Bergvesenet

Postboks 3021, N-7441 Trondheim

Rapportarkivet

Bergvesenet rapport nr	Intern Journal nr	Internt arkiv nr	Rapport lokalisering	Gradering
7014				

Kommer fra ..arkiv	Ekstern rapport nr	Oversendt fra	Fortrolig pga	Fortrolig fra dato:
Kautokeino kobberfelter		Bidjovagge Gruber a.s.		

Tittel

Laboratory Report on the Testing of your Three Samples of Copper Ore, our lot nos.1636-1, 2 and 3.

Forfatter	Dato	År	Bedrift (Oppdragsgiver og/eller oppdragstaker)
Huch, R.o.	27.01	1966	Kautokeino kobberfelter A/S, NGU, utført av The Galligher Company

Kommune	Fylke	Bergdistrikt	1: 50 000 kartblad	1: 250 000 kartblad
Kautokeino	Finnmark		18334	Nordreisa

Fagområde	Dokument type	Forekomster (forekomst, gruvefelt, undersøkelsesfelt)
Oppredning		Bidjovagge

Råstoffgruppe	Råstofftype
Malm/metall	Cu

Sammendrag, innholdsfortegnelse eller innholdsbeskrivelse

Hensikten med testene var å sjekke tidligere utviklede testprosedyrer fra University of London og finne en bedre separering av kopper og grafitt i sample 1.
Forsøkene viser at det kan være mulig oppnå høyere bulksulfid-utvinning etter trykking av grafitt.
Det kan også se ut som det kan være formålstjenelig å behandle grafitt- og felsittmalm hver for seg.

Rapporten gir en del anbefalinger.
Rapporten er også vedlagt rapport fra et preliminært forsok, datert 02.09.1965.

GALIGHER

THE GALIGHER COMPANY

HOME OFFICE – 545-585 West 8th South – P. O. Box 209 – Salt Lake City, Utah 84110
EASTERN OFFICE: 921 Bergen Ave. (Room 922), Jersey City, N.J. 07306
U.S.A.

NORGES GEOLOGISKE UNDERSØKELSE
TRONDHEIM, NORWAY

LABORATORY REPORT ON THE TESTING OF
YOUR THREE SAMPLES OF COPPER ORE
OUR LOT NOS. 1636-1, 2 AND 3

January 27, 1966

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THE GALIGHER COMPANY

ESTABLISHED 1901

CABLE ADDRESS
GALSAL
TELEX 038-536

545-585 WEST EIGHTH SOUTH STREET
P. O. BOX 209
SALT LAKE CITY, UTAH, 84110
U. S. A.

TELEPHONE
359-8731
AREA CODE 801

January 27, 1966

Norges Geologiske Undersokelse
Leiv Eirikssons Vei 39
Postboks 3006
Trondheim, Norway

Attention: Mr. Karl Ingvaldsen
Administrative Director

LABORATORY REPORT ON THE TESTING OF
YOUR THREE SAMPLES OF COPPER ORE
OUR LOT NOS. 1636-1, 2 AND 3

Gentlemen:

In accordance with the arrangements made with you, we are pleased to submit our laboratory report concerning the testing of your three samples of copper ore. These samples were received at our laboratory on April 15, 1965 and were designated as our Lot Nos. 1636-1, 2 and 3.

I. SAMPLE PREPARATION AND ANALYSIS

The three samples were prepared, individually, by passing once through a laboratory jaw crusher to reduce the particle size to approximately minus 1/2 inch. A portion of each sample, which was to be used in the testing program, was then removed with a Jones-type splitter and further reduced to minus 20 mesh using a laboratory roll crusher in closed circuit with a vibrating screen. A head sample was cut out from each sample and was submitted to the Union Assay Office of this city for analysis. They reported the following:

Our Lot No.	Your Type No.	% Cu	% Oxide Cu
1636-1	1	1.843	0.113
1636-2	2	0.665	0.018
1636-3	3	3.401	0.110

It was observed that the copper mineral contained in these samples was chalcopyrite. Samples 1 and 2 had relatively high graphite contents

(no analyses were conducted to determine the amount) while Sample 3 had little or none.

II. INVESTIGATION OBJECTIVES

In accordance with our exchanges of correspondence, the objectives of this investigation were to consist of:

1. Check testing the previous testing procedures as developed by the University of London. A copy of their ore testing report was submitted to us.

2. Concentrating our developmental work on Sample No. 1 regarding effecting a more satisfactory separation of the copper and the graphite.

Our primary aim during the course of these tests was that of concentrating on copper metallurgy. No attempts were made to produce marketable graphite concentrates.

III. SUMMARY OF TEST RESULTS

Thirty-seven tests have been conducted in this investigation, the complete details of which may be found on the data sheets appended to this report. The results obtained in these tests are discussed as follows:

A. Lot No. 1636-1, Your Sample No. 1 (Graphitic Ore)

The majority of the test work conducted to date has been devoted to the study of this sample, thirty tests being conducted.

The University of London report stated that the best result they were able to obtain in treating this type of ore was a copper concentrate assaying 20.1% Cu at a recovery of 64% of the copper. The flowsheet used to obtain this result involved bulk flotation of the copper and the graphite, this bulk concentrate then being subjected to copper depression using a large quantity of sodium sulfide (13 pounds per ton), this being followed with graphite flotation. In view of the relatively poor results obtained with this method, and what we thought to be an unnecessarily complex flowsheet involving high reagent costs, we did not feel that further studies in this direction were warranted. Our work was directed, therefore, toward studying possibilities involving graphite depression--copper flotation, and graphite flotation followed with copper flotation. The results obtained in these tests are summarized as follows:

1. Various attempts were made to depress the graphite and float the copper using the SO_2-starch process for graphite depression. (See Test Nos. 21-24, 26-29). This reagent combination was quite effective for that purpose; however, we were unable to obtain a high recovery of the copper, the test results being quite negative from that point of view. There is the possibility that we can obtain a high bulk

sulfide recovery after graphite depression, such a bulk concentrate being subjected to a selective iron-copper separation. This is one possibility which we desire to pursue further.

2. The most favorable results obtained to date were those utilizing the flowsheet of graphite flotation followed with copper flotation. (See Test Nos. 1-20, 25, 30). Indicated loss of copper in the graphite concentrate is in the range of 4 to 5%, while the copper concentrate grade is indicated at about 20% copper with 81% recovery in open circuit testing. The flowsheet used and results obtained in test No. 11 are summarized as follows:

a) 1000 grams of sample were ground in a laboratory ball mill at 50% solids, the screen analysis of the ball mill discharge being as follows:

Mesh	+48	+65	+100	+150	+200	+325	-325
Wt.%	0.9	5.9	13.8	18.9	11.7	15.4	33.4

b) A carbon rougher concentrate was floated for eight minutes using 0.06 pound of MIBC (methyl isobutyl carbinol) per ton of ore at the start of flotation, and 0.03 pound stage additions after three and five minutes of flotation, the pH being 6.7.

c) The carbon rougher tailing was conditioned for ten minutes with 2.6 pounds of lime and 0.02 pound of NaCN, the pH being 11.0.

d) A copper rougher concentrate was floated for eight minutes using 0.1 pound Z-6 and 0.03 pound MIBC at the start of flotation, stage adding 0.05 pound of Z-6 and 0.03 pound MIBC after six minutes of flotation.

e) The carbon rougher concentrate was cleaned once for eight minutes using 0.03 pound of MIBC after six minutes of flotation.

f) The copper rougher concentrate was cleaned twice, each cleaner being preceded by two minutes' conditioning with 1.0 pound of lime (pH of 11.1) and 0.03 pound MIBC, flotation times being four minutes in the first and three minutes in the second cleaner.

The results obtained in test No. 11, Lot No. 1636-1, are summarized as follows:

Product	Wt. %	% Cu	Dist.
Carbon Cleaner Concentrate	22.4	0.346	4.1
Carbon Cleaner Tailing	1.6	2.10	1.8
Copper No. 2 Cleaner Concentrate	7.9	19.33	81.1
Copper No. 2 Cleaner Tailing	2.6	1.21	4.2
Copper No. 1 Cleaner Tailing	7.4	0.504	2.0
Copper Rougher Tailing	54.1	0.236	6.8
Head (Calc.)	100.0	1.883	100.0
Carbon Rougher Concentrate	24.0	0.462	5.9
Copper No. 1 Cleaner Concentrate	14.5	11.08	85.3
Copper Rougher Concentrate	21.9	7.51	87.3

The above results show that 10.9% of the copper is lost to the carbon cleaner concentrate and the copper rougher tailing, 81.1% of the copper reporting to the copper No. 2 cleaner concentrate. 8.0% of the copper is contained in the circulating load products (cleaner tailings).

3. Testing was conducted in which kerosene was added to the ball mill as a graphite collector. It was indicated that the graphite was much more positively activated and a larger weight percent of the mineral floated in the carbon float. However, copper losses were higher due to the larger weight floating (test No. 20, carbon cleaner concentrate, 46.6 weight percent assaying 0.390% copper carrying 9.7% of the copper).

4. Results to date are somewhat inconclusive regarding the optimum grind for carbon flotation. Grinding finer than the grind of test No. 11 (33.4% minus 325 mesh) did not reduce copper losses in the carbon concentrate, and it is felt that coarser grinding may be more ideal for graphite flotation.

5. The following reagents were tested in the graphite rougher flotation circuit, and no particular benefit was observed: lime, sodium cyanide and sodium silicate.

6. Testing to date has indicated that it may be rather difficult to produce copper concentrates containing more than 20% copper at a recovery of about 80%. One flowsheet which was very quickly checked, and which shows promise regarding higher copper recoveries and concentrate grades, consisted of the following (see test No. 14):

   a) graphite flotation;
   b) bulk sulfide flotation; and,
   c) treatment of the bulk sulfide concentrate with SO_2 (to a pH of about 3.0) for a selective separation of the copper and iron sulfides.

   By utilizing this approach, we obtained a copper rougher concentrate assaying 20% copper representing a recovery of 82.6%. Cleaning of this concentrate would be expected to improve concentrate grade, and further testing in this direction is indicated.

B. Lot No. 1636-2, Your Sample No. 2 (Graphitic Ore)

Three tests have been conducted with this low grade sample (0.665% Cu) and it was indicated that the problems encountered with this sample would be similar to those of sample 1636-1. Because of this, flowsheet development was limited to the testing of sample 1636-1.

Preliminary results showed that about 6 to 7% of the copper occurred in the graphite rougher concentrate and that the copper rougher concentrate assayed about 3 to 3.5% copper representing a recovery of 77% of the copper. No attempts, to date, have been made to upgrade the copper rougher concentrate.

C. Lot No. 1636-3, Your Sample No. 3 (Fels Ore)

Three tests have been conducted with this sample, and it was determined that a major portion of the copper contained therein was floatable with frother only (82.5% of the copper in a rougher concentrate assaying 23% Cu). The testing had also shown that the copper was not susceptible to sodium cyanide (0.5 pound per ton) depression.

The milling of this ore by itself should present no metallurgical or flowsheet complications because of the readily floating copper contained therein. It is understood, however, that these ores will be blended with the graphitic ores for milling and, from the results presented thus far, problems would be expected since it is indicated that the graphite must be floated prior to the copper. Frother is used to float the graphite and one would expect the copper contained in the fels ore to float with the graphite.

D. Lot No. 1636-2,3 Composite

To test the effect of mixing the fels and graphitic ores, a 1:1 composite of samples 1636-2 and 1636-3 was prepared, the head assay being approximately 2% copper. A single test was conducted with this composite in which sodium cyanide (0.5 pound per ton) was ground with the ore, frother being used for graphite flotation and Z-6, with lime and copper sulfate, for copper flotation. The following results were obtained:

Product	Wt. %	% Cu	% Dist.
Carbon Rougher Concentrate	26.8	0.418	5.4
Copper Rougher Concentrate	12.1	15.20	88.8
Copper Rougher Tailing	61.1	0.198	5.8
Head (Calculated)	100.0	2.07	100.0

The above results are quite similar to those presented for test No. 11, Lot No. 1636-1 regarding graphite flotation. It is indicated, therefore, that the presence of the graphite in the grinding circuit, with sodium cyanide, actually deactivates the copper contained in the fels ore, and that composites of the fels ore with the graphitic ores should respond to the flowsheet developed for the straight graphitic ores. It would certainly be desirable, however, to treat the two ore types separately if this is at all possible.

It was not established whether or not the cyanide used in the preceding test was necessary to result in copper deactivation, and further testing should be conducted to determine this. It would also be desirable to test different ratios of fels to graphitic ores throughout the range of compositing which you anticipate in your mining program.

IV. RECOMMENDATIONS

Based on the testing which has been conducted to date, we believe that

the following future studies should be pursued:

1. Determine the possibility of floating the graphite at coarser grinds and the effect of coarse grinds on copper losses in the graphite concentrate.

2. Study the possibility of recovering additional copper from the graphite concentrate. These studies would include either graphite depression and copper flotation (using SO_2 and starch) or copper depression and graphite flotation (using sodium sulfide or Nokes reagent).

3. Attempt to improve copper cleaner concentrate grades by utilizing additional selectivity assisting reagents in the copper cleaners, such as SO_2 or NaCN.

4. Study further the idea of bulk sulfide flotation following graphite flotation in attempts to improve both copper concentrate grade and recovery.

5. Attempt a bulk sulfide flotation in a circuit in which graphite depression is accomplished with SO_2 and starch.

6. Study the possibility of separate flotation of the sand and slime fractions after grinding.

7. Determine the effect of varying composites of the fels and graphitic ores. If you have some information as to how these ores will be composited, this would be of assistance concerning these studies.

We would estimate that $1,500 to $2,000 would be required to complete the above outlined studies, this to include both laboratory and assaying charges. In the event that you wish to have us proceed with this work, or any of the above phases, kindly provide us with your authorization. In the meantime, we will hold in abeyance further work on this project until we hear from you.

Sincerely yours,

THE GALIGHER COMPANY

R. O. Huch
Metallurgist

ROH/mc

cc: Nyhammars Bruk

METALLURGICAL RESEARCH DEPT.

CABLE "GALIGHER"

THE GALIGHER COMPANY

P. O. BOX 203 — 645-665 WEST 6TH SOUTH STREET
SALT LAKE CITY, UTAH 84110 — U.S.A.

TELEPHONE 359-6791

OUR LOT NO. 1636-1
DATE 6/25/65
BY JX

TEST NO. 1 NAME Norges Geologiske

PRODUCT	WEIGHT	ASSAY Cu	DISTRIBUTION Cu
C Ro Conc.	25.7	0.428	6.2
C Ro Tail	74.3	2.24	93.8
Head (Calc.)	100.0	1.77	100.0

LB. PER TON

OPERATION	BM	C-Ro	C-Ro	C-Ro
TIME	10	4	2	2
REAGENTS				
MIBC		0.06	0.03	0.03
MACHINE		1000		
R.P.M.		1100		
pH		6.8		
% SOLIDS	50	25		
TEMPERATURE				

GRINDING PRODUCT — Head

MESH	%	%
+10		
+14		
+20		
+28		
+35		
+48	0.9	
+65	5.9	
+100	13.8	
+150	18.9	
+200	11.7	
+325	15.4	
-325	33.4	

REMARKS: Slime carbon at beginning of Ro, coarse carbon and sulfides floating toward the end of rougher float.

METALLURGICAL RESEARCH DEPT. CABLE "GALIGHER"

THE GALIGHER COMPANY

P. O. BOX 719 — 245 RIO GRAND AND SOUTH STREET
SALT LAKE CITY, UTAH 84110 — U.S.A.

TELEPHONE 355-7261

OUR LOT NO. 1636-1
DATE 6/25/65
BY JK

TEST NO. 2 NAME Norges Geologiske

Same as Test No. 1 except NaCN in IM and Cu Ro float.

PRODUCT	WGHT	Assay Cu	Distribution Cu
C Ro Conc.	25.3	0.346	4.9
Cu Ro Conc.	11.6	12.26	79.9
Cu Ro Mill	63.3	0.428	15.2
Head (Calc.)	100.0	1.78	100.0

REAGENTS

OPERATION	IM	C-Ro	C-Ro	C-Ro	Conc	Cu Ro
TIME	10	4	2	2	2	6
NaCN	0.5					
MIBC		0.06	0.03	0.03		0.03
Xanx					2.0	
Z-6						0.1
CuSO4						1.0
LIME		1000				
NAM		1100				
pH		7.0			11.0	
% SOLIDS	50	25				
TEMPERATURE						
REMARKS						

SCREEN ANALYSIS

MESH	+	Product	Head
		%	%
+35			0.9
+48			
+65			
+100			
+150			
+200			
+270			
-270			33.4

METALLURGICAL RESEARCH DEPT.

CABLE "GALSAL"

THE GALIGHER COMPANY

P. O. BOX 728 — 245-265 WEST 6TH SOUTH STREET
SALT LAKE CITY, UTAH 84110 - U.S.A.

TELEPHONE 328-8751

OUR LOT NO. 1636-1
DATE 6/25/65
BY JX

TEST NO. 3 NAME Norges Geologiske

Same as Test No. 2 except with lime in BM.

PRODUCT	WEIGHT	ASSAY								DISTRIBUTION				
			Cu							Cu				
C Mo Conc.		22.3	0.491							6.0				
Cu Mo Conc.		11.5	13.18							83.5				
Cu Mo Tail		66.2	0.289							10.5				
Head (Calc.)		100.0	1.82							100.0				

REAGENTS												PRODUCT	
OPERATION	BM	C-Mo	C-Mo	C-Mo	Cond	Cond	Cu Mo	Cu Mo					
TIME	10	4	2	2	1	1	4	1/2				Head	
Lime	4.5										MESH	%	%
NaCN	0.5										-100		
MIBC		0.06	0.03	0.03		0.03					+100		
Z-6						0.05		0.05			-100		
CuSO4					1.0						+150		
											-150		
											+200	0.9	
											-200		
											+325		
											-325	33.4	
FINAL		1000											
R.P.M.		1100											
pH		11.3											
% SOLIDS	50												
TEMPERATURE													

REMARKS

Last 1/2 minute of Cu Mo float appears low grade.

METALLURGICAL RESEARCH DEPT.

CABLE "GALCO"

THE GALIGHER COMPANY
P. O. BOX 328 — 649-665 WEST 6th SOUTH STREET
SALT LAKE CITY, UTAH 84110 — U.S.A.

TELEPHONE 328-8781

OUR LOT NO. 1636-1
DATE 6/25/65
BY JX

TEST NO. 4 NAME Norges Geologiske

Same as Test No. 3 except finer grind.

PRODUCT	Weight	Percent Weight	ASSAY							DISTRIBUTION				
				Cu						Cu				
C Ro Conc.		29.0		0.466						7.1				
Cu Ro Conc.		11.2		14.41						85.1				
Cu Ro Tail		59.8		0.245						7.8				
Head (Calc.)		100.0		1.896						100.0				

OPERATION	BM	C-Ro	C-Ro	C-Ro	Cond	Cond	Cu Ro			GRIND IN	
TIME	20	3	3	2	1	1	5-1/2			PRODUCT	
										Head	
ZAero	4.5							MESH		%	%
NaCN	0.5							+10			
MIBC		0.06	0.03	0.03				+14			
Z-6						0.05		+20			
CuSO4					1.0			+28			
								+35			
								+48			
								+65		0.6	
								+100		4.6	
								+150		13.5	
MACHINE		1000						+200		13.4	
R.P.M.		1100						+325		21.6	
pH		11.0						-325		46.3	
% SOLIDS	50	25									
TEMPERATURE											

REMARKS:

METALLURGICAL RESEARCH DEPT.

CABLE "GALLAH"

THE GALLIHER COMPANY

P. O. BOX 208 — 548-558 WEST 2nd SOUTH STREET
SALT LAKE CITY, UTAH 84110 — U.S.A.

TELEPHONE 328-8731

OUR LOT NO. 1636-1
DATE 7/1/65
BY JX

TEST NO. 5 NAME Norges Geologiske

Same as Test No. 1 except -20 mesh rougher feed and with more frother.

PRODUCT	Weight	Percent Weight	ASSAY							DISTRIBUTION				
			Cu							Cu				
C Ro Conc.		8.8	0.551							2.7				
C Ro Tail		91.2	1.97*							97.3				
Head (Assay)		100.0	1.843							100.0				

* Calculated by difference

OPERATION	C Ro	C Ro	C Ro										
TIME	2	3	3										
REAGENTS	0.06	0.06	0.06										
GRINDING	1000												
R.P.M.	1100												
pH	6.2												
% SOLIDS	25												
TEMPERATURE													
REMARKS													

MESH	%	%
+48		
+65		
+100		
+150		
+200		
+270		
+325		
+400		
-400		

METALLURGICAL RESEARCH DEPT. CABLE "GALIGHER"

THE GALIGHER COMPANY
P.O. BOX 106 — 345-353 WEST 3rd SOUTH STREET
SALT LAKE CITY, UTAH 84110 — U.S.A.

TELEPHONE 328-4761

OUR LOT NO. 1636-1
DATE 7/2/65
BY JX

TEST NO. 6 NAME Norges Geologiske

C Ro same as Test No. 1 except clean C Ro conc. Cu Ro same as Test No. 2 except clean Cu Ro conc.

PRODUCT	Weight	Percent Weight	ASSAY Cu		DISTRIBUTION Cu		
C Cl Conc.		22.6	0.318		4.0		
C Cl Tail		2.1	1.12		1.3		
Cu Cl Conc.		13.2	10.60		70.6		
Cu Cl Tail		15.2	0.907	3.95	7.8	90.4	
Cu Scav Conc.		12.3	0.579		4.0		
Cu Scav Tail		34.6	0.220		4.3		
Head (Calc.)		100.0	1.76		100.0		
C Ro Conc.		24.7	0.388		5.3		
Cu Ro Conc.		28.4	5.42		86.4		
Cu Ro Tail		46.9	0.313		8.3		

OPERATION	BM	C-Ro	C-Ro	C-Ro	Cond	Cu Ro	Cu Scav	C-Cl	C-Cl	Cu Cl		SIEVE PRODUCT
TIME	10	3	2	3	5	6	1-2	6	2	2-3		Head
R.O.C		0.06	0.03	0.03		0.03	0.03		0.03		Mesh	%
Lime					2.6					1.0	+10	
Z-6						0.1	0.05				+14	
											+20	
											+28	
											+35	
											+48	0.9
											+65	
											+100	
MACHINE		1000						500		500	+150	
R.P.M.		1100						1100		1100	+325	
pH		6.9			11.4			6.8		11.6	-325	33.4
% SOLIDS	50	25										
CONCENTRATIONS												
REMARKS												

Cu Ro conc pulled to a good end point. Heavy mineralized froth upon stage addition of collector for the Cu Scav float. Cu Scav float nonselective, high weight.

METALLURGICAL RESEARCH DEPT.

CABLE "GALAL"

THE GALIGHER COMPANY

P. O. BOX 259 — 345-365 WEST 6TH SOUTH STREET
SALT LAKE CITY, UTAH 84110 — U.S.A.

TELEPHONE 328-4701

OUR LOT NO. 1636-1
DATE 7/2/65
BY JX

TEST NO. 7 NAME Normes Geologiske

Same as Test No. 6 except regrind C Ro tail before Cu flotation and no C cleaner float.

PRODUCT	Weight	Weight	ASSAY Cu								DISTRIBUTION Cu				
C Ro Conc.		25.6	0.418								5.9				
C Scav Conc.		7.9	0.453								2.0				
Cu Cl Conc.		14.0	10.80								83.6				
Cu Cl Tail		16.0	0.504	4.26							4.5	90.1			
Cu Scav Conc.		8.2	0.441								2.0				
Cu Scav Tail		28.3	0.132								2.0				
Head (Calc.)		100.0	1.81								100.0				
Comb. C Conc.		33.5	0.427								7.9				
C Ro Conc.		30.0	5.31								88.1				
Cu Ro Tail		36.5	0.20								4.0				

C Ro Tail

OPERATION	DM	C-Ro	C-Ro	C-Ro	Thick.	Regrind	C-Scav	Cu Ro	Cu Scav	Cu Cl		PRODUCT Head	PRODUCT Cu Ro Feed
TIME	10	3	2	3		10	3	6	1-2	2-3			
NaCN		0.05	0.03	0.03			0.03	0.03	0.03			%	%
Lime						4.0				1.0			
Z-6								0.1	0.05				
												0.9	
													0.2
													3.8
													13.4
GRIND		1000					1000			500			13.6
R.P.M.		1100					1100			1100			22.8
pH		6.9										33.4	46.2
% SOLIDS	50	25											
TEMPERATURE													
CHARGE													

METALLURGICAL RESEARCH DEPT. CABLE "GALBAL"

THE GALIGHER COMPANY

P. O. BOX 000 — 000-000 WEST 000 SOUTH STREET
SALT LAKE CITY, UTAH 84110 — U.S.A.

TELEPHONE 000-0000

OUR LOT NO. 1636-1
DATE 7/9/65
BY JX

TEST NO. 8 NAME Norges Geologiske

Same as Test No. 4 except finer grind, C and Cu cleaner floats and a Cu scav conc.

PRODUCT	Weight	Percent Weight	ASSAY								INTERMEDIATE				
			Cu								Cu				
C Cl Conc.		25.0	0.308								1.1				
C Cl Tail		3.3	1.72								3.1				
Cu Cl Conc.		5.4	24.49								71.0				
Cu Cl Tail		3.2	4.47	8.53							7.7	68.1			
Cu Scav Conc.		10.6	1.65								9.1				
Cu Scav Tail		52.5	0.170								4.7				
Head (Calc.)		100.0	1.86								100.0				
C Ro Conc.		28.3	0.473								4.2				
Cu Ro Conc.		8.6	17.03								78.7				
Cu Ro Tail		63.1	0.410								17.1				

OPERATION	BM	C-Ro	C-Ro	C-Ro	Cond	Cond	Cu Ro	Cu Scav	C-Cl	Cu Cl		SCREENING PRODUCT	
TIME	30	4	2	2	1	1	5-1/2	1-1	8	1-3			
												Head	
Lime	4.5									1.0	MESH	%	%
NaCN	0.5										+8		
MIBC		0.06	0.03	0.03					0.09*		+10		
Z-6						0.05		0.05	-		+20		
CuSO4					1.0						+35		
											+48		
											+65	0.1	
											+100	1.7	
											+150	7.4	
GRIND		1000							1000	500	+200	10.0	
R.P.M.		1100							1100	1100	+325	23.3	
pH		11.1							8.7	11.4	-325	57.5	
K SOLIDS	50	29											
TEMPERATURE													

REMARKS

Cu Scav conc nonselective, excessive Fe sulfides floating. Tight froth.

* Staged as needed.

METALLURGICAL RESEARCH DEPT. CABLE "GALGAL"

THE GALIGHER COMPANY

P. O. BOX 205 — 348-368 WEST 4th SOUTH STREET
SALT LAKE CITY, UTAH 84110 — U.S.A. TELEPHONE 359-0791

OUR LOT NO. 1636-1
DATE 7/9/65
BY JX

TEST NO. 9 NAME Norges Geologiske

Same as Test No. 8 except finer grind.

PRODUCT	Weight	Assay Cu	Distribution Cu		
C Cl Conc.	30.8	0.352	5.7		
C Cl Tail	4.1	2.06	4.4		
Cu Cl Conc.	7.9	17.37	72.2		
Cu Cl Tail	7.2	1.00 ~ 6.13	3.8 ~ 84.9		
Cu Scav Conc.	11.2	1.51	8.9		
Cu Scav Tail	38.8	0.239	5.0		
Head (Calc.)	100.0	1.898	100.0		
C Ro Conc.	34.9	0.55	10.1		
Cu Ro Conc.	15.1	9.56	76.0		
Cu Ro Tail	50.0	0.524	13.9		

REAGENTS	BM	C-Ro	C-Ro	C-Ro	Cond	Cond	Cu Ro	Cu Scav	C-Cl	Cu Cl		Grinding Product
LBS. PER TON												
OPERATION	BM	C-Ro	C-Ro	C-Ro	Cond	Cond	Cu Ro	Cu Scav	C-Cl	Cu Cl		
STEP	45	4	2	2	1	1	5-1/2	1-1	8	1-3		
Lime	4.5									1.0	MESH	Head %
NaSH	0.5										+10	
AERO		0.06	0.03	0.03					0.09*		+14	
Z-6						0.05		0.05	-		+20	
CuSO4					1.0						+28	
											+35	
											+48	
											+65	
											+100	0.2
											+150	2.0
MINUTES		1000							1000	500	+200	5.2
R.P.M.		1100							1100	1100	+325	19.4
pH		10.5							9.0	11.1	-325	73.2
% SOLIDS	50	25										
TEMPERATURE												
REMARKS												

* Staged as needed.

METALLURGICAL RESEARCH DEPT.

CABLE "GALIGHER"

THE GALIGHER COMPANY

P. O. BOX 1350 — 340-345 WEST 6th SOUTH STREET
SALT LAKE CITY, UTAH 84110 — U.S.A.

TELEPHONE

OUR LOT NO. 1636-1
DATE 7/21/65
BY JK

TEST NO. 10 NAME Norgos Geologists

Same as Test No. 6 except condition with lime and NaCN before Cu Ro flotation.

PRODUCT	Weight	Percent Weight	ASSAY								DISTRIBUTION				
			PRODUCTS NOT SAVED												

OPERATION	Pb	C-Ro	C-Ro	C-Ro	Cond	Cu Ro	Cu Ro	C Cl	C Cl	Cu Cl #1	Cu Cl #2	SCREEN	SCREENED PRODUCT	
TIME	10	3	2	3	10	6	3-2	6	2	2-3	2-			
													Head	
PbSO4		0.06	0.03	0.03		0.03	0.03		0.03			MESH	%	%
Lime					2.6					1.0	1.0	+48		
2-6						0.1	0.05					+65		
NaCN					0.1							+100		
												+150		
												+200		
												+270	0.2	
												-270		
												-400		
MACHINE		1000			1000							-400		
R.P.M.		1100			1100							+325		
pH		6.7			11.1							+400		
% SOLIDS	50											-400	33.4	
TEMPERATURE														
REMARKS														

Cu depressed by addition of NaCN.

METALLURGICAL RESEARCH DEPT. CABLE "GALREAL"

THE GALIGHER COMPANY

P. O. BOX 2290 — 241-253 WEST 4TH SOUTH STREET
SALT LAKE CITY, UTAH 84110 — U.S.A.

TELEPHONE 359-8791

OUR LOT NO. 1636-1
DATE 7/27/65
BY JX

TEST NO. 11 NAME Norges Geologiske

Same as Test No. 10 except less NaCN (0.02 pot)

PRODUCT	WEIGHT	DISTRIBUTION WEIGHT	ASSAY Cu	DISTRIBUTION Cu
C Cl Conc.		22.4	0.346	4.1
C Cl Tail		1.6	2.10	1.8
Cu Cl Conc #2		7.9	19.33	81.1
Cu Cl Tail #2		6.6	1.21	4.2
Cu Cl Tail #1		7.4	0.504	2.0
Cu Ro Tail		54.1	0.236	6.8
Head (Calc.)		100.0	1.883	100.0
C Ro Conc.		24.0	0.462	5.9
Cu Cl Conc #1		14.5	11.08	85.3
Cu Ro Conc.		21.9	7.51	87.3

OPERATION	BM	C Ro	C Ro	C Ro	Cond	Cu Ro	Cu Ro	C Cl	C Cl	Cu Cl #1	Cu Cl #2
TIME	10	3	2	3	10	6	2	6	2	2-4	2-3
LIME		0.06	0.03	0.03		0.03	0.03		0.03	0.03	0.03
Xan					2.6					1.0	1.0
Z-6						0.1	0.05				
NaCN					0.02						
MACHINE		1000						1000		500	500
MIN.		1100						1100		1100	1100
pH		6.7			11.0					11.2	11.1
% SOLIDS	50										
TEMPERATURE											
REMARKS											

DISTRIBUTION			
MESH	%		%
+48			
+65			
+100			
+150			
+200			
+270			
+325		Head	
+400			
-325		33.4	

The stage addition of Z-6 in the Cu Ro float caused a heavy mineralized froth. The end of the Cu Ro float and the Cu cleaner floats 1 and 2 were not floated to an end point.

METALLURGICAL RESEARCH DEPT.

CABLE
"GALGAL"

THE GALIGHER COMPANY
P. O. BOX 209 — 545-585 WEST 8TH SOUTH STREET
SALT LAKE CITY, UTAH 84110 – U.S.A.

TELEPHONE
355-8731

OUR LOT NO. 1636-1
DATE 7/28/65
BY JK

TEST NO. 12 NAME Norges Geologiske

Same as Test No. 11 except aeration conditioning prior to Cu Ro flotation.

PRODUCT	Weight	Percent Weight	ASSAY								DISTRIBUTION				
C Ro Conc.		25.0													
Cu Ro Conc #1		8.3													
Cu Ro Conc #2		13.4													
Cu Ro Tail		53.3													
Head		100.0													
Comb. Cu Ro Conc.		21.7													
					PRODUCTS NOT ASSAYED										

OPERATION	BM	C Ro	C Ro	C Ro	Cond	Cu Ro#1	Cu Ro#2
					REAGENTS PER TON		
TIME	10	3	2	3	15	6	2
MIBC		0.06	0.03	0.03		0.03	0.03
Lime					2.6		
Z-6					0.1		0.05
NaCN					0.02		
MACHINE		1000					
R.P.M.		1100					
pH		6.7			11.0-10.5		
% SOLIDS	50						
TEMPERATURE							

GRINDING PRODUCT

MESH	Head %	%
+10		
+14		
+20		
+28		
+35		
+48	0.9	
+65		
+100		
+150		
+200		
+325		
−325	33.4	

REMARKS:

Appeared to be coarse copper floating in the Cu Ro #2 float.

METALLURGICAL RESEARCH DEPT.

CABLE GALRAY

THE GALIGHER COMPANY
P. O. BOX 209 — 345-385 WEST 6TH SOUTH STREET
SALT LAKE CITY, UTAH 84110 — U.S.A.

TELEPHONE 532-6731

OUR LOT NO. 1636-1
DATE 7/28/65
BY JX

TEST NO. 13 NAME Norges Geologiske

Same as Test No. 11 except 20-minute grind.

PRODUCT	Weight	Dry Weight	ASSAY									DISTRIBUTION				
C Ro Conc #1		16.0														
C Ro Conc #2		13.4														
Cu Ro Conc #1		22.2														
Cu Ro Conc #2		15.6														
Cu Ro Tail		32.8														
Head		100.0														
C Ro Conc.		29.4				PRODUCTS NOT ASSAYED										
Comb. Cu Ro Conc.		37.8														

		LBS. PER TON								GRINDING PRODUCT		
	DH	C Ro #1	C Ro #1	C Ro #2	Cond	Cu Ro	Cu Ro	Cl #1	Cl #2			Head
	20	3	2	3	10	6	2	2-4	2-3	MESH	%	%
		0.06	0.03	0.03		0.03	0.03	0.03	0.03			
					2.6			1.0	1.0			
						0.1	0.05					
					0.02							
												5.2
		1000						500	500			
		1100						1100	1100			
		7.0										46.3
	50	25										

Too much pyrite floating in Cu Ro #2.

METALLURGICAL RESEARCH DEPT.

CABLE "GALIGHER"

THE GALIGHER COMPANY

P. O. BOX 875 — 245-255 WEST 5th SOUTH STREET
SALT LAKE CITY, UTAH 84110 — U.S.A.

TELEPHONE 355-8731

OUR LOT NO. 1636-1
DATE 7/29/65
BY JX

TEST NO. 1b NAME Norman Coolerisk

SO2 Cu-Fe separation

PRODUCT	Weight	Percent Weight	ASSAY Cu		DISTRIBUTION Cu	
C Ro Conc #1		19.2	0.300	0.438	4.1	7.9
C Ro Conc #2		13.9	0.501		3.8	
Sep Ro Conc - Cu		7.5	20.13		82.6	
Sep Ro Tail - Fe		33.7	0.381		7.0	
Bulk Cl Tail		4.5	0.315		0.8	
Bulk Ro Tail		21.2	0.148		1.7	
Head (Calc.)		100.0	1.83		100.0	
Bulk Cl Conc.		41.2	3.97		89.6	
Bulk Ro Conc.		45.7	3.61		90.4	

OPERATION	DM	C Ro #1	C Ro #1	C Ro #2	Bulk Ro	Bulk Ro	Bulk Ro	Bulk Cl	Sep Cond	Sep Cond	Sep Ro	GRINDING PRODUCT
TIME	20	3	2	3	5	2	1	10	5	5	4	
												Head
MIBC		0.06	0.03	0.03	0.06	0.03						WEIGHT %
Lime												+10
Z-6					0.1	0.05	0.05					+14
NaCN												+20
Aerofroth 65								0.1			0.05	+28
SO2									4.5	4.5		+35
												+48
												+65
												+100 5.2
												+150
SULFIDE		1000						1000	500			+200
R.P.M.		1100						1100	1100			+325
pH		7.0						7.3	2.9-4.5	2.7-3.0		-325 46.3
% SOLIDS	50											
TEMPERATURE												

REMARKS

No frothing action with MIBC on bulk Cl float.

METALLURGICAL RESEARCH DEPT.

CABLE "GALIHAL"

THE GALIGHER COMPANY

P. O. BOX 205 — 343-363 WEST 6TH SOUTH STREET
SALT LAKE CITY, UTAH 84110 — U.S.A.

TELEPHONE

OUR LOT NO. 1636-1
DATE 7/30/65
BY JX

TEST NO. 15-1 NAME Norges Geologiske

Same as Test No. 14 except regrind prior to separation

PRODUCT	Weight	Percent Weight	ASSAY Cu	DISTRIBUTION Cu
Sep Cl Conc - Cu		7.3	19.12	75.7
Sep Cl Tail - Fe		3.1	0.595	1.0
Sep Ro Tail - Fe		10.1	0.179	1.0
Regrind C Ro Conc.		13.4	1.51	11.0
C Ro Conc.		35.6	}	}
Bulk Cl Tail		9.8	} 0.316*	} 11.3
Bulk Ro Tail		20.7	}	}
Head (Assay)		100.0	1.843	100.0

* Calculated by difference

OPERATION		BM	C-Ro	C-Ro	C-Ro	Bulk Ro	Bulk Ro	Bulk Ro	Bulk Conc Regr.	C-Ro	Bulk Cleaner	Bulk Cleaner		GRAMS PER PRODUCT
TIME		20	3	2	3	5	2	1	20	1-1/2	3	2		Head
XXXC			0.06	0.03	0.03	0.06	0.03			0.03	0.03		MESH	% %
Lime													+10	
Z-6						0.1	0.05	0.05			0.1	0.05	+14	
													+20	
													+28	
													+35	
													+48	
													+65	
													+100	5.2
													+150	
AMOUNTS			1000							1000	500		+200	
TOTAL			1100							1100	1100		+325	
pH			7.2							8.0			-325	46.3
% SOLIDS		50												
TEMPERATURE														
REMARKS														

METALLURGICAL RESEARCH DEPT.

CABLE
"GALGAL"

THE GALIGHER COMPANY

P. O. BOX 209 — 545-555 WEST 2ND SOUTH STREET
SALT LAKE CITY, UTAH 84110 — U.S.A.

TELEPHONE
359-8731

OUR LOT NO. 1636-1
DATE 7/30/65
BY JX

TEST NO. 15-2

NAME Norges Geologiske

PRODUCT	Weight	Percent Weight	ASSAY								DISTRIBUTION				

				LBS. PER TON
	Sep	Sep	Sep	
OPERATION	Cond	Ro	Cl	
TIME	10	7	5	
SO2	9.0			
MIBC			0.03	
MACHINE	500		500	
R.P.M.	1100		1100	
pH	2.4-2.7			
% SOLIDS				
TEMPERATURE				

GRINDING PRODUCT		
MESH	%	%
+10		
+14		
+20		
+28		
+35		
+48		
+65		
+100		
+150		
+200		
+325		
−325		

REMARKS:

METALLURGICAL RESEARCH DEPT.

CABLE "GALBAL"

THE GALIGHER COMPANY
P. O. BOX 209 — 345-365 WEST 6TH SOUTH STREET
SALT LAKE CITY, UTAH 84110 — U.S.A.

TELEPHONE 328-8721

OUR LOT NO. 1636-1
DATE 8/6/65
BY JX

TEST NO. 16 NAME Norges Geologiske

Same as Test No. 4 except C and Cu Ro conc's cleaned.

PRODUCT	Weight	Percent Weight	ASSAY Cu	DISTRIBUTION Cu
C Cl Conc.		18.4	0.324	3.2
C Cl Tail		5.7	1.03	3.1
Cu Cl Conc.		6.5	19.86	68.2
Cu Cl Tail		3.4	1.67	3.0
Cu Ro Conc #2		7.8	3.55	14.6
Cu Ro Tail		58.2	0.255	7.9
Head (Calc.)		100.0	1.89	100.0
C Ro Conc.		24.1	0.494	6.3
Cu Ro Conc.		9.9	13.6	71.2

		LBS. PER TON					Cu	Cu				ORIENTING PRODUCT
OPERATION	BM	C-Ro	C-Ro	C-Ro	Cond	Cond	Ro #1	Ro #2	C-Cl	C-Cl	Cu Cl	
TIME	20	3	3	2	1	1	5-1/2	2	2	3	5	Head
Lime	4.5											MESH % %
NaCN	0.5											+10
NaSC		0.06	0.03	0.03		0.03				0.03	0.03	+14
Z-6						0.05		0.05				+20
Cu(OH)					1.0							+28
												+35
												+42
												+48
												+100 5.2
												+150
GRINDING		1000							1000			+200
R.P.M.		1100							1100			+325
pH		10.8										-325 46.3
% SOLIDS	50	25										
TEMPERATURE												

REMARKS: Tight froth condition at the beginning of the Cu Cl float.

METALLURGICAL RESEARCH DEPT.

CABLE "GALGAL"

THE GALIGHER COMPANY

P. O. BOX 209 — 545-555 WEST 5TH SOUTH STREET
SALT LAKE CITY, UTAH 84110 — U.S.A.

TELEPHONE [illegible]

OUR LOT NO. 1636-1
DATE 8/6/65
BY JX

TEST NO. 17

NAME Norges Geologiske

Same as Test No. 16 except no CuSO4 and more collector for the Cu Ro float.

PRODUCT	Weight	Percent Weight	ASSAY								DISTRIBUTION				
					PRODUCTS NOT SAVED										

	LBS. PER TON					
OPERATION	BM	C-Ro	C-Ro	C-Ro	Cond	Cu Ro
TIME	20	3	3	2	1	5-1/2
Lime	4.5					
NaCN	0.5					
MIBC		0.06	0.03	0.03	0.03	
Z-6					0.1	
MACHINE						
R.P.M.						
pH						
% SOLIDS						
TEMPERATURE						

GRINDING PRODUCT		
	Head	
MESH	%	%
+10		
+14		
+20		
+28		
+35		
+48		
+65		
+100	5.2	
+150		
+200		
+325		
-325	46.3	

REMARKS: Cu Ro float nonselective.

METALLURGICAL RESEARCH DEPT.

CABLE "GALBAL"

THE GALIGHER COMPANY

P. O. BOX 209 — 849-869 WEST 6TH SOUTH STREET
SALT LAKE CITY, UTAH 84110 — U.S.A.

TELEPHONE 359-8781

OUR LOT NO. 1636-1
DATE 8/9/65
BY JX

TEST NO. 18 NAME Norges Geologiske

Same as Test No. 13 except with Z-200.

PRODUCT	Weight	Percent Weight	ASSAY									DISTRIBUTION				
C Ro Conc.		31.6														
Cu Cl Conc #2		12.8														
Cu Cl Tail #2		7.4														
Cu Cl Tail #1		7.2														
Cu Ro Tails		41.0														
Head		100.0														
			PRODUCTS NOT ASSAYED													

OPERATION	BM	C-Ro	C-Ro	C-Ro	Cond	Cu Ro	Cu Ro	Cu Cl #1	Cu Cl #2			
TIME	20	3	2	3	10	1-6	3	5	4			Head
MIBC		0.06	0.03	0.03		0.03				MESH	%	%
Lime					2.6				1.0	+10		
Z-200						0.1	0.04			+14		
NaCN					0.02					+20		
										+28		
										+35		
										+48		
										+65		
										+100	5.2	
										+150		
MACHINE		1000						1000	500	+200		
R.P.M.		1100						1100	1100	+325		
pH		7.3			10.9			7.6	10.8	−325	46.3	
% SOLIDS	50	25										
TEMPERATURE												

REMARKS:

No weight drop in the Cu Cl tail #1. The Cu Ro conc appeared selective as far as Fe sulfides were concerned, but seemed to float excessive C that didn't drop out in the cleaner floats. More weight dropped out in the #2 Cl float.

METALLURGICAL RESEARCH DEPT.

CABLE "GALIGHER"

THE GALIGHER COMPANY
P. O. BOX 209 — 545-585 WEST 8TH SOUTH STREET
SALT LAKE CITY, UTAH 84110 — U.S.A.

TELEPHONE [illegible]

OUR LOT NO. 1636-1
DATE 8/9/65
BY JX

TEST NO. 19 NAME Norges Geologiske

Same as Test No. 16 except aeration conditioning.

PRODUCT	Weight	Percent Weight	ASSAY	DISTRIBUTION
			PRODUCTS NOT SAVED	

LB. PER TON

OPERATION	BM	C-Ro	C-Ro	C-Ro	Cond	Cu Ro	Cu Ro	Cu Cl
TIME	20	3	3	2	15	5	2	5
Lime	4.5							
NaOH	0.5							
MIBC		0.06	0.03	0.02		0.03		
Z-6					0.05			
CuSO4					1.0			
Z-200							0.08	
MACHINE		1000						500
R.P.M.		1100						1100
pH		10.5						11.6
% SOLIDS	50	25						
TEMPERATURE								

SCREEN ANALYSIS

PRODUCT	Head	
MESH	%	%
+10		
+14		
+20		
+28		
+35		
+48		
+65		
+100	5.2	
+150		
+200		
+325		
−325	46.3	

REMARKS: Extremely tight froth through the entire Cu Ro float. Cu Ro float was not pulled to an end point. Selective rougher and cleaner float, but impossible froth condition.

METALLURGICAL RESEARCH DEPT.

CABLE "GALSAL"

THE GALIGHER COMPANY

P. O. BOX 209 — 349-359 WEST 8th SOUTH STREET
SALT LAKE CITY, UTAH 84110 — U.S.A.

TELEPHONE 328-8731

OUR LOT NO. 1636-1
DATE 8/10/65
BY ROH

TEST NO. 20 NAME Norges Geologiske

Same as Test 18 except kerosene added to BM.

PRODUCT	Weight	Percent Weight	ASSAY Cu	DISTRIBUTION Cu
C Cl Conc.		46.6	0.390	9.7
C Cl Tail		6.8	2.49	9.0
Cu Ro Conc #1		3.7	10.55	20.7
Cu Ro Conc #2		4.0	25.50	54.3
Cu Ro Tail		38.9	0.302	6.3
Head (Calc.)		100.0	1.88	100.0
C Ro Conc.		53.4	0.657	18.7
Comb. Cu Conc.		7.7	18.3	75.0

Cu Ro #1 + #2 Cu

OPERATION	BM	C-Ro	C-Ro	Cond	Ro #1	Ro #2	C-Cl	C-Cl
TIME	20	3	4	10	5	1-4	3	2
Kerosene	0.20							
MIBC		0.06	0.06					0.03
Lime				2.6				
Z-200				0.04		0.04		
R404				0.02				
MACHINE		1000					1000	
R.P.M.		1100					1100	
pH		7.2		11.0				
% SOLIDS	50	25						
OBSERVATIONS								
REMARKS								

CUMULATIVE PRODUCT

MESH	Head %	%
+10		
+14		
+20		
+28		
+35		
+48		
+65		
+100	5.2	
+150		
+200		
+325		
−325	46.3	

METALLURGICAL RESEARCH DEPT. CABLE "GALSAL"

THE GALIGHER COMPANY
P. O. BOX 300 — 348-355 WEST 6th SOUTH STREET
SALT LAKE CITY, UTAH 84110 — U.S.A.

TELEPHONE 355-4231

OUR LOT NO. 1636-1
DATE 8/10/65
BY ROH

TEST NO. 21 NAME: Norges Geologiske

Carbon depression with SO2 - starch.

PRODUCT	Weight	Percent Weight	ASSAY Cu	DISTRIBUTION Cu
Cu Cl Conc.		5.6	14.95	44.2
Cu Cl Tail		4.3	3.22	7.3
Cu Ro Tail		90.1	1.02	48.5
Head		100.0	1.89	100.0
Cu Ro Conc.		9.9	9.85	51.5
Cu Ro Tail - Sand		49.9	1.12	61.2
Cu Ro Tail - Slime		40.2	0.883	38.8
Cu Ro Tail (Calc.)		90.1	1.01	100.0

LBS. PER TON

OPERATION	BM	Cond	Cu Ro	Ro	Cu Cl	Cu Cl
TIME	20	1	2	2	2	2
SO2		4.5				
Caustic Starch		0.5		0.25	0.05	
Z-6			0.1	0.1		0.02
MIBC			0.06	0.03	0.03	0.03
WATER		1000			1000	
TOTAL		1100			1100	
pH		5.7	5.4		5.9	
% SOLIDS	50	25				
TEMPERATURE						
REMARKS						

GRINDING PRODUCT

MESH	Head %	%
+14		
+28		
+35		
+48		
+65		
+100		
+150		5.2
+200		
+270		
+325		
-325		46.3

Carbon depression looked good. Possibly high pyrite floating on stage addition of Z-6 in rougher.

METALLURGICAL RESEARCH DEPT. CABLE "GALBAL"

THE GALIGHER COMPANY
P. O. BOX 209 — 838-885 WEST 8TH SOUTH STREET
SALT LAKE CITY, UTAH 84110 — U.S.A.

TELEPHONE

OUR LOT NO. 1636-1
DATE 8/11/65
BY ROH

TEST NO. 22 NAME Norges Geologiske

Same as Test 21 except finer grind.

PRODUCT	Weight	Percent Weight	ASSAY Cu	DISTRIBUTION Cu
Cu #2 Cl Conc.		2.6	23.04	29.0
Cu #2 Cl Tail		0.9	7.24	3.1
Cu #1 Cl Tail		6.5	2.30	7.3
C Ro Conc.		43.8	1.54	32.5
Fe Ro Conc.		25.3	2.18	26.7
Fe Ro Tail		20.9	0.132	1.4
Head (Calc.)		100.0	2.07	100.0
Cu #1 Cl Conc.		3.5	19.0	32.1
Cu Ro Conc.		10.0	8.14	39.4
Cu Ro Tail		90.0	1.395	60.6

OPERATION	BM	Cond	Cu Ro	Ro	Cond	C Ro	Ro	Cond	Fe Ro	Ro
	40	1	2	2	1	4	3	1	3	3
		4.5								
Caustic Starch		0.5		0.25						
4-6			0.1	0.1					0.3	0.1
MIBC			0.06	0.03					0.03	
Kerosene					0.2					
Frother 65							0.05			0.05
CuSO4								1.0		
MACHINE		1000								
G.M.		1100								
pH		5.9	5.4				6.7			
REAGENTS	50	25								
TEMPERATURE										
REMARKS										

MESH	Head %	
+48		
+65		
+100		
+150		
+200	2.6	
+270	5.6	
+325	18.2	
-325	73.6	

Attempt at cleaning of carbon rougher concentrate negative in that very little of the sulfides were rejected.

METALLURGICAL RESEARCH DEPT.

CABLE "GALBAL"

THE GALIGHER COMPANY
P. O. BOX 209 — 545-565 WEST 5TH SOUTH STREET
SALT LAKE CITY, UTAH 84110 — U.S.A.

TELEPHONE 355-8731

OUR LOT NO. 1636-1
DATE 8/11/65
BY ROH

TEST NO. 22 (cont'd.) NAME Norgee Geologiske

PRODUCT	Weight	Percent Weight	ASSAY									DISTRIBUTION				
				Cu												
Fe Ro Conc:																
+325 Mesh		26.1		2.53	2.14											
-325 Mesh		73.9		2.00												
Fe Ro Tail:																
+325 Mesh		27.3		0.075	0.131											
-325 Mesh		72.7		0.151												

OPERATION	Cu Cl #1	Cl	Cu Cl #2	LBS. PER TON								GRINDING PRODUCT	
TIME	1	2	2										
SO2	1.8										MESH	%	%
Caustic Starch	0.05										+10		
NaCN	0.03		0.03								+14		
Z-6		0.02									+20		
											+28		
											+35		
											+48		
											+65		
											+100		
											+150		
MACHINE	1000		500								+200		
R.P.M.	1100		1100								+325		
pH	4.5		7.0								-325		
% SOLIDS													
TEMPERATURE													

REMARKS:

METALLURGICAL RESEARCH DEPT. CABLE "GALHAL"

THE GALIGHER COMPANY
P. O. BOX 109 — 848-865 WEST 8TH SOUTH STREET
SALT LAKE CITY, UTAH 84110 — U.S.A.

TELEPHONE 359-8781

OUR LOT NO. 1636-1
DATE 8/13/65
BY JX

TEST NO. 23 NAME Norges Geologiske

Same as Test No. 21 except higher SO2 and longer conditioning time for SO2 and starch.

PRODUCT	Weight	Percent Weight	ASSAY										DISTRIBUTION				
						PRODUCTS NOT SAVED											

OPERATION	BM	Cond	Cu Ro	Cu Ro	LBS PER TON									GRINDING PRODUCT	
pH	20	5	1-2	2											
														Head	
SO2		36											MESH	%	%
Caustic Starch		0.5		0.25									+10		
Z-6		0.1		0.1									+14		
MIBC			0.06	0.03									+20		
Z-200			0.04										+28		
													+35		
													+48		
													+65		
													+100	5.2	
													+150		
AGITATING		1000											+200		
R.P.M.		1100											+325		
pH		4.3-4.6											-325	46.3	
% SOLIDS	50	25													
TEMPERATURE															

REMARKS:

Cu sulfides completely depressed.

METALLURGICAL RESEARCH DEPT.

CABLE "GALSAL"

THE GALIGHER COMPANY

P. O. BOX 209 — 545-565 WEST 6TH SOUTH STREET
SALT LAKE CITY, UTAH 84110 — U.S.A.

TELEPHONE 359-5781

OUR LOT NO. 1636-1
DATE 8/13/65
BY JX

TEST NO. 24 NAME Norges Geologiske

Same as Test No. 21 except with less starch and longer rougher float.

PRODUCT	Weight	Percent Weight	ASSAY Cu	DISTRIBUTION Cu
Cu Cl Conc.		13.3	5.16	63.6
Cu Cl Tail		9.4		
Cu Ro Tail		77.3	0.870	36.4
Head (Assay)		100.0	1.843	100.0

OPERATION	BM	Cond	Cu Ro	Ro	Ro	Cu Cl
TIME	20	1	2	2	2	2
SO2		4.5				0.9
Caustic Starch		0.25				0.025
Z-6			0.1	0.1	0.1	
MIBC			0.06	0.03	0.3	0.03
MACHINE		1000				1000
R.P.M.		1100				1100
pH		5.8				
% SOLIDS	50	25				
TEMPERATURE						

LBS. PER TON

GRINDING PRODUCT

MESH	Head %	%
+10		
+14		
+20		
+28		
+35		
+48		
+65		
+100	5.2	
+150		
+200		
+325		
−325	46.3	

REMARKS: Too much weight in the cleaner concentrate.

METALLURGICAL RESEARCH DEPT. CABLE "GALSAL"

THE GALIGHER COMPANY
P. O. BOX 208 — 348-368 WEST 6TH SOUTH STREET
SALT LAKE CITY, UTAH 84110 — U.S.A.

TELEPHONE 328-8751

OUR LOT NO. 1636-1
DATE 8/17/65
BY ROH

TEST NO. 25 NAME Norges Geologiske

Same as Test 20 except sodium silicate added to BM - Z-6 for Cu collector.

PRODUCT	Weight	Product Weight	ASSAY Cu	DISTRIBUTION Cu
C Cl Conc.		49.3	0.340	9.2
C Cl Tail		4.2	3.07	7.0
Cu Cl Conc.		6.8	19.55	72.6
Cu Cl Tail		7.0	1.89	7.2
Cu Ro Tail		32.7	0.226	4.0
Head		100.0	1.833	100.0
C Ro Conc.		53.5	0.555	16.2
Cu Ro Conc.		13.8	10.0	79.8

OPERATION	BM	C-Ro	C-Ro	Cond	Cu Ro	Cu Cl
TIME	20	3	3	10	3	5-3
Aerofloat	0.20					
Na2SiO3	5.0					
MIBC		0.06	0.06			
Lime				2.6		2.0
Z-6				0.02		
NaCN				0.02		
MACHINE		1000				500
R.P.M.		1100				1100
pH				10.4		11.2
% SOLIDS	50	25				
TEMPERATURE						
REMARKS						

REAGENTION

GRINDING

MESH	PRODUCT Head %	%
+10		
+14		
+20		
+30		
+35		
+48		
+65		
+100	5.2	
+150		
+200		
+325		
−325	46.3	

Cu conc looked high in pyrite.

METALLURGICAL RESEARCH DEPT.

CABLE "GALGAL"

THE GALIGHER COMPANY

P. O. BOX 209 — 545-585 WEST 6TH SOUTH STREET
SALT LAKE CITY, UTAH 84110 — U.S.A.

TELEPHONE 359-5731

OUR LOT NO. 1636-1
DATE 8/19/65
BY JK

TEST NO. 26 NAME Norges Geologiske

Same as Test No. 21 except thiocarbanolide in BM.

PRODUCT	Weight	Percent Weight	ASSAY Cu	DISTRIBUTION Cu
Cu Cl Conc.		3.0	13.1*	47.6
Cu Cl Tail		3.7		
Cu Ro Tail		93.3	1.036	52.4
Head (Assay)		100.0	1.843	100.0

* Calculated by difference

OPERATION	BM	Cond	Cu Ro	Ro	Cu Cl	Cu Cl
TIME	20	1	2	2	1/2	2-1/2
Thiocarbanolide	0.1					
SO2		4.5				
Caustic Starch		0.5		0.25	0.05	
Z-6			0.1	0.1		0.02
MIBC			0.06	0.03	0.03	0.03
MACHINE		1000			1000	
R.P.M.		1100			1100	
pH		6.0				
% SOLIDS	50	25				
TEMPERATURE						

LBS. PER TON

GRINDING PRODUCT

MESH	Head %	%
+10		
+14		
+20		
+28		
+35		
+48		
+65		
+100	5.2	
+150		
+200		
+325		
-325	46.3	

REMARKS:

Carbon depression good.

METALLURGICAL RESEARCH DEPT.

CABLE "GALSAL"

THE GALIGHER COMPANY

P. O. BOX 20[illegible] — 345-365 WEST 8TH SOUTH STREET
SALT LAKE CITY, UTAH 84110 — U.S.A.

TELEPHONE 3[illegible]-[illegible]

OUR LOT NO. 1636-1
DATE 8/19/65
BY JX

TEST NO. 27 NAME Norges Geologiske

Same as Test No. 26 except Minerec in BM in place of thiocarbanolide.

PRODUCT	Weight	Percent Weight	ASSAY Cu	DISTRIBUTION Cu
Cu Cl Conc.		5.0	10.5*	45.0
Cu Cl Tail		2.9		
Cu Ro Tail		92.1	1.100	55.0
Head (Assay)		100.0	1.043	100.0

* Calculated by difference

LBS. PER TON

OPERATION	BM	Cond	Cu Ro	Ro	Cu Cl
TIME	20	1	2	2	4
Minerec B	0.08				
SO2		4.5			
Caustic Starch		0.5		0.25	0.05
Z-6			0.1	0.1	0.02
NaCNC			0.06	0.03	0.03
MACHINE		1000			500
FINAL		1100			1100
pH		6.0			6.1
% SOLIDS	50	25			
TEMPERATURE					
REMARKS					

GRINDING PRODUCT

MESH	Head %	%
+10		
+14		
+20		
+28		
+35		
+48		
+65		
+100	5.2	
+150		
+200		
+325		
−325	46.3	

METALLURGICAL RESEARCH DEPT.

CABLE "GALSAL"

THE GALIGHER COMPANY
P. O. BOX 209 — 345-385 WEST 8TH SOUTH STREET
SALT LAKE CITY, UTAH 84110 — U.S.A.

TELEPHONE 328-8731

OUR LOT NO. 1636-1
DATE 8/19/65
BY JX

TEST NO. 28 NAME Norges Geologiske

Same as Test No. 27 except Z-6 in BM in place of Mincrec.

PRODUCT	Weight	Report Weight	ASSAY Cu	DISTRIBUTION Cu
Cu Cl Conc.		7.4	10.85*	58.3
Cu Cl Tail		2.5		
Cu Ro Tail		90.1	0.853	41.7
Head (Assay)		100.0	1.843	100.0

* Calculated by difference

LBS. PER TON

OPERATION	BM	Cond	Cu Ro	Ro		Cu Cl
TIME	20	1	2	2		4
SO2		4.5				
Caustic Starch		0.5		0.25		0.05
Z-6	0.2		0.1	0.1		0.02
HIBC			0.06	0.03		0.03
MACHINE		1000				500
R.P.M.		1100				1100
pH		6.0				6.1
% SOLIDS	50	25				
TEMPERATURE						

REMARKS:

GRINDING PRODUCT

	Head	
mesh	%	
+10		
+14		
+20		
+28		
+35		
+48		
+65		
+100	5.2	
+150		
+200		
+325		
−325	46.3	

METALLURGICAL RESEARCH DEPT.

CABLE "CALSAL"

THE GALIGHER COMPANY
P. O. BOX 209 — 648-656 WEST 6TH SOUTH STREET
SALT LAKE CITY, UTAH 84110 – U.S.A.

TELEPHONE 359-8791

OUR LOT NO. 1636-J
DATE 8/19/65
BY JX

TEST NO. 29 NAME Norges Geologiske

Same as Test No. 28 except lime in the BM and no SO2.

PRODUCT	Weight	Percent Weight	ASSAY									DISTRIBUTION				
			PRODUCTS NOT SAVED													

OPERATION	BM	Cond	Cu Ro	Cu Ro		Cu Cl						GRINDING PRODUCT		
TIME	20	1	2	2		4								
												Head		
Lime	5.0											MESH	%	%
S-6	0.2		0.1	0.1		0.02						-+10		
Caustic Starch		0.5		0.25		0.05						-+14		
MIBC			0.06	0.03		0.03						-+20		
												-+28		
												-+35		
												-+48		
												-+65		
												-+100	5.2	
												-+150		
SECONDS		1000				500						-+200		
R.P.M.		1100				1100						-+325		
pH		11.0										-325	46.3	
% SOLIDS	50	25												
TEMPERATURE														
REMARKS:														

Carbon did not depress.

METALLURGICAL RESEARCH DEPT. CABLE "GALSAL"

THE GALIGHER COMPANY
P. O. BOX 209 — 345 825 WEST 8TH SOUTH STREET
SALT LAKE CITY, UTAH 84110 — U.S.A.

TELEPHONE 363-5731

OUR LOT NO. 1636-1
DATE 8/19/65
BY JX

TEST NO. 30 NAME Norges Geologiske

Same as Test No. 11 except sodium silicate in BM. Less Z-6 and conditioned with lime.

PRODUCT	Weight	Assay Cu	Distribution Cu
C - Cl Conc.	23.9	0.321	4.2
C - Cl Tail.	1.8	2.20	2.2
Cu Cl Conc #2	5.7	20.73	64.1
Cu Cl Tail #2	1.5		
Cu Cl Tail #1	2.3		
Cu Ro Conc #2	13.7		
Cu Ro Tail	51.1		
Head (Assay)	100.0	1.843	
C - Ro Conc.	25.7	0.455	6.4

OPERATION	BM	C-Ro	C-Ro	C-Ro	Cond	Cu Ro	Cu Ro	C-Cl	Cu Cl #1	Cu Cl #2	Grind	Recycle
TIME	10	3	2	3	10	3-6	2	6	2-4	2-3	Head	
NaSC		0.06	0.03	0.03		0.03	0.03	0.06*	0.03	0.03	Mesh %	%
Lime					2.6				1.0	1.0	+10	
Z-6					0.05	0.05	0.05				+14	
NaCN					0.02						+20	
Sod. Silicate	5.0										+28	
											+35	
											+48	0.9
											+65	
											+100	
											+150	
MACHINE		1000						1000	500	500	+200	
R.P.M.		1100						1100			+270	
pH		7.1			11.2-11.0				11.2	11.0	-270	33.4
% SOLIDS	50	25										
TEMPERATURE												

REMARKS:

There was no activation of Cu minerals after the lime conditioner. Additional collector was needed.

* Staged as needed.

METALLURGICAL RESEARCH DEPT.

CABLE "GALIHAL"

THE GALIGHER COMPANY

P. O. BOX 209 — 545-555 WEST 6th SOUTH STREET
SALT LAKE CITY, UTAH 84110 — U.S.A.

TELEPHONE 363-8751

OUR LOT NO. 1636-2
DATE 6/28/65
BY JX

TEST NO. 1 NAME Norges Geologiske

PRODUCT	Weight	Percent Weight	ASSAY Cu	DISTRIBUTION Cu
C - Ro Conc.		27.8	0.198	8.8
C - Ro Tail		72.2	0.793	91.2
Head (Calc.)		100.0	0.63	100.0

		LBS. PER TON			GRINDING PRODUCT	
OPERATION	BM	C-Ro	C-Ro	C-Ro		
TIME	10	4	2	2		
REAG		0.06	0.03	0.03	MESH	Head %
					+10	
					+14	
					+28	
					+48	
					+65	
					+48	2.4
					+65	10.1
					+100	17.5
					+150	17.8
SULFIDE		1000			+200	10.0
R.S.M.		1100			+325	12.7
pH		7.4			-325	29.5
% SOLIDS	50					
TEMPERATURE						
REMARKS						

METALLURGICAL RESEARCH DEPT.

CABLE "GALIGHER"

THE GALIGHER COMPANY

P. O. BOX 208 -- 345-355 WEST 2ND SOUTH STREET
SALT LAKE CITY, UTAH 84110 -- U.S.A.

TELEPHONE 328-8791

OUR LOT NO. 1636-2
DATE 6/28/65
BY JX

TEST NO. 2 NAME Norges Geologiske

Same as Test No. 1 except with NaCN in BN and Cu float this test.

PRODUCT	Weight	Percent	ASSAY Cu							DISTRIBUTION Cu				
C - Ro Conc.		22.8	0.186							6.3				
Cu Ro Conc.		10.0	5.13							76.9				
Cu Ro Tail		67.2	0.166							16.8				
Head (Calc.)		100.0	0.67							100.0				

OPERATION	BN	C-Ro	C-Ro	C-Ro	Cond	Cu Ro								
TIME	10	4	2	2	2	6								
NaCN	0.5													
KEX		0.06	0.03	0.03		0.03								
Xanth					2.0									
F-O						0.1								
$CuSO_4$						1.0								
LIME		1000												
NaOH		1.00												
pH		7.5			10.9									
% SOLIDS	50													

MESH	Head %	
+10		
+14		
+20		
+28		
+35		
+48	2.4	
+65		
+100		
+150		
+200		
+325		
-325	29.5	

REMARKS

METALLURGICAL RESEARCH DEPT.

CABLE "GALSAL"

THE GALIGHER COMPANY

P. O. BOX 300 — 345-353 WEST 5TH SOUTH STREET
SALT LAKE CITY, UTAH 84110 — U.S.A.

TELEPHONE 359-8721

OUR LOT NO. 1636-2
DATE 6/28/65
BY JX

TEST NO. 3 NAME Norges Geologiske

Same as Test No. 2 except with lime in RM.

PRODUCT	Weight	Percent Weight	ASSAY								DISTRIBUTION				
				Cu							Cu				
C - Ro Conc.		21.5		0.204							6.6				
Cu Ro Conc.		9.5		5.44							77.3				
Cu Ro Tail		69.0		0.157							16.1				
Head (Calc.)		100.0		0.67							100.0				

OPERATION	RM	C-Ro	C-Ro	C-Ro	Cond	Cond	Cu Ro	Cu Ro					
TIME	10	4	2	2	1	1	4	1/2					
Lime	4.5											Head	
NaCN	0.5										MESH	%	%
MIBC		0.06	0.03	0.03		0.03					+10		
Z-6						0.05		0.05			+14		
CuSO4					1.0						+20		
											+35		
											+48	2.4	
											+65		
											+100		
											+150		
WATER		1000									+200		
FEED		1100									+325		
pH		11.5									-325	29.5	
% SOLIDS	50												
TEMPERATURE													
REMARKS													

METALLURGICAL RESEARCH DEPT.

CABLE "GALSAL"

THE GALIGHER COMPANY

P. O. BOX 300 — 345-365 WEST 6TH SOUTH STREET
SALT LAKE CITY, UTAH 84110 — U.S.A.

TELEPHONE 328-4791

OUR LOT NO. 1636-3
DATE 6/28/65
BY JX

TEST NO. 1 NAME Norges Geologiske

PRODUCT	Weight	Percent Weight	ASSAY Cu	DISTRIBUTION Cu
Cu Ro Conc #1		12.3	23.13	82.5
Cu Ro Conc #2		7.5	5.74	12.5
Cu Ro Tail		80.2	0.217	5.0
Head (Calc.)		100.0	3.45	100.0
Comb. Cu Conc.		19.8	16.5	95.0

OPERATION	Ball Mill	Cu Ro #1	Cu Po #2
TIME	10	4	2
REAGENT			
Misc		0.06	
Z-6			0.05
FACTORS			
REAL		1000	
REAL		1100	
pH		7.0	
% SOLIDS	50		
GRIND, MINS			

LBS. PER TON

SCREEN ANALYSIS		
	Head	
MESH	%	%
+10		
+14		
+20		
+28		
+35		
+48		
+65	1.2	
+100		
+150		
+200		
+270		
-270	53.5	

REMARKS: Cu Ro conc #2 low grade. Z-6 seems to give a brittle froth.

METALLURGICAL RESEARCH DEPT.

CABLE "GALSAL"

THE GALIGHER COMPANY

P. O. BOX 209 — 349-365 WEST 5TH SOUTH STREET
SALT LAKE CITY, UTAH 84110 — U.S.A.

TELEPHONE 328-8731

OUR LOT NO. 1636-3
DATE 6/28/65
BY JX

TEST NO. 2 NAME Norges Geologiske

Same as Test No. 1 except with NaCN and lime in BM.

PRODUCT	Weight	Percent Weight	ASSAY Cu	DISTRIBUTION Cu
Cu Ro Conc #1		9.9	24.7	69.5
Cu Ro Conc #2		6.7	13.44	25.8
Cu Ro Tail		83.4	0.195	4.7
Head (Calc.)		100.0	3.49	100.0
Comb. Cu Conc.		16.6	20.0	95.3

OPERATION	BM	Cu Ro	Cu Ro
TIME	10	4	2
Lime	4.5		
NaCN	0.5		
MIBC		0.06	
A-6			0.05
HAZTANK		1000	
R.P.M.		1100	
pH		11.6	
% SOLIDS	50		
FROTH SIZE			
REMARKS			

SCREENING FIG. 1	Head
MESH	%
+48	
+65	
+100	
+150	
+200	
+270	
+325	1.2
+400	5.6
+500	11.9
+635	10.2
+635	17.6
-635	53.5

METALLURGICAL RESEARCH DEPT.

CABLE "GALHER"

THE GALIGHER COMPANY

P. O. BOX 300 — 845-855 WEST 6TH SOUTH STREET
SALT LAKE CITY, UTAH 84110 — U.S.A.

TELEPHONE 359-8721

OUR LOT NO. 1636-3
DATE 7/27/65
BY JK

TEST NO. 3 NAME Norges Geologiske

Same as Test No. 2 except no NaCN, higher Z-6, and Cu cleaner floats.

PRODUCT	WEIGHT	YIELD	ASSAY							DISTRIBUTION				
			Cu							Cu				
Cu Cl Conc #2		10.6	28.79							89.3				
Cu Cl Tail #2		1.4	5.46							2.2				
Cu Cl Tail #1		2.9	2.00							3.5				
Cu Ro Tail		82.1	0.211							5.0				
Head (Calc.)		100.0	3.42							100.0				
Cu Cl Conc #1		12.0	26.0							91.5				
Cu Ro Conc.		17.9	18.1							95.0				

OPERATION	BM	Cu Ro	Cu Ro	Cu Cl #1	Cu Cl #2							GRINDING PRODUCT	
TIME	10	4	2	1-6	1-4								
												Head	
Lime	4.5			1.0	1.0						MESH	%	%
MIBC		0.06		0.03							+10		
Z-6		0.05	0.05								+14		
											+20		
											+28		
											+35		
											+48		
											+65	1.2	
											+100		
											+150		
MACHINE		1000		500	500						+200		
R.P.M.		1100		1100	1100						+325		
pH		11.2									-325	53.5	
% SOLIDS	50												
TEMPERATURE													

REMARKS

Tight froth conditions in both the Cu Ro and cleaner floats.

METALLURGICAL RESEARCH DEPT.

CABLE "GALSAL"

THE GALIGHER COMPANY

P. O. BOX 200 — 548-565 WEST 6TH SOUTH STREET
SALT LAKE CITY, UTAH 84110 — U.S.A.

TELEPHONE 363-8731

OUR LOT NO. 1636-2,3
DATE 7/1/65
BY JX

TEST NO. 1 NAME: Norges Geologiske

Same as Test No. 2, Lot No. 1636-1 except 50-50 composite this test.

PRODUCT	Weight	Percent Weight	ASSAY Cu	DISTRIBUTION Cu
C - Ro Conc.		26.8	0.418	5.4
Cu Ro Conc.		12.1	15.20	88.8
Cu Ro Tail		61.1	0.198	5.8
Head (Calc.)		100.0	2.07	100.0

OPERATION		BM	C-Ro	C-Ro	C-Ro	Cond	Cond	Cu Ro
TIME		10	4	2	2	2	2	6
		0.5						
			0.06	0.03	0.03			0.03
						2.0		
								0.1
							1.0	
MACHINE			1000					
R.P.M.			1100					
pH			7.2			11.0		
% SOLIDS		50	25					
TEMPERATURE								

GRINDING PRODUCT Head

MESH	%	Σ
+10		
+14		
+20		
+28		
+35		
+48	0.5	
+65	3.8	
+100	10.0	
+150	15.5	
+200	10.5	
+325	15.1	
-325	44.6	

REMARKS

Telephone 363-3302

Hand Sample Serial 399

Mine Norway Geological

1636-1

RESULTS PER TON OF 2000 POUNDS

Aug. 23, 1965

ASSAY REPORT

UNION ASSAY OFFICE, Inc.

W. C. WANLASS, President
L. G. HALL, Vice President
G. P. WILLIAMS, Treasurer
LILY M. HOTTINGER, Secretary
P. O. Box 1528
Salt Lake City 10, Utah

NUMBER	GOLD Ozs. per Ton	SILVER Ozs. per Ton	LEAD Wet on Ore	COPPER Per Cent	INSOL. Per Cent	ZINC Per Cent	SULPHUR Per Cent	IRON Per Cent	LIME Per Cent	Per Cent	Per Cent
Test 24 Cu Ro Tail				0.870							

Remarks

Charges $

W. C. Wanlass

Telephone 363-3302

Hand Sample Serial 396-398

Mine Norway Geological

1636-1

RESULTS PER TON OF 2000 POUNDS

August 23, 1965

ASSAY REPORT

UNION ASSAY OFFICE, Inc.

W. C. WANLASS, President
L. G. HALL, Vice President
G. P. WILLIAMS, Treasurer
LILY M. HOTTINGER, Secretary
P. O. Box 1528
Salt Lake City 10, Utah

NUMBER	GOLD Ozs. per Ton	SILVER Ozs. per Ton	LEAD Wet on Ore	COPPER Per Cent	INSOL. Per Cent	ZINC Per Cent	SULPHUR Per Cent	IRON Per Cent	LIME Per Cent	Per Cent	Per Cent
Test 25 Cu Cl	Conc			19.55							
Test 25 Cu Cl	Tail			1.89							
Test 25 Cu Ro	Tail			0.226							

Remarks

Charges $

Glen P. Williams

Telephone 363-3302

Hand Sample Serial 385-390

ASSAY REPORT

UNION ASSAY OFFICE, Inc.

W. C. WANLASS, President
L. G. HALL, Vice President
G. P. WILLIAMS, Treasurer
LILY M. HOTTINGER, Secretary
P. O. Box 1528
Salt Lake City 10, Utah

Mine Norway Geological Survey

1636-1

RESULTS PER TON OF 2000 POUNDS

August 23, 1965

NUMBER	GOLD Ozs. per Ton	SILVER Ozs. per Ton	LEAD Wet on Ore	COPPER Per Cent	INSOL. Per Cent	ZINC Per Cent	SULPHUR Per Cent	IRON Per Cent	LIME Per Cent	Per Cent	Per Cent
Test 26 Cu Ro Tail				1.036							
Test 27 Cu Ro Tail				1.100							
Test 28 Cu Ro Tail				0.853							
Test 30 C Cl Conc				0.321							
Test 30 C Cl Tail				2.20							
Test 30 Cu Cl Conc #2				20.73							

Remarks

Charges $

W. C. Wanlass

ASSAY REPORT

UNION ASSAY OFFICE, Inc.

W. C. WANLASS, President
L. G. HALL, Vice President
G. P. WILLIAMS, Treasurer
LILY M. HOTTINGER, Secretary
P. O. Box 1528
Salt Lake City 10, Utah

Telephone 363-3302

Hand Sample Serial 360-361

Mine Norway Geological Survey

1636-1

RESULTS PER TON OF 2000 POUNDS

Aug. 18, 1965

NUMBER	GOLD Ozs. per Ton	SILVER Ozs. per Ton	LEAD Wet on Ore	COPPER Per Cent	INSOL. Per Cent	ZINC Per Cent	SULPHUR Per Cent	IRON Per Cent	LIME Per Cent	Per Cent	Per Cent
Test 25 Carbon Cl Conc				0.340							
Test 25 Carbon Cl Tail				3.07							

Remarks

Charges $

W. C. Wanlass

Telephone 363-3302

Hand Sample Serial 340-341

ASSAY REPORT

UNION ASSAY OFFICE, Inc.

W. C. WANLASS, President
L. G. HALL, Vice President
G. P. WILLIAMS, Treasurer
LILY M. HOTTINGER, Secretary
P. O. Box 1528
Salt Lake City 10, Utah

Mine Norway Geological Survey

1636-1

RESULTS PER TON OF 2000 POUNDS

August 16, 1965

NUMBER	GOLD Ozs. per Ton	SILVER Ozs. per Ton	LEAD Wet on Ore	COPPER Per Cent	INSOL. Per Cent	ZINC Per Cent	SULPHUR Per Cent	IRON Per Cent	LIME Per Cent	Per Cent	Per Cent
Test 21 Cu Ro Tail Plus 325 Mesh				1.12							
Test 21 Cu Ro Tail Minus 325 Mesh				0.883							

Remarks

Charges $

W. C. Wanlass

Telephone 363-3302

Hand Sample Serial 320-323

Mine Norway Geological Survey

1636-1

ASSAY REPORT

UNION ASSAY OFFICE, Inc.

W. C. WANLASS, President
L. G. HALL, Vice President
G. P. WILLIAMS, Treasurer
LILY M. HOTTINGER, Secretary
P. O. Box 1528
Salt Lake City 10, Utah

RESULTS PER TON OF 2000 POUNDS

Aug. 12, 1965

NUMBER	GOLD Ozs. per Ton	SILVER Ozs. per Ton	LEAD Wet on Ore	COPPER Per Cent	INSOL. Per Cent	ZINC Per Cent	SULPHUR Per Cent	IRON Per Cent	LIME Per Cent	Per Cent	Per Cent
Test 22 Fe Ro Conc Plus 325 Mesh				2.53							
Test 22 Fe Ro Conc Minus 325 Mesh				2.00							
Test 22 Fe Ro Tail Plus 325 Mesh				0.075							
Test 22 Fe Ro Tail Minus 325 Mesh				0.151							

Remarks

Charges $

W. C. Wanlass

Telephone 363-3302

Hand Sample Serial 303-308

Mine Norway Geological Survey

1636-1

ASSAY REPORT

UNION ASSAY OFFICE, Inc.

W. C. WANLASS, President
L. G. HALL, Vice President
G. P. WILLIAMS, Treasurer
LILY M. HOTTINGER, Secretary
P. O. Box 1528
Salt Lake City 10, Utah

RESULTS PER TON OF 2000 POUNDS

August 12, 1965

NUMBER	GOLD Ozs. per Ton	SILVER Ozs. per Ton	LEAD Wet on Ore	COPPER Per Cent	INSOL. Per Cent	ZINC Per Cent	SULPHUR Per Cent	IRON Per Cent	LIME Per Cent	Per Cent	Per Cent
Test 22											
C Ro Conc				1.54							
Cu #2 Cl Conc				23.04							
Cu #1 Cl Tail				2.30							
Cu #2 Cl Tail				7.24							
Fe Ro Conc				2.18							
Fe Ro Tail				0.132							

Remarks

Charges $

W. C. Wanlass

Telephone 363-3302

Hand Sample Serial 290-297

Mine Norway Geological Survey

1636-1

ASSAY REPORT

UNION ASSAY OFFICE, Inc.

W. C. WANLASS, President
L. G. HALL, Vice President
G. P. WILLIAMS, Treasurer
LILY M. HOTTINGER, Secretary
P. O. Box 1528
Salt Lake City, Utah 84110

RESULTS PER TON OF 2000 POUNDS

August 11, 1965

NUMBER	GOLD Ozs. per Ton	SILVER Ozs. per Ton	LEAD Wet on Ore	COPPER Per Cent	INSOL. Per Cent	ZINC Per Cent	SULPHUR Per Cent	IRON Per Cent	LIME Per Cent	Per Cent	Per Cent
Test 20 Cl Cl Conc				0.390							
Test 20 C Cl Tail				2.49							
Test 20 Cu Ro Conc #1				10.55							
Test 20 Cu Ro Conc #2				25.50							
Test 20 Cu Ro Tail				0.302							
Test 21 Cu Cl Conc				14.95			34.54				
Test 21 Cu Cl Tail				3.22							
Test 21 Cu Ro Tail				1.02			13.51				

Remarks

Charges $

G. P. Williams

Telephone 363-3302

Hand Sample Serial 246-251

Mine Norway Geological Survey

1636-1

ASSAY REPORT

UNION ASSAY OFFICE, Inc.
W. C. WANLASS, President
L. G. HALL, Vice President
G. P. WILLIAMS, Treasurer
LILY M. HOTTINGER, Secretary
P. O. Box 1528
Salt Lake City 10, Utah

RESULTS PER TON OF 2000 POUNDS

August 9, 1965

NUMBER	GOLD Ozs. per Ton	SILVER Ozs. per Ton	LEAD Wet on Ore	COPPER Per Cent	INSOL. Per Cent	ZINC Per Cent	SULPHUR Per Cent	IRON Per Cent	LIME Per Cent	Per Cent	Per Cent
Test 16											
C Cl Conc				0.324							
C Cl Tail				1.03							
Cu Ro Conc #2				3.55							
Cu Ro Tail				0.255							
Cu Cl Conc				19.86							
Cu Cl Tail				1.67							

Remarks

Charges $

W. C. Wanlass

Telephone 363-3302

Hand Sample Serial 187-190

Mine Norway Geological Survey

1631-1

RESULTS PER TON OF 2000 POUNDS

ASSAY REPORT

UNION ASSAY OFFICE, Inc.
W. C. WANLASS, President
L. G. HALL, Vice President
G. P. WILLIAMS, Treasurer
LILY M. HOTTINGER, Secretary
P. O. Box 1528
Salt Lake City 10, Utah

August 3, 1965

NUMBER	GOLD Ozs. per Ton	SILVER Ozs. per Ton	LEAD Wet on Ore	COPPER Per Cent	INSOL. Per Cent	ZINC Per Cent	SULPHUR Per Cent	IRON Per Cent	LIME Per Cent	Per Cent	Per Cent
Test 15 Reg. C- Ro Conc				1.51							
Test 15 Sep Cl Conc - Cu				19.12							
Test 15 Sep Cl Tail - Fe				0.595							
Test 15 Sep Ro Tail - Fe				0.179							

Remarks

Charges $

W. C. Wanlass

Telephone 363-3302

Hand Sample Serial 179-184

Mine Norway Geological Survey

1636-1

RESULTS PER TON OF 2000 POUNDS

Aug. 2, 1965

ASSAY REPORT

UNION ASSAY OFFICE, Inc.

W. C. WANLASS, President
L. G. HALL, Vice President
G. P. WILLIAMS, Treasurer
LILY M. HOTTINGER, Secretary
P. O. Box 1528
Salt Lake City 10, Utah

NUMBER	GOLD Ozs. per Ton	SILVER Ozs. per Ton	LEAD Wet on Ore	COPPER Per Cent	INSOL. Per Cent	ZINC Per Cent	SULPHUR Per Cent	IRON Per Cent	LIME Per Cent	Per Cent	Per Cent
Test 14											
C Ro Conc #1				0.390							
C Ro Conc #2				0.501							
Bulk Cl Tail				0.315							
Bulk Ro Tail				0.148							
Sep.Ro Conc -	Cu			20.13							
Sep.Ro Tail -	Fe			0.381							

Remarks

Charges $

W. C. Wanlass

Telephone 363-3302

Hand Sample Serial 169-174

Mine Norway Geological Survey

1636-1

RESULTS PER TON OF 2000 POUNDS

July 28, 1965

ASSAY REPORT

UNION ASSAY OFFICE, Inc.

W. C. WANLASS, President
L. G. HALL, Vice President
G. P. WILLIAMS, Treasurer
LILY M. HOTTINGER, Secretary
P. O. Box 1528
Salt Lake City 10, Utah

NUMBER	GOLD Ozs. per Ton	SILVER Ozs. per Ton	LEAD Wet on Ore	COPPER Per Cent	INSOL. Per Cent	ZINC Per Cent	SULPHUR Per Cent	IRON Per Cent	LIME Per Cent	Per Cent	Per Cent
Test 11 C Cl Conc				0.346							
Test 11 C Cl Tail				2.10							
Test 11 Cu Cl Conc #2				19.33							
Test 11 Cu Cl Tail #1				0.504							
Test 11 Cu Cl Tail #2				1.21							
Test 11 Cu Ro Tail				0.236							

Remarks

Charges $

Glen G. Williams

Telephone EMpire 3-3302 Hand Sample Serial 70-81

Mine Norway Geological Survey

1636-1

RESULTS PER TON OF 2000 POUNDS July 13,1965

ASSAY REPORT

UNION ASSAY OFFICE, Inc.

J .V. SADLER, President
W. C. WANLASS, Vice-Pres. & Treas.
LILY M. HOTTINGER, Secretary
P. O. Box 1528
Salt Lake City 10, Utah

NUMBER	GOLD Ozs. per Ton	SILVER Ozs. per Ton	LEAD Wet on Ore	COPPER Per Cent	INSOL. Per Cent	ZINC Per Cent	SULPHUR Per Cent	IRON Per Cent	LIME Per Cent	Per Cent	Per Cent
Test 8 C Cl Conc				0.308							
" C Cl Tail				1.72							
" Cu Scav Conc				1.65							
" Cu Scav Tail				0.170							
" Cu Cl Conc				24.49							
" Cu Cl Tail				4.47							
Test 9 C Cl Conc				0.352							
" C Cl Tail				2.06							
" Cu ~~Cl~~ Scav Conc				1.51							
" Cu Scav Tail				0.239							
" Cu Cl Conc				17.37							
" Cu Cl Tail				1.00							

Remarks

Charges $

W. C. Wanlass

ASSAY REPORT

UNION ASSAY OFFICE, Inc.

W. C. WANLASS, President
L. G. HALL, Vice President
G. P. WILLIAMS, Treasurer
LILY M. HOTTINGER, Secretary
P. O. Box 1528
Salt Lake City, Utah 84110

Telephone 363-3302

Head Sample Serial 35-45

Mine Norway Geological Survey

1631-1

RESULTS PER TON OF 2000 POUNDS

July 6, 1965

NUMBER	GOLD Ozs. per Ton	SILVER Ozs. per Ton	LEAD Wet on Ore	COPPER Per Cent	INSOL. Per Cent	ZINC Per Cent	SULPHUR Per Cent	IRON Per Cent	LIME Per Cent	Per Cent	Per Cent
Test 6 C Cl Conc				0.318							
Test 6 C Cl Tail				1.12							
Test 6 Cu Cl Conc				10.60							
Test 6 Cu Cl Tail				0.907							
Test 6 Cu Scav Conc				0.579							
Test 6 Cu Scav Tail				0.220							
Test 7 C Ro Conc				0.418							
Test 7 C Scav Conc				0.453							
Test 7 Cu Cl Conc				10.80							
Test 7 Cu Cl Tail				0.504							
Test 7 Cu Scav Conc				0.441							
Test 7 Cu Scav Tail				0.132							

Remarks

Charges $

G. P. Williams

Telephone 363-3302

Hand Sample Serial 18

ASSAY REPORT

UNION ASSAY OFFICE, Inc.

W. C. WANLASS, President
L. G. HALL, Vice President
G. P. WILLIAMS, Treasurer
LILY M. HOTTINGER, Secretary
P. O. Box 1528
Salt Lake City 10, Utah

Mine Norway Geological Survey

1636-1

RESULTS PER TON OF 2000 POUNDS

July 6, 1965

NUMBER	GOLD Ozs. per Ton	SILVER Ozs. per Ton	LEAD Wet on Ore	COPPER Per Cent	INSOL. Per Cent	ZINC Per Cent	SULPHUR Per Cent	IRON Per Cent	LIME Per Cent	Per Cent	Per Cent
Test 5 Cu Ro Conc				0.551							

Remarks

Charges $

W. C. Wanlass

Telephone 363-3302

Hand Sample Serial 30789-30799

ASSAY REPORT

UNION ASSAY OFFICE, Inc.

W. C. WANLASS, President
L. G. HALL, Vice President
G. P. WILLIAMS, Treasurer
LILY M. HOTTINGER, Secretary
P. O. Box 1528
Salt Lake City, Utah 84110

Mine Norway Geological Survey

1636-1

RESULTS PER TON OF 2000 POUNDS

June 28, 1965

NUMBER	GOLD Ozs. per Ton	SILVER Ozs. per Ton	LEAD Wet on Ore	COPPER Per Cent	INSOL. Per Cent	ZINC Per Cent	SULPHUR Per Cent	IRON Per Cent	LIME Per Cent	Per Cent	Per Cent
Test 1 C Ro Conc				0.428							
Test 1 Ro Tail				2.24							
Test 2 C Ro Conc				0.346							
Test 2 Cu Ro Conc				12.26							
Test 2 Cu Ro Tail				0.428							
Test 3 C Ro Conc				0.491							
Test 3 Cu Ro Conc				13.18							
Test 3 Cu Ro Tail				0.289							
Test 4 C Ro Conc				0.466							
Test 4 Cu Ro Conc				14.41							
Test 4 Cu Ro Tail				0.245							

Remarks

Charges $

W. C. Wanlass

Telephone 363-3302

Hand Sample Serial 30448

Mine Norway Geological Survey

1636-1

RESULTS PER TON OF 2000 POUNDS

ASSAY REPORT

UNION ASSAY OFFICE, Inc.

W. C. WANLASS, President
L. G. HALL, Vice President
G. P. WILLIAMS, Treasurer
LILY M. HOTTINGER, Secretary
P. O. Box 1528
Salt Lake City 10, Utah

NUMBER	GOLD Ozs. per Ton	SILVER Ozs. per Ton	LEAD Wet on Ore	COPPER Per Cent	~~NICKEL~~ Ox Cu Per Cent	ZINC Per Cent	SULPHUR Per Cent	IRON Per Cent	LIME Per Cent	Per Cent	Per Cent
Head Sample Original				1.843	0.113						

Remarks

Charges $

W. C. Wanlass

Telephone 363-3302

Hand Sample Serial 273

ASSAY REPORT

UNION ASSAY OFFICE, Inc.

W. C. WANLASS, President
L. G. HALL, Vice President
G. P. WILLIAMS, Treasurer
LILY M. HOTTINGER, Secretary
P. O. Box 1528
Salt Lake City 10, Utah

Mine Norway Geological Survey

1636-1

RESULTS PER TON OF 2000 POUNDS

August 11, 1965

NUMBER	GOLD Ozs. per Ton	SILVER Ozs. per Ton	LEAD Wet on Ore	COPPER Per Cent	INSOL. Per Cent	ZINC Per Cent	SULPHUR Per Cent	IRON Per Cent	LIME Per Cent	Per Cent	Per Cent
Head Original							15.95	13.6			

Remarks

Charges $

W. C. Wanlass

ASSAY REPORT

UNION ASSAY OFFICE, Inc.

W. C. WANLASS, President
L. G. HALL, Vice President
G. P. WILLIAMS, Treasurer
LILY M. HOTTINGER, Secretary
P. O. Box 1528
Salt Lake City, Utah 84110

Telephone 363-3302

Hand Sample Serial 30820-30827

Mine Norway Geological Survey

1636-2

RESULTS PER TON OF 2000 POUNDS

June 30, 1965

NUMBER	GOLD Ozs. per Ton	SILVER Ozs. per Ton	LEAD Wet on Ore	COPPER Per Cent	INSOL. Per Cent	ZINC Per Cent	SULPHUR Per Cent	IRON Per Cent	LIME Per Cent	Per Cent	Per Cent
Test 1 C Ro Conc				0.198							
Test 1 C Ro Tail				0.793							
Test 2 C Ro Conc				0.186							
Test 2 Cu Ro Conc				5.13							
Test 2 Cu Ro Tail				0.166							
Test 3 C Ro Conc				0.204							
Test 3 Cu Ro Conc				5.44							
Test 3 Ro Tail				0.157							

Remarks

Charges $

Glen P. Williams

Telephone 363-3302

Hand Sample Serial 30449

Mine Norway Geological Survey

1636-2

RESULTS PER TON OF 2000 POUNDS

May 14, 1965

ASSAY REPORT

UNION ASSAY OFFICE, Inc.

W. C. WANLASS, President
L. G. HALL, Vice President
G. P. WILLIAMS, Treasurer
LILY M. HOTTINGER, Secretary
P. O. Box 1528
Salt Lake City 10, Utah

NUMBER	GOLD Ozs. per Ton	SILVER Ozs. per Ton	LEAD Wet on Ore	COPPER Per Cent	~~NICKEL~~ Per Cent	ZINC Per Cent	SULPHUR Per Cent	IRON Per Cent	LIME Per Cent	Per Cent	Per Cent
					Ox Cu						
Head Sample Original				0.665	0.018						

Remarks

Charges $

W. C. Wanlass

Telephone 363-3302

Hand Sample Serial 175-178

Mine Norway Geological Survey

1636-3

RESULTS PER TON OF 2000 POUNDS

July 28, 1965

ASSAY REPORT

UNION ASSAY OFFICE, Inc.

W. C. WANLASS, President
L. G. HALL, Vice President
G. P. WILLIAMS, Treasurer
LILY M. HOTTINGER, Secretary
P. O. Box 1528
Salt Lake City 10, Utah

NUMBER	GOLD Ozs. per Ton	SILVER Ozs. per Ton	LEAD Wet on Ore	COPPER Per Cent	INSOL. Per Cent	ZINC Per Cent	SULPHUR Per Cent	IRON Per Cent	LIME Per Cent	Per Cent	Per Cent
Test 3											
Cu Cl Conc #2				28.79							
Cu Cl Tail #1				2.00							
Cu Cl Tail #2				5.46							
Cu Ro Tail				0.211							

Remarks

Charges $

Glen D. Williams

Telephone 363-3302

Hand Sample Serial 30828-30833

ASSAY REPORT

UNION ASSAY OFFICE, Inc.

W. C. WANLASS, President
L. G. HALL, Vice President
G. P. WILLIAMS, Treasurer
LILY M. HOTTINGER, Secretary
P. O. Box 1528
Salt Lake City 10, Utah

Mine Norway Geological Survey

1636-3

RESULTS PER TON OF 2000 POUNDS June 30, 1965

NUMBER	GOLD Ozs. per Ton	SILVER Ozs. per Ton	LEAD Wet on Ore	COPPER Per Cent	INSOL. Per Cent	ZINC Per Cent	SULPHUR Per Cent	IRON Per Cent	LIME Per Cent	Per Cent	Per Cent
Test 1 Cu Ro Conc #1				23.13							
Test 1 Cu Ro Conc #2				5.74							
Test 1 Cu Ro Tail				0.217							
Test 2 Cu Ro Conc #1				24.47							
Test 2 Cu Ro Conc #2				13.44							
Test 2 Cu Ro Tail				0.195							

Remarks

Charges $

Glen D. Williams

Telephone 363-3302

Hand Sample Serial 30450

Mine Norway Geological Survey

1636-3

RESULTS PER TON OF 2000 POUNDS

May 14, 1965

ASSAY REPORT

UNION ASSAY OFFICE, Inc.

W. C. WANLASS, President
L. G. HALL, Vice President
G. P. WILLIAMS, Treasurer
LILY M. HOTTINGER, Secretary
P. O. Box 1528
Salt Lake City 10, Utah

NUMBER	GOLD Ozs. per Ton	SILVER Ozs. per Ton	LEAD Wet on Ore	COPPER Per Cent	~~INSOLX~~ Per Cent	ZINC Per Cent	SULPHUR Per Cent	IRON Per Cent	LIME Per Cent	Per Cent	Per Cent
					Ox Cu						
Head Sample Original				3.481	0.110						

Remarks

Charges $

W. C. Wanlass

Telephone 363-3302

Hand Sample Serial 19-21

Mine Norway Geological Survey

1636- 2, 3

ASSAY REPORT

UNION ASSAY OFFICE, Inc.

W. C. WANLASS, President
L. G. HALL, Vice President
G. P. WILLIAMS, Treasurer
LILY M. HOTTINGER, Secretary
P. O. Box 1528
Salt Lake City 10, Utah

RESULTS PER TON OF 2000 POUNDS

July 6, 1965

NUMBER	GOLD Ozs. per Ton	SILVER Ozs. per Ton	LEAD Wet on Ore	COPPER Per Cent	INSOL. Per Cent	ZINC Per Cent	SULPHUR Per Cent	IRON Per Cent	LIME Per Cent	Per Cent	Per Cent
Test 1 C Ro Conc				0.418							
Test 1 Cu Ro Conc				15.20							
Test 1 Cu Ro Tail				0.198							

Remarks

Charges $

W. C. Wanlass

15.9.64. EJ.

Rapport av Sept. 2. 68 på The Gallegher Company.

/ Bør i tilfelle første G.'s forslag tatt til.

/ Forslag til Stavanger dessuten.

/ Erfaring av C. i Lausanne?

Myrvedsen

THE GALIGHER COMPANY

ESTABLISHED 1901

CABLE ADDRESS
GALSAL
TELEX 038-536

545-585 WEST EIGHTH SOUTH STREET
P. O. BOX 209
SALT LAKE CITY, UTAH, 84110
U.S.A.

TELEPHONE
359-8731
AREA CODE 801

September 2, 1965

Norges Geologiske Undersokelse
Leiv Eirickssons Vei 39
Postboks 3006
Trondheim, Norway

Attention: Mr. Karl Ingvaldsen
Administrative Director

Gentlemen:

We wish to inform you that we have completed some of the preliminary testing regarding the study of your graphitic copper ores. The results obtained in this preliminary work are discussed as follows:

Lot No. 1636-1, Your Sample No. 1 (Graphitic Ore)

The majority of the test work conducted to date has been devoted to the study of this sample, thirty tests being conducted thus far. As a result of these tests, certain conclusions have been reached, these being summarized as follows:

1. Various attempts were made to depress the graphite and float the copper using the SO_2-starch process for graphite depression. This reagent combination was quite effective for that purpose; however, we were unable to obtain a high recovery of the copper, the test results being quite negative from that point of view. There is the possibility that we can obtain a high bulk sulfide recovery after graphite depression, such a bulk concentrate being subjected to a selective iron-copper separation. This is one possibility which we desire to pursue further.

2. The most favorable results obtained to date were those utilizing the flowsheet of graphite flotation followed with copper flotation. The results check fairly well those which were presented in the various reports which were submitted to us. Indicated loss of copper in the graphite concentrate is in the range of 4 to 5%, while the copper concentrate grade is indicated at about 20% copper with 81% recovery in open

circuit testing. The flowsheet used and results obtained in test No. 11 are summarized as follows:

a) 1000 grams of sample were ground in a laboratory ball mill at 50% solids, the screen analysis of the ball mill discharge being as follows:

Mesh	+48	+65	+100	+150	+200	+325	-325
Wt.%	0.9	5.9	13.8	18.9	11.7	15.4	33.4

b) A carbon rougher concentrate was floated for eight minutes using 0.06 pound of MIBC (methyl isobutyl carbinol) per ton of ore at the start of flotation, and 0.03 pound stage additions after three and five minutes of flotation, the pH being 6.7.

c) The carbon rougher tailing was conditioned for ten minutes with 2.6 pounds of lime and 0.02 pound of NaCN, the pH being 11.0.

d) A copper rougher concentrate was floated for eight minutes using 0.1 pound Z-6 and 0.03 pound MIBC at the start of flotation, stage adding 0.05 pound of Z-6 and 0.03 pound MIBC after six minutes of flotation.

e) The carbon rougher concentrate was cleaned once for eight minutes using 0.03 pound of MIBC after six minutes of flotation.

f) The copper rougher concentrate was cleaned twice, each cleaner being preceded by two minutes conditioning with 1.0 pound of lime (pH of 11.1) and 0.03 pound MIBC, flotation times being four minutes in the first and three minutes in the second cleaner.

The results obtained in test No. 11, Lot No. 1636-1, are summarized as follows:

Product	Wt. %	% Cu	Dist.
Carbon Cleaner Concentrate	22.4	0.346	4.1
Carbon Cleaner Tailing	1.6	2.10	1.8
Copper No. 2 Cleaner Concentrate	7.9	19.33	81.1
Copper No. 2 Cleaner Tailing	6.6	1.21	4.2
Copper No. 1 Cleaner Tailing	7.4	0.504	2.0
Copper Rougher Tailing	54.1	0.236	6.8
Head (Calc.)	100.0	1.883	100.0
Carbon Rougher Concentrate	24.0	0.462	5.9
Copper No. 1 Cleaner Concentrate	14.5	11.08	85.3
Copper Rougher Concentrate	21.9	7.51	87.3

The above results show that 10.9% of the copper is lost to the carbon cleaner concentrate and the copper rougher tailing, 81.1% of the copper reporting to the copper No. 2 cleaner concentrate. 8.0% of the copper

is contained in the circulating load products (cleaner tailings).

3. Testing was conducted in which kerosene was added to the ball mill as a graphite collector. It was indicated that the graphite was much more positively activated and a larger weight percent of the mineral floated in the carbon float. However, copper losses were higher due to the larger weight floating (test No. 20, carbon cleaner concentrate, 46.6 weight percent assaying 0.390% copper carrying 9.7% of the copper).

4. Results to date are somewhat inconclusive regarding the optimum grind for carbon flotation. Grinding finer than the grind of test No. 11 (33.4% minus 325 mesh) did not reduce copper losses in the carbon concentrate, and it is felt that coarser grinding may be more ideal for graphite flotation.

5. The following reagents were tested in the graphite rougher flotation circuit, and no particular benefit was observed: lime, sodium cyanide and sodium silicate.

6. Testing to date has indicated that it may be rather difficult to produce copper concentrates containing more than 20% copper at a recovery of about 80%. One flowsheet which was very quickly checked, and which shows promise regarding higher copper recoveries and concentrate grades, consisted of the following:

   a) graphite flotation;
   b) bulk sulfide flotation; and,
   c) treatment of the bulk sulfide concentrate with SO_2 (to a pH of about 3.0) for a selective separation of the copper and iron sulfides.

   By utilizing this approach, we obtained a copper rougher concentrate assaying 20% copper representing a recovery of 82.6%. Cleaning of this concentrate would be expected to improve concentrate grade, and further testing in this direction is indicated.

Lot No. 1636-2, Your Sample No. 2 (Graphitic Ore)

Three tests have been conducted with this low grade sample (0.665% Cu) and it was indicated that the problems encountered with this sample would be similar to those of sample 1636-1. Because of this, flowsheet development was limited to the testing of sample 1636-1.

Preliminary results showed that about 6 to 9% of the copper occurred in the graphite rougher concentrate and that the copper rougher concentrate assayed about 5 to 5.5% copper representing a recovery of 77% of the copper. No attempts, to date, have been made to upgrade the copper rougher concentrate.

Lot No. 1636-3, Your Sample No. 3 (Fels Ore)

Three tests have been conducted with this sample, and it was determined that a major portion of the copper contained therein was floatable with frother

only (82.5% of the copper in a rougher concentrate assaying 23% Cu). The testing had also shown that the copper was not susceptible to sodium cyanide (0.5 pound per ton) depression.

The milling of this ore by itself should present no metallurgical or flowsheet complications because of the readily floating copper contained therein. It is understood, however, that these ores will be blended with the graphitic ores for milling and, from the results presented thus far, problems would be expected since it is indicated that the graphite must be floated prior to the copper. Frother is used to float the graphite and one would expect the copper contained in the fels ore to float with the graphite.

Lot No. 1636-2,3 Composite

To test the effect of mixing the fels and graphitic ores, a 1:1 composite of samples 1636-2 and 1636-3 was prepared, the head assay being approximately 2% copper. A single test was conducted with this composite in which sodium cyanide (0.5 pound per ton) was ground with the ore, frother being used for graphite flotation and Z-6, with lime and copper sulfate, for copper flotation. The following results were obtained:

Product	Wt. %	% Cu	% Dist.
Carbon Rougher Concentrate	26.8	0.416	5.4
Copper Rougher Concentrate	12.1	15.20	88.8
Copper Rougher Tailing	61.1	0.198	5.8
Head (Calculated)	100.0	2.07	100.0

The above results are quite similar to those presented on page 2 of this letter regarding graphite flotation. It is indicated, therefore, that the presence of the graphite in the grinding circuit, with sodium cyanide, actually deactivates the copper contained in the fels ore, and that composites of the fels ore with the graphitic ores should respond to the flowsheet developed for the straight graphitic ores. It would certainly be desirable, however, to treat the two ore types separately if this is at all possible.

It was not established whether or not the cyanide used in the preceding test was necessary to result in copper deactivation, and further testing should be conducted to determine this. It would also be desirable to test different ratios of fels to graphitic ores throughout the range of compositing which you anticipate in your mining program.

Recommendations

Based on the testing which has been conducted to date, we believe that the following future studies should be pursued:

1. Determine the possibility of floating the graphite at coarser grinds and the effect of coarse grinds on copper losses in the graphite concentrate.

2. Study the possibility of recovering additional copper from the graphite

concentrate. These studies would include either graphite depression and copper flotation (using SO_2 and starch) or copper depression and graphite flotation (using sodium sulfide or Nokes reagent).

3. Attempt to improve copper cleaner concentrate grades by utilizing additional selectivity assisting reagents in the copper cleaners, such as SO_2 or NaCN.

4. Study further the idea of bulk sulfide flotation following graphite flotation in attempts to improve both copper concentrate grade and recovery.

5. Attempt a bulk sulfide flotation in a circuit in which graphite depression is accomplished with SO_2 and starch.

6. Study the possibility of separate flotation of the sand and slime fractions after grinding.

7. Determine the effect of varying composites of the fels and graphitic ores. If you have some information as to how these ores will be composited, this would be of assistance concerning these studies.

The total charges which have accrued to date in this project amount to $1046.52 ($650.00 for laboratory charges, $329.25 for assaying and $67.27 for sample freight from New York City to Salt Lake City). We would estimate that $1500.00 to $2000.00 in addition to the above amount would be required to complete the above outlined studies, this to include both laboratory and assaying charges. In the event that you wish to have us proceed with this work, or any of the above phases, kindly provide us with your authorization. In the meantime, we will hold in abeyance further work on this project until we hear from you.

Sincerely yours,

THE GALIGHER COMPANY

R. O. Huch
Metallurgist

ROH/mc

cc: Nyhammars Bruk