

## INTER OFFICE MEMORANDUM

006553

To: R. Coleman  
From: W. Scheduling  
Subject: Final Compositing for Vangorda Metallurgical Testing Program at Lakefield.

May 17, 1988

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We can now give Lakefield detailed compositing instructions, following the meeting of May 16th, with the following in attendance:

CurraghConsultants

Greg Gilson (Manager of Geology)  
Lee Pigage (Senior Geologist)  
Cameron Reed (Geologist)

Dick Coleman (Metallurgy)  
Ion Vintilla (Mine Planning)

Bill Scheduling (Chief Metallurgist)

Compositing on the basis of the core log gave us our preliminary categories. After printing out in spreadsheet form, it became apparent that porous and non-porous core had not been wholly separated by the procedure. Corrections are now being undertaken by Cameron Reed in Whitehorse - final versions will be available for faxing to Lakefield by Thursday, May 19th. Due to problems with FAX transmission on compressed print, it is recommended that a copy of the major composite composition be brought for Lakefield at your first meeting.

Compositing has been carried out in accordance with the following criteria:

(i) Separation of porous and non-porous core, to minimize and isolate the effect of drilling additives on metallurgy.

(ii) Ore-type, in accordance with the original core logging (conforming to the Anvil area lithostratigraphic code) and where distinctions are possible on a mining scale.

(iii) Location within the deposit (east, west or centre).

(iv) Visible weathering, core oxidation and sawn surface oxidation (according to geological log and subsequent surveys).

(v) Mining Plan - Material outside the pit limits and shovel - separable intervals of waste grade have not been composited into ore composites (except for Composite 5, which will be investigated separately). Waste intervals of insufficient width to be mined separately have been included in ore composites, where these bound the waste above and below. Exceptions to this rule are made for intervals of porous or heavily oxidized material, which may effect the whole composite adversely due to drilling mud effects or which do not allow the effect of oxidation to be seen in isolation.

The final selection of composites is described below:

#### Composite 1

E G ore from both Eastern and Western sections of the deposit, which is either porous or shows signs of weathering or core and split oxidation. To be included, the interval must have a total oxidation indicator of 5 or more (combined score from weathering, core oxidation and split oxidation columns on spreadsheet).

This composite, comprising about 60 intervals and weighing about 250 kg, should not be combined at present. Further separation into the following categories may be required to assess the effects of drilling mud and oxidation independently:

(a) Porous core with oxidation indicator of 3 or less (about 25 intervals or about 100 kg)

(b) Non-porous core with oxidation indicators of 5 or above (about 15 intervals or about 60 kg). The remainder, in neither category should be left in original bags and will probably remain untested).

#### Composite 2

E G ore from the Eastern section of the deposit, which is non-porous and has an oxidation score of less than 5 (about 50 intervals, or 200 kg).

#### Composite 3

E G ore from the Western section of the deposit, which is non-porous and has an oxidation score of less than 5 (about 240 intervals, or 950 kg).

#### Composite 4

A-type ore from both Eastern and Western sections of the deposit, which is non-porous. Oxidation is not a consideration here, with the indicator never exceeding 3.

### Composite 5

E C ore from both Eastern and Western sections of the deposit, in any state of porosity and oxidation and almost exclusively below cut-off grade. This material is 95% non-porous and has a lower oxidation level than the E G ore. Average head grades are in the 2% combined Pb and Zn range, with 20 g/t Ag and 0.7 g/t Au. This comprises about 225 intervals or about 900kg. Most of this material is within the final pit envelope and requires no stripping or has to be dumped to waste to reach other ore. It may also be representative of an extra 2,000,000 tonnes of similar material in the pit floor.

Testing of this composite is not of the the highest priority and preparation (or further subdivision) should take place in the future.

At present, only Composite 3 needs to be prepared. Testing should proceed immediately thereafter. This represents the great majority of the ore-grade metal reserves and must form the basis of the future flowsheet and reagent scheme. While samples are being sorted, the other composites should be assembled in order and left in cold storage, but not combined and crushed until required. The whole interval may be used for compositing purposes, so long as all composites are kept in cold storage prior to testing. Duplicate (crushed) intervals from the other half drill core are available in cold storage at Faro, if required.

The centre of the orebody only had two drill-holes (87V0112) in this program - insufficient for compositing purposes. These will be stored and tested with further material, which should be forthcoming in a 1988 drilling program.

*W. Scheduling*

W. Scheduling  
WS/ag

Richard Coleman  
156 Hollyrood Hts. Dr.  
Mississauga, Ont.  
L5G 2H4

25 January, 1989

Mr. Bill Weymark  
Manager  
Curragh Resources Inc.  
P.O. Box 1000  
Faro  
Yukon Y0B 1K0

Dear Sir:

The 1988 metallurgical research conducted by Lakefield Research on the Vangorda deposit has been completed and reports have been forwarded to your people. The work started in the spring of 1988 with suites of samples for a mineralogical examination followed by the laboratory mineral dressing research between June and December.

The research confirms the complexity of the deposit but suggests that reasonable grades and recoveries of lead, zinc and precious metals can be expected. Modifications to the existing Faro concentrator layout and equipment will be essential when processing this ore. In addition finer grinds and higher reagent consumptions can be expected although plant practice may not be as severe as indicated during the research.

The majority of the research was conducted on ore types E and G with minor oxidation and of a non-porous nature. This material represents 70% of the mineral inventory and was called Composite No 3 during the testing. The flowsheet developed for this ore was utilized for research on the other types of ore available. Favorable results on all NON-POROUS types of ore including even the low grade (represented by Composite 5) were obtained. However, ore type represented by Composite 1A was the most refractory, was porous and oxidized, was carbonaceous and contained secondary copper minerals. The results in general from this material were not acceptable except that the precious metal recovery was encouraging.

General comments about the ore types and responses would include the following remarks:

Composite 1A Most Refractory  
Carbonaceous - Porous  
Poor selectivity  
Good lead concentrate grades not possible  
High zinc content of lead concentrate  
Good recovery of gold and fair recovery of silver  
in lead concentrate.

C. H. FRAME  
You will find these  
statements encouraging  
KJ

- Composite 2 Course grained  
Good lead, gold and silver recoveries  
High zinc loss with lead concentrate  
Good zinc concentrate grade but lowest recovery
- Composite 3 70% of deposit  
Good metallurgy with new flowsheet  
Reagent consumption (particularly NaCN) higher
- Composite 4 Graphitic quartzite  
Requires special depressant to improve lead grade  
Lowest lead, gold and silver recoveries  
Lowest grade tested (except for Composite 5 which may  
not be considered ore)  
Good zinc recovery acceptable zinc grade
- Composite 5 Low grade  
Good metallurgy
- Composite 6 Instructions for compositing not received.  
However, it is understood that material would be  
similar to that of Composite 5 and therefore good  
metallurgy could be expected with higher head assays.

General

If the samples tested are truly representative of the ores from the zones, a modified flowsheet with new reagents could be expected to produce

Lead Concentrates of	62% Pb	84% Recovery
	8% Zn	
	6 to 10 gms/T Au	62% Recovery
	700 gms/T Ag	70% Recovery
Zinc Concentrates of	1% Pb	
	54% Zn	82% Recovery
	45 gms/T Ag	

Deleterious metal contents of the concentrates may include copper, manganese, arsenic and magnesia in the lead concentrate and copper and silica in the zinc concentrate.

In the bulk scale test of material from Vangorda proceeds in the fall of 1989 with the flowsheet revisions and reagent regimes recommended, the metallurgy might be expected to be plus 61% Pb in Pb conc. 83% recovery  
plus 54% Zn in Zn conc. 86% recovery

Based on their research, Lakefield have drawn certain conclusions and make specific recommendations. I support their comments. At the same time I would like to emphasize certain features when ore from the Vangorda deposit is processed.

1. Finer primary grind will benefit precious metal recovery.
2. A new lead collector is recommended.
3. More lead products should be reground.
4. Open circuit lead cleaning is essential.
5. An organic depressant for the lead circuit is required for some of the ore types.
6. High speed conditioning in the zinc circuit will be extremely beneficial.
7. During the bulk scale testing of this deposit a representative of the Lakefield research company should be present.
8. If blending with Faro 3 ore is contemplated extensive laboratory research should be done.

Further Recommendations

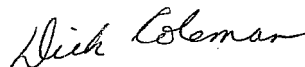
Some of the knowledge gained during this research project should be rested in the current milling technique on the Faro 3 ores. Specifically the collector combination A317/3418A. Regrinding of all lead rougher and scavenger concentrates, open circuit cleaning of lead concentrates, the use of DS20 depressant, and high speed zinc circuit conditioning should be tested in the laboratory and on the circuit as soon as practical.

Additionally it is a good time to start the research on the Grum deposit so that results can be available for your long term planning. I continue to recommend that Lakefield Research be engaged for this purpose and I am available to assist if you wish my services.

Since carbonaceous ores may be a factor in the life of your company, it might be worthwhile for a new project to be initiated to do basic research on this type of refractory material.

Yours Very Truly

R. L. Coleman



cc. ~~K. Forgaard~~  
E. Beaumont  
G. Jilson

CURRAGH RESOURCES INC.  
METALLURGICAL LABORATORY

INTER OFFICE MEMORANDUM

*Handwritten notes:*  
Am 2/27/88  
J. J. F.F.  
D. J. F.F.  
D. J. F.F.

To : Eric Beaumont  
cc Bill Weymark  
Marcus Leijon

SUBJECT : REAGENT SCHEME DEVELOPED FOR VANGORDA ORE  
BY LAKEFIELD RESEARCH.

The reagent scheme developed by Lakefield Research for Vangorda ore requires higher reagent consumptions than for current Faro Mill .

The economical and technical implication which occur in the field of : milling cost , transportation & storage , enviroment, reagents handling and mixing sistem , etc. are shown bellow .

1 . MILLING COST .

The milling cost affected by new reagents and reagents consumption is shown in the table 1 .

As one can see from table 1 , the difference between Faro reagent scheme and Vangorda reagent scheme , amounts \$ 12.9 million annually in milling cost, and represents approx. 42% increase in milling cost .

The mill capacity was supposed to be 5 million tonnes per year ( 13.700 tonnes per day )

2 . Reagents transportation and storage .

High reagents addition and the new reagents , required six time more storage space ( 8.5 Kg/t modifying reagents for Vangorda VS. 2.1 Kg/t for Faro ) ,and in the winter time when we have to assure a reagent stock for at least 3 - 3 months , the reagents storage could create difficulties .

TABLE 1

INFLUENCE OF REAGENTS CONSUMPTION ON MILLING COST

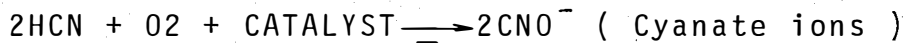
REAGENTS Kg/t	FARO MILL BUDGET	VANGORDA	DIFFERENCE Kg/t	REAGENT COST \$/Kg	TOTAL MILLING COST \$
<u>MODIFYING AGENTS</u>					
SODA ASH	0.876	2.000	1.124	0.090	505,800
LIME	0.608	5.000	4.392	0.085	1,866,600
COPPER SULPHATE	0.500	0.900	0.400	1.475	2,950,000
SODIUM CYANIDE	0.124	0.395	0.271	3.402	4,609,710
SODIUM SILICATE	NIL	0.250	0.250	1.200	1,500,000
TOTAL 1					11,432,110
<u>COLLECTORS</u>					
A317	0.144	0.025	-0.119	1.777	-1,057,315
3418A	NIL	0.025	0.025	8.200	1,025,000
A350	NIL	0.080	0.080	2.250	0,900,000
TOTAL 2					867,685
<u>FROTHERS</u>					
MIBC	0.017	0.063	0.046	2.250	517,500
DOW	0.015	0.025	0.010	1.520	76000
TOTAL 3					593,500
TOTAL 1+2+3					<u>12,893,295</u>

### 3 . ENVIROMENT

Very high cyanide consumption ( 395 g/t ) , will create some enviromental problems , especial in winter time .

Molecular Hydrogen Cyanide ( HCN ) is the most toxic form of cyanide . Concentrations of HCN as low as 0.05 mg/l can be lethal to fish .

The natural degradatíon and oxidation of HCN AND CN<sup>-</sup> is slow down in the winter time because of lack of sunlight ( catalyst )



Both hydrogen cyanate and cyanate ions are much less toxic than HCN .

We will have to spend much more money for chemical destruction of cyanide ( clorination , air/sulphur dioxide , Hydrogen Peroxide etc . ) , to meet standard requirments .

### 4 . REAGENTS HANDLING AND MIXING SYSTEM .

The following working have to be done on reagents and mixing system :

4.1 Install an additional reagent preparation and feeding<sub>system</sub>

for :

4.1.1 New collector 3418A / or 317/3418A (ratio 1/1 ) for feeding:

- Tertiary ball mill
- Lead scavanger
- Lead regrind mill

4.2 Sodium silicate - SiO<sub>3</sub>Na<sub>2</sub> , for lead cleaner feed .

4.3 Feeding of the NaCN to the following points :

- Lead 2-nd cleaning feed
- Lead 3-rd cleaning feed

4.4 Feeding of collector ( Xanthate ) to the following points:

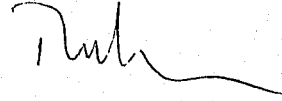
- Lead regrind mill feed
- Zinc regrind mill feed
- Zinc conditioner - Stage 2
- High speed conditioning for Zinc

4.5 Feeding of CuSO<sub>4</sub> to the following points :

- Zinc regrind mill feed

- Zinc conditioner - Stage 2

The cost price for additional handling and mixing system  
has not been done yet .



Dumitru Tului  
Senior Metallurgist

April 20 , 1989

Godfrey

This whole area must be  
investigated in greater detail - I  
find it hard to believe that  
these reagent consumption are real

KT

CURRAGH RESOURCES INC

INTER-OFFICE MEMORANDUM

FARO OFFICE

DATE: August 30, 1990

TO: GODFREY MACDONALD  
V.P. METALLURGY  
TORONTO OFFICE

FROM: CAM REED  
EXPLORATION GEOLOGIST  
WHITEHORSE OFFICE

SUBJECT: VANGORDA METALLURGICAL COMPOSITING

=====

A 20kg. composite of gold bearing semi-massive pyritic sulphide from the footwall of the Vangorda Deposit has been sent to Lakefield Research. The composite has been sent in a single pail by air freight and should be arriving there shortly. A listing of the samples and corresponding Pb, Zn, Ag, Au, insoluble and soluble iron are included in the following tables (within boxed in area). Unfortunately copper assays were not completed on this core. I expect the copper content to average about 0.2% to 0.3% for this composite.

I talked to Serge Bulativich and he is expecting the pail and a call from you for further instructions. He also mentioned that he may be able to locate composite # 5 sent to Lakefield in early 1988.

*see table  
step 100%*  
I have sent some representative core samples of this material to your office via air-freight. You should be receiving them shortly.

If you require any additional samples or information you may reach me at the Faro Mine.

Cam Reed  
Exploration Geologist

CR:cc

ASSAYS

Drill Hole: 88V-31  
 Northing: 9787.4  
 Length: 32.2

Easting: 10001.0  
 Elevation: 1147.6  
 Core: NQ

Sample #	---Depths---	Int	Rec	Rock	Rock	Pulp	Pb+Zn	Pb	Zn	Ag-AA	Ag-FA	Au	Po+Py	Po	Py	Bas
	From To	m	%	Unit	Code	S.G.	%	%	%	g/t	g/t	g/t	%	%	%	
0	0 9.4	9.4	-1	WASTE	100	-1.00	-1.00	-1.00	-1.00	-1.0	-1.0	-1.00	-1.00	-1.00	-1.00	-1.00
16752	9.4 10.7	1.3	100	4E08	50	4.00	1.06	.74	.32	12.0	-1.0	1.37	41.50	11.50	30.00	-1.00
16753	10.7 12.2	1.5	100	4E18	50	4.10	.96	.65	.31	21.0	-1.0	2.23	34.60	4.06	30.54	-1.00
16754	12.2 13.5	1.3	100	4E18	50	3.80	1.60	1.10	.50	31.0	-1.0	1.23	32.90	4.62	28.28	-1.00
16755	13.5 14.5	1.0	100	4E18	50	3.50	2.17	.68	1.49	17.0	-1.0	1.44	27.40	10.90	16.50	-1.00
16756	14.5 15.8	1.3	100	4E18	50	3.60	3.33	1.11	2.22	27.0	-1.0	1.23	29.90	8.84	21.06	-1.00
16757	15.8 17.4	1.6	100	4C3	30	3.60	.72	.23	.49	11.0	-1.0	1.03	27.80	4.89	22.91	-1.00
16758	17.4 18.9	1.5	100	4C3	30	4.10	.27	.14	.13	9.0	-1.0	.62	34.80	2.54	32.26	-1.00
16759	18.9 20.5	1.6	100	4A0	20	3.30	.34	.23	.11	8.0	-1.0	.82	21.20	2.20	19.00	-1.00
16760	20.5 21.3	.8	100	4C3 &5	30	3.20	.77	.26	.51	11.0	-1.0	.41	21.40	4.31	17.09	-1.00
16761	21.3 22.5	1.2	100	4C3	30	3.80	.34	.21	.13	13.0	-1.0	.55	35.10	2.66	32.44	-1.00
16762	22.5 23.7	1.2	100	4C3	30	3.50	.11	.05	.06	6.0	-1.0	1.37	30.00	3.34	26.66	-1.00
16763	23.7 25.1	1.4	100	4C3	30	3.40	.38	.16	.22	9.0	-1.0	.69	25.80	4.18	21.42	-1.00
16764	25.1 26.4	1.3	100	4C37 &8	30	3.20	.80	.49	.31	11.0	-1.0	.82	22.00	4.53	17.47	-1.00
16765	26.4 27.7	1.3	100	4C37 &8	30	3.20	1.18	.89	.29	21.0	-1.0	.41	22.30	5.21	17.09	-1.00
16766	27.7 29.0	1.3	100	4D37 &8	80	3.30	3.79	.72	3.07	13.0	-1.0	.55	24.50	10.30	14.20	-1.00
16767	29.0 30.3	1.3	100	4D37 &8	80	3.50	5.35	1.17	4.18	15.0	-1.0	.41	25.00	6.99	18.01	-1.00
0	30.3 32.2	1.8	-1	WASTE	100	-1.00	-1.00	-1.00	-1.00	-1.0	-1.0	-1.00	-1.00	-1.00	-1.00	-1.00

AS HAYS

Drill Hole: 88V-21  
 Northing: 9689.6 Easting: 10014.6 Elevation: 1153.9  
 Length: 39.6 Core: NQ

Sample #	---Depths---	Int	Rec	Rock	Rock	Pulp	Pb+Zn	Pb	Zn	Ag-AA	Ag-FA	Au	Po+Py	Po	Py	BaO
	From To	m	%	Unit	Code	S.G.	%	%	%	g/t	g/t	g/t	%	%	%	%
0	.0 14.7	14.7	-1	WASTE	0	-1.00	-1.00	-1.00	-1.00	-1.0	-1.0	-1.00	-1.00	-1.00	-1.00	-1.00
16657	14.7 15.2	.5	85	400	30	3.10	4.68	1.44	3.24	32.0	-1.0	.41	10.60	4.60	6.00	-1.00
16658	15.2 16.2	1.0	100	4G4 &#	60	4.30	14.71	5.70	9.01	106.0	-1.0	1.37	11.70	1.68	10.02	-1.00
16659	16.2 17.5	1.3	100	4C3	30	3.80	1.20	.61	.59	21.0	-1.0	1.51	29.20	2.47	26.73	-1.00
16660	17.5 18.9	1.4	91	4C3	30	4.10	4.18	4.05	.13	38.0	-1.0	.75	30.20	1.29	28.91	-1.00
16661	18.9 20.1	1.1	100	4C3	30	4.10	2.08	1.86	.22	21.0	-1.0	1.37	33.60	3.69	29.91	-1.00
16662	20.1 21.1	1.0	100	4E48&1	50	4.30	8.48	4.81	3.67	49.0	-1.0	1.17	29.10	8.52	20.58	-1.00
16663	21.1 22.3	1.2	100	4E48&1	50	4.40	5.39	2.54	2.85	28.0	-1.0	.82	38.70	11.00	27.70	-1.00
16664	22.3 23.2	.9	100	4E8 &1	50	4.20	1.02	.48	.54	23.0	-1.0	.89	35.50	3.85	31.65	-1.00
16665	23.2 25.0	1.8	100	4E18 &7	50	3.60	1.47	.63	.84	15.0	-1.0	1.85	31.30	14.00	17.30	-1.00
16666	25.0 26.2	1.2	100	4C3	30	3.50	.70	.23	.47	15.0	-1.0	.34	26.40	5.98	20.42	-1.00
16667	26.2 27.3	1.1	100	4C3	30	3.70	1.09	.33	.76	17.0	-1.0	.34	32.40	3.62	28.78	-1.00
16668	27.3 28.1	.8	100	4LO	120	2.90	1.08	.14	.94	4.0	-1.0	.14	9.61	4.82	4.97	-1.00
16669	28.1 29.1	1.0	100	4C3	30	3.00	.53	.13	.40	17.0	-1.0	.21	17.80	6.28	11.22	-1.00
16670	29.1 30.4	1.3	91	4C3	30	3.10	.94	.45	.49	9.0	-1.0	.69	17.20	8.78	8.42	-1.00
16671	30.4 32.0	1.6	86	4E1 &8	50	3.80	.76	.31	.45	13.0	-1.0	2.02	32.70	9.45	23.25	-1.00
0	32.0 39.6	7.6	-1	WASTE	0	-1.00	-1.00	-1.00	-1.00	-1.0	-1.0	-1.00	-1.00	-1.00	-1.00	-1.00

VANDU.2DA Cu-Au-Ag STATS. Arrange in order  
 DEPOSIT AVERAGES

Cu Assays by Ore Type

4EG  
 4EC  
 4C  
 4A  
 4L

	%	Min	Max	Mean	# Samples	Dist
20'S	4AGD	0.01	1.62	0.11	292	log N
30'S	4CD	0.04	0.85	0.30	258	N
40'S	4EC	0.02	1.16	0.32	152	N
50-60'S	4EG	0.01	0.66	0.15	404	LN
120	4L	0.01	1.93	0.13	235	LN

Au Assays by Ore Type

	g/t	Min	Max	Mean	# Samples	Dist	
20'S	4AGD	0.01	2.60	0.56	0.02 oz/ton 373	LN + N	
30'S	4CD	0.10	6.65	0.79	0.03	349	LN + N
40'S	4EC	0.02	6.48	1.06	0.025	275	N
50-60'S	4EG	0.01	4.18	0.87	0.03	727	N
120	4L	0.01	7.17	0.25	0.009	260	LN

Ag Assays by Ore Type

	g/t	Min	Max	Mean	# Samples	Dist
20'S	4AGD	0.10	98.0	26.3	379	LN + N
30'S	4CD	0.1	224.0	16.3	365	LN
40'S	4EC	0.1	64.9	19.9	291	LN
50-60'S	4EG	0.1	334.0	65.8	737	N
120	4L	0.0	166.0	11.5	269	LN

## M E M O R A N D U M

TO: Mr. Cliff Frame,  
Chairman & Chief  
Executive Officer

FROM: Godfrey McDonald, Curragh  
John Goode, Kilborn

DATE: October 22, 1990

COPIES: J.B. Mitchell, C.A. Freitag  
A.J. Williams, J.A. Wells,  
R.H. Walton

A review of the copper occurrence in the ore and contamination of the lead concentrate in the Vangorda deposit does not show anything different in reference to the overall deposit (0.2 - 0.4% Cu in the lead concentrate). However there is a short term affect in which a high copper content in the lead concentrate is experienced. The copper and gold enrichment of the near-surface area of the orebody is the reason for the contamination. The early development stage of the Vangorda pit includes a significantly high percentage of near-surface ore, a high copper-gold occurrence and high contamination of the lead concentrate.

Testwork done at Lakefield in April, 1990 on Composite No.1 that represented the first, 400,000 tonnes of ore and Composite No.2 the represented the first, 6 metres of the proposed mine plan, have the following metallurgical responses.

## Composite No.1

Pb Conc. - 3.3% Cu  
55.4% Pb  
13.55 g/t Au

## Composite No.2

Pb Conc. - 2.4% Cu  
52.4% Pb  
12.04 g/t Au

These metallurgical results were discussed with Toronto and minesite personnel as well as a plan initiated to do the following laboratory testwork during and after the scheduled June, 1990 mill test of 100,000 tonnes:

- a) Investigate and develop a copper/lead separation for the final lead concentrate.
- b) Determine the gold association with copper and lead minerals.
- c) Consider blending Vangorda and Faro lead concentrates so copper specification are closer to market specifications and payment for the gold in the Vangorda lead concentrate will be realized. Current Faro smelter gold content.

## Recommendations for Current Copper contamination concern:

- a) Stockpile Vangorda only lead concentrate and blend as applicable.
- b) Review the quarterly mine plan to determine copper content in the mill feed and lead concentrate so blends can be scheduled.

**CURRAGH RESOURCES INC.**  
Inter-Office Memorandum

To: Dave Tenney, Chief Geologist  
Faro Minesite

cc Gregg Jilson, V.P. Exploration  
Whitehorse Office

From: Cam Reed, Exploration Geologist  
Whitehorse office

10 26 90

RE: **Testing of secondary metal enrichment/depletion at Vangorda**

Recent metallurgical bench testing at Faro of the upper more oxidized Vangorda ore zones yielded less than satisfactory results. Poor selectivity of sphalerite and galena and unexpected high concentrations of copper in the lead rougher concentrate are the major problems. Explanations for these results are currently being pursued.

A possible explanation is the hypothesis of higher than average copper concentration near the top of the Vangorda Orebody due to weathering and supergene sulphide enrichment. The copper may be rimming some of the sphalerite and galena grains which would result in poor sphalerite/galena separation for material in this zone. The higher copper concentration may partly be the result of secondary copper and zinc enrichment due to the percolation of groundwater (supergene enrichment) through the orebody. As water percolates through the oxidized orebody above the water table it would leach out soluble zinc and copper. As the water moved downwards through the zone of oxidation it may precipitate copper and zinc oxides above the water table and also precipitate secondary copper and zinc sulphides as the metal bearing water descended into a more reducing environment below the water table. This would result in secondary sulphide enrichment of the orebody in a thin zone below the groundwater table. This zone may have characteristically poor metallurgical response.

If this zone does exist, it is likely to be thin and near the overburden surface. It would make up an anomalous high proportion of the current Vangorda stockpile because we have been mining the most shallow reserves SE of section 12.

To test for this zone, I have plotted copper histograms down each drillhole trace for those holes which have been assayed for copper from section 12 to 26. Although some holes show that there does seem to be elevated copper concentrations near the overburden interface, the trend is not consistent from hole to hole and is far from conclusive.

I have compiled a list of samples from selected 1990 drillholes SE of section 12 in areas where the ore zone subcrops. The samples will have to be recovered from Grum camp (Preferably the pea sized rejects because after they would likely oxidize at a slower rate than the pulp samples). The samples would be sent out to be analyzed for non sulphide lead, non sulphide zinc, and non sulphide copper.

This study would give us a better understanding of the size and distribution of the oxidized ore zone and the amounts of recoverable metal in this zone. It will also give some insight into possible local sulphide and nonsulphide metal enrichment or depletion due to weathering or the movement of groundwater.

If time permits, It would be beneficial to have polished thin section descriptions completed for some of the split core samples sent out for these analyses.

Should the testwork confirm the existence of a copper enriched zone in the shallow SE section of the orebody, then I recommend additional testing of 1990 drillholes in the upper zones in the NW part of the orebody.

I have not been able to contact Northern Analytical to confirm that they are capable of performing these analyses. It is likely that we may have to send the samples to a lab in Vancouver to complete the assaying.

If you have any suggestions which may help explain the less than satisfactory metallurgical results of the initial testing of the Vangorda stockpile, please let me know.

The following samples are to be assayed for non sulphide lead, non sulphide zinc, and non sulphide copper.

Hole ID	Sample #s	# of samples
Vetical X-section 12E		
90v-47	60317 to 60327	11
90v-48	60442 to 60464	23
Vetical X-section 13E		
90v-43	60595 to 60605	11
90v-44	60611 to 60624	14
90v-45	60539 to 60564	6
* 90v-113	61716 to 61722	7
Vetical X-section 17E		
90v-72	60465 to 60472	8
90v-79	60418 to 60427	10
90v-80	60408 to 60417	10
Vetical X-section 19E		
90v-36	60298 to 60305	8
90v-38	60272 to 60279	8
Vetical X-section 23E		
90v-12	60043 to 60066	24
Total samples:		140

\* TOTAL COPPER ASSAYS ARE REQUIRED FOR THIS HOLE.

November 2, 1990

University of Western Ontario  
Surface Science Western  
Natural Sciences Building  
Room No. 6  
LONDON, Ontario  
N6A 5B7

**ATTENTION:** Dr. S. Chryssoulis

Dear Dr. Chryssoulis:

Further to our telephone conversation this morning, we are requesting your immediate assistance in resolving a very difficult flotation problem that has recently come to our attention. The "cap" rock on our new orebody is causing lead/zinc selective flotation problems. The ore in the "cap" is not responding to our reagent scheme and a bulk lead/zinc concentrate is produced.

The reason for this loss in selective flotation is not known although several hypothesis have been made:

- a) a coating on the sphalerite particles that encourage or permits its flotation in the lead circuit.
- b) a secondary mineral that is dissolved by sodium cyanide; then coats the sphalerite grains so it is activated and will float in the lead circuit.
- c) something in the "cap" rock is water soluble that coats (activates) the sphalerite so it floats in the lead circuit.

Seven samples have been gathered from the laboratory programme and are as follows:

- a) Lead - Zinc Bulk Flotation Response Ore
  - Sample No. 1 - Mill feed sample
  - Sample No. 2 - Bulk (Pb-Zn) concentrate
  - Sample No. 3 - Bulk tailing
- b) Lead - Zinc Selective Flotation Response Ore
  - Sample No. 4 - Mill feed sample
  - Sample No. 5 - Lead concentrate
  - Sample No. 6 - Zinc concentrate
  - Sample No. 7 - Zinc tailing

If you should have any questions please feel free to ask myself and/or Gordon Wilson, Chief Metallurgist at Faro.

Telephone No. (myself)	416-363-7111
Telephone No. (G. Wilson)	403-994-2600

Yours truly

**CURRAGH RESOURCES INC.**

G. W. McDonald  
Vice-President Metallurgy

GWM/jdm

CURRAGH RESOURCES INC

INTER-OFFICE MEMORANDUM

FARO OFFICE

DATE: November 7, 1990

TO: GORDON WILSON  
CHIEF METALLURGIST

FROM: DAVE TENNEY  
CHIEF GEOLOGIST

SUBJECT: VANGORDA METALLURGICAL SAMPLES  
=====

V 90 DT-13: Sampled and delivered to mill in two pails by myself on November 3rd. Material is leached pyritic sand with minor black oxidized baritic ore. Taken from about 1146 elevation (top of 1140 GG Blast) near section 14E. The grade of this sample is low.

V 90 DT-14: Sampled 1134AA blast and delivered to mill in two pails by myself November 3rd. Sample comprises sooty black oxidized baritic ore (high grade) from the top of the 1134AA blast near 1140 elevation, 10m below bedrock surface. Minor weathered metabasite is present.

V 90 DT-15: Sampled by Mitch Wasel, Javier Lopez and myself on November 6th and delivered to mill in six pails the same day. Sample comprises sooty black oxidized baritic ore (high grade) with minor leached pyritic sand (low grade) from about 11mm below bedrock surface at the east edge of the 1134BB blast.

*D. Tenney*  
Dave Tenney  
Chief Geologist

DT:cc

cc: G. MacDonald  
E. Beaumont  
B. Dunn

**RICHARD F. DOWN, P.Eng.**  
CONSULTING SERVICES IN MINERAL PROCESSING

Richard F. Down  
& Associates Inc.  
195 Sweeney Drive  
Toronto, Ont. M4A 1V5

TELEPHONE 416-757-1727

November 12, 1990

Dr. Godfrey McDonald  
Vice-President, Metallurgy  
Curragh Resources Inc.  
Suite 1900  
Box 12  
95 Wellington St. West  
Toronto  
Ontario  
M5J 2N7

Re: Vangorda Refractory Caprock Ore.

Dear Dr. McDonald,

I visited Faro November 5 to 10, 1990, to study the problem of milling Vangorda refractory caprock ore. This letter contains my comments. Testwork is still ongoing and hence any conclusions at this time are necessarily tentative. Nevertheless, at this time we do know the cause of the problem and one way of dealing with it. My comments are summarized as follows.

1. The sands fraction of the Vangorda refractory caprock ore contains soluble copper which activates the zinc in the ore and causes flotation of a bulk lead-zinc concentrate.
2. The sands contaminate any other ore with which they may be mixed because the soluble copper also activates the zinc in that other ore. As little as 1% sands may be sufficient to cause contamination.
3. The sands can be removed by screening.
4. The plus screen fraction can be mixed with Faro ore for milling.
5. The minus screen fraction is probably untreatable except to produce a bulk lead-zinc concentrate. The marketing of such a concentrate should be investigated.
6. Effective screening in wintertime is doubtful.
7. The mill can probably treat competent caprock from Vangorda this winter; but more samples should be tested to confirm this.
8. Zinc sulphate improves lead-zinc selectivity when treating Vangorda refractory ore.

9. When milling Vangorda refractory ore (plus screen fraction or competent rock) mixed with Faro ore, the zinc assay of the lead concentrate will be higher than normal.

10. The copper assay of the lead concentrate will also be high.

The rest of this letter discusses some of these comments in more detail.

#### Categories of Vangorda Refractory Ore.

The Vangorda refractory caprock ore may be divided into two, or possibly three, categories. The first category is the sands. This material contains a range of sizes from claylike fines, through sands to gravel. The minerals have been oxidized. One sample of baritic sands, DT 14, assayed 1.89% Ox Pb, 0.12% Ox Zn and 2.34% Ox Cu.

The sands contain soluble lead, zinc, iron and copper. It is the soluble copper which has activated the sphalerite and which will activate any other sphalerite with which it comes in contact. This is the worst feature of this material - it contaminates other good ore with which it is mixed. A calculation, assuming that the above 2.34% Ox Cu is soluble, and knowing that 800 g/t of copper sulphate is used in Faro zinc flotation, indicates that as little as 1% of baritic sands may contaminate good ore.

The second category is competent caprock. Oxidation has occurred and the sphalerite has been activated, to some extent at least. However, this material does not seem to contain soluble copper and does not seem to contaminate other ore. It appears that this material can be mixed with Faro ore for milling, with appropriate adjustments to the reagent recipe. Testwork is still being done to confirm this conclusion.

A third possible category is vuggy ore, which is porous and oxidized. This material is probably intermediate between the other two in flotation characteristics.

In practical terms, only two categories appear to need to be recognized, sands or coarse rock. These categories can be easily identified visually in the open pit. Should there be any doubt about the visual identification, oxide copper assays can be used. Material containing less than 0.1% Ox Cu is acceptable ore. Material containing more than 0.4% Ox Cu is contaminated. Further testwork is required to identify material in the range of 0.1% to 0.4% Ox Cu.

### Screening.

Screening is the obvious method of separating contaminated sands from acceptable coarse rock. While I believe that screening can be successfully done in the summertime, I am doubtful that sufficiently effective screening will be possible in the wintertime. A test run the night of November 9, screening some 10 to 20 tons of material over the screening plant near the Faro mine stockpiles, looked to be successful. This material came from the stockpile at Faro.

By my observation, the stockpile at Vangorda contains a greater proportion of sands. It also has frozen lumps which would be difficult to screen in winter. I suggest that a screening test should be run on Vangorda stockpile material (but not the coarse rock from the toe of the stockpile) before any decision is made to screen during the winter.

### Flotation.

Flotation tests on the plus screen fraction from laboratory screening were run on the last day of my visit. Full assay results are not yet available, and further tests need to be run, but from my observations I believe that it should be possible to mix a proportion of the plus screen fraction of Vangorda refractory ore with Faro ore.

Zinc sulphate, in addition to sodium cyanide, appeared to improve lead-zinc selectivity when treating the plus screen fraction of Vangorda refractory ore - as it had done in some earlier tests. If it is cheaper to do so, it may well prove possible to use a sodium cyanide - zinc oxide mix instead of zinc sulphate. I recommend that you have a test quantity of zinc sulphate on hand when you do your first mill test with Vangorda ore.

When milling Vangorda refractory ore with Faro ore, difficulties with lead-zinc selectivity can be anticipated. The lead concentrate will assay higher in zinc than normal.

Because of the copper content of the Vangorda ore, the lead concentrate will also assay high in copper.

### Further Work.

At Faro, the first priority should be testwork to confirm that the plus screen fraction and competent caprock can be mixed with Faro ore for milling.

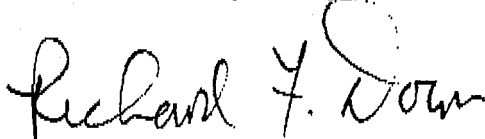
Further testwork on the minus screen fraction (or on total caprock containing the minus screen fraction) can be carried out at Faro, as a second priority, and at Lakefield Research to try to find a way of treating this material. However, I doubt that production of selective lead and zinc concentrates will be possible.

In my opinion, for the time being production planning at the Vangorda open pit should be based on the assumption that screening of the sands from the coarse rock will be necessary.

The possibility of marketing a bulk lead-zinc concentrate should be investigated. When screening of the caprock has been finished, it would be possible to treat the minus screen fraction through the mill by itself in a single campaign to produce such a concentrate.

I would be pleased to discuss the contents of this letter with you at any time. Thank you for this assignment. It was a pleasure to visit Faro again. Please convey my thanks to your staff, especially Eric Beaumont and Gordon Wilson, for their help during my visit.

Yours very truly,

A handwritten signature in cursive script that reads "Richard F. Down". The signature is written in dark ink and is positioned below the typed name.

Richard F. Down.