1.10	16.34	83.1	8.5	22.7	
NaCN and $ZnSO_4$ added	Pb conc	16.6	3.97	39.37	180.10	3.0	74.8	61.5	74.6
separately in place	Pb cl tail	15.9	18.82	9.14	48.18	13.9	16.7	15.8	
of Zn CN compound, pH 9.6	Feed	100.0	21.62	8.74	48.61	100.0	100.0	100.0	
	Pb ro conc	32.5	11.26	24.60	115.63	16.9	91.5	77.3	
Test 34	Cu conc	59.9	28.33	1.23	18.15	72.1	7.9	21.7	
Repeat of Test 29 but	Pb conc	13.7	4.07	48.40	200.50	2.4	71.5	55.1	64.2
with primary grind	Pb cl tail	26.4	22.71	7.26	44.03	25.5	20.6	23.2	
coarsened to 75%	Feed	100.0	23.52	9.30	50.03	100.0	100.0	100.0	
-200 m from 83% -200 m	Pb ro conc	40.1	16.33	21.35	97.62	27.9	92.1	78.3	
Test 35	Cu conc	72.4	27.41	1.18	23.02	87.4	10.0	34.4	
Standard test but	Pb conc	12.4	0.26	47.22	154.60	0.1	69.3	39.5	77.4
with soda ash	Pb cl tail	15.2	18.54	11.56	83.24	12.5	20.7	26.1	
added to conditioning	Feed	100.0	22.70	8.52	48.46	100.0	100.0	100.0	
pH 11.6	Pb ro conc	27.6	10.34	27.79	115.27	12.6	90.0	65.6	

TABLE 11

Comparison of Copper-Lead Separation Results Using Dichromate and Sulphur Dioxide - Starch Methods on Bulk Concentrate Produced from F-7 Sample

Test No. and Remarks	Product	Wt %	Assays			Distribution %			Sep Eff. %
			Cu	Pb	Ag	Cu	Pb	Ag	
Test 32 Dichromate	Cu conc	22.0	29.10	3.38	73.95	94.2	2.3	53.4	
	Cu cl tail	8.8	2.89	30.14	40.45	3.8	8.0	11.7	
	Pb conc	69.2	0.20	42.88	15.44	2.0	89.7	34.9	87.7
	Feed	100.0	6.81	33.05	30.54	100.0	100.0	100.0	
	Cu ro conc	30.8	21.62	11.01	64.39	98.0	10.3	65.1	
Test 39 Dichromate at pulp temp of 55°C	Cu conc	14.7	29.06	2.44	83.19	83.6	1.1	44.2	
	Cu cl tail	6.8	8.29	36.01	55.79	11.0	7.7	13.7	
	Pb conc	78.5	8.35	36.83	14.80	5.4	91.2	42.1	85.8
	Feed	100.0	5.10	31.73	27.63	100.0	100.0	100.0	
	Cu ro conc	21.5	22.48	13.06	74.51	94.6	8.8	57.9	
Test 40 Sulphur dioxide-starch pH 3.8	Cu conc	12.8	26.75	4.47	95.61	81.0	1.5	41.2	
	Cu cl tail	5.2	7.61	37.15	76.15	9.5	5.3	13.5	
	Pb conc	82.0	0.49	42.16	16.39	9.5	93.2	45.3	83.7
	Feed	100.0	4.22	37.08	29.65	100.0	100.0	100.0	
	Cu ro conc	18.0	21.17	14.00	89.93	90.5	6.8	54.7	

Cyanide Method

Effect of Boiling Bulk Concentrate Slurry

Boiling of the bulk concentrate slurry to remove collector coatings prior to the separation step resulted in a more selective separation between galena and chalcopyrite as evidenced by the increase in separation efficiency from 54.4% to 72.1% (Tests 8 and 9, Table 9). It was therefore adopted as standard practice for all subsequent separation tests using the cyanide method.

Effect of pH

A lowering of the pH from about 11.5 to 9.6 resulted in an improvement in separation efficiency (compare Test 21 with Test 29 in Table 10). Also more silver was recovered in the lead concentrate at the lower pH. This indicates that the high pH has a depressing effect on the freibergite (silver-bearing tetrahedrite).

Effect of Soda Ash Addition

The addition of 2.0 lb/ton soda ash to copper-lead separation along with the zinc-cyanide compound (Test 35) resulted in an improvement in separation efficiency even greater than that obtained when the pH was lowered.

Effect of Coarser Grind

The purpose of coarsening the grind to 75% minus 200 mesh from the standard 83% minus 200 mesh was to determine whether the formation of lesser amounts of galena slimes would have a beneficial effect on copper-lead separation. Instead of improving results, the coarser grind resulted in poorer selectivity as evidenced by the lower separation efficiency attained (64.2% for the coarser grind in Test 34 against 74.6% in the comparison Test 29). It did not, however, appear to have any effect on grades and recoveries for bulk copper-lead flotation (compare results of Tests 21 and 34 in Tables 7 and 8).

Dichromate and Sulphur Dioxide-Starch Methods

The best results were achieved using the dichromate method (Test 32). Note that in Test 32 there was an increase in separation efficiency from 87.7% for copper rougher flotation to 91.9% after cleaning (94.2% — 2.3%). This is due to the fact that the rejection of lead in the cleaning operation was greater than the loss of copper. The difference between these two figures (8.0% - 3.8% = 4.2%) is equal to the increase in separation efficiency. It would be advantageous, therefore, to combine the copper cleaner tailings with the lead concentrate rather than recirculating as is the normal practice. When this is done the calculated assays of the resultant product are 0.50% copper and 41.44% lead.

There was no advantage in heating the pulp in conjunction with the dichromate method (Test 39).

Selective Flotation Directly from the Ore

In the initial tests using this method, it was found that it was not possible to lower the pH of the pulp to the desired value of about 5.5 even though excess amounts of sulphur dioxide were added. For example, in Test 6, the addition of 10 lb/ton sulphur dioxide resulted in only a drop in pH from 8 to 6.3. After copper flotation, 12 lb/ton soda ash was required to increase the pH to 7.3 for lead flotation. Despite the high consumption of reagents, some promising results were obtained when amyl xanthate was used as the copper collector.

In one test (11) sulphuric acid and caustic soda were added in conjunction with sulphur dioxide and soda ash in order to reduce the consumption of these reagents. This scheme was unsuccessful. Poor selectivity was obtained in the copper float (excessive amounts of iron sulphides floated) and this was accompanied by a high loss of copper and silver in the tailing.

Aerative conditioning as a means of reducing sulphur dioxide consumption was tried in Test 13 and proved to be successful. It was found that the addition of 4 lb/ton sulphur dioxide along with 20 minutes aeration in a 4-inch-diameter aerator, resulted in a decrease in pH to 5.6. However,

when amyl xanthate was again employed as the copper collector, poor selectivity was obtained between chalcopyrite, galena, and pyrite. A selective copper float was again achieved when the copper promoters Minerec "A", Aerofloat 194 and Z-200 were substituted for amyl xanthate.

Copper Flotation

A comparison of copper rougher flotation results using the various collectors is given in Table 12 followed by Table 13, which compares the effectiveness of lime and sulphur dioxide as depressants in the copper cleaners.

The copper promoter Minerec "A" gave the best results in tests on the F-1 sample but it was not as effective as Z-200 in tests on the F-2 sample. As was mentioned previously, amyl xanthate gave poor selectivity when the pulp was aerated prior to copper flotation (Test 13) but gave satisfactory results when aeration was not employed (Test 6). The difference in results may, to some degree, be related to the different pH's (6.3 in Test 6 vs 5.6 in Test 13).

From the comparison of results in Table 13, it can be seen that lime was not an effective depressant for galena and pyrite when cleaning copper rougher concentrates floated from the F-1 sample. In fact, better results were obtained when lime was not added to the cleaners (Test 15). In tests on the F-7 sample, lime was found to be an excellent depressant for pyrite (Test 33) but it did not depress galena as effectively as sulphur dioxide.

Lead Flotation

The main problem encountered in floating a lead concentrate from the copper rougher tailing was the depression of pyrite. Also, lead losses in the tailing were appreciably higher than when copper and lead were floated together (bulk flotation).

Table 14 gives a comparison of results for lead rougher flotation using lime and soda ash as alkalinity regulators. From the results, it can be seen that the pyrite depression problem is related to the very high ratio of iron sulphides to galena in the feed. Even though better than 97% of the

TABLE 12

Comparison of Results for Copper Rougher Flotation

Test No and Sample	Reagents and Conditions				Product	Wt %	Assays					Distribution %				Sep Eff % Cu from Pb
	SO_2 lb/ton	Aeration	pH	Collector			Cu	Pb	Zn	Ag	Fe/FeS	Cu	Pb	Zn	Ag	
6 F-1	10.0	No	6.3	C X 51	Cu ro conc	2.99	17.84	1.24	4.73	76.42	12.1	75.4	3.0	1.8	62.4	72.4
					Cu ro tail	97.01	0.18					24.6				
13 F-1	4.0	Yes	5.6	C X 51	Cu ro conc	11.21	5.86	5.61	4.68	26.00	31.6	88.9	49.3	5.6	73.7	39.6
					Cu ro tail	88.79	0.09					11.1				
15 F-1	"	"	"	Minerec "A"	Cu ro conc	4.70	13.44	1.42	6.92	54.39	20.7	82.0	5.7	3.6	63.1	76.3
					Cu ro tail	95.30	0.15					18.0				
16 F-1	"	"	"	AF 194	Cu ro conc	2.38	18.21	1.08	5.00	75.72	16.0	59.5	2.1	1.3	45.7	57.4
					Cu ro tail	97.62	0.30					40.5				
22 F-2			5.3	Z-200*	Cu ro conc	7.95	15.96	1.40	4.90	27.93	17.8	89.4	17.7	4.6	61.7	71.7
					Cu ro tail	92.05	0.16					10.6				
23 F-2	"	"	"	Minerec "A"	Cu ro conc	7.18	17.51	2.21	5.45	32.86	15.5	89.1	25.5	4.6	64.5	63.6
					Cu ro tail	92.82	0.16					10.9				

* 2/3 added to grind

TABLE 13

Comparison of Results Using Lime and Sulphur Dioxide as Depressants in Copper Cleaners

Test No and Sample	Reagents added lb/ton		Product	Wt %
	1st Cleaner	2nd Cleaner		
15 F-1	none	none	Copper conc 1st stage Cu cleaner conc Copper rougher conc	44.25 65.96 100.00
17 F-1	lime 0.6 pH 11.4	none pH 10.3	Copper conc 1st stage Cu cleaner conc Copper rougher conc	68.66 80.02 100.00
33 F-7	lime 0.6 pH 11.6	none pH 10.6	Copper conc Copper rougher conc	43.93 100.00
37 F-7	SO_2 0.5 pH 3.3	SO_2 0.25 pH 3.6	Copper conc Copper rougher conc	66.74 100.00

iron as iron sulphides is distributed in the tailing, the remaining portion which floats with the galena is enough to appreciably lower the grade of lead concentrate. The same is true of sphalerite, although it does not contaminate the lead concentrate to the same extent as pyrite.

Note that appreciably better selectivity between galena and pyrite was achieved on the F-7 Sample, which has a lower ratio of iron sulphides to galena in the feed. (Tests 33 and 37).

A high pH with lime (Test 13) did not result in better pyrite depression nor did the addition of a high amount of soda ash (Test 16) bring about an improvement in lead recovery. The galena was effectively depressed by sulphur dioxide during the initial copper flotation step and no reagent combination could be found which would reactivate it completely to its natural, readily floatable state.

TABLE 13

Assays					Distribution %					Separation Efficiency
										Copper from
Cu	Pb	Zn	Ag	Fe/FeS	Cu	Pb	Zn	Ag	Fe/FeS	Pb	Zn	Fe/FeS
23.15	1.08	4.38	89.20	11.7	76.2	33.7	28.0	72.6	25.0	42.5	48.2	51.2
18.12	1.16	5.41	70.91	17.5	88.9	53.9	51.6	86.0	55.9	35.0	37.3	33.0
13.44	1.42	6.92	54.39	20.7	100.0	100.0	100.0	100.0	100.0			
17.04	1.76	6.76	60.00	16.2	95.0	76.3	74.3	80.7	50.6	18.7	20.7	44.4
15.04	1.71	6.52	53.88	19.0	97.7	86.8	82.9	84.5	69.1	10.9	14.8	28.6
12.33	1.58	6.26	51.08	22.0	100.0	100.0	100.0	100.0	100.0			
25.78	11.50	4.76	45.78	5.1	85.6	62.3	39.1	71.4	9.0	23.3	46.5	76.6
13.24	8.10	5.03	28.16	24.9	100.0	100.0	100.0	100.0	100.0			
25.04	4.33	2.16	40.88	8.5	89.1	51.9	40.0	79.2	37.3	37.2	49.1	51.8
18.72	5.56	3.82	34.50	15.2	100.0	100.0	100.0	100.0	100.0			

The addition of cyanide to the cleaners, or a combination of lime and cyanide (Test 17), did not depress pyrite and sphalerite to the extent desired. Generally, on the F-1 and F-2 samples, it was possible to clean the rougher concentrate to a grade of only about 40% lead. On the F-7 sample from which higher grades of rougher concentrates were produced, cleaner concentrate grades of 50% or better were achieved (Tests 33 and 37).

Selective Flotation Augmented by Copper-Lead Separation

Table 15 gives a summary of procedure used in tests employing this scheme.

TABLE 14

Comparison of Results for Lead Rougher Flotation

Test No. and Sample	Reagents and Conditions			Product	Wt %
	Alkalinity regulator lb/ton	pH	Collector		
13	Lime		AF 242 +	Pb ro conc Pb ro tail	2.22 97.78
F-1	4.0	11.0	C X 51	Feed (calcd)*	100.00
14	Lime		AF 242	Pb ro conc	1.92
F-1	3.0	9.7	+	Pb ro tail	98.08
			C X 51	Feed (calcd)	100.00
15	Soda ash			Pb ro conc	3.21
F-1	4.0	7.3	AF 242	Pb ro tail	96.79
				Feed (calcd)	100.00
16	Soda ash			Pb ro conc	3.51
F-1	5.0	7.6	AF 242	Pb ro tail	96.49
				Feed (calcd)	100.00
22	Lime			Pb ro conc	1.33
F-2	3.0	9.6	AF 242	Pb ro tail	98.67
				Feed (calcd)	100.00
23	Soda ash		AF 242	Pb ro conc	2.38
F-2	5.0	8.7		Pb ro tail	97.62
				Feed (calcd)	100.00
37	Lime			Pb ro conc	5.03
F-7	3.0	9.5	AF 242	Pb ro tail	94.97
				Feed (calcd)	100.00

TABLE 14

Assays					Distribution %					Sep.Eff.% Pb from Fe/FeS
Cu	Pb	Zn	Ag	Fe/FeS	Cu	Pb	Zn	Ag	Fe/FeS	
0.15	15.60	10.66	10.68	26.4	3.6	47.6	2.4	20.3	2.9	44.7
0.09	0.39	9.85	0.95	20.4	96.4	52.4	97.6	79.7	97.1	
0.09	0.73	9.87	1.17	20.5	100.0	100.0	100.0	100.0	100.0	
0.18	17.54	13.15	13.31	21.8	2.5	59.9	2.5	21.9	2.2	57.4
0.14	0.23	9.91	0.93	19.0	97.5	40.1	97.5	78.1	97.8	
0.14	0.56	9.97	1.17	19.1	100.0	100.0	100.0	100.0	100.0	
1.18	26.67	9.72	20.61	18.0	26.3	74.7	3.4	42.1	2.7	72.0
0.11	0.30	9.09	0.94	21.6	73.7	25.3	96.6	57.9	97.3	
0.14	1.15	9.11	1.57	21.5	100.0	100.0	100.0	100.0	100.0	
2.57	25.17	9.09	29.76	19.9	29.8	69.6	3.3	47.6	3.1	66.5
0.22	0.40	9.60	1.19	22.4	70.2	30.4	96.7	52.4	96.9	
0.30	1.27	9.58	2.19	22.3	100.0	100.0	100.0	100.0	100.0	
0.89	28.59	8.33	30.62	18.8	7.4	67.0	1.3	27.3	1.1	65.7
0.15	0.19	8.66	1.10	23.5	92.6	33.0	98.7	72.7	98.9	
0.16	0.57	8.66	1.49	23.4	100.0	100.0	100.0	100.0	100.0	
0.61	14.44	6.58	11.25	29.0	9.0	68.8	1.8	20.9	2.9	65.9
0.15	0.16	8.86	1.04	23.3	91.0	31.2	98.2	79.1	97.1	
0.16	0.50	8.81	1.28	23.4	100.0	100.0	100.0	100.0	100.0	
0.43	38.01	7.72	21.40	15.0	11.2	84.8	4.4	49.4	2.8	82.0
0.18	0.36	8.78	1.16	27.1	88.8	15.1	95.6	50.6	97.2	
0.19	2.25	8.73	2.18	26.5	100.0	100.0	100.0	100.0	100.0	

TABLE 15

Summary of Procedure for Tests Employing
Selective Flotation Augmented by Copper-Lead Separation

Test No. and Sample	Flowsheet	Copper Flotation Reagents	Lead Flotation Reagents	Remarks
24 F-2	3A	Lime, $ZnSO_4$, NaCN Z-200		Preliminary test, did not float lead conc
25 F-2	3A	Na_2CO_3 $ZnSO_4$, NaCN AF 238		Copper flotation only - test products not assayed
27 F-2	3A	Lime, $ZnSO_4$, NaCN Z-200	AF 242	Copper-lead separation not carried out.
28 F-2	3A	Lime, $ZnSO_4$, NaCN AF 238	AF 242	Repeat of Test 28 but with AF 238 replacing Z-200.
30 F-2	3A	Lime, $ZnSO_4$, NaCN Z-200	AF 242, AF 208	Similar to Test 27 but with copper-lead separation.
31 F-7	3A	As above	As above	Repeat of Test 30 on F-7 Sample
38 Comp	3B	Na_2SO_3 Z-200	Na_2CO_3, NaCN AF 242, AF 208	

As indicated in the above table several tests were carried out before copper-lead separation of the lead concentrate was attempted (Flowsheet 3A). Since this scheme depended on the initial flotation of a finished, low-lead copper concentrate containing most of the copper in the ore, it was necessary to establish reagents and conditions to achieve this end before proceeding further.

Of the two selective copper promoters tried, Z-200 proved to be superior to Aerofloat 238. It not only gave better selectivity between chalcopyrite and galena but also a higher copper recovery in the copper rougher concentrate (refer to Tests 27 and 28 in appendix). Aerofloat 238 was also tried with soda ash replacing lime as the alkalinity regulator (Tests 25 and 26). Normally, aerofloat promoters function more effectively in a soda ash circuit. However, in both tests a heavily mineralized, non-selective copper froth was obtained; therefore, the tests were discontinued and test products discarded.

Only one test was carried out using Flowsheet 3B(38). In this test 24.5% of the lead was recovered in the copper rougher concentrate which assayed 12.9% copper and 5.7% lead. When the rougher concentrate was cleaned, most of the lead (19.8%) was rejected to the cleaner tailing to give a cleaner concentrate assaying 22.0% copper and 2.2% lead. Since this can be considered to be a finished grade of copper concentrate, delead-ing of the concentrate, as was done in this test, is not necessary. The procedure employed in this test, therefore, could be used as a method for the selective flotation of copper and lead concentrates directly from the ore.

It should be noted that the reagents used in conjunction with Flowsheet 3A and 3B are essentially the same as those employed for bulk copper-lead flotation. The only difference was the order of addition of reagents and the use of Z-200 and Aerofloat 238 as copper promoters.

CONCLUSIONS

Marketable grades of copper, lead, and zinc concentrates with good recoveries can be produced from this ore by flotation at a grind of 83% minus 200 mesh.

Flotation of a bulk copper-lead concentrate followed by copper-lead separation was found to be the most efficient technique for producing copper and lead concentrates. The cyanide separation method was effective on the high-copper, low-lead, F-2 sample, whereas the dichromate method gave excellent results on the low-copper, high-lead, F-7 sample. The cyanide method was also successfully applied on bulk concentrate produced from a composite made up of equal weights of the F-2 and F-7 samples.

Selective flotation of copper and lead concentrates directly from the ore gave acceptable grades of copper and lead concentrates, but copper, lead and silver recoveries were appreciably lower than those obtained by bulk flotation. Reagent consumption was also higher. There was no particular advantage in employing a combination of selective flotation and copper-lead separation techniques.

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AS:RWB/ec

APPENDIX

Screen Analyses of Primary Grinds

45 min Rod Mill Grind on F-1 Sample		
Tyler Mesh Size	Wt %	Cumulative Wt %
+100	0.6	0.6
+150	1.8	2.4
+200	14.7	17.1
+325	28.7	45.8
-325	54.2	100.0
Total	100.0	
30 min Rod Mill Grind on F-2 Sample		
+100	0.6	0.6
+150	3.2	3.8
+200	21.6	25.4
+325	27.9	53.3
-325	46.7	100.0
Total	100.0	

Classification of Tests According to Treatment Schemes Employed and Ore Sample

Treatment Scheme	Ore Sample and Test No.			
	F-1	F-2	F-7	Comp
Bulk flotation followed by copper-lead separation of bulk concentrate	1, 2, 3, 4 8, 9, 10	18, 19, 20 21, 29, 34 35	32, 39, 40	36
Selective flotation of copper and lead concentrates directly from the ore	5, 6, 7, 11 12, 13, 14 15, 16, 17	22, 23,	33	
Selective flotation augmented by decoppering of lead concentrate-Flowsheet 3A		24, 25, 26 27, 28, 30	31, 37	
Selective flotation augmented by deleading of copper concentrate-Flowsheet 3B				38

Abbreviations Used in Flotation Test Reports

RM	Rod mill
CX 51	Potassium ethyl xanthate (Canadian Chemical Co.)
DF 250	Dowfroth 250 - Dow Chemical Co. frother
NaAF	Sodium Aerofloat-American Cyanamid Co. promoter.
Fe/Fes	Iron present as iron sulphides.
Z-200	Trade name for Dow Chemical Co. selective copper promoter.
AF 194,208 238,242	American Cyanamid Co. Aerofloat promoters.
Min A	Minerec A - Minerec Corp. selective copper promoter.
ZnCN	Na_2 ZN $(CN)_4$
Dich	Sodium dichromate
CS	Caustic Starch-aqueous solution of caustic soda and starch in in the ratio 1:2.

AS:RWB/ec

MINES BRANCH FLOTATION TEST REPORT

TEST NO. 1 | SAMPLE: Mattagami - Sturgeon Lake F-1 | DATE: Jan. 14, 1970

OBJECT OF TEST: To float copper-lead and zinc concentrates using the combination lime + $ZnSO_4$ + NaCN | CHARGE: 2000 g | TESTED BY A.S.

OPERATION	Time min	% Solids	pH	Unit used	Reagents, lb per ton									
					Lime	$ZnSO_4$	NaCN	CX51	DF250	$CuSO_4$	NaAF			
Grinding	45*	64		7 x 14 RM	2.0	0.5	0.05							
Conditioning	10		10.8	1000-g cell				0.02						
Copper-lead rougher														
Stage 1	1/2								0.02					
" 2	1/2							0.01						
" 3	1							0.02						
" 4	2							0.02	0.005					
Conditioning	10		11.1		1.0					1.0				
Zinc rougher														
Stage 1	1										0.05			
" 2	1								0.005		0.05			
" 3	2								0.005		0.05			

PRODUCT	WT %	ANALYSIS %							DISTRIBUTION %			
		Cu	Pb	Zn	Fe	Insol	Ag	Fe/FeS	Cu	Pb	Zn	Ag
Copper-lead conc**	2.85	18.28	20.63	5.75	22.2	0.8	87.61	5.4	70.3	56.2	1.8	63.2
Copper-lead cl tail No.3	0.67	6.71	14.45	13.65	27.2	3.2	29.20	19.7	6.1	9.3	1.0	4.9
" " " " No.2	0.78	4.25	11.46	17.76	25.0	4.6	24.10	19.2	4.5	8.5	1.5	4.8
" " " " No.1	2.31	1.78	6.37	17.20	25.9	9.5	12.94	22.3	5.5	14.1	4.3	7.6
Zinc rougher conc	13.77	0.27	0.38	55.14	8.4	2.2	1.89	1.7	5.0	5.0	81.6	6.6
Zinc rougher tail	79.62	0.08	0.09	1.15			0.64		8.6	6.9	9.8	12.9
Feed (calcd)	100.00	0.74	1.05	9.30			3.95		100.0	100.0	100.0	100.0

*82.8% minus 200 mesh
**Au assay, 0.14 oz/ton
***Ag assay in oz/ton in this and all subsequent Test Reports.

REMARKS: Copper-lead float - light froth, appeared to be some sphalerite floating at end, bright clean copper froth during cleaning - no galena in evidence. (Continued on Sheet 2)

MINES BRANCH FLOTATION TEST REPORT

TEST NO. 1	SAMPLE: Mattagami - Sturgeon Lake F-1	DATE: Jan. 14, 1970
OBJECT OF TEST:		CHARGE:
		TESTED BY:

OPERATION	Time min	% Solids	pH	Unit used	Reagents, lb per ton									
									DF250					
Copper-lead cleaners														
No. 1	1½		8.8	500-g cell					0.002					
No. 2	1			250-g cell										
No. 3	1			" " "										

PRODUCT	WT %	ANALYSIS %							DISTRIBUTION %				
		Cu	Pb	Zn	Fe	Insol	Ag	Fe/FeS	Cu	Pb	Zn	Ag	
Calculated Assays													
Copper-lead cl conc													
2nd stage	3.57	15.85	19.18	7.15	22.83	1.24	75.42	8.1	76.4	65.5	2.8	68.1	
1st stage	4.35	13.77	17.80	9.06	23.22	1.84	66.22	10.0	80.9	74.0	4.3	72.9	
Copper-lead ro conc	6.66	9.61	13.83	11.88	24.15	4.50	47.74	14.4	86.4	88.1	8.6	80.5	
" " " tail	93.39	0.11	0.13				0.82		13.6	11.9	11.9	19.5	

REMARKS: (continued from Sheet 1) Zinc float - clean active zinc float but cursory examination under microscope showed that course sphalerite was still floating at end.

MINES BRANCH FLOTATION TEST REPORT

TEST NO. 2	SAMPLE: Mattagami - Sturgeon Lake F-1	DATE: Jan. 14, 1970
OBJECT OF TEST:	Repeat of Test 1 but pulp aerated before copper-lead flotation.	CHARGE: 2000-g
		TESTED BY: A.S.

OPERATION	Time min	% Solids	pH	Unit used	Reagents, lb per ton									
					Lime			CX51	DF250	CuSO4	NaAF			
Grinding-as in Test 1														
Conditioning	20		9.1	Aerator				0.02						
Copper-lead rougher				1000-g cell										
Stage 1	½							0.01	0.02					
" 2	½							0.01						
" 3	1							0.02	0.005					
" 4	2							0.01						
Conditioning	10		11.6		3.0					1.0				
Zinc rougher														
Stage 1	½							0.02			0.05			
" 2	½							0.01	0.005		0.05			
" 3	3										0.05			

PRODUCT	WT %	ANALYSIS %							DISTRIBUTION %				
Copper-lead ro conc	25.55												
Zinc rougher conc	15.80												
Zinc rougher tail	58.65												
	100.00												

REMARKS: Copper-lead float - a lot of pyrite floated, pH too low?

Zinc float - light clean froth at end - apparently xanthate addition required at start to float coarse sphalerite (see Test 1 remarks)

PRODUCTS NOT ASSAYED

MINES BRANCH FLOTATION TEST REPORT

TEST NO. 3 | SAMPLE: Mattagami - Sturgeon Lake F-1 | DATE: Jan. 15, 1970

OBJECT OF TEST: Repeat of Test 2 but added more lime to increase pH of copper-lead float from 9.1 to 10.3 | CHARGE: 2000 g. | TESTED BY: A.S.

OPERATION	Time min	% Solids	pH	Unit used	Reagents, lb per ton										
					Lime			CX51	DF250	$CuSO_4$	NaAF				
Grinding - as in Test 1															
Conditioning	20		10.3	Aerator	1.0			0.02							
Copper-lead rougher				1000-g cell											
- as in Test 2															
Conditioning	10		11.6		2.0					1.0					
Zinc rougher															
Stage 1	½							0.02		0.05					
" 2	½							0.01	0.005	0.05					
" 3	½								0.005						
" 4	2½									0.05					

PRODUCT	WT %	ANALYSIS %							DISTRIBUTION %			
		Cu	Pb	Zn	Fe	Insol	Ag	Fe/FeS	Cu	Pb	Zn	Ag
Copper-lead conc	3.71	15.50	18.98	6.50	23.8	1.3	70.43	9.4	77.3	68.3	2.6	67.4
Copper-lead cl tail No.3	0.59	2.70	5.35	8.76	36.3	3.3	13.45	33.7	2.1	3.1	0.6	2.0
" " " " No.2	0.85	1.80	5.93	10.85	31.6	5.0	17.50	27.9	2.1	4.9	1.0	3.8
" " " " No.1	3.12	1.43	3.89	12.65	29.9	9.5	9.80	27.1	6.0	11.8	4.3	7.9
Zinc conc	8.54	0.17	0.16	58.63	6.9	0.3	0.99	-	1.9	1.3	54.0	2.2
Zinc cleaner tail No. 2	1.80	0.35	0.67	54.01	8.6	1.6	2.48	2.0	0.8	1.2	10.5	1.1
" " " No. 1	5.36	0.35	0.68	39.12	14.4	9.8	2.57	9.5	2.6	3.5	22.6	3.6
Zinc rougher tail	76.03	0.07	0.08	0.55			0.61		7.2	5.9	4.4	12.0
Feed (calcd)	100.00	0.74	1.03	9.27			3.88		100.0	100.0	100.0	100.0

REMARKS: Copper-lead float - increase in pH resulted in depression of pyrite
Zinc float - similar to Test 2 but "gummier" especially at end of float

MINES BRANCH FLOTATION TEST REPORT

TEST NO. 3	SAMPLE: Mattagami - Sturgeon Lake F-1	DATE: Jan. 15, 1970
OBJECT OF TEST:		CHARGE:
		TESTED BY:

OPERATION	Time min	% Solids	pH	Unit used	Reagents, lb per ton									
					Lime				DF250					
Copper cleaners														
No. 1	1½		8.7	500 g cell										
No. 2	1		8.6	250 g cell										
No. 3	1		8.4	" "										
Zinc cleaners														
No. 1	2		11.7	500 g cell	1.0									
No. 2	1½		11.6	" "	0.75				0.01					

PRODUCT	WT %	ANALYSIS %							DISTRIBUTION %			
		Cu	Pb	Zn	Fe	Insol	Ag	Fe/FeS	Cu	Pb	Zn	Ag
Calculated assays												
Copper-lead cl conc												
2nd stage	4.30	13.74	17.11	6.81	25.52	1.57	62.61	12.5	79.4	71.4	3.2	69.4
1st stage	5.15	11.77	15.27	7.48	26.52	2.14	55.17	15.2	81.5	76.3	4.2	73.2
Copper-lead ro conc	8.27	7.87	10.97	9.43	27.78	4.92	38.05	18.0	87.5	88.1	8.5	81.1
" " " tail	91.73	0.10	0.13				0.80		12.5	11.9		18.9
1st stage zinc cl conc	10.34	0.20	0.25	57.83	7.20	0.53	1.25	0.3	2.7	2.5	64.5	3.3
Zinc rougher conc	15.70	0.25	0.40	51.44	9.66	3.69	1.70	3.5	5.3	6.0	87.1	6.9

REMARKS:

MINES BRANCH FLOTATION TEST REPORT

TEST NO. 4	SAMPLE: Mattagami - Sturgeon Lake F-1	DATE: Jan. 15, 1970
OBJECT OF TEST:	To float copper-lead and zinc concentrates using the combination Na_2CO_3 + Na_2SO_3 + NaCN along with aeration	CHARGE: 2000 g
		TESTED BY: A.S.

OPERATION	Time min	% Solids	pH	Unit used	Reagents, lb per ton									
					Na_2CO_3	Na_2SO_3	NaCN	CX51	DF250	Lime	$CuSO_4$	NaAF		
Grinding	45	65		7x14 RM	3.0	1.0	0.10							
Conditioning	20		9.5	Aerator				0.02						
Copper roughers				1000-g cell										
Stage 1	½								0.02					
" 2	1								0.02					
" 3	3½													
Conditioning	10		11.7							4.0	1.0			
Zinc roughers														
Stage 1	½							0.03				0.05		
" 2	1							0.01				0.05		
" 3	2							0.01	0.02			0.05		

PRODUCT	WT %	ANALYSIS %							DISTRIBUTION %				
		Cu	Pb	Zn	Fe	Insol	Ag	Fe/FeS	Cu	Pb	Zn	Ag	
Copper-lead conc *	3.46	17.16	22.78	6.50	21.3	2.0	84.67	5.4	80.0	72.6	2.4	72.1	
Copper-lead cl tail **	2.29	3.55	6.09	11.65	23.7	2.0	16.69	19.2	10.9	12.9	2.9	9.4	
Zinc conc	5.95	0.11	0.13	58.32	7.3	0.3	1.14	0.4	0.9	0.7	37.4	1.7	
Zinc cleaner tail No. 2	2.56	0.14	0.25	55.35	8.5	1.4	1.28	1.9	0.5	0.6	15.2	0.8	
" " " No. 1	7.05	0.14	0.36	49.08	10.7	5.1	1.32	4.9	1.3	2.3	37.2	2.3	
Zinc rougher tail	78.69	0.06	0.15	0.58			0.71		6.4	10.9	4.9	13.7	
Feed (calcd)	100.00	0.74	1.09	9.30			4.06		100.0	100.0	100.0	100.0	

REMARKS: Copper-lead float - very gummy at start - "weeping" at end, effect of excess soda ash?
Zinc float - clean and voluminous at start, coarse sphalerite came up in second rougher, "weeping" froth at end of float.

* Au assay, 0.14 oz/ton.

** No. 1 and 2 combined.

MINES BRANCH FLOTATION TEST REPORT

TEST NO 4	SAMPLE: Mattagami - Sturgeon Lake F-1	DATE: Jan. 15, 1970
OBJECT OF TEST:		CHARGE:
		TESTED BY:

OPERATION	Time min	% Solids	pH	Unit used	Reagents, lb per ton									
									DF250	Lime				
Copper cleaners														
No. 1	1½			500-g cell					0.01					
No. 2	1½			" " "					0.004					
Zinc cleaners														
No. 1	2		~ 12	500-g cell					0.01	1.0				
No. 2	1½		"	" " "					0.01	0.75				

PRODUCT	WT %	ANALYSIS %							DISTRIBUTION %				
		Cu	Pb	Zn	Fe	Insol	Ag	Fe/FeS	Cu	Pb	Zn	Ag	
Caclulated assays													
Copper-lead ro conc	5.75	11.74	16.13	8.55	22.25	2.00	57.60	11.0	90.9	85.5	5.3	81.5	
" " " tail	94.25	0.07	0.17				0.80						
1st stage zinc cl conc	85.1	0.12	0.17	57.43	7.66	0.63	1.18	0.9	1.4	1.3	52.6	2.5	
Zinc rougher conc	15.56	0.13	0.25	53.64	9.04	2.66	1.24	2.7	2.7	3.6	89.8	4.8	

REMARKS:

MINES BRANCH FLOTATION TEST REPORT

TEST NO. 5	SAMPLE: Mattagami - Sturgeon Lake F-1	DATE: Feb. 10, 1970
OBJECT OF TEST:	To float copper, lead and zinc concentrates using SO_2 as galena depressant along with Z-200 as copper promoter.	CHARGE: 2000 g
		TESTED BY: A.S.

OPERATION	Time min	% Solids	pH	Unit used	Reagents, lb per ton									
					SO_2	Z-200	CX 51							
Grinding	45	65	8.0*	7 x 14 RM										
Conditioning	5		6.1	1000-g cell	9.0	0.04	0.02							

PRODUCT	WT %	ANALYSIS %							DISTRIBUTION %				

REMARKS: Could not lower pH below 6.0 as intended despite the addition of high amounts of SO_2. Z-200 gave a barren, effervescent froth but chalcopyrite came up very quickly upon addition of CX 51 - test was terminated at this point.

* After dilution in cell.

MINES BRANCH FLOTATION TEST REPORT

TEST NO. 6	SAMPLE: Mattagami - Sturgeon Lake F-1	DATE: Feb. 10, 1970
OBJECT OF TEST: As in Test 5 but substitute CX 51 as copper promoter in place of Z-200.		CHARGE: 2000 g
		TESTED BY: A.S.

OPERATION	Time min	% Solids	pH	Unit used	Reagents, lb per ton								
					SO_2	CX 51	DF250	Na_2CO_3	NaCN	AF242	Lime	$CuSO_4$	NaAF
Grinding	45	65		7 x 14 RM									
Conditioning	10		6.3	1000-g cell	10.0	0.02							
Copper rougher	1						0.02						
Copper scavenger	1												
Conditioning	10		7.3					12.0					
"	5								0.10				
"	5									0.02			
Lead rougher	1												
Conditioning	10		11.7								8.0	1.0	
Zinc rougher, stage 1	1					0.02							0.10
" " " 2	1					0.01							0.05
" " " 3	2												0.05

PRODUCT	WT %	ANALYSIS %						DISTRIBUTION %			
		Cu	Pb	Zn	Fe	Ag	Fe/FeS	Cu	Pb	Zn	Ag
Copper conc	1.45	25.70	0.94	3.90	27.9	101.21	4.9	52.6	1.1	0.7	40.1
Copper cleaner tail	0.74	8.65	1.83	5.92	29.2	40.20	20.9	9.0	1.1	0.5	8.1
Copper scavenger conc	0.80	12.20	1.26	6.38	28.4	65.00	16.9	13.8	0.8	0.6	14.2
Lead conc	0.95	0.07	49.78	6.54	12.9	21.60	12.1	0.1	39.2	0.7	5.6
Lead cleaner tail	1.36	0.34	14.70	9.13	24.4	12.84	23.0	0.6	16.5	1.4	4.8
Zinc rougher conc	10.98	0.70	0.42	51.85	9.6	2.97	2.9	10.8	3.8	66.3	8.9
Zinc rougher tail	83.72	0.11	0.54	3.05		0.80		13.1	37.5	29.8	18.3
Feed (Calcd)	100.00	0.71	1.21	8.58		3.66		100.0	100.0	100.0	100.0

REMARKS: Looked like normal copper and lead float but pyrite in evidence in froth in both cases. Zinc float was bright and clean.

MINES BRANCH FLOTATION TEST REPORT

TEST NO. 6 | SAMPLE: Mattagami - Sturgeon Lake F-1 | DATE: Feb. 10, 1970

OBJECT OF TEST: | CHARGE: | TESTED BY:

OPERATION	Time min	% Solids	pH	Unit used	Reagents, lb per ton									
						CX51	DF250		NaCN					
Copper cleaner	½			250-g cell		0.001	0.007							
Lead cleaner	1			" "					0.10					

PRODUCT	WT %	ANALYSIS %							DISTRIBUTION %				
		Cu	Pb	Zn	Fe	Ag	Fe/FeS		Au	Pb	Zn	Ag	
Calculated assays													
Copper rougher conc	2.19	19.94	1.24	4.59	28.3	80.59	10.3		61.6	2.2	1.2	48.2	
Copper ro + scav conc	2.99	17.84	1.24	4.73	28.4	76.42	12.1		75.4	3.0	1.8	62.4	
Lead rougher conc	2.31	0.23	29.13	8.06	19.7	16.44	18.5		0.7	55.7	2.1	10.4	
Lead rougher tail	94.70	0.18	0.53			1.05			23.9	41.3		27.2	

REMARKS:

MINES BRANCH FLOTATION TEST REPORT

TEST NO. 7	SAMPLE: Mattagami - Sturgeon Lake F-1	DATE: Feb. 10, 1970
OBJECT OF TEST: To try copper-lead-zinc selective float as in Tests 5 and 6 but with (1) lower SO_2 addition and (2) AF238 and AF242 as copper and lead promoters		CHARGE: 2000 g
		TESTED BY: A.S.

OPERATION	Time min	% Solids	pH	Unit used	Reagents, lb per ton									
					SO_2	AF238	CX51	DF250	NaCN	AF242	Na_2CO_3			
Grinding	60	65		7x14 RM										
Conditioning	5		6.9	1000-g cell	2.5									
"	5					0.02	0.01							
Copper rougher	1										3.0			
Copper scavenger	1													
Conditioning	5		7.4					0.02	0.10					
"	5									0.03				
Lead rougher														
Stage 1	½													
Stage 2	½									0.02				

PRODUCT	WT %	ANALYSIS %							DISTRIBUTION %				
Copper rougher conc	5.22												
Copper scav conc	1.40												
Lead rougher conc	1.94												
Lead rougher tail	91.44												
Feed	100.00												

REMARKS: Copper float not as selective as Test 7, excessive amounts of pyrite floated.
Not too much galena floated in lead float, therefore test terminated at this po[illegible]

PRODUCTS NOT ASSAYED

MINES BRANCH FLOTATION TEST REPORT

TEST NO. 8	SAMPLE: Mattagami - Sturgeon Lake F-1	DATE: Feb. 11, 1970
OBJECT OF TEST: To try copper-lead separation on copper-lead conc using ZnCN complex as copper depressant (copper-lead rougher float similar to Test 1).		CHARGE: 2x2000 g
		TESTED BY: A.S.

OPERATION	Time min	% Solids	pH	Unit used	Reagents, lb per ton									
					Lime	$ZnSO_4$	NaCN	CX51	DF250					
Grinding	45	65		7x14 RM	1.5	0.5	0.10							
Conditioning			10.1	1000-g cell				0.02						
Copper-lead rougher														
Stage 1	½								0.02					
Stage 2	½							0.02						
Stage 3	1								0.01					
Stage 4	1							0.02						
Stage 5	1							0.01						
Copper-lead cleaners														
No. 1	1½			250-g cell										
No. 2	1½			" "										
No. 3	1½			" "										

PRODUCT	WT %	ANALYSIS %							DISTRIBUTION %				
		Cu	Pb	Zn	Fe	Ag	Fe/FeS		Cu	Pb	Zn	Ag	
Copper conc	1.74	23.20	8.42	3.90	26.7	60.25	5.8		57.3	14.1	0.8	27.9	
Lead conc	0.66	0.37	56.98	4.96	10.1	44.90	9.2		0.3	36.1	0.4	7.9	
Lead cleaner tail No. 2	0.34	3.05	22.30	8.36	25.6	77.00	21.9		1.5	7.3	0.3	7.0	
" " " No. 1	1.03	12.60	15.32	6.04	25.7	99.52	13.9		18.4	15.1	0.7	27.2	
Copper-lead cl tail No.3	0.50	5.14	8.58	9.24	28.9	27.00	23.3		3.6	4.1	0.5	3.6	
" " " " No.2	0.46	4.43	7.92	8.54	26.7	25.60	21.8		2.9	3.5	0.5	3.1	
" " "	0.63	2.82	4.32	9.11	24.9	14.64	21.3		2.5	2.6	0.7	2.5	
Copper-lead ro tail	94.64	0.10	0.19	8.79		0.83			13.5	17.2	96.1	20.8	
Feed (calcd)	100.00	0.70	1.04	8.65		3.76			100.0	100.0	100.0	100.0	

REMARKS: Two 2000 gram batches floated separately - copper-lead rougher concentrates combined for cleaning and copper-lead separation. Bright, leady froth in copper-lead separation but chalcopyrite "lurking" underneath.

MINES BRANCH FLOTATION TEST REPORT Sheet 2 of 2

TEST NO. 8	SAMPLE: Mattagami - Sturgeon Lake F-1	DATE: Feb. 11, 1970
OBJECT OF TEST:		CHARGE:
		TESTED BY:

OPERATION	Time min	% Solids	pH	Unit used	Reagents, lb per ton									
					Lime				DF250	ZnCN	AF242			
Copper-lead separation														
Conditioning	5		11.7	250-g cell	0.1					1.75				
Lead rougher	½			" "										
Lead cleaner No. 1	½		11.0	" "										
" " No. 2	1			" "					0.004		0.002			

PRODUCT	WT %	ANALYSIS %						DISTRIBUTION %				
		Cu	Pb	Zn	Fe	Ag	Fe/FeS	Cu	Pb	Zn	Ag	Fe/FeS
Copper conc	46.1	23.20	8.42	3.90	26.7	60.25	5.8	73.8	19.4	35.4	39.8	26.5
Lead conc	17.4	0.37	56.98	4.96	10.1	44.90	9.2	0.4	49.5	17.0	11.2	15.9
Lead cleaner tail No. 2	9.1	3.05	22.30	8.36	25.6	77.00	21.9	1.9	10.1	15.0	10.0	19.8
" " " No. 1	27.4	12.60	15.32	6.04	25.7	99.52	13.9	23.9	21.0	32.6	39.0	37.8
Feed (calcd)*	100.0	14.49	20.06	5.07	23.4	69.80	10.1	100.0	100.0	100.0	100.0	100.0
Calculated assays												
1st stage lead cl conc	26.5	1.28	45.19	6.11	15.4	55.81	13.5	2.3	59.6	32.0	17.4	35.7
Lead rougher conc	53.9	7.02	30.03	6.07	20.6	77.99	13.7	26.2	80.6	64.6	47.5	73.5

REMARKS: Shown above is metallurgical balance for copper-lead separation.
*Copper-lead cleaner concentrate.

MINES BRANCH FLOTATION TEST REPORT

TEST NO. 9	SAMPLE: Mattagami - Sturgeon Lake F-1	DATE: Feb. 12, 1970
OBJECT OF TEST: Repeat of Test 8 but boiled copper-lead conc slurry for 5 minutes prior to separation step to desorb xanthate from mineral surfaces.		CHARGE: 2x2000 g
		TESTED BY: A.S.

OPERATION	Time min	% Solids	pH	Unit used	Reagents, lb per ton									
					ZnCN	AF242	CX51	DF250						
Grinding } as														
Copper-lead rougher } in														
Copper-lead cleaners } Test 8														
Copper-lead separation														
Desorption*														
Conditioning	5			250-g cell	0.33	0.01	0.0015							
"	3				0.08									
Lead rougher	1½													
Lead cleaner	1			250-g cell				0.004						

PRODUCT	WT %	ANALYSIS %							DISTRIBUTION %				
		Cu	Pb	Zn	Fe	Ag	Fe/FeS		Cu	Pb	Zn	Ag	
Copper conc	2.09	22.90	6.98	3.34	27.7	73.65	7.2		68.7	13.9	0.8	42.0	
Lead conc	0.59	0.55	65.68	4.80	6.8	56.15	5.7		0.5	36.8	0.3	9.0	
Lead cleaner tail	0.60	6.24	32.76	7.10	17.8	114.27	11.5		5.4	18.7	0.5	18.7	
Copper-lead cl tail No.3	0.51	4.50	6.44	10.30	30.0	19.65	24.8		3.3	3.1	0.6	2.7	
" " " " No.2	0.55	4.69	7.98	9.82	26.9	25.70	21.7		3.7	4.2	0.6	3.9	
" " " " No.1	0.76	3.17	4.92	9.20	24.1	16.28	20.2		3.5	3.6	0.8	3.4	
Copper-lead ro tail	94.90	0.11	0.22	8.78		0.78			14.9	19.7	96.4	20.3	
Feed (calcd)	100.00	0.70	1.05	8.65		0.66			100.0	100.0	100.0	100.0	

REMARKS: *Copper-lead concentrate was filtered, washed once with fresh water, repulped and boiled for 5 minutes. After boiling, concentrate was again filtered and repulped in cell with fresh water.

Bright, leady colour in both lead rougher and cleaner - clear, barren froth at end in both cases.

MINES BRANCH FLOTATION TEST REPORT Sheet 2 of 2

TEST NO. 9	SAMPLE: Mattagami - Sturgeon Lake F-1	DATE: Feb. 12, 1970
OBJECT OF TEST:		CHARGE:
		TESTED BY:

OPERATION	Time min	% Solids	pH	Unit used	Reagents, lb per ton									

PRODUCT	WT %	ANALYSIS %						DISTRIBUTION %				
		Cu	Pb	Zn	Fe	Ag	Fe/FeS	Cu	Pb	Zn	Ag	Fe/FeS
Copper conc	63.9	22.90	6.98	3.34	27.7	73.65	7.2	92.2	20.1	49.8	79.9	59.6
Lead conc	17.9	0.55	65.68	4.80	6.8	56.15	5.7	0.6	53.0	20.0	5.5	13.2
Lead cleaner tail	18.2	6.24	32.76	7.10	17.8	114.27	11.5	7.2	26.9	30.2	14.6	27.2
Feed (calcd)*	100.0	15.83	22.26	4.29	22.1	77.93	7.7	100.0	100.0	100.0	100.0	100.0
Lead rougher conc (calcd)	36.1	3.42	49.08	5.96	12.3	85.45	8.6	7.8	79.9	50.2	39.6	40.4

REMARKS: Shown above is metallurgical balance for copper-lead separation.
*Copper-lead cleaner concentrate.

MINES BRANCH FLOTATION TEST REPORT

TEST NO. 10	SAMPLE: Mattagami - Sturgeon Lake F-1	DATE: March 4, 1970.
OBJECT OF TEST: Repeat of Test 9 but skimmed lead rougher conc longer (in 4 increments) in an attempt to reduce lead content in copper concentrate		CHARGE: 2x2000 g
		TESTED BY: A.S.

OPERATION	Time min	% Solids	pH	Unit used	Reagents, lb per ton ZnCN	AF242	CX51
Grinding } as							
Copper-lead rougher } in							
Copper-lead cleaners } Test 9							
Copper-lead separation							
Desorption*							
Conditioning	5			250-g cell	0.33	0.01	0.0015
Lead rougher No. 1	½						
" " No. 2	½						
" " No. 3	½					0.01	
" " No. 4	½					0.01	
Cleaning of lead rougher conc No.1	1			50-g cell			

PRODUCT	WT %	ANALYSIS % Cu	Pb	Zn	Fe	Ag	Fe/FeS	DISTRIBUTION % Cu	Pb	Zn	Ag
Copper conc	1.80	22.00	2.46	8.48	27.88	42.50	7.6	57.4	4.0	1.7	21.5
Lead conc	1.01	1.85	51.10	6.92	13.43	65.20	11.0	2.7	46.7	0.8	18.6
Lead cleaner tail	0.78	8.65	11.00	8.69	29.29	46.70	20.7	9.8	7.8	0.8	10.3
Lead rougher conc No. 2	0.50	8.37	19.07	8.52	25.05	72.70	16.7	6.1	8.6	0.5	10.2
" " " No. 3	0.29	8.73	10.10	9.51	28.58	73.30	19.8	3.7	2.6	0.3	6.0
" " " No. 4	0.19	10.25	7.14	10.02	29.49	83.30	19.3	2.8	1.2	0.2	4.5
Copper-lead cl tail No.3	0.39	4.25	8.57	15.61	24.64	26.10	19.1	2.4	3.0	0.7	2.9
" " " " No.2	0.48	3.60	8.00	15.42	23.33	24.60	18.3	2.5	3.5	0.8	3.3
" " " " No.1	0.69	1.76	3.53	16.78	23.03	10.80	19.5	1.8	2.2	1.3	2.1
Copper-lead ro tail	93.87	0.08	0.24	8.95		0.78		10.8	20.4	92.9	20.6
Feed (calcd)	100.00	0.69	1.11	9.03		3.55		100.0	100.0	100.0	100.0

REMARKS: *See remarks, Test 9, Sheet 1.

MINES BRANCH FLOTATION TEST REPORT

TEST NO. 10	SAMPLE: Matta_ami - Sturgeon Lake F-1	DATE: March 4, 1970
OBJECT OF TEST:		CHARGE:
		TESTED BY:

OPERATION	Time min	% Solids	pH	Unit used	Reagents, lb per ton									

PRODUCT	WT %	ANALYSIS %							DISTRIBUTION %				
		Cu	Pb	Zn	Ag	Fe/FeS			Cu	Pb	Zn	Ag	Fe/FeS
Copper conc	39.4	22.00	2.46	8.48	42.50	7.6			69.6	5.7	40.2	30.3	23.3
Lead conc	22.0	1.85	51.10	6.92	65.20	11.0			3.3	65.6	18.3	26.0	18.8
Lead cleaner tail	17.1	8.65	11.00	8.69	46.70	20.7			11.9	11.0	17.9	14.5	27.5
Lead rougher conc No. 2	11.0	8.37	19.07	8.52	72.70	16.7			7.4	12.2	11.3	14.5	14.3
" " " No. 3	6.3	8.73	10.10	9.51	73.30	19.8			4.4	3.7	7.2	8.4	9.7
" " " No. 4	4.2	10.25	7.14	10.02	83.30	19.3			3.4	1.8	5.1	6.3	6.4
Feed (calcd)*	100.0	12.46	17.13	8.31	55.19				100.0	100.0	100.0	100.0	100.0
Calculated assays													
Lead ro conc No. 1	39.1	4.82	33.56	7.69	57.11	15.2			15.2	76.6	36.2	40.5	46.3
" " " No. 1+2	50.1	5.60	30.38	7.88	60.53	15.6			22.6	88.8	47.5	55.0	60.6
" " " No. 1+2+3	56.4	5.95	28.12	8.06	61.96	16.0			27.0	92.5	54.7	63.4	70.3
" " " No. 1+2+3+4	60.6	6.25	26.66	8.19	63.44	16.3			30.4	94.3	59.8	69.7	76.7

REMARKS: Shown above is metallurgical balance for copper-lead separation.
*Copper-lead cleaner concentrate.

MINES BRANCH FLOTATION TEST REPORT

TEST NO. 11 | SAMPLE: Mattagami-Sturgeon Lake F-1 | DATE: March 5, 1970

OBJECT OF TEST: To try copper-lead-zinc flotation directly on the ore using H_2SO_4 to lower the pH in conjunction with SO_2. | CHARGE: 2000 | TESTED BY: A.S.

OPERATION	Time min	% Solids	pH	Unit used	Reagents, lb per ton									
					H_2SO_4	SO_2	CX51	NaOH	Na_2CO_3	NaCN	AF242	DF250		
Grinding	45	65	8.2	7x14 RM										
Conditioning	5		6.6	1000-g cell	1.6									
"	5		6.6			2.5								
"	3						0.02							
Copper rougher, Stage 1	½											0.02		
" " " 2	1½		6.0				0.01							
Conditioning	5		7.2					0.85						
"	10		8.2						2.0	0.10				
"	3										0.02			
Lead rougher, Stage 1	½													
" " " 2	1										0.02			

PRODUCT	WT %	ANALYSIS %							DISTRIBUTION %				
		Cu	Pb	Zn	Fe	Ag	Fe/FeS		Cu	Pb	Zn	Ag	
Copper conc	1.64	5.45	8.16	1.80	36.66	34.10	31.7		13.8	12.3	0.3	14.9	
Copper cleaner tail No.2	0.58	0.64	0.96	1.89	40.80	6.27	40.0		0.6	0.5	0.1	1.0	
" " " No.1	7.19	0.21	0.62	1.86	41.91	4.07	41.5		2.3	4.1	1.5	7.8	
Lead conc	1.02	0.31	46.08	9.79	13.74	33.20	12.3		0.5	43.1	1.1	9.1	
Lead cleaner tail	0.79	3.84	14.49	10.15	18.58	50.10	14.0		4.7	10.5	0.9	10.6	
Zinc conc	5.87	1.40	0.72	55.24	8.08	4.87	0.4		12.7	3.9	35.2	7.7	
Zinc cleaner tail	6.30	1.72	0.66	49.93	9.70	6.03	2.4		16.7	3.8	34.2	10.2	
Zinc rougher tail	76.61	0.41	0.31	3.21		1.89			48.7	21.8	26.7	38.7	
Feed (calcd)	100.00	0.65	1.09	9.20		3.74			100.0	100.0	100.0	100.0	

REMARKS: Fine, bright coppery froth at start of zinc conditioning.

MINES BRANCH FLOTATION TEST REPORT

TEST NO. 11 | SAMPLE: Mattagami-Sturgeon Lake F-1 | DATE: March 5, 1970

OBJECT OF TEST: | CHARGE: | TESTED BY:

OPERATION	Time min	% Solids	pH	Unit used	Reagents, lb per ton									
							CX51	DF250		NaCN	AF242	Lime	$CuSO_4$	NaAF
Conditioning	10		11.7									4.0	1.0	
Zinc rougher, Stage 1	½						0.03							0.10
" 2	½													0.05
" 3	½						0.01							
" 4	2													0.05
Copper cleaner No. 1	1½			250-g cell			0.004	0.002						
" " No. 2	2			50-g cell				0.001						
Lead cleaner No. 1	1			250-g cell						0.10	0.004			
" " No. 2	2			50-g cell										
Zinc cleaner	2		11.9	500-g cell				0.01				1.0		

PRODUCT	WT %	ANALYSIS %							DISTRIBUTION %				
		Cu	Pb	Zn	Fe	Ag	Fe/FeS		Cu	Pb	Zn	Ag	
Calculated Assays													
Copper rougher conc	9.41	1.15	1.96	1.85	40.93	9.44	39.7		16.7	16.9	1.9	23.7	
Copper rougher tail	90.59	0.60	1.00			3.14							
Lead rougher conc	1.81	1.85	32.29	9.95	15.85	40.57	38.8		5.2	53.6	2.0	19.7	
Lead rougher tail	88.78	0.57	0.36			2.38							
Zinc rougher conc	12.17	1.57	0.69	52.49	8.92	5.47	1.4		29.4	7.7	69.4	17.9	

REMARKS:

MINES BRANCH FLOTATION TEST REPORT

TEST NO. 12	SAMPLE: Mattagami-Sturgeon Lake F-1	DATE: April 15, 1970.
OBJECT OF TEST: To try copper-lead-zinc flotation directly on the ore using Z-200 as a copper promoter without any specific galena depressant.		CHARGE: 2000 g.
		TESTED BY: A. S.

OPERATION	Time min	% Solids	pH	Unit used	Reagents, lb per ton									
					Lime	$ZnSO_4$	NaCN	Z-200	DF250					
Grinding	45	65		7 x 14 RM	2.5	0.5	0.10							
Conditioning			9.4					0.009						
Copper rougher														
Stage 1								0.009	0.02					

PRODUCT	WT %	ANALYSIS %							DISTRIBUTION %				

REMARKS: Z-200 did not work, it gave a dirty, depressed, effervescent, froth. Some CX51 was added in an attempt to float chalcopyrite but all of the sulphides floated, therefore test was terminated.

MINES BRANCH FLOTATION TEST REPORT

TEST NO. 13 | SAMPLE: Mattagami-Sturgeon Lake F-2 | DATE: April 15, 1970

OBJECT OF TEST: Copper-lead selective flotation using SO_2 in conjunction with aeration of the pulp prior to copper flotation.

CHARGE: 2000 g

TESTED BY: A.S.

OPERATION	Time min	% Solids	pH	Unit used	Reagents lb per ton									
					SO_2	CX51	DF250	Lime	NaCN	AF242				
Grinding	45	65		7 x 14 RM										
Conditioning	20		5.6	Aerator	4.0	0.02								
Copper rougher No. 1	1			1000-g cell			0.02							
" " No. 2	1					0.005								
" " No. 3	1					0.005								
Conditioning	5		11.0					4.0	0.10					
Lead rougher #1, Stage 1	½					0.01				0.01				
" " " " 2	½					0.01								
Lead rougher #2, Stage 1	½					0.02								
" " " " 2	½					0.02								
" " " " 3	½					0.02								

PRODUCT	WT %	ANALYSIS %							DISTRIBUTION %			
		Cu	Pb	Zn	Fe	Ag	Fe/FeS		Cu	Pb	Zn	Ag
Copper rougher conc No.1	6.12	9.06	2.48	4.60	37.9	36.95	29.4		75.0	11.9	3.0	57.2
" " " No.2	2.95	2.64	7.97	4.66	37.9	14.38	35.1		10.5	18.4	1.5	10.7
" " " No.3	2.14	1.17	11.33	4.91	34.5	10.73	36.1		3.4	19.0	1.1	5.8
Lead rougher conc No. 1	1.15	0.10	18.12	10.52	27.4	10.93	26.1		0.2	16.3	1.3	3.2
" " " No. 2	0.82	0.22	12.06	10.87	27.9	10.32	26.4		0.2	7.8	1.0	2.1
Lead rougher tail	86.82	0.091	0.39	9.85	21.6	0.95			10.7	26.6	92.1	21.0
Feed (calcd)	100.00	0.74	1.28	9.29	23.5	3.95			100.0	100.0	100.0	100.0
Calculated Assays												
Copper rougher conc (combined)	11.21	5.86	5.61	4.68	37.25	26.00	3.2		88.9	49.3	5.6	73.7
Copper rougher tail	88.79	0.09	0.73			1.17						
Lead rougher conc (combined)	1.97	0.15	15.60	10.66	27.61	10.68	26.4		0.4	24.1	2.3	5.3

REMARKS: Active copper float but galena depressed, pH too high?

MINES BRANCH FLOTATION TEST REPORT

TEST NO. 14 | SAMPLE: Mattagami-Sturgeon Lake F-1 | DATE: April 15, 1970

OBJECT OF TEST: Repeat of Test 13 but (1) combined copper rougher concentrates and cleaned twice, (2) employed a lower pH in lead flotation, (3) floated a zinc conc. | CHARGE: 2000 g | TESTED BY: A.S.

OPERATION	Time min	% Solids	pH	Unit used	Reagents, lb per ton									
					CX51	DF250	Lime	NaCN	AF242	$CuSO_4$	NaAF			
Grinding } as in														
Copper roughers } Test13														
Conditioning	5		9.7	1000-g cell			3.0	0.10						
Lead rougher #1, Stage 1	½								0.01					
" " " " 2	½								0.01					
Lead rougher #2	2				0.02									
Conditioning	10						2.0			2.0				
Zinc rougher, Stage 1	2				0.02	0.02					0.10			
" " " 2	3										0.05			
Copper cleaners														
No. 1	1½			250-g cell										
No. 2	½			" " "										

PRODUCT	WT %	ANALYSIS %							DISTRIBUTION %			
		Cu	Pb	Zn	Fe	Ag	Fe/FeS		Cu	Pb	Zn	Ag
Copper conc	7.82	6.37	4.60	2.00	38.0	29.05	32.2		66.5	31.7	1.7	57.5
Copper cleaner tail #2	3.72	2.57	4.42	3.52	39.1	12.56	36.4		12.8	14.5	1.5	11.8
" " " #1	3.56	0.89	3.69	5.47	36.6	6.22	35.2		4.2	11.6	2.2	5.6
Lead rougher conc #1	0.85	0.10	21.60	13.34	24.9	13.23	23.3		0.1	16.2	1.3	2.8
" " " #2	0.78	0.27	13.12	12.94	22.0	13.40	20.3		0.3	9.0	1.1	2.6
Zinc rougher conc	15.12	0.33	0.56	52.73	8.6	1.98	2.1		6.6	7.5	88.6	7.6
Zinc rougher tail	68.15	0.10	0.16	0.48		0.70			9.5	9.5	3.6	12.1
Feed (calcd)	100.00	0.75	1.14	8.95		3.95			100.0	100.0	100.0	100.0
Calculated Assays												
1st Stage Copper cleaner conc	11.54	5.14	4.54	2.49	38.4	23.73	33.5		79.3	46.2	3.2	69.3
Copper rougher conc	15.10	4.14	4.34	3.19	37.9	19.60	33.9		83.5	57.8	5.4	74.9
Copper rougher tail	84.90	0.15	0.56			1.17						
Lead rougher conc (combined)	1.63	0.18	17.54	13.15	23.5	13.31	21.8		0.4	25.2	2.4	5.4
Lead rougher tail	83.27	0.14	0.23			0.93						

REMARKS: Lead float similar to Test 13 despite reduction in pH.

MINES BRANCH FLOTATION TEST REPORT

TEST NO. 15	SAMPLE: Mattagami-Sturgeon Lake F-1	DATE: April 16, 1970
OBJECT OF TEST:	Copper-lead-zinc selective flotation with aeration of the pulp prior to copper flotation and Minerec A as copper promoter.	CHARGE: 2000
		TESTED BY: A.S.

OPERATION	Time min	% Solids	pH	Unit used	Reagents. lb per ton									
					SO_2	Min A	DF250	Na_2CO_3	NaCN	AF242				
Grinding	45	65		7 x 14 RM										
Conditioning		5.6		Aerator	4.0	0.011								
Copper rougher				1000-g cell										
Stage 1	1						0.02							
" 2	1					0.011								
" 3	1					0.011								
Conditioning	5	7.3						4.0	0.10					
Lead rougher														
Stage 1	1									0.02				
" 2	2									0.02				

PRODUCT	WT %	ANALYSIS %							DISTRIBUTION %				
		Cu	Pb	Zn	Fe	Ag	Fe/FeS		Cu	Pb	Zn	Ag	
Copper conc	2.08	23.15	1.08	4.38	32.6	89.20	11.7		62.5	1.9	1.0	45.8	
Copper cleaner tail No. 2	1.02	7.87	1.33	7.52	37.1	33.60	29.3		10.4	1.2	0.8	8.5	
" " " No. 1	1.60	4.36	1.91	9.84	31.8	22.39	26.8		9.1	2.6	1.7	8.8	
Lead conc	1.82	0.64	38.40	8.73	20.4	23.67	13.8		1.5	20.3	1.7	10.6	
Lead cleaner tail	1.24	1.21	9.28	11.01	26.4	16.11	24.1		3.2	10.1	2.5	4.9	
Zinc rougher conc	14.77	0.22	0.66	54.27	8.73	1.70	2.2		4.2	8.4	88.1	6.2	
Zinc rougher tail	77.47	0.09	0.23	0.48	25.40	0.79			9.1	15.5	4.2	15.2	
Feed (calcd)	100.00	0.77	1.16	9.10	23.4	4.05			100.0	100.0	100.0	100.0	

REMARKS:

Minerec A gave a fine-grained, brittle froth.

MINES BRANCH FLOTATION TEST REPORT

TEST NO. 15 | SAMPLE: Mattagami-Sturgeon Lake F-1 | DATE: April 16, 1970

OBJECT OF TEST: | CHARGE: | TESTED BY:

OPERATION	Time min	% Solids	pH	Unit used	Reagents, lb per ton									
							DF250		NaCN		Lime	$CuSO_4$	CX51	NaAF
Conditioning	10		10.9								4.0	2.0		
Zinc rougher														
Stage 1	1												0.02	0.10
" 2	1						0.02							
" 3	1													0.05
" 4	2													0.05
Copper cleaners														
No. 1	1			250-g cell										
No. 2	1			" " "			0.004							
Lead cleaner	1			" " "					0.10					

PRODUCT	WT %	ANALYSIS %						DISTRIBUTION %			
		Cu	Pb	Zn	Fe	Ag	Fe/FeS	Cu	Pb	Zn	Ag
Calculated Assays											
1st Stage Copper cleaner conc	3.10	18.12	1.16	5.41	34.1	70.91	17.5	72.9	3.1	1.8	54.3
Copper rougher conc	4.70	13.44	1.42	6.92	33.3	54.39	20.7	82.0	5.7	3.5	63.1
Copper rougher tail	95.30	0.15	1.15			1.57					
Lead rougher conc	3.06	1.18	26.67	12.62	28.2	20.61	25.7	4.7	70.4	4.2	15.5
Lead rougher tail	92.24	0.11	0.30			0.94					

REMARKS:

MINES BRANCH FLOTATION TEST REPORT

TEST NO. 16 | SAMPLE: Mattagami-Sturgeon Lake F-1 | DATE: April 16, 1970

OBJECT OF TEST: Repeat of Test 15 but used Aerofloat 194 as copper promoter in place of Minerec A. | CHARGE: 2000 g | TESTED BY: A.S.

OPERATION	Time min	% Solids	pH	Unit used	Reagents. lb per ton									
					SO_2	AF194	DF250	Na_2CO_3	NaCN	AF242				
Grinding - as in Test15														
Conditioning	20		5.6	Aerator	4.0	0.0085								
Copper rougher, Stage 1	1			1000-g cell		0.0085	0.02							
" " " 2	1					0.0085								
" " " 3	1					0.0085								
Conditioning	5		7.6					5.0	0.10					
Lead rougher, Stage 1	1									0.02				
" " " 2	1									0.01				
" " " 3	1									0.01				
Copper cleaner	1			250-g cell			0.004							
Lead cleaner No. 1	1			" " "					0.10					
" " No. 2	1			" " "			0.004							

PRODUCT	WT %	ANALYSIS %							DISTRIBUTION %				
		Cu	Pb	Zn	Fe	Ag	Fe/FeS		Cu	Pb	Zn	Ag	
Copper conc	1.68	23.54	0.87	3.66	33.2	94.70	12.0		54.3	1.2	0.7	40.3	
Copper cleaner tail	0.70	5.40	1.60	8.23	31.0	30.15	25.3	-	5.2	0.9	0.6	5.4	
Lead conc	1.95	1.23	37.27	8.78	21.4	32.25	19.3		3.3	57.4	1.8	16.0	
Lead cleaner tail No. 2	0.54	5.81	10.75	8.56	28.1	28.07	22.0		4.3	4.6	0.5	3.8	
" " " No. 1	0.94	3.49	8.33	10.04	24.2	25.57	19.9		4.5	6.2	1.0	6.1	
Lead rougher tail	94.19	0.22	0.40	9.60	23.7	1.19			28.4	29.7	95.4	28.4	
Feed (calcd)	100.00	0.73	1.27	9.47		3.94			100.0	100.0	100.0	100.0	
Calculated Assays													
Copper rougher conc	2.38	18.21	1.08	5.00	32.6	75.72	16.0		59.5	2.1	1.3	45.7	
Copper rougher tail	97.62	0.30	1.27			2.19							
1st stage lead cleaner conc	2.49	2.22	31.52	8.73	22.9	31.35	19.9		7.6	62.0	2.3	19.8	
Lead rougher conc	3.43	2.57	25.17	9.09	23.2	29.76	19.8		12.1	68.2	3.3	25.9	

REMARKS:

Froth in copper float similar to that obtained in Test 15 with Minerec A.

MINES BRANCH FLOTATION TEST REPORT

TEST NO. 17 | SAMPLE: Mattagami-Sturgeon Lake F-1 | DATE: May 26, 1970

OBJECT OF TEST: Repeat of Test 15 but lime added to both copper and lead cleaners for pyrite depression. | CHARGE: 2000 g | TESTED BY: A.S.

OPERATION	Time min	% Solids	pH	Unit used	Reagents, lb per ton DF250	NaCN	Lime	AF242
Grinding as in								
Copper rougher Test 15								
Lead rougher								
Copper cleaners								
No. 1	1½		11.4	250-g cell	0.01		0.6	
No. 2	1		10.3	" " "				
Lead cleaners								
No. 1	1		10.9	250-g cell		0.10	0.3	
No. 2	3/4		9.6	" " "				0.005

PRODUCT	WT %	ANALYSIS % Cu	Pb	Zn	Fe	Fe/FeS	DISTRIBUTION % Cu	Pb	Zn
Copper conc	3.38	17.04	1.76	6.76	32.0	15.7	81.0	5.8	2.6
Copper cleaner tail #2	0.56	2.94	1.40	5.06	39.1	35.9	2.3	0.8	0.3
" " " #1	0.98	1.44	1.08	5.21	35.8	33.9	2.0	1.0	0.6
Lead conc	1.45	0.14	39.50	7.90	21.8	20.8	0.3	55.6	1.3
Lead cleaner tail #2	0.60	1.01	16.40	8.89	26.6	24.7	0.9	9.6	0.6
" " " #1	0.69	1.39	7.40	9.52	28.2	25.9	3.3	12.2	1.8
Lead rougher tail	91.34	0.08	0.17	8.91			10.2	15.0	92.8
Feed (calcd)	100.00	0.71	1.03	8.78			100.0	100.0	100.0
Calculated Assays									
1st Stage copper cleaner conc	3.94	15.04	1.71	6.52	33.0	19.0	83.3	6.6	2.9
Copper rougher conc	4.92	12.33	1.58	6.26	33.6	22.1	85.3	7.6	3.5
Copper rougher tail	95.08	0.11	1.00						
1st stage lead cleaner conc	2.05	0.40	32.74	8.19	23.2	22.7	1.2	65.2	1.9
Lead rougher conc	3.74	0.84	21.29	8.79	25.5	24.7	4.5	77.4	3.7

REMARKS:

MINES BRANCH FLOTATION TEST REPORT

TEST NO. 18 | SAMPLE: Mattagami - Sturgeon Lake F-2 | DATE: May 27, 1970

OBJECT OF TEST: Preliminary test on new F-2 sample - to float copper-lead and zinc concentrates using the combination lime + $ZnSO_4$ + NaCN | CHARGE: 2000 g | TESTED BY: A.S.

OPERATION	Time min	% Solids	pH	Unit used	Reagents, lb per ton									
					Lime	$ZnSO_4$	NaCN	CX51	DF250	$CuSO_4$	NaAF			
Grinding	45	65		7 x 14 RM	1.5	0.5	0.1							
Conditioning	10		10.1	1000-g cell				0.02						
Copper-lead ro, Stage 1	½								0.02					
" " " " 2	½							0.01						
" " " " 3	1							0.01						
" " " " 4	1							0.01						
" " " " 5	1							0.01						
Conditioning	10		11.6		2.0					1.0				
Zinc rougher, Stage 1	½							0.02			0.05			
" " " 2	½							0.01			0.05			
" " " 3	1										0.05			
" " " 4	1½										0.05			

PRODUCT	WT %	ANALYSIS %							DISTRIBUTION %				
		Cu	Pb	Zn	Fe	Ag	Fe/FeS		Cu	Pb	Zn	Ag	
Copper-lead conc	3.31	29.64	4.21	1.72	27.8	56.16	1.6		70.2	21.0	0.7	51.5	
Copper-lead cl tail No. 3	0.49	16.51	13.71	5.32	25.9	33.23	10.8		5.8	10.1	0.3	4.5	
" " " " No. 2	0.60	8.20	14.50	7.16	27.0	26.24	19.0		3.5	13.1	0.5	4.4	
" " " " No. 1	2.34	5.73	9.24	8.17	29.2	19.08	23.2		9.6	32.5	2.3	12.4	
Zinc conc	7.32	0.40	0.25	58.22	6.7	2.03	-		2.1	2.8	50.2	4.1	
Zinc cleaner tail	6.00	0.57	0.42	48.68	10.9	3.01	9.1		2.4	3.8	34.4	5.0	
Zinc rougher tail	79.94	0.11	0.14	1.24		0.82			6.4	16.7	11.6	18.1	
Feed (calcd)	100.00	1.40	0.67	8.49		3.61			100.0	100.0	100.0	100.0	

REMARKS:

Copper-lead rougher - bright, clean copper froth at start but pyrite appeared in froth at end of float.

Zinc rougher - coarse sphalerite floated in Stage 2.

MINES BRANCH FLOTATION TEST REPORT

TEST NO. 18 | SAMPLE: Mattagami-Sturgeon Lake F-2 | DATE: May 27, 1970

OBJECT OF TEST: | CHARGE: | TESTED BY:

OPERATION	Time min	% Solids	pH	Unit used	Reagents, lb per ton: Lime	DF250
Copper-lead cleaners						
No. 1	1½			250-g cell		
No. 2	1½			" " "		0.004
No. 3	1			" " "		
Zinc cleaner	2		11.9	500-g cell	1.0	

PRODUCT	WT %	ANALYSIS % Cu	Pb	Zn	Fe	Ag	Fe/FeS	DISTRIBUTION % Cu	Pb	Zn	Ag
Calculated Assays											
Copper-lead cleaner conc											
2nd Stage	3.80	27.95	5.44	2.18	27.6	53.20	2.7	76.0	31.1	1.0	56.0
1st Stage	4.40	25.25	6.67	2.86	27.5	49.53	5.0	79.5	44.2	1.5	60.4
Copper-lead rougher conc	6.74	18.48	7.56	4.71	28.1	38.96	11.4	89.1	76.7	3.8	72.8
Copper-lead rougher tail	93.26	0.16	0.17			1.06		10.9	23.3		27.2
Zinc rougher conc	13.32	0.48	0.33	53.92	8.6	2.47	1.9	4.5	6.6	84.6	9.1

REMARKS:

MINES BRANCH FLOTATION TEST REPORT

TEST NO. 19 | SAMPLE: Mattagami-Sturgeon Lake F-2 | DATE: May 27, 1970

OBJECT OF TEST: To float copper-lead and zinc concentrates using the combination Na_2CO_3 + Na_2SO_3 + NaCN along with aeration and Aerofloat 208 and 242 as copper and lead promoters. | CHARGE: 2000 g | TESTED BY: A.S.

OPERATION	Time min	% Solids	pH	Unit used	Reagents, lb per ton									
					Na_2CO_3	Na_2SO_3	NaCN	AF208	AF242	DF250	Lime	$CuSO_4$	CX51	NaAF
Grinding	45	65		7 x 14 RM	4.0	1.0	0.1							
Conditioning	20			Aerator				0.02						
Copper-lead rougher				1000-g cell										
Stage 1	2		9.5						0.01	0.02				
Stage 2	1									0.01				
Stage 3	1							0.01	0.01					
Conditioning	10		11.3								4.0	1.0		
Zinc rougher														
Stage 1	1												0.02	0.05
Stage 2	1									0.01				
Stage 3	3									0.01				0.05

PRODUCT	WT %	ANALYSIS %						DISTRIBUTION %			
		Cu	Pb	Zn	Fe	Ag	Fe/FeS	Cu	Pb	Zn	Ag
Copper-lead conc	5.81	20.93	9.12	4.81	27.6	46.92	8.6	8.7	78.0	3.3	74.3
Copper-lead cl tail No. 3	1.03	3.55	1.81	7.88	35.0	10.09	31.0	2.6	2.7	1.0	2.8
" " " " No. 2	0.96	3.02	1.58	8.33	33.4	8.62	29.7	2.1	2.2	1.0	2.3
" " " " No. 1	1.25	2.45	1.05	9.07	29.7	6.38	26.4	2.2	1.9	1.4	2.2
Zinc conc	8.87	0.15	0.09	59.86	6.1	1.27		1.0	1.2	63.3	3.1
Zinc cleaner tail	4.02	0.22	0.21	47.14	10.0	1.59	4.3	0.6	1.2	22.6	1.7
Zinc rougher tail	78.06	0.08	0.11	0.81		0.64		4.4	12.8	7.4	13.6
Feed (calcd)	100.00	1.40	0.68	8.39		3.67		100.0	100.0	100.0	100.0

REMARKS: Copper-lead rougher - "gummy" froth but improved towards end of float.
Zinc rougher - "gummy", well-mineralized froth, difficult to skim throughout float.

MINES BRANCH FLOTATION TEST REPORT

TEST NO. 19	SAMPLE: Mattagami-Sturgeon Lake F-2	DATE: May 27, 1970
OBJECT OF TEST:		CHARGE:
		TESTED BY:

OPERATION	Time min	% Solids	pH	Unit used	Reagents, lb per ton									
									DF250	Lime				
Copper-lead cleaners														
No. 1	1½			250-g cell					0.01					
No. 2	1½			" " "					0.004					
No. 3	1½			" " "										
Zinc cleaner	2		~ 12	500-g cell					0.01	1.0				

PRODUCT	WT %	ANALYSIS %							DISTRIBUTION %				
		Cu	Pb	Zn	Fe	Ag	Fe/FeS		Cu	Pb	Zn	Ag	
Calculated Assays													
Copper-lead cleaner conc													
2nd Stage	6.84	18.31	8.02	5.27	28.7	41.37	12.0		89.7	80.7	4.3	77.1	
1st Stage	7.80	16.43	7.23	5.65	29.3	37.34	14.2		91.8	82.9	5.3	79.4	
Copper-lead rougher conc	9.05	14.50	6.37	6.12	29.4	33.07	16.0		94.0	84.8	6.7	81.6	
Copper-lead rougher tail	90.95	0.09	0.11			0.74			6.0	15.2		18.4	
Zinc rougher conc	12.89	0.17	0.13	55.89	7.3	1.37	0.7		1.6	2.4	85.9	4.8	

REMARKS:

MINES BRANCH FLOTATION TEST REPORT

TEST NO. 20	SAMPLE: Mattagami - Sturgeon Lake F-2	DATE: June 4, 1970
OBJECT OF TEST: Repeat of Test 18 with deleading of copper-lead concentrate		CHARGE: 2 x 2000 g
		TESTED BY: A.S.

OPERATION	Time min	% Solids	pH	Unit used	Reagents, lb per ton									
					Lime	ZnCN	AF242	DF250						
Grinding - as in Test 18														
Conditioning	10		10.4*		0.5									
Copper-lead rougher - as in Test 18														
Copper-lead cleaner No.1	1½			500-g cell										
" " " No.2	1			" " "										
Copper-lead separation														
Desorption - as in Test 9														
Conditioning	5			250-g cell		0.88								
Lead rougher, stage 1	1						0.01							
" " " 2	½						0.005							
Lead cleaner No. 1	1			250-g cell				0.004						
" " No. 2	1			" " "			0.01							

PRODUCT	WT %	ANALYSIS %							DISTRIBUTION %			
		Cu	Pb	Zn	Fe	Ag	Fe/FeS		Cu	Pb	Zn	Ag
Copper conc	2.82	29.07	1.40	4.29	28.6	32.16	2.6		58.6	6.1	1.5	26.1
Lead conc	0.19	4.78	51.58	4.22	8.6	218.03	3.9		0.7	15.2	0.1	11.9
Lead cleaner tail No. 2	0.11	18.46	20.68	4.18	22.0	130.71	5.3		1.5	3.5	0.1	4.1
" " " No. 1	0.55	25.50	9.26	4.19	27.8	76.76	4.9		10.0	7.9	0.3	12.2
Copper-lead cl tail No. 2	0.68	11.70	12.28	11.25	24.4	31.94	12.8		5.7	12.9	1.0	6.3
" " " " No. 1	1.61	6.40	8.62	11.93	26.2	19.43	19.2		7.4	21.5	2.4	9.0
Copper-lead rougher tail	94.04	0.24	0.23	8.05		1.12			16.1	32.9	94.6	30.4
Feed (calcd)	100.00	1.40	0.65	8.00		3.47			100.0	100.0	100.0	100.0

REMARKS: Two 2000-gram batches ground and floated separately, rougher concentrates combined for cleaning and copper-lead separation. *Had intended to use same pH as Test 18 (10.1) but pH reading at start of conditioning was only 9.6, therefore added additional lime which resulted in an increase in pH to 10.4.

MINES BRANCH FLOTATION TEST REPORT

TEST NO. 20	SAMPLE: Mattagami-Sturgeon Lake F-2	DATE: June 4, 1970
OBJECT OF TEST:		CHARGE:
		TESTED BY:

OPERATION	Time min	% Solids	pH	Unit used	Reagents, lb per ton									

PRODUCT	WT %	ANALYSIS %						DISTRIBUTION %				
		Cu	Pb	Zn	Fe	Ag	Fe/FeS	Cu	Pb	Zn	Ag	Fe/FeS
Metallurgical Balance for Copper-Lead Separation												
Copper conc	76.81	29.07	1.40	4.29	28.6	32.16	2.6	82.8	18.7	77.2	48.0	64.5
Lead conc	5.15	4.78	51.58	4.22	8.6	218.03	3.9	0.9	46.2	5.1	21.8	6.5
Lead cleaner tail No. 2	3.05	18.46	20.68	4.18	22.0	130.71	5.3	2.1	11.0	3.0	7.8	5.2
" " " No. 1	14.99	25.50	9.26	4.19	27.8	76.76	4.9	14.2	24.1	14.7	22.4	23.8
Feed. (calcd)*	100.00	26.96	5.76	4.27	27.2	51.42	3.1	100.0	100.0	100.0	100.0	100.0
Calculated Assays												
1st Stage Lead cl conc	8.20	9.87	40.09	4.20	13.6	185.55	4.4	3.0	57.2	8.1	29.6	11.7
Lead rougher conc	23.19	19.97	20.16	4.20	22.8	115.23	4.7	17.2	81.3	22.8	52.0	35.5

REMARKS: * Copper-lead cleaner concentrate

MINES BRANCH FLOTATION TEST REPORT

TEST NO. 21	SAMPLE: Mattagami-Sturgeon Lake F-2	DATE: June 8, 1970
OBJECT OF TEST:	Repeat of Test 19 but without aeration and with deleading of copper-lead concentrate	CHARGE: 2 x 2000 g
		TESTED BY: A.S.

OPERATION	Time min	% Solids	pH	Unit used	Reagents, lb per ton					
					Na_2CO_3	Na_2SO_3	NaCN	AF208	AF242	DF250
Grinding	45	65		7 x 14 RPM	4.0	1.0	0.1			
Conditioning	10		9.7	1000-g cell				0.01	0.01	
Copper-lead rougher										
Stage 1	1									0.02
" 2	1									0.01
" 3	2							0.01	0.01	
Copper-lead cleaners										
No. 1	1½			500-g cell						0.02
No. 2	1½			250-g cell						0.005
No. 3	1½			" " "						0.01
Copper-lead separation										
as in Test 20										

PRODUCT	WT %	ANALYSIS %							DISTRIBUTION %			
		Cu	Pb	Zn	Fe	Ag	Fe/FeS		Cu	Pb	Zn	Ag
Copper conc	3.41	27.92	1.60	3.43	30.5	27.20	5.6		68.5	8.7	1.4	26.8
Lead conc	0.49	1.62	46.61	5.68	12.1	98.80	10.0		0.6	36.6	0.3	14.0
Lead cleaner tail No. 2	0.39	10.42	20.10	6.27	24.4	115.30	14.5		2.9	12.6	0.3	13.0
" " " No. 1	0.81	23.86	6.72	3.55	28.7	56.22	7.3		13.9	8.7	0.3	13.1
Copper-lead cl tail No. 3	0.43	6.36	4.21	7.51	33.5	18.21	27.0		2.0	2.9	0.4	2.3
" " " " No. 2	0.89	5.10	3.59	7.43	33.5	14.90	28.1		3.3	5.1	0.8	3.8
" " " " No. 1	2.33	1.77	1.53	7.98	32.6	6.74	30.1		3.0	5.7	2.2	4.5
Copper-lead rougher tail	91.25	0.09	0.13	8.60		0.86			5.8	19.7	94.3	22.5
Feed (calcd)	100.00	1.39	0.62	8.33		3.46			100.0	100.0	100.0	100.0

REMARKS: Two 2000-gram batches ground and floated separately, rougher concentrates combined for cleaning and copper-lead separation.

MINES BRANCH FLOTATION TEST REPORT

TEST NO. 21 | SAMPLE: Mattagami-Sturgeon Lake F-2 | DATE: June 8, 1970

OBJECT OF TEST: | CHARGE: | TESTED BY:

OPERATION	Time min	% Solids	pH	Unit used	Reagents, lb per ton									

PRODUCT	WT %	ANALYSIS %							DISTRIBUTION %				
		Cu	Pb	Zn	Fe	Ag	Fe/FeS		Cu	Pb	Zn	Ag	Fe/FeS
Metallurgical Balance for Copper-Lead Separation													
Copper conc	66.83	27.92	1.60	3.43	30.5	27.20	5.6		79.7	13.1	59.1	40.0	53.7
Lead conc	9.54	1.62	46.61	5.68	12.1	98.80	10.0		0.7	54.7	14.0	20.7	13.7
Lead cleaner tail No. 2	7.68	10.42	20.10	6.27	24.4	115.30	14.5		3.4	19.0	12.4	19.5	16.0
" " " No. 1	15.95	23.86	6.72	3.55	28.7	56.22	7.3		16.2	13.2	14.5	19.8	16.6
Feed (calcd)*	100.00	23.42	8.13	3.88	28.0	45.43	7.0		100.0	100.0	100.0	100.0	100.0
Calculated Assays													
1st Stage Lead cl conc	17.22	5.54	34.79	5.94	17.59	106.16	12.0		4.1	73.7	26.4	40.2	29.7
Lead rougher conc	33.17	14.35	21.29	4.79	22.93	82.15	9.7		20.3	86.9	40.9	60.0	46.3

REMARKS:

* Copper-lead cleaner concentrate.

MINES BRANCH FLOTATION TEST REPORT

TEST NO. 22 | SAMPLE: Mattagami-Sturgeon Lake F-2 | DATE: June 9, 1970

OBJECT OF TEST: To try copper-lead-zinc selective flotation directly on the ore using the SO_2 method with Z-200 as the copper promoter (added to grind). | CHARGE: 2000 g | TESTED BY: A.S.

OPERATION	Time min	% Solids	pH	Unit used	Reagents, lb per ton					
					Z-200	SO_2	DF250	Lime	NaCN	AF242
Grinding	45	65		7 x 14 RM	0.018					
Conditioning	20		5.3	Aerator		4.0				
Copper rougher				1000-g cell						
Stage 1	1						0.02			
Stage 2	2				0.009					
Conditioning	5		9.6					3.0	0.1	
"	5									0.02
Lead rougher										
Stage 1	½									
Stage 2	1									0.01

PRODUCT	WT %	ANALYSIS %						DISTRIBUTION %			
		Cu	Pb	Zn	Fe	Ag	Fe/FeS	Cu	Pb	Zn	Ag
Copper conc	3.77	27.24	1.07	3.64	29.9	33.15	5.6	72.4	6.4	1.6	34.7
Copper cleaner tail No. 2	1.43	12.52	2.68	7.01	32.5	36.70	20.7	12.6	6.1	1.2	14.6
" " " No. 1	2.75	2.29	1.20	5.53	35.9	16.21	33.3	4.4	5.2	1.8	12.4
Lead conc	0.69	0.42	39.07	7.55	17.2	30.56	15.9	0.2	42.6	0.6	5.9
Lead cleaner tail	0.54	1.49	15.19	9.34	24.8	30.68	22.4	0.6	13.0	0.6	4.6
Zinc rougher conc	14.69	0.32	0.43	51.70	9.3	2.37	3.0	3.3	10.0	90.9	9.7
Zinc rougher tail	76.13	0.12	0.14	0.35		0.86		6.5	16.7	3.3	18.1
Feed (calcd)	100.00	1.42	0.63	8.35		3.60		100.0	100.0	100.0	100.0

REMARKS:

Z-200 gave a brittle, fine-grained froth.

MINES BRANCH FLOTATION TEST REPORT

TEST NO. 22 | SAMPLE: Mattagami-Sturgeon Lake F-2 | DATE: June 9, 1970

OBJECT OF TEST: | CHARGE: | TESTED BY:

OPERATION	Time min	% Solids	pH	Unit used	Reagents, lb per ton									
							DF250	Lime	NaCN	AF242	$CuSO_4$	CX51	NaAF	
Conditioning	10		11.5					3.0			2.0			
Zinc rougher														
Stage 1	1											0.02		
" 2	1												0.10	
" 3	2						0.02						0.05	
Copper cleaners														
No. 1	2		11.1	250-g cell			0.005	0.6						
No. 2	1		10.2	" " "										
Lead cleaner	½		11.5	" " "				0.3	0.10	0.01				

PRODUCT	WT %	ANALYSIS %						DISTRIBUTION %			
		Cu	Pb	Zn	Fe	Ag	Fe/FeS	Cu	Pb	Zn	Ag
Calculated Assays											
1st stage Copper cl conc	5.20	23.19	1.51	4.66	30.6	34.13	9.7	85.0	12.5	2.8	49.3
Copper rougher conc	7.95	15.96	1.40	4.90	32.4	27.93	17.8	89.4	17.7	4.6	61.7
Lead rougher conc	1.23	0.89	28.59	8.33	20.5	30.62	18.7	0.8	55.6	1.2	10.5
Lead rougher tailing	90.82	0.15	0.19			1.10		9.8	26.7		27.8

REMARKS: Lead cleaner depressed before addition of AF 242 - this was probably due to high lime alkalinity.

MINES BRANCH FLOTATION TEST REPORT

TEST NO. 23 | SAMPLE: Mattagami - Sturgeon Lake F-2 | DATE: June 9, 1970

OBJECT OF TEST: Copper-lead-zinc selective flotation as in Test 22 but used Minerec A as copper promoter in place of Z-200 (similar to Test 17) | CHARGE: 2000 g | TESTED BY: A.S.

OPERATION	Time min	% Solids	pH	Unit used	Reagents, lb per ton									
					SO_2	Min A	DF250	Na_2CO_3	NaCN	AF242				
Grinding	45	65		7 x 14 RM	4.0									
Conditioning	20		5.3	Aerator		0.018								
Copper rougher				1000-g cell										
Stage 1	½						0.02							
" 2	1					0.009								
" 3	½					0.009								
" 4	1					0.009								
Conditioning	5		8.7					5.0	0.10					
Lead rougher														
Stage 1	1									0.01				
" 2	1									0.01				

PRODUCT	WT %	ANALYSIS %							DISTRIBUTION %				
		Cu	Pb	Zn	Fe	Ag	Fe/FeS		Cu	Pb	Zn	Ag	
Copper conc	4.41	24.31	1.69	3.31	31.6	36.25	9.9		76.0	12.0	1.7	43.7	
Copper cleaner tail No. 2	1.07	8.59	3.46	7.08	34.7	31.12	26.5		6.5	5.9	0.9	9.1	
" " " No. 1	1.70	5.48	2.77	9.97	29.1	25.18	23.1		6.6	7.6	2.0	11.7	
Lead conc	0.98	0.20	25.05	6.42	26.8	20.95	25.9		0.1	39.5	0.7	5.6	
Lead cleaner tail No. 2	0.31	1.10	9.61	7.26	31.4	14.01	29.6		0.2	4.8	0.3	1.2	
" " " No. 1	0.92	0.88	4.76	6.52	33.7	11.78	32.1		0.6	7.0	0.7	3.0	
Zinc rougher conc	14.47	0.33	0.26	53.24	9.5	1.97	3.0		3.4	6.0	89.9	7.8	
Zinc rougher tail	76.14	0.12	0.14	0.43		0.86			6.6	17.2	3.8	17.9	
Feed (calcd)	100.00	1.41	0.62	8.57		3.66			100.0	100.0	100.0	100.0	

REMARKS:

MINES BRANCH FLOTATION TEST REPORT

TEST NO. 23 | SAMPLE: Mattagami - Sturgeon Lake F-2 | DATE: June 9, 1970

OBJECT OF TEST: | CHARGE: 2000 g | TESTED BY: A.S.

OPERATION	Time min	% Solids	pH	Unit used	Reagents, lb per ton									
							DF250		NaCN	AF242	Lime	$CuSO_4$	CX51	NaAF
Conditioning	10		11.3								6.0	2.0		
Zinc rougher														
Stage 1	1												0.02	0.10
" 2	1												0.01	0.05
" 3	2						0.02							0.05
Copper cleaners														
No. 1	1½		11.4	250-g cell			0.01				0.6			
No. 2	1		10.3	" " "										
Lead cleaners														
No. 1	1		10.9	250-g cell					0.10		0.3			
No. 2	3/4		9.6	" " "						0.005				

PRODUCT	WT %	ANALYSIS %						DISTRIBUTION %			
		Cu	Pb	Zn	Fe	Ag	Fe/FeS	Cu	Pb	Zn	Ag
Calculated Assays											
1st stage Copper cl conc	5.48	21.24	2.03	4.05	32.2	35.25	13.0	82.5	17.9	2.6	52.8
Copper rougher conc	7.18	17.51	2.21	5.45	31.5	32.86	15.5	89.1	25.5	4.6	64.5
1st stage Lead cl conc	1.29	0.42	21.34	6.62	27.9	19.28	26.7	0.3	44.3	1.0	6.8
Lead rougher conc	2.21	0.61	14.44	6.58	30.3	11.25	29.0	0.9	51.3	1.7	9.8
Lead rougher tail	90.61	0.15	0.16			1.04		10.0	23.2		25.7

REMARKS:

MINES BRANCH FLOTATION TEST REPORT

TEST NO. 24	SAMPLE: Mattagami-Sturgeon Lake F-2	DATE: Aug. 13, 1970
OBJECT OF TEST: To float off a low-lead copper conc directly from the ore by utilizing the selective properties of Z-200.		CHARGE: 2000-g
		TESTED BY: A.S.

OPERATION	Time min	% Solids	pH	Unit used	Reagents, lb per ton									
					Lime	$ZnSO_4$	NaCN	Z-200	DF250					
Grinding	45	65		7x14 RM	1.5	0.5	0.1	0.008						
Conditioning	5		9.7	1000-g cell				0.008						
Copper rougher														
Stage 1	½								0.01					
Stage 2	2							0.012						
Copper cleaner	1½			250-g cell					0.002					

PRODUCT	WT %	ANALYSIS %							DISTRIBUTION %				
		Cu	Pb	Zn	Fe	Ag	Fe/FeS		Cu	Pb	Zn	Ag	
Copper conc	1.28	30.76	0.81	1.50	29.6	45.31	2.4		28.3	1.5	0.2	15.5	
Copper cleaner tail	0.97	17.42	2.49	5.80	25.6	35.76	9.6		12.1	3.5	0.7	9.3	
Copper rougher tail	97.75	0.85	0.67	8.47		2.87			59.6	95.0	99.1	75.2	
Feed (calcd)	100.00	1.39	0.69	8.35		3.73			100.0	100.0	100.0	100.0	
Copper rougher conc (calcd)		25.01	1.54	3.36		41.20	5.5		40.4	5.0	0.9	24.8	

REMARKS:

MINES BRANCH FLOTATION TEST REPORT

TEST NO. 25	SAMPLE: Mattagami-Sturgeon Lake F-2	DATE: August 14, 1970.
OBJECT OF TEST: As in Test 24 but employed AF 238 as the selective copper promoter also replaced lime + $ZnSO_4$ + NaCN with Na_2CO_3 + Na_2SO_3 + NaCN		CHARGE: 2000 g.
		TESTED BY: A.S.

OPERATION	Time min	% Solids	pH	Unit used	Reagents, lb per ton									
					Na_2CO_3	Na_2SO_3	NaCN	DF 250	AF 238	AF 242				
Grinding	45	65		7 x 14 RM	4.0	1.0	0.1							
Conditioning	5		9:9				0.1	0.2						
Copper rougher														
Stage 1	1													
" 2	2								0.02					
Conditioning	5						0.1			0.04				

PRODUCT	WT %	ANALYSIS %							DISTRIBUTION %				

REMARKS Bright heavily-mineralized froth after grinding, therefore added additional cyanide to copper conditioning. Pyrite in evidence during lead conditioning - test terminated at this point because of lack of selectivity and test products discarded.

MINES BRANCH FLOTATION TEST REPORT

TEST NO. 26 | SAMPLE: Mattagami-Sturgeon Lake F-2 | DATE: August 14, 1970

OBJECT OF TEST: Repeat of Test 25 to confirm results | CHARGE: 2000 b.

TESTED BY: A.S.

OPERATION	Time min	% Solids	pH	Unit used	Reagents, lb per ton									
Grinding) as in														
Conditioning)Test														
Copper rougher) 25														

PRODUCT	WT %	ANALYSIS %							DISTRIBUTION %				

REMARKS: Results similar to Test 25 - test products discarded

MINES BRANCH FLOTATION TEST REPORT

TEST NO. 27	SAMPLE: Mattagami-Sturgeon Lake F-2*	DATE: Aug. 18, 1970
OBJECT OF TEST: As in Test 24 but added more Z-200 to copper flotation and floated for a longer period - also floated off a copper-lead conc with AF 242		CHARGE: 2000-g
		TESTED BY: A.S.

OPERATION	Time min	% Solids	pH	Unit used	Reagents, lb per ton									
					Lime	$ZnSO_4$	NaCN	Z-200	DF250	AF242				
Grinding	45	65		7x14 RM	1.5	0.5	0.1	0.012						
Conditioning	5		10.2	1000-g cell				0.008						
Copper roughers														
No. 1, stage 1	1								0.004					
" 2	1							0.012						
No. 2	1							0.012						
No. 3	1							0.012						
Conditioning	5		9.5							0.02				
Copper-lead ro, stage 1	½													
" " " " 2	1									0.02				
Copper-lead cleaner No.1	1			250-g cell					0.004					
" " " No.2	½			" "					0.004					

PRODUCT	WT %	ANALYSIS %							DISTRIBUTION %				
		Cu	Pb	Zn	Fe	Ag	Fe/FeS		Cu	Pb	Zn	Ag	
Copper rougher conc No. 1	2.35	26.16	1.19	3.27	28.5	49.05	5.1		42.3	4.4	0.9	31.9	
" " " No. 2	0.95	19.27	1.47	6.07	27.0	37.28	9.4		12.6	2.2	0.7	9.8	
" " " No. 3	1.28	11.97	1.46	8.51	23.9	24.16	12.4		10.5	3.0	1.3	8.5	
Copper-lead conc.	1.32	13.04	21.65	5.86	22.9	63.25	10.7		11.8	45.2	0.9	23.1	
Copper-lead cl tail No. 2	0.47	12.25	10.54	7.28	28.0	19.09	16.4		4.0	7.8	0.4	2.5	
" " " " No. 1	0.75	11.49	6.80	10.27	25.4	11.49	14.1		5.9	8.1	0.9	2.4	
Copper-lead rougher tail	92.88	0.20	0.20	8.74		0.85			12.9	29.3	94.9	21.8	
Feed (calcd)	100.00	1.45	0.63	8.55		3.62			100.0	100.0	100.0	100.0	
Combined copper rougher conc (calcd)	4.58	20.77	1.33	5.31		39.65	8.1		65.4	9.6	2.9	50.2	

REMARKS: *Newly crushed portion - previous crushed portion had been stored in freezer for about 3½ months. This old sample gave a pH of 9.7 (Test 24) as against a pH of 10.2 for this test.

MINES BRANCH FLOTATION TEST REPORT

TEST NO. 28	SAMPLE: Mattagami-Sturgeon Lake F-2	DATE: Aug. 18, 1970
OBJECT OF TEST: Flotation of a low-lead copper conc and copper-lead conc as in Test 27 but used AF238 as the selective copper promoter in place of Z-200		CHARGE: 2000-g
		TESTED BY: A.S.

OPERATION	Time min	% Solids	pH	Unit used	Reagents, lb per ton									
					Lime	$ZnSO_4$	NaCN	AF238	DF250	AF242				
Grinding	45	65		7x14 RM	1.5	0.5	0.1	0.015						
Conditioning	5		10.3	1000-g cell				0.02	0.02					
Copper roughers														
No. 1	1													
No. 2	1							0.02						
No. 3	2							0.02						
Conditioning	5									0.02				
Copper-lead roughers														
Stage 1	½													
" 2	1									0.02				
Lead cleaner No. 1	1			250-g cell					0.004					
" " No. 2	1			" "										

PRODUCT	WT %	ANALYSIS %							DISTRIBUTION %				
		Cu	Pb	Zn	Fe	Ag	Fe/FeS		Cu	Pb	Zn	Ag	
Copper rougher conc No. 1	1.57	21.11	2.59	4.04	26.4	44.77	7.4		24.2	5.9	0.7	18.3	
" " " No. 2	1.12	17.20	3.51	5.59	24.9	39.31	9.1		14.0	5.7	0.7	11.5	
" " " No. 3	1.46	12.16	4.94	7.28	23.1	33.85	11.6		12.9	10.4	1.2	12.9	
Copper-lead conc	0.66	6.95	35.83	5.86	19.5	78.84	12.7		3.3	34.1	0.4	13.6	
Copper-lead cl tail No. 2	0.49	12.71	10.81	7.03	28.0	22.38	16.0		4.5	7.6	0.4	2.9	
" " " " No. 1	0.66	5.36	6.80	9.63	25.4	14.13	19.6		2.6	6.5	0.7	2.4	
Copper-lead rougher tail	94.04	0.56	0.22	8.86	24.9	1.57			38.5	29.8	95.9	38.4	
Feed (calcd)	100.00	1.37	0.69	8.70	24.8	3.84			100.0	100.0	100.0	100.0	
Combined copper rougher conc (calcd)	4.15	16.90	3.67	5.60	24.8	39.46	9.3		51.1	22.0	2.6	43.7	

REMARKS:

MINES BRANCH FLOTATION TEST REPORT

TEST NO. 29 | SAMPLE: Mattagami-Sturgeon Lake F-2 | DATE: Aug. 19, 1970

OBJECT OF TEST: Separation of copper-lead conc using cyanide with $ZnSO_4$ added to reduce pH to ~9.5 (copper-lead flotation as in Test 21) | CHARGE: 2 x 2000-g | TESTED BY: A.S.

OPERATION	Time min	% Solids	pH	Unit used	Reagents, lb per ton NaCN	$ZnSO_4$	AF242
Grinding	as in Test 21						
Conditioning							
Copper-lead roughers							
Copper-lead cleaners							
Copper-lead separation							
Desorption(as in Test 9)							
Conditioning	10		*	250-g cell	0.8	0.66	
Lead rougher, stage 1	½						
" " " 2	1						0.005
Lead cleaners							
No. 1	1			250-g cell			0.005
No. 2							

PRODUCT	WT %	ANALYSIS % Cu	Pb	Zn	Fe	Ag	Fe/FeS	DISTRIBUTION % Cu	Pb	Zn	Ag
Copper conc	3.63	26.60	1.10	4.04	30.0	16.34	6.2	71.0	5.9	1.7	15.7
Lead conc	0.89	3.97	39.37	8.01	16.4	180.10	12.0	2.6	51.4	0.8	42.4
Lead cleaner tail No. 2	0.32	12.45	14.58	6.90	26.2	70.68	14.4	2.9	6.9	0.3	6.0
" "	0.54	22.67	5.98	4.39	28.6	35.14	8.2	9.0	4.7	0.3	5.0
Combined Cu-Pb cl tail	2.70	3.89	2.76	8.65	32.7	11.72	28.3	7.7	10.9	2.6	8.4
Copper-lead rougher tail	91.92	0.10	0.15	9.07		0.93		6.8	20.2	94.3	22.5
Feed (calcd)	100.00	1.36	0.68	8.83		3.78		100.0	100.0	100.0	100.0

REMARKS: Two 2000-g batches ground and floated separately, copper-lead rougher concentrates combined for cleaning and copper-lead separation. *9.0 at start, 11.0 after addition of NaCN, 9.6 after addition of $ZnSO_4$

MINES BRANCH FLOTATION TEST REPORT

TEST NO. 29 , | SAMPLE: Mattagami-Sturgeon Lake F-2 | DATE: Aug. 19, 1970

OBJECT OF TEST: | CHARGE: | TESTED BY:

OPERATION	Time min	% Solids	pH	Unit used	Reagents, lb per ton									

PRODUCT	WT %	ANALYSIS %						DISTRIBUTION %				
		Cu	Pb	Zn	Fe	Ag	Fe/FeS	Cu	Pb	Zn	Ag	Fe/FeS
Metallurgical Balance for Copper-Lead Separation												
Copper conc	67.5	26.60	1.10	4.04	30.0	16.34	6.2	83.1	8.5	55.6	22.7	53.3
Lead conc	16.6	3.97	39.37	8.01	16.4	180.10	12.0	3.0	74.8	27.1	61.5	25.4
Lead cleaner tail No. 2	5.9	12.45	14.58	6.90	26.2	70.68	14.4	3.4	9.8	8.3	8.6	10.8
" " " No. 1	10.0	22.67	5.98	4.39	28.6	35.14	8.2	10.5	6.9	9.0	7.2	10.5
Feed (calcd)*	100.0	21.62	8.74	4.80	27.4	48.61	7.8	100.0	100.0	100.0	100.0	100.0
Calculated Assays												
1st stage lead cl conc	22.5	6.19	32.87	7.72		151.41	12.6	6.4	84.6	35.4	70.1	36.2
Lead rougher conc	32.5	11.26	24.60	6.69		115.63	11.3	16.9	91.5	44.4	77.3	46.7

REMARKS: *copper-lead cleaner concentrate

MINES BRANCH FLOTATION TEST REPORT

TEST NO. 30 | SAMPLE: Mattagami-Sturgeon Lake F-2 | DATE: Sept. 16, 1970

OBJECT OF TEST: To float a low-lead copper conc with Z-200 followed by copper-lead bulk flotation and separation using the dichromate method.

CHARGE: 2 x 2000 g

TESTED BY: A.S.

OPERATION	Time min	% Solids	pH	Unit used	Reagents, lb per ton									
					Lime	$ZnSO_4$	NaCN	Z-200	DF250	AF242	AF208			
Grinding	45	65		7 x 14 RM	1.25	0.5	0.1	0.015						
Conditioning	5		9.2	1000-g cell				0.005						
Copper rougher A				" " "										
Stage 1	1								0.004					
" 2	1							0.005						
" 3	1							0.005						
" 4	1							0.005						
Conditioning	5		8.9							0.02	0.02			
Copper-lead rougher														
Stage 1	1													
" 2	1									0.02				

PRODUCT	WT %	ANALYSIS %							DISTRIBUTION %				
		Cu	Pb	Zn	Fe	Ag	Fe/FeS		Cu	Pb	Zn	Ag	
Copper conc A*	2.39	30.62	1.52	1.58	28.4	44.31	1.3		53.6	5.3	0.4	28.8	
Copper cleaner tail #2-A	0.70	21.88	4.05	4.32	26.7	46.86	7.0		11.2	4.2	0.4	8.9	
" " " #1-A	1.57	12.28	3.64	7.60	25.1	27.84	13.4		14.1	8.4	1.4	11.9	
Copper conc B**	0.48	27.69	0.83	3.66	28.2	111.00	3.4		9.7	0.6	0.2	14.5	
Copper cleaner tail B	0.16	8.11	9.93	8.11	29.8	51.38	21.7		1.0	2.3	0.2	2.2	
Lead conc	1.31	0.32	23.24	6.56	27.6	18.48	26.5		0.3	44.8	1.0	6.6	
Copper-lead cl tail No.2	0.47	1.69	5.04	8.46	32.6	10.31	30.1		0.6	3.5	0.5	1.3	
" " " " No.1	0.85	1.67	3.52	10.32	27.2	8.43	24.5		1.0	4.4	1.0	2.0	
Copper-lead ro tail	92.07	0.13	0.20	8.83		0.95			8.5	26.5	94.9	23.8	
Feed (calcd)	100.00	1.36	0.68	8.56		3.68			100.0	100.0	100.0	100.0	
Combined copper conc A + B (calcd)	2.87	30.13	1.40	1.93	28.4	55.46			63.3	5.9	0.6	43.3	

REMARKS Two 2000-g batches ground and floated separately - rougher concentrates combined for cleaning and copper-lead separation.

*Copper conc initially floated from the ore with Z-200.

**Copper conc from copper-lead separation of bulk copper-lead conc.

MINES BRANCH FLOTATION TEST REPORT

TEST NO. 30 | SAMPLE: Mattagami-Sturgeon Lake F-2 | DATE: Sept. 16, 1970

OBJECT OF TEST: | CHARGE: | TESTED BY:

OPERATION	Time min	% Solids	pH	Unit used	Reagents, lb per ton: Lime	Z-200	DF250	Dich
Copper cleaners A								
No. 1	1½		11.0	500-g cell	0.2		0.004	
No. 2	1		11.2	250-g cell	0.1		0.002	
Copper-lead cleaners								
No. 1	1			250-g cell			0.004	
No. 2	1			" " "			0.002	
Copper-lead separation								
Conditioning	5		5.8	250-g cell			0.004	0.3
Copper rougher B	1			" " "				
Copper cleaner B	1			" " "		0.005	0.004	

PRODUCT	WT %	ANALYSIS % Cu	Pb	Zn	Fe	Ag	Fe/FeS	DISTRIBUTION % Cu	Pb	Zn	Ag	Fe/FeS
Calculated Assays												
1st Stage copper cl concA	3.09	28.64	2.09	2.20	28.0	44.89	2.6	64.8	9.5	0.8	37.7	
Copper rougher conc A	4.66	23.13	2.61	4.02	27.0	39.14	6.2	78.9	17.9	2.2	49.6	
Copper-lead ro conc	3.27	5.27	11.56	7.46	28.4	29.89	22.9	12.6	55.6	2.9	26.6	
Metallurgical Balance for Copper-Lead Separation												
Copper conc B	24.59	27.69	0.83	3.66	28.2	111.00	3.4	88.4	1.2	15.1	62.0	4.1
Copper cleaner tail B	8.41	8.11	9.93	8.11	29.8	51.38	21.7	8.9	5.0	11.4	9.8	8.9
Lead conc	67.00	0.32	23.24	6.56	27.6	18.48	26.5	2.7	93.8	73.5	28.2	87.0
Feed (calcd)*	100.00	7.71	16.61	5.98	27.9	44.00	20.4	100.0	100.0	100.0	100.0	100.0
Copper rougher conc B(calcd)	33.00	22.70	3.15	4.79	28.6	95.81	8.1	97.3	6.2	26.5	71.8	13.0

REMARKS: * Copper-lead cleaner conc.

MINES BRANCH FLOTATION TEST REPORT

TEST NO. 31	SAMPLE: Mattagami-Sturgeon Lake F-7	DATE: Sept. 17, 1970
OBJECT OF TEST: Repeat of Test 30 on F-7 sample		CHARGE: 2 x 2000 g
		TESTED BY: A.S.

OPERATION	Time min	% Solids	pH	Unit used	Reagents, lb per ton									
					Lime	$ZnSO_4$	NaCN	Z-200	DF250	AF242	AF208			
Grinding	45	65		7 x 14 RM	1.25	0.5	0.1	0.02						
Conditioning	10		9.5	1000-g cell	0.5			0.01						
Copper rougher A				" " "										
Stage 1	½								0.004					
" 2	1							0.01						
Conditioning	5									0.02	0.02			
Copper-lead rougher														
Stage 1	½								0.004					
" 2	½									0.02				
" 3	1									0.02				

PRODUCT	WT %	ANALYSIS %							DISTRIBUTION %				
		Cu	Pb	Zn	Fe	Ag	Fe/FeS		Cu	Pb	Zn	Ag	
Copper conc A*	1.11	24.76	16.32	2.02	22.8	48.45	0.8		44.7	8.0	0.3	17.9	
Copper cleaner tail #2-A	0.50	12.00	25.27	5.92	17.9	39.37	6.7		9.8	5.6	0.3	6.5	
" " " #1-A	0.71	6.20	17.90	9.18	19.7	26.42	13.2		7.2	5.6	0.7	6.2	
Copper conc B**	0,47	25.41	8.35	3.94	27.0	68.61	4.2		19.4	1.7	0.2	10.7	
Copper cleaner tail B	0.44	3.20	31.08	6.00	14.6	40.40	11.1		2.3	6.0	0.3	5.9	
Lead conc	2.49	0.20	45.04	5.96	17.0	16.32	16.1		0.8	49.4	1.7	13.5	
Copper-lead cl tail No. 2	0.73	1.49	15.30	11.98	23.4	13.97	20.7		1.8	4.9	1.0	3.4	
" " " " No. 1	1.65	0.84	7.03	12.75	23.2	7.78	21.0		2.3	5.1	2.4	4.3	
Zinc rougher conc	15.00	0.17	0.72	51.44	10.0	1.83	4.2		4.2	4.7	88.3	9.1	
Zinc rougher tail	76.90	0.06	0.27	0.54		0.88			7.5	9.0	4.8	22.5	
Feed (calcd)	100.00	0.61	2.27	8.74		3.01			100.0	100.0	100.0	100.0	
Combined copper conc A+B (calcd)	1.58	24.94	13.95	2.59	24.1	1.8	54.45		64.1	9.7	0.5	28.6	

REMARKS: Two 2000-g batches ground and floated separately - rougher concentrates combined for cleaning and copper-lead separation.

* Copper conc initially floated from the ore with Z-200.

** Copper conc from copper-lead separation of bulk copper-lead conc.

MINES BRANCH FLOTATION TEST REPORT

TEST NO. 31	SAMPLE: Mattagami-Sturgeon Lake F-7	DATE: Sept. 17, 1970
OBJECT OF TEST:		CHARGE:
		TESTED BY:

OPERATION	Time min	% Solids	pH	Unit used	Reagents, lb per ton									
					Lime			Z-200	DF250			$CuSO_4$	NaAF	
Conditioning	10		11.5	1000-g cell	2.5							1.0		
Zinc rougher				" " "										
Stage 1	1												0.05	
" 2	1												0.05	
" 3	1												0.05	
" 4	1												0.05	
Copper cleaners A														
No. 1	1		11.2	250-g cell	0.15			0.005						
No. 2	1		10.2	" " "										
Copper-lead cleaners														
No. 1	1½			500-g cell										
No. 2	1			" " "					0.004					

PRODUCT	WT %	ANALYSIS %						DISTRIBUTION %				
		Cu	Pb	Zn	Fe	Ag	Fe/FeS	Cu	Pb	Zn	Ag	Fe/FeS
Calculated Assays												
1st stage copper cl concA	1.61	20.80	19.11	3.23	21.3	45.63	2.6	54.5	13.6	0.6	24.4	
Copper rougher conc A	2.32	16.33	18.74	5.05	20.8	39.75	5.9	61.7	19.2	1.3	30.6	
Copper-lead ro conc	5.78	2.83	26.39	8.50	20.2	19.67	16.7	26.6	67.1	5.6	37.8	
Metallurgical Balance for Copper-Lead Separation												
Copper conc B	13.83	25.41	8.35	3.94	27.0	68.61	4.2	86.2	3.0	9.6	35.6	4.2
Copper cleaner tail B	13.03	3.20	31.08	6.00	14.6	40.40	11.1	10.2	10.6	13.8	19.7	10.5
Lead conc	73.14	0.20	45.04	5.96	17.0	16.32	16.1	3.6	86.4	76.7	44.7	85.3
Feed (calcd)*	100.00	4.07	38.15	5.69	18.1	26.69	13.8	100.0	100.0	100.0	100.0	100.0
Copper rougher conc B (calcd)	26.86	14.64	19.38	4.94	21.0	54.92	7.6	96.4	13.6	23.4	55.3	14.7

REMARKS: * Copper-lead cleaner conc.

MINES BRANCH FLOTATION TEST REPORT

TEST NO. 31	SAMPLE: Mattagami-Sturgeon Lake F-7	DATE: Sept. 17, 1970
OBJECT OF TEST:		CHARGE:
		TESTED BY:

OPERATION	Time min	% Solids	pH	Unit used	Reagents, lb per ton									
									DF250					Dich
Copper-lead separation														
Conditioning	5			250-g cell										0.3
Copper rougher B	1			" " "					0.004					
Copper cleaner B	½			" " "										

PRODUCT	WT %	ANALYSIS %							DISTRIBUTION %				

REMARKS:

MINES BRANCH FLOTATION TEST REPORT

TEST NO. 32 | SAMPLE: Mattagami-Sturgeon Lake F-7 | DATE: Sept. 18, 1970

OBJECT OF TEST: Copper-lead bulk flotation on F-7 sample with copper-lead separation using the dichromate method. | CHARGE: 2 x 2000 g | TESTED BY: A.S.

OPERATION	Time min	% Solids	pH	Unit used	Reagents, lb per ton									
					Lime	$ZnSO_4$	NaCN	AF 242	AF 208	DF 250				
Grinding	45	65		7x14 RM	1.5	0.5	0.1	0.02	0.02					
Conditioning	5		9.2	1000-g cell				0.01	0.01					
Copper-lead rougher				" " "										
Stage 1	½									0.004				
" 2	½							0.01	0.01					
" 3	1							0.01	0.01					
" 4	1							0.02						
Copper-lead cleaners														
No. 1	1½			500-g cell										
No. 2	1			" " "										

PRODUCT	WT %	ANALYSIS %							DISTRIBUTION %			
		Cu	Pb	Zn	Fe	Ag	Fe/FeS		Cu	Pb	Zn	Ag
Copper conc	1.11	29.10	3.38	3.16	26.9	73.95	1.0		55.0	1.7	0.4	28.2
Copper cleaner tail No.2	0.14	4.62	29.82	7.50	14.5	57.41	9.6		1.1	1.9	0.1	2.8
" " " No. 1	0.30	2.05	30.29	5.46	11.2	32.24	8.8		1.1	4.0	0.2	3.3
Lead conc	3.48	0.20	42.88	5.64	17.2	15.44	16.4		1.2	66.5	2.2	18.4
Copper-lead cl tail No.2	1.08	3.48	15.58	10.14	23.0	17.94	18.8		6.4	7.5	1.3	6.7
" " " " No. 1	1.75	1.80	8.67	11.78	23.8	10.72	20.8		5.4	6.8	2.3	6.4
Copper-lead ro tail	92.14	0.19	0.29	8.91		1.09			29.8	11.6	93.5	34.2
Feed (calcd)	100.00	0.59	2.24	8.78		2.92			100.0	100.0	100.0	100.0

REMARKS: Two 2000-g batches ground and floated separately - rougher concentrates combined for cleaning and copper-lead separation.

MINES BRANCH FLOTATION TEST REPORT

TEST NO. 32 | SAMPLE: Mattagami-Sturgeon Lake F-7 | DATE: Sept. 18, 1970

OBJECT OF TEST: | CHARGE: | TESTED BY:

OPERATION	Time min	% Solids	pH	Unit used	Reagents, lb per ton									
										DF250	Dich			
Copper-lead separation														
Conditioning	5			250-g cell							0.3			
Copper rougher	1½			" " "						0.004				
Copper cleaners														
No. 1	1			" " "						0.004	0.1			
No. 2	1			" " "						0.002				

PRODUCT	WT %	ANALYSIS %							DISTRIBUTION %				
		Cu	Pb	Zn	Fe	Ag	Fe/FeS		Cu	Pb	Zn	Ag	Fe/FeS
Metallurgical Balance for Copper-Lead Separation													
Copper conc	22.04	29.10	3.38	3.16	26.9	73.95	1.0		94.2	2.3	13.6	53.4	1.8
Copper cleaner tail No. 2	2.87	4.62	29.82	7.50	14.5	57.41	9.6		1.9	2.6	4.2	5.4	2.2
" " " No. 1	5.93	2.05	30.29	5.46	11.2	32.24	8.8		1.9	5.4	6.3	6.3	4.2
Lead conc	69.16	0.20	42.88	5.64	17.2	15.44	16.4		2.0	89.7	75.9	34.9	91.8
Feed (calcd)*	100.00	6.81	33.05	5.14	18.9	30.54	12.4		100.0	100.0	100.0	100.0	100.0

REMARKS: *Copper-lead cleaner conc.

MINES BRANCH FLOTATION TEST REPORT

TEST NO. 33 | SAMPLE: Mattagami-Sturgeon Lake F-7 | DATE: Nov. 3, 1970

OBJECT OF TEST: Selective flotation directly on the ore using SO_2 and Z-200 - repeat of Test 22 on F-7 sample | CHARGE: 2000-g | TESTED BY: A.S.

OPERATION	Time min	% Solids	pH	Unit used	Reagents, lb per ton					
					Z-200	SO_2	DF250	Lime	NaCN	AF 242
Grinding	45	65		7 x 14 RM	0.02					
Conditioning	20		5.6	Aerator		4.0				
Copper rougher				1000-g cell						
Stage 1	1									
Stage 2	2				0.01					
Conditioning	5		9.7					2.5	0.10	
"	5									0.02
Lead rougher										
Stage 1	½									
Stage 2	½									0.02
Stage 3	1									0.01

PRODUCT	WT %	ANALYSIS %						DISTRIBUTION %			
		Cu	Pb	Zn	Fe	Ag	Fe/FeS	Cu	Pb	Zn	Ag
Copper conc	1.67	25.78	11.50	4.76	28.4	45.78	5.1	71.4	8.1	0.9	27.7
Copper cleaner tail No.2	0.52	6.64	8.30	7.38	36.7	24.22	30.0	5.7	1.8	0.5	4.6
" " " No.1	1.61	2.36	4.50	4.56	46.3	11.15	43.7	6.3	3.1	0.9	6.5
Lead conc	2.39	0.06	57.60	5.28	10.1	20.91	9.4	0.2	58.3	1.5	18.1
Lead cleaner tail No. 2	0.28	0.21	31.75	9.94	17.9	14.41	16.5	0.1	3.8	0.3	1.5
" " " No. 1	1.03	0.44	20.90	10.58	19.1	20.32	17.5	0.7	9.1	1.3	7.6
Zinc rougher conc	15.31	0.31	1.02	50.36	9.6	2.49	3.4	7.9	6.6	91.1	13.8
Zinc rougher tail	77.19	0.06	0.28	0.39		0.73		7.7	9.2	3.5	20.2
Feed (calcd)	100.00	0.60	2.36	8.47		2.76		100.0	100.0	100.0	100.0

REMARKS:

MINES BRANCH FLOTATION TEST REPORT

TEST NO. 33 | SAMPLE: Mattagami-Sturgeon Lake F-7 | DATE: Nov. 3, 1970

OBJECT OF TEST: | CHARGE: | TESTED BY:

OPERATION	Time min	% Solids	pH	Unit used	Reagents, lb per ton									
							DF250	Lime	NaCN	AF242	$CuSO_4$	CX 51	NaAF	
Conditioning	10		11.3	1000-g cell				3.0			2.0			
Zinc rougher				" " "										
Stage 1	1											0.02		
Stage 2	1												0.10	
Stage 3	2						0.02						0.05	
Copper cleaners														
No. 1	1		11.6	250-g cell			0.004	0.6						
No. 2	1		10.6	" " "										
Lead cleaners														
No. 1	1		9.5	500-g cell					0.10	0.01				
No. 2	1			250-g cell						0.005				

PRODUCT	WT %	ANALYSIS %							DISTRIBUTION %				
		Cu	Pb	Zn	Fe	Ag	Fe/FeS		Cu	Pb	Zn	Ag	
Calculated Assays													
1st stage copper cl conc	2.19	21.23	10.74	5.38	30.4	40.66	11.1		77.1	9.9	1.4	32.3	
Copper rougher conc	3.80	13.24	8.10	5.03	37.1	28.16	24.9		83.4	13.0	2.3	38.8	
Copper rougher tail	96.20	0.10	2.13			1.76							
1st stage lead cl conc	2.67	0.07	54.89	5.77	10.9	20.22	10.1		0.3	62.1	1.8	19.6	
Lead rougher conc	3.70	0.18	45.43	7.10	13.2	20.25	12.2		1.0	71.2	3.1	27.2	
Lead rougher tail	92.50	0.10	0.40			1.02							

REMARKS:

MINES BRANCH FLOTATION TEST REPORT

TEST NO. 34 | SAMPLE: Mattagami-Sturgeon Lake F-2 | DATE: November 4, 1970

OBJECT OF TEST: Copper-lead bulk flotation and separation using the cyanide method as in Test 29 but primary grinding time reduced from 45 to 30 min. | CHARGE: 2 x 2000-g | TESTED BY: A.S.

OPERATION	Time min	% Solids	pH	Unit used	Reagents, lb per ton									
					Na_2CO_3	Na_2SO_3	NaCN	AF 208	AF 242	Lime	$CuSO_4$	CX 51	NaAF	DF 250
Grinding	30	65		7 x 14 RM	4.0	1.0	0.1							
Conditioning	10		9.8	1000-g cell				0.01	0.01					
Copper-lead rougher-as in Test 21														
Conditioning	10		11.2							4.0	1.0			
Zinc rougher				1000-g cell										
Stage 1	½											0.01	0.05	
" 2	1½													0.02
" 3	3												0.05	0.02

PRODUCT	WT %	ANALYSIS %						DISTRIBUTION %			
		Cu	Pb	Zn	Fe	Ag	Fe/FeS	Cu	Pb	Zn	Ag
Copper conc	2.73	28.33	1.23	3.04	29.7	18.15	4.4	56.4	5.1	1.0	14.6
Lead conc	0.63	4.07	48.46	6.40	11.6	200.50	7.3	1.9	1.9	0.5	37.3
Lead cleaner tail No.2	0.35	15.90	12.40	5.94	26.8	64.76	12.1	4.1	4.1	0.2	6.7
" " " No.1	0.85	25.56	5.12	3.16	28.4	35.38	5.5	15.9	15.9	0.3	8.9
Copper-lead Cl tail No. 3	0.57	6.74	4.40	8.80	30.9	16.79	24.0	2.8	2.8	0.6	2.8
" " " " No. 2	0.89	5.33	3.99	8.56	31.5	14.02	25.8	3.5	3.5	0.9	3.7
" " " " No. 1	2.92	4.10	1.55	8.06	30.8	8.18	26.3	8.7	8.7	2.7	7.1
Zinc rougher conc	14.25	0.22	0.18	53.48	8.9	1.29	2.5	2.3	2.3	87.8	5.4
Zinc rougher tail	76.81	0.08	0.13	0.69		0.59		4.4	4.4	6.0	13.5
Feed (calcd)	100.00	1.37	0.66	8.68		3.38		100.0	100.0	100.0	100.0
Copper-lead ro tail(calcd)	91.06	0.10	0.14			0.70					

REMARKS: Screen analysis of 30 min grind, 74.6% minus 200 mesh as against about 83% minus 200 mesh for 45 min. grind.

MINES BRANCH FLOTATION TEST REPORT

TEST NO. 34 | SAMPLE: Mattagami-Sturgeon Lake F-2 | DATE: November 4, 1970

OBJECT OF TEST: | CHARGE: | TESTED BY:

OPERATION	Time min	% Solids	pH	Unit used	Reagents, lb per ton								
							NaCN		AF 242				$ZnSO_4$
Copper-lead cleaners - as in Test 21													
Copper-lead separation													
Desorption(as in Test 9)													
Conditioning	5		9.9	250-g cell			1.2						1.0
Lead rougher				" "									
Stage 1	½												
" 2	1								0.005				
Lead cleaners													
No. 1	1			250-g cell			0.2		0.005				
No. 2	1			" "			0.2		0.002				

PRODUCT	WT %	ANALYSIS %						DISTRIBUTION %				
		Cu	Pb	Zn	Fe	Ag	Fe/FeS	Cu	Pb	Zn	Ag	Fe/FeS
Metallurgical Balance for Copper-Lead Separation												
Copper conc	59.88	28.33	1.23	3.04	29.7	18.15	4.4	72.1	7.9	48.6	21.7	47.0
Lead conc	13.74	4.07	48.40	6.46	11.6	200.50	7.3	2.4	71.5	23.5	55.1	17.9
Lead cleaner tail No. 2	7.77	15.90	12.40	5.94	26.8	64.76	12.1	5.3	10.4	12.3	10.1	16.9
" " " No. 1	18.61	25.56	5.12	3.16	28.4	35.38	5.5	20.2	10.2	15.6	13.1	18.3
Feed (calcd)*	100.00	23.52	9.30	3.75	26.7	50.03	5.6	100.0	100.0	100.0	100.0	100.0
Calculated Assays												
1st Stage Lead cl conc	21.51	8.34	35.40	6.23	17.1	151.47	9.1	7.7	81.9	35.8	65.2	34.7
Lead rougher conc	40.12	16.33	21.35	4.81	22.3	97.62	7.4	27.9	92.1	51.4	78.3	53.0

REMARKS: Copper-lead cleaner conc

MINES BRANCH FLOTATION TEST REPORT

TEST NO. 35 | SAMPLE: Mattagami-Sturgeon Lake F-2 | DATE: November 5,1970

OBJECT OF TEST: To determine the effect of adding soda ash to copper-lead separation. | CHARGE: 2 x 2000-g | TESTED BY: A.S.

OPERATION	Time min	% Solids	pH	Unit used	Reagents, lb per ton									
					DF250	ZnCN	Na_2CO_3	AF242	NaCN					
Grinding)as in														
Conditioning)Test 21														
Copper-lead rougher)														
Copper-lead cleaners)														
Copper-lead separation														
Desorption(as in Test 9)														
Conditioning	10		11.6*	250-g cell		0.88	2.0							
Lead rougher	1							0.005						
Lead cleaners														
No. 1	1							0.005	0.2					
No. 2	3/4				0.004									

PRODUCT	WT %	ANALYSIS %							DISTRIBUTION %				
		Cu	Pb	Zn	Fe	Ag	Fe/FeS		Cu	Pb	Zn	Ag	
Copper conc	3.51	27.41	1.18	3.22	29.4	23.02	4.9		72.4	6.6	1.3	22.9	
Lead conc	0.60	0.26	47.72	5.26	12.1	154.60	11.3		0.1	45.3	0.4	26.3	
Lead cl tail No.2	0.17	12.78	20.60	5.16	22.6	114.90	10.8		1.6	5.5	0.1	5.5	
" " " No.1	0.56	20.33	8.76	4.32	27.2	73.42	8.8		8.6	7.8	0.3	11.7	
Copper-lead cl tail No.3	0.76	7.88	4.60	8.40	31.6	21.40	23.7		4.5	5.5	0.7	4.6	
" " " No. 2	0.89	5.69	3.54	8.04	33.1	15.82	27.2		3.8	5.0	0.8	4.0	
" " " No. 1	2.78	1.97	1.27	8.42	33.2	5.74	30.5		4.1	5.6	2.7	4.5	
Copper-lead ro tail	90.73	0.07	0.13	8.96		0.79			4.9	18.7	93.7	20.5	
Feed (calcd)	100.00	1.33	0.63	8.68		3.52			100.0	100.0	100.0	100.0	

REMARKS:* pH 11.7 before addition of Soda ash

MINES BRANCH FLOTATION TEST REPORT

TEST NO. 35	SAMPLE: Mattagami-Sturgeon Lake F-2	DATE: November 5, 1970
OBJECT OF TEST:		CHARGE:
		TESTED BY:

OPERATION	Time min	% Solids	pH	Unit used	Reagents, lb per ton									

PRODUCT	WT %	ANALYSIS %						DISTRIBUTION %				
		Cu	Pb	Zn	Fe	Ag	Fe/FeS	Cu	Pb	Zn	Ag	Fe/FeS
Metallurgical Balance for Copper-Lead Separation												
Copper conc	72.42	27.41	1.18	3.22	29.4	23.02	4.9	87.4	10.0	63.5	34.4	55.8
Lead conc	12.38	0.26	47.72	5.26	12.1	154.60	11.3	0.1	69.3	17.7	39.5	22.0
Lead cleaner tail No. 2	3.60	12.78	20.60	5.16	22.6	114.90	10.8	2.0	8.7	5.1	8.5	6.1
" " " No. 1	11.60	20.33	8.76	4.32	27.2	73.42	8.8	10.5	12.0	13.7	17.6	16.1
Feed (calcd)	100.00	22.70	8.52	3.67	26.8	48.46	6.4	100.0	100.0	100.0	100.0	100.0
Calculated Assays												
1st Stage Lead cl conc	15.98	3.08	41.61	5.24	14.5	145.66	11.2	2.1	78.0	22.8	48.0	28.1
Lead rougher conc	27.58	10.34	27.79	4.85	19.8	115.27	10.1	12.6	90.0	36.5	65.6	44.2

REMARKS:

MINES BRANCH FLOTATION TEST REPORT

TEST NO. 36	SAMPLE: Mattagami-Sturgeon Lake F-2+F-7 Composite (1:1)	DATE: December 2, 1970
OBJECT OF TEST:	Repeat of Test 35 on F-2 + F-7 composite	CHARGE: 2 x 2000-g
		TESTED BY: A.S.

OPERATION	Time min	% Solids	pH	Unit used	Reagents, lb per ton
Grinding)as					
Conditioning)in					
Copper-lead rougher)Test	21				
Copper-lead cleaners					
No. 1	1½			500-g cell	
No. 2	1½			" "	
No. 3	1¼			250-g cell	
No. 4	1½			" "	

PRODUCT	WT %	ANALYSIS %							DISTRIBUTION %			
		Cu	Pb	Zn	Fe	Ag	Fe/FeS		Cu	Pb	Zn	Ag
Copper conc	2.79	21.70	2.11	5.24	30.4	27.02	10.8		63.5	4.0	1.7	24.7
Lead conc	1.52	0.86	55.50	5.32	10.6	49.62	9.2		1.4	58.0	0.9	24.7
Lead cleaner tail No. 3	0.34	6.35	24.24	7.60	22.6	50.10	16.1		2.3	5.7	0.3	5.6
" " " No. 2	0.40	14.05	18.57	5.66	24.0	44.71	11.0		5.9	5.1	0.3	5.8
" " " No. 1	0.62	19.82	10.37	4.84	26.6	35.57	8.6		12.9	4.4	0.3	7.2
Copper-lead cl tail No. 4	0.78	1.36	3.34	8.80	34.7	6.69	32.5		1.1	1.8	0.8	1.7
" " " " No. 3	1.06	2.43	4.35	8.12	32.8	8.71	29.9		2.7	3.2	1.0	3.0
" " " " No. 2	1.09	1.63	3.48	9.12	31.8	7.04	28.3		3.4	4.8	2.1	4.6
" " " " No. 1	2.60	0.83	1.90	10.78	27.9	4.75	25.9		2.3	3.4	3.2	4.0
Copper-lead ro tail	87.90	0.05	0.16	8.84		0.65			4.5	9.6	89.4	18.7
Feed (calcd)	100.00	0.95	1.46	8.69		3.06			100.0	100.0	100.0	100.0

REMARKS:

MINES BRANCH FLOTATION TEST REPORT

TEST NO. 36	SAMPLE: Mattagami-Sturgeon Lake F-2 + F-7 Composite (1:1)	DATE: December 2, 1970
OBJECT OF TEST:		CHARGE:
		TESTED BY:

OPERATION	Time min	% Solids	pH	Unit used	Reagents, lb per ton									
					DF250	ZnCN	Na_2CO_3	AF242	NaCN					
Copper-lead Separation														
Desorption(as in Test 9)														
Conditioning	5		11.3	250-g cell		0.88	2.0							
Lead rougher				" "										
Stage 1	½													
" 2	½							0.005						
" 3	3/4							0.005						
Lead cleaners														
No. 1	1			250-g cell	0.0025				0.2					
No. 2	1			" "	0.0025				0.2					
No. 3	1			" "	0.0025				0.1					

PRODUCT	WT %	ANALYSIS %							DISTRIBUTION %				
		Cu	Pb	Zn	Fe	Ag	Fe/FeS		Cu	Pb	Zn	Ag	Fe/FeS
Metallurgical Balance for Copper-Lead Separation													
Copper conc	49.25	21.70	2.11	5.24	30.4	27.02	10.8		74.0	5.2	47.9	36.3	50.9
Lead conc	26.83	0.86	55.50	5.32	10.6	49.62	9.2		1.6	75.2	26.5	36.3	23.6
Lead cleaner tail No. 3	5.95	6.35	24.24	7.60	22.6	50.10	16.1		2.6	7.3	8.4	8.1	9.2
" " " No. 2	7.05	14.05	18.57	5.66	24.0	44.71	11.0		6.9	6.6	7.4	8.6	7.4
" " " No. 1	10.92	19.82	10.37	4.84	26.6	35.57	8.6		14.9	5.7	9.8	10.7	8.9
Feed (calcd)*	100.00	14.45	19.81	5.39	23.8	36.64	10.5		100.0	100.0	100.0	100.0	100.0
Calculated Assays													
2nd Stage Lead cl conc	32.78	1.86	49.83	5.73	12.8	49.71	10.5		4.2	82.5	34.9	44.4	32.8
1st " " " "	39.83	4.01	44.29	5.72	14.8	48.82	10.5		11.1	89.1	42.3	53.0	40.2
Lead rougher conc	50.75	7.42	36.99	5.53	17.3	45.97	10.1		26.0	94.8	52.1	63.7	49.1

REMARKS: * Copper-lead cleaner conc

MINES BRANCH FLOTATION TEST REPORT

TEST NO. 37 | SAMPLE: Mattagami-Sturgeon Lake F-7 | DATE: December 3, 1970

OBJECT OF TEST: Copper-lead Selective Flotation as in Test 33 but decreased skimming time for copper rougher and increased skimming time for lead rougher | CHARGE: 2000-g | TESTED BY: A.S.

OPERATION	Time min	% Solids	pH	Unit used	Reagents, lb per ton									
					Z-200	SO_2	DF 250	Lime	NaCN	AF242				
Grinding	45	65		7 x 14 RM	0.01									
Conditioning	20		5.5	Aerator	0.01	4.0								
Copper rougher	1½			1000-g cell			0.01							
Conditioning	5		9.5					3.0	0.1					
" "	5									0.02				
Lead rougher				1000-g cell										
Stage 1	½													
" 2	½									0.02				
" 3	1									0.02				
" 4	1									0.02				

PRODUCT	WT %	ANALYSIS %							DISTRIBUTION %				
		Cu	Pb	Zn	Fe	Ag	Fe/FeS		Cu	Pb	Zn	Ag	
Copper conc	1.44	25.04	4.33	2.16	31.0	40.88	8.5		60.8	2.7	0.4	20.5	
Combined copper cl tail	0.72	6.08	8.02	7.14	34.0	21.73	27.9		7.4	2.5	0.6	5.4	
Lead conc	3.15	0.09	50.17	5.84	13.6	21.68	12.8		0.5	68.0	2.1	23.7	
Lead cleaner tail No. 2	0.30	0.75	19.08	10.94	23.2	15.32	21.2		0.4	2.5	0.4	1.6	
" " " No. 1	1.47	1.09	15.82	11.10	20.8	22.05	18.5		2.7	10.0	1.9	11.3	
Lead rougher tail	92.92	0.18	0.36	8.78		1.16			28.2	14.3	94.6	37.5	
Feed (calcd)	100.00	0.59	2.32	8.62		2.88			100.0	100.0	100.0	100.0	
Calculated Assays													
Copper rougher conc	2.16	18.72	5.56	3.82	32.0	34.50	15.2		68.2	5.2	1.0	25.9	
Lead rougher conc	4.92	0.43	38.01	7.72	16.3	21.40	15.0		3.6	80.5	4.4	36.6	

REMARKS:

MINES BRANCH FLOTATION TEST REPORT

TEST NO. 37 | SAMPLE: Mattagami-Sturgeon Lake F-7 | DATE: December 3, 1970

OBJECT OF TEST: | CHARGE: | TESTED BY:

OPERATION	Time min	% Solids	pH	Unit used	Reagents, lb per ton									
						SO_2	DF250		NaCN	AF 242				
Copper cleaners														
No. 1	1		3.3	250-g cell		0.5	0.004							
No. 2	3/4		3.6	" "		0.25	0.004							
Lead cleaners														
No. 1	1			500-g cell					0.1	0.01				
No. 2	1			250-g cell						0.005				

PRODUCT	WT %	ANALYSIS %							DISTRIBUTION %				

REMARKS:

MINES BRANCH FLOTATION TEST REPORT

TEST NO.38 | SAMPLE: Mattagami-Sturgeon Lake F-2 + F-7 Composite (1:1) | DATE: December 15, 1970

OBJECT OF TEST: Selective copper-lead flotation with Na_2SO_3 added to the grind and Z-200 as copper promoter followed by copper-lead separation of the copper conc | CHARGE: 2 x 2000 g | TESTED BY: A.S.

OPERATION	Time min	% Solids	pH	Unit used	Reagents, lb per ton									
					Na_2SO_3	Z-200	DF250	Na_2CO_3	NaCN	AF242	AF208			
Grinding	45	65		7 x 14 RM	1.0	0.01								
Conditioning	5		7.6	1000-g cell		0.02	0.02							
Copper rougher	2			" "										
Conditioning	5		9.4					3.0	0.1					
Lead rougher A														
Stage 1	½									0.01	0.01			
" 2	1									0.02				
" 3	½									0.01				
Copper cleaners														
No. 1	1½			500-g cell										
No. 2	1			250-g cell										

PRODUCT	WT %	ANALYSIS %						DISTRIBUTION %			
		Cu	Pb	Zn	Fe	Ag	Fe/FeS	Cu	Pb	Zn	Ag
Final copper conc*	2.99	23.15	1.14	2.00	31.8	20.84	11.3	69.3	2.2	0.7	18.3
Copper cleaner tail No.2	0.97	6.41	8.06	4.76	33.0	19.68	26.8	6.2	5.1	0.5	5.6
" " " No.1	2.26	2.05	9.95	6.96	30.2	12.49	27.6	4.6	14.7	1.8	8.3
Lead conc B**	0.19	7.22	16.35	3.64	22.4	211.30	15.7	1.4	2.0	0.1	11.8
Lead cleaner tail B	0.19	19.32	4.21	2.46	30.0	56.90	12.7	3.7	0.5	0.1	3.2
Lead conc A***	2.34	0.12	33.63	6.46	21.8	18.11	20.9	0.3	51.4	1.7	12.4
Lead cleaner tail No.2-A	0.54	0.49	8.33	9.32	31.6	11.54	30.1	1.0	6.1	2.1	8.9
" " " No.1-A	1.01	0.88	6.88	10.20	27.0	13.56	25.0	0.9	4.5	1.2	4.0
Lead rougher tail	89.51	0.14	0.23	8.92		1.05		12.6	13.5	91.8	27.5
Feed (calcd)	100.00	1.00	1.53	8.70		3.41		100.0	100.0	100.0	100.0

REMARKS: Two 2000-g batches ground and floated separately - rougher concentrates combined for cleaning and copper-lead separation.

* Tailing from copper-lead separation of copper concentrate.

** Lead conc from copper-lead separation of copper concentrate

*** Lead conc floated directly from the ore.

MINES BRANCH FLOTATION TEST REPORT

TEST NO. 38	SAMPLE: Mattagami-Sturgeon Lake F-2 + F-7 Composite (1:1)	DATE: December 15,1970
OBJECT OF TEST:		CHARGE:
		TESTED BY:

OPERATION	Time min	% Solids	pH	Unit used	Reagents, lb per ton									
									NaCN	AF242		$ZnSO_4$		
Lead cleaners A														
No. 1	1			500-g cell					0.1					
No. 2	1			250-g cell					0.05					
Copper-lead separation														
of copper conc														
Conditioning	5		9.5	250-g cell					0.8			0.65		
Lead rougher B	½			" "										
" cleaner B	1			" "						0.005				

PRODUCT	WT %	ANALYSIS %						DISTRIBUTION %				
		Cu	Pb	Zn	Fe	Ag	Fe/FeS	Cu	Pb	Zn	Ag	Fe/FeS
Calculated Assays												
Copper rougher conc	6.60	12.90	5.70	4.68	31.1	24.33	19.3	85.2	24.5	3.2	47.2	
Lead rougher conc A	3.89	0.57	29.71	11.34	24.5	46.35	22.7	2.2	62.0	5.0	25.3	
Combined lead conc A+B	2.53	0.65	32.33	6.25	21.8	32.62	20.5	1.7	53.4	1.8	24.2	
Metallurgical Balance for Copper-Lead Separation												
Final copper conc	88.82	23.15	1.14	2.00	31.8	20.84	11.3	93.3	46.7	83.9	55.1	86.3
Lead conc B	5.63	7.22	16.35	3.64	22.4	211.30	15.7	1.8	42.5	9.7	35.4	7.6
Lead cleaner tail B	5.55	19.32	4.21	2.46	30.0	56.90	12.7	4.9	10.8	6.4	9.5	6.1
Feed (calcd)*	100.00	22.04	2.17	2.12	31.2	33.56	11.6	100.0	100.0	100.0	100.0	100.0

REMARKS: * Copper concentrate

MINES BRANCH FLOTATION TEST REPORT

TEST NO. 39	SAMPLE: Mattagami-Sturgeon Lake F-7	DATE: February 23/71
OBJECT OF TEST: Copper-lead separation using the dichromate method in conjunction with a hot pulp		CHARGE: 2 x 2000 g
		TESTED BY: A.S.

OPERATION	Time min	% Solids	pH	Unit used	Reagents, lb per ton									
					Na_2CO_3	Na_2SO_3	NaCN	AF208	AF242	DF250	$CuSO_4$	Lime	Z-200	NaAF
Gringing	45	65		7 x 14 RM	4.0	1.0	0.1							
Conditioning	10		9.8	1000-g cell				0.01	0.02					
Copper-lead rougher														
Stage 1	1									0.004				
" 2	1							0.01	0.01	0.004				
" 3	2								0.02					
Conditioning	10		10.9								1.0	6.0		
Zinc rougher														
Stage 1	1/2												0.01	
" 2	1									0.02				
" 3	2									0.02				
" 4	1													0.05

PRODUCT	WT %	ANALYSIS %						DISTRIBUTION %			
		Cu	Pb	Zn	Fe	Ag	Fe/Fes	Cu	Pb	Zn	Ag
Copper conc	0.81	29.06	2.44	5.04	26.9	83.19	0.8	42.8	0.9	0.5	25.2
Copper cleaner tail No2	0.10										
" " " " 1	0.28	8.29	36.01	9.60	1.40	55.79	5.6	5.7	6.0	0.4	7.9
Lead conc	4.34	0.35	36.83	3.24	19.9	14.80	19.2	2.7	70.5	1.6	24.1
Copper-lead cl tail No.3	0.68	8.27	8.08	8.72	29.7	14.70	21.4	10.2	2.4	0.7	3.7
" " " " No.2	1 80	5.79	7.47	9.98	29.1	12.89	22.8	18.9	5.9	2.1	8.7
" " " " No.1	2.57	1.91	3.71	9.48	31.5	8.20	28.7	8.9	4.2	2.8	7.9
Zinc conc	11.29	0.12	0.19	58.77	7.3	0.93	0.3	2.5	0.9	77.5	3.9
Zinc cleaner tail	2.19	0.35	1.50	29.70	17.0	2.43	13.2	1.4	1.4	7.6	2.0
Zinc rougher tail	75.94	0.05	0.23	0.76		0.58		6.9	7.8	6.8	16.6
Feed (calcd)	100.00	0.55	2.27	8.56		2.67		100.0	100.0	100.0	100.0

REMARKS:

MINES BRANCH FLOTATION TEST REPORT

TEST NO. 39 | SAMPLE: Mattagami-Sturgeon Lake F-7 | DATE: Feb. 23, 1971

OBJECT OF TEST: | CHARGE: | TESTED BY:

OPERATION	Time min	% Solids	pH	Unit used	Reagents, lb per ton: Dich	NaCN	DF250	Lime	Z-200
Copper-lead cleaners									
No. 1	1 1/2			500-g cell		0.05			
No. 2	1 1/2			" "					0.005
No. 3	1 1/2			250-g cell			0.002		
Zinc cleaner	2		11.1	1000-g cell			0.02	1.0	
Copper-lead separation									
Conditioning*	5			250-g cell	0.3				
Copper rougher									
Stage 1	1						0.002		
Stage 2	1/2								0.01
Cleaner No. 1**	1 1/2						0.002		
" No. 2	1						0.002		

PRODUCT	WT %	ANALYSIS % Cu	Pb	Zn	Fe	Ag	Fe/Fes	DISTRIBUTION % Cu	Pb	Zn	Ag	Fe/Fes
Metallurgical Balance for Copper-Lead Separation												
Copper conc	14.68	29.06	2.44	5.04	26.9	83.19	0.8	83.6	1.1	18.8	44.2	0.8
Copper cleaner tail No.2	1.76											
" " " No.1	5.04	8.29	36.01	9.60	14.0	55.79	5.6	11.0	7.7	16.6	13.7	2.4
Lead conc	78.52	0.35	36.83	3.24	19.9	14.80	19.2	5.4	91.2	64.6	42.1	96.8
Feed (calcd)	100.00	5.10	31.73	3.94	20.5	27.63	15.6	100.0	100.0	100.0	100.0	100.0
Copper ro conc (calcd)	21.48	22.48	13.06	6.48	22.8	74.51	2.3	94.6	8.8	35.4	3.2	57.9

REMARKS

* Temp 56°C, ** Temp 55°C in both cleaners

MINES BRANCH FLOTATION TEST REPORT

TEST NO. 40 | SAMPLE: Mattagami-Sturgeon Lake F-7 | DATE: Feb. 24, 1971

OBJECT OF TEST: Copper-lead separation using the SO_2- Starch method | CHARGE: 2 x 2000 g.

TESTED BY: A. S.

OPERATION	Time min	% Solids	pH	Unit used	Reagents, lb per ton									
					Na_2CO_3	Na_2SO_3	NaCN	AF 208	AF 242	DF 250	Z-200			
Grinding	45	65		7 x 14 RM	3.0	1.0	0.15							
Conditioning	10		9.6	1000-g cell				0.01	0.01					
Copper-lead roughers														
Stage 1	1/2									0.004				
" 2	1							0.01	0.01	0.004				
" 3	1								0.01					
" 4	1								0.01					
Copper-lead cleaners														
No. 1	1 1/2			500-g cell			0.025							
No. 2	2			" "						0.002	0.005			
No. 3	1 1/2			250-g cell										

PRODUCT	WT %	ANALYSIS %							DISTRIBUTION %			
		Cu	Pb	Zn	Fe	Ag	Fe/Fes		Cu	Pb	Zn	Ag
Copper conc	0.61	26.75	4.47	4.56	27.7	95.61	3.7		29.9	1.2	0.3	22.1
Copper cleaner tail	0.25	7.61	37.15	8.05	15.2	76.15	7.6		3.5	4.0	0.2	7.2
Lead conc	3.93	0.49	42.16	6.32	18.1	16.39	17.0		3.5	70.8	2.8	24.4
Copper-lead cl tail No. 3	0.71	7.02	8.79	8.32	29.7	14.24	22.5		9.1	2.7	0.7	3.8
" " " " No. 2	1.66	7.65	6.36	8.54	30.3	12.25	22.6		23.3	4.5	1.6	7.7
" " " " No. 1	2.77	4.10	5.83	9.44	30.1	10.54	25.4		20.8	6.9	3.0	11.1
Copper-lead rougher tail	90.07	0.06	0.26	8.89		0.69			9.9	9.9	91.4	23.7
Feed (calcd)	100.00	0.55	2.34	8.77		2.64			100.0	100.0	100.0	100.0

REMARKS.

MINES BRANCH FLOTATION TEST REPORT

TEST NO. 40 | SAMPLE: Mattagami-Sturgeon Lake F-7 | DATE: Feb. 24, 1971.

OBJECT OF TEST: | CHARGE:

TESTED BY: .

OPERATION	Time min	% Solids	pH	Unit used	Reagents, lb per ton									
										DF250	Z-200	CS	SO_2	
Copper-lead separation														
Conditioning No. 1	5			250-g cell								0.02		
" " No. 2	5		3.8										0.05	
Copper rougher	2										0.01			
Copper cleaner	1 1/2		3.3	150-g cell						0.002			0.035	

PRODUCT	WT %	ANALYSIS %						DISTRIBUTION %				
		Cu	Pb	Zn	Fe	Ag	Fe/Fes	Cu	Pb	Zn	Ag	Fe/Fes
Metallurgical Balance for Copper-Lead Separation												
Copper conc	12.77	26.75	4.47	4.56	27.7	95.61	3.7	81.0	1.5	9.4	41.2	3.2
Copper cleaner tail	5.26	7.61	37.15	8.05	15.2	76.15	7.6	9.5	5.3	6.8	13.5	2.7
Lead conc	81.97	0.49	42.16	6.32	18.1	16.39	17.0	9.5	93.2	83.8	45.3	94.1
Feed (calcd)	100.00	4.22	37.08	6.19	19.2	29.65	14.8	100.0	100.0	100.0	100.0	100.0
Copper ro conc (calcd)	18.03	21.17	14.00	5.58	24.1	89.93	4.8	90.5	6.8	16.2	54.7	5.9

REMARKS