

006206

To

J. Levanaho

Date

July 10, 1983

From

R. Murarka

Subject Cu/Au/Ag metallurgical response of Anvil ore: a review of best results.

This review includes work done on Anvil ore for recovering Cu. The period covered is 1972 to 1979. Very little work has been done on Au, Ag recoveries. The work done recently in the CAMC lab is not included here because the metallurgy obtained so far has not been as good as past work.

- I. April 1972, CAMC Lab. Table I shows the technical details of the test. This was truly a Cu pre-float test. The flotation feed grind was 57% - 74 um. Flotation feed density was 28% solids by weight.

Table II shows the metallurgical balance of the whole circuit.

The main conclusion drawn by this study was that by using stronger collectors eg. Z-200

- (a) Pb recoveries can be improved
- (b) a Cu conc. can be produced

- II. August 1977, CAMC Lab. Table III shows technical details of this test. Table IV is the cumulative metallurgical balance of Pb and Cu in the Pb circuit only. Pb R1 and R2 represent Cu pre-flotation while Pb S₁, S₂ and S₃ represent Pb flotation.

The head Cu grade in this work was very high (0.38% Cu). In spite of this, the metallurgy was poorer than the work in 1972. Ag recoveries were also determined in this work but were less than 50% in the overall Pb circuit.

- III. February 1979, Lakefield Lab. These are the best results to date. Table V gives the technical details. Table VI lists the metallurgy. Although Cu metallurgy was good, only 59.4% of Zn left the circuit which means contamination of Cu and Pb with Zn. The principal conclusions drawn were: (a) Cu pre-flotation causes the Pb grade in the Pb conc. to drop and (b) it causes the recoveries of Pb and Zn in their respective concentrates to drop.



R. Murarka
Metallurgist

CYPRUS ANVIL

TABLE I

Grind	Na ₂ CO ₃	2.5#/ton		
	Na ₂ SO ₃	2.5#/ton	17 mins.)	
	Z-200	0.10#/ton	3 mins.)	20 min
Cu.R.C.			pH 9.5	1 min
Cu.Sc.C.				4 min
NaCN Cond.	NaCN	0.15 #/ton		10 min
	Z-11	0.025#/ton		
Pb.Sc.C.				5 min
Zn. Cond.	CaO	1.25#/ton		
	CuSO ₄	0.75#/ton		
	Z-11	0.075#/ton		2 min
Zn.R.C.	Df1012		pH 10.6	5 min
	Z-11	0.025#/ton		
Zn.Sc.C.	Df1012			6 min

TABLE II

Product	%Wt.	ASSAY %			DISTRIBUTION %		
		Pb	Zn	Cu	Pb	Zn	Cu
Cu.R.C.	0.4	8.4	10.2	16.5	0.6	0.6	41.3
Cu.Sc.C.	0.9	12.8	13.2	2.2	2.6	1.7	13.0
Pb.R.C.	7.9	48.3	8.0	0.08	81.1	8.9	4.0
Pb.Sc.C.	3.8	6.7	10.9	0.11	5.6	5.8	2.6
Zn.R.C.	10.6	1.0	47.7	0.20	2.4	71.4	13.2
Zn.Sc.C.	2.5	2.2	15.2	0.17	1.3	5.4	2.7
Zn.Sc.T.	73.9	0.4	0.6	0.05	6.4	6.2	23.2
Heads		4.7	7.1	0.16			

<u>Reagents</u> <u>lb/ton</u>		<u>Addition</u> <u>Point</u>
NaCN	0.06	Grind 11 min.
Na ₂ CO ₃	3.5	
Na ₂ SO ₃	2.0	
Z-11	0.07	Grind 2 min.
pH	10.1	Pb R1
NaCN		Pb R2
Z-11		
NaCN	0.04	Pb S1
Z-11	0.02*	
Z-11		Pb S2
Z-11	0.02	Pb S3

* Reagents added and conditioned for three minutes.

TABLE IV

	<u>Grade</u>		<u>Recovery</u>	
	<u>Pb</u>	<u>Cu</u>	<u>Pb</u>	<u>Cu</u>
Pb R1	21.0	10.5	21.0	63.6
R2	21.9	8.2	32.3	72.7
Pb S1	31.0	5.5	70.8	75.8
S2	31.7	5.1	72.3	75.8
S3	38.3	4.1	87.7	75.8

TABLE V

Purpose: A preliminary test to investigate the flotation of copper and lead but use a 1:1 mixture of Z-6 and 3501 in the copper rougher and add ZnSO₄ to the copper regrind.

Procedure: Grind and float a copper concentrate and a lead concentrate. Regrind the copper concentrate and clean three times.

Feed: 2000 grams minus 10 mesh Mill Feed Sample

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

Conditions:

Stage	Reagents Added, grams per tonne							Time, minutes			pH
	Na ₂ CO ₃	Na ₂ SO ₃	Z-6/ 3501	MIBC	NaCN	R-242	ZnSO ₄	Grind	Cond.	Froth	
Grind	2000	1000	15	-	-	-	-	20	-	-	-
Cu Rougher	-	-	10	20	-	-	-	-	2	3	9.6
	-	-	10	5	-	-	-	-	1	2	-
	-	-	5	5	-	-	-	-	1	2	-
Condition	-	-	-	-	150	-	500	-	2	-	9.0
Pb Rougher	-	-	5	-	-	15	-	-	1	3	-
	-	-	5	-	-	5	-	-	1	3	-
	-	-	-	-	-	5	-	-	1	3	-
		H-31	Z200		** A.C.	SO ₂	** ACTIVATED CARBON				
Cu Conc. Reagr. *	-	-	-	-	-	-	300	20'	-	-	-
Condition	100	125	-	-	40	-	-	-	5	-	9.0
	-	-	-	-	-	250	-	-	5	-	5.0
Cu 1st Cl.	-	-	20	-	-	-	-	-	5	2	6.0
	-	-	5	-	-	20	-	-	1	2	-
Cu 2nd Cl.	-	50	-	2.5	-	15	-	-	2	1	5.0
	-	-	5	-	-	-	-	-	1	2	-
Cu 3rd Cl.	-	25	-	2.5	-	10	-	-	2	1	5.0
	-	-	2.5	-	-	-	-	-	1	1	-

ROUGHER 1st. Cu. Cl. 2nd & 3rd

machine
rpm.
% solids

D - 1
1900
33

D - 1
1300
-

D - 1
1000
-

* Cu regrind mill - pebble mill

TABLE VI

Product	Weight %	Assays, %			% Distribution		
		Cu	Pb	Zn	Cu	Pb	Zn
1. Cu Cleaner Conc.	0.52	20.5	5.98	14.0	53.8	0.5	0.5
2. Cu 3rd Cleaner Tail.	0.27	4.96	21.3	21.9	6.8	1.0	0.5
3. Cu 2nd Cleaner Tail.	0.82	1.43	31.3	19.5	5.9	4.4	2.0
4. Cu 1st Cleaner Tail.	9.16	0.17	38.8	13.4	7.9	60.4	15.0
5. Pb Rougher Conc.	14.99	0.091	11.5	11.2	6.9	29.3	21.5
6. Pb Rougher Tail.	74.24	0.050	0.35	6.29	18.7	4.4	59.1
Head (Calculated)	100.00	0.20	5.88	7.87	100.0	100.0	100.0

Calculated Grades and Recoveries

Products 1 and 2	0.79	15.2	11.2	16.7	60.6	1.5	1.7
Products 1 to 3	1.61	8.18	21.4	18.1	66.5	5.9	3.7
Products 1 to 4	10.77	1.37	36.2	14.1	74.4	66.3	19.3
Products 5 and 6	89.23	0.057	2.22	7.11	25.6	33.7	80.7

To

J. Levanaho

Date

July 11, 1983

From

R. Murarka

cc: M. Nicholson

Subject Copper test work: an up-date

SUMMARY:

Test work was carried out using three different approaches: Cu separation from a Pb 3rd Cleaner conc., Cu pre-flotation and Cu/Pb Bulk flotation-separation. It appears that the best route to follow is the last one. With ores similar to ours, this route is most common in the industry. The success in producing a Cu concentrate so far has been limited but further test work with a different set of Pb depressants used in the industry may prove Beneficial.

INTRODUCTION:

Cu test work was conducted mainly on 2BCD ore (head Cu assay varying from 0.18 to 0.30%). Minor work was done on 2EF ore because of its lower head grade (0.15% Cu) but more work can be planned depending on the success with 2BCD ore. The success with these ore types will determine the feasibility of Cu concentrate production. Other ore-types occur in minor proportions in the Faro ore body.

2EF ORE:

Only 2 tests were carried out trying to pre-float the Cu. Very little NaCN and Z-11 were used. It was hoped that the amount of NaCN would be just sufficient to depress the iron in the ore but not Cu. Small amount of Z-11 was added in order to float Cu only. In the second test Na_2SO_3 was also added to further retard flotation of Pb.

The results are presented in Table 1. It can be seen that Cu/Pb separation is very poor.

2BCD ORE:

- (a) Cu/Pb separation from Pb final concentrate: It was noticed in earlier work with 2BCD ore that much Cu was found in the final Pb concentrate. Thus the obvious route to go was to produce a large scale final Pb concentrate and extract the Cu from it.

In the first three tests (table II), no collector was added.

TABLE 1

ORE TYPE & TEST DESCRIPTION	SAMPLE	WTS.	ASSAYS					DISTRIBUTION				
			Pb	Zn	Fe	Cu	Ag	Pb	Zn	Fe	Cu	Ag
2 EF-no Na ₂ SO ₃ -10g/t NaCN -30g/t Z-11 to grind -50g/t Z-11 to flot.	Cu/Pb conc.	87.4	28.7	5.97	22.6	.66	8.83	74.6	12.5	5.8	57.5	47.5
	Cu/Pb Tls.	916.5	.93	4.00	35.1	.10	.93	25.4	87.5	94.2	42.5	52.5
	Heads	1003.9	3.35	4.17	34.0	.15	1.62	100.0	100.0	100.0	100.0	100.0
2 EF-with Na ₂ SO ₃ -10g/t NaCN ³ -30g/t Z-11 to grind -30g/t Z-11 to flot.	Cu/Pb conc	56.1	9.31	7.55	29.1	.99	3.12	15.4	9.4	4.8	37.1	12.2
	Cu/Pb tls.	942.0	3.06	4.33	34.2	.10	1.34	84.6	90.6	95.2	62.9	87.8
	Heads	998.1	3.41	4.51	33.9	.15	1.44	100.0	100.0	100.0	100.0	100.0

Cu/Pb Separation
from $PbCl_3$

TABLE II

ORE TYPE and TEST DESCRIPTION	SAMPLE	WTS.	Assays					Distribution				
			Pb	Zn	Fe	Cu	Ag	Pb	Zn	Fe	Cu	Ag
<u>ZBCD</u> - Assayed Heads ($PbCl_3$)	$PbCl_3$	—	59.3	4.13	6.3	2.51	20.72	—	—	—	—	—
	$PbCl_3$	—	3.25	9.43	18.8	.64	2.08	—	—	—	—	—
1. <u>ZBCD</u> - 1200g/t $K_2Cr_2O_7$ - no 2-11 - 2 drops MIBC	Cu Conc	16.4	46.6	4.97	8.5	5.54	17.44	32.3	21.5	27.7	63.9	33.8
	Cu Tls	35.5	45.2	8.36	10.2	1.45	15.78	67.7	78.5	72.3	36.1	66.2
	Heads	51.9	45.6	7.29	9.7	2.74	16.36	100.0	100.0	100.0	100.0	100.0
2. <u>ZBCD</u> - 1800g/t $K_2Cr_2O_7$ - no 2-11 - no MIBC	Cu Conc	9.5	50.0	3.97	8.1	6.01	18.69	14.4	12.0	17.4	38.5	15.4
	Cu Tls	49.6	57.2	5.56	7.4	1.84	19.60	85.6	89.0	82.6	61.5	84.6
	Heads	59.1	56.0	5.30	7.5	2.51	19.45	100.0	100.0	100.0	100.0	100.0
3. <u>ZBCD</u> - Rougher - 1800g/t $K_2Cr_2O_7$ + 1 drop MIBC - Cleaner - 500g/t $K_2Cr_2O_7$ + 1 dr. MIBC	Rougher Conc	13.3	55.3	4.47	7.11	4.75	19.36	21.1	19.4	21.4	39.1	21.5
	Cu Conc	3.5	46.2	4.18	9.1	7.73	17.03	4.6	4.8	7.2	16.7	5.0
	Cu 1st Tls	9.8	58.5	4.58	6.4	3.68	20.14	16.5	14.7	14.2	22.3	16.5
	Cu 2nd Tls	47.2	58.1	5.21	7.4	2.08	19.91	78.1	80.5	78.6	61.0	78.5
Heads	60.5	57.5	5.05	7.3	2.67	19.79	100.0	100.0	100.0	100.0	100.0	

2BCD ORE cont"d:

$K_2Cr_2O_7$ was used for depressing the Pb but it can be seen that increasing quantities of $K_2Cr_2O_7$ depress more Cu along with Pb. Increasing the amount of frother floats more Pb and Cu.

In tests 4 to 8, (table 111) effect of varying Z-11, MIBC (frother) and $K_2Cr_2O_7$ was studied. It can be concluded here that adding more Z-11 enhances flotation of both Pb and Cu.

So far, in all but one tests, no cleaning of the "Cu conc" was attempted. At this point it was decided to clean this "Cu conc". Variation in the amounts of $K_2Cr_2O_7$ and MIBC was again tried and three tests were conducted (table 1V, tests 9 to 11). Although a "Cu conc" grading 14% Cu was produced, the overall Cu recovery was very poor and the Pb grade of this "Cu conc" was too high.

(b) Cu Pre-flotation:

Similar strategy was used here as for 2EF ore. Since NaCN depressed some Cu (test 1, table V), no NaCN was used in tests 2 and 3. As can be seen, no improvement in Cu recovery resulted. In test 3, depression of Pb that accompanied Cu in preflotation was attempted. This resulted in a concentrate grading 6% Cu with 55% recovery.

(c) Cu/Pb Bulk flotation-separation - I :-

Although pre-flotation of Cu was the objective, the result in tests 4 to 8 turned out to be Cu/Pb bulk flotation (table VI). No NaCN and 1 kg/t of Na_2SO_3 was used in order to encourage Cu flotation and discourage Pb_3 flotation. The bulk conc. was subsequently treated with $K_2Cr_2O_7$ to depress the Pb.

The first cleaner grade/recovery of Cu were the best so far in this series of tests. However, it was thought that $K_2Cr_2O_7$ usage to depress Pb may have an adverse effect in the Pb_2 circuit. As a result another test was carried out without $K_2Cr_2O_7$. Also very little Z-11 was added to discourage Pb flotation. Strictly speaking this was an attempt to pre-float the Cu (table VII, test 9). The first cleaner conc. had grade/recovery of 9.5% Cu/41% recovery but contamination with Pb, Zn, Fe was high. Pb and Ag recoveries to the rougher conc. are very poor in comparison with Cu. This strengthens the belief that Ag is not associated with Cu.

Another test was carried out to discourage Pb flotation by adding twice as much Na_2SO_3 as in previous tests. Results are shown in table VII, test 10. Clearly the extra Na_2SO_3 was not helpful.

Cu / Pb Separation TABLE IV
from PbCl₂

ORE TYPE and Test Description	SAMPLE	WT _S	ASSAYS (%)					DISTRIBUTION (%)				
			Pb	Zn	Fe	Cu	Ag	Pb	Zn	Fe	Cu	Ag
9. 2BCD R ₀ - 1200 g/t K ₂ Cr ₂ O ₇ - 50g/t Z-11 - 2 drops MiBC C ₁ - 600g/t K ₂ Cr ₂ O ₇ - 25g/t Z-11 - 1 drop MiBC C ₂ - 180g/t K ₂ Cr ₂ O ₇ - 7.5g/t Z-11 - 1 drop MiBC	CuCC ₂	2.89	32.8	5.05	12.4	11.21	14.07	4.03	4.04	7.02	25.06	4.98
	CuCT ₂	12.5	51.6	5.00	7.6	4.95	18.64	27.34	17.28	18.62	47.87	28.54
	Calc. CuCC ₁	15.4	48.1	5.01	8.5	6.13	17.78	(31.42)	(21.32)	(25.64)	(72.93)	(33.52)
	CuCT ₁	15.0	50.7	5.25	7.8	1.38	17.22	32.29	21.78	22.93	16.02	31.64
	Calc. Cu Ro. Conc.	30.4	49.4	5.13	8.2	3.78	17.50	(63.71)	(43.10)	(48.57)	(88.95)	(65.16)
	Cu Ro. Tls.	21.0	40.7	9.80	12.5	0.68	13.54	36.29	56.91	51.44	11.05	34.83
	Calc. Head	51.4	45.8	7.04	9.9	2.52	15.88	100	100	100	100	100
10. 2BCD R ₀ - 3000 g/t K ₂ Cr ₂ O ₇ - 50g/t Z-11 - 2 drops MiBC C ₁ - 1500g/t K ₂ Cr ₂ O ₇ - 25g/t Z-11 - 1 drop MiBC C ₂ - 450g/t K ₂ Cr ₂ O ₇ - 7.5g/t Z-11 - 1 drop MiBC	CuCC ₂	2.38	19.2	7.25	15.2	13.89	10.59	1.15	4.28	6.39	18.66	1.82
	CuCT ₂	12.8	43.4	7.19	8.5	6.77	16.41	13.97	22.83	19.22	48.92	15.18
	Calc. CuCC ₁	15.2	39.6	7.20	9.6	7.89	15.50	(5.12)	(27.11)	(25.61)	(67.58)	(17.00)
	CuCT ₁	25.9	62.0	4.60	4.9	1.46	20.81	40.39	29.56	22.41	21.35	38.96
	Calc. Cu Ro. Conc.	41.1	53.7	5.56	6.6	3.83	18.85	(55.51)	(56.67)	(48.02)	(88.93)	(55.96)
	Cu Ro. Tls.	32.7	54.1	5.34	9.0	0.60	18.63	44.49	43.32	51.98	11.08	44.04
	Calc. Head	73.8	53.9	5.46	7.7	2.40	18.75	100	100	100	100	100
11. 2BCD R ₀ - 1800g/t K ₂ Cr ₂ O ₇ - 50g/t Z-11 - 4 drops MiBC C ₁ - 900g/t K ₂ Cr ₂ O ₇ - 25g/t Z-11 - 2 drops MiBC C ₂ - 270g/t K ₂ Cr ₂ O ₇ - 7.5g/t Z-11 - 1 drop MiBC	CuCC ₂	3.56	29.7	6.98	11.9	9.73	12.58	5.24	6.29	7.91	28.11	6.23
	CuCT ₂	11.2	42.8	7.08	8.7	5.05	15.84	23.74	20.08	18.20	45.90	24.67
	Calc. CuCC ₁	14.8	39.6	7.06	9.5	6.18	15.05	(28.98)	(26.37)	(26.11)	(74.01)	(30.90)
	CuCT ₁	16.5	48.8	6.89	7.7	1.45	17.03	39.87	28.79	23.73	19.42	39.07
	Calc. Cu Ro. Conc.	31.3	44.5	6.97	8.5	3.68	16.10	(68.85)	(55.16)	(49.84)	(93.43)	(69.97)
	Cu Ro. Tls.	18.4	34.2	9.62	14.6	0.44	11.77	31.16	44.83	50.17	6.57	30.11
	Calc. Head	49.7	40.7	7.95	10.8	2.48	14.48	100	100	100	100	100

Cu PRE-FLOAT TESTS

Table V

ORE - TYPE & TEST DESCRIPTION	SAMPLE	WTS.	ASSAYS					DISTRIBUTION				
			Pb	Zn	Fe	Cu	Ag	Pb	Zn	Fe	Cu	Ag
1. 2BCD-with Na ₂ SO ₃ -10g/t NaCN -30g/t Z-11 to grind -30g/t Z-11 to float	Cu/Pb conc.	134.2	19.4	9.03	11.9	1.04	7.05	83.3	18.4	12.5	61.4	63.0
	Cu/Pb Tls.	854.3	.61	6.30	13.1	.10	.65	16.7	81.6	87.5	38.6	37.0
	Heads	988.5	3.16	6.67	12.9	.23	1.52	100.0	100.0	100.0	100.0	100.0
2. 2BCD-with Na ₂ SO ₃ -no NaCN -30g/t Z-11 to grind -30g/t Z-11 to float	Cu/Pb conc.	129.0	17.0	8.93	12.6	1.07	6.37	72.1	18.8	12.8	62.9	56.8
	Cu/Pb Tls.	868.3	.98	6.16	12.7	.09	.72	27.9	81.2	87.2	37.1	43.2
	Heads	997.3	3.05	6.52	12.7	.22	1.45	100.0	100.0	100.0	100.0	100.0
3. 2BCD-with Na ₂ SO ₃ -no NaCN -30g/t Z-11 to grind -30g/t Z-11 to float.	Rougher	87.9	12.6	10.13	11.5	1.61	5.02	35.7	13.5	7.8	61.5	29.8
	Cu conc.	21.0	12.8	13.40	14.0	6.06	6.60	8.7	4.3	2.3	55.3	9.4
	Cu Tls.	66.9	12.5	9.10	10.7	.21	4.53	27.0	9.3	5.5	6.1	20.5
	CuRO Tls.	912.8	2.19	6.24	13.0	.10	1.14	64.3	86.4	92.2	38.6	70.1
CLnr.-1000g/t K ₂ Cr ₂ O ₇ -20 g/t Z-11	Heads	1000.7	3.10	6.58	12.9	.23	1.48	100.0	100.0	100.0	100.0	100.0

TABLE VI

ZBCD ORETYPE				SAMPLE	WTS	ASSAYS					DISTRIBUTION					
and Test Description						Pb	Zn	Fe	Cu	Ag	Pb	Zn	Fe	Cu	Ag	
4.	9/4 Z-11 Grind Ro Chl 50 30 20	K ₂ Cr ₂ O ₇ to Clml	2000	Cu Conc	15.7	16.20	10.71	15.10	6.75	7.76	8.85	2.83	1.74	59.23	9.96	
				Cu Tls I	68.7	25.80	7.20	11.00	.26	9.05	61.70	8.34	5.56	9.94	50.85	
				Cu RoMet	84.4	24.01	7.85	11.76	1.47	8.71	70.55	11.17	7.30	6.92	60.81	
				Cu RoTls	909.6	.93	5.80	13.80	.06	.53	29.45	88.83	92.70	30.79	39.19	
				Heads	994.0	2.89	5.97	13.67	.18	1.23	100.00	100.00	100.00	100.00	100.00	
5.	50	30	20	3000	Cu Conc	17.8	15.60	11.25	14.60	6.40	7.62	9.15	3.27	1.90	63.19	9.67
					Cu Tls I	77.1	26.50	7.97	11.60	.26	9.47	68.04	10.02	6.55	11.12	52.07
					Cu RoMet	94.9	24.70	8.54	12.16	1.41	9.12	77.24	13.29	8.46	74.31	61.74
					Cu RoTls	906.7	.76	5.86	13.80	.05	.59	22.76	86.71	91.55	25.69	38.26
					Heads	1001.6	3.03	6.12	13.64	.18	1.40	100.00	100.00	100.00	100.00	100.00
6.	70	30	20	2000	Cu Conc	18.5	13.30	11.52	15.70	6.07	6.60	8.17	3.45	2.20	59.85	8.77
					Cu Tls I	82.5	22.10	7.39	12.60	.16	8.42	62.73	7.88	7.87	7.04	44.89
					Cu RoMet	101.0	21.14	8.15	13.17	1.24	8.09	70.90	13.33	10.07	66.89	58.66
					Cu RoTls	886.5	.99	6.08	13.40	.07	.65	29.10	86.67	89.93	33.11	41.34
					Heads	987.5	3.05	6.25	13.38	.19	1.41	100.00	100.00	100.00	100.00	100.00
7.	100	50	30	2000	Cu Conc	29.1	13.10	8.67	19.90	4.14	6.12	12.86	4.36	4.27	67.04	14.87
					Cu Tls I	131.4	16.90	5.26	21.00	.16	6.26	74.90	11.94	20.35	11.70	68.66
					Cu RoMet	160.5	16.21	5.84	20.80	.88	6.23	87.76	16.30	24.62	78.74	83.53
					Cu RoTls	837.8	.43	5.74	12.20	.05	.23	12.24	83.70	75.38	21.26	16.47
					Heads	994.3	2.97	5.80	13.58	.18	1.20	100.00	100.00	100.00	100.00	100.00
8.	100	50	30	3000	Cu Conc	22.4	13.80	9.21	19.40	5.06	6.77	10.14	3.34	3.39	59.86	11.89
					Cu Tls I	150.4	15.80	5.10	23.30	.15	5.99	77.93	12.42	27.30	11.92	70.63
					Cu RoMet	172.8	15.54	5.63	22.79	.79	6.09	88.07	15.76	30.69	61.78	82.52
					Cu RoTls	823.7	.44	6.32	10.90	.06	.27	11.93	84.24	69.31	38.22	17.48
					Heads	996.5	3.06	6.20	12.88	.19	1.28	100.00	100.00	100.00	100.00	100.00

Table VIII lists the results of additional tests some of which are Cu-pre float tests but are presented in this section for chronological continuity. Test 11 was identical to test 7, (table VI) except that the primary grind was longer. 2BCD ore is harder than 2EF or 2H ore types and needs to be ground longer to attain similar fineness. The metallurgy was not better than test 7.

Test 12 was also same as test 7, (table VI) except for higher Z-11 usage. The results are similar to test 7. Test 13 uses conditions which are a combination of conditions used in tests 9 and 10, (table VII). There is no improvement in results.

In test 14 an attempt was made to pre-float Cu using an acid pH (4.7) and very low Z-11. The results were satisfactory as compared to many previous tests. However, slightly higher Z-11 may improve Cu rougher recovery.

Another test that should be carried out involves $K_2Cr_2O_7$ addition to primary grind without Z-11. This may help in achieving a better separation of Pb in the rougher stage.

(d) Cu/Pb bulk flotation - separation -II:-

The accidental finding of Cu/Pb bulk flotation while attempting Cu pre-flotation in tests 4 to 8 (table VI), led to the use of test 7 as standard procedure for producing a Cu/Pb bulk rougher conc. Table IX shows the metallurgy obtained when a Cu/Pb Bulk conc. was produced on a large scale using a large grinding mill and flotation cell. Obviously the metallurgy differs from test 7 (table VI) very drastically. Many changes in procedure may be necessary in order to obtain comparable metallurgy in a large scale test.

The Cu/Pb rougher conc. produced as above was used for Pb/Cu separation tests. Table X lists results of six such tests. In test 1 to 5 an attempt was made to depress Cu using NaCN in the regrind mill. As the amount of NaCN increases so does Cu in the Pb first cleaner tails. Unfortunately much of the Pb is also depressed making Cu/Pb separation using this technique impractical.

Another cleaner test was carried out using a Finnish flow scheme called Vihanti process (test 6). The results are very poor.

Table XI lists results of a test which was a repetition of test 4 (table X) except that the bulk rougher conc. was prepared without any Na_2SO_3 in the primary grind. This was done based on the hypothesis that Na_2SO_3 renders galena insensitive to flotation in presence of NaCN as found in tests 1 to 5 (table X).

TABLE VIII

ORETYPE and Test Description	SAMPLE	WTS	ASSAYS					DISTRIBUTION				
			Pb	Zn	Fe	Cu	Ag	Pb	Zn	Fe	Cu	Ag
11. <u>2BCD</u> Same as test 7 (Tab VI) but with a 20 minute primary grind.	CuCC ₁	36.8	13.00	8.16	17.0	3.18	5.71	15.93	4.41	5.53	48.29	15.15
	CuCT ₁	167.6	12.60	5.99	16.4	.18	4.80	70.34	14.75	25.05	12.45	67.99
	Cu/Pb Ro Conc.	204.4	12.67	6.38	16.9	.72	4.96	86.27	19.16	30.58	60.74	73.14
	Cu/Pb ScTIs	792.8	.52	6.44	9.9	.12	.47	13.73	80.84	67.42	39.26	26.86
	Heads	997.2	3.01	6.83	11.84	.24	1.39	100.00	100.00	100.00	100.00	100.00
12. <u>2BCD</u> Same as test 7 (Tab VI) with high Z-II	Cu/Pb Ro Conc.	274.3	9.71	5.07	20.4	.57	3.84	88.88	14.91	51.07	64.27	83.87
	Cu/Pb ScTIs	724.5	.46	7.72	7.4	.12	.29	11.12	80.09	48.93	35.73	16.63
	Heads	998.8	3.00	6.99	10.97	.24	1.26	100.00	100.00	100.00	100.00	100.00
13. <u>2BCD</u> -no NaCN -2 kg/t Na ₂ SO ₃ -70 g/t Z-II (total) -no K ₂ Cr ₂ O ₇	CuCC ₁	23.9	30.60	10.26	9.9	5.33	12.26	24.61	3.74	2.04	51.02	14.25
	CuCT ₁	34.2	9.74	9.67	10.2	.28	3.52	11.21	5.04	3.01	3.84	7.91
	Cu/Pb Ro Conc.	58.1	18.32	9.91	10.1	2.36	7.12	35.82	8.78	5.05	54.86	27.16
	Cu/Pb ScTIs	934.4	2.03	6.37	11.7	.12	1.18	64.18	91.22	94.94	45.15	72.84
	Heads	997.5	2.98	6.58	11.61	.25	1.53	100.00	100.00	100.00	100.00	100.00
14. <u>2BCD</u> Cu/Pb Ro Conc. Low pH with H ₂ SO ₃ -20 g/t Z-II	Cu/Pb Ro Conc.	24.0	18.30	10.00	12.5	4.99	7.69	14.82	3.63	2.48	45.02	12.97
	Cu/Pb ScTIs	974.9	2.59	6.54	12.1	.15	1.27	85.18	96.37	97.52	54.98	87.03
	Heads	998.9	2.97	6.62	12.11	.27	1.42	100.00	100.00	100.00	100.00	100.00

TABLE IX

ORETYPE and Test Description	SAMPLE	WTS	ASSAYS					DISTRIBUTION					
			Pb	Zn	Fe	Cu	Ag	Pb	Zn	Fe	Cu	Ag	
Cu/Pb Ro. Conc. generation for group D1-5 Using test 7 (table VII) scheme													
	Cu/Pb Ro Conc	570.10	26.40	4.63	16.0	1.69	10.37	62.77	4.87	9.06	44.64	46.52	
	Cu/Pb Ro Tls	7429.4	1.20	6.94	12.3	.16	.83	37.23	95.13	90.94	55.36	53.48	
	Heads	8000.0	3.00	6.78	12.6	.27	1.59	100.00	100.00	100.00	100.00	100.00	

Table X (cont'd)

ORETYPE and Test Description	SAMPLE	WT%	ASSAYS					DISTRIBUTION				
			Pb	Zn	Fe	Cu	Ag	Pb	Zn	Fe	Cu	Ag
2BCD 4. std Pb cleaning circuit - 200 g/ft NaCN to Regrind	PbCC ₃	6.4	75.56	1.04	2.0	.42	26.19	17.77	1.56	.80	1.55	16.72
	PbCT ₃	7.3	61.40	1.87	4.9	1.13	22.18	16.62	3.06	2.25	4.75	16.15
	PbCC ₂	13.7	68.25	1.50	3.5	.80	24.05	34.34	4.62	3.05	6.30	32.87
	PbCT ₂	9.3	31.40	4.18	14.0	2.28	11.98	10.74	8.71	8.17	12.22	11.11
	PbCC ₁	23.0	53.35	2.58	7.7	1.40	14.17	45.13	13.33	11.22	18.52	43.98
	PbCT ₁	77.7	19.20	4.51	18.2	1.82	7.23	54.87	86.67	84.78	81.48	56.02
	* Heads	100.7	27.00	4.43	15.8	1.72	9.96	100.00	100.00	100.00	100.00	100.00
5. std Pb cleaning circuit - 500 g/ft NaCN to regrind.	PbCC ₃	6.8	61.40	1.21	1.9	0.33	26.08	16.46	1.87	.81	1.33	17.97
	PbCT ₃	5.1	58.60	3.07	5.5	.94	20.45	11.78	3.50	1.77	3.09	10.57
	PbCC ₂	11.9	60.20	1.99	3.4	.61	23.67	28.24	5.37	2.58	4.33	28.54
	PbCT ₂	10.2	33.40	6.04	12.7	1.88	12.50	13.43	14.01	8.16	11.40	12.92
	PbCC ₁	22.1	47.83	3.86	7.7	1.20	18.51	41.66	19.39	10.74	15.73	41.46
	PbCT ₁	77.4	19.00	4.55	18.2	1.82	7.42	58.34	80.61	82.26	84.27	58.55
	* Heads	100.0	25.37	4.40	15.9	1.68	9.87	100.00	100.00	100.00	100.00	100.00
6. 2BCD Vihanti process Bulk Flotation to Third cleaner conc and separate. - pH to 10.8 with lime - 240 g/ft Z-11 (total) - Fourth cleaner 2000 g/ft K ₂ Cr ₂ O ₇	Cu Conc.	2.3	31.40	22.00	7.7	3.13	12.00	1.27	3.54	.46	2.36	1.39
	Pb Conc.	31.4	52.00	9.40	6.3	1.78	17.08	28.68	20.63	5.18	18.34	27.09
	Cu/PbCT ₃	28.3	34.70	10.05	10.5	2.42	12.64	17.25	19.88	7.79	22.47	18.07
	Cu/PbCC ₂	62.0	43.34	10.16	8.3	2.12	14.86	47.20	44.05	13.43	43.17	46.55
	Cu/PbCT ₂	21.9	21.60	5.81	16.3	1.39	8.03	12.15	8.89	4.36	9.99	8.88
	Cu/PbCC ₁	83.9	37.67	9.02	10.4	1.93	13.08	59.35	52.94	22.79	53.16	55.43
	Cu/PbCT ₁	150.3	15.40	4.48	19.6	.95	5.87	40.65	47.06	77.21	46.85	44.56
* Heads	234.2	24.31	6.11	16.29	1.30	8.45	100.00	100.00	100.00	100.00	100.00	
* HEADS WERE Cu/Pb rougher conc.												

The results of this test show that Cu/Pb separation in the first Pb cleaning stage has improved but grade/recovery of Cu in Pb first cleaner tails is hopelessly low.

CONCLUSIONS:

So far we have had only a limited success with Cu separation. It has been discovered that the main problem is Cu/Pb separation.

A look at the flow sheet of other mines presently producing a Cu conc. from Cu/Pb bulk conc. suggests that the best route to go may be to depress Pb instead of Cu. Since the volume of Cu mineral is much smaller than that of Pb mineral, it is logical to try to float Cu from the bulk conc. The use of $K_2Cr_2O_7$ to depress Pb is quite rare in the industry. Since we have carried out many tests with $K_2Cr_2O_7$ so far, further tests should be suspended.

Another depressant for Pb used extensively in the industry is SO_2 in the presence of starch. In test 14 (table VIII) an acid pH (2) was tried and the results were better than many other pre-float tests. More tests at lower pH with SO_2 /starch may significantly improve Cu metallurgy.

RECOMMENDATIONS:

- (a) Carry out a series of tests using the SO_2 /starch reagent scheme similar to the one used at Magmont Concentrator, Missouri.
- (b) Try to duplicate the results of test 7 (table VI) on a large scale.



R. Murarka
Metallurgist

To J. Levanaho

cc M Nicholson

From R. Murarka

R. Visagie

Date July 26, 1983

Subject Cu flotation up-date

SUMMARY:

With 2BCD ore, production of a Cu-Pb bulk rougher conc. and a subsequent separation seems to be more promising. For 2EF and 2H ore types, Cu pre-flotation has been found to be more successful. However, more bulk flotation tests should be performed before drawing final conclusions.

2BCD ORE:

A Cu pre-flotation cleaner test using very low collector addition (70g/t) gave Cu grade/recovery of 9.5/40.7. A locked cycle test using this scheme gave grade/recovery of 10.6/40.3.

When both Pb and Cu are floated in a bulk rougher conc., high Pb, Cu and Ag recoveries are obtained (table 1). This suggests that the best route to go is Cu-Pb bulk flotation and a subsequent separation. Although Cu-Pb separation has not been successful yet, cleaner tests using SO_2 -starch should be tried.

Some more work with K-amyl Xanthate should be carried out since it was found to be very selective towards Pb and Cu (ie. separation of Fe and Zn was better). However, Ag recovery was found to be 70% maximum. This must be confirmed.

2EF ORE:

Most work was done on the lines of 2BCD tests. The best test turned out to be the one similar to the pre-flotation cleaner test with very low collector addition mentioned above. The metallurgy is listed in table 11.

A locked cycle test was carried out using the above-mentioned scheme but results were much poorer than the cleaner test! The reasons for this abnormality are not clear at the present time.

2H ORE:

Similar testwork was conducted for 2H ore. The best test was

