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DEPARTMENT OF MINES AND TECHNICAL SURVEYS

OTTAWA

MINES BRANCH INVESTIGATION REPORT IR 65-65

INVESTIGATION OF ORE SAMPLES FROM DOLLY VARDEN MINES LIMITED, ALICE ARM, B.C.

by

T. F. BERRY

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.

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Mines Branch Investigation Report IR 65-65

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SUMMARY OF RESULTS

The North Star and Wolfe No. 2 samples submitted for investigation assayed 13.51 and 24.01 oz Ag/ton respectively. The North Star ore contained 35.56% $BaSO_4$ while in the Wolfe No. 2 ore this element was not detected.

Both ores contained freibergite $(CuFeAg)_{12}Sb_4S_{13}$ which can contain up to 18% silver.

The silver in the North Star was not as amenable to recovery by flotation as was the case with the Wolfe No. 2 ore. In Test 6, Tables 7-c and 7-b the final concentrates assayed 754.04 and 222.44 oz Ag/ton for the North Star and Wolfe No. 2 ores respectively with recoveries of 61.1% and 84.0% of the silver from the two ores.

Cyanidation tests on North Star flotation tailings may be extracted. No cyanidation tests were done on the Wolfe No. 2 ore.

A barite concentrate assaying 93.56% $BaSO_4$ was obtained from the North Star ore.

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*Technical Officer, Mineral Processing Division, Mines Branch, Department of Mines and Technical Surveys, Ottawa, Canada.

TABLE OF CONTENTS

INTRODUCTION

On February 12, 1963 Mr. H. M. Wright of Wright Engineers Limited, 1103 West Pender Street, Vancouver 1, B. C., asked the Mines Branch to start an investigation on a silver bearing ore from the Alice Arm area of B. C.

Location of Property

Dolly Varden Mines Limited, from which the ore originated, is a former silver-lead producer, located in the Alice Arm area of B. C. about 18 miles north of the head of Alice Arm Inlet.

Shipment

The following ore samples were received at the Mines Branch.

Sample 1 - March 6, 1963,	126 lb	North Star ore
Sample 2 - October 22, 1963,	116 lb	North Star ore
Sample 3 - December 23, 1963	114 lb	Wolfe No. 2 ore

Sampling and Analysis

As these three samples were received, representative specimens were selected for a mineralogical examination. The remainder was crushed to -10 mesh and three head samples were obtained by riffling, for a chemical analysis.

TABLE 1

Results of Head Sample Analysis*

Element	North Star		Wolfe No. 2
	Sample 1	Sample 2	
Gold (Au) oz/ton	0.00125	trace	-
Silver (Ag) oz/ton	13.51	13.61	24.01
Lead (Pb) per cent	0.50	0.50	0.63
Zinc (Zn) "	1.53	1.46	0.49
Copper (Cu) "	0.036	0.039	0.24
Iron (Fe, Sol) per cent	3.03	2.35	10.68
Sulphur (S total) "	8.44	9.75	6.60
Barium Sulphate ($BaSO_4$) per cent	35.56	35.70	none detected
Insoluble per cent	83.19	81.60	61.98

*From Internal Reports MS-AC 63-386, 932 and 64-406.

MINERALOGICAL INVESTIGATION

The mineralogical work on the first sample of the North Star ore is contained in Investigation Report IR 63-78*. A summary of that work is as follows:

"Samples of a lead-zinc-silver ore from the Alice Arm area in British Columbia were examined and found to consist of barite and metallic minerals disseminated in a quartz-calcite-dolomite gangue. Pyrite is the most abundant metallic mineral, but significant amounts of sphalerite, chalcopyrite, galena and freibergite are also present."

The dominant silver-bearing mineral in the sections examined is freibergite. This is a complex mineral, the silver-bearing variety of tetrahedrite with the general formula $(CuFeAg)_{12}Sb_4S_{13}$. Freibergite can contain up to 18% silver as this element replaces the Cu and Fe in the min-

*Investigation Report IR 63-78 by W. Petruk, July 31, 1963

eral, but usually contains less than 5% silver. It is to be noted that in tetrahedrite, elements such as Pb, Hg and Bi can also replace the Cu and Fe ions and As can replace the Sb.

The following photomicrographs show the relationship between freibergite and the other minerals in the sample.

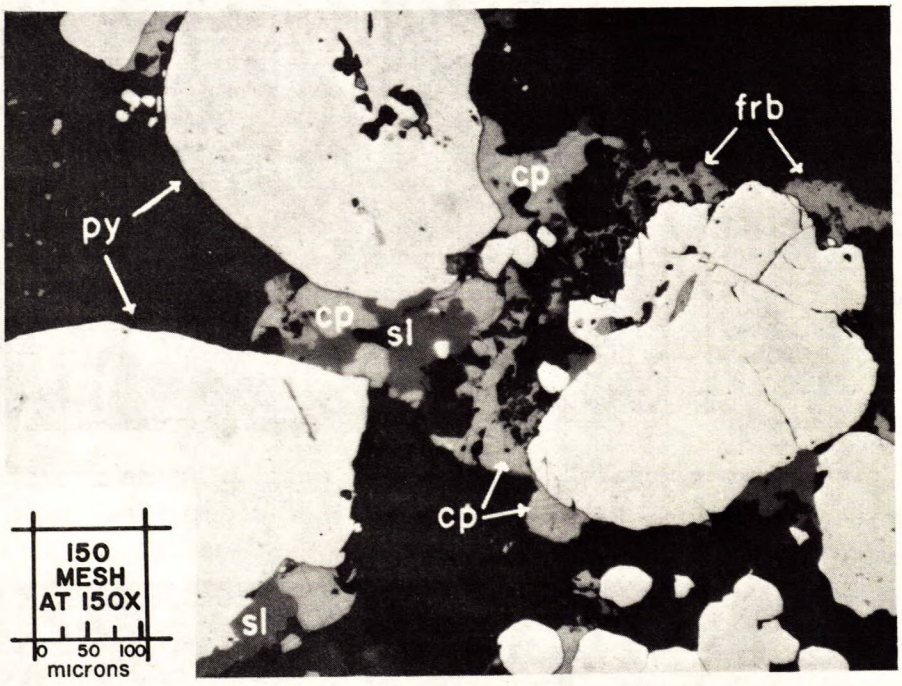

Figure 1. Photomicrograph of a polished section of the ore showing a field that contains pyrite (py), chalcopyrite (cp), sphalerite (sl) and freibergite (frb). The dark background represents gangue.

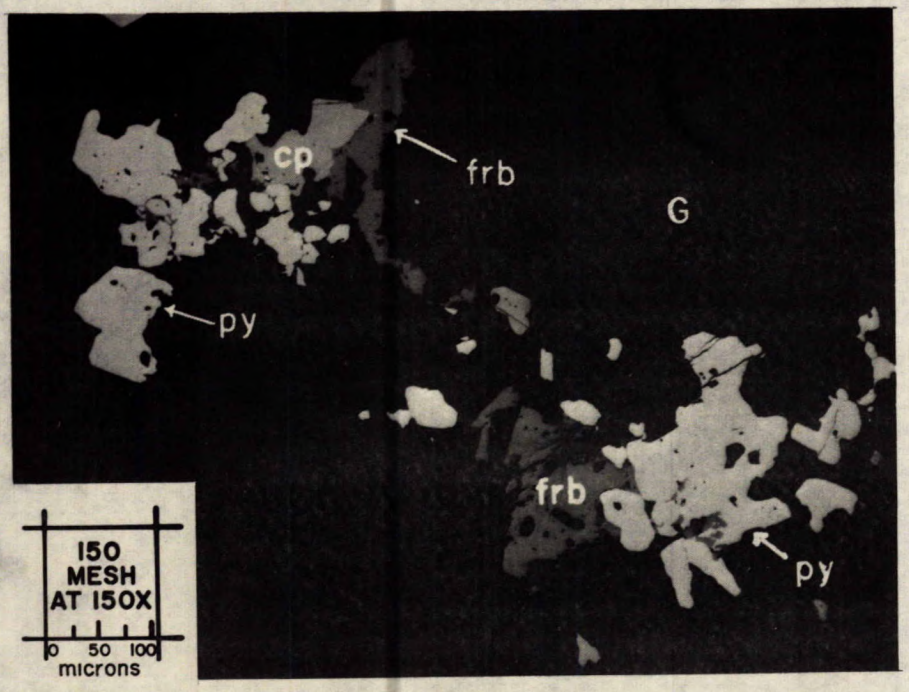

Figure 2. Photomicrograph of a polished section of the ore showing a field that contains pyrite (py), chalcopyrite (cp), freibergite (frb) and gangue (G).

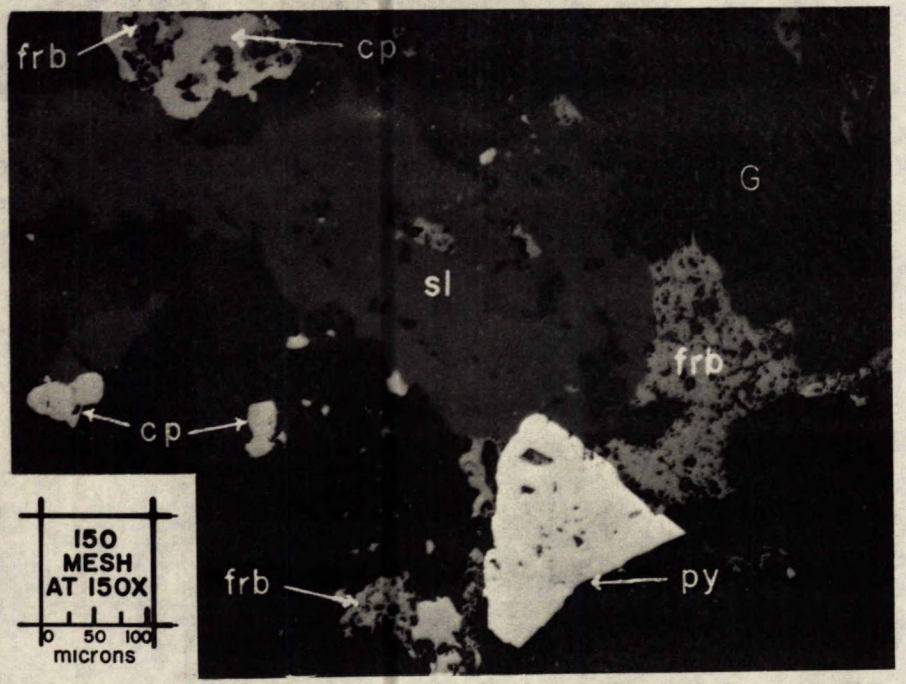

Figure 3. Photomicrographs of a polished section of the ore showing a field that contains sphalerite (sl), freibergite (frb), chalcopyrite (cp), pyrite (py) and gangue (G).

The second sample of North Star ore was microscopically examined and the following report* was submitted.

The metallic minerals are sphalerite, chalcopyrite, galena, pyrite, freibergite and native silver. The sphalerite, chalcopyrite, galena, pyrite and freibergite occur as masses and disseminated grains in gangue, and the native silver occurs as minute grains in vein quartz.

The sphalerite contains exsolution particles of chalcopyrite and inclusions of galena, pyrite, freibergite, and chalcopyrite. The galena contains inclusions of chalcopyrite and freibergite, and the chalcopyrite contains inclusions of sphalerite and freibergite.

Mineralogically this sample of North Star ore was essentially the same as the first sample examined and reported previously.

A portion of minus 10 mesh head sample and selected hand specimens from the Wolfe No. 2 ore were submitted for microscopic examination**.

The head sample was separated into metallic and non-metallic mineral fractions by means of heavy liquids. Polished sections were prepared from the metallic mineral fraction and the hand specimen. The minerals were identified by microscopical methods.

The ore consists of metallic minerals disseminated in gangue. The metallic minerals are pyrite, sphalerite, galena, chalcopyrite, freibergite, arsenopyrite, pyrrhotite and native silver. The pyrite and arsenopyrite are present as irregular grains and cubic crystals, and the pyrite contains irregular inclusions of chalcopyrite, freibergite and pyrrhotite. Sphalerite and galena occur as small masses in gangue, and the sphalerite contains minute rounded chalcopyrite exsolution bodies. The chalcopyrite and freibergite occur as small masses and irregular inclusions in gangue and pyrite, and occasionally are intergrown with each other. Native silver was found only as inclusions in freibergite.

The gangue consists of quartz, calcite, dolomite and chlorite.

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*Internal Report MS-63-105 by W. Petruk, November 8, 1963.
**Internal Report MS-64-26 by W. Petruk, April 1, 1964.

DETAILS OF INVESTIGATION

Flotation

Test 1

A 2000 gram sample of -10 mesh ore from the North Star Sample 1, was ground to 86.3% -200 mesh and floated using the procedure shown in Table 2-a. The test results are shown in Table 2-b.

TABLE 2-a

Flotation Data Test 1

Reagents lb/ton feed	Grind	Conditioning			Rougher Flotation			Cleaner Flotation	
		Ag-Pb	Zn	$BaSO_4$	Ag-Pb	Zn	$BaSO_4$	Zn	$BaSO_4$
NaCN	0.10								
Pot Ethyl Xanthate		0.05			0.07				
$CuSO_4$			0.50						
Sodium Aerofloat			0.05			0.05			
Sodium Silicate				2.0					1.00
Aerofloat 825				0.50			1.50		
Cresylic Acid		0.02							
Dowfroth 250			0.015						
Grind %-200 mesh	86.3								
Time min	20	3	6	5	3	6	9	3	4
pH	8.7		8.8	9.4		8.8			

TABLE 2-b

Results of Test 1

Product	Weight %	Analysis*				Distribution %			
		oz/ton		%					
		Ag	Pb	Zn	$BaSO_4$	Ag	Pb	Zn	$BaSO_4$
Pb conc	2.7	332.19	17.76	7.10	30.30	63.8	85.3	12.6	2.3
Zn Cl conc	5.2	37.93	0.60	24.70	2.64	14.0	5.5	84.6	0.4
" " tail	2.9	21.32	0.53	0.40	33.06	4.4	2.7	0.8	0.2
Barite Cl conc	34.2	1.18	0.01	0.033	91.80	2.9	0.6	0.7	89.2
" " tail	9.3	6.18	0.11	0.063	23.32	4.1	1.8	0.4	6.2
Flotn tail	45.7	3.31	0.051	0.028	1.34	10.8	4.1	0.9	1.7
Head (calcd)	100.0	14.05	0.56	1.52	35.22	100.0	100.0	100.0	100.0

*From Internal Report MS-AC-63-506

Test 2

At a slightly finer grind of 88.3% -200 mesh a silver-lead concentrate was floated using 0.04 lb Aerofloat 242/ton and 0.02 lb cresylic acid/ton. This concentrate was not cleaned. The zinc was floated using the same reagents as in Test 1. The zinc concentrate was cleaned once for 1 1/2 minutes instead of the 3 minutes in Test 1. A barite concentrate was floated as in Test 1 and was cleaned twice using 1.0 lb sodium silicate/ton in each stage. The results of this test are shown in Table 3.

TABLE 3

Results of Test 2

Product	Weight %	Analysis*				Distribution %			
		oz/ton		%					
		Ag	Pb	Zn	$BaSO_4$	Ag	Pb	Zn	$BaSO_4$
Pb conc	4.5	171.72	11.70	3.20	45.98	58.4	89.8	9.7	6.0
Zn Cl conc	1.6	35.76	0.11	59.20	0.80	4.3	0.3	63.7	0.1
" " tail	6.9	43.82	0.34	3.52	17.44	22.8	4.0	16.3	3.3
Barite Cl conc	27.8	0.60	0.01	0.045	93.56	1.2	0.5	8.4	71.5
2nd barite Cl tail	2.8	2.82	0.053	0.086	75.22	0.6	0.3	0.2	5.8
1st " " "	9.4	4.54	0.10	0.090	41.48	3.2	1.6	0.6	10.7
Flotn tail	47.0	2.66	0.044	0.035	2.08	9.5	3.5	1.1	2.6
Head (calcd)	100.0	13.45	0.59	1.49	36.38	100.0	100.0	100.0	100.0

*From Internal Report MS-AC-63-506

Test 3

In this test NaCN was added to the cleaning stage of the silver-lead rougher concentrate. This was an attempt to depress the sphalerite and pyrite which had floated, thereby enriching the final silver-lead concentrate while maintaining the recovery of these minerals achieved in Tests 1 and 2. Three cleaning stages for the zinc rougher concentrate were also employed. The flotation conditions are shown in Table 4-a and the results in Table 4-b.

TABLE 4-a

Flotation Data Test 3

Reagents lb/ton feed	Grind	Conditioning		Rougher Flotation		Cleaner Flotation			
		Ag-Pb	Zn	Ag-Pb	Zn	Ag-Pb	1st Zn	2nd Zn	3rd Zn
NaCN	0.10					0.10			
$ZnSO_4$	0.30								
Aerofloat 208		0.02							
Aero xanthate 303		0.05		0.05					
$CuSO_4$			1.00						
Sodium Aerofloat			0.05		0.05				
Cresylic acid				0.35					
Dowfroth 250					0.04				
Grind % -200 mesh	86.3								
Time min	20	3	7	3	5	2	3	2	11/2
pH	8.6		9.4*						

*adjusted with lime

TABLE 4-b

Results of Test 3

Product	Weight %	Analysis*			Distribution %		
		oz/ton	%				
		Ag	Pb	Zn	Ag	Pb	Zn
Pb conc	0.8	105.33	39.41	3.84	6.6	73.0	2.0
" Cl tail	1.8	401.32	3.02	4.80	56.3	12.6	5.7
Zn conc	3.6	28.76	0.21	31.54	8.1	1.8	74.8
3rd Zn Cl tail	1.0	50.72	0.59	10.40	4.0	1.4	6.8
2nd " " "	1.4	39.86	0.56	7.20	4.4	1.8	6.6
1st " " "	2.1	17.18	0.31	1.41	2.8	1.5	1.9
Flotn tail	89.3	2.57	0.04	0.04	17.8	7.9	2.2
Head (calcd)	100.0	12.82	0.43	1.52	100.0	100.0	100.0

*From Internal Report MS-AC-63-1092

While the percentage of lead in the final concentrate did increase the use of NaCN in the cleaning stage apparently depressed the silver into the lead cleaner tailing.

Test 4

In this test an attempt was made to float a bulk Ag-Pb-Zn concentrate and then make a separation between the Ag-Pb and the Zn. In this test the bulk concentrate was reground with Na_2CO_3 and NaCN and a Ag-Pb concentrate was floated and cleaned twice. The Zn concentrate which was floated was cleaned once.

TABLE 5-a

Flotation Data Test 4

Reagents lb/ton feed		Regrind bulk conc	Conditioning		Rougher Flotation	Regrind Separation		Cleaner Flotation		
			Ag-Pb	Zn	Ag-Pb-Zn	Ag-Pb	Zn	1st Ag-Pb	2nd Ag-Pb	Zn
Na_2CO_3		1.00		0.10						
NaCN		0.50								
$CuSO_4$				0.25			0.25			
Sod isopropyl xanthate			0.10		0.10					
Pine oil					0.02					
Dowfroth 250					0.04		0.02			
Grind % -200 mesh	61.1									
Time, min	10	10	3	4	12	3	3	2	1	2
pH	8.1	9.1	8.0							

TABLE 5-b

Results of Test 4

Product	Weight %	Analysis* oz/ton Ag	Analysis* % Pb	Analysis* % Zn	Distribution % Ag	Distribution % Pb	Distribution % Zn
Pb conc	0.4	198.53	63.60	4.49	6.3	51.3	1.2
2nd Pb Cl tail	0.2	152.62	17.31	6.19	2.4	7.0	0.8
1st " " "	1.5	371.28	7.12	10.11	44.0	21.5	9.9
Zn conc	2.6	80.03	1.85	46.70	16.5	9.7	79.3
" Cl tail	1.4	33.65	0.67	5.55	3.7	1.9	5.1
Regrind tail	7.6	15.59	0.28	0.38	9.4	4.3	1.9
Flotn tail	86.3	2.59	0.025	0.033	17.7	4.3	1.8
Head (calcd)	100.0	2.64	0.50	1.53	100.0	100.0	100.0

*From Internal Report MS-AC-63-1149

In this test as in Test 4 the use of cyanide in the regrind mill apparently depressed the silver minerals.

Test 5

A 2000 gram sample of the Wolfe No. 2 sample was ground for 30 minutes to 84.8% -200 mesh and was floated. Since the silver was of prime importance, no attempt was made to recover the zinc in a separate concentrate.

TABLE 6-a

Flotation Data Test 5

Reagents lb/ton feed	Grind	Condition	Rougher Flotation Bulk Ag-Pb-Zn	Cleaner Flotation 1st	Cleaner Flotation 2nd
Lime	0.70				
Pot. amyl xanthate	0.10		0.05		
Pine oil		0.04	0.02		
Grind % -200 mesh	84.8				
Time, min	30	1	9	3	2
pH	9.0			10.0*	9.0*

*adjusted with lime

TABLE 6-b

Results of Test 5

Product	Weight %	Analysis*			Distribution %		
		oz/ton	%				
		Ag	Pb	Zn	Ag	Pb	Zn
Final conc	5.4	421.70	9.10	3.14	88.3	80.8	38.4
2nd Cl tail	4.2	38.34	1.09	1.60	6.2	7.5	15.2
1st " "	5.0	12.96	0.57	1.19	2.5	4.7	13.5
Flotn "	85.4	0.91	0.05	0.17	3.0	7.0	32.9
Head (calcd)	100.0	25.81	0.61	0.44	100.0	100.0	100.0

*From Internal Report MS-AC-64-520

Test 6

The good concentrate grade and high silver recovery obtained in Test 5 prompted this comparison test on the floatabilities of the Wolfe No. 2 and the North Star ores. In each test two -2000 gram samples of -10 mesh ore were ground for 30 minutes and the bulk Ag-Pb-Zn concentrates which were floated were combined for cleaning. The test procedure outlined in Table 7a was used on each ore sample.

TABLE 7-a

Flotation Data Test 6

Reagents lb/ton feed	Grind	Condition	Rougher Flotation Bulk Ag-Pb-Zn	Cleaner Flotation			
				1st	2nd	3rd	4th
Lime	0.70		-	0.15	-	0.025	-
Pot. amyl xanthate	0.10	0.05	0.10	-	-	-	-
Pine oil		0.04	0.02	0.02	-	-	-
Grind % -200 mesh	8	84.8					
Time, min	30	2	9	3 1/2	2 1/2	2	1 1/2
pH	8.9		8.5	10.2	9.3	10.1	9.6
Cell size grams			2000	1000	500	250	250

TABLE 7-b

Results of Test 6 - Wolfe No. 2

Product	Weight %	Analysis* oz/ton Ag	Analysis* % Pb	Analysis* % Zn	Distribution % Ag	Distribution % Pb	Distribution % Zn
Final conc	2.9	754.04	13.80	5.99	84.0	73.4	38.1
4th Cl tail	1.3	88.10	1.79	1.77	4.4	4.3	5.0
3rd " "	2.0	41.61	1.33	1.48	3.2	4.9	6.6
2nd " "	1.8	30.78	0.73	0.72	2.1	2.4	2.8
1st " "	10.0	9.60	0.41	0.86	3.7	7.5	18.8
Flotn "	82.0	0.82	0.05	0.16	2.6	7.5	28.7
Head (calcd)	100.0	26.03	0.54	0.47	100.0	100.0	100.0

*From Internal Report MS-AC-64-1068

TABLE 7-c

Results of Test 6 - North Star

Product	Weight %	Analysis* oz/ton Ag	Analysis* % Pb	Analysis* % Zn	Distribution % Ag	Distribution % Pb	Distribution % Zn
Final conc	3.7	222.44	8.87	3.85	61.1	72.7	10.6
4th Cl tail	0.7	122.96	4.07	13.20	6.4	6.3	6.9
3rd " "	0.9	78.44	2.29	15.40	5.2	4.6	10.3
2nd " "	1.4	46.20	1.16	11.20	4.8	3.6	11.7
1st " "	5.7	22.80	0.48	7.78	9.6	6.1	33.0
Flotn "	87.6	1.96	0.038	0.42	12.9	6.7	27.5
Head (calcd)	100.0	13.46	0.45	1.34	100.0	100.0	100.0

*Report of Analysis Nov. 24, 1964, Extraction Metallurgy Division

The flotation tailings from Test 6 were screened and infrasized and the fractions were assayed for silver.

TABLE 7-d

Screened Infrasizer Analysis of Flotation Tailings

Particle Size	Wolfe No. 2			North Star		
	Weight %	Ag oz/ton	Distn %	Weight %	Ag oz/ton	Distn %
+48 mesh	-	-	-	-	-	-
+65 "	0.2	2.94	6.9	-	-	-
+100 "	2.4			1.7	3.35	3.1
+150 "	12.4	1.06	11.9	9.3	2.76	14.0
+200 "	9.9	0.74	6.6	8.3	2.42	11.0
+56 microns	5.8	0.82	4.3	8.8	1.61	7.7
+40 "	17.7	0.51	8.2	19.9	1.47	16.1
+28 "	13.4	0.71	8.6	16.4	1.03	9.2
+20 "	10.7	0.70	6.8	10.8	0.94	5.5
+14 "	7.1	0.67	4.3	6.9	0.94	3.5
+10 "	4.6	0.75	3.1	4.0	1.12	2.4
-10 "	15.8	2.76	39.3	13.9	3.63	27.5
Total	100.0	1.11	100.0	100.0	1.83	100.0

*Report of Analysis, Nov. 24, 1964, Extraction Metallurgy Division

Cyanidation of Flotation Tailings

The flotation of the North Star ore resulted in a flotation tailing assaying of 1.96 oz Ag/ton in Test 6. This was the lowest tailing achieved in all of the tests on this ore.

In an attempt to recover additional silver from the flotation tailings a series of cyanidation tests was done. In Table 8 the cyanidation conditions and the results of this work are shown.

TABLE 8

Results of Cyanidation Tests on Flotation Tailings of North Star Ore

Test No.	Grinding Time min	Grinding % -200m	Cyanidation Agitation time hr	Solids %	Solution Strength NaCN lb/ton	Solution Strength CaO lb/ton	Reagent Consumption NaCN lb/ton	Reagent Consumption CaO lb/ton	Au oz/ton* Feed	Au oz/ton* Residue	Gold** Extraction %	Remarks
7	10	54.1	24	33	1.0	1.0	0.34	1.20	2.59	1.85	28.6	Test No's 13, 14, 16, 17 and 19 were cyanided 24 hours then filtered, repulped in fresh solution and cyanided for an additional 24 hr. Test No. 17 was repulped a second time and given an additional 24 hrs of cyanidation
8	"	11	48	"	"	"	0.53	1.28	"	1.41	45.6	
9	20	72.2	48	"	"	"	0.77	1.31	"	0.93	64.1	
10	10	54.1	72	"	"	"	0.44	1.36	"	1.24	52.1	
11	20	69.7	48	"	0.5	0.5	0.64	1.48	2.04	1.04	49.0	
12	30	93.2	48	"	"	"	1.00	1.40	"	0.88	56.9	
13	20	69.7	48	"	"	"	1.20	2.24	"	1.03	49.5	
14	30	93.2	48	"	"	"	1.16	2.84	"	0.765	62.5	
15	"	"	48	"	"	"	0.96	1.80	"	0.74	63.7	Ground with 1.0 lb NaCN/ton
16	"	"	48	"	"	"	1.84	2.60	"	0.63	69.1	
17	"	"	72	"	"	"	2.48	3.24	"	0.55	73.0	
18	40	98.0	48	"	"	"	1.12	2.00	"	0.60	70.6	
19	"	"	48	20	"	"	4.56	5.04	"	0.40	80.4	
20	20	74.2	24	33	1.0	1.0	0.72	1.20	2.665	1.06	60.2	
21	"	"	48	"	"	"	0.80	1.76	"	0.86	67.7	
22	"	"	72	"	"	"	1.04	1.76	"	0.78	73.7	
23	"	73.5	24	"	2.0	2.0	0.56	2.04	2.55	0.91	64.3	
24	"	"	48	"	"	"	1.12	3.36	"	0.76	70.2	
25	"	"	72	"	"	"	1.08	3.52	"	0.75	70.6	
26	"	74.5	24	"	4.0	4.0	2.08	7.92	3.00	0.89	70.3	
27	"	"	48	"	"	"	2.64	14.72	"	0.80	73.3	
28	"	"	72	"	"	"	2.56	17.20	"	0.72	76.0	

*From Internal Reports MS-AC-63-1256 and 63-1478

**Calculated by difference

MINERALOGICAL EXAMINATION OF MILL PRODUCTS*

The cyanidation residues shown in Table 8 all contained appreciable quantities of silver. In Tests 15 to 19 inclusive, the flotation tailings were ground in cyanide and then subjected to long and rigorous cyanidation conditions, and the residues still contained about 0.5 oz Ag/ton.

To determine the mode of occurrence of this silver, superpanned concentrates were prepared from the combined flotation tailing rejects and the combined cyanidation residue rejects from those five tests. Those two concentrates were subjected to a mineralogical examination with the following results:

Superpan Concentrate from Flotation Tailings

The sample consists largely of gangue, with only a small proportion of metallic minerals. The metallic minerals are pyrite, galena, native silver, hematite, spinel, cassiterite and chalcopyrite. Of these, pyrite and galena are the principal ones. They are present largely as free grains, although some of the pyrite contains small inclusions of galena. The other metallic minerals are present as free grains. The grains of native silver vary from 36 to 120 microns in size (see Figure 4).

Superpan Concentrate from Cyanide Residue

This sample is similar to the flotation tailing concentrate except that it has a higher proportion and a greater variety of metallic minerals. The metallic minerals are pyrite, galena, native silver, spinel, hematite, ilmenite, cassiterite, chalcopyrite, loellingite and rutile. Pyrite and galena are the principal metallic minerals and are present largely as free grains, except for a few grains of pyrite that contain inclusions of galena. The native silver is also present as free grains, which vary from 20 to 150 microns in size, (see Figure 5). The other metallic minerals also occur largely as free grains, except for a few grains of spinel, which are rimmed with hematite.

No freibergite was detected in either sample.

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*Internal Report MS-65-81 by D. Owens and W. Petruk, July 27, 1965.

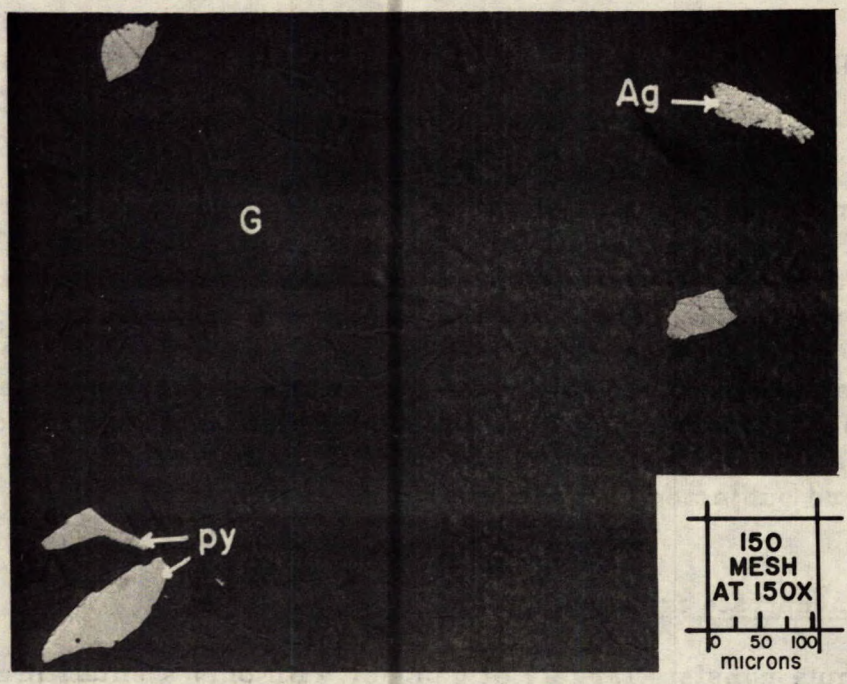

Figure 4. Photomicrograph of the flotation tailing concentrate showing one grain of native silver (Ag) and a few grains of pyrite (Py) with a large number of grains of gangue (G).

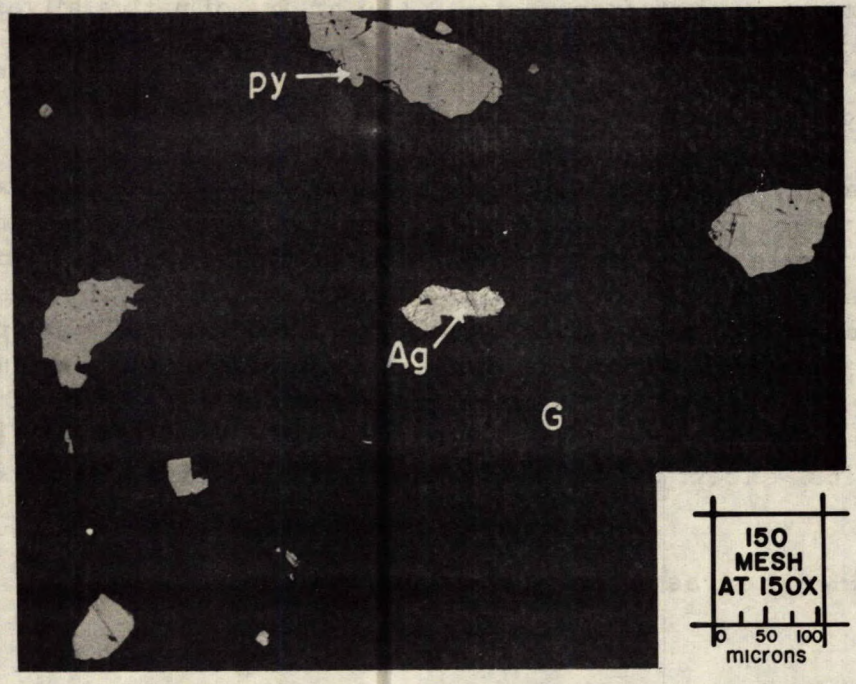

Figure 5. Photomicrograph of the cyanidation residue concentrate showing one grain of native silver (Ag) a few grains of pyrite (Py) and gangue (G).

CONCLUSIONS AND DISCUSSION

Although both the ores which were tested contained some lead and zinc, they were primarily silver ores.

The mineralogical reports on the North Star and the Wolfe No. 2 samples indicated that these two ores were similar insofar as the metallic minerals were concerned. A chemical analysis however showed that the North Star ore contained about 13 oz Ag/ton and about 35% $BaSO_4$ while the Wolfe No. 2 ore contained about twice this amount of silver and no $BaSO_4$ was detected.

Both samples contained freibergite, a complex copper, iron, silver, antimony sulphide with the general formula $(Cu, Fe, Ag)_{12} Sb_4 S_{13}$. This mineral can contain up to 18% silver. During the flotation tests where cyanide was used in a regrind or cleaner stage on the silver-lead rougher concentrate, as a pyrite or zinc depressant, the resultant silver-lead cleaner tailings contained more silver than did the final concentrates. In Test 3 (Table 4-b) the lead was up-graded during one cleaner stage to 39.41% Pb with a recovery of 73.0% while the silver was depressed and reported 401.32 oz/ton in the cleaner tailing with a recovery in this product of 56.3%. Similarly in Test 4 (Table 5-b), two cleaner stages following a regrind with cyanide, a final lead concentrate assayed 63.60% Pb with 51.3% recovery, while 44% of the silver reported in the first cleaner tailing assaying 371.28 oz/ton.

While not investigated, the treatment of a silver-lead rougher concentrate with cyanide is a possible method of producing separate high grade silver and lead concentrates.

The silver in the Wolfe No. 2 ore was more amenable to recovery, than was the silver in the North Star ore. In Test 6 (Tables 7-b and 7-c) the comparative floatabilities of the silver in the two ores is shown. Following an identical flotation scheme during which cyanide was not used, the final concentrates from the Wolfe No. 2 and the North Star samples assayed 754.04 oz Ag/ton and 222.44 oz Ag/ton with a final concentrate recovery of 84% and 61.1% of the silver respectively. The flotation tailing on the North Star ore was 1.96 oz Ag/ton, which was the lowest tailing obtained on all of the tests in this ore.

The flotation tailing from the North Star ore may require a cyanidation treatment to avoid the loss of about 2 oz Ag/ton which represents about 12% of the silver in this ore. Table 8 shows the results of a series of cyani-

dation tests on various flotation tailings from the North Star ore. In Test 19, under rigorous conditions, which included grinding in cyanide to 98.0% -200 mesh, followed by cyanidation for 24 hours, filtering, washing and repulping in fresh cyanide solution for an additional 24 hours agitation, the cyanide residue still contained 0.4 oz Ag/ton, which represented an extraction of 80.4% of the silver in the flotation tailing:

In Test 2 a barite concentrate assaying 93.56% $BaSO_4$, was made from the North Star ore, but this grade of concentrate may have no commercial importance.

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TFB:gt