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MINES BRANCH INVESTIGATION REPORT IR 73-3

FLOTATION OF COPPER FROM A TALCOSE ORE HARVEY HILL DEPOSIT, LEEDS TOWNSHIP, MEGANTIC COUNTY, QUEBEC

by

A. STEMEROWICZ AND R. W. BRUCE

MINERAL PROCESSING DIVISION

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A. Stemerowicz* and R. W. Bruce**

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SUMMARY OF RESULTS

The talcose ore investigated in the pilot-plant contained 1.44% copper in the form of chalcopyrite, bornite and chalcocite. Flotation at a grind of 51% minus 200 mesh gave a copper concentrate assaying 36.2% copper and 6.9% insolubles with a copper recovery of 96.6%. These results were achieved using Depramin 75 as talc depressant along with small amounts of amyl xanthate as collector and Dowfroth 250 as frother.

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Direction des mines
Rapport d'investigation IR-73-3

FLOTTATION D'UN MINERAI DE CUIVRE À HAUTE TENEUR EN TALC DU GISEMANT D' HARVEY HILL CANTON DE LEEDS, COMTÉ DE MÉGANTIC, QUÉBEC.

PAR

A. STEMEROWICZ* ET R. W. BRUCE**

RÉSUMÉ

Les auteurs ont fait une étude en usine-pilote sur un minerai talceux contenant 1.44% de cuivre sous forme de chalcopyrite, de bornite et chalcosine. A la suite d'essais de flottation à un broyage de 51% moins 200 mailles, ils ont pu obtenir un concentré contenant 36.2% de cuivre et 6.9% de matière insoluble avec une récupération en cuivre de 96.6%. Ils ont obtenu de tels resultats en se servant du "Depramin 75" pour déprimer le talc, ainsi que de petites quantités d'amyl xanthate comme collecteur et de "Dowfroth 250" comme moussant.

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INTRODUCTION

Location of Property

The property which is known as the "Harvey Hill" deposit is located in Leeds Township, Megantic County Quebec, about five miles from Thetford Mines.

Shipment

Three shipments of ore were received as follows:

Date	Sample	Weight	Remarks
September 21, 1972	No. 1 (high talc)	64 lb	for bench-scale tests
October 2, 1972	No. 2 (low talc)	60 lb	" " " "
October 12, 1972	Bulk	19.5 tons	for pilot-plant investigations

Nature of Investigation Requested

In a letter of August 29, 1972 from Dr. R. A. Marleau, President, Marval Mines Inc. a pilot-plant investigation was requested on ore from the Harvey Hill deposit. Bench-scale work carried out by Mr. D. A. Livingstone in 1955-56 indicated that, at a coarse grind of 50% minus 200 mesh, the ore could be concentrated by flotation to give a copper concentrate grading 42% copper with a copper recovery of 95% on a 1.5% copper head. As Dr. Marleau planned to put the property into production, he wished to confirm Mr. Livingstone's work in order to establish mill equipment requirements.

Before proceeding with a pilot-plant investigation, it was desirable to carry out some bench-scale tests in order to become familiar with the flotation characteristics of the ore. Two samples were submitted for this purpose, a high-talc sample and a low-talc sample.

Sampling and Analysis

The two small samples were air dried, crushed in stages to minus 10 mesh and riffled into 16 portions. One of the portions was chosen at random as a head sample while the remaining portions made up the charges for batch tests.

The large bulk sample was crushed in two stages to about minus $1\frac{1}{2}$ inches and stored in a pile on the receiving floor. During the course of crushing, the crushed ore stream was automatically sampled to give a head sample amounting to about 2% of the weight of the ore. This sample was set aside for possible future reference. The pile of minus $1\frac{1}{2}$-inch ore was moved once with a front-end loader to ensure thorough mixing. Daily pilot plant requirements were taken from this pile and further crushed to minus 3/8 inch, a suitable size for feeding to the ball mill.

Head sample analyses are given in Table 1 followed by a semi-quantitative spectrochemical analysis of Sample No. 2 in Table 2.

TABLE 1

Head Sample Analyses

Sample	Analysis %			
	Copper(Cu)	Iron(Fe)	Sulphur (S)	Insolubles(Insol)
No. 1 (high talc)	2.05	5.55	1.42	71.37
No. 2 (low talc)	2.35	4.19	1.15	74.76
Bulk	1.44*			

* Average of feed to 9 pilot-plant test runs which ranged from 1.37 to 1.49 % Cu.

TABLE 2

Semi-Quanitative Spectrochemical
Analysis of No. 2 (low-talc) Sample

Range %	Elements
Principal constituents	Si, Cu, Al
1.01 to 0.1	Fe, Mg, Ca, Ti, Ba, Cr
0.1 to 0.01	Ni, Mn, Mo, Zr, V
Not detected	Cd, Be, B, Co, P, Sb, Ge, As W, Pb, Sn, Ga, Nb, Ta, Bi, Li, Sr, Ag

Mineralogical Examination

As previous work had indicated that the copper sulphides were

liberated at a coarse grind, mineralogical examination of the samples was not considered essential to the investigation. In a letter from Mr. Jean Boissonnault, geological consultant for Marval Mines, it was stated that the ore minerals were bornite, chalcocite and chalcopyrite while the gangue minerals consisted of quartz, feldspar, chlorite, sericite, some pyrite, talc and carbonates.

BENCH-SCALE INVESTIGATION

Outline of Investigation

In the initial tests on Sample No. 1 (high talc), it became apparent that satisfactory flotation of the copper sulphides could not be achieved without the use of an effective depressant. Two talc depressants were tried; Orzan A, which is the Crown Zellerbach Corp. trade name for ammonium lignin sulphonate, and Depramin, an anionic polymer sold by Hollimex Products Co. Ltd., # 509, 10201-104 Street, Edmonton 14, Alberta. Two grades of Depramin were tested, viz., Depramin 40 and Depramin 75. For maximum effectiveness it was necessary to feed this reagent in two stages; (1) to a conditioning step before the addition of collector and (2) after the rougher froth had been skimmed for two minutes.

The first test on Sample No. 2 (low-talc) gave satisfactory results without the aid of a talc depressant. Therefore, it only remained to carry out a parallel test employing the talc depressant, Depramin 75, to determine what effect, if any, this reagent had on this type of ore.

In all tests, potassium amyl xanthate was employed as the copper collector along with Dowfroth 250 as the frother. Early in the investigation, the practice was adopted of adding lime to the grind to ensure pyrite depression.

During the course of the investigation, the grind (as measured by the screen analysis of the rougher tailing) was varied from 56 to 79% minus 200 mesh.

The high talc content in the first sample greatly increased the viscosity of the ground pulp such that it was necessary to reduce the density in the lab rod mill from a standard 65% solids to 50% solids to ensure a fluid pulp.

Full details of all tests are given in Appendix A.

Evaluation and Discussion of Results

Results achieved on the high-talc sample using Depramin 75 as the depressant for talc (Test 9) are given in Table 3 while the results obtained on the low-talc sample without the aid of a talc depressant (Test 10) are shown in Table 4.

TABLE 3

Results Obtained on High-Talc Sample Using Depramin 75 as Talc Depressant (Test 9)

Product	Wt %	Analysis %		Distn %
		Cu	Indol	Cu
Copper conc	4.89	43.90	7.36	93.1
Copper recleaner tail	0.16	14.13	54.92	1.0
Copper cleaner tail	1.37	1.11	77.22	0.7
Copper rougher tail	93.58	0.13		5.2
Feed (calcd)	100.00	2.31		100.0
Copper rougher conc	6.42	34.03	23.45	94.8

TABLE 4

Results Obtained on Low-Talc Sample without the Aid of a Talc Depressant (Test 10)

Product	Wt %	Analysis %		Distn %
		Cu	Insol	Cu
Copper conc	4.36	46.49	5.04	97.4
Copper cleaner tail	1.22	1.35	69.80	0.8
Copper rougher tail	94.42	0.04		1.8
Feed (calcd)	100.00	2.08	19.20	100.0
Copper rougher conc.	5.58	36.62		98.2

In both of the above tests, a coarse grind was employed; 56% and 59% minus 200 mesh in Tests 9 and 10 respectively. The copper lost in the tailing in Test 9 is higher than that obtained in other tests on the same sample and using similar procedure. For example, in Test 7, at the same grind, the copper content in the tailing was 0.08%. The only difference between the two tests was in the total amount of collector added; 0.0072 lb/ton in Test 9 as against 0.008 lb/ton in Test 7. It is possible that the difference was great enough to affect copper losses in the tailing.

Orzan A versus Depramin as Talc Depressant

Table 5 compares results obtained using Orzan A and Depramin as talc depressants on the high-talc sample.

TABLE 5

Comparison of Results
Orzan A versus Depramin as Talc Depressant

Test No	Talc Depressant lb/ ton	Copper Rougher Conc			Tail
		Wt %	% Cu	% Insol	% Cu
1	None	20.90	*	*	*
3	Orzan A, 2.32	10.95	17.91	52.21	0.15
5	Depramin 40, 0.69	5.72	33.68	17.60	0.09
8	Depramin 75, 0.69	6.40	34.45	22.68	0.12

* Products not analyzed.

From the above table it can be seen that Depramin is much superior to Orzan A as a talc depressant. In Test 1 the very high weight of copper rougher concentrate produced is a measure of the excessive amount of talc which floats when a talc depressant is not added.

Initially, Depramin 40 was used as the talc depressant. A switch was made to Depramin 75 after it was learned that a large enough sample of this grade was on hand to satisfy pilot-plant requirements. Both grades appeared to be equally effective as talc depressants.

Although a talc depressant was not required on the low-talc sample, a relatively small but significant improvement in concentrate grade was obtained when one was employed. Referring to Tests 10 and 11, grade of copper concentrate was improved from 46.49% copper and 5.04% insolubles to 48.11% copper and 3.20% insolubles upon the addition of Depramin 75.

Effect of Fineness of Grind

No significant difference in results was noted as the fineness of grind was varied from 79% to 50% minus 200 mesh.

PILOT-PLANT INVESTIGATION

Outline of Investigation

After the initial test run on October 17, the purpose of which was to fill the grinding and flotation circuits and to observe the flotation behaviour of the sample, 9 test runs were carried out before the supply of ore was exhausted on November 1, 1972.

A feed rate of 500 lb/hr was employed in the first three test runs and this was increased to 600 lb/hr for the remaining test runs. Duration of the test runs ranged from $5\frac{1}{2}$ to $7\frac{1}{4}$ hours. Samples of various products were taken once every $\frac{1}{2}$ hour during the last $1\frac{1}{2}$ to 2 hours of the test run when it was assumed that conditions had stabilized. Sample preparation and analysis were done by Mines Branch personnel on an overtime basis following the completion of each test run.

All concentrates produced in the pilot plant were saved, filtered and stored in drums.

In the initial test run, it immediately became apparent that the bulk sample submitted was of the high-talc variety requiring the use of a talc depressant. Pilot-plant test procedure, therefore, was based on that employed in the batch tests on the high-talc sample but with two important differences:

(1) It was necessary to increase the initial addition of Depramin 75 by 50% (from 0.42 to 0.68 lb/ton) in order to completely depress the talc.

(2) Rougher flotation had to be split into two stages with the froth from the second or scavenger stage recirculated to rougher feed whereas in lab batch tests, all of the rougher froth was combined and cleaned to give a finished grade of copper concentrate.

A further departure from batch test procedure was the addition of Depramin to the cleaners. This practice was adopted after cleaning tests on samples of pilot-plant rougher concentrate indicated that the use of Depramin resulted in an appreciable improvement in copper cleaner concentrate grade.

Test runs were conducted at grinds ranging from 49 to 76% minus 200 mesh. A 30-inch-diameter Sweco vibrating screen was used as the classifier. Because of the deceptive ease with which the ore was ground, many reductions in ball load were required in order to coarsen the grind to the desired 50% minus 200 mesh (ball load was reduced in 4 steps from an initial 1100 lb to 400 lb).

Detailed test procedure, metallurgical balances and pilot-plant flowsheets are given in Appendix B.

Evaluation and Discussion of Results

Best Results Using Coarse Grind

The best results obtained at a coarse grind of 51% minus 200 mesh are given below in Table 6.

TABLE 6

Best Results Obtained at a Coarse Grind (Test Run No.9)

Product	Wt %	Analysis			Distn %	
		Cu	Insol	Ag	Cu	Ag
Copper Conc*	3.79	36.22	6.86	6.27	96.6	77.9
Final tailing	96.21	0.05		0.07	3.4	22.1
Feed (calc)	100.00	1.42		0.30	100.0	100.0
Copper rougher conc.		34.23	9.14			
1st stage Cu cleaner conc		35.49	6.70			

* Additional analyses, Fe: 23.21%, S: 30.01%

As can be seen from the above table, excellent results can be obtained on this ore at a coarse grind and using Depramin 75 as talc depressant. In fact, selectivity between the sulphides and gangue minerals was so good in the roughers that the rougher concentrate (34.23% Cu, 9.14% Insol) could be taken as the final concentrate.

Note that the grade of copper concentrate is not as high as that obtained in batch tests although the insolubles content is in the same range. This would indicate that the proportion of bornite and chalcocite in the pilot-plant bulk sample is lower than in the smaller samples submitted for batch tests.

Initial Results Using Fine Grind

Excellent results were immediately obtained at a fine grind (71 to 75% minus 200 mesh) in the early part of the investigation in Test Runs 2 and 3. Copper concentrates produced in these two test runs assayed 39.0% and 35.6% copper with copper recoveries of 98.1% and 96.7% respectively.

Therefore, it appeared that it only remained to coarsen the grind to 50% minus 200 mesh, conduct a few test runs at this grind, and then the investigation could be brought to a successful conclusion. This, however, was not the case. Not only did it require many reductions in ball load to achieve the desired coarse grind but, starting with Test Run No. 4, copper concentrate grade began to deteriorate and it was not until the final test run (No. 9) that copper concentrate grade was on a par with that obtained in Test Runs 2 and 3.

Effect of Froth Characteristics on Concentrate Grade

The deterioration in concentrate grade was related to froth characteristics in the rougher cells. It was found that a "loose" free-flowing, voluminous froth resulted in a high content of insolubles in the copper rougher concentrate. This was because there was much more bubble surface area available than was required for sulphide attachment with the result that the extra space was taken up by talc particles and mica flakes. The "loose" froth condition was caused primarily by the addition to the first rougher of an insufficient amount of xanthate. By increasing the xanthate addition, the froth characteristics could be modified to give a "tight" well-mineralized froth. With this type of froth there was a considerable reduction in froth volume which resulted in all the available space on the bubble surfaces being occupied by copper sulphides which "crowded" out the less floatable gangue particles. If, however, a slight excess of xanthate was added the froth bed would be transformed into a thin layer of heavily-mineralized scum which could not be separated from the pulp.

It was possible by careful adjustment of xanthate feed rate to

obtain a well-mineralized but free-flowing froth in the roughers but this condition could not be maintained during the duration of the sampling period. Usually after about half an hour or so of steady operation, the froth would either become too loose or too scummy. In an attempt to overcome this problem an "on-off" method of controlling xanthate feed rate was adopted. This practice, which was successfully employed in Test Run No. 9, consisted of keeping a careful watch on froth conditions in the roughers. At the first sign that the froth was becoming scummy, the xanthate feeder was shut off for 1 or 2 minutes in order to "loosen" the froth. If, on the other hand, the froth showed signs of becoming too loose and free-flowing, an extra addition of xanthate (5 to 10 cc) was made manually in order to "tighten" the froth.

It is believed that the difficulty in maintaining the desired froth characteristics in the pilot plant was related to the scale of operation. For instance, the rate at which the rougher froth was being formed in the rougher cells was sufficient to give an intermittent froth overflow only (cells overflowing about half the time). Any disturbance, such as sampling of the recirculated scavenger concentrate, which involved cutting off all of the flow for one minute would be enough at times to "tighten" the froth, preventing overflow and resulting in a transformation to a "scummy" condition.

The fineness of the grind also had an effect on maintenance of the desired froth characteristics. When a fine grind was employed, the more finely-ground sulphides would have a greatly increased surface area requiring a much greater bubble area for attachment thus making the achievement of a well-mineralized froth a lot less difficult. This is, perhaps, one of the reasons the problem of froth characteristics did not manifest

itself in the early part of the investigation when a fine grind was being employed.

Generally, the character of the froth is an important factor in all types of sulphide flotation but is especially critical for this ore because of the ready floatability of talc and mica.

Effect of Fineness of Grind

Loss of copper in the tailing was constant at 0.05% to 0.06% throughout the investigation indicating that the coarsest grind employed (49% minus 200 mesh) was adequate for essentially complete liberation of the sulphides from the gangue. Other than its effect on froth characteristics noted above, the fineness of grind in the range employed did not have any significant effect on concentrate grade.

As a screen was used for classification the sulphides in the ground ore were coarser than would be the case for classification with a mechanical classifier or cyclone. This is because the latter two devices classify by gravity and not by particle size as does the screen. Gravity classification results in the concentration of the larger sulphide particles in the underflow fraction and subsequent overgrinding.

Effect of Depramin in Cleaning

Table 7 compares results of batch cleaning tests, with and without the addition of Depramin 75, on pilot-plant rougher concentrates produced in Test Run No. 1. Included in the comparison are the cleaning circuit results for Test Run No. 1

TABLE 7

Comparison of Results for Batch Cleaning Tests
on Pilot-Plant Copper Rougher Concentrate

Test No.	Remarks	Product	Wt %	Analysis % Cu	Analysis % Insol	Distn % Cu	Distn % Insol	Sep** Eff.%
Pilot Plant Test Run No.1	No reagents added	Cleaner conc	69.45	20.00	46.69	99.4	58.9	40.5
		Cleaner tail	30.55	0.26	74.19	0.6	41.1	
		Feed (calcd)	100.00	13.97	55.09	100.0	100.0	
Batch Test No. P-1	" " "	Cleaner conc	66.46	20.54	45.72	96.5	56.0	40.5
		Cleaner tail	33.54	1.47	71.06	3.5	44.0	
		Feed (calcd)	100.00	14.14	54.22	100.0	100.0	
Batch Test No. P-2	0.93 lb/ton* Depramin 75 added.	Cleaner conc	48.01	30.00	29.62	97.2	25.7	71.5
		Cleaner tail	51.99	0.79	79.00	2.8	74.3	
		Feed (calcd)	100.00	14.81	55.29	100.0	100.0	

* Per ton of cleaner feed

** Separation efficiency, % copper recovered minus % insolubles recovered in cleaner concentrate.

As can be seen from the above comparison the addition of Depramin 75 to the copper cleaner in Batch Test P-2 resulted in a substantial increase in concentrate grade. For this reason, the practice was adopted of feeding Depramin to the copper cleaner starting with Test Run No. 3, but at only about half the feed rate (0.40 to 0.55 lb per ton of cleaner feed). Whether or not Depramin was beneficial in the pilot plant at this level is open to question but, judging from the difficulty experienced in upgrading the rougher concentrate, it would appear that this

reagent, at the level employed, had little, if any, effect in cleaning.

Lime as Pyrite Depressant

It was not possible by iron analysis to determine the effectiveness of lime as a pyrite depressant but when the final tailing was run over a Wilfley table a pyrite streak was visible indicating that it was being depressed. Whether or not it was possible to obtain satisfactory results without the addition of lime was not determined.

Distribution of Insolubles in Various Size Fractions of Copper Concentrate

Tables 8 and 9 give the distribution of copper and insolubles in various size fractions of low-grade copper concentrate from Test Run No. 7 and high-grade copper concentrate from Test Run No. 9 respectively.

TABLE 8

Distribution of Insolubles in Various Size Fractions of Low-Grade Copper Concentrate from Test Run No.7

Tyler Mesh Size	Wt %	Analysis %		Distribution %	
		Cu	Insol	Cu	Insol
+65	4.5	28.92	19.64	4.4	4.0
+100	9.4	32.50	14.34	10.2	6.1
+150	14.6	34.82	13.48	17.1	8.9
+200	16.6	30.78	18.18	17.1	13.7
+325	16.7	29.76	21.44	16.7	16.3
-325	38,2	26.93	29.38	34.5	51.0
Total	100.0	29.81	22.02	100.0	100.0

TABLE 9

Distribution of Insolubles in Various Size Fractions of High-Grade Copper Concentrate from Test Run No. 9

Tyler Mesh Size	Wt %	Analysis %		Distribution %	
		Cu	Insol	Cu	Insol
+65	11.5	32.71	11.14	10.4	17.0
+100	15.1	35.63	7.88	14.8	15.8
+150	15.4	36.80	6.00	15.6	12.3
+200	14.8	38.67	4.30	15.7	8.5
+325	13.7	38.67	4.20	14.6	7.6
-325	29.5	35.63	9.90	28.9	38.8
Total	100.0	36.22	7.53	100.0	100.0

From the above tables, it can be seen that the intermediate size fractions have the lowest insolubles content, whereas the coarsest fractions and the minus 325 mesh fraction contain the highest amount of insolubles. The size fractions were not submitted for mineralogical examination but, by visual examination, it can be seen that the coarse fractions are contaminated by mica flakes. Presumably, the insoluble content in the minus 325-mesh fraction is due to talc.

The grinding characteristics of this high-talc ore are unusual in that the gangue minerals are preferentially ground finer than the sulphides. Generally, for other types of sulphide ores the opposite is true. Table 10 gives a comparison of screen analyses of the ground ore (screen undersize) and copper concentrate for Test Runs 7 and 9.

TABLE 10

Comparison of Screen Analyses of
Screen Undersize and Concentrate

Test Run No.	Product	Tyler Mesh Size						
		+65	+100	+150	+200	+325	-325	-200
7	Screen u'size(feed)	10.0	9.2	10.9	13.1	14.5	42.3	56.8
	Copper conc	4.5	9.4	14.6	16.6	16.7	38.2	54.9
9	Screen u'size(feed)	15.1	11.2	10.8	12.0	12.4	38.5	50.9
	Copper conc	11.5	15.1	15.4	14.8	13.7	29.5	43.2

Flotation Capacity

The flotation capacity employed in Test Run No. 9 (Flowsheet No. 4) is given in Table 11.

TABLE 11

Flotation Capacity Employed in
Test Run No. 9 (Flowsheet No. 4)

Operation	Units	Cu ft per ton	Contact time min*	Density % Sol
Conditioning	1- No. 7 Denver cells @ 0.87 cu ft	0.12	2½	35
Rougher Flotation	2- " " " " " " " "	0.24	5	35
Scavenger Flotation	5- " " " " " " " "	0.60	12	35
1st Stage Cleaner	4-No. 5 Denver cells @ 0.23 cu ft	0.13	19	12
2nd Stage Cleaner	3 " " " " " " " "	0.10	12	10

*Calculations based on assumed S.G. of 2.8 for feed to rougher and scavenger flotation and S.G. of 4.0 for cleaner feed.

The pulp contact time of 17 minutes in the rougher and scavengers corresponds to a skimming time of 5 minutes in lab batch tests and appears to be a reasonable figure for a full-scale plant. An increase of about 25%

in flotation capacity to about 1 cu ft/ton treated might be warranted to take care of a higher copper head.

Note that in Test Run No. 9 the third scavenger cell tailing assayed 0.08%. It thus required 2 additional cells or a 40% increase in flotation capacity to reduce the tailing to its final value of 0.05% copper. This is equivalent to the recovery of an additional 0.6 lb of copper per ton treated and on this basis it would appear that the additional flotation capacity required to achieve the lower tailing is economically justified.

The first-stage cleaner cell capacity employed in the pilot plant, viz., 0.13 cu ft/ton treated, is in the range used in full-scale flotation plants. As is evident from the results obtained in Test Run No. 9, a second stage of cleaning is not required.

CONCLUSIONS

Despite the high talc content, a high-grade copper concentrate with excellent recovery can be produced from this ore at a coarse grind of 50% minus 200 mesh. This confirms the results obtained by Mr. Livingstone in work carried out in 1955-56.

The key to success in treating the high-talc ore was the effectiveness of Depramin 75 as a talc depressant along with the maintenance of a heavily mineralized but free-flowing rougher froth. Because froth characteristics are so important it is recommended that an air-injected type of flotation cell be employed in the full-scale plant. This will allow for much closer control over froth characteristics.

As was mentioned previously, the high-talc ore was found extremely easy to grind and therefore grinding costs should be very low.

No attempt was made to measure power consumption for grinding because, from previous experience, it had been found that there was no significant difference between the power consumed by the pilot-plant ball mill when it was running empty and with the feed on. The talc in the ore affects the viscosity of the pulp such that, for pulp densities beyond about 60% solids, the pulp ceases to become fluid. Because of this limitation, ball mill capacity would be reduced, but this should be more than offset by the ease with which the ore can be ground.

The grade of the copper concentrate that can be produced from this ore will vary, depending on the chalcocite-bornite to chalcopyrite ratio in the mill feed. As this ratio increases so will the grade of the final copper concentrate.

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APPENDIX A

LABORATORY FLOTATION TEST REPORTS

Abbreviations Used in Flotation Test Reports

RM	Rod mill
BM	Ball mill
Xan	Potassium ethyl xanthate
DF, DF 250	Dowfroth 250 - Dow Chemical Co. frother
Orz A	Orzan A, Crown Zellerbach, trade name for ammonium lignin sulphonate
Dep	Depramin, trade name for talc depressant sold by Hollimex Products Co. Ltd.,, Edmonton, Alberta
ro	rougher
scav	scavenger
cl	cleaner
conc	concentrate
flot	flotation

Screen Analyses of Rougher Tailings from Lab Flotation Tests

Test No.	Grinding Time, min	% Solids	Tyler Mesh Size, Wt %						
			+65	+100	+150	+200	+325	-325	-200
4 (No.1 Sple)	20	50	0.3	2.5	8.7	19.5	24.6	44.4	69.0
5 " " "	30	50	0.2	1.1	4.8	15.1	24.4	54.4	78.8
7 " " "	12	50	1.2	7.9	16.5	18.6	18.8	37.0	55.8
8 " " "	15	50	0.7	4.6	13.1	20.0	19.7	41.9	61.6
11 (No.2 Sple)	12	50	1.0	7.6	15.4	16.7	17.6	41.7	59.3

APPENDIX B

PILOT-PLANT FLOTATION TEST REPORTS

MINES BRANCH
PILOT-PLANT FLOTATION TEST REPORT

Test Run No: 1	Flowsheet No: 1	Feed Rate: 500 lb/hour
Date: October 18, 1972	Time Operated: 9:00 a.m. - 3:30 p.m.	
Ore: Marval Mines Inc.	Sampling Period: 1:30 - 3:30 p.m.	

OBJECT OF TEST RUN: Initial test run based on procedure developed in lab batch tests.

Ball charge: 1100 lb

AVERAGE CONDITIONS DURING SAMPLING PERIOD

Point Of Addition	Reagents - lb/ton Ore Treated							Product	% Sol	pH
	Lime	Dep	Xan	DF						
Ball mill	2.0							B.M. disch	55	
Condit-1		0.68						Flot feed	35	10.3
No.1 ro cell			.0031	0.061				Cleaner feed	12	19.6
No.2 " "			.0031	0.022				Cleaner tail	5	
Condit-2		0.18								
No.3 ro cell			.0039	0.030						
No.5 " "			.0032							

Screen Analysis	+65m	+100m	+150m	+200m	+325m	-325m	-200m
Screen undersize	0.5	4.2	7.8	11.8	16.5	59.2	75.7

METALLURGICAL BALANCE

Product	Wt %	Analysis %				Distribution %			
		Cu	Insol			Cu			
Cu conc	6.97	20.0	46.69			96.8			
Final tail	93.03	0.05				3.2			
Feed (calcd)	100.00	1.44				100.0			
Cu ro conc		13.97	55.09						
Cu cl tail		0.26							

Remarks: Started with 0.41 lb/ton Depramin to No. 1 Condit (amount used in lab tests) but this did not depress all of the talc - found it necessary to increase Depramin by about 50% in order to obtain a bright, coppery froth.

MINES BRANCH
PILOT-PLANT FLOTATION TEST REPORT

Test Run No: 2	Flowsheet No: 2	Feed Rate: 500 lb/hour
Date: October 19, 1972	Time Operated: 9:15 a.m. - 3:30 p.m.	
Ore: Marval Mines Inc.	Sampling Period: 1:30 - 3:30 p.m.	

OBJECT OF TEST RUN: Made following changes to improve rougher conc grade: (1) Converted last 4 rougher cells to scavengers with scav conc returned to No. 1 rougher cell (2) Switched Depramin from No. 3 to No. 2 rougher cell and allowed froth from this cell to overflow. Also switched copper cleaner tail from waste to No. 1 rougher cell.

AVERAGE CONDITIONS DURING SAMPLING PERIOD

Point Of Addition	Reagents - lb/ton Ore Treated							Product	% Sol	pH
	Lime	Dep	Xan	DF						
Ball Mill	1.22							B.M. disch	50	
Conditioner		0.68						Flot feed	32	9.5
No.1ro cell			.0012	0.057				Cleaner feed	6	8.8
No.2 " "		0.16								
No.3 " "			.0019	0.021						
No.1 scav cell			.0035	0.030						
No.3 " "			.0034							
Cleaner feed				0.011						

Screen Analysis	+65m	+100m	+150m	+200m	+325m	-325m	-200m
Screen undersize	0.5	4.3	7.8	12.2	15.3	59.9	75.2

METALLURGICAL BALANCE

Product	Wt %	Analysis %				Distribution %			
		Cu	Insol			Cu			
Cu conc	3.74	39.03	4.24			98.1			
Final tail	96.26	0.03				1.9			
Feed (calcd)	100.00	1.49				100.0			
Cu ro conc		36.45	8.69						
Cu scav conc		6.10	56.64						
Cu cleaner tail		22.09							

Remarks: Found it difficult to regulate xanthate feed rates to roughers in order to obtain a well-mineralized but free-flowing froth but by 1.00 p.m. this was achieved.

MINES BRANCH
PILOT-PLANT FLOTATION TEST REPORT

Test Run No: 3	Flowsheet No: 3	Feed Rate: 500 lb/hour
Date: October 23, 1972	Time Operated: 9:15 a.m. - 3:30 p.m.	
Ore: Marval Mines Inc.	Sampling Period: 1:30 - 3:30 p.m.	

OBJECT OF TEST RUN: To try a coarser grind by reducing ball charge by 200 lb - other conditions as in previous test run except that Depramin 75 was fed to cleaner (lab tests had indicated that its addition was beneficial).

AVERAGE CONDITIONS DURING SAMPLING PERIOD

Point Of Addition	Reagents - lb/ton Ore Treated							Product	% Sol	pH
	Lime	Dep	Xan	DF						
Ball Mill	1.11							B.M. disch	56	
Conditioner		0.68						Flot feed	34	9.3
No.1 ro cell			.0031	0.057				Cleaner feed	14	8.6
No.2 " "		0.13						Cleaner tail	4	
No.3 " "			.0021	0.021						
No.1scav cell			.0035	0.030						
No.3 " "			.0032							
Cleaner feed		0.017		0.017						

Screen Analysis	+65m	+100m	+150m	+200m	+325m	-325m	-200m
Screen undersize	0.5	5.5	9.8	13.2	14.6	56.4	71.0

METALLURGICAL BALANCE

Product	Wt %	Analysis %				Distribution %			
		Cu	Insol			Cu			
Cu conc	4.00	35.55	4.54			96.7			
Final tail	96.00	0.05				3.3			
Feed (calcd)	100.00	1.47				100.0			
Cu ro conc		33.68	12.54						
Cu ro tail		0.17							
Cu scav conc		2.58	68.66						
Cu cleaner tail		16.03							

Remarks:

MINES BRANCH
PILOT-PLANT FLOTATION TEST REPORT

Test Run No: 4	Flowsheet No: 2	Feed Rate: 600 lb/hour
Date: October 24, 1972	Time Operated: 8:45 a.m. - 4:00 p.m.	
Ore: Marval Mines Inc.	Sampling Period: 2:30 - 4:00 p.m.	

OBJECT OF TEST RUN: To try a feed rate of 600 lb/hour as a means of coarsening grind (the reduction in ball charge in Test Run No. 3 did not give the desired result).

AVERAGE CONDITIONS DURING SAMPLING PERIOD

Point Of Addition	Reagents - lb/ton Ore Treated							Product	% Sol	pH
	Lime	Dep	Xan	DF						
Ball Mill	1.32							B.M. disch	51	
Conditioner		0.57						Flot feed	33	10.4
No.1 ro cell			.0022	0.046				Cleaner feed	12	9.6
No.2 " "		0.15						Cleaner tail	5	
No.3 " "			.0026	0.020						
No.1 scav										
cell			.0018	0.013						
No.3 "										
Cleaner										
feed		0.022	.0031	0.009						

Screen Analysis	+65m	+100m	+150m	+200m	+325m	-325m	-200m
Screen undersize	0.5	5.9	7.1	13.2	19.4	53.9	73.3

METALLURGICAL BALANCE

Product	Wt %	Analysis %				Distribution %			
		Cu	Insol			Cu			
Cu conc	4.53	30.06	15.28			96.6			
Final tail	95.47	0.05				3.4			
Feed (calcd)	100.00	1.41				100.0			
Cu ro conc		28.72							
Cu ro tail		0.11							
Cu scav conc		2.06	69.93						
Cu cleaner tail		2.60							

Remarks: Bucket elevator conveying ball mill discharge to screen broke down at 1:30 p.m. - switched over to pump but no flotation feed for about 20 min. Held off sampling till 2:30 p.m.

MINES BRANCH
PILOT-PLANT FLOTATION TEST REPORT

Test Run No: 5	Flowsheet No: 2	Feed Rate: 600 lb/hour
Date: October 25, 1972	Time Operated: 9:15 a.m. - 3:30 p.m.	
Ore: Marval Mines Inc.	Sampling Period: 2:00 - 3:30 p.m.	

OBJECT OF TEST RUN: To try an additional reduction in ball charge of 200 lb in another attempt to coarsen grind (increase in feed rate from 500 to 600 lb/hr did not have any effect on grind).

AVERAGE CONDITIONS DURING SAMPLING PERIOD

Point Of Addition	Reagents - lb/ton Ore Treated							Product	% Sol	pH
	Lime	Dep	Xan	DF						
Ball mill	0.88							B.M. disch	51	
Conditioner		0.57						Flot feed	33	9.9
No.1 ro cell			.0034	0.037				Cleaner feed	12	8.9
No.2 " "		0.15						Cleaner tail	3	
No.3 " "			.0018	0.020						
No.1 scav										
cell			.0018	0.013						
No.3 "			.0031							
Cleaner										
feed		0.022		0.013						

Screen Analysis	+65m	+100m	+150m	+200m	+325m	-325m	-200m
Screen undersize	1.7	6.4	9.6	12.0	19.8	50.5	70.3

METALLURGICAL BALANCE

Product	Wt %	Analysis %				Distribution %			
		Cu	Insol			Cu			
Cu conc	4.25	33.25	13.72			96.1			
Final tail	95.75	0.06				3.9			
Feed (calcd)	100.00	1.47				100.0			
Cu ro conc		28.75	24.40						
Cu ro tail		0.16							
Cu scav conc		2.60	70.50						
Cu cleaner tail		4.56							

Remarks: Ball mill discharge pump line plugged 10:40 - 10:50 a.m. and 11:10 - 11:30 a.m. - sampling delayed till 2:00 p.m. A large increase in circulating load on screen noted at end of run.

MINES BRANCH
PILOT-PLANT FLOTATION TEST REPORT

Test Run No: 6	Flowsheet No: 3	Feed Rate: 600 lb/hour
Date: October 26, 1972	Time Operated: 9:45 a.m. - 3:30 p.m.	
Ore: Marval Mines Inc.	Sampling Period: 2:00 - 3:30 p.m.	

OBJECT OF TEST RUN: To try 30 mesh screen cloth on Sweco screen in place of 65 mesh cloth in a further attempt to coarsen grind (the 65 mesh cloth had been installed in error for 50 mesh cloth). Also added second stage of cleaners to improve concentrate grade.

AVERAGE CONDITIONS DURING SAMPLING PERIOD

Point Of Addition	Reagents - lb/ton Ore Treated							Product	% Sol	pH
	Lime	Dep	Xan	DF						
Ball Mill	0.79							B.M. disch	50	
Conditioner		0.57						Flot feed	32	9.8
No.1ro cell			.0030	0.037				No.1 cl feed	12	9.2
No.2 " "		0.15						" " tail	2	
No.3 " "			.0018	0.020				No.2 cl feed	11	
No.1scav										
cell			.0021	0.011				No.2 cl tail	1	
No.3 "			.0031							
Cleaner										
feed		0.022		0.016						

Screen Analysis	+65m	+100m	+150m	+200m	+325m	-325m	-200m
Screen undersize	7.1	7.0	10.0	10.3	15.3	50.3	65.6

METALLURGICAL BALANCE

Product	Wt %	Analysis %				Distribution %			
		Cu	Insol			Cu			
Cu conc	4.22	33.50	12.00			96.1			
Final tail	95.78	0.06				3.9			
Feed (calcd)	100.00	1.47				100.0			
Cu ro conc		25.90	29.15						
Cu ro tail		0.16							
1st stage Cu cl									
conc		29.36	22.03						
" " cl tail		5.00							
2nd stage Cu cl									
tail		17.50							

Remarks: During sampling period copper rougher froth was not quite as well-mineralized as desired - found desired froth condition (well-mineralized and just overflowing) difficult to achieve.

MINES BRANCH
PILOT-PLANT FLOTATION TEST REPORT

Test Run No: 7	Flowsheet No: 3	Feed Rate: 600 lb/hour
Date: October 27, 1972	Time Operated: 9:30 a.m. - 3:30 p.m.	
Ore: Marval Mines Inc.	Sampling Period: 2:00 - 3:30 p.m.	

OBJECT OF TEST RUN: To try a further reduction in ball charge of 200 lb (total charge down to 500 lbs) in a continuing attempt to coarsen grind. Also increased Depramin 75 on conditioner from 0.57 to 0.68 lb/ton.

AVERAGE CONDITIONS DURING SAMPLING PERIOD

Point Of Addition	Reagents - lb/ton Ore Treated							Product	% Sol	pH
	Lime	Dep	Xan	DF						
Ball Mill	0.75							B.M. disch	50	
Conditioner		0.68						Flot feed	35	10.0
No.1ro cell			.0035	0.037				No.1 cl feed	11	9.3
No.2 " "		0.15						" " tail	2	
No.3 " "			.0018	0.012				No.2 cl feed	10	
No.1scav cell			.0021	0.011				" " tail	2	
No.3 " "			.0031							
Cleaner										
feed		0.022		0.016						

Screen Analysis	+65m	+100m	+150m	+200m	+325m	-325m	-200m
Screen undersize	10.0	9.2	10.9	13.1	14.5	42.3	56.8

METALLURGICAL BALANCE

Product	Wt %	Analysis %					Distribution %				
		Cu	Insol				Cu				
Cu conc	4.31	30.43	21.16				95.8				
Final tail	95.69	0.06					4.2				
Feed (calcd)	100.00	1.37					100.0				
Cu ro conc		24.10	32.90								
Cu ro tail		0.11									
1st stage Cu cl											
conc		30.43	18.28								
" " " tail		2.62									
2nd stage Cu cl											
tail		8.76									

Remarks: Found it difficult to obtain desired froth - alternated between "gummed up" and light "runaway" froth condition.

MINES BRANCH
PILOT-PLANT FLOTATION TEST REPORT

Test Run No: 8	Flowsheet No: 3*	Feed Rate: 600 lb/hour
Date: October 31, 1972	Time Operated: 9:00 a.m. - 3:30 p.m.	
Ore: Marval Mines Inc.	Sampling Period: 2:00 - 3:30 p.m.	

OBJECT OF TEST RUN: To try for a grind of approx 50% minus 200 mesh by reducing ball charge from 500 lb to 400 lb. Also switched first stage cleaner tailing from head of roughers to head of scavengers to allow for better froth control in roughers. *Except for disposition of cleaner tailing as noted above.

AVERAGE CONDITIONS DURING SAMPLING PERIOD

Point Of Addition	Reagents - lb/ton Ore Treated							Product	% Sol	pH
	Lime	Dep	Xan	DF						
Ball Mill	0.75							B.M. disch	51	
Conditioner		0.68						Flot feed	32	10.2
No.1ro cell			.0028	0.037				No.1 cl feed	10	9.2
No.2 " "		0.15						" " tail	2	
No.3 " "			.0018	0.010				No.2 cl feed	14	
No.1scav cell			.0021	0.011				" " tail	1	
No.3 " "			.0031							
Cleaner										
feed		0.022		0.016						

Screen Analysis	+65m	+100m	+150m	+200m	+325m	-325m	-200m
Screen undersize	15.1	12.0	11.2	12.4	11.5	37.8	49.3

METALLURGICAL BALANCE

Product	Wt %	Analysis %				Distribution %			
		Cu	Insol			Cu			
Cu conc	4.06	32.79	14.24			1195.9			
Final tail	95.94	0.06				4.1			
Feed (calcd)	100.00	1.39				100.0			
Cu ro conc		26.50	27.58						
Cu ro tail		0.16							
No.2scav cell tail		0.08							
1st stage Cu clconc		30.51	17.18						
" " " "tail		2.39							
2nd stage Cu cl									
tail		6.94							

Remarks: Managed to keep a well-mineralized froth on first two roughers by "on-off" xanthate control on first cell but light, free-flowing froth from third rougher lowered rougher concentrate grade.

MINES BRANCH
PILOT-PLANT FLOTATION TEST REPORT

Test Run No: 9	Flowsheet No: 4	Feed Rate: 600 lb/hour
Date: November 1, 1972	Time Operated: 9:30 a.m. - 3:00 p.m.	
Ore: Marval Mines Inc.	Sampling Period: 1:00 - 3:00 p.m.	

OBJECT OF TEST RUN: Repeat of Test Run No. 9 but number of roughers decreased from 3 to 2 cells.

AVERAGE CONDITIONS DURING SAMPLING PERIOD

Point Of Addition	Reagents - lb/ton Ore Treated							Product	% Sol	pH
	Lime	Dep	Xan	DF						
Ball Mill	0.84							B.M. disch	53	
Conditioner		0.68						Flot feed	35	10.4
No.1ro cell			.0018	0.039				1st cl feed		9.6
No.2 " "		0.15								
No.1scav cell			0.0019	0.011						
No.2 " "			0.0019							
No.4 " "			0.0029	0.012						
1st cl feed		0.022		0.015						

Screen Analysis	+65m	+100m	+150m	+200m	+325m	-325m	-200m
Screen undersize	15.1	11.2	10.8	12.0	12.4	38.5	50.9

METALLURGICAL BALANCE

Product	Wt %	Analysis %				Distribution %			
		Cu	Insol	Ag		Cu	Ag		
Cu conc	3.79	36.22	6.86	6.27		96.6	77.9		
Final tail	96.29	0.05		0.07		3.4	22.1		
Feed (calcd)	100.00	1.42		0.30		100.0	100.0		
Cu ro conc		34.23	9.14						
Cu ro tail		0.54							
Cu scav conc		6.72	62.60						
No.3 scav cell tail		0.08							
1st stage Cu cl conc		35.49	6.70						
" " Cu " tail		3.75							
2nd stage Cu cl tail		11.20							

Remarks: Employed "on-off" control on xanthate fed to first rougher cell as in Test Run No. 8

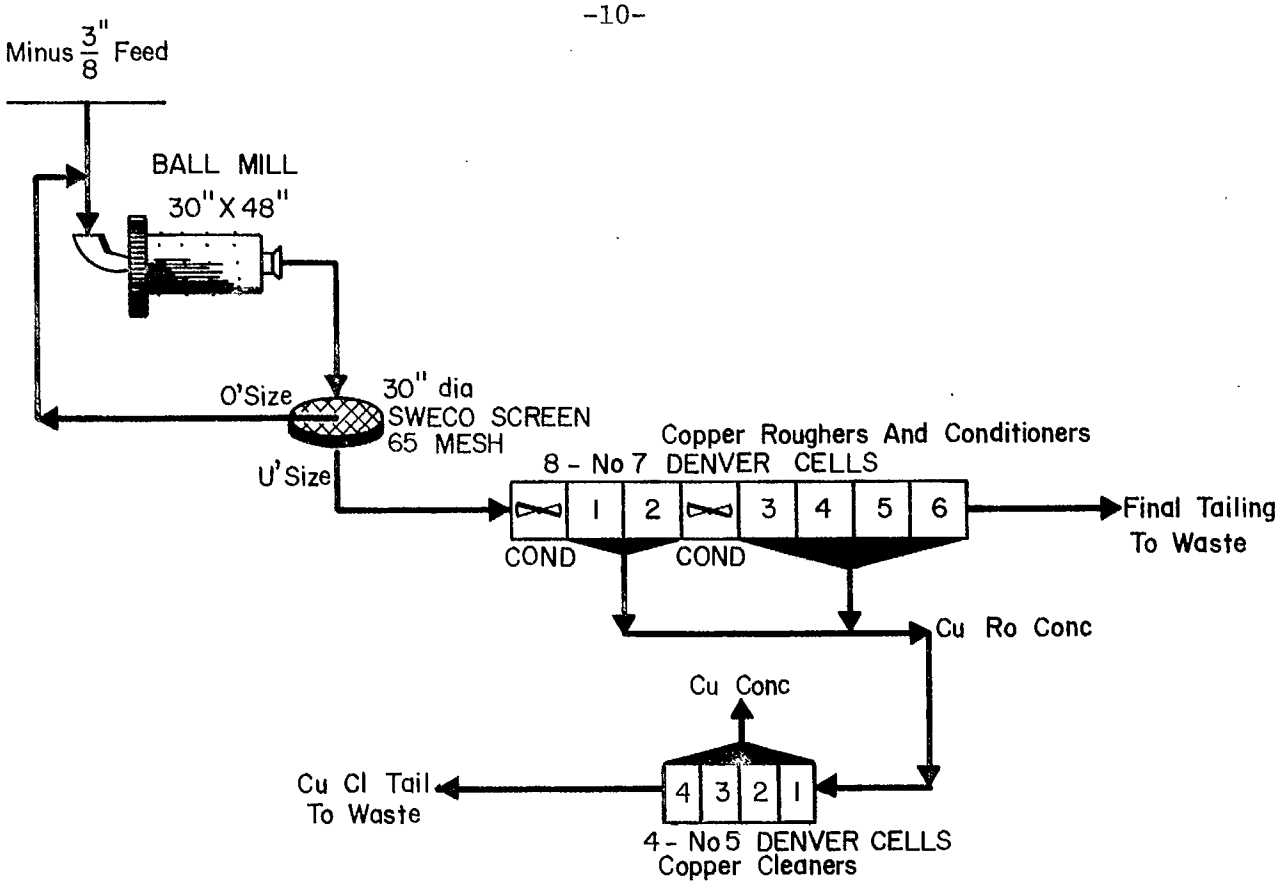

Figure 1. PILOT-PLANT FLOWSHEET No. 1

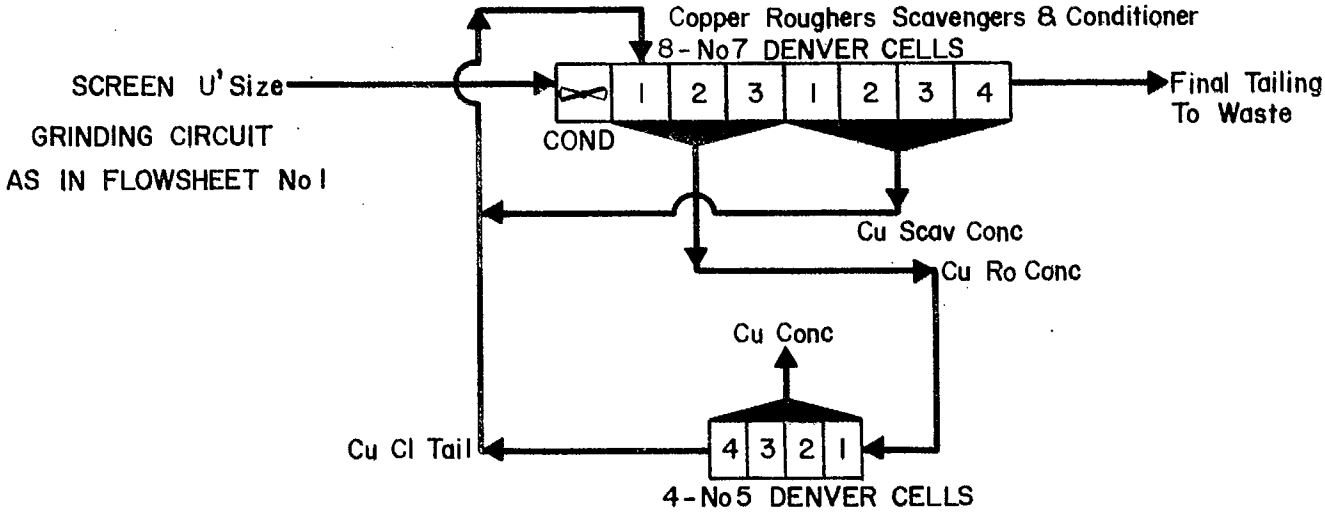

Figure 2. PILOT-PLANT FLOWSHEET No. 2

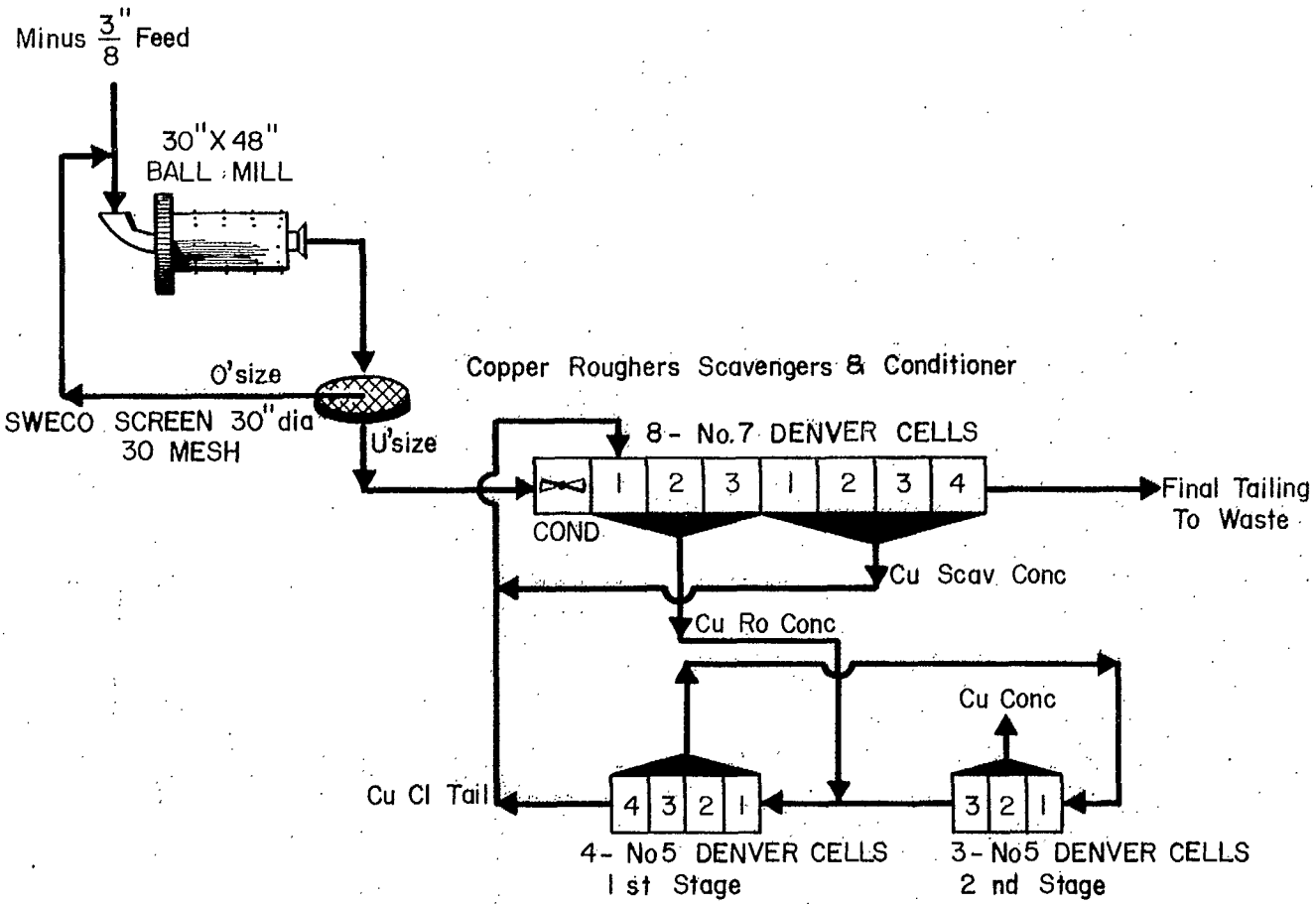

Figure 3. PILOT-PLANT FLOWSHEET No. 3

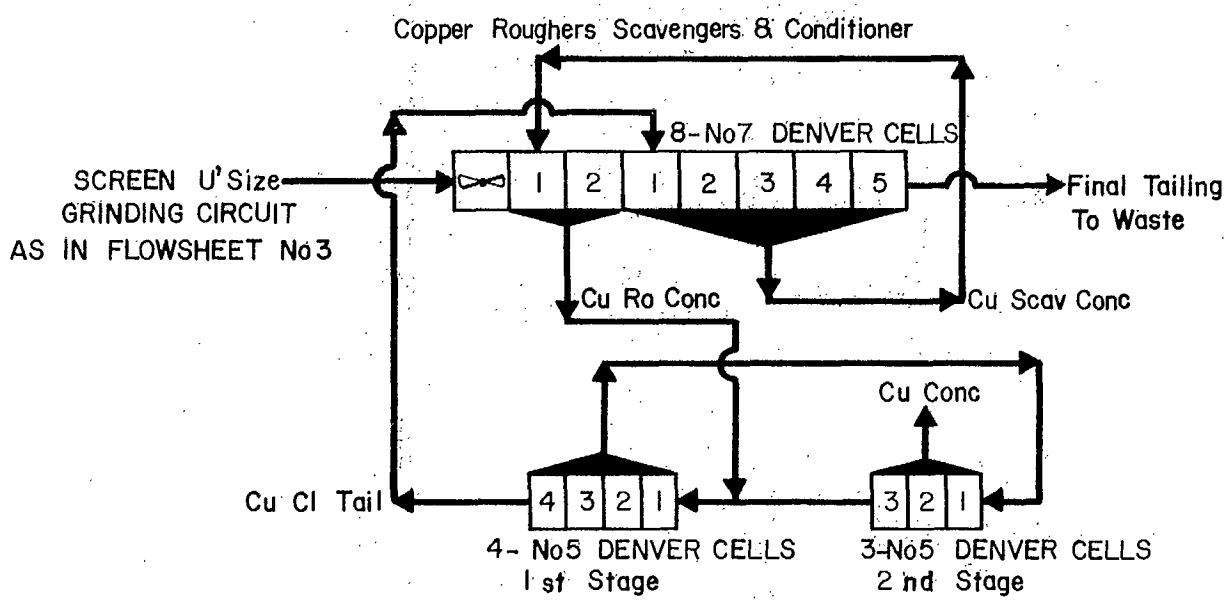

Figure 4. PILOT-PLANT FLOWSHEET No. 4

MINES BRANCH FLOTATION TEST REPORT

TEST NO. P-1	SAMPLE: Marval Pilot-Plant copper rougher conc	DATE. October 18, 1972
OBJECT OF TEST: 1½ min cut, 3.30 pm To try Depramin 75 in cleaning		CHARGE: 539 g TESTED BY: A.S.

OPERATION	Time min	% Solids	pH	Unit used	Reagents, lb per ton								
					Dep 75								
Conditioning	1	12		1000-g cell	0.93								
Cleaning	2												

PRODUCT	WT %	ANALYSIS %							DISTRIBUTION %				
		Cu	Insol						Cu	Insol			
Copper cleaner conc	48.01	30.00	29.62						97.2	25.7			
" " tail	51.99	0.79	79.00						2.8	74.3			
Feed (calcd)	100.00	14.81	55.29						100.0	100.0			

REMARKS:

MINES BRANCH FLOTATION TEST REPORT

TEST NO. P-2	SAMPLE: Marval Pilot-Plant copper rougher conc	DATE: October 18, 1972
OBJECT OF TEST: 1½ min cut, 3.30 p.m. Comparison test for P-1, no Depramin 75 added		CHARGE: 521 g
		TESTED BY: A.S.

OPERATION	Time min	% Solids	pH	Unit used	Reagents. lb per ton									
Cleaning	2	12		1000-g cell										

PRODUCT	WT %	ANALYSIS %							DISTRIBUTION %				
		Cu	Insol						Cu	Insol			
Copper cleaner conc	66.46	20.54	45.76						96.5	56.0			
" " tail	33.54	1.47	71.06						3.5	44.0			
Feed (calcd)	100.00	14.14	54.22						100.0	100.0			

REMARKS:

MINES BRANCH FLOTATION TEST REPORT

TEST NO. 1	SAMPLE: Marval Mines No. 1	DATE: Sept. 25, 1972
OBJECT OF TEST: Preliminary test without talc depressant and employing a 15 min grind at 65% solids		CHARGE: 1729 g
		TESTED BY: A.S.

OPERATION	Time min	% Solids	pH	Unit used	Reagents, lb per ton									
					Xan	DF250								
Grinding	15	65		7 x 14 RM										
Conditioning	5	32	8.4	1000-g cell	0.023									
Copper rougher														
Stage 1	½					0.023								
" 2	1				0.023									
" 3	2				0.023	0.023								

PRODUCT	WT %	ANALYSIS %							DISTRIBUTION %				
Copper rougher conc	20.09												
Copper rougher tailing	79.91												
Feed	100.00												

REMARKS: At 65% solids rod mill pulp very viscous - would not flow freely.
Excessive amounts of talc floated, therefore test products not assayed.

MINES BRANCH FLOTATION TEST REPORT

TEST NO. 2	SAMPLE: Marval Mines No. 1	DATE: Sept. 25, 1972
OBJECT OF TEST: To try Orzan A as talc depressant, also increased grinding time to 20 min		CHARGE: 1729 g
		TESTED BY: A.S.

OPERATION	Time min	% Solids	pH	Unit used	Reagents, lb per ton									
					Orz A	Xan	DF250							
Grinding	20	65		7 x 14 RM										
Conditioning - 1	2	32	8.4	1000-g cell	1.16									
" - 2	1					0.023	0.023							
Copper rougher														
Stage 1	½													
" 2	½					0.023								
" 3	1					0.023	0.023							

PRODUCT	WT %	ANALYSIS %							DISTRIBUTION %					
Copper rougher conc	14.73													
Copper rougher tailing	85.27													
Feed	100.00													

REMARKS: Talc depressed in stages 1 and 2 but came up profusely upon addition of reagents in stage 3. Test products not assayed.

MINES BRANCH FLOTATION TEST REPORT

TEST NO. 3 | SAMPLE: Marval Mines No. 1 | DATE: Sept. 25, 1972

OBJECT OF TEST: To try double the amount of Orzan A used in Test 2, also ground for 30 min at 50% solids | CHARGE: 1729 g | TESTED BY: A.S.

OPERATION	Time min	% Solids	pH	Unit used	Reagents, lb per ton		
					Orz A	Xan	DF250
Grinding	30	50		7 x 14 RM			
Conditioning - 1	2	32	8.4	1000-g cell	2.32		
" - 2	1					0.023	0.023
Copper rougher							
Stage 1	¼						
" 2	¼					0.023	
" 3	½					0.023	
Copper scavenger	1					0.023	0.023

PRODUCT	WT %	ANALYSIS %		DISTRIBUTION %
		Cu	Insol	Cu
Copper rougher conc	4.32	34.12	29.20	70.4
Copper scavenger conc	6.63	7.35	67.20	23.3
Copper scavenger tail	89.05	0.15		6.3
Feed (calcd)	100.00	2.09		100.0
Copper rougher + scav conc	10.95	17.91	52.21	93.7

REMARKS: Good talc depression in copper rougher but talc came up in scavenger upon addition of frother.

MINES BRANCH FLOTATION TEST REPORT

TEST NO. 4	SAMPLE: Marval Mines No. 1	DATE: Sept. 26, 1972
OBJECT OF TEST: To try Depramin 40 as talc depressant along with lime to grinding.		CHARGE: 1729 g
		TESTED BY: A.S.

OPERATION	Time min	% Solids	pH	Unit used	Reagents, lb per ton									
					Lime	Dep40	Xan	DF250						
Grinding	20	50			1.16									
Conditioning-1	2	32	9.9	1000-g cell		0.46	0.029	0.046						
" -2	1													
Copper rougher														
Stage 1	1													
" 2	1							0.046						
Conditioning	1					0.23								
Copper rougher														
Stage 3	2													

PRODUCT	WT %	ANALYSIS %							DISTRIBUTION %				
		Cu	Insol						Cu	Insol			
Copper rougher conc	8.98	31.25	42.34						98.4	5.5			
Copper rougher tailing	91.02	0.05	72.18						1.6	94.5			
Feed (calcd)	100.00	2.85	69.50						100.0	100.0			

REMARKS: Much improved copper flotation over previous tests - well-mineralized, gummy froth at start, effervescent froth at end. Talc came up quickly at end of 2nd rougher, therefore added additional Depramin 40.

MINES BRANCH FLOTATION TEST REPORT

TEST NO. 5	SAMPLE: Marval Mines No. 1	DATE: Sept. 26, 1972
OBJECT OF TEST: Repeat of Test 4 but with finer grind, more lime to the grind and lower xanthate addition.		CHARGE: 1729 g
		TESTED BY: A.S.

OPERATION	Time min	% Solids	pH	Unit used	Reagents, lb per ton									
					Lime	Dep 40	Xan	DF 250						
Grinding	30	50		7 x 14 RM	1.74									
Conditioning - 1	2	32	10.7	1000-g cell		0.46								
" - 2	1						0.014	0.023						
Copper rougher														
1	½													
2	½							0.023						
3	½							0.023						
Conditioning	1					0.23								
Copper rougher														
Stage 4	2													

PRODUCT	WT %	ANALYSIS %							DISTRIBUTION %				
		Cu	Insol						Cu	Insol			
Copper rougher conc	5.72	33.68	17.60						95.8	1.5			
Copper rougher tailing	94.28	0.09	71.20						4.2	98.5			
Feed (calcd)	100.00	2.01	68.13						100.0	100.0			

REMARKS: Reduction in xanthate did not alleviate gummy froth condition.

MINES BRANCH FLOTATION TEST REPORT

TEST NO. 6	SAMPLE: Marval Mines No. 1	DATE: Sept. 26, 1972
OBJECT OF TEST: Depramin 40 as talc depressant along with much lower xanthate additions than used in Tests 4 and 5.		CHARGE: 1729 g
		TESTED BY: A.S.

OPERATION	Time min	% Solids	pH	Unit used	Reagents, lb per ton									
					Lime	Dep40	Xan	DF250						
Grinding	30	50		7 x 14 RM	1.16									
Conditioning - 1	2	32	10.0	1000-g cell		0.46								
" - 2	1						0.006	0.023						
Copper rougher														
Stage 1	1													
" 2	1						0.003							
Conditioning	1					0.23		0.023						
Copper rougher														
Stage 3	2													
Copper scavenger	1													

PRODUCT	WT %	ANALYSIS %							DISTRIBUTION %				
		Cu	Insol						Cu	Insol			
Copper rougher conc	6.86	33.68	26.40						97.9	2.6			
Copper scavenger conc	0.85	1.46	84.24						0.5	1.0			
Copper scavenger tail	92.29	0.04	73.26						1.6	96.4			
Feed (calcd)	100.00	2.36	70.14						100.0	100.0			
Copper ro + scav conc	7.71	30.13	32.77						98.4	3.6			
Copper rougher tailing	93.14	0.05							2.1	97.4			

REMARKS: The very low xanthate additions resulted in a lighter, more voluminous froth in contrast to the gummy froth obtained in Tests 4 and 5.

MINES BRANCH FLOTATION TEST REPORT

TEST NO. 7	SAMPLE: Marval Mines No. 1	DATE: Oct. 2, 1972
OBJECT OF TEST:	To try Depramin 75 in place of Depramin 40, also decreased grinding time to 12 min	CHARGE: 1729 g
		TESTED BY: A.S.

OPERATION	Time min	% Solids	pH	Unit used	Reagents, lb per ton									
					Lime	Dep75	Xan	DF250						
Grinding	12	50			1.16									
Conditioning - 1	2	32	10.2			0.46								
" - 2	1						0.006	0.023						
Copper rougher														
Stage 1	1							0.012						
" 2	1							0.012						
Conditioning	1					0.23								
Copper rougher														
Stage 3	1						0.0014	0.006						
" 4	1						0.0014							
" 5	1													

PRODUCT	WT %	ANALYSIS %							DISTRIBUTION %				
		Cu	Insol						Cu				
Copper rougher conc	6.82	32.40	28.38						96.7				
Copper rougher tail	93.18	0.08							3.3				
Feed (calcd)	100.00	2.28							100.0				

REMARKS: Gummy, well-mineralized froth obtained despite low xanthate addition.

MINES BRANCH FLOTATION TEST REPORT

TEST NO. 8	SAMPLE: Marval Mines No. 1	DATE: Oct. 2, 1972
OBJECT OF TEST: Repeat of Test 7, but with grinding time increased from 12 to 15 min and with a small reduction in xanthate addition		CHARGE: 1729 g
		TESTED BY: A.S.

OPERATION	Time min	% Solids	pH	Unit used	Reagents, lb per ton									
					Lime	Dep75	Xan	DF 250						
Grinding	15	50	10.2		1.16									
Conditioning - 1	2	32		1000-g cell		0.46								
" - 2	1						0.003	0.023						
Copper rougher														
Stage 1	1													
" 2	1							0.006						
Conditioning	1					0.23								
Stage 3	1						0.0014							
" 4	1						0.0014	0.006						
" 5	1						0.0014							

PRODUCT	WT %	ANALYSIS %							DISTRIBUTION %				
		Cu	Insol						Cu	Insol			
Copper rougher conc	6.40	34.45	22.68						95.2				
Copper rougher tail	93.60	0.12							4.8				
Feed (calcd)	100.00	2.32							100.0				

REMARKS: Lower xanthate addition resulted in a lighter froth than was obtained in Test 7.

MINES BRANCH FLOTATION TEST REPORT

TEST NO. 9	SAMPLE: Marval Mines No. 1	DATE: Oct. 2, 1972
OBJECT OF TEST: Repeat of Test 8 at a 12 min grind, also cleaned rougher conc		CHARGE: 2x1729 g
		TESTED BY: A.S.

OPERATION	Time min	% Solids	pH	Unit used	Reagents, lb per ton	
					Lime	DF250
Grinding	12	50			1.16	
Copper rougher - as in Test 8						
Copper cleaners						
No. 1	2½		9.2	500-g cell		0.009*
No. 2	1½		8.6	250-g cell		0.006*

PRODUCT	WT %	ANALYSIS %		DISTRIBUTION %
		Cu	Insol	Cu
Copper conc	4.89	43.90	7.36	93.1
Copper cleaner tail No. 2	0.16	14.13	54.92	1.0
" " " No. 1	1.37	1.11	77.22	0.7
Copper rougher tailing	93.58	0.13		5.2
Feed (calcd)	100.00	2.31		100.0
1st stage copper cl conc	5.05	42.96	8.87	94.1
Copper rougher conc	6.42	34.03	23.45	94.8

REMARKS: Two batches ground and floated separately - rougher concentrates combined for cleaning.

* Stage fed

MINES BRANCH FLOTATION TEST REPORT

TEST NO. 10	SAMPLE: Marval Mines No. 2	DATE: Oct. 4, 1972
OBJECT OF TEST: Preliminary test on No. 2 sample without talc depressant		CHARGE: 2 x 1729 g
		TESTED BY: A.S.

OPERATION	Time min	% Solids	pH	Unit used	Reagents, lb per ton									
					Lime	Xan	DF 250							
Grinding	12	50		7 x 14 RM	1.16									
Conditioning	1	32	10.0	1000-g cell		0.003	0.023							
Copper rougher														
Stage 1	½													
" 2	1					0.003								
" 3	½						0.012							
" 4	1					0.003								
" 5	1					0.003								
" 6	1					0.003								
Copper cleaner	2			500-g cell			0.003							

PRODUCT	WT %	ANALYSIS %							DISTRIBUTION %				
		Cu	Insol						Cu				
Copper conc	4.36	46.49	5.04						97.4				
Copper cleaner tail	1.22	1.35	69.80						0.8				
Copper rougher tail	94.42	0.04							1.8				
Feed (calcd)	100.00	2.08							100.0				
Copper rougher conc	5.58	36.62	19.20						98.2				

REMARKS: Bright, clean froth obtained - no talc in evidence.
Two batches ground and floated separately - rougher concentrates combined for cleaning.

MINES BRANCH FLOTATION TEST REPORT

TEST NO. 11	SAMPLE: Marval Mines No. 2	DATE: Oct. 4, 1972
OBJECT OF TEST: To determine the effect of the addition of Depramin 75 on No. 2 sample		CHARGE: 2 x 1729 g
		TESTED BY: A.S.

OPERATION	Time min	% Solids	pH	Unit used	Reagents, lb per ton									
					Lime	Dep 75	Xan	DF 250						
Grinding	12	50		7 x 14 RM	1.16									
Conditioning - 1	2	32	10.0	1000-g cell		0.46								
Conditioning - 2	1						0.003	0.023						
Copper rougher														
Stage 1	1													
" 2	1							0.012						
Conditioning	1					0.23								
Copper rougher														
Stage 3	1						0.003							
" 4	1						0.003	0.006						
" 5	1						0.003							
Copper cleaner	2½			500-g cell				0.003						

PRODUCT	WT %	ANALYSIS %							DISTRIBUTION %					
		Cu	Insol						Cu					
Copper conc	4.14	48.11	3.20						97.2					
Copper cleaner tail	0.90	0.90	73.60						0.7					
Copper rougher tail	94.96	0.045							2.1					
Feed (calcd)	100.00	2.05							100.0					
Copper rougher conc	5.04	39.80	15.77						97.9					

REMARKS: No perceptible difference in appearance of froth over that obtained in Test 10. Two batches ground and floated separately - rougher concentrates combined for cleaning.