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January 20, 1977

Mr. M.D. Rowswell,  
Kerr Addison Mines Limited,  
P.O. Box 91,  
Commerce Court West,  
Toronto, Ontario,  
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Dear Sir:



Review of Two Test Reports on Grum Deposit

Introduction

In accordance with your instructions, we were pleased to make a brief review of the following test reports delivered to this office on Wednesday, January 12th, 1977:

1. "The Recovery of Lead and Zinc from Grum Deposit Samples submitted by Noranda Mines Limited".
  - Lakefield Research of Canada Limited Progress Report No. 6 dated December 18th, 1976.
2. Flotation Process for Ores from the Grum Deposit, Memo #4.
  - Mattagami Lake Mines Limited, Inter-office memorandum, K.V. Konigsmann to R.L. Coleman, dated December 30th, 1976.

This letter summarizes the discussions on the project review which were held in the Kerr Addison Mines' offices on Friday, January 14th, 1977, attended by:

M.D. Rowswell	- Kerr Addison Mines
P.S. Cross	- Kerr Addison Mines
J.K. Carrington	- Kerr Addison Mines
A.H. Ross	- A.H. Ross & Associates
N. Gibson	- A.H. Ross & Associates

The preliminary review has been expanded to illustrate reagent addition economics and to present some views on items for inclusion in future test programs.

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Qualifications

The reports, which are here reviewed, are only two among several which relate to the metallurgy of the Grum deposit.

It is unfortunate that we do not have results from the treatment of identical fresh ore samples at each of the laboratories. Despite these limitations, we offer some provisional comments on the testwork and make certain general recommendations for future test programs. The latter do not constitute a comprehensive list nor are they presented in detail. Undoubtedly, the on-going Mattagami Mines test program will embrace many of the suggestions, either in part or totally, that are being proposed here.

Summary of Results

The Mattagami Lake Mines Report outlines testwork on a 1,000 lb sample (designated B4) received September 14th, 1976 and a suite of 14 different mineralogical samples taken from the deposit in November 1976. From the B4 testwork, details not included in the preliminary report, the following plant results were projected.

	Assay				Recovery		
	Pb %	Zn %	Ag oz/ton	Hg ppm	Pb %	Zn %	Ag %
Mill Feed	4.7	9.3	2.3	82	100	100	
Lead Concentrate	45-55	8-10	15-20	100	75		65
Zinc Concentrate	2.5	53+	-	500		80	
Flotation Tailings	1.0	1.4					

It is stated that lead concentrates could possibly be upgraded by additional regrinding, use of higher reagent additions, further cleaning stages or other means.

The 14 different mineralogical samples were tested by a standard flotation technique and categorized into three groups; two of these could not satisfactorily be treated to produce marketable concentrates. Tests on the third group (6 of the 14 samples) alleged to represent 91 percent of the ore reserves were reported as giving a 'normal' flotation response for the very fine grained mineralization.

The head grades of the six samples varied from 1.32 to 8.82 percent lead and from 3.01 to 21.01 percent zinc. Results of the standard flotation test, for that sample having head grades closest to the predicted plant feed grade, are shown below:

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	Weight %	Assay %		Distribution %	
		Pb	Zn	Pb	Zn
Mill Feed	100.0	4.37	9.49	100.0	100.0
Lead Concentrate	8.7	39.70	10.04	78.6	9.1
Zinc Rougher and Scavenger Concentrate	28.8	1.79	29.05	11.8	88.3
Zinc Rougher Tailings	62.5	0.67	0.39	9.6	2.6

All results are from only one test series and confirmatory tests are required to demonstrate the production of marketable concentrate grades at acceptable metal recoveries.

B type ores are held to represent less than 10 percent of the total deposit and it is suggested that in plant practice, design throughputs will be reduced, when treating this particular material because of grinding and flotation requirements.

Investigations into grinding characteristics and flotation techniques are proceeding.

The report by Lakefield Research of Canada Limited is primarily concerned with the flotation response in batch and locked cycle tests, of two fresh ore samples, PPB and PPC, (designated B-2 and C-2 respectively) received on March 16, 1976. Other investigations into aging of samples and the suitability of Grum water were reported.

While the two samples, B-2 and C-2, differed in the nature and distribution of the mineral associations, the Lakefield standard test procedure gave highly satisfactory results both in terms of concentrate grade and metal recovery. Typical projected plant results are as follows:

Weight %	Assays				Distribution			
	Pb %	Zn %	Au oz/t	Ag oz/t	Pb %	Zn %	Au %	Ag %

Type B-2 Ore (Test 126)

Mill Feed	100.00	7.83	15.6	0.050	3.16	100.0	100.0	100.0	100.0
Lead Concentrate	10.73	65.1	10.80	0.070	22.36	89.2	7.4	15.9	76.0
Zinc Concentrate	24.34	1.85	57.5	0.030	1.76	5.7	89.7	15.4	13.6
Zinc Tailing	64.93	0.61	0.69	0.050	0.51	5.1	2.9	68.7	10.4

Type C-2 Ore (Test 127)

Mill Feed	100.00	4.62	9.83	0.031	2.06	100.0	100.0	100.0	100.0
Lead Concentrate	6.51	63.5	4.78	0.160	24.06	89.5	3.2	33.9	76.2
Zinc Concentrate	15.88	0.90	55.8	0.030	1.22	3.1	90.1	15.5	9.4
Zinc Tailing	77.61	0.44	0.85	0.020	0.38	7.4	6.7	50.6	14.4

The C-2 sample contained less sulphides, there were fewer complex intergrowths and being generally coarser grained than B-2 permitted less regrinding to achieve similar results.

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Attention is drawn not only to the difference in head grades between the reported figures from the Mattagami proposed flowsheet (based on tests with the B4 ore) and those from the B-2 tests at Lakefield but also to the probable mineralogical differences.

At the meeting, we were informed that the B-2 sample was collected in January 1976 and was split to the Lakefield and Mattagami laboratories. It was reported that the Lakefield procedure gave the best result. Lakefield were subsequently requested to test the Mattagami B-2 sample and found evidence of aging as shown below:

	<u>Weight</u> %	<u>Assays %</u>		<u>Distribution %</u>	
		<u>Pb</u>	<u>Zn</u>	<u>Pb</u>	<u>Zn</u>
<u>B-2 Ore from Mattagami (Test 139)</u>					
Head (calculated)	100.0	8.36	15.8	100.0	100.0
Lead Concentrate	12.52	57.9	12.9	86.2	10.2
Zinc Concentrate	22.94	2.42	56.4	6.6	81.7
Zinc Tailing	64.54	0.93	2.0	7.2	8.1

From a comparison of test results on the B-2 samples at Lakefield, (the Mattagami results are not in these reports) a noticeable decrease of lead concentrate grade is apparent, while metal recoveries, particularly zinc, were also lower.

Results from other flotation testwork on samples PPB and B-2, which had been stored at Lakefield for varying periods under different conditions, gave a markedly poorer response; higher levels of oxide lead content in the aged samples were recorded. It has not been claimed or demonstrated that a suitably modified standard flotation procedure will negate the effects of aging.

A comparative flotation test was conducted on sample C-2, using a water sample from the Grum deposit. Frothing problems were experienced in the cleaner stages of the test and the results cannot readily be interpreted.

Ore Grind

There is evidence in the reports that the Lakefield test procedure results in a finer ore grind than that practiced at Mattagami; the Mattagami report comments on the investigation of additional regrinding as a means of increasing lead concentrate grades.

The following comparative data is extracted from the two reports:

	<u>Mattagami</u>	<u>Lakefield</u>	
	<u>Test Grind</u>	<u>Sample</u>	<u>Test Grind</u>
Primary Grind % - 74 microns	85	B-2	92
		C-2	73
Lead Regrind % - 32 microns	No data		100
Zinc Regrind	Used		Not
	No data		used

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From the mineralogical studies at Lakefield, it would seem that a characteristic of the more 'refractory' ore samples is the significantly higher proportion of galena and sphalerite associated with pyrite. If, as in some ores, the economic mineral is exsolved in the pyrite, then fine grinding may be a prerequisite for good liberation. At Mattagami, the analysis of screen fractions in three products from test Van - 131 on B4 ore shows a large part of the lead and zinc content is present in the -10 micron sizes.

#### Flotation Practice

There are three significant differences in the two laboratory flowsheets.

- (a) Lakefield employ four stages of cleaners in each of the lead and zinc circuits compared to the three at Mattagami.
- (b) Lakefield only regrind the lead rougher concentrate whereas Mattagami regrind both the lead and the zinc rougher concentrates.
- (c) Mattagami operate the lead cleaners in open circuit, to avoid unmanageable circulating loads, but recognize the need for counter current recirculation of cleaner tailings in a plant design.

The flotation procedures as represented by the Mattagami Van-131 test on B4 ore and the Lakefield test 131 on a B-2 ore sample are depicted in Appendix I. The Lakefield procedure is more elaborate than that used at Mattagami having more reagent addition points and longer retention times.

#### Reagent Consumption and Costs

In accordance with your request, we have presented a rough estimate of reagent costs for what is believed to be the two standard flotation test procedures in use at Mattagami and Lakefield. These are shown in Appendix II. For the purposes of this comparative study, current F.O.B. budget prices have been used. The Lakefield reagent cost at 169 cents per ton ore, although 74 cents above the Mattagami figure, is not necessarily unreasonable for what would seem to be a complex lead-zinc ore.

Before commenting on the figures, it should be ascertained as to whether Lakefield have optimized reagent additions and combinations (Mattagami report that this, as fineness of grind, has not been done in their own work).

#### Recommendations

##### 1. Mineralogical Studies

- (a) Identify associations and liberation size of the various ore types relative to location in deposit.
- (b) Investigate aging phenomena on weathered ore samples.
- (c) Determine how metals are locked up in tailings.

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2. Flotation Testwork

- (a) Evaluate individual laboratory standard flotation techniques on a single sample from the deposit split by accepted methods in one of the laboratories. This same sample would provide check assay information.
- (b) Assess the flotation response of different mineralogical samples and relate to reserves and location in deposit.
- (c) Investigate measures to help counteract effects of aging. As an example, tarnished galena, which has been identified as a probable consequence of weathering in these ores, has successfully been scrubbed of its oxide film by SO<sub>2</sub> conditioning; the oxidation products of pyrite can also significantly affect flotation response.
- (d) Consider separate flotation of carbonaceous material if the reagent adsorption problem is of significant proportions.
- (e) Investigate stage flotation whereby excessive mechanical losses of metals in slime may be avoided.
- (f) Monitor mercury and arsenic in the flotation process before investigating removal or reduction of same. Marketability and economics of production can be seriously affected by these impurity levels in concentrates.
- (g) When mineralogy and flotation response is understood, efforts can be made towards economic optimization of reagent associations and additions.

3. Soluble Salts

Soluble salts, particularly the sulphates of iron, zinc, manganese, magnesium, calcium and copper can have a buffering action in pulps and possibly participate in ion exchange reactions with minerals to alter their normal flotation response. The presence of these salts in the Grum deposit should be quantified.

We were pleased to have the opportunity to participate in this project and look forward to receiving the further test reports which should facilitate a clearer understanding of testwork status.

Yours sincerely,



N. Gibson, P.Eng.

NG/ec

cc: Mr. P.S. Cross (with attachments)

Flotation Conditions

Laboratory Ore Sample Test	Mattagami B4 <u>VAN 131</u>	Lakefield B-2 <u>131</u>
<u>Primary Grind</u>		
Na <sub>2</sub> CO <sub>3</sub> - lbs/ton	6.0	3.0
ZnSO <sub>4</sub> - lbs/ton	1.0	1.0
NaCN - lbs/ton	0.2	0.3
R 242 - lbs/ton	-	0.08
R 355 - lbs/ton	0.13	-
<u>Lead Rougher</u>		
R 242 - lbs/ton	0.02	0.04 (stage)
R 343 - lbs/ton	0.02	-
R 404 - lbs/ton	-	0.04 (stage)
M.I.B.C. - lbs/ton	-	0.02
Retention time - minutes	5	4 (conditioning) 12 (flotation)
pH		9.4
<u>Lead Regrind</u>		
Na <sub>2</sub> CO <sub>3</sub> - lbs/ton	0.5	1.5
ZnSO <sub>4</sub> - lbs/ton	-	1.0
NaCN - lbs/ton	0.2	0.3
R 242 - lbs/ton	-	0.05
R 343 - lbs/ton	0.015	-
<u>Lead Cleaners</u>		
Stages	3	4
Na <sub>2</sub> CO <sub>3</sub> - lbs/ton	-	0.9 (3 stages)
ZnSO <sub>4</sub> - lbs/ton	-	0.3 (2 stages)
NaCN - lbs/ton	-	0.25 (3 stages)
R 242 - lbs/ton	-	0.01 (1st stage)
R 343 - lbs/ton	0.005 (1st)	-
R 404 - lbs/ton	-	0.02 (1st stage)
Retention time - minutes	9.5	8 (conditioning) 19 (flotation)
pH		9.7

<u>Laboratory Ore Sample Test</u>	<u>Mattagami B4 VAN 131</u>	<u>Lakefield B-2 131</u>
<u>Zinc Conditioner</u>		
CuSO <sub>4</sub> - lbs/ton	1.25	1.5
Z 200 - lbs/ton	0.08	-
Ca(OH) <sub>2</sub> - lbs/ton	-	3.0
Retention time - minutes	-	3.0
pH	-	10.8
<u>Zinc Rougher</u>		
CuSO <sub>4</sub> - lbs/ton	-	0.5
R 343 - lbs/ton	0.01	-
Z 11 - lbs/ton	-	0.06
R 404 - lbs/ton	-	0.02
Z 200 - lbs/ton	0.01	0.12
Retention time - minutes	5	4 (conditioning) 6 (flotation)
<u>Zinc Scavenger</u>		
Z 200 - lbs/ton	0.01	)
R 343 - lbs/ton	0.01	) not practiced
Retention time - minutes	5	
<u>Zinc Regrind</u>		
CuSO <sub>4</sub>	0.25	)
Z 200	0.03	) not practiced
CaO	0.5	)
<u>Zinc Cleaners</u>		
Stages	3	4
Ca(OH) <sub>2</sub> - lbs/ton	-	2.6 (stage)
Z 200 - lbs/ton	-	0.006 (1st stage)
Retention time - minutes	9.5	5 (conditioning) 14.5 (flotation)
pH	12	11.2
Total Retention Time - Minutes		
conditioning	-	24
flotation	34	51.5

Summary of Test Reagent Consumption and Costs

	<u>Consumption - lbs/ton ore</u>		Reagent Cost cents per pound f.o.b.	<u>Cost in Cents per ton ore</u>		
	<u>Mattagami (1)</u>	<u>Lakefield (2)</u>		<u>Mattagami (1)</u>	<u>Lakefield (2)</u>	<u>Difference (2) - (1)</u>
<u>Primary Grind and Lead Circuit</u>						
Na <sub>2</sub> CO <sub>3</sub>	6.5 (2)	5.4 (3)				
ZnSO <sub>4</sub>	1.0 (1)	2.3 (3)				
NaCN	0.4 (2)	0.85 (3)				
R 242	0.02 (1)	0.18 (6)				
R 343	0.04 (3)	-				
R 355	0.13 (1)	-				
R 404	-	0.06 (6)				
M.I.B.C.	-	0.02 (1)				
<u>Zinc Circuit</u>						
CaO	0.5 (1)	-				
Ca(OH) <sub>2</sub>	-	5.6 (5)				
CuSO <sub>4</sub>	1.5 (2)	2.0 (2)				
Z 200	0.13 (3)	0.126 (3)				
Z11	-	0.06 (2)				
R 343	0.02 (2)	-				
R 404	-	0.02 (1)				
<u>Total Flowsheet</u>						
Na <sub>2</sub> CO <sub>3</sub>	6.5 (2)	5.4 (3)	-			
ZnSO <sub>4</sub>	1.0 (1)	2.3 (3)	24.05	24.05	55.32	+31.27
NaCN	0.4 (2)	0.85 (3)	30.5	12.20	25.93	+13.73
CaO	0.5 (1)	-	-			
Ca(OH) <sub>2</sub>	-	5.6 (5)	-			
CuSO <sub>4</sub>	1.5 (2)	2.0 (2)	29.5	44.25	59.00	+14.75

	<u>Consumption - lbs/ton ore</u>		Reagent Cost cents per pound f.o.b.	<u>Cost in Cents per ton ore</u>		
	<u>Mattagami (1)</u>	<u>Lakefield (2)</u>		<u>Mattagami (1)</u>	<u>Lakefield (2)</u>	<u>Difference (2) - (1)</u>
R 242	0.02 (2)	0.18 (6)	97.0	1.94	17.46	+15.52
R 343	0.06 (5)	-	47.5	2.85	-	- 2.85
Z 11	-	0.06 (2)	47.0	-	2.82	+ 2.82
R 355	0.13 (1)	-	31.0	4.03	-	- 4.03
R 404	-	0.08 (7)	28.0	-	2.24	+ 2.24
Z 200	0.13 (3)	0.126 (3)	48.0	6.24	6.05	- 0.19
M.I.B.C.	-	0.02 (1)	30.0	-	0.60	+ 0.60
Totals	(18)	(35)		95.56	169.42	+73.86

( ) figures in parenthesis are numbers of addition points.