*B O L I D E N  R E P O R T*

00o545

*December 8th, 1987*

To: Bill Scheding, Curragh Resources

From: Nils Johan Bolin, Boliden Mineral AB

Subject: Testwork on the Grum ore performed up to 1982

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Summary

A short summary has been done based on some of the reports on the Grum ore up to 1982.

Good results were reported in 1977 by Noranda based on pilot plant tests performed on material from an adit, 62 % Pb at 80 % recovery and 56 % Zn at 84 % recovery.

However, Lakefield performed more lab tests in 1979 with good lead recovery, but somewhat lower lead grade. The zinc grade was considerablY lower. In the tests performed by Kamloops in 1982, the results for the most important ore types (4A, 4BCD) were poor.

The reagent consumption has been similar to what has been used in the testing on Vangorda ore and fairly good results can be expected on some of the ore from Grum. The recovery of gold has been poor.

A similar study as has been planned for Vangorda should be done on Grum. In particular 4A ore coming from different parts of the deposit should be tested.

Recommendations that have been given in the Vangorda report are also valid for the Grum ore.


Nils Johan Bolin

# Testwork on the Grum ore performed up to 1982

## 1. Introduction

On a visit to Faro I (N J Bolin, Boliden Mineral AB) was asked to give my opinion on previous work that has been done on the Grum deposit up to 1982.

The available information comprised only a few reports of all that is listed, see Appendix A. However the most important reports were available.

This report consists of data that are valid for future work and some conclusions have been drawn from the results given in the reports.

## 2. Samples for testing

Assays on samples that have been tested in the reports are given in Appendix C.

A list of samples used in Kamloops final tests are given in Appendix B.

Head assays on the same samples are also given in Appendix B. The grade of Pb, Zn and Ag in ore types 4DC and 4A are low, but the grade of Au is fairly high in type 4A (1.4 g/t). Type 4E has a high grade of Au (1.7, 2.1, 1.9 g/t respectively).

## 3. Grinding

The grinding requirements for Grum ore seem to be similar to those for Vangorda ore. An estimate would be 90 +-5% -74 microns in the lab. A comparision between lab grinding and plant grinding should be made for Faro to be able to make adjustments for the different slope of the particle size distributions in the lab and in the plant.

## 4. Flotation

Test data is given in Appendix C and results in appendix D. Fine grinding is as essential for the Grum ore as it is for Vangorda ore. Lakefield got good results at a grind of 91-93 % -74 microns in tests made in 1979. Different results have been achieved at different times. In Table 1 a summary is given.

## Table 1

Summary of different results on the Grum ore:

| | Lead flotation | | Zinc flotation | |
|---|---|---|---|---|
| | Grade | Recovery | Grade | Recovery |
| Noranda forecast (on Lakefields results in 1977 adjusted to average grade) | 62 | 80 | 56 | 84 |
| Lakefield 1979 | 52-62 | 75-87 | 47-53 | 60-91 |
| Kamloops 1982 | 25-55 | 77-87 | 38-58 | 72-80 |

Tests made by Lakefield in 1977 were performed at pilot plant scale and the test material came from an adit.

The worst results in all Kamloops tests came from samples of 4BCD and 4A which comprise a substantial part of the ore body ( see Table 2).

## Table 2

Relative abundance of ore types based on Section 64 of the Grum deposit. (Taken from G-4, page 32)

| Ore type | Percent of total |
|---|---|
| G | 12 |
| E | 16 |
| DC | 29 |
| A | 41 |

The conditions have varied as follows:

In lead flotation

| | | |
|---|---|---|
| Na2CO3 | 1.4 - 5.1 | kg/t |
| pH | 9.1 - 10.2 | |
| ZnSO4 | 0 - 1.0 | kg/t |
| NaCN | 0.15- 0.8 | kg/t |

In zinc flotation

| | | |
|---|---|---|
| Ca(OH)2 | 0.9 - 3.5 | kg/t |
| pH | 10.7 - 11.5 | |
| CuSO4 | 0.3 - 1.25 | kg/t |

The highest additions have been made by Kamloops and Lakefield (1979). Aeration effects have been tested by Kamloops, otherwise little else has been tried besides reagent levels and different grinds.

NaIPX has been used most frequently as a collector both in the lead and zinc flotation. Dithiophosphates have also been used in lead flotation and Z-200 has been used in zinc flotation.

As frother, MIBC has been used both in lead and zinc flotation. Dowfroth 1012 has also been used in the zinc flotation. Kamloops does not state what frother they have used, if any.

## 5. Discussions - recommendations

It is more clearly stated from where the samples have been taken in the tests performed on Grum compared to Vangorda, if the drill hole can be located in the orebody plan.

If the sample of 4A and 4BCD from Grum in the tests done by Kamloops comprise a substantial part of the orebody, there may be great difficulty in achieving satisfactory results.

It is therefore neccesary to do a lab study on Grum ore in a similiar fashion as for Vangorda.

In addition to a general lab testing program, the ore types 4A and 4BCD which have given bad results should be tested to find out how big a problem these ore types are. If samples from different locations in the ore give the same bad results, then a special study should be done to try to find a good way to treat these ore types.

The recommendations that are given for Vangorda are also valid for Grum.

## METALLURGICAL REPORTS ON GRUM ORES

### INDEX

| FILE | COMPANY | TITLE | DATE |
|---|---|---|---|
| G-1 | K.R.A.L. KM014 | Preliminary Grind Effects Study-Grum Pilot Plant Composite | Dec 1979 |
| G-2 | K.R.A.L. KM020 | Aeration Effects in Laboratory Grinding-Grum Ore Composite Sample | May 1980 |
| G-3 | K.R.A.L. KM045 | Cyprus Anvil Mining Corporation Preliminary Testwork-Grum Deposit | Feb 1982 |
| G-4 | K.R.A.L. KM060 | Metallurgical Response of Grum Ore-Grum Deposit-Vangorda Plateau | May 1982 |
| G-5 | NORANDA Report | Geological and Mineralogical Investigation of the Metallurgy of The Grum Orebody, Yukon Territory | Mar 1977 |
| G-6 | MATTAGAMI | Current Status of Beneficiation Testwork on Vangorda Grum Ores | Apr 1976 |
| G-7 | MATTAGAMI | Flotation Process for Ores from The Grum Deposit | Sept 1976 |
| G-8 | LAKEFIELD 1869-PR1 | An Investigation of The Recovery of Lead and Zinc From a Grum Sample | Oct 1975 |
| G-9 | LAKEFIELD 1869-PR2 | An Investigation of The Recovery of Lead and Zinc From a Grum Deposit Sample | Dec 1975 |
| (SEE G-30) | | | |
| G-10 | LAKEFIELD 1868-PR2 | Microscopic Examination of Grum Project Pilot Plant Samples | Mar 1976 |
| G-11 | LAKEFIELD 1868-PR3 | An Investigation of the Recovery of Lead and Zinc From a Grum Deposit Sample PPA | Apr 1976 |
| G-12 | LAKEFIELD 1868-PR4 | An Investigation of the Recovery of Lead and Zinc From a Grum Deposit sample PPB | May 1976 |
| F-28 | Lakefield | The recovery of Lead and Zinc from Grum and Cyprus Anvil Samples. | Dec 1979 |

| | | | | | |
|---|---|---|---|---|---|
| | G-13 | LAKEFIELD 1868B-PR5 | An Investigation of The Recovery of Lead and Zinc From a Grum Deposit Sample PPC | Nov | 1976 |
| | G-14 | LAKEFIELD 1868-PR6 | An Investigation of The Recovery of Lead and Zinc From Grum Deposit Samples | Dec | 1976 |
| | G-15 | LAKEFIELD 1991-PR7 | An Investigation of The Recovery of Lead and Zinc From Grum Deposit Samples | June | 1977 |
| | G-16 | LAKEFIELD 1991-PR8 | An Investigation of The Recovery of Lead and Zinc From Grum Deposit Samples | Sept | 1977 |
| | G-17 | LAKEFIELD 1991-PR9 | An Investigation of The Recovery of Lead and Zinc From Grum Deposit Samples | Mar | 1978 |
| | G-18 | LAKEFIELD 2027-PR10 | A Laboratory Investigation of The Recovery of Lead and Zinc on Grum Deposit Pilot Plant Samples | Mar | 1978 |
| | G-19 | LAKEFIELD 2027-PR11 Vol. 1 | A Pilot Plant Investigation of The Recovery of Lead and Zinc From Grum Deposit Samples | Feb | 1978 |
| | G-20 | LAKEFIELD 2027-PR11 Vol 4 | A Pilot Plant Investigation of The Recovery of Lead and Zinc From Grum Deposit Samples | Feb | 1978 |
| | G-21 | DOWA Report | Flotation Test of Grum Ore For Kerr Addison Mines Limited | Oct | 1976 |
| × | G-22 | C.A.M.C. Report | The Grum Project | Jan | 1977 |
| | G-23 | C.A.M.C. Report | Evaluation of Grum | Oct | 1978 |
| × | G-24 | BURTON Report | A Review of Some Aspects of Treatment of Faro and Grum Ores | Jan | 1979 |
| | G-25 | C.A.M.C. Memo | Flotation Testwork to Investigate Compatability of Anvil and Grum Ores | May | 1979 |
| | G-26 | MICHAELSON Letter | Faro Concentrator Expansion | May | 1980 |

| | | | | | |
|---|---|---|---|---|---|
| | G-27 | C.A.M.C. Data | Cyprus Anvil Mining Corporation Ownership, Assets, etc. | | 1983 |
| | G-28 | CURRAGH Telefax | Mercury Content Vangorda & Grum Lead Concentrates | Apr | 1987 |
| x | G-29 | NORANDA | Pilot Plant Testing of Grum Ores | Dec | 1977 |
| | G-30 | LAKEFIELD 1868-PRI | A Pilot Plant Investigation of The Recovery of Lead and Zinc From Grum Deposit Samples | Feb | 1976 |
| x | | Lakefield | Grum testing data (pilot plant testing) | | 1977 |

x Samples available for this study

GRUM

Kamloop samples for final testing (report jan -82)

| Type | Drill hole | Sample number |
|---|---|---|
| 4G>15% combined | 80-A203 | 5491-3 |
| | -A205 | 5624, 5626 |
| | -A208 | 5808 |
| | -A210 | 5694, 5698 |
| 4G<15% combined | 80-A203 | 5494, 5501, 5504-5 |
| | -A205 | 5623 |
| | -A208 | 5809-10 |
| | -A210 | 5695, 5701-2 |
| 4E<6% combined | 80-A203 | 5506 |
| | -A204 | 5608, 5611 |
| | -A205 | 5622, 5666, 5671, 5674-5 |
| | -A209 | 5925-26, 5700, 5703 |
| | -A211 | 5739, 5793 |
| | -A212 | 5889-91, 5894 |
| | -A213 | 5911 |
| 4E 6-10% combined | 80-A203 | 5540-41, 5543-45 |
| | -A205 | 5667, 5672 |
| | -A209 | 5699 |
| | -A211 | 5792 |
| | -A212 | 5892-93, 5895 |
| | -A213 | 5906 |
| 4E>10% combined | 80-A205 | 5623-24, 5626 |
| | -A209 | 5917-18, 5704 |
| | -A211 | 5738 |
| | -A213 | 5898-99, 5902-3 |
| 4DC | 80-A200 | 2075-9, 2084-6 |
| | -A202 | 5466-9 |
| | -A208 | 5823-6 |
| 4A | 80-A200 | 2052-3 |
| | -A202 | 5436, 5439, 5448, 5450-1 |
| | -A203 | 5502, 5938-40 |
| | -A204 | 5599-5601 |
| | -A205 | 5644-47 |

TABLE I - 6

Head Assays of Ore Type Composites

| Ore Type | Grade Group | Assays % | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Au* | Ag* | Cu | Pb | Zn | Fe | Po | Mn | As | Sb | Hg* |
| G | < 15% | 1.2 | 82 | 0.15 | 4.6 | 7.3 | 18.9 | 0.88 | 0.06 | 0.08 | 0.04 | 53 |
| | > 15% | 1.2 | 97 | 0.12 | 5.9 | 9.7 | 20.9 | 1.14 | 0.07 | 0.12 | 0.05 | 91 |
| E | < 6% | 1.7 | 35 | 0.30 | 1.6 | 2.8 | 39.6 | 2.02 | 0.13 | 0.20 | 0.04 | 25 |
| | 6-10% | 2.1 | 50 | 0.26 | 2.9 | 3.8 | 37.5 | 4.68 | 0.30 | 0.24 | 0.04 | 34 |
| | > 10% | 1.9 | 84 | 0.18 | 5.2 | 6.4 | 35.3 | 3.63 | 0.09 | 0.15 | 0.05 | 46 |
| DC | < 4% | .75 | 24 | 0.30 | 1.3 | 1.8 | 28.5 | 8.7 | 0.51 | 0.19 | 0.02 | 37 |
| A | < 4% | 1.4 | 27 | 0.08 | 1.4 | 2.4 | 12.5 | 2.2 | 0.06 | 0.18 | 0.02 | 26 |

GRUM data for labtesting

| Report | Date | Grind | Lead-flotation | | | | kg / ton | Zinc-flotation | | | kg / ton | Sample, e t c |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Na2CO3 | pH | NaCN | ZnSO4 | Collec.-froth. | Ca(OH)2 | pH | CuSO4 | Collec.-froth. | |
| Cyprus Anvil | Jan 1977 | k80= 115 um | 2.5 | 10 | 0.15 | 0.45 | R-242, 404, MIBC | 0.9 | 10.9 | 0.45 | Z-11, 200, Dow 1012 | D-1 |
| | Jan 1977 | k80= 110 um | 2.5 | 9.8 | 0.15 | 0.45 | R-242, 404 | 0.9 | 10.7 | 0.45 | Z-11, 200 | E-1 |
| | Jan 1977 | k80= 90 um | 2.5 | 9.1 | 0.15 | 0.45 | R-242, 404 | 0.9 | 10.9 | 0.45 | Z-11, 200 | F-1 |
| | Jan 1977 | k80= 180 um | 2.5 | 10.1 | 0.15 | 0.45 | R-242, 404, MIBC | 0.9 | 10.9 | 0.32 | Z-11, 200 | G-1 |
| | Jan 1977 | k80= 100 um | 2.5 | 9.6 | 0.15 | 0.45 | R-242, 404, MIBC | 0.9 | 10.7 | 0.45 | Z-11, 200, Dow 1012 | H-1 |
| Noranda | Dec 12/77 | 91% -74 um | 1.4- | 9.2 | 0.1 | | R-343, MIBC | 1.1 | 10 | 0.9 | Z 200,R343,Dow 250 | |
| | | 70% -38 um | 2.3 | | | | | | | | | |
| Lakefield | Aug 23/79 | 93% -74 um | 5.1 | 9.4 | 0.45 | 1 | Z-11, R-242, MIBC | 3 | 11.1 | 1 | Z-11, 200, MIBC | K |
| | | 71% -38 um | | | | | | | | | M-748, 1902 | |
| | Aug 23/79 | 92% -74 um | 4.1 | 9.6 | 0.45 | 1 | Z-11, R-242, MIBC | 3 | 11.3 | 1 | Z-11, 200, MIBC | J |
| | | 66% -38 um | | | | | | | | | M-748 | |
| | Aug 23/79 | 91% -74 um | 5.1 | 9.3 | 0.45 | 1 | Z-11, R-242, MIBC | 3.5 | 10.8 | 1.25 | Z-11, 200, MIBC | B |
| | | 68% -38 um | | | | | | | | | M-748 | |
| Kamloops | May 3/82 | k80=36um * | 2.5 | 9.9 | 0.5 | | Z-11 | 1 | 11 | 1.2 | Z-11 | 4G |
| | May 3/82 | k80=34um * | 5 | 9.4 | 0.8 | | Z-11 | 1 | 11 | 1.2 | Z-11 | 4E |
| | May 3/82 | k80=39um * | 3 | 9.5 | 0.7 | | Z-11 | 1 | 11.5 | 0.7 | Z-11 | 4DC |
| | May 3/82 | k80=38um * | 3 | 10.2 | 0.8 | | Z-11 | 1 | 11.5 | 0.7 | Z-11 | 4A |

* with cyclosizer

| | | | |
|---|---|---|---|
| R-343 | NaIPX | Af 25 | Dikresyldithiophosphate |
| Z-9 | PIPX | Af 31 | Af 25 + secondary collector |
| Z-11 | NaIPX | Af 130 | Thiocarbanilid |
| Dow 250 | Polypropyleneglycolmethylether | Af 242 | Ammoniumsalt of 31 |
| MIBC | Methylisobutylcarbinol | Af 404 | Mixture of Diisobutyldithophosphate and mercaptobenzothiazol |
| Froth 65 | Polypropyleneglycol | | |
| Z-200 | Isopropylethylthionocarbamate | 1902 | ? |
| | | M-748 | ? |

GRUM metallurgical balances

| Company | | Date | Head grade Pb | Zn | S | Cu | Au | Ag | Pb-concentrate Grade Pb | Zn | Recovery Pb | Zn | Au | Ag | Zn-concentrate Grade Pb | Zn | Recovery Pb | Zn | Sample description |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cyprus | ? | Jan -77 | 5.03 | 9.90 | | 0.21 | | | 35 | | 71 | | | | 35 | | 76 | | D-1 |
| Anvil | ? | Jan -77 | 6.52 | 11.40 | | 0.07 | | | 35 | | 75 | | | | 34 | | 72 | | E-1 |
| | ? | Jan -77 | 4.61 | 13.10 | | 0.08 | | | 40 | | 78 | | | | 54 | | 81 | | F-1 |
| | ? | Jan -77 | 1.73 | 4.30 | | 0.09 | | | 21 | | 62 | | | | 19 | | 75 | | G-1 |
| | ? | Jan -77 | 5.46 | 9.40 | | 0.11 | | | 36 | | 83 | | | | 34 | | 70 | | H-1 |
| Noranda forecast | ** | Dec 12/77 | 5.80 | 10.00 | | | 0.90 | 84 | 62 | 10 | 77 | | 33 | 72 | 3 | 56 | | 81 | Composite |
| Corrected aver. ore | ** | Dec 12/77 | 4.00 | 8.00 | | | 0.80 | 62 | 62 | 8 | 80 | | 33 | 72 | 2 | 56 | | 84 | pred. aver. ore |
| Lakefield | * | Aug 23/79 | 4.98 | 9.13 | 34 | 0.14 | | | 60 | 8 | 81 | 5 | | | 1 | 52 | 1 | 59 | Composite |
| | *** | | | | | | | | 60 | 8 | 87 | 6 | | | 1 | 52 | 2 | 91 | Composite |
| | * | | | | | | | | 53 | 10 | 84 | 9 | | | 1 | 53 | 2 | 64 | K-composite |
| | *** | | | | | | | | 53 | 10 | 86 | 9 | | | 1 | 53 | 3 | 84 | K-composite |
| | * | | | | | | | | 56 | 10 | 74 | 9 | | | 1 | 52 | 2 | 55 | J-sample |
| | *** | | | | | | | | 56 | 10 | 82 | 10 | | | 1 | 52 | 3 | 84 | J-sample |
| | * | | | | | | | | 53 | 16 | 66 | 12 | | | 2 | 47 | 1 | 7 | B-sample |
| | *** | | | | | | | | 53 | 16 | 74 | 13 | | | 2 | 47 | 4 | 60 | B-sample |
| Kamloop | *** | May 13/82 | 5.25 | 8.67 | | 0.14 | 1.20 | 90 | 55 | 12 | 87 | 12 | 33 | 68 | 1 | 58 | 3 | 80 | *4G* -81 drilling |
| | *** | | 3.20 | 5.83 | | 0.25 | 1.90 | 56 | 42 | 6 | 80 | 8 | 27 | 60 | 2 | 50 | 4 | 69 | *4E* -81 drilling |
| | *** | | 1.16 | 1.67 | | 0.30 | 0.75 | 24 | 26 | 3 | 83 | 8 | 66 | 51 | 1 | 38 | 2 | 77 | *4DC* -81 drilling |
| | *** | | 1.45 | 2.16 | | 0.08 | 1.40 | 27 | 25 | 3 | 77 | 7 | 11 | 57 | 1 | 51 | 3 | 73 | *4A* -81 drilling |

* labresults
** predicted from pilot plant tests
*** predicted from labtests