

006344

To W. Muir

Date January 25, 1977.

From M. Holm

Subject The Metallurgical Testwork on the Five Ore Samples from the Grum Deposit.OBJECTIVES

To determine, by a series of flotation tests, the compatibility of Grum ores to:

1. The Anvil reagent scheme
2. The flotation scheme developed by Lakefield Research.

SUMMARY

All the Grum samples except the quartz sulphides responded favorably to the flotation scheme used in the Anvil concentrator. Slight adjustments were required in reagent additions due to the higher Grum metal contents (see Table I below).

TABLE I - GRUM HEAD ASSAYS

<u>Sample Number</u>	<u>Ore Type</u>	<u>Pb</u>	<u>Zn</u>	<u>Fe</u>	<u>Cu</u>
D-1	Massive banded sulphides	5.03	9.9	8.0	0.21
E-1	Massive flow sulphides	6.52	11.4	8.4	0.07
F-1	Massive porous sulphides	4.61	13.1	26.7	0.08
G-1	Quartz sulphides	1.73	3.3	6.2	0.09
H-1	Banded sulphides	5.46	9.4	15.5	0.11
	Anvil crusher stockpile	4.73	9.6	35.1	
	1976 Y.T.D. Anvil feed	2.66	5.48	30.7	

The good responses of these Grum samples were a marked contrast to those Grum samples previously tested at Cyprus Anvil<sup>1</sup>. The previous testing showed the Grum ore to be highly oxidized and containing preactivated zinc which floated with the lead concentrate. The latest Grum samples were not as oxidized and did not contain as much preactivated zinc.

<sup>1</sup> M. Fernandes, July 1975.

The Grum quartz sulphide ore sample did not respond as well as the other Grum samples because it contained graphite, had lower heads, and was much more difficult to grind due to its hardness (see Table II).

The Cyprus Anvil flotation scheme proved superior to the Lakefield Research flotation scheme<sup>2</sup>, which produced uncontrollable foaming when a duplication was attempted in the Anvil metallurgical laboratory. The Cyprus Anvil flotation scheme also proved itself equal to a modified Lakefield flotation scheme<sup>3</sup> (see Table III). The considerably finer primary grinding used in the Lakefield flotation scheme did not appear to yield any benefits not obtained by regrinding the rougher concentrates<sup>4</sup>, as is the practice at Cyprus Anvil. The fine grind, however, did cause some sliming in the lead and zinc rougher flotation.

In general, the Grum ores responded very similarly to normal Anvil ore using Anvil practices in the lead flotation circuit. The zinc flotation of Grum ores with the Cyprus Anvil scheme was slightly superior to that of normal Anvil ore, this was due to the high zinc heads of the Grum ores, which made cleaning the rougher concentrates relatively simple.

<sup>2</sup> See Lakefield Test #139 in Appendix.

<sup>3</sup> This had reduced reagent quantities to control foaming.

<sup>4</sup> See regrind and cleaning test Appendix.

INTRODUCTION

This series of flotation tests was carried out on Grum ore samples which were frozen in water to prevent oxidation during storage. The purpose of the metallurgical testwork was to determine the response of the various types of Grum ores to the milling practices of the Anvil mill. The possibility of Cyprus Anvil custom milling Grum ore had also been expressed.

The testing also included a reagent and grinding scheme developed by Lakefield Research, specifically for Grum ores. The intention was to reproduce the Lakefield results at Cyprus Anvil.

John Carrington, of A. E. X., advised us that it would be possible to mine massive banded sulphides, massive flow sulphides and massive porous sulphides separately from the quartzitic and banded ores. He also advised us that massive sulphides constitute the major part of the orebody.

DISCUSSION

1. Grinding

There are considerable differences in the grindabilities of Grum ores and this was sometimes reflected in the flotation results. Screen analysis of flotation tailings from tests with the standard Anvil test grinding time<sup>5</sup> yielded the results contained in Table II.

TABLE II - SCREEN ANALYSIS DATA (ANVIL GRIND)

Tyler Mesh	Cumulative Weight % Passing						Size Microns <i>μ</i>
	Anvil Crusher Stk. Pile	Grum Quartz Sulphides	Grum Massive Flow	Grum Massive Banded	Grum Massive Porous	Grum Banded (H-1)	
100	93.4	72.5	93.9	90.5	99.6	95.2	150
150	77.9	61.4	82.0	78.8	98.0	84.5	106
200	51.1	51.0	62.0	62.8	69.0	67.0	74
325	32.1	42.2	48.6	50.3	39.6	55.6	44
P <sub>80</sub>	120 <i>μ</i>	180 <i>μ</i>	110 <i>μ</i>	115 <i>μ</i>	90 <i>μ</i>	100 <i>μ</i>	

<sup>5</sup> The Anvil test grind aims for @ 65% -200 mesh.

## 2. Oxidation

Although oxide assays were not performed on the Grum samples, it is evident that the degree of oxidation present in previous samples obtained from Grum was far greater. The ore samples used by Lakefield Research were also highly oxidized<sup>6</sup>. This point was underlined by the amounts of sodium carbonate required to achieve a pH of 9.8 during lead rougher flotation in the Lakefield Test #139\* and during testing at Cyprus Anvil. The decrease of five pounds per ton consumption of soda ash, a fifty percent reduction from the Lakefield testing to the Cyprus Anvil testing, indicates significantly less oxidation. The fact that the latest samples from Grum had a great deal less preactivated zinc floating in the lead roughers, than during previous testing, is another sign of less oxidized ore.

## 3. The Grum milling scheme developed by Lakefield Research

Since a copy of a flotation test performed at Lakefield Research on Grum ore was available at Cyprus Anvil, an attempt was made to duplicate the results in an identical test in the Cyprus Anvil laboratory. This attempt produced a float which foamed excessively and floated all minerals available with no selectivity.

A modified Lakefield test, with reduced reagent amounts<sup>7</sup>, produced good results. This was adopted as the basic or modified Lakefield flotation test for the purpose of comparison. The results were comparable to those obtained with the standard Anvil tests<sup>8</sup>. The complete results of these tests are in Appendix III.

\* See Appendix.

<sup>6</sup> Lakefield Research Progress Report #3.

<sup>7</sup> See Table III.

<sup>8</sup> See Table IV.

TABLE III

MODIFICATIONS ON LAKEFIELD TEST #139

<u>Reagent</u>	<u>Lakefield #139 lbs./ton</u>	<u>Modified Lakefield lbs./ton</u>	<u>Change lbs./ton</u>
Na <sub>2</sub> CO <sub>3</sub>	10	5.0	-5.0
ZnSO <sub>4</sub>	1.0	1.0	Nil
NaCN	0.30	0.30	Nil
R-242	0.12	0.07	-0.05
R-404	0.04	0.025	-0.015
M.I.B.C.	Nil	Nil	Nil
Ca(OH) <sub>2</sub>	2.0	2.0	Nil
CuSO <sub>4</sub>	1.5	1.0	-0.50
Z-200	0.14	@ 0.014	-0.126
M.I.B.C.	0.02	Nil	-0.02
Teefroth A*	0.01	N/A	-0.01
D.F. 1012	Nil	@ 0.02	+0.015
Z-11	0.04	@ 0.15	+0.11
Pb flot. time	12 min. (rgr.)	12 min. (rgr.)	Nil
Zn flot. time	7 min. (rgr.)	10 min.	+3 minutes
grind time	30 minutes	same	Nil
grind % pass	87.5% -325 mesh	same	Nil

\* N/A (not available)

4. Testing with the Anvil standard flotation test

The flotation scheme used at Anvil, with the minor changes required by the higher mineral contents of the Grum ores, was tested on each individual Grum ore type. It was also used on a combination sample containing all Grum ore types, as well as a 1:1 blend of each Grum ore plus a sample of Anvil crusher stockpile ore. The following table contains some of the results.

TABLE IV FLOTATION RESULTS

Ore Sample	Cumulative Grades				Cumulative Recoveries			
	Anvil		Mod. Lakefield		Anvil		Mod. Lakefield	
	Pb	Zn	Pb	Zn	Pb	Zn	Pb	Zn
Grum H-1	35.5	33.9	32.3	25.4	82.7	70.1	82.9	74.6
Grum Banded	34.7	34.6	25.8	29.1	71.4	75.6	60.4	81.0
Grum Flow	35.1	34.1	34.9	35.4	74.9	72.1	78.9	74.9
Grum Porous	40.1	53.9	38.3	51.2	77.6	80.9	84.2	79.1
Grum Quartz	21.2	18.9	21.7	20.9	61.7	75.0	60.2	81.9
Grum Combined*	28.7	27.4	N/A	N/A	82.9	71.5	N/A	N/A
Grum Comb. + Anvil	36.7	40.6	N/A	N/A	84.0	78.7	N/A	N/A
<u>Anvil Stk. Pile</u>	55.6	38.1	48.3	50.5	90.4	<u>70.6</u>	92.0	<u>80.5</u>

\* Composite of all Grum Samples

*(Handwritten: A circle around '70.6' and '80.5' with arrows pointing to a circled 'N/A' to the right.)*

TABLE V - GRADE VS RECOVERY

Sample Type	Pb Grade @ 70% Rec.		Zn Grade @ 70% Rec.	
	Anvil	Lakefield	Anvil	Lakefield
Massive Banded (D-1)	36	graphite	42	46
Massive Flow (E-1)	43	40	37	47
Massive Porous (F-1)	46	51	58	51
Quartzitic (G-1)	24 *	22 *	37	39
Banded (H-1)	52	46	34	42
Anvil Stockpile +	<u>67</u>	<u>67</u>	<u>46</u>	<u>50</u>
Grum Combined	43	N/A	35	N/A

N/A not available

\* at 60% recovery

+ exceptional Anvil ore sample

Notes: Lakefield grind 30 minutes or 87.5% -325 mesh.

Anvil test grind 11 minutes or 60% -200 mesh.

This is slightly coarser than normal in the Anvil mill.

TABLE VII

## GRADE VS RECOVERY

Ore Type Plus 50% Anvil Ore	Anvil Ore & Grum Ore (1:1) Combinations		
	Cumulative %Pb Grade @ 75% Rec.	Cumulative Zn Grade @ 75% Rec.	Cumulative %Zn Grade @ 70% Rec.
Massive Banded (D-1)	52	46	51.5
Massive Flow (E-1)	48	46	52.0
Massive Porous (F-1)	49.5	56.5	57.5
Quartz Sulphide (G-1)	45	47	50.0
Banded (H-1)	48.5	40.5	50
Grum Combination	48.5	47.5	50.5

The results obtained from this series of tests were excellent and far superior to the results normally obtained in the Anvil mill with Anvil ores alone.

It was found, however, that careful control of collector to the lead roughers was essential in limiting the amount of zinc floating in the lead rougher concentrates. In attempting to improve lead recoveries by increasing the amount of collector used it was observed that the zinc sulphides in the lead concentrates increased dramatically after about 82 percent recovery, however this also occurs with Anvil ores. Zinc sulphate was tested as a zinc depressant as Lakefield Research had included it in their reagent scheme. The results of these tests showed that zinc sulphate had little or no affect on the amount of zinc floating with the lead. This is demonstrated in tests #2955 versus #2963 where in test #2963 with 1#/ton  $ZnSO_4$  21.0% of the total zinc floated in the lead roughers and scavengers, in test #2955 in which no zinc sulphate was used only 18.3% of the total zinc floated with the lead. This is further demonstrated by tests #9229 and #9233 (see Grade Recovery Curve #10).

The good results obtained with the relatively coarse Anvil grind (compared to the Lakefield) show that the extremely fine grind used by Lakefield research is probably unnecessary if regrinding of rougher concentrates is to be used, as in the Anvil mill. A standard Anvil regrind and cleaning test done on Grum banded (H-1) ores yielded final concentrates of 78.3% lead in the lead concentrate and 54.9% zinc in the zinc concentrate. This is at least as good as the best Anvil ores produce for concentrate grades. The complete cleaning tests are available as tests #2985 and #2986 in Appendix III.

The grum quartzitic, banded and flow samples do contain some graphite which may interfere with lead flotation as occurs in test #2946, and is usually not a serious problem.

CONCLUSIONS AND RECOMMENDATIONS

There should be no real problem milling the various Grum ores in the Anvil mill if they are not oxidized. The reagent consumption will be slightly higher than with normal Anvil ore, due primarily to the higher mineral contents of most of the Grum ores which would require slightly more copper sulphate and collector.

The tonnage milled per hour may have to be reduced somewhat if Grum ore is milled without blending with Anvil ore. This would have to be done for two main reasons. The first reason would be to ensure a slightly finer primary grind than with Anvil ore if the Grum ore was quartzitic material. The other reason for slightly reducing the T. P. H. milled would be the very real possibility of overloading the zinc cleaning circuit due to extremely high zinc heads, especially with Grum porous ores.

Recoveries and grades should approximate or better those obtained with Anvil ores.

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