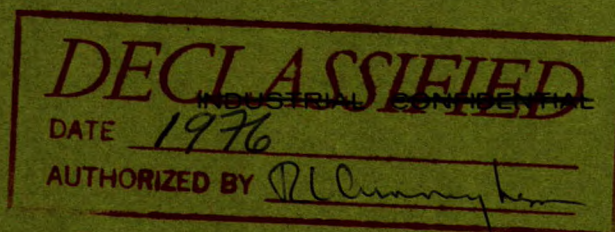


This document was produced  
by scanning the original publication.

Ce document est le produit d'une  
numérisation par balayage  
de la publication originale.

CANADA



DEPARTMENT OF ENERGY, MINES AND RESOURCES

OTTAWA

MINES BRANCH INVESTIGATION REPORT IR 73-4

**A METHOD FOR IMPROVING RECOVERY AND  
REDUCING ARSENOPYRITE CONTAMINATION IN  
STIBNITE FLOTATION AT CONSOLIDATED DURHAM  
MINES AND RESOURCES LTD.,  
PRINCE WILLIAM, NEW BRUNSWICK**

by

**G.I. MATHIEU 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.*



**Declassified**  
**Déclassifié**

Industrial Confidential

# Mines Branch Investigation Report IR 73-4

## A METHOD FOR IMPROVING RECOVERY AND REDUCING ARSENOPYRITE CONTAMINATION IN STIBNITE FLOTATION AT CONSOLIDATED DURHAM MINES AND RESOURCES LTD., PRINCE WILLIAM, NEW BRUNSWICK

by

G.I. Mathieu\* and R.W. Bruce\*\*

- - - -

### SUMMARY OF RESULTS

A sample cut from the tailing pond of Consolidated Durham contained 0.61% Sb, 0.82% As and 2.58% Fe. These analyses were said to be representative of regular mill tailing. Antimony occurred as stibnite while arsenic was present as arsenopyrite, and iron as pyrite. A screen test indicated that only 29.4% of the product was minus 200 mesh. At this fineness, only half of the stibnite was in the form of free grains.

Three flotation tests, made under various conditions, produced the following concentrates:

<u>Conditions</u>	<u>Concentrate Grade (%)</u>			<u>Recovery (%)</u>	
	<u>Sb</u>	<u>As</u>	<u>Fe</u>	<u>Sb</u>	<u>As</u>
Direct flotation	4.1	11.8	30.2	21.9	46.5
Regrind and Flotation	6.2	8.2	22.8	66.7	61.5
Regrind and use of NaOCl (in flotation)	30.8	0.5	5.5	54.6	0.6

The test work was limited due to the very small sample of mill tailing available for the investigation.

---

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

## INTRODUCTION

After the completion of a research project on the activation-flotation of the antimony minerals, G.I. Mathieu visited Consolidated Durham Mines and Resources Limited, which is the only producing antimony mine in Canada.

The mine is located at Prince William, New Brunswick, which is about 20 miles northwest of Fredericton.

Unfortunately, at the time of the visit on August 31, 1972, the milling operations of the plant were suspended pending the installation of facilities for controlling the arsenic level of its effluent. Nevertheless, in a conversation with the Mine Manager, Mr. Ken North, it was learned that the mill had difficulties obtaining tailings below 0.6% Sb without severely diluting the stibnite concentrate with arsenopyrite. According to Mr. North, the only method used in the mill for curtailing the arsenopyrite flotation consisted of adding a starvation amount of collector to the circuit for a preferential action on stibnite. This might explain the low antimony recovery. It was brought to the attention of Mr. North that sodium hypochlorite (bleaching powder) was highly recommended for arsenic depression in an antimony flotation plant.

In order to assess the applicability of the method to the Consolidated Durham ore and to determine how much additional antimony could be recovered from the mill tailing without undue contamination by arsenopyrite, a 20-lb sample of mill tailing was collected for a preliminary investigation.

### Sampling and Analysis

A representative head sample was riffled out from the mill tailing and analysed with the results shown in Table 1.

TABLE 1

Chemical Analysis of Head Sample\*

<u>Element</u>	<u>Analysis (%)</u>
Antimony (Sb)	0.61
Arsenic (As)	0.63
Iron (Fe)	3.09
Sulphur (S)	2.92
Insoluble	70.10

\*From Internal Report MS-AC-393

Mineralogical Examination\*

A portion of the head sample was sent to the Mineralogy Section of the Mineral Sciences Division for identification of the minerals in the mill tailing and determination of the liberation characteristics of antimony constituents.

One polished section was prepared from one half of the sample, and one from a heavy mineral concentrate obtained from the other half by separating it in a liquid that had a specific gravity of 3.30. Based on the examination of the sections and on the weights of the separated fractions, the mineral composition of the mill tailing sample was calculated as shown in Table 2.

TABLE 2

Mineral Composition of Mill Tailing Sample

Type of Mineral	Name	Per cent Content (approximate)
Antimony	Stibnite	0.5
	Native antimony	Tr
Metallic	Pyrite	2.0
	Arsenopyrite	0.5
	Marcassite	0.2
	Rutile	0.2
	Pyrrhotite	Tr
	Sphalerite	Tr
	Covellite	Tr
Gangue	Quartz	90
	Feldspar	3

\*From Internal Report MS-AC-72-30 by D. Owens

The only significant antimonide present in the mill tailing is stibnite. Approximately half of the stibnite grains are free, with the balance present as inclusions in the gangue. Almost no stibnite is associated with the other sulphides. The free grains of stibnite are relatively coarse and vary in size from 5 to 300 microns with the majority larger than 75 microns. Those which occur locked in the gangue range from 5 to 200 microns. The high stibnite in the tailing is due to entrappment of coarse grains of stibnite as well as to the inclusions locked in the gangue.

Interpretation of this mineralogy in terms of mineral dressing follows:

- 1) antimony occurs in a form (stibnite) recoverable by flotation;
- 2) regrinding would be necessary to achieve a high recovery of the residual antimony;
- 3) selective depression of pyrite and arsenopyrite must be used in order to avoid undue contamination of the stibnite flotation concentrate.

#### OUTLINE OF INVESTIGATION

Although the sample of mill tailing was very small, a testing program was devised to cope with the findings of the mineralogical examination and to verify its conclusion. This consisted in three flotation tests using lead acetate as a stibnite activator, potassium amyl xanthate as a collector, and Dowfroth 250, but with the following special features:

- a) in Test 1, the mill tailing was floated as received;
- b) in Test 2, it was reground for five minutes prior to flotation;
- c) in Test 3, the regrinding stage was retained and sodium hypochorite was added to depress arsenopyrite and pyrite.

## DETAILS OF INVESTIGATION

The flotation tests were made on 2,000-g samples of mill tailings. The first test was done without regrinding, whereas the test samples were reground for 4 and 6 minutes, respectively, in the subsequent tests.

Screen analysis of the feed to each test gave the following results:

TABLE 3  
Screen Analysis of Flotation Feed

Size (mesh)	Test 1	Test 2	Test 3
+ 65	10.3	2.6	2.0
-65 +100	19.5	13.1	11.1
-100 +150	22.5	25.0	21.2
-150 +200	18.3	21.2	21.0
-200 +325	14.6	15.8	18.5
-325	14.8	22.3	26.2
Total	100.0	100.0	100.0

The details of the flotation conditions and the results obtained are shown in Tables 4 and 5.

TABLE 4  
Reagents and Conditions of Flotation

Operation	Time min	Reagents			pH	
		Name	lb/ton		Test 1 & 2	Test 3
			Tests 1 & 2	Test 3		
Conditioning	3	Lavo*	-	15 ml	7.8	8.2
Rougher flotation	7	Xanthate Z-6	0.03	0.05	7.7	8.0
		Dowfroth 250	0.02	0.03		
		Lead acetate	0.10	0.15		
Cleaner flotation	3	Lavo	-	2 ml	7.8	8.3
		Xanthate Z-6	0.02	0.03		
		Dowfroth 250	0.02	0.03		
		Lead acetate	0.05	0.08		

\*Trade name of commercial sodium hypochlorite (NaOCl)

TABLE 5  
Results of Flotation

Test	Product	Weight %	Analysis*			Distribution %	
			Sb	As	Fe	Sb	As
1 (Direct Flotation)	Sb cl conc	3.2	4.07	11.83	30.2	21.9	46.5
	Cleaner tailing	1.2	0.50	3.68	-	1.0	5.4
	Flot tailing	95.6	0.48	0.41	-	77.1	48.1
	Feed (calcd)	100.0	0.60	0.81	-	100.0	100.0
2. (Regrind & Flotation)	Sb cl conc	6.1	6.25	8.24	22.8	66.7	61.5
	Cleaner tailing	3.0	0.58	3.21	-	3.1	11.8
	Flot tailing	90.9	0.19	0.24	-	30.2	26.7
	Feed (calcd)	100.0	0.57	0.82	-	100.0	100.0
3 (Regrind & Use of Lavo)	Sb cl conc	1.0	30.8	0.50	5.5	54.6	0.6
	Cleaner tailing	2.4	1.41	1.32	-	6.0	3.8
	Flot tailing	96.6	0.23	0.83	-	39.4	95.6
	Feed (calcd)	100.0	0.56	0.84	-	100.0	100.0

\*From Internal Reports MS-AC-72-397 and 438.

### CONCLUSION

Although the investigation was of limited scope, it was sufficient to demonstrate that:

1. Antimony in the mill tailing was in the form of stibnite which is recoverable by flotation.
2. Regrinding was necessary both to refresh mineral surfaces and to liberate additional stibnite; this is evidenced by the sharp increase in recovery obtained when the mill tailing was reground prior to flotation (e.g. 21.9% without regrinding versus 61.5% with regrinding).
3. The addition of sodium hypochlorite was effective in depressing pyrite as well as arsenopyrite, as shown by the following concentrate grades:

Concentrate Analysis (%)					
Flotation without NaOCl			Flotation with NaOCl		
Sb	As	Fe	Sb	As	Fe
6.2	8.2	22.8	30.8	0.5	5.5

Because of the small amount of the antimony concentrate, assaying 30.8% Sb, produced in Test 3, it was not possible to upgrade it to marketable specification ( 60% Sb). However, this should be possible in plant operation. In any event, the additional concentrate obtained by further treatment of the mill tailing would be so small that it would not lower appreciably the grade of the final concentrate in mill production and would reduce tailing loss by over 50 per cent.

It is recommended that, in milling the consolidated Durham ore, a slightly finer grind be tried along with the use of sodium hypochlorite to depress the flotation of arsenopyrite and pyrite. This should effectively increase the grade of the antimony concentrate by reducing deleterious impurities and increase over-all antimony recovery.

Although not part of this investigation, a possible solution to problem of arsenic pollution of the mill tailing effluent would be to concentrate the arsenopyrite by selective flotation of the antimony rougher flotation tailing. The arsenic concentrate, so recovered, could be carefully impounded or stored.

#### ACKNOWLEDGEMENTS

The writers wish to acknowledge the contribution to this investigation by members of the Mineral Sciences Division, namely, D. Owens for the mineralogical examination, J. Cloutier, A. Letendre, P. Lanthier, and D. Cumming for the chemical analysis.