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CANADA

DEPARTMENT OF ENERGY, MINES AND RESOURCES

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MINES BRANCH INVESTIGATION REPORT IR 70-61

RECOVERY OF GOLD AND SILVER FROM AN ORE FROM MOUNT NANSEN MINES LIMITED, Y.T.

by

T. F. BERRY AND R. W. BRUCE

MINERAL PROCESSING DIVISION

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SUMMARY OF RESULTS

The shipment of ore assayed 0.415 oz Au/ton and 17.405 oz Ag/ton.

A grind of 55% minus 200 mesh and a flotation time of 20 minutes gave the best recovery by flotation. In Test 26 a final concentrate assaying 2.99 oz Au/ton and 149.38 oz Ag/ton was produced with a recovery of 72.0% of the gold and 83.8% of the silver. The flotation rougher recovery in this test was 90.4% and 93.7% of the gold and silver respectively. The cyanidation of the rougher tailing gave an additional recovery of 3.8% of the gold and 3.5% of the silver.

Weight losses of over 30% were achieved during roasting by the partial elimination of the arsenic, antimony and sulphur in the concentrate. However, a high loss of gold and silver occurred particularly in those roasting tests in which salt was used.

In no test in which cyanidation alone was tried on the ground ore, on the flotation concentrate, or on a calcine, was the recovery of gold and silver sufficiently high to make this method of treatment an attractive proposition.

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INTRODUCTION

Mount Nansen Mines Limited is a silver-gold property under development in the Carmacks district of the Yukon Territory. The company is 66 per cent controlled by Peso Silver Mines Limited.

The property at present consists of three main orebodies, two of which, the Webber and the Brown-McDade, are oxide and the third, the Heustis, contains high-grade massive sulphides.

In 1967, metallurgical work was done by the Mineral Processing Division of the Mines Branch on a shipment of oxide ore from the Webber deposit. The results of this work are contained in Investigation Report IR 67-59.

On February 16, 1968, Mr. B.S. Imrie, General Manager, Mount Nansen Mines Limited, 420-475 Howe Street, Vancouver 1, B.C. expressed some concern with the high tailing losses shown in the original investigation. He felt that a new approach was warranted and requested an investigation on a fresh sample of ore from the property.

During a visit to the Mines Branch, Mr. Imrie indicated that a cyanidation plant would be installed at the property to recover additional silver and gold from the flotation tailing.

Shipment

On February 23, 1968, three boxes of mixed sulphide-oxide, weighing 300 lb, were received at the Mines Branch. The investigation was started on March 7, 1968 and was given the Project No. MP-OD-6803.

Sampling and Analysis

The shipment which was all minus ¼ inch was riffled into two fractions, one of which was bagged for future work. From the other, a large number of hand specimens were selected for a mineralogical investigation. The remainder of this ore was crushed to minus 10 mesh and was split into 2000-gram test samples.

One of the test samples was taken as a head sample for spectrographic, chemical and screen analyses. These results are shown in Tables 1, 2 and 3.

TABLE 1

Semi-quantitative Spectrographic Analysis*

Si, Al	-	Principal constituent
As	-	<2.0 per cent
Fe	-	<1.0 " "
Sb, Ca, Mg, Cr, Ti, Ni	-	<0.1 " "
Cu, Ag, Co	-	<0.01 " "

*From Internal Report MS-AC-68-55.

TABLE 2

Head Sample Analysis*

Gold (Au)	-	0.415 oz/ton
Silver (Ag)	-	17.405 " "
Lead (Pb)	-	1.32 per cent
Zinc (Zn)	-	0.40 " "
Copper (Cu)	-	0.08 " "
Antimony (Sb)	-	0.43 " "
Arsenic (As)	-	1.91 " "
Iron (Sol Fe)	-	4.62 " "
Sulphur (Total S)	-	1.16 " "
Insoluble	-	68.32 " "

*From Internal Report MS-AC-68-210.

TABLE 3

Analysis of Head Sample Screen Fractions

Product	Wt %	Assays*					Distribution %				
		Au	Ag	As	Fe	S	Au	Ag	As	Fe	S
+10 mesh	-	-	-	-	-	-	-	-	-	-	-
-10+14 "	27.4	0.265	12.645	1.69	3.80	2.38	18.3	20.9	21.8	21.5	20.4
-14+20 "	20.0	0.290	13.61	1.81	4.00	2.57	14.7	16.4	17.1	16.6	16.1
-20+28 "	12.1	0.285	15.435	1.77	4.10	2.86	8.7	11.6	10.1	10.3	10.8
-28+35 "	8.1	0.270	17.03	1.69	4.30	3.19	5.5	8.3	6.5	7.3	8.1
-35+48 "	5.8	0.45	19.30	1.77	4.90	3.49	6.6	6.8	4.8	5.9	6.3
-48+65 "	5.0	0.37	20.48	2.12	5.30	4.01	4.7	6.2	5.0	5.5	6.3
-65+100 "	3.8	0.525	21.575	2.62	5.90	4.51	5.0	5.0	4.7	4.6	5.4
-100+150 "	3.3	0.65	23.77	3.54	6.80	5.32	5.4	4.7	5.5	4.6	5.5
-150+200 "	2.8	0.85	25.48	4.58	8.90	6.40	6.0	4.3	6.0	5.3	5.6
-200 "	11.7	0.845	22.215	3.33	7.60	4.18	25.1	15.8	18.5	18.4	15.5
Head (calcd)	100.0	0.40	16.55	2.12	4.83	3.19	100.0	100.0	100.0	100.0	100.0

*From Internal Reports MS-AC-68-316, 68-324.
*Assays in this and all succeeding tables are in per cent except gold and silver which are in oz per ton.

Mineralogy of the Ore

The results of the mineralogical investigation of this ore were published in Mines Branch Investigation Report IR 68-33 by D. Owens*, June 10, 1968.

In summary, the ore consists of siliceous rock and breccia which contains disseminated grains of a wide variety of minerals. The silver is present in the form of freibergite, andorite, pyrargyrite and electrum. Electrum was the only gold-bearing mineral found in the ore. Other minerals included boulangerite, bournonite, galena, pyrite, arsenopyrite, marcasite, pyrrhotite, sphalerite, chalcopyrite, covellite, goethite, anatase, quartz, jarosite, scorodite, mica, chlorite, feldspar and graphite.

The main silver- and gold-bearing minerals are shown in the following photomicrographs (Figures 1, 2 and 3).

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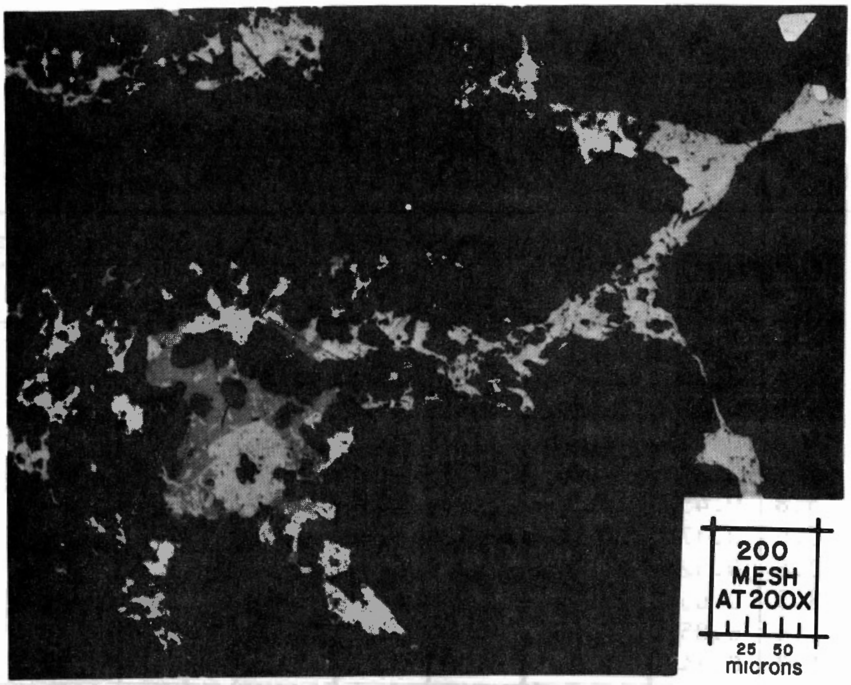


Figure 1. - Photomicrograph (in oil immersion) of a polished section showing galena (white) and pyrargyrite (light grey) combined in gangue (black).

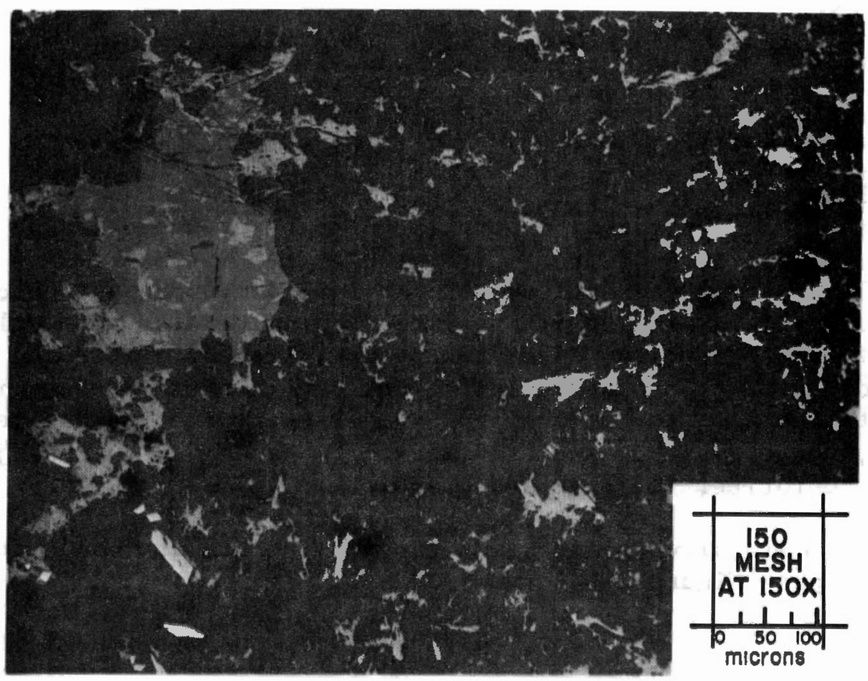


Figure 2. - Photomicrograph (in oil immersion) of a polished section showing numerous small inclusions of boulangerite (greyish white) and a few grains of arsenopyrite (white) in gangue (black). The large grain in the upper left portion of the photomicrograph is freibergite (medium grey), containing inclusions of both galena and boulangerite.

Figure 3. - Photomicrograph (in oil immersion) of a polished section showing a number of grains of andorite (?)(dark grey) in gangue (black). The andorite (?) contains a few grains of electrum (el). The other greyish white grains are arsenopyrite.

DETAILS OF INVESTIGATION

Grinding (Tests 1, 2, 3 and 4)

To determine the grinding characteristics of the ore, four samples were ground for different times and a screen analysis was carried out on each. The results are shown in Table 4. Curves showing the size distributions and the reduction rate to minus 200 mesh are shown in Figures 4 and 5.

TABLE 4

Screen Analysis of Ground Ore

Test No.	Product	Wt %	Assays*		Distn %	
			Au	Ag	Au	Ag
1 15 min grind	+65 mesh	8.1	0.185	5.725	3.7	2.8
	-65+100 "	11.6	0.19	8.35	5.5	5.7
	-100+150 "	14.6	0.24	12.57	8.7	10.9
	-150+200 "	11.8	0.385	16.385	11.3	11.5
	-200 "	53.9	0.527	21.633	70.8	69.1
	Head (calcd)	100.0	0.40	16.86	100.0	100.0
2 20 min grind	+100 mesh	7.1	0.125	5.625	2.3	2.4
	-100+150 "	13.0	0.213	9.577	7.1	7.4
	-150+200 "	15.1	0.295	14.045	11.3	12.6
	-200 "	64.8	0.48	20.10	79.3	77.6
	Head (calcd)	100.0	0.39	16.79	100.0	100.0
3 25 min grind	+100 mesh	3.6	-	-	-	-
	-100+150 "	9.8	0.24	8.14	8.3	6.5
	-150+200 "	13.8	0.245	12.95	8.7	10.6
	-200 "	72.8	0.44	19.23	83.0	82.9
	Head (calcd)	100.0	0.39	16.88	100.0	100.0
4 30 min grind	+150 mesh	8.0	0.25	7.53	5.2	3.6
	-150+200 "	12.8	0.225	11.86	7.6	9.0
	-200 "	79.2	0.42	18.71	87.2	87.4
	Head (calcd)	100.0	0.38	16.94	100.0	100.0

*From Internal Reports MS-AC-68-311, 68-316.

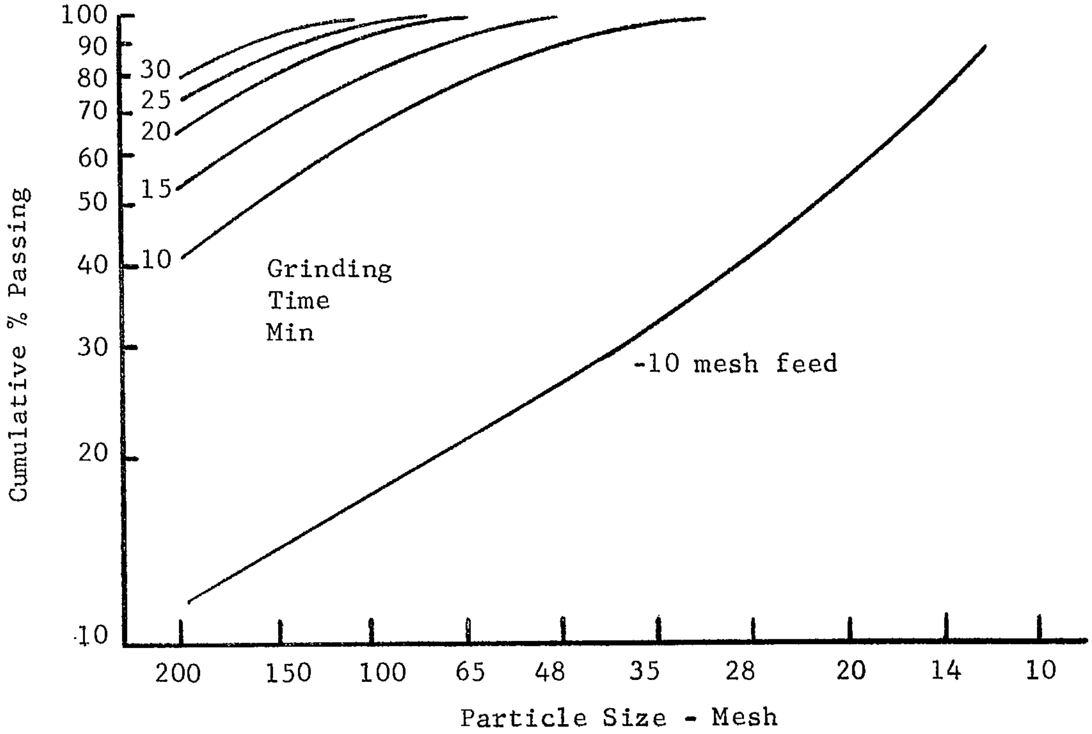


Figure 4. - Size Distribution of Feed and Ground Ore.

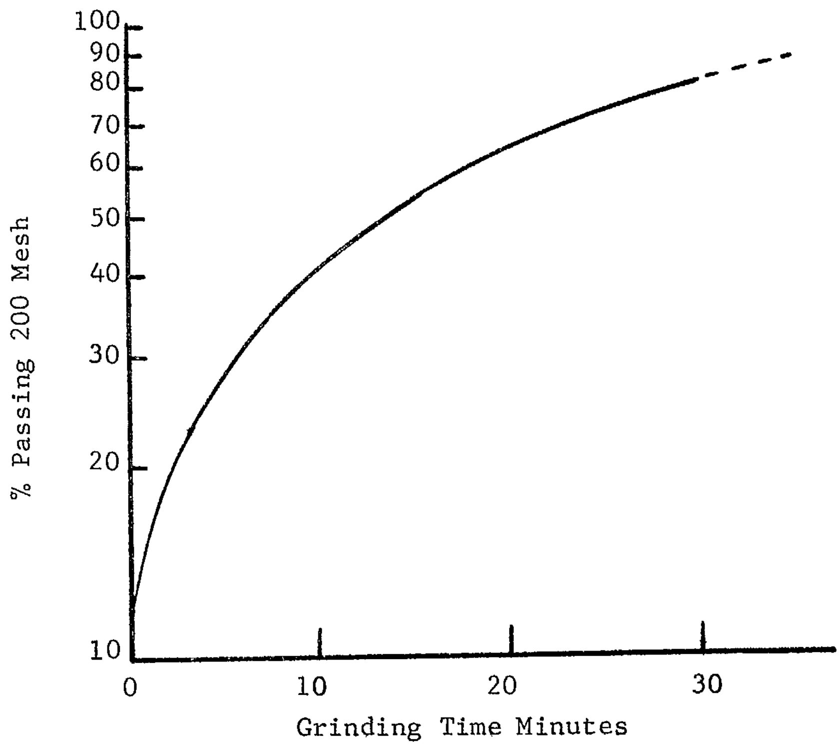


Figure 5. - Rate of Reduction to Minus 200 Mesh.

Preliminary Flotation (Tests 5, 6, 7 and 8)

Preliminary flotation tests were carried out on 2000-gram samples of the ore at four different grinds. The flotation scheme used is shown in Table 5. Slight variations in the amount of frother used were made with increasing fineness of grind. The results of these tests are shown in Table 6.

TABLE 5

Flotation Scheme Tests 5, 6, 7 and 8

Operation	Time Min	% S	pH	Reagents - lb/ton			
				Na_2CO_3	$CuSO_4$	**301	***P.O.
Grind		65		5.0	-	-	-
Condition	10	35	7.9	2.0	1.0	-	-
Condition	3					0.1	0.02
*Flotation	21					0.15	0.08

*Reagents were stage added over the flotation time with brief conditioning at each stage.
**301 - Aero Xanthate 301.
***P.O. - Pine Oil.

TABLE 6

Results of Tests 5, 6, 7 and 8

Test No.	Grind** % -200 mesh	Product	Wt %	Assays*		Distn %	
				Au	Ag	Au	Ag
5	65.0	Flot conc	28.7	1.06	54.53	79.5	89.7
		" tail	71.3	0.11	2.53	20.5	10.3
		Head (calcd)	100.0	0.38	17.45	100.0	100.0
6	70.0	Flot conc	26.6	1.185	57.93	81.1	90.6
		" tail	73.4	0.10	2.185	18.9	9.4
		Head (calcd)	100.0	0.39	17.01	100.0	100.0
7	85.0	Flot conc	35.5	0.921	54.34	83.5	93.4
		" tail	64.5	0.10	1.785	16.5	6.6
		Head (calcd)	100.0	0.39	17.24	100.0	100.0
8	90.0	Flot conc	40.2	0.837	39.74	83.6	93.8
		" tail	59.8	0.11	1.75	16.4	6.2
		Head (calcd)	100.0	0.40	16.94	100.0	100.0

*From Internal Reports MS-AC-68-311, 68-324.
**No screen test was done on any of the flotation tailings. The finenesses of grind were determined from the graph shown in Figure 5.

Flotation Rate (Test 9)

This test was done to determine the flotation rate of the gold and silver minerals. The flotation scheme is shown in Table 7 and the test results in Table 8. In Figure 6 these results are graphically illustrated. A size analysis of the flotation tailing from this test is shown in Table 9.

TABLE 7

Flotation Scheme Test 9

Operation	Time Min	% Solids	pH	Reagents - lb/ton			
				Na_2CO_3	$CaSO_4$	301	P.O.
Grind	40	65		10	0.5	-	-
Condition	3	35	8.2			0.5	-
Flot No. 1	1					-	0.04
" No. 2	1					-	0.03
" No. 3	2					-	-
Condition	3		8.4			0.02	-
Flot No. 4	4					-	0.03
" No. 5	4					-	-
Condition	3		8.4			0.02	0.015
Flot No. 6	8					-	-
Condition	3		8.5			0.04	-
Flot No. 7	8					-	0.03

TABLE 8

Results of Test 9

Product	Wt %	Assays*				Distribution %			
		Au	Ag	As	S	Au	Ag	As	S
Flot conc No. 1	3.4	1.95	235.49	9.47	22.02	17.2	47.9	14.8	24.3
" " " 2	4.2	2.31	71.98	13.71	25.34	25.1	18.1	26.5	34.6
" " " 3	4.1	1.78	49.39	9.86	14.91	19.0	12.1	18.6	19.8
" " " 4	4.7	0.84	27.38	4.04	5.42	10.2	7.7	8.7	8.3
" " " 5	4.6	0.38	10.89	1.46	1.60	4.5	3.0	3.1	2.4
" " " 6	7.5	0.26	7.26	1.12	0.96	5.2	3.2	3.9	2.3
" " " 7	7.6	0.20	4.30	1.00	0.65	3.9	2.0	3.5	1.6
Flot tail	63.9	0.09	1.57	0.71	0.32	14.9	6.0	20.9	6.7
Head (calcd)	100.0	0.38	16.72	2.17	3.08	100.0	100.0	100.0	100.0

*From Internal Report MS-AC-68-324.

TABLE 9

Results of Size Analyses of Flotation Tailing Test 9

Product	Wt %	Assays*				Distribution %			
		Au	Ag	As	S	Au	Ag	As	S
+100 mesh	0.6	-	-	-	-	-	-	-	-
-100+150 "	5.0	0.045	1.395	0.37	0.22	2.6	5.0	3.0	4.1
-150+200 "	12.5	0.05	1.57	0.50	0.20	6.6	12.6	10.3	9.4
-200+56 microns	4.2	0.097	2.935	0.81	0.32	4.3	7.9	5.6	5.0
-56+40 "	18.9	0.07	1.53	0.50	0.21	14.0	18.6	15.5	14.9
-40+28 "	15.0	0.085	1.335	0.57	0.23	13.5	12.9	14.1	13.0
-28+20 "	12.1	0.10	1.30	0.61	0.22	12.8	10.1	12.1	10.0
-20+14 "	7.6	0.10	1.33	0.65	0.22	8.0	6.5	8.1	6.3
-14+10 "	4.5	0.129	1.41	0.69	0.24	6.1	4.1	5.1	4.1
-10 "	19.6	0.155	1.77	0.81	0.45	32.1	22.3	26.2	33.2
Head (calcd)	100.0	0.095	1.55	1.55	0.26	100.0	100.0	100.0	100.0

*From Internal Report MS-AC-68-339.

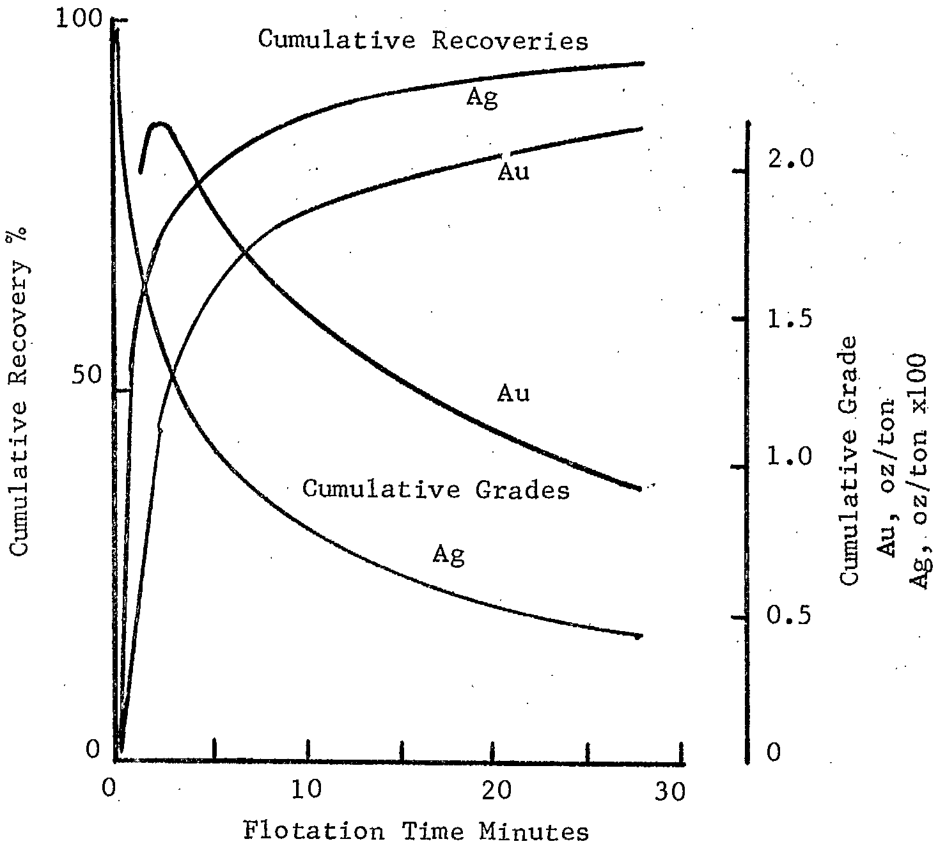


Figure 6. - Test 9, Cumulative Grades and Recoveries vs Flotation Time.

Flotation Cleaning (Test 10)

This test was similar to Test 9 except that somewhat heavier reagent additions were used. The grind was approximately 90% minus 200 mesh and the rougher and scavenger concentrates which were floated were each cleaned twice using sodium silicate as a gangue depressant.

TABLE 10

Flotation Scheme Test 10

Operation	Time Min	% Solids	pH	Reagents - lb/ton				
				Na_2CO_3	$CuSO_4$	301	P.O.	Sod Sil
Grind	40	65		10.0	0.5	-	-	-
Condition	3	35	8.1			0.05	-	-
Rougher Flotation*	12					0.04	0.10	-
1st cleaner	5							0.50
2nd cleaner	3							0.50
Scavenger Flotation								
Condition	3					0.06		
Flotation*	16					0.02	0.09	
1st cleaner	5							1.0
2nd cleaner	2							1.0

*Reagents were stage added during flotation.

TABLE 11

Results of Test 10

Product	Wt %	Assays*		Distn %	
		Au	Ag	Au	Ag
Flot conc	8.7	2.44	144.92	57.1	75.9
2nd cl tail	3.2	0.965	38.92	8.3	7.5
1st cl tail	8.7	0.365	9.29	8.6	4.9
Scavenger conc	1.0	0.72	33.09	1.9	2.0
2nd cl tail	3.1	0.375	5.85	3.2	1.1
1st cl tail	11.2	0.18	3.68	5.4	2.5
Flot tail	64.1	0.09	1.60	15.5	6.1
Head (calcd)	100.0	0.37	16.61	100.0	100.0

*From Internal Report MS-AC-68-327.

Use of Aero Promoter 404 and 425 (Tests 11, 12, 13 and 14)

Aero Promoter 404 and 425 were investigated in these four tests at grinds of 90% minus 200 mesh and 75% minus 200 mesh.

TABLE 12

Flotation Scheme Tests 11, 12, 13, 14

Test No.	Operation	Time Min	% Solids	pH	Grind	Reagents - lb/ton			
						Na_2CO_3	Aero 404	Aero 425	Aero 242
11	Grind	40	65		90% -200 mesh	10.0			
12	Grind	26.5	65		75% -200 mesh	10.0			
	Condition	5		8.2			0.10		0.10
	Ro flot	15					0.10		0.10
	Scavenger flot	7					0.10		0.05
13	Grind	40	65		90% -200 mesh	10.0			
14	Grind	26.5	65		75% -200 mesh	10.0			
	Condition	5		8.2				0.10	0.10
	Ro flot	15						0.10	0.10
	Scavenger flot	7						0.10	0.05

TABLE 13

Results of Tests 11, 12, 13, 14

Test No.	Product	Wt %	Assays*		Distn %	
			Au	Ag	Au	Ag
11	Ro flot conc	26.8	0.83	50.60	75.2	91.7
	Scavenger conc	9.2	0.20	3.76	5.5	2.3
	Flot tail	64.0	0.10	1.38	19.3	6.0
	Head (calcd)	100.0	0.33	14.79	100.0	100.0
12	Ro flot conc	24.9	1.04	58.30	76.0	90.8
	Scavenger conc	8.2	0.22	5.09	5.3	2.6
	Flot tail	66.9	0.095	1.57	18.7	6.6
	Head (calcd)	100.0	0.34	15.98	100.0	100.0
13	Ro flot conc	25.2	1.23	62.19	78.4	91.5
	Scavenger conc	7.2	0.245	5.00	4.4	2.1
	Flot tail	67.6	0.10	1.61	17.2	6.4
	Head (calcd)	100.0	0.37	16.95	100.0	100.0
14	Ro flot conc	23.1	1.26	66.09	78.1	90.1
	Scavenger conc	8.2	0.24	5.34	5.3	2.6
	Flot tail	68.7	0.09	1.81	16.6	7.3
	Head (calcd)	100.0	0.37	16.95	100.0	100.0

*From Internal Report MS-AC-68-327, 68-355, 68-363.

Flotation at Natural pH (Test 15 and 16)

In all previous tests the ore was ground with soda ash to provide an alkaline pulp with a pH of about 8.0. In these two tests, the ore was floated at the natural pH of about 6.6 after grinding to 75% and 90% minus 200 mesh. In each test the rougher flotation concentrate was cleaned three times.

TABLE 14

Flotation Scheme Tests 15 and 16

Test No.	Operation	Time Min	% Solids	pH	Fineness of Grind	Reagents - lb/ton		
						301	Z-6**	P.O.
15	Grind	26.5	65		75% -200 mesh	0.10	-	-
16	Grind	40	65		90% -200 mesh	0.10	-	-
	Condition	5	35	6.6		-	0.10	-
	Flotation*	20				0.10	0.30	0.16
	1st cleaner	7.5		6.1		-	-	0.04
	2nd "	4						
	3rd "	4						

*Reagents were stage added during flotation.
**Z-6 - Potassium Amyl Xanthate.

TABLE 15

Results of Tests 15 and 16

Test No.	Product	Wt %	Assays*				Distn %	
			Au	Ag	As	Sb	Au	Ag
15	Final conc	9.5	2.67	145.83	15.09	2.33	64.3	81.4
	3rd cl tail	0.7	0.955	24.56			1.7	1.0
	2nd " "	1.7	0.52	15.57			2.2	1.6
	1st " "	19.9	0.235	5.165			11.9	6.0
	Flot "	68.2	0.115	2.495			19.9	10.0
	Head (calcd)	100.0	0.39	17.02			100.0	100.0
16	Final conc	8.6	2.76	164.0	15.63	2.45	63.0	83.7
	3rd cl tail	1.0	0.915	26.81			2.4	1.6
	2nd " "	3.6	0.36	7.95			3.4	1.7
	1st " "	25.8	0.195	3.835			13.3	5.6
	Flot "	61.0	0.11	2.06			17.9	7.4
	Head (calcd)	100.0	0.38	16.85			100.0	100.0

*From Internal Report MS-AC-68-392, 68-472.

Regrinding of Rougher Concentrate (Test 17)

In this test the ore was ground to 75% minus 200 mesh and was floated at the natural pH of 6.5. The rougher concentrate was reground, floated, and the concentrate was cleaned four times.

TABLE 16

Flotation Scheme Test 17

Operation	Time Min	% Solids	pH	Reagents - lb/ton		
				301	Z-6	P.O.
Grind	26.5	65		0.10	-	-
Condition	5	33	6.5	-	0.10	0.10
Flotation*	19			-	0.20	0.10
Regrind	10			0.05	0.05	-
1st cleaner	10		6.6		0.05	0.06
2nd "	5					
3rd "	2.5					
4th "	2					

*Reagents were stage added during rougher flotation.

TABLE 17

Results of Test 17

Product	Wt %	Assays*				Distn %	
		Au	Ag	As	Sb	Au	Ag
Final conc	8.7	2.78	158.25	16.25	2.45	66.5	81.7
4th cl tail	0.5	1.165	64.93			1.6	1.9
3rd " "	1.5	0.73	28.62			2.8	2.5
2nd " "	0.4	0.375	10.00			0.4	0.2
1st " "	25.0	0.175	4.02			12.0	6.0
Flot	63.9	0.095	2.025			16.7	7.7
Head (calcd)	100.0	0.36	16.84			100.0	100.0

*From Internal Report MS-AC-68-472.

Flotation at a Coarse Grind (Tests 18 and 19)

These tests were done to determine how the recovery of gold and silver would be affected by grinding the ore coarser than in previous tests. The tests were carried out at the natural pH of the ore. The rougher concentrate was cleaned three times.

TABLE 18

Flotation Scheme Tests 18 and 19

Test No.	Operation	Time Min	% Solids	pH	Fineness of Grind	Reagents - lb/ton		
						301	Z-6	P.O.
18	Grind	21	65		65% -200 mesh	0.10	-	-
19	Grind	16.5	65		55% -200 mesh	0.10	-	-
	Condition	5	35	6.5		-	0.10	-
	Flotation*	19				0.10	0.20	0.22
	1st cleaner	7.5		6.4				0.04
	2nd "	4						
	3rd "	2.5						

*Reagents were stage added during rougher flotation.

TABLE 19

Results of Tests 18 and 19

Test No.	Product	Wt %	Assays*		Distn %	
			Au	Ag	Au	Ag
18	Final conc	10.0	2.46	132.85	64.1	80.8
	3rd cl tail	0.6	1.248	46.58	2.0	1.7
	2nd " "	2.0	0.49	11.37	2.6	1.4
	1st " "	20.3	0.23	5.195	12.2	6.4
	Flot "	67.1	0.11	2.38	19.1	9.7
	Head (calcd)	100.0	0.38	16.44	100.0	100.0
19	Final conc	10.4	2.29	128.54	63.4	80.2
	3rd cl tail	0.7	1.17	31.25	2.2	1.3
	3nd " "	2.7	0.43	16.65	3.1	2.7
	1st " "	18.1	0.255	5.73	12.3	6.2
	Flot "	68.1	0.105	2.355	19.0	9.6
	Head (calcd)	100.0	0.38	16.68	100.0	100.0

*From Internal Report MS-AC-68-499.

Cyanidation of Flotation Tailing (Test 20)

The results of all of the preceeding tests show that the amount of gold and silver remaining in the flotation tailings is too high to be discarded.

Table 20 shows the results of cyanidation tests on the flotation tailings from Tests 15 and 16. For comparison purposes the results of cyanidation tests on the ore ground to the same fineness and cyanided for the same time are also shown in this table.

TABLE 20

Results of Cyanidation Tests on Ground Ore and on the Flotation Tailings from Tests 15 and 16

Feed	Grind % -200 m	Agitation time hr	Consumption lb/ton feed		Assays* oz/ton				Extraction** %	
					Feed		Residue			
			NaCN	CaO	Au	Ag	Au	Ag	Au	Ag
Ore	75	24	1.58	5.60	0.40	16.84	0.242	8.89	39.5	47.2
"	90	24	1.04	5.62	0.40	16.75	0.225	8.645	43.8	48.4
"	75	48	1.74	8.02	0.40	16.84	0.23	8.285	42.5	50.8
"	90	48	1.40	7.78	0.40	16.75	0.22	8.15	45.0	51.3
Flotation Tailing Tests 15 and 16										
15	75	24	0.56	2.40	0.115	2.495	0.04	0.92	65.2	63.1
15	75	48	0.94	8.30	0.115	2.495	0.04	0.90	65.2	63.9
16	90	24	0.50	7.62	0.11	2.06	0.04	0.965	63.6	53.2
16	90	48	1.62	8.14	0.11	2.06	0.04	0.82	63.6	60.2

*From Internal Report MS-AC-68-392, 68-396, 68-472.
**Calculated by difference.

Flotation and Cyanidation (Tests 21, 22, 23, and 24)

In Test 19 it was seen that sufficient liberation of the minerals to give an optimum recovery by flotation was achieved at a grind of about 55% minus 200 mesh. The following tests show that the gold and silver recovery increases with flotation time and the overall recovery is enhanced by the cyanidation of the flotation tailing. The results are contained in Table 20 and are presented graphically in Figure 7.

TABLE 21

Flotation Scheme - Tests 21, 22, 23 and 24

Test No.	Operation	Time Min	% Solids	pH	Reagents - lb/ton		
					301	Z-6	P.O.
all tests	Grind	16.5	65		0.10	-	-
21	Condition Flotation*	5 6	35	6.4	- -	0.10 -	- 0.12
22	Condition Flotation*	5 10	35	6.4	- 0.05	0.10 0.10	- 0.18
23	Condition Flotation*	5 15	35	6.4	- 0.10	0.10 0.20	- 0.24
24	Condition Flotation*	5 20	35	6.4	- 0.15	0.10 0.30	- 0.30

*Reagents were stage added during flotation.

Regrinding and Cleaning Stages

all tests	Regrind 1st cleaner 2nd " 3rd "	10 5 3 2			- - - -	0.05 - - -	- 0.04 - -

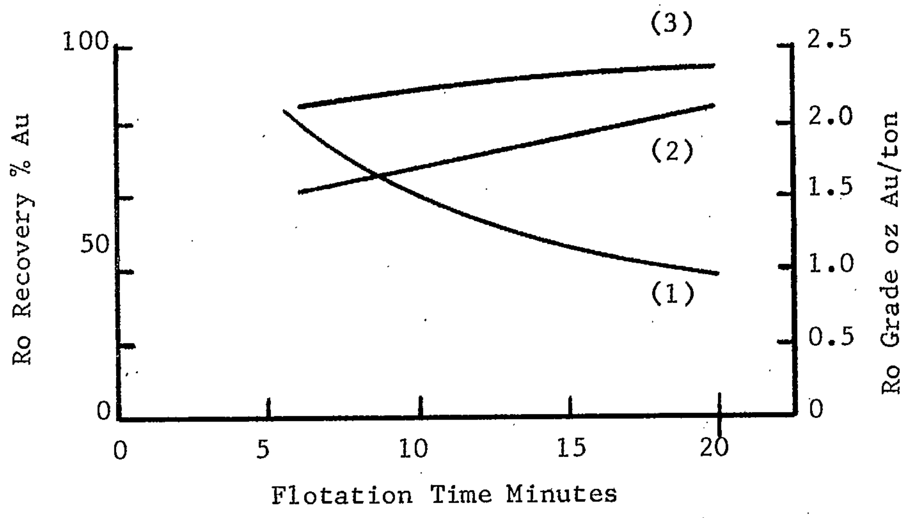
TABLE 22

Results of Tests 21, 22, 23 and 24

Test No.	Product	Wt %	Assays*		Distn %	
			Au	Ag	Au	Ag
21	Final conc	6.2	2.59	174.76	43.0	67.2
	3rd cl tail	0.6	2.08	38.51	4.5	1.4
	2nd " "	1.2	1.405	27.715	4.5	2.0
	1st " "	3.5	0.95	9.70	8.9	2.2
	Flot "	88.5	0.165	4.95	39.1	27.2
	Head (calcd)	100.0	0.37	16.17	100.0	100.0
	1. Ro conc	11.5	1.98	103.29	60.9	72.8
	2. Pregnant soln**		0.100	3.35	23.7	17.2
	Overall recovery (1 + 2)				84.6	90.0
22	Final conc	7.2	2.60	167.72	47.6	71.0
	3rd cl tail	0.7	1.58	47.60	2.8	2.0
	2nd " "	3.0	1.35	38.80	10.3	6.8
	1st " "	7.2	0.44	6.465	8.1	2.7
	Flot "	81.9	0.15	3.64	31.2	17.5
	Head (calcd)	100.0	0.39	17.01	100.0	100.0
	1. Ro conc	18.1	1.49	77.56	68.8	82.5
	2. Pregnant soln**		0.10	2.37	20.8	11.4
	Overall recovery (1 + 2)				89.6	93.9
23	Final conc	8.3	2.69	150.55	57.6	74.9
	3rd cl tail	0.8	0.56	37.57	1.2	1.8
	2nd " "	4.7	0.595	17.27	7.2	4.9
	1st " "	12.3	0.32	7.955	10.2	5.9
	Flot "	73.9	0.125	2.84	23.8	12.5
	Head (calcd)	100.0	0.39	16.68	100.0	100.0
	1. Ro conc	26.1	1.13	55.92	76.2	87.5
	2. Pregnant soln**		.085	1.80	16.2	7.9
	Overall recovery (1 + 2)				92.4	95.4
24	Final conc	8.2	2.88	154.29	59.8	75.2
	3rd cl tail	0.6	1.52	64.61	2.3	2.3
	2nd " "	2.8	0.70	28.08	5.0	4.7
	1st " "	26.5	0.245	6.325	16.4	10.0
	Flot "	61.9	0.105	2.145	16.5	7.8
	Head (calcd)	100.0	0.39	16.83	100.0	100.0
	1. Ro conc	28.1	1.17	51.61	83.5	92.2
	2. Pregnant soln**		0.070	9.120	11.0	4.2
	Overall recovery (1 + 2)				94.5	96.6

*From Internal Report MS-AC-68-536.

**Cyanidation - 24 hr at a dilution of 2:1 and a solution strength of 1.0 lb NaCN/ton and 1.0 lb CaO/ton, assays of pregnant soln calculated by difference.



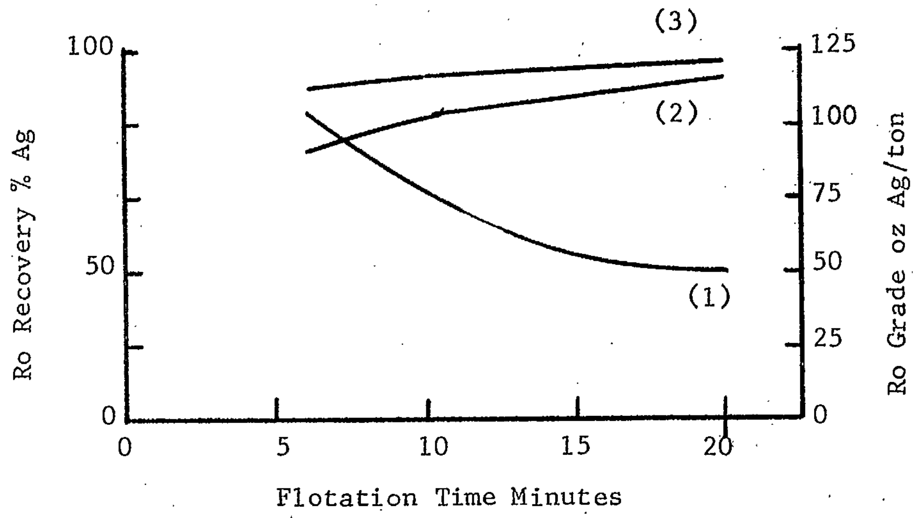


Figure 7. - Tests 21, 22, 23 and 24, Cumulative Rougher Recovery and Grade vs Flotation Time.
(1) Rougher concentrate grade oz/ton.
(2) Rougher recovery by flotation.
(3) Overall recovery by flotation and cyanidation of flotation tailing.

Flotation with Lower Reagent Additions (Test 25)

The optimum recovery of the gold and silver appears to occur at a grind of about 55% minus 200 mesh and a rougher flotation time of 20 minutes. A deliberate attempt was made in this test to reduce the amounts of flotation reagents which had been used in other tests. Additionally, Dowfroth 250 was substituted for pine oil. The results of this test, in which successive concentrates were removed at 1, 3, 6, 10, 15 and 20 minutes of flotation time are shown in the following tables and are graphically illustrated in Figure 8.

TABLE 23

Flotation Scheme Test 25

Operation	Time Min	% Solids	pH	Reagents - lb/ton		
				301	Z-6	D.F. 250
Grind	16.5	65		0.05	-	0.04
Flotation No. 1	1	35	6.5	-	-	0.02
" No. 2	2					
Condition	3			0.05	0.05	0.02
Flotation No. 3	3					
Condition	3			0.05	0.05	0.02
Flotation No. 4	4					
" No. 5	5					
Condition	3			0.05	0.05	0.04
Flotation No. 6	5					

TABLE 24

Results of Test 25

Product	Wt %	Assays*		Distn %	
		Au	Ag	Au	Ag
Flot conc No. 1	2.9	1.36	248.90	10.5	44.0
" " No. 2	3.2	1.60	108.73	13.6	21.2
" " No. 3	5.6	2.30	32.35	34.3	11.0
" " No. 4	5.3	0.71	17.60	10.1	5.7
" " No. 5	6.0	0.36	10.63	5.8	3.9
" " No. 6	5.0	0.28	8.30	3.7	2.5
Flot tail	72.0	0.115	2.665	22.0	11.7
Head (calcd)	100.0	0.38	16.41	100.0	100.0

*From Internal Report MS-AC-68-549.

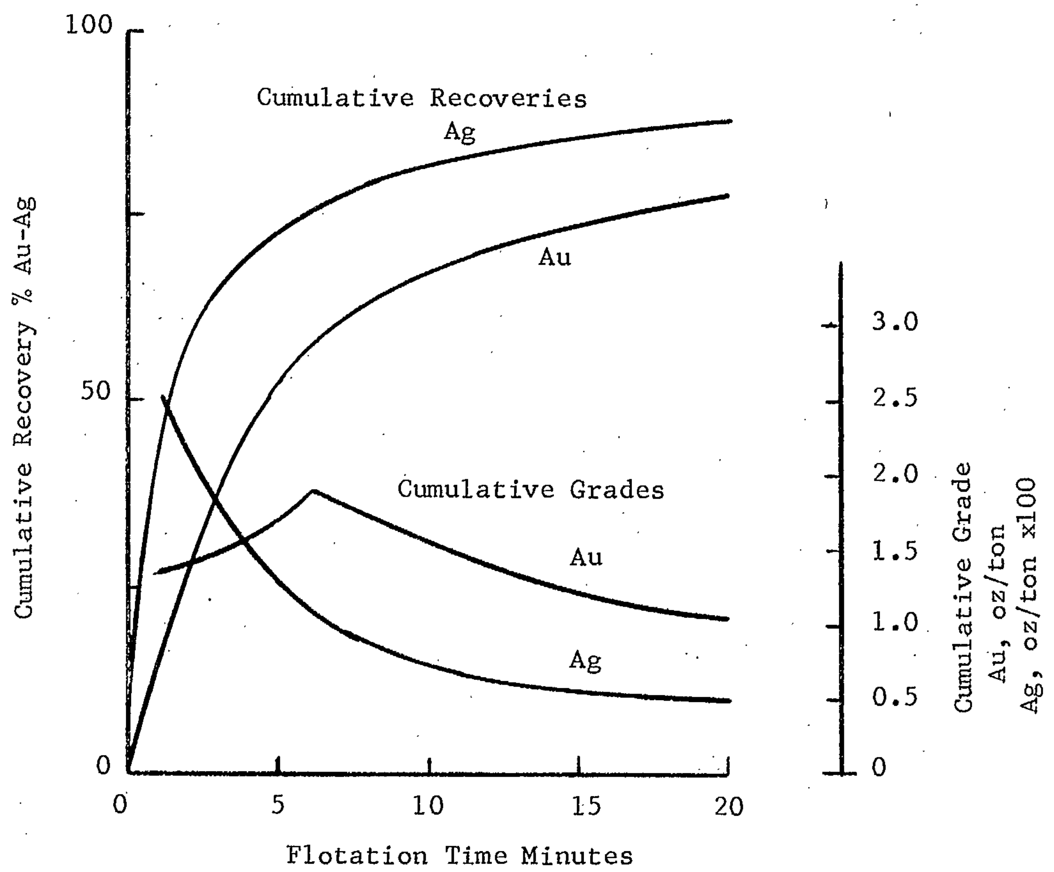


Figure 8. - Test 25, Cumulative Grades and Recoveries vs Flotation Time.

Flotation with Cyanide and Lime (Test 26)

In an operation involving flotation and cyanidation it is sometimes advantageous to grind in cyanide solution. This is particularly true where the gold particles are tarnished and slow-floating. In this particular test,cyanide and lime were added to the grind in anticipation of the cyanide acting to clean the mineral particles, thus making them more amenable to recovery by flotation.

The rougher concentrate in this test was reground and cleaned four times.

TABLE 25

Flotation Scheme Test 26

Operation	Time Min	% Solids	pH	Reagents - lb/ton				
				NaCN	CaO	301	Z-6	D.F. 250
Grind	16.5	65		1.0	1.0	-	-	-
Condition	5	35	8.4	-	-	0.05	-	0.06
Flotation*	20			-	-	0.10	0.30	0.08
Regrind	10			-	-	-	-	-
Condition	3		7.8	-	-	-	0.05	0.04
1st cleaner	8						0.05	0.02
2nd "	4		7.3					
3rd "	2		7.1					
4th "	2		6.8					

*Reagents were stage added during rougher flotation.

TABLE 26

Results of Test 26

Product	Wt %	Assays*		Distn %	
		Au	Ag	Au	Ag
Final conc	8.5	2.99	149.38	72.0	83.8
4th cl tail	0.5	1.49	55.72	2.0	1.8
3rd " "	1.2	0.71	17.14	2.4	1.4
2nd " "	3.5	0.38	8.87	3.8	2.0
1st " "	18.9	0.195	3.77	10.2	4.7
Flot "	67.4	0.05	1.41	9.6	6.3
Head (calcd)**	100.0	0.42	15.15	100.0	100.0

*From Internal Report MS-AC-68-565, 68-569.

**The filtrates from all of the flotation products were combined and assayed for gold and silver. Using 20 assay tons of filtrate only trace amounts of these elements were detected.

Cyanidation of Flotation Tailing (Test 26)

Samples of the rougher flotation tailing and of the 1st cleaner tailing were cyanided for 24 hours at a dilution of 2:1 and a solution strength of 1.0 NaCN/ton and 1.0 lb CaO/ton.

TABLE 27

Results of Cyanidation Test (Test 26)

Product	Consumption lb/ton feed		Assays oz/ton*				Extraction** %	
			Feed		Residue			
	NaCN	Cao	Au	Ag	Au	Ag	Au	Ag
Ro flot tail	1.0	2.1	0.05	1.41	0.03	0.625	40.0	55.7
1st cleaner tail	1.6	5.75	0.198	3.77	0.11	0.875	44.4	76.8

*From Internal Report MS-AC-68-573.
**Calculated by difference.

Cyanidation and Flotation (Test 27)

The preceding work has been concerned primarily with the flotation recovery of a saleable grade of concentrate. This method of treatment was augmented by the cyanidation of the rougher flotation tailing to ensure maximum recovery of the silver and gold. An alternative method of treatment was tried in which the ground ore was cyanided at a dilution of 2:1 for 24 hours and the cyanide residue was then subjected to flotation concentration, regrinding and cleaning.

The test procedure in this test is shown in Table 28.

TABLE 28

Cyanidation and Flotation Scheme Test 27

Operation	Time hr-min	% Solids	pH	Reagents lb/ton					
				NaCN	CaO	301	Z-6	$CuSO_4$	DF-250
Grind	26.5	65		1.0	1.0				
Cyanidation(1)	24	33		4.72	5.0				
Condition	12	35	10.1			0.05	0.05	1.0	
Flotation(2)	18					0.025	0.15		0.10
Regrind	10		9.1			0.02	0.02		
1st cleaner	8					0.025	0.025		0.02
2nd "	4								
3rd "	2								
4th "	2								

(1) The cyanide pulp was filtered and washed and the pregnant solution was reserved for assay. The L:S ratio of the pulp was 2:1.
(2) Reagents were stage added during rougher flotation.

The results of this test are shown in Table 29.

TABLE 29

Results of Test 27

Product	Wt %	Assays**		Distribution %	
		Au	Ag	Au	Ag
Pregnant solution*	-	0.102	2.654	43.2	33.0
Final concentrate	7.7	2.48	114.29	40.5	54.7
4th cl tailing	0.4	1.742	54.358	1.5	1.4
3rd " "	0.5	1.039	26.386	1.1	0.8
2nd " "	3.0	0.441	6.552	2.8	1.2
1st " "	23.2	0.11	1.845	5.4	2.7
Flotation tailing	65.2	0.04	1.53	5.5	6.2
Head (calcd)	100.0	0.472	16.08	100.0	100.0

*Assays expressed in oz per ton of solution.
**From Internal Report MS-AC-69.

Flotation and Cyanidation (Test 28)

Following the flotation scheme outlined in Table 22, 28000 grams of ore was ground and floated in two batches in a large Agitair cell. The rougher concentrates were combined, reground, and cleaned. This large amount of ore was used to obtain sufficient final concentrate for roasting tests.

The flotation tailing was sampled and cyanided in an open agitator for 48 hours at a dilution of 2:1 and a solution strength of 1.0 lb NaCN/ton and 1.0 lb CaO/ton.

TABLE 30

Results of Flotation and Cyanidation Test 28

Product	Wt %	Assays*		Distn %	
		Au	Ag	Au	Ag
Final conc	8.8	3.21	141.15	67.7	83.6
4th cl tail	1.3	0.615	14.89	1.9	1.3
3rd " "	2.3	0.415	8.83	2.3	1.4
2nd " "	4.2	0.425	9.085	4.3	2.6
1st " "	8.6	0.29	4.89	6.0	2.8
Flot "	74.8	0.10	1.59	17.8	8.3
Head (calcd)	100.0	0.42	14.85	100.0	100.0
Cyanide residue**		0.04	0.795	10.7	4.2
Overall recovery %				92.9	95.9

*From Internal Report MS-AC-68-769.
**Calculated by difference.

A complete analysis of the final concentrate in Test 28 was as follows.

TABLE 31

Analysis* of Final Concentrate Test 28

Gold (Au)	-	3.21 oz/ton
Silver (Ag)	-	141.15 " "
Arsenic (As)	-	16.86 per cent
Antimony (Sb)	-	2.10 " "
Lead (Pb)	-	6.40 " "
Zinc (Zn)	-	3.80 " "
Copper (Cu)	-	0.80 " "
Sulphur (Tot S)	-	26.94 " "
Insoluble	-	13.26 " "

*From Internal Report MS-AC-68-767.

Roasting (Tests 29, 30 and 31)

A series of roasting tests was carried out on samples of the concentrate produced in Test 28. In all of these tests a hairpin muffle-furnace was used. Rabbling of the charge was done by hand.

Test 29

A 100-gram charge was placed in the furnace which had been preheated to 300°C. The temperature was raised to 400°C with the door ajar, the fan on, and with intermittent rabbling. The temperature was held at 420°C until the As_2O_3 formed had disappeared. The temperature was then raised to 650°C and held for two hours during which time the charge was rabbled every five minutes. The charge was then withdrawn from the furnace and cooled. The roasting time was 5 hours.

Test 30

Test 29 was repeated. In this case the charge was removed from the furnace when the As_2O_3 formed had evolved. The roasting time was 2 hours.

Test 31

Test 29 was repeated. In this test the charge, after the evolution of the arsenic as As_2O_3, was held at a temperature of 650°C for 1 hour. The total roasting time was 3½ hours.

The calcines from these tests were weighed, screen tested, and analysed with results as shown in the following tables.

TABLE 32

Screen Tests on Concentrate and Calcines

Particle Size	Concentrate Test 28	Calcine Test 29	Calcine Test 30	Calcine Test 31
+48 mesh		4.3		
+65 "		6.7	2.6	2.9
+100 "	0.4	4.4	3.6	3.1
+150 "	2.6	8.8	6.8	8.4
+200 "	4.3	14.6	13.6	14.3
+325 "	23.8	25.9	28.2	24.6
-325 "	68.9	35.3	45.2	46.7
Total	100.0	100.0	100.0	100.0

TABLE 33

Analysis* of Concentrates and Calcines

Element	Concentrate Test 28	Calcine Test 29	Calcine Test 30	Calcine Test 31
	100	77.1	76.7	76.3
Au oz/ton	3.21	4.015	4.09	4.20
Ag " "	141.15	184.545	193.48	190.28
As per cent	16.86	3.54	4.08	3.21
Sb	2.10	1.86	1.68	1.74
Tot S " "	26.94	4.55	7.73	4.21
Sol S " "	-	3.28	1.53	2.38

*From Internal Report MS-AC-68-769.

Roasting (Test 32)

In order to obtain sufficient calcine for cyanidation tests, a 1000-gram charge of concentrate from Test 27 was roasted in a hairpin furnace at 200°C with excess air. The temperature was raised to 500°C with almost continuous rabbling. When the As_2O_3 had evolved, the temperature was raised to 750°C with limited air, rabbling every five minutes, and held at that temperature for ½ hour. The roasting time was four hours.

Roasting (Test 33)

The roasting procedure outlined above was repeated with a 200-gram charge in which 20 grams of salt had been mixed.

The results of these two tests were as follows:

TABLE 34

Analysis* of Concentrate and Calcines

Element	Concentrate	Calcine Test 32	Calcine Test 33
Au oz/ton	3.21	4.39	3.66
Ag " "	141.15	198.88	172.11
As per cent	16.86	1.52	1.77
Sb " "	2.10	1.16	0.99
Tot S " "	26.94	2.0	4.0
Weight loss in calcines		28%	20%

TABLE 35

Results of Cyanidation Tests on Ground Concentrate and Calcine from Tests 28, 32 and 33

Charge	Reagents to Grind lb/ton charge				Cyanidation Conditions: Solution Strength lb/ton Sol		Cyanidation Conditions: Reagent Consumption lb/ton charge		Assays, oz/ton: Charge		Assays, oz/ton: Residue*		Extraction** %	
	NaCN	CaO	NaCl	PbO	NaCN	CaO	NaCN	CaO	Au	Ag	Au	Ag	Au	Ag
Conc (Test 28)	-	-	-	-	5.0	1.0	35.8	59.4	3.21	141.15	2.38	97.60	25.8	30.8
Calcine (Test 32)	-	-	-	-	"	"	42.0	108.0	4.39	198.88	3.57	136.46	18.7	31.4
"	-	-	10	-	"	"	40.0	100.0	"	"	3.96	184.24	9.8	7.4
"	0.25	-	-	-	"	"	36.0	78.0	"	"	2.685	130.76	38.8	34.2
"	-	-	-	0.05	"	"	40.0	100.0	"	"	3.42	142.35	22.1	28.4
"	0.25	-	-	0.05	"	"	40.0	100.0	"	"	2.54	125.92	42.1	36.7
"	-	0.25	-	-	"	"	38.0	100.0	"	"	3.42	135.10	22.1	32.1
Calcine (Test 33)	-	-	-	-	"	"	56.0	100.8	3.66	172.11	2.94	49.36	19.7	71.3

*From Internal Report MS-AC-68-818.
**Calculated by difference.

Note: Grinding time was 20 minutes resulting in a grind of 99.1% minus 200 mesh. Dilution was 20% solids and the cyanidation time was 48 hours.

Roasting and Cyanidation Test 34

A second series of roasting and cyanidation tests was carried out. As in Test 28, a 28000-gram sample of minus 10-mesh ore was ground and floated. The final gold-silver concentrate assayed as follows:

TABLE 36

Analysis* of Roaster Feed

Silver (Ag)	158.69	oz/ton
Gold (Au)	3.372	" "
Arsenic (As)	17.43	per cent
Antimony (Sb)	1.64	" "
Iron (sol Fe)	29.49	" "
Sulphur (tot S)	28.56	" "

*From Internal Report MS-AC-70-102 and 70-138

The roasting tests were done in a large ceramic tray in a hairpin muffle furnace. The door of this furnace was opened sufficiently throughout the tests to permit almost continuous rabbling of the charge and, with the exhaust fan on, a sweep of air was provided over the surface of the charge. In an attempt to overcome the detrimental effect of antimony on cyanidation, varying amounts of salt (NaCl) were mixed into the charges. The roasting conditions and the results are shown in Table 37. The results obtained from cyaniding the calcines are shown in Table 38.

TABLE 37

Roasting Conditions and Results Test 34

Test No.	Weight in grams			Weight Loss %	Time at Temp °C, min				Total time		Remarks
	charge	NaCl	calcine		450	550	650	750	hr	min	
34	200	concentrate		-	-	-	-	-	-	-	
34-1	"	10	143	31.9	55	-	-	-	2	15	after As_2O_3 evolution
34-2	"	0	141	29.5	55	-	-	-	2	15	raise temp to 750°C and
34-3	"	20	153	30.4	70	-	-	-	2	30	then pull charge
34-4	"	10	149	32.7	55	-	35	-	2	50	Same as above except hold
34-5	"	0	146	27.0	55	-	35	-	2	35	at 650°C then raise to 750°C
34-6	"	20	148	32.7	60	-	80	-	3	20	and pull charge
34-7	"	10	144	31.4	55	60	-	-	2	25	raise to 550°C - 1 hr - pull
34-8	"	10	142	32.4	55	-	60	-	2	45	NaCl added after As_2O_3

Test No.	Calcine Analysis*						Gold-Silver Balance			
	oz/ton		Per cent				Units		% Gain(+) % Loss(-)	
	Au	Ag	As	Sb	Sol Fe	Tot S	Au	Ag	Au	Ag
34	3.372	158.69	17.43	1.64	29.49	28.56	674	31738	0	0
34-1	3.88	181.62	1.48	0.89	38.70	3.26	555	25972	-17.7	-18.2
34-2	4.76	220.40	1.52	1.04	40.14	2.57	671	31076	-0.5	-2.1
34-3	3.34	214.10	1.44	0.92	38.44	3.35	511	32757	-24.2	+3.2
34-4	3.65	176.05	1.48	0.86	39.68	3.06	544	26231	-19.3	-17.4
34-5	4.76	213.40	1.63	1.13	40.25	2.26	695	31156	+3.1	-2.9
34-6	2.18	166.75	1.48	0.86	39.22	3.90	323	24679	-52.1	-22.3
34-7	4.47	225.67	0.96	1.11	39.10	2.66	644	32496	-4.5	+2.4
34-8	3.20	195.35	0.97	1.49	40.52	2.63	454	27740	-32.7	-12.6

*From Internal Report MS-AC-70-143, 70-158, 70-214, 70-216.

TABLE 38

Test Conditions and Results of Cyanidation of Calcines

Test No.	Weight in grams		Weight Loss %	Grind min	Dilution w/s	Agitation Time hr	Reagents			
							Soln Strength lb/ton		Consumption lb/ton	
	Calcine	Residue					NaCN	CaO	NaCN	CaO
34-1	100	87.4	12.6	20	5/1	48	2.0	1.0	24.0	27.0
34-2	"	92.6	7.4	"	"	"	"	"	41.0	30.0
34-3	"	82.8	17.2	"	"	"	"	"	23.6	14.0
34-4	"	87.7	12.3	"	"	"	"	"	15.0	23.0
34-5	"	92.8	7.2	"	"	"	"	"	41.5	30.0
34-6	"	84.1	15.9	"	"	"	"	"	16.0	15.0
34-7	"	89.0	11.0	"	"	"	"	"	16.8	22.0
34-8	"	88.0	12.0	"	"	"	"	"	18.1	19.6

Test No.	Cyanide Residue Analysis*						Weight Loss Correction		Extraction %	
	oz/ton		per cent							
	Au	Ag	As	Sb	Sol Fe	Tot S	Au	Ag	Au	Ag
34-1	3.095	40.98	1.48	0.89	38.70	3.26	2.705	35.82	30.3	80.3
34-2	2.025	94.405	1.52	1.04	40.14	2.57	1.875	87.419	60.6	60.3
34-3	1.28	10.125	1.44	0.92	38.44	3.35	1.06	8.383	68.3	96.0
34-4	3.125	37.545	1.48	0.86	39.68	3.06	2.741	32.927	24.9	81.3
34-5	1.97	122.06	1.63	1.13	40.25	2.26	1.83	113.83	61.6	46.7
34-6	1.605	23.415	1.48	0.86	39.22	3.90	1.35	19.692	38.1	88.2
34-7	2.84	37.33	1.46	1.62	42.53	1.21	2.53	33.22	43.4	85.3
34-8	2.38	18.02	1.10	1.65	45.77	0.25	2.10	15.86	34.4	91.9

*From Internal Reports MS-AC-70-158, 70-160, 70-214, 70-216.

CONCLUSIONS AND DISCUSSION

Electrum, an alloy of gold and silver was identified in the ore using an electron probe analyzer and was the only gold-bearing mineral found in the ore.

An assessment of the results of all of the tests indicates that the final flowsheet should include a combination of flotation and cyanidation.

The optimum flotation recovery of the gold and silver was obtained at a grind of between 55% and 60% minus 200 mesh and a flotation time of 20 minutes. When this was augmented by the cyanidation of the rougher flotation tailing an overall recovery of about 94% and 96% of the gold and silver respectively was obtained. The results of such a treatment are illustrated in Figure 7, in which the recoveries and the concentrate grades, of Tests 21 to 24 inclusive, for gold and silver are plotted against the flotation time. The top line in each graph represents the overall recovery after the cyanidation of the flotation tailing. In Test 24 (Table 22), a rougher flotation recovery of 83.5% of the gold and 92.2% of the silver was obtained. Cyanidation of the flotation tailing increased the recovery to 94.5% and 96.6% of the gold and silver respectively. Almost identical flotation results were obtained in Test 25 (Table 24) in which drastically reduced amounts of reagents were used. The rougher concentrates are of course rather low grade and the necessary flotation cleaning stages required to increase the concentrate grades to marketable levels result in reduced recoveries in the final concentrate.

An alternative method of treatment involves the cyanidation of the ground ore followed by washing, repulping, and the flotation of the cyanide residue. For comparison purposes, a summary of the results of the two methods of treatment are shown in the following Table. In Test 26 flotation was followed by cyanidation and in Test 27 cyanidation was followed by flotation. In each test the final concentrate was obtained after four cleaner stages.

TABLE 39

Comparison of Final Recoveries Test 26 and Test 27

	Recovery %	Au	Ag
Test 26	Final flot conc	72.0	83.8
	Cyanidation of Ro flot tailing	3.8	3.5
	Total	75.8	87.3
Test 27	Cyanidation of ore	43.2	33.0
	Final flot conc	40.5	54.7
	Total	83.7	87.7

A large number of roasting tests were done with and without the addition of salt. In every case a weight loss of about 30% resulted because the arsenic, antimony, and sulphur were volatilized. The operating conditions and the results of the roasting tests detailed in Table 37 show that when salt is used during roasting large losses of gold and silver occur. Great care was taken during roasting to avoid mechanical losses and this leads to the conclusion that gold and silver chloride which are formed during the roasting are volatilized. The largest contributing factor to these losses appears to be the amount of salt added rather than the temperature of the roast.

Cyanidation of the ore ground as fine as 90% minus 200 mesh (Table 20) yielded extractions of only 45% of the gold and 51% of the silver. Extractions were much lower when a concentrate was cyanided (Table 35). In Table 38 in which the results of the cyanidation tests on the calcines produced in Test 34 are tabulated, poor extraction of the gold and silver was obtained. These figures become much worse when one considers the large gold and silver losses which occurred during roasting.

The results of the investigation indicate that neither cyanidation of a concentrate nor roasting followed by cyanidation of a concentrate would be economically feasible. The flowsheet for the treatment of this ore should be one in which a marketable flotation concentrate is produced. This process should include a cyanidation circuit either before or after flotation to provide maximum recovery of the gold and silver.

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