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CYANIDATION TESTS ON A SAMPLE OF
GOLD-SILVER ORE
submitted by
NEWMONT MINING CORPORATION
OF CANADA LTD.
Progress Report No.1

Our Project No: B196

Date: September 10, 1968

Investigation by: Britton Research Limited,
Consulting Metallurgist,

1612 West 3rd Avenue,
Vancouver B.C. V6J 1K1

INTRODUCTION

A 16 pound sample of gold-silver ore was received from Mr. J. Livermore, on behalf of Newmont Mining Corporation of Canada Limited, on August 21, 1968, with a request for cyanidation tests to be carried out on the sample.

SUMMARY AND CONCLUSIONS

1. The head sample assayed 0.20 ounces of gold and 2.57 ounces of silver per short ton.
2. Three cyanidation tests were carried out on the sample at varying degrees of fineness. In each test the ore was agitated for three successive periods of 24 hours, using a fresh cyanide solution for each stage.
3. Results are summarised in the following table:

<u>Test No.</u>	<u>Grind % -200 mesh</u>	<u>Cyan. period Hours (total)</u>	<u>Extraction %</u>		<u>Reagent consumption</u>	
			<u>Gold</u>	<u>Silver</u>	<u>Lb/ton of ore</u>	
					<u>NaCN</u>	<u>CaO</u>
C1	23	24	61.8	64.1	0.44	1.4
"	"	48	66.9	69.4	0.72	2.4
"	"	72	69.9	72.3	0.90	3.0
C2	64	24	96.2	88.7	0.50	2.4
"	"	48	97.6	89.9	0.92	2.9
"	"	72	97.9	90.3	1.20	3.4
C3	89	24	97.4	91.7	0.38	2.3
"	"	48	98.1	93.5	0.70	3.0
"	"	72	98.6	93.8	0.82	3.5

4. Test C1 was carried out on ore which had only been crushed to minus 10 mesh; only 69.9% of the gold and 72.3% of the silver were extracted in 72 hours. In test C2 the ore was ground in a ball mill for 15 minutes prior to thickening and cyanidation of the thickened pulp. A high extraction of the gold (96.2%) and a fairly high extraction of the silver (88.7%) were obtained in 24 hours.

A further 24 hours treatment increased the gold and silver recoveries by 1.4% and 1.2% respectively but an additional 24 hours treatment gave an almost negligible improvement. After grinding for 30 minutes (test C3) the gold and silver recoveries in 24 hours increased to 97.4% and 91.7% respectively.

5. Some of the silver was refractory to cyanidation; it is probable that fresh ore would contain a higher proportion of refractory silver. If this is the case, flotation of the gold and silver, followed by cyanidation of the tailing if necessary, may prove to be the best method of treatment.

6. The cyanide and lime consumptions were moderate and the cyanide solutions contained relatively small amounts of copper.

Respectfully submitted,
BRITTON RESEARCH LIMITED

John W. Britton, P. Eng.

John W. Britton, P. Eng.,
Consulting Metallurgist

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DETAILS OF TESTS

The whole of the sample was crushed to minus 10 mesh and mixed thoroughly before riffing to give samples suitable for test work and assay.

The first cyanidation test (C1) was carried out on the minus 10 mesh ore, using a 1000 gram sample, which was agitated in a bottle on rollers at a pulp density of 40% solids, at room temperature (approx. 20°C). Sodium cyanide (8 pounds per ton of ore) and calcium hydroxide (equivalent to 4 pounds CaO per ton of ore) were added at the start. After 24 hours agitation, the pulp was filtered and the residue was washed and retreated for 24 hours, the cyanide and lime additions being reduced to 6 and 2 pounds per ton respectively. After again filtering and washing, the residue was retreated under the same conditions for 24 hours. The final residue and the three filtrates were assayed for gold, silver, copper, cyanide and lime. Results are shown in tables 1 and 2; the screen analysis of the residue is given in table 7.

In test C2, a 1000 gram sample of minus 10 mesh ore was ground in a ball mill for 15 minutes at 60% solids, lime equivalent to 4 pounds CaO per ton being added before grinding. The mill used for grinding had previously been standardised, using ores of known grindability; the power required for grinding to the same fineness in a full scale mill could therefore be calculated (10 K.W.H. per short ton from minus 10 mesh).

The pulp was thickened and cyanided for 24 hours under the same conditions as in test C1, except that the lime addition was reduced to 2 pounds per ton. The remainder of the test was carried out under the same conditions as in test C1. Results are shown in tables 3 and 4.

In test C3, conditions were similar to those used in test C2 except that the grinding time was increased to 30 minutes, equivalent to about 20 K.W.H. per ton of ore. Results are shown in tables 5 and 6.

Comments: As expected, relatively low extractions of the gold (69.9% in 72 hours) and silver (72.3% in 72 hours) were obtained on the minus 10 mesh ore, but grinding to 64% minus 200 mesh gave a high extraction of the gold (96.2% in 24 hours) and a fairly high extraction of the silver (88.7% in 24 hours). Grinding to 89% minus 200 mesh increased the gold and silver extractions in 24 hours by 1.2% and 3.0% respectively. The cyanide and lime consumptions were not excessive and the solutions had fairly low copper contents (less than the silver assays), although some malachite was observed in the ore. Owing to the clay present, filtration was fairly slow and the use of counter-current decantation might be required in practice.

It should be noted that part of the silver was refractory to cyanidation, even after fine grinding and prolonged treatment. It is possible that this silver is associated with a sulphide mineral such as galena and that the proportion of such refractory silver would tend to increase if fresh ore was treated. Tests should therefore be carried out on samples taken below the zone of oxidation. As an alternative to cyanidation, flotation or a combination of flotation and cyanidation, should also be investigated, especially if the proportion of refractory silver tends to increase with depth.

Cyanidation test on gold and silver ore

Test 196-C1

Grind: 100% -10 mesh, 23% -200 mesh; 19% -325 mesh

Table 1

Metallurgical results

#	Product	Cyan. time-		Amount	Au	Assays		Cu	Distribution %			
		Hours	Ind. Cum.			Ag	Au		Ag	Ind.	Cum.	Ind.
1	1st cyan.filtrate*	24	24	3.0 liter	1.40 mg/l	19.24 mg/l	0.016 g/l	61.8	61.8	64.1	69.1	69.1
2	2nd " "	* 24	48	2.5 "	0.14 "	1.92 "	0.003 "	5.1	66.9	5.3	69.4	69.4
3	3rd " "	* 24	72	2.5 "	0.08 "	1.02 "	0.002 "	3.0	69.9	2.9	72.3	72.3
4	Final residue	-	-	99.75%	0.06 oz/ton	0.73 oz/ton	N.A.	30.1	100.0	27.7	100.0	100.0
5	Head (calculated)	-	-	100.00%	0.20 oz/ton	2.63 oz/ton	N.A.	100.0	100.0	100.0	100.0	100.0
5	Head (direct assays)	-	-	-	0.20 oz/ton	2.57 oz/ton	N.A.	-	-	-	-	-

*Including washes.

N.A. = Not assayed.

Table 2

Cyanide and lime consumptions

Cyan. period	Cyanidation period -		Sodium cyanide				Lime			
	Hours		Lb. 100% NaCN/ton of ore		Lb. 100% CaO/ton of ore		Lb. 100% CaO/ton of ore		Lb. 100% CaO/ton of ore	
	Ind	Cum.	Added	Consumed	Added	Consumed	Added	Consumed	Added	Consumed
1st	24	24	7.76	7.76	0.44	0.44	4.00	4.00	1.42	1.42
2nd	24	48	5.82	13.58	0.28	0.72	2.00	6.00	1.00	2.42
3rd	24	72	5.82	19.40	0.18	0.90	2.00	8.00	0.60	3.02
Total	-	-	19.40	19.40	0.90	0.90	8.00	8.00	3.02	3.02

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Cyanidation test on gold and silver ore

Test 196-C2

Grind: 64% -200 mesh, 47% -325 mesh

Table 3

Metallurgical results

#	Product	Cyan. time -		Amount	Au	Assays		Cu	Distribution %			
		Hours	Ind. Cum.			Au	Ag		Au		Ag	
		Ind.	Cum.						Ind.	Cum.	Ind.	Cum.
1	1st cyan. filtrate*	24	24	3.0 liter	2.18 mg/l	27.16 mg/l	0.017 g/l	96.2	96.2	88.7	88.7	
2	2nd " " *	24	48	2.5 "	0.04 "	0.46 "	0.003 "	1.4	97.6	1.2	89.9	
3	3rd " " *	24	72	2.5 "	0.006 "	0.14 "	0.001 "	0.3	97.9	0.4	90.3	
4	Final residue	--	--	100.07%	0.004 oz/ton	0.26 oz/ton	N.A.	2.1	100.0	9.7	100.0	
5	Head (calculated)	--	--	100.00%	0.20 oz/ton	2.68 oz/ton	N.A.	100.0	100.0	100.0	100.0	
5	Head (direct assays)				0.20 oz/ton	2.57 oz/ton	N.A.					

*Including washes.

N.A. = Not assayed.

Table 4

Cyanide and lime consumptions

Cyan. period	Cyanidation period -		Sodium cyanide				Lime			
	Hours	Ind. Cum.	Lb. 100% NaCN/ton of ore Added		Consumed		Lb. 100% CaO/ton of ore Added		Consumed	
	Ind.	Cum.	Ind.	Cum.	Ind.	Cum.	Ind.	Cum.	Ind.	Cum.
Grind	--	--	--	--	--	--	4.00	4.00	/	/
1st	24	24	7.76	7.76	0.50	0.50	2.00	6.00	2.42	2.42
2nd	24	48	5.82	13.58	0.42	0.92	2.00	8.00	0.50	2.92
3rd	24	72	5.82	19.40	0.28	1.20	2.00	10.00	0.46	3.38
Total	--	--	19.40	19.40	1.20	1.20	10.00	100.0	3.38	3.38

/ Including CaO added to grind.

Cyanidation test on gold and silver ore

Test 196-C3

Grind: 89% -200 mesh, 68% -325 mesh

Table 5

Metallurgical results

#	Product	Cyan. time -		Amount	Au	Assays		Cu	Distribution %				
		Hours	Ind. Cum.			Ag			Au	Ag	Ind.	Cum.	
1	1st cyan.filtrate*	24	24	3.0 liter	2.26 mg/l	27.08 mg/l	0.016 g/l	97.4	97.4	91.7	91.7		
2	2nd " "	* 24	48	2.5 "	0.02 "	0.64 "	0.003 "	0.7	98.1	1.8	93.5		
3	3rd " "	* 24	72	2.5 "	0.01 "	0.10 "	0.001 "	0.5	98.6	0.3	93.8		
4	Final residue	-	-	100.27%	0.003 oz/ton	0.16 oz/ton	N.A.	1.4	100.0	6.2	100.0		
5	Head (calculated)	-	-	100.00%	0.20 oz/ton	2.58 oz/ton	N.A.	100.0	100.0	100.0	100.0		
5	Head (direct assays)				0.20 oz/ton	2.57 oz/ton	N.A.						

*Including washes.

N.A. = Not assayed.

Table 6

Cyanide and lime consumptions

Cyan. period	Cyanidation period -		Sodium cyanide				Lime			
	Hours	Ind. Cum.	Lb. 100% NaCN/ton of ore		Lb. 100% caO/ton of ore		Lb. 100% caO/ton of ore		Lb. 100% caO/ton of ore	
	Ind.	Cum.	Added	Cum.	Consumed	Added	Cum.	Consumed	Added	Cum.
Grind	-	-	-	-	-	-	-	-	4.00	4.00
1st	24	24	7.76	7.76	0.38	0.38	2.00	6.00	2.30/	2.30/
2nd	24	48	5.82	13.58	0.32	0.70	2.00	8.00	0.70	3.00
3rd	24	72	5.82	19.40	0.12	0.82	2.00	10.00	0.50	3.50
Total	-	-	19.40	19.40	0.82	0.82	10.00	10.00	3.50	3.50

/ Including CaO added to grind

Screen analyses of cyanidation residues

Table 7

Mesh (Tyler)	Test 196-C1 residue			Test 196-C2 residue			Test 196-C3 residue		
	% retained Ind.	% passing Cum.	% passing Cum.	% retained Ind.	% passing Cum.	% passing Cum.	% retained Ind.	% passing Cum.	% passing Cum.
10	-	-	100.0	-	-	100.0	-	-	100.0
14	15.8	15.8	84.2	0.1	0.1	99.9	-	-	100.0
20	13.4	29.2	70.8	-	0.1	99.9	-	-	100.0
28	13.9	43.1	56.9	0.1	0.2	99.8	-	-	100.0
35	8.2	51.3	48.7	0.1	0.3	99.7	-	-	100.0
48	7.5	58.8	41.2	0.3	0.6	99.4	0.1	0.1	99.9
65	5.4	64.2	35.8	1.2	1.8	98.2	-	0.1	99.9
100	5.7	69.9	30.1	10.5	12.3	87.7	0.2	0.3	99.7
150	3.7	73.6	26.4	11.6	23.9	76.1	2.7	3.0	97.0
200	3.3	76.9	23.1	12.4	36.3	63.7	8.1	11.1	88.9
+ 325	4.0	80.9	19.1	17.0	53.3	46.7	20.7	31.8	68.2
- 325	19.1	100.0	-	46.7	100.0	-	68.2	100.0	-
Total	100.0	100.0	-	100.0	100.0	-	100.0	100.0	-

Note: Test 196-C1 was carried out on ore which had been crushed to minus 10 mesh but not ground.

Test 196-C2 was carried out on ore which had been ground in a ball mill at 60% solids (1000 grams for 15 minutes).

Test 196-C3 was similar to test 196-C2 but the grinding time was increased to 30 minutes.

Siliceous Ore Settlement - Final



APPENDIX B

Our Serial No. 9573-C
 In Account with DUSTY MAC MINES LTD.
 c/o CANNON-HICKS ASSOCIATES LTD.
 744 W. HASTINGS ST.
 VANCOUVER, B.C.

Trail, B.C. OCTOBER 1, 19 69

For Siliceous Ore Lot No. 1 Car No. 2 trucks Received Sept. 8th

Freight Value \$ Freight Rate \$

Scale Weight			Weight of Shipment				.9% H ₂ O	Net Dry Wt.	Dry Tons
Gross	Tare	Net	Gross	No. Sacks	Wt of Sacks	Net Wet Wt.			
lbs.	lbs.	lbs.	lbs.		lbs.	lbs.	lbs.	lbs.	
						53,710	483	53,227	26.6135

Assays										
Gold	Silver	Wet Lead	Zinc	Sulphur	Silica	Iron	Lime	Arsenic	Alumina	Antimony
oz. per dry ton	oz. per dry ton	%	%	%	%	%	%	%	%	%
	1.1	.2	.1	.1	75.5	2.2	.4	.1	11.4	.1

Average Quotations

Week Ending Sept. 20, 19 69 Exchange

London Final Price \$						Less \$1.25	Net \$	oz.
New York Price \$ 1.784				@ 7.78122		Less .04	Net \$ 1.88282	oz.
New York Price \$	C. lb.					Less	C. Net	C. lb.
St. Louis Price \$	C. lb.					Less	C. Net	C. lb.

Contents and Value

Contents	Contents Paid for	Net Quotation	Value
29.27 Ozs. Gold	%	ozs. @ \$	\$
Oz. Silver	26.61 lbs. M.D.	2.66 ozs. @ \$ 1.88282	/oz. 5.01
Lbs. Lead	%	lbs. @	C./lb.
Lbs. Zinc	%	lbs. @	C./lb.

Add:	\$ 5.01
* Credit @ \$	16.16 Dr
Less:	Total Gross Value \$ 11.15 Dr
Trucking	
Switching	
Freight	
	\$ 11.15 Dr

Less % Royalty on \$ to

Silica		\$ 11.15 Dr
CREDIT	\$3.50 Cr	
Dr. Alumina	11.4 @ .15	1.71 *
Dr. Iron Fe ₂ O ₃	2.2 x 1.43	3.1 @ .15
Dr. Lead as Pb 5	.2 x 1.15	.2 @ .15
Zinc as Zn 5	.1 x 1.49	.1 @ .15
Arsenic		
Dr. Moisture		
Dr. Handling	Truck	.75

Treatment base .52 x 26.6135 = 13.84 Cr
 Breaking lumps 30.00
 16.16 Dr

Siliceous Ore Settlement - Final



Our Serial No. 237-C
 In Account with Dusty Mac Mines Ltd.
 c/o Cannon-Hicks Associates Ltd.
 744 W. Hastings St.
 Vancouver, B.C.

Trail, B.C. Jan. 15, 1970

For siliceous ore Lot No. 2 Car No. CP 358405 Received Dec. 12/69

Freight Value \$ 64.04 per W.T.
 Freight Rate \$ 13.08

Scale Weight			Weight of Shipment						
Gross	Tare	Net	Gross	No. Sacks	Wt of Sacks	Net Wet Wt.	% H ₂ O	Net Dry Wt.	Dry Tons
214,160	48,340	165,820				165,820	3.5	160,016	80.008
lbs.	lbs.	lbs.	lbs.		lbs.	lbs.	lbs.	lbs.	

Assays										
Gold	Silver	Wet Lead	Zinc	Sulphur	Silica	Iron	Lime	Arsenic	Alumina	Antimony
.904	19.4	.2	.3	.2	85.9	1.8	.4	.1	5.9	.1
oz. per dry ton	oz. per dry ton	%	%	%	%	%	%	%	%	%

Average Quotations										
Week Ending	Dec. 20, 1969				Exchange					

Gold	London Final Price	\$ 35.052	@	7.425	Less \$1.25	Net \$36.40461	oz.
Silver	New York Price	\$ 1.745	"		Less \$0.04	Net \$ 1.83457	oz.
Lead	New York Price	\$	C. lb.		Less	C. Net	C. lb.
Zinc "PW"	St. Louis Price	\$	C. lb.		Less	C. Net	C. lb.

Contents and Value							
Contents		Contents Paid for			Net Quotation		Value
72.327	Ozs. Gold	95	%	68.711	ozs. @ \$	36.40461 /oz.	\$ 2,501.40
1,552.16	Oz. Silver	80.01 oz.	%	1,472.15	ozs. @ \$	1.83457 /oz.	2,700.76
	Lbs. Lead		%		lbs. @	C./lb.	
	Lbs. Zinc		%		lbs. @	C./lb.	

* Treatment base \$2.13 Cr. x 80.008 = \$170.42*
 Breaking lumps 63.00
 Cr. \$107.42

Add: Details Below
 Credit @ \$ Total Gross Value \$ 5,309.58
 Less: Trucking
 Switching
 Freight \$13.08 x 82.91

Less % Royalty on \$ to \$ 4,225.12

Silica	
CREDIT	\$3.50
Dr. Alumina 5.9 @ \$.15	.89
Dr. Iron Fe ₂ O ₃ 1.8 x 1.43 = 2.6 @ \$.15	.39
Dr. Lead as Pb 5 .2 x 1.15 = .2 @ \$.15	.03
Dr. Zinc as Zn 5 .3 x 1.49 = .4 @ \$.15	.06
Dr. Arsenic	
Dr. Moisture	
Dr. Extra Handling	

Cost per Dry Ton \$ 2.13 Cr. /ag