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Ottawa, July 9, 1946.

R E P O R T

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 2075.

Summary of Amalgamation, Flotation and Cyanidation Tests on Five Samples of Gold Ore from the Kenville Gold Mines Limited, Nelson, B.C.

Note:
This report relates essentially to the samples as receive It shall not, nor any correspond ence connected therewith, be use in part or in full as publicity or advertising matter for the sa of shares in any promotion.

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BUREAU OF MINES
DIVISION OF METALLIC MINERALS
ORE DRESSING AND
METALLURGICAL LABORATORIES

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MINES AND GEOLOGY BRANCH

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Shipment:

Samples of ore, representing five different veins, were received on May 21, 1946, from the Kenville Gold Mines Limited, P.O. Box 390, Nelson, B.C., per Mr. John Black. The markings and weights of the different samples are tabulated below:

Sample No.	Weight, in Pounds.
G	286
H	324
M	302
P	292
Y	290

Purpose of Tests:

In a letter dated April 16, 1946, Mr. Black requested preliminary examination and routine ore dressing testing of the samples.

Location of Property:

The samples came from the property of the Kenville Gold Mines Limited whose properties are located in the Nelson mining district of British Columbia.

Sampling and Analysis:

The samples were crushed, sampled, and assayed by standard methods. The results are tabulated below:

	G	H	M	P	Y
Gold, oz./ton	0.23	0.51	0.23	0.23	0.36
Silver, oz./ton	0.17	0.38	0.14	0.23	0.34
Copper, per cent	0.05	0.18	0.26	0.05	0.07
Zinc, "	0.08	0.08	0.08	0.05	0.05
Lead, "	N.d.	N.d.	N.d.	N.d.	N.d.
Iron, "	3.53	3.93	4.54	2.92	4.13
WO_3, "	-	N.d.	-	-	-
Sulphur, "	1.73	2.58	2.80	1.45	1.58
Insoluble, "	86.76	81.52	79.30	84.60	81.14

A composite sample, consisting of equal parts of all five samples, was prepared and assayed. The results were 0.27 ounce gold per ton and 0.27 ounce silver per ton.

Microscopic Examination:

Fifteen polished sections, three from each sample, were prepared and examined under a reflecting microscope. Since the character of each sample is essentially similar both as to metallics and gangue, they will not be described separately in this report.

Gangue -

The gangue material is a mixture of milky white quartz, soft light to dark greenish grey rock, and abundant finely disseminated carbonate. In a few places it exhibits small, local, light brown stains of iron oxides and is transected by narrow, hairlike fractures.

Metallic Minerals -

Metallic mineralization is only moderately strong

(Microscopic Examination, cont'd) -

in the polished sections and is represented by pyrite, chalcopyrite, magnetite, galena, sphalerite, hematite, "limonite," bornite, and native gold. Pyrite preponderates over all the others and is the only metallic mineral which is really abundant.

The iron sulphide occurs as coarse to fine anhedral to euhedral crystals disseminated unevenly through gangue, with the coarser sizes predominant. In four of the polished surfaces which represent four different samples, pyrite grains are so closely aggregated as to form coarsely crystalline masses up to about 3/4 of an inch in size. The sulphide of iron contains occasional small inclusions of gangue and metallics and, where fractured, the fractures are often filled with gangue, sometimes with chalcopyrite and/or galena.

Chalcopyrite is scattered sporadically through gangue and pyrite as narrow stringers, irregular grains, and small masses up to about 2 millimetres in size. It frequently fills spaces between grains of pyrite, sometimes completely surrounding them. As displayed in the polished sections the copper mineral is somewhat more abundant in samples M and H than in the others.

Magnetite is present in gangue and in pyrite as small irregular grains up to about 420 microns (35 Tyler mesh) in size. It is unevenly disseminated and is more abundant in greenish rock than in white quartz.

Both galena and sphalerite have the same modes of occurrence as chalcopyrite, with which mineral they are frequently associated. In the polished sections the lead mineral is considerably more abundant than the zinc mineral but the total amount of each is small.

A small quantity of hematite is present as tiny

(Microscopic Examination, cont'd) -

particles in gangue and in magnetite. "Limonite" reveals its presence as a few small, local, light-brown stains in gangue and, in sample Y, it is visible as frames around several grains of pyrite. In this sample, too, one or two tiny grains of bornite are associated with chalcopyrite.

Fifteen grains of gold, eleven in gangue and four in pyrite, were observed in three of the five samples. Of those in gangue nine are alone and two are against pyrite. All eleven grains are more or less equidimensional in shape and range from 120 microns (-100 +150 Tyler mesh) down to 6 microns (2300 Tyler mesh) in size.

Three of the four particles in pyrite are between grains in a granular mass and are irregular in shape (see Figure 1), the largest being approximately 200 microns long by 25 microns wide. The fourth tiny particle, about 36 microns in diameter, is associated with an inclusion of galena in apparently dense pyrite.

(Figure 1 follows,
on Page 5.)

(Microscopic Examination, cont'd) -

Figure 1.

Photomicrograph of a polished surface showing an irregular elongated particle of gold (white rough surface) along a grain boundary in massive pyrite (white smooth surface). Pits and grain boundaries are black; the straight, more or less broken, black lines are scratches. A 200-mesh Tyler screen opening is outlined in white.

X200.

Summary of Results of Test Work:

1. These samples bear very little resemblance to the samples submitted in 1936, the test work on which was reported in Investigations in Ore Dressing and Metallurgy, 1936, Investigation No. 686. The gold, silver and copper assays are all much lower in the new samples.

2. The analyses of the samples showed that gold is the only mineral which is present in any economic quantity.

(Summary of Results of Test Work, cont'd) -

3. Amalgamation tests were carried out and showed that 80 per cent of the gold was free at a grind of 66 per cent minus 200 mesh.

4. Amalgamation followed by flotation gave a gold recovery of 98 per cent.

5. Flotation at a grind of 71 per cent minus 200 mesh gave a concentrate containing 98.3 per cent of the gold. Cyanidation of the flotation concentrate gave a recovery of 98.4 per cent of the gold in the concentrate and a recovery of 96.7 per cent of the gold in the flotation feed.

6. Cyanidation at a grind of 66 per cent minus 200 mesh gave a gold extraction of 98.1 per cent.

7. A cycle cyanidation test showed that no appreciable fouling of the solution took place.

8. Straight cyanidation of the ore gave a slightly higher extraction of the gold than flotation followed by cyanidation of the concentrate. The choice of a milling method will depend mainly on the original installation and operational cost of the two plants.

9. The five samples can be treated in one plant, as shown by the results obtained on treating the composite sample.

EXPERIMENTAL TESTS

Amalgamation and Flotation.

Amalgamation tests were made on each of the five samples and on the composite sample. In each case, a 1,000-gram sample of the ore was ground in a pebble mill for 15 minutes. The balls were then removed and the sample was agitated for 1 hour with 7 c.c. of mercury with a pulp dilution of 1 to 1.

In four of the tests, the resulting tailing from

(Experimental Tests, cont'd) -

amalgamation was floated. After the mercury and amalgam were removed in a hydroseparator, the pulps were filtered and the cakes repulped in a flotation cell. In each case, the pulp was conditioned for five minutes with 0.10 pound Aerofloat No. 208 and 0.10 pound Reagent No. 301 per ton; 0.6 pound Aerofloat No. 25 per ton was added as a frother; and the concentrate was removed for seven minutes.

The results are shown in Table I, following:

TABLE I. - Results of Amalgamation and Flotation.

Test No.	Sample No.	PRODUCT	Grind, % -200 mesh	Wt., per cent	Assay, Au, oz./ton	pH of Flotation	Distribution, per cent		
							Gold to Amal.	Gold to Flot.	Total Gold
15	G.	Amalgam	60				80.1		80.1
		Amalg. tlg.		100.0	0.046*		19.9		19.9
		Flot. conc.		6.4	0.64	8.5		89.8	17.9
		Flot. tlg.		93.6	0.005			10.2	2.0
		Head		100.0	0.23				100.0
2	H.	Amalgam	69				87.6		87.6
		Amalg. tlg.		100.0	0.06*		12.4		12.4
		Flot. conc.		8.1	0.70	8.4		89.1	11.1
		Flot. tlg.		91.9	0.007			10.9	1.3
		Head		100.0	0.51				100.0
13	M.	Amalgam	68				80.0		80.0
		Amalg. tlg.		100.0	0.046*		20.0		20.0
		Flot. conc.		12.5	0.34	8.9		90.7	18.1
		Flot. tlg.		87.5	0.005			9.3	1.9
		Head		100.0	0.23				100.0
1	P.	Amalgam	66				91.4		91.4
		Amalg. tlg.			0.02		8.6		8.6
		Head			0.23				100.0
14	Y.	Amalgam	71				87.8		87.8
		Amalg. tlg.		100.0	0.044*		12.2		12.2
		Flot. conc.			0.38	8.2		89.9	11.0
		Flot. tlg.			0.005			10.1	1.2
		Head			0.36				100.0
19	Comp.	Amalgam	57				81.5		81.5
		Amalg. tlg.			0.05		18.5		18.5
		Head			0.27				100.0

* Calculated assay.

(Experimental Tests, cont'd) -

The recovery obtained by these amalgamation tests indicates that the gold is 80 per cent free milling at a grind of 70 per cent minus 200 mesh.

The flotation concentrate and tailing of Test No. 2 were assayed and the following results obtained:

	Flotation Concentrate	Flotation Tailing
Gold, oz. per ton	0.70	0.007
Silver, "	3.30	0.07
Copper, per cent	2.42	N.d.
Zinc, "	0.51	N.d.
Lead, "	1.14	N.d.
WO_3, "	N.d.	-

-

Flotation.

A series of flotation tests were carried out on the various samples. In the case of the individual samples, each was ground in a pebble mill for 15 minutes. The composite samples were ground in a ball mill for 15 minutes. The pH of the flotation pulp was not adjusted.

Reagents:

To Ball Mill -	Lb./ton
Aerofloat No. 208	0.10
Reagent No. 301	0.10
To Flotation Cell -	
Aerofloat No. 25	0.06

The results of these tests are tabulated in Table II.

(Table II follows,
(on Page 9.)

TABLE II. - Results of Flotation.

Test No.	Sample No.	Grind, % -200 mesh	pH of Float	Per Cent Weight of Feed in Conc.	Per Cent Weight of Feed in Tailing	Assay, oz./ton Heads Au	Heads Ag	Concentrate Au	Concentrate Ag	Tailing Au	Tailing Ag	Distribution, per cent Concentrate Au	Concentrate Ag	Tailing Au	Tailing Ag
5	G	60	8.5	4.9	95.1	0.29⊕	0.20⊕	5.64	3.36	0.015	0.04	95.1	81.2	4.9	18.8
12	H	69	8.9	9.7	90.3	0.42⊕	0.38	3.80	3.76	0.06	0.02⊕	87.2	96.0	12.8	4.0
3	M	68	7.4	7.1	92.9	0.23	0.18⊕	2.94	1.86	0.02	0.05	91.8	74.0	8.2	26.0
11	P	66	8.4	5.9	94.1	0.30⊕	0.22	4.70	3.68	0.02	0.01⊕	92.9	98.7	7.1	1.3
4	Y	71	8.3	4.2	95.8	0.37⊕	0.33⊕	8.52	7.20	0.01	0.03	97.4	91.3	2.6	8.7
20	Comp.	71	8.5	4.8	95.2	0.27	0.27	5.52⊕	-	0.005	-	98.2	-	1.8	-
21	"	71	8.4	5.2	94.8	0.31⊕	-	5.92	-	0.005	-	98.5	-	1.5	-
26	"	71	8.4	5.2	94.8	0.27	-	5.10⊕	-	0.005	-	98.2	-	1.8	-

⊕ Calculated assay.

(Experimental Tests, cont'd) -

The flotation concentrate from Test No. 20 was reground to approximately 100 per cent minus 200 mesh and amalgamated, with the following results:

Amalgamation feed	-	5.52 oz. Au/ton
Amalgamation tailing	-	1.59 " "
Extraction of gold	-	71.2 per cent
Combined tailing	-	0.08 oz. Au/ton
Overall gold recovery	-	69.8 per cent

The flotation concentrate from Test No. 21 was cyanided for 48 hours at a dilution of 4 to 1, with the following results:

Cyanide feed	-	5.92 oz. Au/ton
Cyanide tailing	-	0.435 " "
Extraction of gold	-	92.65 per cent
Overall extraction	-	91.3 "
Combined tailing	-	0.027 oz. Au/ton

NaCN consumption: 7.04 lb./ton of concentrate = 0.37 lb./ton ore.

The flotation concentrate from Test No. 26 was cyanided for 48 hours at a dilution of 4 to 1 with a solution strength of 2.0 pounds NaCN and 2.0 pounds CaO per ton, with the following results:

Cyanide feed	-	5.10 oz. Au/ton
Cyanide tailing	-	0.08 " "
Extraction by cyanidation	-	98.4 per cent
Overall extraction	-	96.7 "
Final combined tailing	-	0.0089 oz. Au/ton

NaCN consumption: 11.72 lb./ton concentrate = 0.61 lb./ton ore.
CaO consumption: 9.0 lb./ton concentrate = 0.47 lb./ton ore.

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Cyanidation.

A 1,000-gram charge of each of the five samples and of the composite sample was ground in a pebble mill for 15 minutes and cyanided for 48 hours at a dilution of 2 to 1. Solution strengths were maintained at 1.0 pound NaCN and 1.0 pound CaO per ton. The results are tabulated below:

(Continued on next page)

(Experimental Tests, cont'd) -

Test No.	Sample No.	Grind, %: minus 200 mesh	Assay, Au, oz./ton: Heads	Assay, Au, oz./ton: Tailing	Gold Recovery, per cent	Reagent Consumption, lb./ton: NaCN	Reagent Consumption, lb./ton: CaO
10	G	67	0.23	0.0075	96.7	0.56	2.24
9	H	73	0.51	0.005	99.0	2.24	1.76
8	M	73	0.23	0.005	97.8	0.76	1.76
6	P	72	0.23	0.01	95.7	1.20	1.76
7	Y	77	0.36	0.005	98.6	1.50	2.24
16	Comp.	66	0.27	0.005	98.1	1.60	1.88

A series of tests were carried out to determine the necessary grind for a satisfactory recovery of the gold by cyanidation. 1,000-gram charges of the composite sample were ground for various periods of time and cyanided for 48 hours. The results are tabulated below:

Test No.	Sample No.	Grind, %: minus 200 mesh	Assay, Au, oz./ton: Heads	Assay, Au, oz./ton: Tailing	Gold Recovery, per cent	Reagent Consumption, lb./ton: NaCN	Reagent Consumption, lb./ton: CaO
17	Comp.	81.0	0.27	0.005	98.1	1.76	2.84
16	"	66.0	0.27	0.005	98.1	1.60	1.88
22	"	55.0	0.27	0.0075	97.3	1.24	2.24
23	"	44.0	0.27	0.01	96.3	0.92	1.76

A grind of approximately 66 per cent minus 200 mesh is required to give 98.1 per cent extraction of the gold.

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Cycle Cyanidation Test.

The occurrence of chalcopyrite, bornite and sphalerite in the ore indicated the necessity of carrying out a cycle cyanidation test to determine the amount of fouling that might take place in the solution, and its effect on the gold extraction.

The test consisted of four 48-hour cycles. Solution strengths were maintained at 1.0 pound NaCN and 1.0 pound CaO per ton, at a pulp dilution of 2 to 1. In each case, the grind was 66 per cent minus 200 mesh.

(Continued on next page)

(Experimental Tests, cont'd) -

Cycle No. 1.

Two bottles, each containing 1,000 grams of the composite sample and 2.000 c.c. of solution at a strength of 1.0 pound NaCN and 1.0 pound CaO per ton, were agitated for 48 hours.

Results:

Bottle	Reagents Consumed, lb./ton		Assay, Au, oz./ton:		Extraction of Gold, per cent
	NaCN	CaO	Feed:	Tailing:	
A	1.60	1.88	0.27	0.005	98.1
B	1.76	2.84	0.27	0.005	98.1

Cycle No. 2.

1,000 grams of the composite sample was ground for 15 minutes in 750 c.c. of filtrate from Cycle No. 1. The pulp was then transferred to a bottle and made up to 2-to-1 dilution with the same filtrate. NaCN and CaO were added to bring the solution strength to 1.0 pound of each per ton. Agitation was carried on for 48 hours.

Results:

Bottle	Reagents Consumed, lb./ton		Assay, Au, oz./ton:		Extraction of Gold, per cent
	NaCN	CaO	Feed:	Tailing:	
C	1.36	2.64	0.27	0.005	98.1

Cycle No. 3.

1,000 grams of the composite sample was ground for 15 minutes in 750 c.c. of filtrate from Cycle No. 2. The pulp was transferred to a bottle and made up to 2-to-1 dilution with the filtrate from Cycle No. 2 plus 200 c.c. of filtrate from Cycle No. 1.

Results:

Bottle	Reagents Consumed, lb./ton		Assay, Au, oz./ton:		Extraction of Gold, per cent
	NaCN	CaO	Feed:	Tailing:	
D	1.24	2.60	0.27	0.005	98.1

(Experimental Tests, cont'd) -

Cycle No. 4.

1,000 grams of the composite sample was ground for 15 minutes in 750 c.c. of filtrate from Cycle No. 3. The pulp was transferred to a bottle and made up to 2-to-1 dilution with the filtrate from Cycle No. 3 plus 200 c.c. of filtrate from Cycle No. 1.

Results:

Bottle	Reagents Consumed, lb./ton NaCN	Reagents Consumed, lb./ton CaO	Assay, Au, oz./ton: Feed	Assay, Au, oz./ton: Tailing	Extraction of Gold, per cent
E	1.08	2.44	0.27	0.005	98.1

Analysis of final cyanide solution:

Reducing power = 340 c.c. $\frac{N}{10}$ $KMnO_4$ per litre.

KCNS = 0.40 gram per litre.
Total iron = 0.19 " " "
Total copper = 0.014 " " "

The following tabulation shows the results obtained by the cycle cyanidation test:

Cycle No.	Reagent Consumption, lb./ton NaCN	Reagent Consumption, lb./ton CaO	Assay, Au, oz./ton: Feed	Assay, Au, oz./ton: Tailing	Extraction of Gold, per cent.
1	1.68	2.36	0.27	0.005	98.1
2	1.36	2.64	0.27	0.005	98.1
3	1.24	2.60	0.27	0.005	98.1
4	1.08	2.44	0.27	0.005	98.1

The analysis of the cyanide solution showed that no serious fouling of the solution took place. The extraction of the gold remained constant. In practice the solution may build up in copper, necessitating bleeding of solutions.

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568 Booth Street,
Ottawa, Ontario,
September 5, 1946.

ADDENDUM TO

REPORT OF INVESTIGATION NO. 2075,

"Summary of Amalgamation, Flotation and Cyanidation Tests on Five Samples of Gold Ore from the Kenville Gold Mines Limited, Nelson, B.C.,"

dated July 9, 1946.

Cyanidation and Flotation Tests on an Ore from the Kenville Gold Mines Limited, Nelson, British Columbia.

Purpose of Addendum:

The report on an investigation of ore from the Kenville Gold Mines Limited was issued on July 9, 1946, as Report of Investigation No. 2075. In a letter dated July 15, 1946, Mr. John Black, of the Quebec Gold Mining Corporation, 184 Bay Street, Toronto, Ontario, requested that some further work be undertaken on this ore, particularly in regard to straight cyanidation as compared to flotation with subsequent cyanidation of the flotation concentrate.

Results of Test Work:

Due to the presence of free gold in both the sulphides and the gangue, it was found impossible to obtain consistently low tailings by flotation, even at a relatively fine grind. Straight cyanidation of the ore was quite successful, giving low tailings and high recoveries consistently.

Details of Test Work:

Cyanidation gave the following results, grinding in cyanide solution and the head sample analysis being 0.295 ounce gold per ton (composite of the five samples submitted). All six tests were similar except for time of agitation or fineness of grind, both of which are shown in Table I.

TABLE I. - Cyanidation of Kenville Ore.

Grind, per cent -200 mesh	Time of agitation, hours	Tailing Assay, Au, oz./ton	Gold Recovery, per cent	Reagent Consumption, lb./ton ore NaCN	CaO
63	48	0.005	98.3	1.74	1.90
63	24	0.005	98.3	1.57	1.78
63	18	0.005	98.3	1.44	1.70
63	12	0.015	94.9	1.10	1.40
58	24	0.005	98.3	1.62	1.78
58	18	0.015	94.9	1.36	1.72

Table II shows the erratic tailings and recoveries obtained on floating a sulphide concentrate from this ore. The flotation procedure was similar to that given in Investigation Report No. 2075.

TABLE II. - Flotation of Kenville Ore.

Test No.	Grind, per cent -200 mesh	Assays, Au oz./ton Flotation Concentrate	Flotation Tailing	Gold Recovery in Concentrate, per cent
F-1	76.6	5.53	0.015	95.3
F-2	62.1	5.04	0.005	98.1
F-3	57.2	5.54	0.03	90.8
F-4	62.3	5.04*	0.04	87.1
F-5**	55.6		0.007	
F-6**	55.5		0.045	

* Calculated from analysis of cyanide residue.

** Concentrates combined for regrinding and cyanidation, hence independent flotation recoveries are not available.

Some test work was undertaken on cyaniding flotation

(Details of Test Work, cont'd) -

concentrates, with fairly good results. In one test (F-4) the flotation concentrate was agitated for 24 hours (without regrinding). The gold recovery was 97.4 per cent of the cyanide feed content but only 84.8 per cent overall recovery on test heads.

A cycle test was made on the flotation concentrates but, unfortunately, the final solution was lost before it could be checked for fouling. The reducing power of this solution, at the end of the fourth cycle, was 1200 c.c. N/10 $KMnO_4$ per litre, which indicates fouling. Because of the erratic results obtained in the flotation tests, work was stopped on this phase of the investigation.

Conclusions:

From the additional work undertaken on the Kenville ore, it would appear that straight cyanidation is the best method of treating this ore. Grinding, in cyanide solution, to 60 to 65 per cent minus 200 mesh, followed by agitation for 18 to 20 hours, gave gold recoveries of approximately 98 per cent. Tests reported in Investigation Report No. 2075, page 13, showed that there was no fouling of the cyanide solution. Therefore, no difficulties should be encountered in treating the ore by this method.

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Ottawa, Ont.,
Sept. 5, 1946.
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