

019806

DEC 23 1974
Gru

Y-9
14E

NORANDA MINES LIMITED
NORANDA, QUEBEC

VANGORDA PROJECT
REPORT NO. 73

FURTHER FLOTATION TESTS ON DD CORE SAMPLES
OF AVERAGE GRADE ORE FROM VANGORDA CREEK AREA

NORANDA ORE DRESSING LABORATORY

DECEMBER 19, 1974

Marcel Larouche
.....
MARCEL LAROUCHE,
LAB TECHNICIAN.

Jacques Lajoie
.....
JACQUES LAJOIE,
LAB METALLURGIST.

DISTRIBUTION
MR. R.L. COLEMAN (4)
MR. P. CONDER (SUPT.)
LAB FILE

TABLE OF CONTENTS

<u>TITLE</u>	<u>PAGE NO.</u>
<u>INTRODUCTION</u>	
<u>SUMMARY</u>	1-3
<u>TESTWORK AND PROCEDURE</u>	4-11
<u>SUMMARY OF RESULTS</u>	12
<u>APPENDIX I</u>	
DETAILS OF SAMPLES AND COMPOSITES	13-14
<u>APPENDIX II</u>	
PROCEDURE AND RESULTS OF INDIVIDUAL TESTS	15-24
<u>APPENDIX III</u>	
LIST OF EQUIPMENT USED	25

(i)

INTRODUCTION

On November 6th 1974, six drums of DD core samples were received from the Vangorda Creek area. As previously indicated (R.L. Coleman's memo dated September 18th), the samples were already divided as four different composites: low grade, average grade, medium grade and high grade. The aim of the testwork was to develop flotation techniques to recover the lead, zinc and silver values of the composites. Suggestions were made (R.L. Coleman's memo dated September 18th) to develop and optimize ore dressing techniques on the average grade ore and to apply them to the other composites. Consideration was to be given also to the possibilities of obtaining saleable products in the various forms: a lead concentrate, a zinc concentrate and a bulk concentrate, or two separate products as attempted in the present testwork.

The purpose of this testwork was to investigate the feasibility of making lead and zinc concentrates as separate products. This report presents the results of nine batch tests and a quintuple locker test. Iron department was not studied in depth.

(ii)

The following parameters were investigated in the testwork.

- fineness of grind
- the effect of sodium cyanide on the pyrite depression
- the influence of sodium sulphite (zinc depressant) as a potential activator of pyrite
- the use of sodium silicate as slime dispersant
- the use of a selective combination of lead collectors
- the flotation of lead in a lime circuit
- the use of sodium cyanide; sulphur dioxide and lime in combination to depress pyrite and sphalerite
- the levels of copper sulphate and xanthate to recover the zinc minerals.

SUMMARY

As indicated by the mineralogical examination of the composite and the results of flotation tests, the mineralization of the values is relatively coarse (about 200 mesh), 93.6 per cent of lead and 92.5 per cent of zinc was sufficiently liberated to be floated, either with the lead or the zinc concentrate.

Results of a quintuple locked test did indicate the need to regrind the middlings products to reduce the losses in the tailings to maintain marketable grade concentrates and to avoid an excessive contamination of zinc concentrate by the rejected lead. The results of the fifth cycle were as follows:

PRODUCT	Wt. (gms)	%Wt.	ASSAY (%)		DISTRIBUTION (%)	
			Pb	Zn	Pb	Zn
2nd Pb Cl. Conc.	103	5.16	53.6	7.4	77.9 ^v	9.2
2nd Zn Cl. Conc.	123	6.17	3.5	51.8	6.1	77.3
Zn Tails	1,769	88.67	0.64	0.63	16.0	13.5
HEAD	1,995	100.0	3.55	4.14	100.0	100.0

Unfortunately, the silver assays were not available at this time, but indications (batch tests) were that the final lead concentrate would assay about 17 ounces per ton of silver and the zinc concentrate 1.6 ounces per ton of silver. Seventy-five per cent of the silver would report in the lead concentrate and 6 to 7 per cent with the zinc.

As previously established from other samples from the same location (1970 Testwork), the depression of pyrite and sphalerite while floating the lead was a major problem with this composite.

The usual pyrite and sphalerite depressants such as sodium cyanide, sodium sulphite (Present Testwork) and zinc sulphate (1970 Testwork) failed to inhibit their floatability. However some success was obtained when sodium cyanide, sulphur dioxide and lime were used in combination. The need for sodium cyanide in this combination was not established. An excess of this reagent in the cleaning stage of a test did not prevent the flotation of prefloted pyrite, but the use of lime with the same concentrate did depress the pyrite.

Lime is believed to be the most effective pyrite depressant for this ore, and a certain amount of this reagent has to be added to be effective, whatever the pH.

Results of tests in which some sodium silicate was used to limit slimes coalescence were not promising.

TESTWORK AND PROCEDURE

TEST NO. V-33

A first exploratory test (V-33), using a standard approach for this type of ore, was used. A fineness of grind of 78 per cent minus 200 mesh was obtained with twelve minutes of grinding time. ✓

Substantial amounts of pyrite and zinc (25.6 per cent of the total zinc) were reported in the lead concentrate (20 per cent lead assay) when usual depressants such as sodium cyanide (NaCN) and sodium sulphite (Na_2SO_3) were used. The depression of pyrite and sphalerite while floating the lead appeared to be a major problem which was also encountered in the previous testwork carried out at Noranda in 1970.

A lead recovery of 88 per cent compared with the figure of previous testwork (90 per cent) obtained with a sample of similar grades.

Some thirteen per cent of the total zinc was rejected in the final tailings, which was higher than previous results (7 - 8 per cent). However a much better overall zinc grade concentrate (39 per cent Zn) was made.

It is remarked that a fineness of grind of 98 per cent minus 200 mesh was previously used.

TEST NO. V-34

In test V-34, the collector addition to the lead flotation stage was cut to 0.035 pounds per ton from 0.05, and the copper sulphate addition to the zinc conditioning was reduced to 0.4 pounds per ton from 0.6, since a tight froth was experienced in the previous test.

The results of the test showed that the grade of the lead concentrate was improved to some extent (24 per cent Pb) at the expense of recovery (84.4 per cent). The contamination of lead concentrate by the zinc was slightly reduced to 22.4 per cent of the zinc. Improvement in the froth characteristics of the zinc flotation was noted, but the zinc losses in the tailings increased.

TEST NO. V-35

Increasing the addition of sodium cyanide (NaCN) to the grinding stage (0.20 pounds per ton), did not prevent the flotation of readily floatable pyrite and zinc while floating the lead.

TEST NO. V-35 (CONTINUED)

Soda ash and lime were used as pH regulator in the first and the second lead cleaning stage respectively. Indications were that the lime was more effective than soda ash for depression of pyrite when cleaning the lead in a high alkaline circuit. It is noted that some sodium cyanide was used in combination with the soda ash in the first cleaning stage, but did not inhibit the pyrite flotation.

The floatability of lead appeared to be good in the presence of lime provided that extra collector was used.

TEST NO. V-35A

The fineness of grind was increased to 91 per cent minus 200 mesh and the addition of sodium sulphite (Na_2SO_3) to the grind was suppressed. Various sources suggest that sodium sulphite might activate the pyrite of certain ores.

The lead recovery increased to 91.9 from 88 per cent, the zinc losses in the tailings were reduced to 9.5 per cent, but the hypothesis with regard to the role of sodium sulphite as a pyrite activator was not verified. Furthermore, in the absence of this reagent, the contamination of lead concentrate by the floating of zinc did not increase significantly.

TEST NO. V-35B

Duplicated on test V-35A, in test V-35B, the addition of sodium sulphite was maintained and some sodium silicate (Na_2SiO_3) was added to the lead conditioner as a slime dispersant. Unfortunately the addition of 2.0 pounds per ton of this last reagent brought up the pH to 10.3. It was decided not to readjust the pH with acidic compounds for the lead flotation.

A primary effect of this was to promote the contamination of zinc during the lead flotation (from 25.6 to 33.5 per cent).

Large amounts of pyrite were found to float while floating the zinc. Since the addition of lime was not required to readjust the pH after the lead floated, it is thought that the use of lime as pH regulator might be of assistance to prevent the flotation of readily floatable pyrite of this ore. The grade of the zinc concentrate decreased to 18 per cent Zinc from 36 to 38 per cent.

TEST NO. V-35C

This test exactly duplicated the test No. V-33, except that a finer grind (91 per cent minus 200 mesh) was used.

TEST NO. V-35C (CONTINUED)

Similar grades but better recoveries were obtained. A lead recovery of 91.9 per cent compared with the figure of 88.0 and the zinc losses in the tailings were reduced to 10 per cent from 13 per cent.

TEST NO. V-36

The aerofloats AF-242 and AF-404 in combination with the xanthate R-317 as a booster were used to collect the lead minerals. As a result of the use of a more selective combination of lead collectors (in place of R-317 alone), the lead grade concentrate was improved but at the expense of recovery (82 per cent only). It was felt, however, that large amounts of xanthate could have been used in the scavenger stage to promote the recovery.

A better balance of copper sulphate and xanthate to collect the zinc minerals resulted in a reduction of the zinc losses in the tailings to 7.5 per cent without increasing the grind. However this was obtained at the expense of the grade which was reduced to 30 per cent zinc.

TEST NO. V-37

The investigation of the flotation of lead in a lime circuit (pH = 9.5) to prevent flotation of excessive amounts of pyrite was indicated by the results of previous tests.

A relative success was obtained if it is considered that the Reagent R-317 was used to collect the lead minerals. The grade of lead concentrate increased from 20.2 to 23.9 per cent lead, but three percentage points of recovery were lost. Only 0.15 pounds per ton of lime was required to bring the pH up to 9.5.

TEST NO. V-38

A combination of sodium cyanide, sulphur dioxide (SO_2 soln) and lime was used to depress both pyrite and sphalerite minerals during the lead flotation. The pH was decreased with the sulphur dioxide to 5.5 for two minutes and readjusted with lime to pH 9.0. The xanthate R-317 was used again to collect the lead.

As indicated by the results of the test, a significant improvement was obtained. A lead concentrate grade of 27.4 per cent lead at a recovery of 86.5 per cent was made and only 18.2 per cent of the

TEST NO. V-38 (CONTINUED)

zinc was reported in this concentrate. However it was noted that the great floatability of pyrite persisted and that the success of the separation would depend on the use of selective collectors for the lead, a careful sequence of this addition, and the use of the above listed combination of depressants.

TEST NO. V-39

A quintuple locked test, duplicated on the test No.V-38 procedure, was carried out to study the behaviour of middlings when re-circulated. An adequate mass balance was achieved in the fifth cycle and the results were as follows:

	Wt. (gms)	%Wt.	ASSAY (%)		DISTRIBUTION (%)	
			Pb	Zn	Pb	Zn
2nd Pb Cl. Conc.	103	5.16	53.6	7.4	77.9	9.2
2nd Zn Cl. Conc.	123	6.17	3.5	51.8	6.1	77.3
Zn Tails	1,769	88.67	0.64	0.63	16.0	13.5
HEAD	1,995	100.0	3.55	4.14	100.0	100.0

The results indicated the need to regrind the middlings product to obtain marketable grade product, to limit lead and zinc losses in the final tailings as well as to avoid an excessive contamination of zinc concentrate by rejected lead from the lead circuit.

TEST NO. V-39 (CONTINUED)

The lead rougher concentrate was cleaned in a high lime circuit (pH = 11.0) to prevent the flotation of pyrite, but substantial amounts of collectors were required to refloat the lead minerals.

The cleaning of the zinc rougher concentrate was performed at pH 10.0 with lime, but it was felt that a higher pH would be suitable to maintain the grade.

In both circuits a scavenger concentrate was floated and recirculated to the conditioner of the respective stages.

SUMMARY OF RESULTS

	Pb CONCENTRATE				Zn CONCENTRATE				TAILS		REMARKS
	ASSAY (%)		DISTRIBUTION (%)		ASSAY (%)		DISTRIBUTION (%)		ASSAY (%)		
	Pb	Zn	Pb	Zn	Pb	Zn	Pb	Zn	Pb	Zn	
33	20.0	7.08	88.0	25.6	1.12	38.8	2.2	61.4	0.43	0.69	(78% 200 Mesh, standard flotation practice lead - zinc ore)
34	24.6	8.04	84.4	22.4	1.47	35.5	3.1	61.9	0.50	0.77	(Cut R-317 to 0.05#/T from 0.05#/T in lead, Cut CuSO ₄ to 0.4 from 0.6#/T)
35	20.1	7.51	87.8	27.2	-	-	-	-	0.48	3.45	(Additional NaCN did not depress iron and Zn sulphides more effectively)
35A	20.6	7.28	91.9	26.9	0.82	36.2	1.7	63.6	0.27	0.49	(Same as V-33 except finer grind 91% 200 Mesh and no Na ₂ SO ₃)
35B	26.0	14.6	79.6	33.5	2.5	18.0	10.5	56.7	0.38	0.50	(Use of Na ₂ SiO ₃ , pH 10.4)
35C	20.2	7.27	91.1	27.8	1.0	40.2	1.8	62.3	0.32	0.53	(Same as V-33/35 except finer grind (91% 200 Mesh)
36	26.13	7.54	82.0	17.8	2.6	30.4	8.5	74.7	0.37	0.39	(Lead flot with AF-242, AF-404 and R-317)
37	23.9	7.06	88.2	22.9	1.3	33.6	2.9	68.7	0.41	0.44	(To float lead in a lime circuit pH 9.5)
38	27.4	7.05	86.5	18.2	1.5	41.7	3.0	69.4	0.42	0.61	(NaCN in combination with sulphur dioxide gas and lime)
39	53.6	7.4	77.9	9.2	3.5	51.8	6.1	77.3	0.64	0.63	(Quintuple locked test)

*RESULTS OF FIFTH CYCLE

APPENDIX I

SAMPLES

On November 6th 1974, six drums of DD core samples were received from the Vangorda Creek area. The samples were already combined in four individual composites. The drums weighed approximately 300 pounds each, labeled as follows:

LOW GRADE	-	2 DRUMS	✓
AVERAGE GRADE	-	1 DRUM	✓
MEDIUM GRADE	-	2 DRUMS	
HIGH GRADE	-	1 DRUM	

Blue core sample

SAMPLES PREPARATION

The composites were crushed individually to 4 mesh and thirty bags (2000 gms) of each composite made up for testing.

Chemical analyses of composites are recorded on Page 14.

CHEMICAL ANALYSES OF COMPOSITES

COMPOSITE	<u>LOW GRADE</u>	<u>AVERAGE GRADE</u>	<u>MEDIUM GRADE</u>	<u>HIGH GRADE</u>
Cu per cent	0.12	0.15	0.11	0.30
Pb per cent	2.17	3.57	4.08	5.38
Pb (as oxide) per cent	0.49	0.72	0.70	0.92
Zn per cent	3.12	4.12	6.67	8.95
Zn (as oxide) per cent	0.13	0.15	0.23	0.28
Au oz./ton	0.024	0.028	0.031	0.035
Ag oz./ton	1.1	1.62	? 0.80	? 0.54
Cd per cent	0.05	0.006	0.09	0.12
As per cent	0.31	0.29	0.26	0.18
Pyrrhotite per cent	4.93	4.10	3.86	3.94
Pyrite per cent	25.97	34.9	41.49	47.16
SiO ₂ per cent	51.1	36.56	27.6	11.1
Al ₂ O ₃ per cent	4.58	3.65	1.89	N.A.
MgO per cent	0.65	0.67	0.99	N.A.
CaO per cent	0.97	1.53	1.59	N.A.
Fe per cent	14.7	19.2	21.3	24.0
S per cent	16.5	22.4	38.1	32.5
Insol per cent	57.8	N.A.	33.3	24.9
SPECIFIC GRAVITY	3.2	3.3	4.0	4.0

39 of 84

APPENDIX II

RESULTS AND CONDITIONS

OF INDIVIDUAL TESTS

NORANDA ORE DRESSING LABORATORY

PROJECT: VANGORDA DATE: NOVEMBER - DECEMBER

SAMPLE NO.: AVERAGE GRADE TEST NO.: V-33

WEIGHT: 2000

MARKS: Exploratory Test

Screen Analyse	GMS	Weight	Cum.	Passing
+65	-	-	-	-
-65 + 100	2	1.0		99.0
-100 + 150	10	5.0		94.0
-150 + 200	31	15.5		78.5
-200 + 325	29	14.5		64.0
- 325	128	64.0		
TOTAL	200	100.0		

	Time Mins.	% Solids	pH	REAGENTS lbs./ton														
				Na ₂ CO ₃	NaCN	Na ₂ SO ₃	R-317	Lime	CuSO ₄	Mibc								
Ind	12	71	-	2.0	0.10	1.0	-	-	-	-								
Cond.	3	25	-	-	-	-	0.05	-	-	-								
Float	10	25	8.5	-	-	-	-	-	-	-								
Cond.	3	24	-	-	-	-	-	0.4	0.6	-								
Float	7	24	10.0	-	-	-	-	-	-	-								

Metallurgical Balance			Assay % or oz./ton				Units			%Distribution		
Product	GMS	%Wt.	Pb	Zn	Ag					Pb	Zn	Ag
Conc.	301	15.1	20.0	7.08	8.61					88.0	25.6	78.2
Tails	1697	84.9	0.48	2.14	0.43					12.0	74.4	21.8
Conc.	131	6.6	1.12	38.8	1.23					2.2	61.4	4.9
Tails	1566	78.4	0.43	0.69	0.36					9.8	13.0	16.9
TAD	1998	100.0	3.43	4.17	1.66					100.0	100.0	100.0

NORANDA ORE DRESSING LABORATORY

SUBJECT: VANGORDA DATE: . NOVEMBER - DECEMBER

SAMPLE NO.: AVERAGE GRADE TEST NO.: V-34

WEIGHT: 2000

REMARKS: Exploratory test including cleaning of zinc

Screen Analyse	GMS	Weight	Cum	Passing
+65	-	-	-	-
-65 + 100	2	1.0		99.0
-100 + 150	10	5.0		94.0
-150 + 200	34	17.0		77.0
-200 + 325	35	17.5		59.5
- 325	119	59.5		
TOTAL	200	100.0		

	Time Mins.	% Solids	pH	REAGENTS lbs./ton											
				Na ₂ CO ₃	NaCN	Na ₂ SO ₃	R-317	Lime	CuSO ₄	Mibc	CF-98				
Ind	12	71	-	1.0	0.10	1.0	-	-	-	-	-				
Cond.	3	25	-	-	-	-	0.02	-	-	-	-				
Float	10	25	8.7	-	-	-	0.015	-	-	0.04	-				
Cond.	3	24	-	-	-	-	0.02	0.4	0.4	-	-				
Ro Float	8	24	10.0	-	-	-	0.005	-	-	-	0.02				
Zn Cl.F.	5	10	11.0	-	-	-	0.002	0.10	-	-	0.01				
Zn Cl.F.	4	8	11.0	-	-	-	-	0.05	-	-	0.01				

Product	Analytical Balance		Assay % or oz./ton			Units			%Distribution		
	GMS	%Wt.	Pb	Zn	Ag				Pb	Zn	Ag
Conc.	224	11.22	25.6	8.04	10.68				84.7	22.4	74.6
Zn Cl.C.	89	4.46	1.40	50.2	1.58				1.8	55.7	4.4
Zn Cl.T.	20	1.00	3.01	21.75	1.95				0.9	5.4	1.2
Zn Cl.C.	109	5.46	1.68	45.0	1.65				2.7	61.1	5.6
Zn Cl.T.	31	1.55	1.62	2.17	1.01				0.7	0.8	1.0
Ro. Conc.	140	7.01	1.67	35.5	1.51				3.4	61.9	6.6
Ro Tails	1633	81.77	0.50	0.77	0.37				12.0	15.7	18.8
	1007	100.0	3.30	4.02	1.61				100.0	100.0	100.0

NORANDA ORE DRESSING LABORATORY

PROJECT: VANGORDA DATE: NOVEMBER-DECEMBER

SAMPLE NO.: AVERAGE GRADE TEST NO.: V-35

CHARGE GMS: 2000

REMARKS: Exploratory test including cleaning of lead.

Lime better than soda ash (pH 10.5) and NaCN to depress

pyrite.

Screen Analyse	GMS	Weight	Cum	Passi
+65	-	-	-	-
-65 + 100	2	1.0	-	99.0
-100 + 150	10	5.0	-	94.0
-150 + 200	33	16.5	-	77.5
-200 + 325	48	24.0	-	53.5
- 325	107	53.5		
TOTAL	200	100.0		

REAGENTS lbs./ton

	Time Mins.	% Solids	pH	Na ₂ CO ₃	NaCN	Na ₂ SO ₃	R-317	Lime	CuSO ₄	Mibc	CF98						
Grind	12	71	-	-	0.20	1.0	-	-	-	-	-						
Pb Cond.	3	25	-	0.1	-	-	0.03	-	-	-	-						
Pb Ro Float	9	25	8.7	-	-	-	-	-	-	0.08	-						
1st Pb Cl.F.	4	20	10.6	0.9	0.10	-	-	-	-	-	-						
2nd Pb Cl.F.	4	12	12.0	-	-	-	0.05	0.5	-	-	-						
Zn Cond.	3	24	-	-	-	-	0.03	0.4	0.6	-	-						
Zn Float	-	24	10.0	(Tight Froth)													

Metallurgical Balance	Assay % or oz/ton						Units			%Distribution		
	GMS	%Wt.	Pb	Zn	Ag					Pb	Zn	Ag
nd Pb Cl.C.	65	3.25	53.5	7.22	17.21					51.8	5.8	37.5
nd Pb Cl.T.	112	5.60	15.60	9.80	7.18					26.0	13.6	26.9
st Pb Cl.C.	177	8.85	29.5	8.86	10.86					77.8	19.4	64.4
st Pb Cl.T.	116	5.80	5.80	5.46	2.67					10.0	7.8	10.4
Pb Ro: Conc.	293	14.65	20.13	7.51	7.62					87.8	27.2	74.8
Tails	1706	85.35	0.48	3.45	0.44					12.2	72.8	25.2
LEAD	1999	100.0	3.36	4.05	1.49					100.0	100.0	100.0

NORANDA ORE DRESSING LABORATORY

PROJECT: VANGORDA DATE: NOVEMBER-DECEMBER

SAMPLE NO.: AVERAGE GRADE TEST NO.: V-35A

CHARGE GMS: 2000

REMARKS: Finer grind than V-35 and no Na₂SO₃ to prevent activation of readily floatable pyrite.

Screen Analyse	WEIGHT GMS	Weight	Cum	Passi
+65	-	-	-	-
-65 + 100	-	-	-	-
-100 + 150	2	1.0	-	99.6
-150 + 200	15	7.5	-	91.5
-200 + 325	53	26.5	-	65.0
- 325	130	65.0		
TOTAL	200	100.0		

REAGENTS lbs./ton

	Time Mins.	% Solids	pH	Na ₂ CO ₃	NaCN	R-317	Lime	CuSO ₄	Mibc	CF-98							
Grind	16	71	-	-	0.20	-	-	-	-	-							
1st Cond.	3	25	-	0.06	-	0.03	-	-	-	-							
1st Float	8	25	8.7	-	-	-	-	-	-	-							
2nd Cond.	3	24	-	-	-	0.03	0.4	0.6	-	0.02							
2nd Float	6	24	10.0	-	-	-	-	-	-	-							

Metallurgical Balance

Assay % or oz./ton

Units

%Distribution

Product	GMS	%Wt.	Pb	Zn	Ag						Pb	Zn	Ag				
1st Conc.	296	14.84	20.6	7.28							91.9	26.9					
1st Tails	1699	85.16	0.32	3.45							8.1	73.1					
2nd Conc.	141	7.07	0.82	36.2							1.7	63.6					
2nd Tails	1558	78.09	0.27	0.49							6.4	9.5					
HEAD	1995	100.0	3.33	4.02							100.0	100.0					

NORANDA ORE DRESSING LABORATORY

PROJECT: VANGORDA DATE: NOVEMBER-DECEMBER

SAMPLE NO.: AVERAGE GRADE TEST NO.: V-35B

CHARGE GMS: 2000

REMARKS: Same as V-35A except Na₂SiO₃ in Pb condit pH went up to 10.3 from 8.2

Screen Analyse	Weight GMS	Weight	Cum	Pass
+65	-	-	-	-
-65 + 100	-	-	-	-
-100 + 150	2	1.0	-	-
-150 + 200	15	7.5	-	-
-200 + 325	53	26.5	-	-
- 325	130	65.0	-	-
TOTAL	200	100.0	-	-

	Time Mins.	% Solids	pH	REAGENTS lbs./ton														
				NaCN	Na ₂ SiO ₃	R-317	Lime	CuSO ₄	Mibc	CF-98								
Grind	16	71	-	0.20	-	-	-	-	-	-								
Pb Cond.	-	25	-	-	2.0	0.03	-	-	-	-								
Pb Float	8	25	10.3	-	-	0.005	-	-	0.03	-								
Zn Cond.	3	24	-	-	-	0.03	-	0.6	-	-								
Zn Float	5	24	10.3	-	-	0.005												

Metallurgical Balance			Assay % or oz./ton				Units				%Distribution				
Product	GMS	%Wt.	Pb	Zn								Pb	Zn		
Pb Conc.	183	9.17	26.0	14.6									33.5		
Pb Tails	1812	90.83	2.5	-									-		
Zn Conc.	251	12.58	2.5	18.0									5.67		
Zn Tails	1561	78.25	0.38	0.50									9.8		
HEAD	1995	100.0	3.00	3.99									100.0		

NORANDA ORE DRESSING LABORATORY

OBJECT:	VANGORDA	DATE:	NOVEMBER-DECEMBER
SAMPLE NO.:	AVERAGE GRADE	TEST NO.:	V-35C
WEIGHT:	2000		
REMARKS:	Same as V-35 and V-33 except finer grind		

Screen Analyse	GMS	Weight	Cum	Passing
+65	-	-	-	-
-65 + 100	-	-	-	-
-100 + 150	2	1.0	-	99.0
-150 + 200	15	7.5	-	91.5
-200 + 325	53	26.5	-	65.0
- 325	130	65.0	-	
TOTAL	200	100.0		

	Time Mins.	% Solids	pH	REAGENTS lbs./ton													
				Na ₂ CO ₃	NaCN	Na ₂ SO ₃	R-317	Lime	CuSO ₄	Mibc	CF-98						
Ind	16	71	-	-	0.20	1.0	-	-	-	-	-						
Cond.	5	-	-	0.1	-	-	0.03	-	-	-	-						
Ro. Float	3	25	8.7	-	-	-	-	-	-	0.06	-						
Scav. Float	5	25	8.5	-	-	-	-	-	-	0.01	-						
Cond.	3	24	-	-	-	-	0.03	0.4	0.5	-	-						
Float	6	24	10.0	-	-	-	-	-	-	-	0.02						

Metallurgical Product	Balance		Assay % or oz/ton				Units				%Distribution		
	GMS	%Wt.	Pb	Zn	Ag					Pb	Zn	Ag	
Ro. Conc.	234	11.77	25.8	7.58	11.37					86.4	21.5	26.5	
Scav. Conc.	81	4.08	4.08	6.40	2.27					4.7	6.3	5.3	
11 Pb Conc.	315	15.85	20.21	7.27	9.03					91.1	27.8	81.8	
Tails	1673	84.15	0.37	3.57	0.38					8.9	72.2	18.2	
Conc.	128	6.44	1.0	40.2	1.34					1.8	62.3	4.9	
Tails ...	1545	77.71	0.32	0.53	0.30					7.1	9.9	13.3	
TOTAL	1988	100.0	3.52	4.15	1.75					100.0	100.0	100.0	

NORANDA ORE DRESSING LABORATORY

PROJECT: VANGORDA DATE: NOVEMBER-DECEMBER

SAMPLE NO.: AVERAGE GRADE TEST NO.: V-36

LARGE GMS: 2000

REMARKS: To prevent activation of readily floatable pyrite and zinc using selective collectors for lead.

SCREEN Analyse	GMS	Weight	Cum.	Passing
+65	-	-	-	-
-65 + 100	-	-	-	-
-100 + 150	2	1.0	-	99.0
-150 + 200	15	7.5	-	91.5
-200 + 325	53	26.5	-	65.0
- 325	130	65.0		
TOTAL	200	100.0		

	Time Mins.	% Solids	pH	REAGENTS lbs./ton											
				Na ₂ CO ₃	NaCN	Na ₂ SO ₃	AF-242	AF-404	R-317	Lime	CuSO ₄	Mibc	CF-98		
Grind	16	71	-	-	0.20	1.0	-	-	-	-	-	-	-	-	-
Cond.	3	-	-	0.01	-	-	0.01	0.01	0.002	-	-	-	-	-	-
Ro. Float	3	25	8.7	-	-	-	-	-	0.003	-	-	0.04	-	-	-
Scav. Float	5	25	8.4	-	-	-	-	-	0.002	-	-	0.01	-	-	-
Cond.	3	-	-	-	-	-	-	-	0.02	0.4	0.5	-	-	-	-
Ro. Float	6	24	10.0	-	-	-	-	-	0.005	-	-	-	-	-	-
Scav. Float	3	24	9.5	-	-	-	-	-	-	-	-	-	-	-	-

Metallurgical Product	Balance		Assay % oz./ton				Units				%Distribution			
	GMS	%Wt.	Pb	Zn							Pb	Zn		
Ro. Conc.	92	4.61	40.4	6.16							59.8	6.9		
Scav. Conc.	103	5.16	13.4	8.78							22.2	10.9		
Total Pb Conc.	195	9.77	26.13	7.54							82.0	17.8		
Ro. Conc.	136	6.82	2.5	42.2							5.5	69.5		
Scav. Conc.	67	3.36	2.8	6.38							3.0	5.2		
Total Zn Conc.	203	10.18	2.60	30.4							8.5	74.7		
Tails	1597	80.05	0.37	0.39							9.5	7.5		

NORANDA ORE DRESSING LABORATORY

PROJECT: VANGORDA DATE: . NOVEMBER-DECEMBER

SAMPLE NO.: AVERAGE GRADE TEST NO.: V-37

CHARGE GMS: 2000

REMARKS: To float lead in lime circuit (pH = 9.5) to inhibit pyrite flotation.

Analyse	GMS	Weight	Cum.	Passing
+65	-	-	-	-
-65 + 100	-	-	-	-
-100 + 150	2	1.0	-	99.0
-150 + 200	15	7.5	-	91.0
-200 + 325	53	26.5	-	65.0
- 325	130	65.0		
TOTAL	200	100.0		

	Time Mins.	% Solids	pH	REAGENTS lbs./ton												
				NaCN	Na ₂ SO ₃	Lime	R-317	CuSO ₄	Mibc	CF-98						
Grind	16	71	-	0.20	1.0	-	-	-	-	-						
Pb Cond.	3	-	-	-	-	0.15	0.03	-	-	-						
Pb Ro. Float	3.5	25	9.5	-	-	-	-	-	0.04	-						
Pb Scav. Float	4.5	25	9.0	-	-	-	-	-	0.02	-						
Zn Cond.	3	-	-	-	-	0.4	0.02	0.6	-	-						
Zn Ro Float	6	24	10.0	-	-	-	0.0025	-	-	-						
Zn Scav. Float	3	24	9.5	-	-	-	0.0075	-	-	-						

Metallurgical Product	Balance		Assay % or oz./ton				Units			%Distribution		
	GMS	%Wt.	Pb	Zn	Ag				Pb	Zn	Ag	
Pb Ro. Conc.	185	9.21	31.8	7.08	13.6				80.7	15.8	72.0	
Pb Scav. Conc.	84	4.18	6.58	7.0	3.38				7.6	7.1	8.1	
Total Pb Conc.	269	13.39	23.9	7.06	10.4				88.2	22.9	80.0	
Zn Ro. Conc.	92	4.58	1.32	41.2	1.60				1.7	45.8	4.2	
Zn Scav. Conc.	67	3.33	1.38	28.3	1.27				1.2	22.9	2.4	
Total Zn Conc.	169	8.41	1.36	33.64	1.37				2.9	68.7	6.6	
Tails	1571	78.20	0.41	0.44	0.30				8.9	8.4	13.4	
Total	2000	100.0	3.63	4.12	1.74				100.0	100.0	100.0	

NORANDA ORE DRESSING LABORATORY

PROJECT: VANGORDA DATE: NOVEMBER-DECEMBER

SAMPLE NO.: AVERAGE GRADE TEST NO.: V-38

CHARGE GMS: 2000

REMARKS: To investigate a combination of SO₂ (gas) and NaCN to depress pyrite and sphalerite

Screen Analyse	Weight GMS	% Weight	% Cum	% Pass
+65	-	-	-	-
-65 + 100	-	-	-	-
-100 + 150	2	1.0	-	99
-150 + 200	15	7.5	-	91
-200 + 325	53	26.5	-	65
- 325	130	65.0	-	-
TOTAL	200	100.0		

	Time Mins.	% Solids	pH	REAGENTS lbs./ton											
				NaCN	SO ₂	Lime	R-317	CuSO ₄	Mibc	CF-98	Na ₂ SO ₃				
Grind	16	71	-	0.20	-	-	-	-	-	-	1.0				
Pb Cond.	3	-	-	-	To pH 5.3	1.4 to pH 8.8	0.03	-	-	-	-	-			
Pb Ro Float	3	25	8.8	-	-	-	-	-	0.04	-	-				
Pb Scav. Float	5	25	8.7	-	-	-	-	-	0.03	-	-				
Zn Cond.	3	-	-	-	-	0.06	0.025	0.55	-	-	-				
Zn Ro Float	6.5	24	10.0	-	-	-	0.005	-	-	-	0.02				
Zn Scav. Float	3.5	24	9.5	-	-	-	-	-	-	-	0.02				

Metallurgical Product	Balance		Assay% or oz/ton			Units			%Distribution		
	GMS	%Wt.	Pb	Zn	Ag				Pb	Zn	Ag
Pb Ro. Conc.	179	8.97	30.6	6.94	12.9				82.8	15.3	68.7
Pb Scav. Conc.	30	1.51	8.22	7.66	6.88				3.7	2.9	6.2
O'11 Pb Conc.	209	10.48	27.38	7.05	12.0				86.5	18.2	74.9
Zn Ro. Conc.	92	4.61	1.34	43.8	1.83				1.9	49.6	5.0
Zn Scav. Conc.	43	2.16	1.76	37.3	1.86				1.1	19.8	2.4
O'11 Zn Conc.	135	6.77	1.48	41.73	1.83				3.0	69.4	7.4
Tails	1651	82.75	0.42	0.61	0.36				10.5	12.4	17.7

NORANDA ORE DRESSING LABORATORY

PROJECT: VANGORDA

DATE: NOVEMBER-DECEMBER

SAMPLE NO.: AVERAGE GRADE

TEST NO.: V-39

LARGE GMS: 2000

MARKS: Quintuple (5) locked test

Analyse	GMS	Weight	Cum.	Pass
+65	-	-	-	-
-65 + 100	-	-	-	-
-100 + 150	2	1.0	-	99.0
-150 + 200	16	8.0	-	91.0
-200 + 325	56	28.0	-	63.0
- 325	126	63.0		
TOTAL	200	100.0		

	Time Mins.	% Solids	pH	REAGENTS lbs./ton													
				NaCN	SO ₂	Lime	AF-242	AF-404	R-317	CuSO ₄	Mibc	CE-98					
Find	16	71	-	0.20	-	-	-	-	-	-	-	-	-	-	-	-	-
Wb Cond.	5	25	-	-	To pH 5.3	to pH 9.0	0.02	0.005	0.005	-	-	-	-	-	-	-	-
Wb Ro.+Scav.F.	10	25	9.2	-	-	-	-	-	0.01	-	-	-	-	-	-	-	-
Wst Pb.Cl.C.	5	20	11.0	0.05	-	0.05	0.005	-	0.003	-	-	-	-	-	-	-	-
Wnd Pb Cl.F.	4	12	11.0	0.025	-	0.04	0.0025	-	0.002	-	-	-	-	-	-	-	-
Wn Cond.	3	24	-	-	-	0.65	-	-	0.025	0.5	-	-	-	-	-	-	-
Wn Ro.+Scav.F.	7	24	10.0	-	-	-	-	-	0.008	-	-	-	-	-	-	-	-
Wst Zn Cl.F.	3	10	10.0	-	-	0.01	-	-	0.002	-	-	-	-	-	-	-	-
Wnd Zn Cl.F.	3	8	10.0	-	-	0.01	-	-	0.001	-	-	-	-	-	-	-	-

Metallurgical Product	Balance Fifth Cycle		Assay% or oz/ton				Units				%Distribution			
	GMS	%Wt.	Pb	Zn							Pb	Zn		
Wd Pb Cl.C.	103	5.16	53.6	7.4							77.9	9.2		
Wd Zn Cl.C.	123	6.17	3.5	51.8							6.1	77.3		
W Tails	1769	88.67	0.64	0.63							16.0	13.5		
WAD	1995	100.0	3.55	4.14							100.0	100.0		

APPENDIX III

GRINDING

8" dia. X 15" lab rod mill

eighteen 1" X 13 7/8" stainless steel rods (25 Kg)

Speed: 84 r.p.m.

FLOTATION

Denver Lab D-1 flotation machine

Roughing 5 litres stainless steel cell

Cleaning 1.4 litres stainless steel cell

Speed: 1800 r.p.m. (roughing)

1000 r.p.m. (cleaning)