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EVALUATION OF THE FLOTATION CHARACTERISTICS OF A COPPER–GOLD–SILVER ORE FROM LUCKY LUKE MINE, USK, BRITISH COLUMBIA

by

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MINERAL PROCESSING DIVISION

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SUMMARY OF RESULTS

Head analyses on three lots received:

Designation	% Cu	oz Au/ton	oz Ag/ton
Mill Head # 1	4.85	0.11	4.19
Mill Head # 2	0.82	0.06	0.58
Mill Head # 3	3.20	0.09	2.45

The copper was present principally as bornite, chalcocite and malachite, the ratio of sulphides to oxide being approximately 3:1. The samples were combined for the investigation. It was necessary to use a sulphidizing agent (sodium sulphide) to recover the malchite. This increased the silver recovery and produced a tailing considerably lower than in mill operation as shown below:

Technique	Analysis						Recovery %		
	Concentrate			Tailing					
	%	oz/ton		%	oz/ton				
	Cu	Ag	Au	Cu	Ag	Au	Cu	Ag	Au
Plant flotation without Na_2S	-	-	-	1.2	0.6	0.03	-	-	-
Lab. flotation without Na_2S	50.6	50.1	1.59	1.2	0.4	0.01	66.6	84.0	83.0
Lab. flotation with Na_2S	49.5	46.3	1.40	0.6	0.2	0.01	82.0	91.3	82.8

When using a combination of finer grinding, sulphidization and stronger promoter, no further improvement in overall copper and silver recovery was achieved, but the gold recovery was increased by about 3%.

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INTRODUCTION

Location of Property

Lucky Luke Mine is a small copper producer located near Terrace, Northwestern British Columbia.

Purpose of Investigation

Mr. Jack Foote who conducts the milling operation requested an investigation aimed at finding the cause of poor copper recovery.

Shipment

The following samples were received from Mr. Foote on August 16, 1965;

Designation	Size	Weight
Mill Head # 1	Minus 1 in.	16 lb.
Mill Head # 2	Minus 1 in.	10 lb.
Flotation Feed	44% - 200 m	10 lb.
Mill Tailing	49% - 200 m	1 lb.

Sampling and Analysis

A few representative pieces were selected from "Mill Head # 1" and "Mill Head # 2" for mineralogical examination. The remainders of these samples were then separately crushed to -10 mesh and head samples were riffled out for chemical analyses. Representative portions were also cut from the samples "Flotation Feed" and "Mill Tailing" for analytical work and mineralogical studies.

The results of the chemical analysis are shown in Table 1.

TABLE 1

Chemical Analysis* of Head Samples

Elements	Mill Head # 1	Mill Head # 2	Flotation Feed	Mill Tailing
Gold (oz Au/ton)	0.11	0.06	0.09	0.03
Silver (oz Ag/ton)	4.19	0.58	2.45	0.60
Copper (% Cu)	4.85	0.82	3.20	1.19
Iron (% Fe)	7.45	6.82	5.51	7.20
Insoluble (%)	58.9	57.2	63.8	67.1

* From Internal Report MS-AC 65-1170.

A spectrographic analysis of a portion of the head samples indicated the elements present in the following approximate order of decreasing abundance.

TABLE 2

Spectrographic Analysis* of Head Samples

I - Si, Fe, Ca (5%)
II - Mg, Al, Cu (5 - 1%)
III - Ti, Mn, V (1 - 0.1%)
IV - Cr, Na, Sn (0.1%)

* From Internal Report MS-AC 65-1102.

Mineralogical Examination**

Representative samples from the mill products submitted by Lucky Luke Mine were sent to the Mineralogy Section of the Mineral Sciences Division for microscopic examination.

The metallic minerals identified were: bornite, chalcocite, digenite, covellite, malachite, hematite, magnetite, native gold and silver. The copper sulphides were generally intergrown together, but malachite was mostly free at a coarse size with the exception of a few grains attached to gangue and bornite. Malachite appeared to count for about 20% of the total copper content.

DETAILS OF INVESTIGATION

Test 1, Simulation of Plant Practice

A 2,000 g sample of mixed ore was floated with identical reagents to those used in plant operation and at the same degree of fineness (45% - 200 m). Flotation procedure and results obtained are shown in Tables 3 and 4.

TABLE 3

Reagents and Conditions of Flotation

Operation	Time min	Reagents	lb/ton	pH
Conditioning	3	Xanthate Z - 6	0.10	7.9
Rougher flotation	10	Dowfroth 250	0.04	
		Pine Oil	0.04	
Cleaner Flotation	4			7.7

** From Investigation Report, Mineral Sciences Division, IR 66-30 by D. Owens and W. Petruk.

TABLE 4

Flotation Results When Simulating Plant Practice

Product	Weight %	Analysis* % Cu	Analysis* oz/ton Au	Analysis* oz/ton Ag	Distribution % Cu	Distribution % Au	Distribution % Ag
Cu conc	4.7	50.6	1.59	50.10	66.6	83.0	84.0
Cleaner tailing	2.5	3.2	0.24	2.66	2.2	6.7	2.4
Flot tailing	92.8	1.2	0.01	0.41	31.2	10.3	13.6
Feed (calcd)	100.0	3.5	0.09	2.80	100.0	100.0	100.0

*From Internal Report MS-AC-1191

A microscopic examination of the flotation tailing indicated that most of its copper content occured as green malachite, an oxidized mineral requiring sulphidization for flotation.

Test 2, Effect of Sulphidization

This test was made using the procedure described in Table 3, except that sodium sulphide and Aero Promoter 425 in ratios of 1.5 lb/ton and 0.05 lb/ton were added prior to rougher flotation.

TABLE 5

Flotation Results with Sodium Sulphide

Product	Weight %	Analysis* % Cu	Analysis* oz/ton Au	Analysis* oz/ton Ag	Distribution % Cu	Distribution % Au	Distribution % Ag
Cu conc	5.9	49.5	1.40	46.32	82.0	82.8	91.3
Cleaner tailing	2.9	3.3	0.28	1.75	2.7	8.1	1.7
Flot tailing	91.2	0.6	0.01	0.23	15.3	9.1	7.0
Feed (calcd)	100.0	3.6	0.10	2.99	100.0	100.0	100.0

*From Internal Report MS-AC-65-1191

Examination of the concentrate showed that the increase in copper recovery was due to the flotation of an appreciable quantity of green malachite.

Tests 3 to 5, Effect of Finer Grinding and Stronger Promoter

In this series of tests to further increase copper recovery, the following techniques were tried successively in conjunction with sulphidization:

1. Grinding to 85% minus 200 mesh prior to rougher flotation;
2. Replacement of potassium sec-amyl xanthate (Z - 5) by potassium amyl xanthate (Z - 6);
3. Grinding to 85% minus 200 mesh and use of potassium amyl xanthate (Z - 6).

Results obtained are shown in Table 6.

TABLE 6

Flotation Results with Finer Grinding and Stronger Promoter

Test	Products	Weight %	Analysis* % Cu	Analysis* oz/ton Au	Analysis* oz/ton Ag	Distribution % Cu	Distribution % Au	Distribution % Ag
3 (85% - 200 m)	Cu conc	5.4	55.3	1.22	48.14	83.0	86.5	92.2
	Cleaner tailing	2.1	7.3	0.05	3.00	4.2	1.4	2.2
	Flot tailing	92.5	0.5	0.01	0.17	12.8	12.1	5.6
	Feed (calcd)	100.0	3.6	0.08	2.82	100.0	100.0	100.0
4 (Xanthate Z - 6)	Cu conc	6.4	45.5	1.24	40.22	82.0	87.6	90.7
	Cleaner tailing	6.2	4.7	0.04	1.72	8.2	2.8	3.8
	Flot tailing	87.4	0.4	0.01	0.18	9.8	9.6	5.5
	Feed (calcd)	100.0	3.6	0.09	2.90	100.0	100.0	100.0
5 (85% - 200 m and xanthate Z - 6)	Cu conc	6.3	47.5	1.12	42.48	80.8	85.9	92.8
	Cleaner tailing	7.4	3.8	0.04	0.84	7.6	3.6	2.1
	Flot tailing	86.3	0.5	0.01	0.17	11.6	10.5	5.1
	Feed (calcd)	100.0	3.7	0.08	2.89	100.0	100.0	100.0

* From Internal Reports MS-AC-65-1191, 1198 and 1211

CONCLUSIONS

Mineralogical examination of the three lots of ore received from Lucky Luke Mine showed that copper occured in each of these mostly as bornite and chalcocite, and to a lesser extent as malachite. Because of this similar mineralogy and of the limited quantity of ore submitted, the three samples were combined for the testwork. This gave a feed containing 3.6% Cu, 0.09 oz Au/ton and 2.87 oz Ag/ton.

The presence of malachite in the ore necessitated the use of a sulphidization stage to achieve a satisfactory copper recovery. This technique also improved silver flotation but had no significant effect on gold. On the other hand, a combination of sulphidization with either finer grinding or stronger promoter gave a small increase in gold recovery without affecting copper and silver flotation. These results are illustrated by the following table:

Procedure	Recovery (%)		
	Cu	Ag	Au
Flotation without sulphidization	66.6	84.0	83.0
Flotation with sulphidization	82.0	91.3	82.8
Sulphidization and finer grinding	83.0	90.7	86.5
Sulphidization and stronger promoter	80.8	92.8	87.6

All these techniques produced concentrates of similar grade (i.e. about 50% Cu, 45 oz Ag/ton and 1.4 oz Au/ton).

Briefly, if the samples submitted are representative of the Lucky Luke orebody, a significant increase in both copper and silver recovery should be achieved by adding sodium sulphide in sufficient amount to promote malachite flotation, and a slight improvement in recovery of gold should be obtained by the use of a stronger promoter.

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