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CANADA

DEPARTMENT OF ENERGY, MINES AND RESOURCES

OTTAWA

MINES BRANCH INVESTIGATION REPORT

IR 72-24 June 1972

RECOVERY OF SILVER FROM TWO SAMPLES OF "CLEAN-UP SAND" SUBMITTED BY COBALT REFINERY DIVISION, KAM KOTIA MINES LIMITED

by

W. Arthur Wall and R. W. Bruce

Mineral Processing Division

Note: This report relates essentially to the samples as received. The report and any correspondence connected therewith shall not be used in full or in part as publicity or advertising matter.

COPY NO.

Mines Branch Investigation Report 72-24

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W. Arthur Wall* and R.W. Bruce**

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SUMMARY OF RESULTS

The silver recovery obtained by flotation of the dry sample was 78 per cent (Test 10) and of the wet sample 72 per cent (Test 9). Gravity concentration was not effective (Tests 1 and 3). Cyanidation of the table tailing of Test 3 produced a residue assaying 1.80 ounces silver per ton and containing only 6.5 per cent of the silver in the original feed.

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*Research Scientist and **Head, Non-Ferrous Minerals Section, Mineral Processing Division, Mines Branch, Department of Energy, Mines and Resources, Ottawa, Canada.

CONTENTS

	Page
Summary of Results	i
Introduction	1
Location of Property	1
Shipment	1
Purpose of Investigation	1
Sampling and Analysis	1
Mineralogical Examination	3
Outline of Investigation	4
Discussion of Results	4
Conclusions	6
Acknowledgements	6
Appendix A	
Appendix B	

INTRODUCTION

Location of Property

The smelter of the Cobalt Refinery Division of Kam Kotia Mines Limited is located approximately six miles southwest of Cobalt, Ontario. The material submitted for this investigation consisted of smelter plant clean-up yard-sand.

Shipment

Two lots of yard-sand (4 drums) were received on May 18, 1971. One lot, weighing 660 pounds, was dry yard-sand and the other lot, weighing 474 pounds, was wet yard-sand. This material was recovered from the area around the smelter and was a mixture of the yard-sand and high-grade concentrate spilt over the years.

Purpose of Investigation

Mr. John N. Cram, General Manager of Cobalt Refinery Division, requested an investigation to determine what concentration and recovery could be obtained by fine grinding, tabling and/or flotation concentration.

The company estimated that they would skim off about 2500 tons of yard-sand running about 30 oz silver per ton. It was their intention to have this material processed in one of the local mills.

Sampling and Analysis

The dry yard-sample weighing 660 pounds was split into quarters. One quarter, selected at random, was riffled into sixteen portions. One of these portions was selected as a head sample. This head sample was riffled down to give one sample for assay and another sample for screen analysis and the sizes were assayed for silver. The head sample assay is shown in Table 1 and the screen analysis in Table 2. In Table 1, the assay results submitted by Cobalt Refinery Division are also tabulated.

The wet yard-sample was air dried and one quarter was split into 2000-gram portions. One portion was selected at random and submitted for silver analysis. The result of this analysis is also shown in Table 1.

TABLE 1

Analyses of Head Samples

Element	Dry Yard-Sand	Wet Yard-Sand
Ag oz /ton[1]	25.41	10.77
Ag oz/ton[2]	31.90	19.16
Fe %[2]	1.25	0.86
SiO %[2]	85.60	86.25
CaO %[2]	8.00	7.25
Cu, Ni, Co, As,[2]	Tr	Tr

(1) From Internal Reports MS-AC-71-254 and 305

(2) From Cobalt Refinery Division

TABLE 2

Screen Analysis of Dry Yard-Sand

Tyler Mesh Size	Weight %	Assay* oz Ag/ton	Distribution Ag %
+ 8	4.8	11.55	2.2
+ 10	5.6	17.76	4.1
+ 14	5.8	18.39	4.3
+ 28	17.5	23.44	16.6
+ 48	25.5	14.60	15.1
+ 65	10.4	11.76	5.0
+100	4.1	16.97	2.8
+150	7.5	17.08	5.2
+200	3.9	27.67	4.4
+325	2.8	46.27	5.2
-325	12.1	71.21	35.1
Head(calcd)	100.0	24.64	100.0

*From Internal Report MS-AC-71-254

MINERALOGICAL EXAMINATION*

A copy of the report covering the mineralogical examination of the sample is attached as Appendix A.

The sample is composed essentially of sand and the minerals identified in it are typical of such material. The principal minerals present are quartz and feldspar with minor amounts of garnet, zircon, epidote, amphibole, magnetite, ilmenite, rutile, hematite and goethite.

The ore minerals present in the sample, include native silver, acanthite, cerargyrite?, chalcopyrite, pyrite, arsenopyrite, pyrrhotite, safflorite, pentlandite, skutterudite and a few grains of galena, native bismuth, tetrahedrite, sphalerite, marcasite, covellite and chalcocite. The dominate metallic minerals in the sample are magnetite and pyrite.

Silver, in the form of its native metal, is the dominant phase of the argentiferous minerals identified in the sample. Acanthite, tetrahedrite and cerargyrite? are also present but in much smaller amounts. The native silver occurs as free grains, as grains with thin alteration rims of acanthite or cerargyrite, and as inclusions in some of the other minerals in the sample. These inclusions of native silver are largely from 2 to 35 microns in size with as many as 20 to 30 inclusions in one grain of arsenides.

The amount of free grains of native silver, or of native silver with alteration rims of acanthite or cerargyrite? is greater than that of native silver as inclusions in other minerals. Viewed in relationship to the amount of native silver observed, the quantity of other silver-bearing minerals is almost insignificant.

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*From Mines Branch Internal Report MS 71-92 by D. R. Ownes

OUTLINE OF INVESTIGATION

A combined jigging and tabling test on a sample of the dry yard-sand produced low-grade gravity concentrates with a poor recovery of the silver in the feed. A combination of tabling and flotation was then tried to improve recovery of the silver. The remainder of the test work consisted of flotation tests in which the variables investigated included grind, pH, and various combinations of promoters, frothers and depressants.

Full details of all tests are shown in the Mines Branch Flotation Test Reports in Appendix B.

DISCUSSION OF RESULTS

Dry Yard-Sand

In Test 1, the sample was ground to minus 10-mesh and treated in a Denver Jig. The combined concentrate and bed assayed 108.31 ounces silver per ton and contained 39.4 per cent of the silver in the feed. The jig tailing was tabled on a Wilfley table with poor results. The table concentrate assayed 132.71 ounces per ton and contained only 9.8 per cent of the silver in the feed. The table tailing assayed 13.32 ounces silver per ton. The table tailing was ground to minus 48-mesh and screened on a 200-mesh screen. The plus 200-mesh portion was split into two fractions and each fraction ground in a rod mill for twenty minutes before being remixed with the original minus 200-mesh material. The pulp was floated to recover a rougher concentrate and a scavenger concentrate. The rougher concentrate assayed 135.22 ounces silver per ton and contained 23.6 per cent of the silver in the feed. The tailing assayed 6.55 ounces silver per ton and contained 23.6 per cent of the silver in feed. Gravity concentration was not effective in producing a higher grade concentrate or satisfactory recovery.

In Test 3, the sample was ground and floated. The flotation tailing was tabled to produce a table concentrate, a table middling and a tailing. Rougher flotation concentrates number 1 and 2 assayed 216.41 ounces silver per ton and contained 72.4 per cent of the silver in the feed. The

flotation tailing assaying 5.90 ounces silver per ton and contained 22.1 per cent of the silver in the feed. Tabling of the flotation tailing was not effective. The combined table concentrate and the table middling were treated in the Davis Tube to separate the magnetic portions but the results were not significant.

The table tailing, assaying 5.485 ounces silver per ton, was cyanided (see Test 4) for forty-eight hours. The cyanide residue assayed 1.80 ounces silver per ton which represented only 6.5 per cent of the silver in the feed.

Test 5 was a flotation test which resulted in a flotation tailing assaying 6.71 ounces silver per ton and containing 25.1 per cent of the silver in the feed. This flotation tailing was screen sized and the sized fractions assayed for silver with the results shown in Table 3.

TABLE 3

Flotation Tailing Size Analysis

Tyler Screen Mesh	Weight %	Silver oz/ton	Distribution Ag %
+ 150	4.2	4.27	2.7
+ 200	23.0	1.33	4.6
+ 270	11.3	1.62	2.8
+ 325	10.5	2.14	3.4
- 325	51.0	11.26	86.5
Total (calcd)	100.0	6.63	100.0
Total (assayed)		6.71	

In Test 10, which was a flotation test carried out under conditions similar to those used in Test 5, the flotation tailing assayed 5.88 ounces silver per ton and contained 21.7 per cent of the silver in the feed. This flotation tailing was screened on a 200-mesh screen. The minus 200-mesh fraction, assaying 7.57 ounces silver/ton, was tabled but there was no significant concentration of the silver.

Tests 11 and 12 were locked flotation tests in which the scavenger concentrate of each cycle was added to the ground pulp of the following cycle before rougher flotation. In Test 11, the overall recovery was 71.7 per cent of the silver and in Test 12, 72.5 per cent.

Wet Yard-Sand

Two flotation tests No. 7 and 9 were conducted on the Wet Yard-Sand Sample. In each test, the grind was different and the flotation reagent combination was different. The results obtained were very similar with an overall silver recovery of 72.0 per cent.

CONCLUSIONS

The investigation showed that the silver in the yard-sand was not amenable to recovery by gravity concentration. However, straight flotation concentration would recover 73 per cent of the silver in a concentrate assaying about 275 oz silver per ton.

This information was reported to the company in a progress report dated July 7, 1971. The company stated that because of recent mill closures in the Cobalt area they were not able to have the material processed locally. However, a deal was worked out to sell the yard sand to Noranda Mines Limited as a flux because of its high silica and lime content. Noranda agreed to pay for 90 per cent of the silver content with a very low base charge.

ACKNOWLEDGEMENTS

The authors wish to acknowledge the assistance of the following members of the Mineral Sciences Division: Mr. D. R. Owens who carried out the mineralogical examination of the ore and Mr. C. A. Derry who did the silver assaying.

WAW:RWB/ec

APPENDICES

Appendix A

#4 Wall

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CANADA

DEPARTMENT OF ENERGY, MINES AND RESOURCES

MINES BRANCH

OTTAWA

MINERAL SCIENCES DIVISION

Internal Report MS 71-92

MINERALOGICAL EXAMINATION OF A SAMPLE OF YARD SAND FROM THE COBALT REFINERY, COBALT, ONTARIO, ON BEHALF OF KAM KOTIA MINES LIMITED

by

D. R. Owens

July 8, 1971

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MINERAL SCIENCES DIVISION

Internal Report MS 71-92

MINERALOGICAL EXAMINATION OF A SAMPLE OF YARD SAND FROM THE COBALT REFINERY, COBALT, ONTARIO, ON BEHALF OF KAM KOTIA MINES LIMITED

by

D. R. Owens*

INTRODUCTION

A sample of sandy material from the yard of the Cobalt Refinery at Cobalt, Ontario, was received from Mr. A. Wall of the Mineral Processing Division on June 2, 1971. Mr. Wall stated that the sample had originally been submitted to the Mines Branch by Mr. John N. Cram, General Manager, Cobalt Refinery Division, Kam Kotia Mines Limited, Cobalt, Ontario. Mr. Wall requested that the sample be examined to determine the identity, size and occurrence of the reported silver-bearing minerals in the ore.

SAMPLE

The sample, as received, consisted of a few hundred grams of sandy material, labelled as "dump ore". In a covering letter Mr. Cram stated that the sample contains in excess of 30 ounces of silver per ton, and that this silver is present as a result of spillage from drums of silver concentrates, received over a period of about 20 years.

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*Technical Officer, Mineralogy Section, Mineral Sciences Division, Mines Branch, Department of Energy, Mines and Resources, Ottawa, Canada.

METHOD OF INVESTIGATION

The head sample was screened into plus 35, 35 to 65, 65 to 150, 150 to 270, 270 to 325 and minus 325 mesh sizes. Each of these fractions, with the exception of the plus 35 and minus 325 mesh sizes, were separated into sink and float products by means of heavy liquids with densities of 2.96 and 3.32. This removed the majority of the minerals composing the yard sand and allowed the heavier silver-bearing minerals to be concentrated in the sink products. Polished sections were prepared from the four sink products and examined microscopically to identify the silver-bearing minerals and to determine their degree of liberation and their association with the other heavy ore minerals. The minerals comprising the yard sand were identified by optical examination of oil immersion mounts of the float products, and by X-ray diffraction studies.

ACKNOWLEDGEMENTS

The author wishes to express his appreciation to Mr. P. O'Donovan for the preparation of the polished sections, and to Mr. E.J. Murray of the Crystal Structure Group for his X-ray powder diffraction analyses of some of the minerals in the sample.

RESULTS OF INVESTIGATION

General Mineralogy of the Sample

The sample is composed essentially of sand, and the minerals identified in it are typical of such material. The principal minerals present are quartz and feldspar. Minor amounts of garnet, zircon, epidote, amphibole, magnetite, ilmenite, rutile, hematite and goethite account of the remainder.

The ore minerals* present in the sample, include native silver, acanthite, cerargyrite?, tetrahedrite, pyrite, chalcopyrite, pyrrhotite, marcasite, pentlandite, sphalerite, galena, skutterudite, safflorite, arsenopyrite, covellite, chalcocite, and native bismuth. Some goethite is also present as part of the concentrates, as it has in some instances partially replaced a few grains of pyrite. There are also a few grains of pyroxene and carbonate minerals in the sample which probably were contaminants in the concentrates, as they do not normally occur in sands.

Taken as a whole the ore minerals are dominated by pyrite and magnetite. The latter is more prevelant in the coarser mesh sizes, while pyrite becomes dominant in the finer sizes. This is probably due to the fact that the concentrates are the result of relatively fine grinding, whereas the sands are typically quite coarse-grained. Only a few grains of galena, native bismuth, tetrahedrite, sphalerite, marcasite, covellite and chalcocite were found. Slightly larger amounts of the other ore minerals were observed, but still much less than that of either magnetite or pyrite.

Some of the ore minerals have undergone differing degrees of alteration, due no doubt to their prolonged exposure to weathering in the yard of the refinery. No further discussion of the minerals listed above will be made, except for those that are silver-beraing or are associated with the argentiferous minerals.

Silver-bearing minerals

Silver, in the form of its native metal, is the dominant phase of the argentiferous minerals identified in the sample. Acanthite, tetrahedrite and cerargyrite? are also present, but in much smaller amounts.

The native silver occurs as free grains; as grains with thin alteration rims of acanthite or cerargyrite ; and as inclusions in some of the other minerals in the sample. The free grains of native silver range

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*The term "ore mineral" as used in this report, does not necessarily have an economic connotation.

in size from about 35 microns to one millimeter. Most, however, are less than 150 microns in size. The grains rimmed with either acanthite or cerargyrite are of the same order of magnitude. The identity of the rims about some of the native silver grains, as being either acanthite or cerargyrite, was established by electron microprobe studies of a number of these rims. These rims are too narrow to perform quantitative analyses, but qualitative analyses show that they are silver sulphides and silver chlorides. The presence of acanthite was reaffirmed by X-ray diffraction studies of a number of free grains of acanthite.

As mentioned above, native silver also occurs as inclusions in some of the other minerals in the sample. By far the most common is as inclusions in grains of skutterudite and safflorite. A much smaller amount of native silver occurs as inclusions in tetrahedrite, combined grains of pyrrhotite and arsenides, and in one instance in gangue. These inclusions of native silver are largely from 2 to 35 microns in size, with as many as 20 to 30 inclusions in one grain of arsenides.

The amount of free grains of native silver, or of native silver with alteration rims of acanthite or cerargyrite? is greater than that of native silver as inclusions in other minerals. Viewed in relationship to the amount of native silver observed, the quantities of other silver-bearing minerals is almost insignificant.

Only a number of tetrahedrite grains were positively identified, and as mentioned above, a few contain inclusions of native silver.

Acanthite, as well as forming alteration rims on some of the native silver grains, also occurs as free grains.

No evidence of cerargyrite? other than as rims on some grains of native silver was found.

CONCLUSIONS

A number of conclusions can now be made, based on the mineralogical examination of the sample. Firstly, the silver is present essentially in its native form, with free grains of native silver more prevelant than those as inclusions in other minerals. Secondly, the grains of native silver present as inclusions are mostly smaller than 30 microns in size.

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DRO/pg

Appendix B

Test Data Sheets.

Abbreviations used in Data Report Sheets.

$NaCO_3$	Sodium Carbonate
Z-6	Potassium Amyl Xanthate
208	Aerofloat Promoter 208
DF250	Dow Froth 250
350	Potassium Amyl Xanthate
A 31	Aerofloat 31
301	Sodium Secondary Butyl Xanthate
$CuSO_4$	Copper Sulphate
NaCN	Sodium Cyanide
CaO	Lime
243	Aerofloat Promoter 243
A15	Aerofloat 15
404	Aero Promoter 404
T 130	Thiocarbanailide 130
3477	Aero Promoter 3477
3501	Aero Promoter 3501
RM	Rod Mill

MINES BRANCH FLOTATION TEST REPORT

TEST NO. 1	SAMPLE: Cobalt Refinery Division - Dry Sample	DATE: May 21, 1971
OBJECT OF TEST: Jigging; Tabling Jig Tail; Flotation Table Tail.		CHARGE: 4440-g
		TESTED BY: WAW

OPERATION	Time min	% Solids	pH	Unit used	Reagents, lb per ton									
					Na_2CO_3	Z-6	208	DF_{250}						
Jig Feed Grind (1)														
Jigging														
Tabling														
Table Tail Grind (2)														
Flotation Condition	10	40	7.8	2 kg cell	0.50	0.2	0.2	0.03						
Float	6	25												
Scavenge	3					0.1	0.1							
Clean	3			500-g cell										
Reclean	2													
Re-reclean	1			250-g cell										

PRODUCT	WT %	ANALYSIS oz/ton							DISTRIBUTION %					
			Ag							Ag				
Jig conc	5.1		145.70							31.6				
bed	3.5		52.92							7.8				
tail (calcd)	91.4		15.59							60.6				
feed (calcd)	100.0		23.53							100.0				
Table conc	1.7		132.71							9.8				
tail (calcd)	89.7		13.32							50.8				
feed (calcd)	91.4		15.59							60.6				
Reclean float conc	1.5		217.93							13.9				
Clean tail	1.5		82.77							5.3				
Reclean tail	0.4		165.02							2.8				
Re-reclean tail	0.2		185.88							1.6				
Scavenger Conc	1.3		64.88							3.6				
Float tail (3)	84.8		6.55							23.6				
Float feed (calcd)	89.7		13.32							50.8				

REMARKS: (1) Jig feed ground minus 10 mesh.
(2) Table tail ground minus 48 mesh, screened on 200 mesh and plus 200 mesh ground 20 minutes.

MINES BRANCH FLOTATION TEST REPORT

TEST NO. 2	SAMPLE: Cobalt Refinery Division - Dry Sample	DATE: May 28, 1971
OBJECT OF TEST: Flotation		CHARGE: 2000-g
		TESTED BY: WAW

OPERATION	Time min	% Solids	pH	Unit used	Reagents, lb per ton									
					350	A 31	Na_2CO_3	208						
Grind	40	67		7x14 RM	0.10	0.10	0.50							
Condition	5	45	7.4	2 kg cell										
Flotation	6	25	7.4		0.20									
Scavenging	4		7.8				1.00	0.20						
No. 1. clean	2			500-g cell										
No. 2. clean	1.5			250-g cell										

PRODUCT	WT %	ANALYSIS % Oz/ton							DISTRIBUTION %					
			Ag								Ag				
Clean conc	1.4		678.88								42.5				
No. 1. clean tail	2.6		114.29								13.3				
No. 2. clean tail	0.6		168.88								4.5				
Rough conc (calcd)	4.6		293.23								60.3				
Scavenger conc	2.1		98.08								9.2				
Rougher tail (1)	93.3		7.31								30.5				
Feed (calcd)	100.0		22.37								100.0				
Feed (Assay)			25.41												

REMARKS: (1) Rougher tail 51.0 per cent minus 200 mesh.

MINES BRANCH FLOTATION TEST REPORT

TEST NO. 3	SAMPLE: Cobalt Refinery Division - Dry Sample	DATE: June 2, 1971
OBJECT OF TEST: Flotation; Tailing tabled; Concentrate and Middling treated in Davis Tube		CHARGE: 2000-g
		TESTED BY: WAW

OPERATION	Time min	% Solids	pH	Unit used	Reagents, lb per ton									
					301	A31	208	Na_2CO_3	$CuSO_4$					
Grind	60	67		7 x 14 RM	0.10	0.10	0.05	1.0						
Flotation	5	25	7.0	2 kg cell										
Flotation	5		7.0		0.10		0.10							
Condition	5		7.7		0.10	0.06	0.10	1.0	1.0					
Flotation	5		7.8											

PRODUCT	WT %	ANALYSIS Oz/ton							DISTRIBUTION %				
			Ag							Ag			
Ro Conc No. 1	2.9		377.51							47.0			
No. 2	4.9		121.07							25.4			
No. 3	4.8		26.69							5.5			
Flotation tails (calcd)	87.4		5.90							22.1			
Flotation feed (calcd)	100.0		23.32							100.0			
Table conc	1.7		23.88							1.7			
Table Middling	2.0		8.10							0.7			
Table tail (1)	83.7		5.49							19.7			
Mag. table conc	0.4		36.17							0.6			
Non Mag table conc	1.3		20.11							1.1			
Table conc	1.7		23.88							1.7			
Mag table Midd	0.2		33.81							0.3			
Non Mag table Midd	1.8		5.23							0.4			
Table Midd	2.0		8.10							0.7			

REMARKS: (1) Table tail 85.8 per cent minus 200 mesh.

MINES BRANCH FLOTATION TEST REPORT

TEST NO. 4	SAMPLE: Cobalt Refinery Division; Test 3 Table Tails	DATE: June 10, 1971.
OBJECT OF TEST: Cyanidation of Test 3 Table tails.		CHARGE: 1002-g
		TESTED BY: WAW

OPERATION	Time hr	% Solids	pH	Unit used	Reagents, lb per ton									
					NaCn	CaO								
Cyanidation	48	35			1.0	1.0								

PRODUCT	WT %	ANALYSIS Oz/ton							DISTRIBUTION %			
			Ag						Ag (of feed		Ag (of ore)	
Cyanide Resideu	100.0		1.80						32.8		6.5	
Extraction									67.2		13.2	

REMARKS:

MINES BRANCH FLOTATION TEST REPORT

TEST NO. 5	SAMPLE: Cobalt Refinery Division - Dry Sample	DATE: June 16, 1971.
OBJECT OF TEST: Flotation		CHARGE: 2000-g
		TESTED BY: WAW

OPERATION	Time min	% Solids	pH	Unit used	Reagents, lb per ton									
					243	301	A 15	404	Na_2CO_3					
Grind	60	67		7 x 14 RM										
Condition	5	50	7.3	2 kg cell	0.10	0.10	0.04	0.10	1.0					
Flotation No. 1	7													
Flotation No. 2	5		7.1		0.05	0.05	0.04							

PRODUCT	WT %	ANALYSIS Oz/ton							DISTRIBUTION %				
			Ag	1						Ag			
No. 1 conc	5.2		318.50							67.4			
No. 2 conc	2.9		64.03							7.5			
Rougher tail (1)	91.9		6.71							25.1			
Feed (calcd)	100.0		24.59							100.0			

REMARKS: (1) Rougher tail 72.8 per cent minus 200 mesh.

MINES BRANCH FLOTATION TEST REPORT

TEST NO. 6	SAMPLE: Cobalt Refinery Division - Dry Sample	DATE: June 16, 1971.
OBJECT OF TEST: Flotation		CHARGE: 2000-g
		TESTED BY: WAW

OPERATION	Time min	% Solids	pH	Unit used	Reagents, lb per ton									
					NaCN	Na_2CO_3	243	301	A 15	404				
Grind	60	67		7 x 14 RM	0.10	1.0								
Condition	5		7.4	2 kg cell			0.10	0.10	0.03	0.10				
Flotation No. 1	7													
Flotation No. 2	5						0.05	0.05	0.03					

PRODUCT	WT %	ANALYSIS Oz/ton							DISTRIBUTION %				
			Ag							Ag			
No. 1 conc	5.7		259.24							66.5			
No. 2 conc	2.7		54.29							6.6			
Rougher tail (1)	91.6		6.525							26.9			
Feed (calcd)	100.0		22.21							100.0			

REMARKS: (1) Rougher tailing 72.8 per cent minus 200 mesh.

MINES BRANCH FLOTATION TEST REPORT

TEST NO. 7	SAMPLE: Cobalt Refinery Division - Wet Sample	DATE: June 16, 1971.
OBJECT OF TEST: Flotation of Second Sample - Received Wet		CHARGE: 2000-g
		TESTED BY: WAW

OPERATION	Time min	% Solids	pH	Unit used	Reagents, lb per ton									
					243	301	404	A15	NaCN	Na_2CO_3				
Grind	60	67		7 x 14 RM										
Condition	5		7.7	2 kg cell	0.10	0.10	0.10	0.03	0.10	1.0				
No. 1 Float	7													
No. 2 Float	5				0.05	0.05		0.03						

PRODUCT	WT %	ANALYSIS Oz/ton							DISTRIBUTION %					
			Ag							Ag				
No. 1 conc	3.6		193.85							59.8				
No. 2 conc	2.8		50.64							12.1				
Rougher tail (1)	93.6		3.50							28.1				
Feed (calcd)	100.0		11.67							100.0				
Feed (Assay)			10.77											

REMARKS: (1) Rougher tail 83.6 per cent minus 200 mesh.

MINES BRANCH FLOTATION TEST REPORT

TEST NO. 8	SAMPLE: Cobalt Refinery Division - Dry Sample	DATE: June 16, 1971
OBJECT OF TEST: Flotation		CHARGE: 2000-g
		TESTED BY: WAW

OPERATION	Time min	% Solids	pH	Unit used	Reagents, lb per ton									
					301	A31	208	T130	3477	3501				
Grind	55	67		7 x 14 RM	0.10	0.06	0.05	0.10						
Condition	2			2 kg cell					0.02	0.02				
No. 1 Float	5	25	7.0											
No. 2 Float	10		7.0		0.10	0.06	0.05		0.02	0.02				

PRODUCT	WT %	ANALYSIS Oz/ton		DISTRIBUTION %	
		Ag		Ag	
No. 1 conc	4.8	280.24		57.4	
No. 2 conc	6.2	78.39		20.7	
Combined conc	11.0	166.47		78.1	
Rougher tail (1)	89.0	5.76		21.9	
Feed (calcd)	100.0	23.43		100.0	

REMARKS: (1) Rougher tailing 71.3 per cent minus 200 mesh.

MINES BRANCH FLOTATION TEST REPORT

TEST NO. 9	SAMPLE: Cobalt Refinery Division - Wet Sample	DATE: June 16, 1971.
OBJECT OF TEST: Flotation at coarser grind		CHARGE: 2000-g
		TESTED BY: WAW

OPERATION	Time min	% Solids	pH	Unit used	Reagents, lb per ton									
					301	A31	208	T130	3477	3501				
Grind	55	67		7x14 RM	0.10	0.10	0.05	0.10						
Condition	2		7.0	2 kg cell					0.04	0.04				
No. 1 Float	6		7.0											
No. 2 Float	10		7.1		0.05	0.06	0.05		0.04	0.04				

PRODUCT	WT %	ANALYSIS Oz/ton							DISTRIBUTION %					
			Ag							Ag				
No. 1 conc	3.3		203.46							60.8				
No. 2 conc	4.9		25.19							11.2				
Rougher tail (1)	91.8		3.365							28.0				
Feed (calcd)	100.0		11.04							100.0				

REMARKS: (1) Rougher tail 73.8 per cent minus 200 mesh.

MINES BRANCH FLOTATION TEST REPORT

TEST NO. 10	SAMPLE: Cobalt Refinery Division - Dry Sample	DATE: June 25, 1971
OBJECT OF TEST: Flotation - Table Minus 200 mesh Fraction of Float Tail		CHARGE: 4000-g
		TESTED BY: W.A.W.

OPERATION	Time min	% Solids	pH	Unit used	Reagents, lb per ton									
					243	301	404	Na_2CO_3	A 15					
Grind (1) (2)	60	67		7 x 14 RM										
Condition (1)	5		7.0	2000-g cell	0.10	0.10	0.10	1.0	0.03					
Float (1)	5		7.5											
Scavenge (1)	10				0.05	0.05								
Flotation tails screened on 200 mesh screen, Minus 200 mesh fraction														
Tabled on slime deck.														

PRODUCT	WT %	ANALYSIS XX oz/ton							DISTRIBUTION %				
			Ag							Ag			
Table conc.	1.7		21.15							1.4			
Table tail	66.1		7.22							19.2			
-200 mesh float tail	67.8		7.57							20.6			
+200 mesh float tail	24.2		1.16							1.1			
Flotation Tailing	92.0		5.88							21.7			
Scavenger conc.	3.2		72.23							9.3			
Rougher conc.	4.8		358.09							69.0			
Combined float conc.	8.0		243.74							78.3			
Feed (calcd)	100.0		24.91							100.0			

REMARKS:
(1) 2 batches of 2000-grams
(2) [illegible]

MINES BRANCH FLOTATION TEST REPORT

TEST NO. 11 | SAMPLE: Cobalt Refinery Division - Dry Sample | DATE: July 7, 1971

OBJECT OF TEST: | CHARGE: 8000-g

Locked Flotation Tests-Scav. conc. cycled | TESTED BY: W.A.W.

OPERATION	Time min	% Solids	pH	Unit used	Reagents, lb per ton									
					T130	208	301	A31	3477	3501				
Grind (1) (2)	55	67		7 x 14 RM	0.10	0.05	0.10	0.06						
Condition (1)	5	40	7.2	2000-g cell					0.04	0.04				
Flotation (1)	5	25												
Scavenging (1)	10		7.2											
Scavenged conc. added to following rougher float except 4th test when scavenge conc. assayed.														

PRODUCT	WT %	ANALYSIS ~~XX~~ oz/ton	DISTRIBUTION %
		Ag	Ag
Conc. 1.	1.01	339.76	14.4
Conc. 2	1.23	311.40	16.0
Conc. 3	1.21	332.11	16.8
Conc. 4	1.21	379.84	19.2
Tail 1	22.72	6.79	6.5
2	23.05	7.15	6.9
3	23.75	7.35	7.3
4	24.44	7.49	7.6
Scavenge conc. 4	1.38	91.74	5.3
Feed (calcd)	100.00	23.91	100.0
Conc. combined (calcd)	4.66	340.69	66.4
Scav. conc.	1.38	91.74	5.3
Tail combined (calcd)	93.96	7.20	28.3
Feed (calcd)	100.00	23.91	100.0

REMARKS:
(1) 2000 gram batches

MINES BRANCH FLOTATION TEST REPORT

TEST NO. 12	SAMPLE: Cobalt Refinery Division - Dry Sample	DATE: July 21, 1971
OBJECT OF TEST: Locked Flotation Test - Scavenger Conc Cycled.		CHARGE: 12000-g
		TESTED BY: W.A.W.

OPERATION	Time min	% Solids	pH	Unit used	Reagents, lb per ton									
					243	301	404	A15	Na_2CO_3					
Grind (1) (2)	60	67		7x14 RM										
Condition (1)	5	40	7.8	2000-g cell	0.10	0.10	0.10	0.02	1.0					
Float	5	25												
Scavenger	10	25	7.7		0.05	0.05								
Clean No. 6 Scav conc	3			250-g cell										
Scavenged concentrate added to following rougher float. No. 6 scavenger conc cleaned and assayed.														

PRODUCT	WT %	ANALYSIS oz/ton							DISTRIBUTION %					
			Ag								Ag			
Conc No. 1	0.72		357.56								11.0			
2	0.89		303.74								11.6			
3	0.98		284.84								12.0			
4	0.93		287.80								11.5			
5	0.91		299.31								11.7			
6	0.83		324.50								11.6			
Conc combined (calcd)	5.26		307.45								69.4			
Tailing No. 1	15.43		6.31								4.2			
2	15.55		7.02								4.7			
3	15.15		7.385								4.8			
4	15.90		6.37								4.3			
5	15.89		6.79								4.6			
6	15.91		7.165								4.9			
Tailing combined	93.83		6.84								27.5			

REMARKS: (1) 2000-g batches
(2) Flotation tailing 83.4 per cent minus 200 mesh.

MINES BRANCH FLOTATION TEST REPORT

TEST NO. 12	SAMPLE:	DATE:
OBJECT OF TEST: (continued)		CHARGE:
		TESTED BY:

OPERATION	Time min	% Solids	pH	Unit used	Reagents, lb per ton									

PRODUCT	WT %	ANALYSIS oz/ton							DISTRIBUTION %					
			Ag							Ag				
Clean scav conc	0.17		152.32							1.1				
Clean scav tail	0.74		62.39							2.0				
Rough scav conc (calcd)	0.91		79.23							3.1				
Conc	5.26		307.45							69.4				
Scavenger conc	0.91		79.23							3.1				
Rougher tails	93.83		6.84							27.5				
Feed (calcd)	100.00		23.30							100.0				

REMARKS: