O T T A W A December 30th, 1941.

R E P O R T

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1139.

Experimental Tests on Gold Ore from the Aetna Prospect in Sudbury Mining Area, Ontario.

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Shipments:

Two shipments of diamond drill cores were received: Shipment No. 1 (on September 6th, 1941), weighing 9 pounds, and Shipment No. 2 (on September 23rd, 1941), weighing 11 pounds. As received, the former was a pulverized product and the latter was minus half inch crushed material. The samples were from the Aetna Prospect in Sudbury Mining Area, Ontario. They were submitted by M. Black, Mill Superintendent,

(Shipments, cont'd) -

Wright-Hargreaves Mines, Limited, Kirkland Lake, Ontario.

Purpose of Investigation:

Mr. M. Black, in his letter of August 21st, 1941, requested an analysis of the samples of ore "so that we might learn the nature of the extremely active cyanicides," and, in his letter of September 3rd, 1941, that "a few small scale tests" be made.

Characteristics of the Ore:

Six polished sections were prepared and examined microscopically for the purpose of determining the character of the ore.

Gangue -

The gangue is a mixture of milky-white quartz and soft greenish-grey rock. In one section there is also exposed a small patch of pinkish-white carbonate which gave no microchemical reaction for iron nor manganese.

Metallic Minerals -

The metallic minerals are quite abundant. In their approximate order of decreasing abundance, the following metallic minerals are present in the polished sections: pyrite, arsenopyrite, chalcopyrite and bornite. Although no free gold was observed in the polished sections, some free gold was present in a jig concentrate.

Pyrite and arsenopyrite are commonly massive and coarse-textured but small amounts are disseminated in the finer sizes also. They are often intimately admixed and, in general, the arsenopyrite is not so coarse-grained as the pyrite. Both sulphides contain numerous inclusions of

(Metallic Minerals, cont'd) -

gangue and chalcopyrite and are extensively veined with the same two minerals.

Chalcopyrite is prevalent as small masses and coarse to fine irregular grains in gangue; as already noted, it also occurs as numerous, irregular inclusions and narrow veinlets in pyrite and arsenopyrite. A very small quantity or bornite intergrown with chalcopyrite is visible in one section.

Sampling and Analysis:

The shipments were sampled by standard methods. The analyses were as follows:

		Shipment No. 1.	Shipment No. 2.
Gold (Au)	-	0.45 oz./ton	0.64 oz./ton
Silver (Ag)	-	0.30 "	0.40 "
Copper (Cu)	-	0.82 per cent	0.97 per cent
Arsenic (As)	-	2.67 "	3.00 "
Nickel (Ni)	-	0.01 "	0.04 "
Manganese (Mn)	-	0.12 "	
Sulphur (S)	-	8.22 "	11.20 "
Pyrrhotite ($Fe_{11}S_{12}$)	-	2.50 "	0.76 "
Cobalt (Co)	-		0.07 "
Selenium (Se)	-	None detected.	
Tellurium (Te)	-	" "	
Antimony (Sb)	-	" "	

Results of Investigation:

The results of investigation showed that the main cyanicides in the ore are the copper minerals and arsenopyrite.

Ammonium sulphate, litharge and lead nitrate decreased the cyanide consumption as well as the amount of copper in cyanide solutions.

The cyanide consumption was decreased appreciably when the pulp was cyanided after a large portion of the copper minerals was removed by flotation. Twenty-four hours' cyanidation of the copper flotation tailing, ground to 93 per cent

(Results of Investigation, cont'd) -

minus 325 mesh, gave a cyanide tailing assaying 0.035 ounce gold per ton and the sodium cyanide consumption was 2.4 pounds per ton (Test No. 9).

Selective flotation of the copper minerals and the pyrite-arsenopyrite, followed by passing the flotation tailing over corduroy strakes, gave a strake tailing assaying 0.025 ounce gold per ton. 48-hours' cyanidation of the pyrite-arsenopyrite and strake concentrates, ground to 65.5 per cent minus 10 microns, gave a cyanide tailing assaying 0.06 ounce gold per ton; the sodium cyanide consumption was 11.1 pounds per ton. The gold value in the cyanide tailing and the strake tailing combined calculate to 0.040 ounce per ton and the sodium cyanide was 4.8 pounds per ton of combined cyanide feed and strake tailing (i.e., copper flotation tailing) (Test No. 8).

Straight cyanidation of the ore, ground to 78.0 per cent minus 325 mesh, gave cyanide tailing assaying 0.07 ounce gold per ton. The cyanide consumption was 5.36 pounds per ton when only lime and sodium cyanide were used; addition of lead nitrate to the pulp decreased the cyanide consumption to 3.62 pounds per ton.

Copper concentrates, obtained by flotation, assayed from 9.03 to 14.50 per cent copper and 4.51 to 2.35 per cent arsenic. From 77.7 to 85 per cent of the copper was in the final copper concentrates. The copper cleaner tailings contained from 14.0 to 5.0 per cent of the copper in the ore. In mill practice the copper cleaner tailing would be returned to the head of the grinding circuit; this would increase the copper recovery. From 50 to 60 per cent of the gold was in the copper concentrates; about 40 per cent of the gold in the

(Results of Investigation, cont'd) -

ore can be removed by amalgamation of the copper concentrates (Test No. 3).

The pyrite-arsenopyrite concentrates assayed over three-tenths per cent copper. The pyrite-arsenopyrite flotation tailing contained from 0.061 to 0.075 ounce gold per ton. By passing the tailing over the strakes, a strake tailing was obtained which assayed 0.025 ounce gold per ton (Test No. 8).

EXPERIMENTAL TESTS:

FLOTATION OF COPPER AND CYANIDATION OF FLOTATION TAILING.

Test No. 1.

In this test an attempt was made to obtain a copper concentrate by selective flotation. A sample of ore pulverized to 84.3 per cent minus 200 mesh (Shipment No. 1) was agitated in a flotation cell for 10 minutes with 2.4 pounds of lime, and 0.08 pound of sodium cyanide per ton of ore. Then 0.28 pound of potassium amyl xanthate and 0.12 pound of pine oil per ton of ore were added and the froth was removed for 10 minutes.

The rougher concentrate was cleaned by refloating, using 2.0 pounds of lime, 0.04 pound of sodium cyanide, 0.04 pound of potassium amyl xanthate, and 0.12 pound of pine oil per ton of ore.

The pH of the rougher circuit solution was 9.12 and that of the cleaner circuit solution was 9.45.

(Continued on next page)

(Test No. 1, cont'd) -

Results of Flotation:

Product	Weight, per cent	Assays, oz./ton: Au	Assays, per cent: Cu	Assays, per cent: As	Distribution, per cent: Au	Distribution, per cent: Cu
Feed	100.00	0.41	0.67	2.67	100.0	100.0
Copper concentrate	7.23	2.58	3.80	6.63	45.7	41.2
Copper cleaner tailing	12.46	0.36	1.08	2.67	11.0	20.2
Flotation tailing	80.31	0.22	0.32	2.31*	43.3	38.6

* Calculated value.

The ore used in this test was from Shipment No. 1, which was pulverized and standing for some weeks, hence it would be subjected to more rapid oxidation than it would when in a coarser state. This may account for the high copper content in the flotation tailing.

The flotation tailing, which was about 78 per cent minus 325 mesh, was treated by cyanidation for 24 hours.

Cyanidation of Flotation Tailing. Au: 0.22 oz./ton, Cu: 0.32 per cent.

	A: Low lime	B: $(NH_4)_2SO_4$, 1.37 lb./ton	C: PbO, 1.37 lb./ton	D: High lime
Dilution (liquid to solid)	2.3:1.	2.3:1.	2.3:1.	2.3:1.
NaCN titration, lb./ton of solution	0.62	0.96	1.76	0.86
CaO titration, lb./ton of solution	0.37	0.42	0.57	1.08
KCNS, lb./ton of solution	1.71	0.85	0.66	1.24
Reducing power, c.c. N/10 $KMnO_4$/litre	544	420	228	452
Reducing power due to KCNS, c.c. N/10 $KMnO_4$/litre	527	262	204	383
Reducing power due to other compounds than KCNS, c.c. N/10 $KMnO_4$/litre	17	158	24	69
NaCN consumed, lb./ton of solids	6.9	6.0	4.2	6.2
Lime " " "	18.1	18.0	17.6	37.9
Cyanide tailing, Au, oz./ton	0.07	0.055	0.04	0.04
Per cent extraction of gold	68.2	75.0	81.8	81.8

(Test No. 1, cont'd) -

Addition of litharge to cyanidation pulp showed marked reduction in cyanide consumption.

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Test No. 2.

In this test the ore from Shipment No. 2. was used. A sample of ore, crushed to minus 14 mesh was ground to minus 74.6 per cent minus 200 mesh with 2.0 pounds of lime and 0.12 pound of sodium cyanide per ton of ore. The copper minerals were floated with 0.10 pound of potassium amyl xanthate and 0.12 pound of pine oil per ton.

The rougher concentrate was conditioned 10 minutes with 2.0 pounds of lime and 0.04 pound of sodium cyanide per ton of ore and cleaned by refloating using 0.12 pound of pine oil per ton of ore.

The pH of the rougher circuit solution was 9.5 and that of the cleaner circuit solution was 10.5.

Results of Flotation:

Product	Weight, per cent	Assays, oz./ton: Au	Assays, per cent: Cu	Assays, per cent: As	Distribution, per cent: Au	Distribution, per cent: Cu
Feed	100.00	0.64	0.94		100.0	100.0
Copper concentrate	6.60	5.60	12.04	3.43	57.7	85.0
Copper cleaner tailing	9.88	1.18	1.00		18.2	10.5
Flotation tailing	83.52	0.185	0.05	2.48	24.1	4.5

Ratio of concentration, 15.1:1.

The flotation tailing was reground to 69.0 per cent minus 325 mesh and filtered.

In Tests Nos. B and C the pulps at dilutions of 5:1 (liquid to solid) were aerated by agitation for 18 hours. Lime was added to aeration treatment. At the end of aeration

(Test No. 2, cont'd) -

period the CaO titration was 0.05 pound per ton of solution. The lime consumption was 49.1 pounds per ton of solids. The pulp was filtered and repulped with water for cyanidation treatment.

Cyanidation of Flotation Tailing. Au, 0.185 oz./ton, Cu, 0.05 per cent.

	A No Pre-aeration	B Pre-aerated	C Pre-aerated PbO, 0.83 lb./ton
Agitation time, hours	24	24	24
Dilution (liquid to solid)	1.86:1.	1.93:1.	2.01:1.
NaCN titration, lb./ton solution	1.40	1.60	1.76
CaO " " "	0.42	0.46	0.47
KCNS, lb./ton of solution	0.68	0.54	0.35
Copper (Cu) lb./ton of solution	0.22	0.18	0.12
Reducing power, c.c. N/10 $KMnO_4$/ litre	208	172	116
Reducing power due to KCNS, c.c. N/10 $KMnO_4$/litre	210	167	108
NaCN consumed, lb./ton of solids	2.16	1.79	1.47
Lime consumed, " " "	18.0	11.9	12.2
Total lime consumed, (pre-aeration & cyanidation), lb./ton of solids		61.0	61.3
Cyanide tailing, Au oz./ton	0.04	0.05	0.05
Per cent extraction of gold	78.4	73.0	73.0

Pre-aeration with lime slightly decreased the cyanide consumption but the gold loss was increased slightly.

Test No. 3.

A sample of Shipment No. 2 ore was ground to 74.6 per cent minus 200 mesh with 2.4 pounds of lime and 0.12 pound of sodium cyanide per ton of ore. The copper minerals were floated with 0.08 pound of potassium ethyl xanthate and 0.12 pound of pine oil per ton.

The rougher concentrate was cleaned by refloating using 2.0 pounds of lime, 0.04 pound of sodium cyanide and 0.12 pound of pine oil per ton of crude ore.

The copper concentrate was amalgamated.

Results:

Product	Weight, per cent	Assays, oz./ton: Au	Assays, per cent: Cu	Assays, per cent: As	Distribution, per cent: Au	Distribution, per cent: Cu
Feed	100.00	0.64	0.90		100.0	100.0
Amalgam					42.3	
Copper concentrate	6.48	1.86	11.62	2.39	18.8	84.1
Copper cleaner tailing	4.64	1.34	0.97		9.7	5.0
Flotation tailing	88.88	0.21	0.11		29.2	10.9

The ratio of concentration was 15.4:1. This does not include the middling product which would be re-treated in mill practice thus lowering the ratio of concentration.

The flotation tailing was tabled and the sands were reground. The reground sands and table slimes were combined for cyanidation. The cyanidation feed was 83 per cent minus 325 mesh.

The pulp was agitated with lime for half an hour before cyanide was added.

(Continued on next page)

(Test No. 3, cont'd) -

Cyanidation of Flotation Tailing. Au, 0.21 oz./ton, Cu, 0.11 per cent.

	A	B	C	D
			PbO 0.88 lb./ton	PbO, 0.88 $(NH_4)_2SO_4$, 1.03 lb./ton
Agitation time, hours	24	48	24	24
Dilution (liquid to solid)	1.92:1.	2.07:1.	1.98:1.	1.77:1.
NaCN titration, lb./ton of solution	0.98	1.02	1.28	1.18
CaO titration, lb./ton of solution	0.13	0.64	0.36	0.38
KCNS, lb./ton of solution	0.55	0.63	0.29	0.42
Copper (Cu), lb./ton of solution	0.24	0.32	0.16	0.22
Reducing power, c.c. N/10 $KMnO_4$/litre	312	328	176	216
Reducing power due to KCNS, c.c. N/10 $KMnO_4$/litre	170	195	90	130
Reducing power due to compounds other than KCNS, c.c. N/10 $KMnO_4$/litre	142	133	86	86
NaCN consumed, lb./ton solids	2.45	2.88	1.86	2.02
Lime consumed, " "	17.0	22.2	15.6	14.6
Cyanide tailing, Au oz./ton	0.05	0.05	0.05	0.04
Per cent extraction of gold	76.2	76.2	76.2	81.0

No increase in gold extraction was attained after 24 hours' agitation.

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BULK FLOTATION, SELECTIVE FLOTATION OF BULK CONCENTRATE, AND CYANIDATION OF PYRITE-ARSENOPYRITE CONCENTRATE.

Test No. 4.

A sample of Shipment No. 2 ore was ground to 74.6 per cent minus 200 mesh with 0.8 pound of soda ash per ton of ore. A bulk flotation concentrate was made using 0.10 pound

(Test No. 4, cont'd) -

of Reagent 301, 0.04 pound of Aerofloat 208 and 0.12 pound of pine oil per ton of ore; the froth was removed for 10 minutes.

The bulk flotation concentrate was conditioned 10 minutes with 2.0 pounds of lime and 0.12 pound of sodium cyanide per ton of ore. Then 0.12 pound of pine oil was added and a froth removed for 6 minutes, giving a rougher copper concentrate; the flotation tailing gave a pyrite-arsenopyrite concentrate.

The rougher copper concentrate was cleaned by refloating using 2.0 pounds of lime, 0.04 pound of sodium cyanide and 0.12 pound of pine oil per ton of ore.

pH of bulk flotation circuit solution - 9.0
pH of copper circuit solution - 10.65
pH of cleaner circuit solution - 10.3

Results of Flotation.

Product	Weight, per cent	Assays, oz./ton: Au	Assays, per cent: Cu	As	S *	Distribution, per cent: Au	Cu
Feed	100.00	0.65	0.87			100.0	100.0
Copper concentrate	7.83	4.36	9.03	4.40		52.6	81.0
Copper cleaner tailing	5.31	1.65	1.57			13.5	9.6
Pyrite-arsenopyrite concentrate	17.05	0.98	0.36		30.26	25.8	7.0
Flotation tailing (gangue)	69.81	0.075	0.03		1.07	8.1	2.4

* Sulphide sulphur.

The ratios of concentration were 12.8:1 for copper and 5.9:1 for pyrite-arsenopyrite.

The pyrite-arsenopyrite concentrate was reground with lime to 98 per cent minus 325 mesh, filtered, and repulped with water for cyanidation treatment.

(Continued on next page)

(Test No. 4, cont'd) -

Cyanidation of Pyrite-Arsenopyrite Concentrate.

Au, 0.98 oz./ton; Cu, 0.36 per cent; Sulphide S, 30.26%.

Litharge (PbO) added lb./ton of solids	1.0
Agitation time, hours	48
Dilution, (liquid to solids)	3.26:1.
NaCN titration, lb./ton of solution	0.54
CaO titration, " " "	0.06
KCNS, lb./ton of solution	1.19
Copper (Cu), lb./ton of solution	0.38
Reducing power, c.c. N/10 $KMnO_4$/litre	540
Reducing power due to KCNS, c.c. N/10 $KMnO_4$/litre	367
Reducing power due to compounds other than KCNS, c.c. N/10 $KMnO_4$/litre	173
NaCN consumed, lb./ton of solids	8.41
Lime consumed (cyanidation), lb./ton of solids	29.3
Total lime consumed (cyanidation and grinding), lb./ton of solids	41.1
Cyanide tailing, Au oz./ton	0.16
Per cent extraction of gold	83.7

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Tests Nos. 5 and 6.

Test No. 5 was similar to Test No. 4 with few exceptions, the grind was finer and quebracho extract was used in place of sodium cyanide.

In Test No. 6 the ground pulp was put over a jig and corduroy blanket strake before flotation treatment. Quebracho extract was used in flotation.

The results of flotation tests were not satisfactory;

(Tests Nos. 5 and 6, cont'd) -

the copper concentrates contained 7.09 per cent arsenic. The pyrite-arsenopyrite concentrate was high in copper (1.30 and 0.98 per cent Cu). This indicates that quebracho extract has a slight depressing effect on copper minerals and has less depressing effect than sodium cyanide on the arsenopyrite.

The jig and strake concentrate showed presence of free gold. About 25 per cent of the gold in the ore was extracted by amalgamation of the jig and blanket concentrates.

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SELECTIVE FLOTATION AND CYANIDATION OF PYRITE-ARSENOPYRITE CONCENTRATE.

Test No. 7.

A sample of ore from Shipment No. 2 was ground to about 80 per cent minus 200 mesh. The pulp was conditioned for 10 minutes with 0.4 pound of sodium hydroxide and 0.04 pound of sodium cyanide per ton of ore. The pH of the pulp solution was 9.45.

A rougher copper concentrate was made using 0.04 pound of Aerofloat 208, 0.02 pound of Reagent 301 and 0.12 pound of pine oil per ton. The froth was removed for 7 minutes.

After the copper minerals were floated out, 0.08 pound of Reagent 301 and 0.12 pound of pine oil per ton were added and a pyrite-arsenopyrite froth removed for 4 minutes. Then 1.2 pound of copper sulphate, 0.06 pound of Reagent 301 and 0.12 pound of pine oil per ton were added and the froth removed for 6 minutes.

The flotation tailing from the pyrite-arsenopyrite circuit was put over a rubberized blanket strake.

The rougher copper concentrate was cleaned by refloating using 0.4 pound of sodium hydroxide and 0.12 pound of pine oil per ton of ore.

(Continued on next page)

(Test No. 7, cont'd) -

Results:

Product	Weight, per cent	Assays, oz./ton Au	Assays, per cent Cu	Assays, per cent As	Assays, per cent S	Distribution, per cent Cu
Feed	100.00		0.92			100.0
Copper concentrate	7.15		10.68	4.51		83.4
Copper cleaner tailing	4.27		1.45			6.8
Pyrite-arsenopyrite concentrate	25.84	1.08	0.30		24.12	8.4
Blanket concentrate	1.64	1.02	0.02			1.4
Blanket tailing	61.10	0.035			0.42	

Pyrite-arsenopyrite tailing, gold, 0.061 oz./ton (calculated).

The ratios of concentration were 14.0:1 for copper and 3.9:1 for pyrite-arsenopyrite.

The strake tailing was amalgamated and the amalgamation tailing was sized by means of a Haultain infrasizer.

Extraction by amalgamation was 0.008 ounce gold per ton.

Infrasizing Analysis:

Mesh or Microns	Weight, per cent	Assays, oz./ton Au	Assays, per cent S	Distribution, per cent Au	Distribution, per cent S
+200 mesh	29.7	0.025	0.09	30.7	7.3
-200 mesh +56 microns	1.9	0.03	0.10	19.6	4.3
-56 +40 microns	13.9				
-40 +28 "	13.6				
-28 +20 "	9.7	0.02	0.04	26.7	3.5
-20 +14 "	5.6				
-14 +10 "	3.4				
-10 "	22.2	0.025	1.40	23.0	84.9
Total	100.0	0.024	0.37	100.0	100.0

The minus 10-micron material contained the major portion of the sulphide minerals. The product assayed 1.40 per cent sulphide sulphur and contained 84.9 per cent of the sulphur in the blanket strake tailing.

(Continued on next page)

(Test No. 7, cont'd) -

The pyrite-arsenopyrite concentrate was reground to 99.7 per cent minus 325 mesh, filtered, repulped with water and agitated one hour with lime before cyanide was added.

Cyanidation of Pyrite-Arsenopyrite Concentrate.

Au, 1.08 oz./ton; Cu, 0.30 per cent; Sulphide S, 24.12%.

	A PbO, 0.80 lb./ton	B PbO, 0.80 lb./ton
Agitation time, hours	48	96
Dilution, (liquid to solids)	4.20:1.	4.42:1.
NaCN titration, lb./ton of solution	0.96	1.42
CaO titration, lb./ton of solution	0.05	0.18
KCNS, lb./ton of solution	1.19	1.67
Copper (Cu), lb./ton of solution	0.56	0.64
Iron (Fe), lb./ton of solution	0.04	0.03
Reducing power, c.c. N/10 $KMnO_4$/litre	720	920
Reducing power due to KCNS, c.c. N/10 $KMnO_4$/litre	367	515
Reducing power due to compounds other than KCNS, c.c. N/10 $KMnO_4$/litre	353	405
NaCN consumed, lb./ton of solids	12.1	16.6
Lime consumed, " " "	51.7	78.3
Cyanide tailing, Au oz./ton	0.105	0.105
Per cent extraction of gold	90.3	90.3

No increase in gold extraction by cyanidation was attained after 48 hours' agitation.

Nickel was present in cyanide solution.

Test No. 8.

This test was similar to Test No. 7 with the exception of a slight increase in the amounts of copper sulphate and Reagent 301 in the pyrite-arsenopyrite circuit and the addition of 0.02 pound of sodium cyanide per ton of ore to the copper cleaner circuit. The copper sulphate was increased by 0.4 pound and Reagent 301 by 0.02 pound per ton.

Results:

Product	Weight, per cent	Assays, oz./ton: Au	Assays, per cent: Cu	Assays, per cent: As	Assays, per cent: S	Distribution, per cent: Au	Distribution, per cent: Cu	Ratio of concentration
Feed	100.00	0.66	0.98			100.0	100.0	
Copper concentrate	7.07	5.30	10.98	3.50		56.9	78.9	14.1:1.
Copper cleaner tailing	9.88	1.22	1.16			18.3	11.6	
Pyrite-arsenopyrite concentrate, Blanket conc.	36.12	0.42	0.22		13.26	23.0	8.1	2.8:1.
Blanket tailing	46.93	0.025	0.03		0.13	1.8	1.4	

The pyrite-arsenopyrite and strake concentrates were combined and reground for cyanidation treatment. The infrazing test on the regrind concentrate was as follows:

Microns	Weight, per cent
+56	0.2
-56 +40	1.0
-40 +28	4.2
-28 +20	7.4
-20 +14	9.3
-14 +10	12.4
-10	65.5
	100.0

(Continued on next page)

(Test No. 8, cont'd) -

Cyanidation of Pyrite-Arsenopyrite and Blanket Concentrate.

Au, 0.42 oz./ton; Cu, 0.22 per cent; Sulphide S, 13.26 %.

	A PbO, 0.86 lb./ton	B $Pb(NO_3)_2$, 1.15 lb./ton
Agitation time, hours	48	48
Dilution (liquid to solid)	3.30:1.	3.33:1.
NaCN titration, lb./ton solution	0.98	1.00
CaO titration, lb./ton solution	0.03	0.03
KCNS, lb./ton of solution		1.65
Copper (Cu), lb./ton of solution	0.78	0.62
Reducing power, c.c. N/10 $KMnO_4$/litre	708	704
NaCN consumed, lb./ton of solids	11.14	11.08
Lime consumed; " " "	36.6	36.3
Cyanide tailing, Au oz./ton	0.07	0.06
Per cent extraction of gold	83.3	85.7

Nickel was present in cyanide solution.

Gold Value in Cyanide Tailing and Strake Tailing Combined.

	Weight, per cent	Au, oz./ton	Units
Cyanide tailing (cyanidation of pyrite-arsenopyrite and strake conc.)	36.12	0.06	2.167
Strake tailing	46.93	0.025	1.173
Cyanide tailing and strake tailing combined	83.05	0.040	3.340

The cyanide consumption per ton of pyrite-arsenopyrite and strake concentrate (cyanidation feed) was 11.1 pounds. Calculating the consumption on the basis of combined cyanidation feed and strake tailing, it was:

$$\frac{36.12 \times 11.1}{83.05} = 4.8 \text{ pounds per ton.}$$

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FLOTATION OF COPPER AND CYANIDATION OF FLOTATION TAILING.

Test No. 9.

A sample of ore from Shipment No. 2 was ground to about 80 per cent minus 200 mesh with 2.4 pounds of lime and 0.04 pound of sodium cyanide per ton of ore. The copper minerals were floated with 0.08 pound of potassium ethyl xanthate and 0.12 pound of pine oil.

The rougher copper concentrate was cleaned by refloating, using 2.0 pounds of lime, 0.02 pound of sodium cyanide and 0.12 pound of pine oil.

Results of Flotation.

Product	Weight, per cent	Assays, oz./ton Au	Assays, per cent Cu	Assays, per cent As	Distribution, per cent Cu	Ratio of concentration
Feed	100.00		0.91		100.0	
Copper concentrate	4.89		14.50	2.35	77.7	20.4:1.
Copper cleaner tailing	10.51		1.21		14.0	
Flotation tailing	84.60	0.18	0.09		8.3	

The copper flotation tailing was classified by means of a cone classifier and the sands reground. The reground sands and classifier slimes were combined for cyanidation. The cyanidation feed was 93 per cent minus 325 mesh.

(Continued on next page)

(Test No. 9, cont'd) -

Cyanidation of Flotation Tailing. Au, 0.18 oz./ton, Cu, 0.09 per cent.

	A	B High cyanide	C $Pb(NO_3)_2$, 1.27 lb./ton
Agitation time, hours	24	24	24
Dilution (liquid to solid)	2.37:1.	2.21:1.	2.18:1.
NaCN titration, lb./ton of solution	0.74	3.08	0.84
CaO titration, lb./ton of solution	0.04	0.10	0.04
KCNS, lb./ton of solution	0.58	0.60	0.42
Copper (Cu), lb./ton of solution	0.20	0.28	0.18
Reducing power, c.c. N/10 $KMnO_4$/litre	312	328	260
Reducing power due to KCNS, c.c. N/10 $KMnO_4$/litre	179	184	130
Reducing power due to compounds other than KCNS, c.c. N/10 $KMnO_4$/litre	133	144	130
NaCN consumed, lb./ton of solids	2.73	3.90	2.40
Lime consumed, lb./ton of solids	21.4	20.1	19.8
Cyanide tailing, Au oz./ton	0.035	0.035	0.035
Per cent extraction of gold	80.6	80.6	80.6

High cyanide strength during agitation did not increase gold extraction.

Infrasizing Analysis on Cyanide Tailing:

Mesh or Microns	Weight, per cent	Assays, oz./ton Au	Assays, per cent S	Distribution, per cent Au	Distribution, per cent S
+200 mesh	3.1				
-200 mesh +56 microns	0.6	0.065	6.61	22.8	15.4
-56 +40 microns	9.4				
-40 +28 "	13.4	0.04	5.66	29.8	28.0
-28 +20 "	14.5				
-20 +14 "	11.6	0.03	6.13	18.0	24.3
-14 +10 "	10.8				
-10 "	36.6	0.03	4.95	29.4	32.3
Total	100.0	0.037	5.63	100.0	100.0

STRAIGHT CYANIDATION OF THE ORE.

Test No. 10.

Straight cyanidation tests were conducted on the ore of Shipment No. 1, which was pulverized to 78.0 per cent minus 325 mesh.

The pulp was agitated with lime for one hour before cyanide was added.

In some tests ammonium sulphate was used in order to react with cupric salts to form di-cuproso-cupric cyanide which will precipitate out and remain in the residue. Any soluble cupric salts of the order of $(NH_3)_4$ Cu-, which may have formed, were removed from the solution by addition of 2.0 pounds of lime per ton of solids prior to filtering.

The results of the tests are given in the following table.

(See Page 21 for table)

(Test No. 10, cont'd)

Straight Cyanidation of the Ore: (Au, 0.45 oz./ton; Cu, 0.82 per cent)

	A High NaCN and CaO.	B Low NaCN and CaO.	C Low NaCN and CaO.	D Low NaCN and CaO.	E	F Low NaCN	G Low NaCN
Ammonium sulphate, lb./ton of solids.			1.00	1.00	1.00		
Litharge, " " "				0.80	0.80	0.80	
Lead nitrate, " " "							1.20
Agitation time, hours.	24	24	24	24	48	24	24
Dilution, liquid to solids.	2.00:1	2.00:1	1.90:1	1.89:1	1.98:1	1.99:1	1.99:1
NaCN, final titr., lb./ton solution.	1.04	0.32	0.34	0.18	1.14	0.28	0.68
CaO, " " " "	0.28	0.06	0.17	0.17	0.24	0.06	0.07
KCNS, " "	1.55	1.41	0.97	1.21	1.32	1.26	0.87
Cu, " "	0.64	0.66	0.52	0.56	0.54	0.54	0.44
Fe, " "	Nil	0.02	0.01	0.02	0.02	0.02	0.02
Reducing power, c.c. N/10 $KMnO_4$/litre.	556	552	404	480	508	492	332
Reducing power due to KCNS, c.c. N/10 $KMnO_4$/litre.	478	435	300	373	407	388	268
Reducing power due to other compounds than KCNS, c.c. N/10 $KMnO_4$/litre.	78	117	104	107	101	104	64
NaCN consumed, lbs./ton of solids.	5.92	5.36	4.10	4.39	5.66	4.42	3.62
Lime consumed, " " "	29.3	17.9	17.7	17.7	23.2	17.8	17.7
Cyanide residue, Au. oz./ton.	0.07	0.07	0.07	0.07	0.065	0.07	0.07
Extraction, per cent.	84.4	84.4	84.4	84.4	85.6	84.4	84.4

CONCLUSIONS:

High cyanide consumption is mainly due to presence of copper minerals and arsenopyrite in the ore. Removal of copper minerals before cyanidation is necessary, this would lower the cyanide consumption as well as the amount of copper in cyanide solutions.

Addition of a salt of lead or ammonia to cyanide pulp would decrease the cyanide consumption, also the amount of copper in cyanide solution.

Fine grinding of the pulp for cyanidation is necessary.

Presence of nickel in cyanide solutions was detected. Nickel in pregnant solutions decreases the precipitation of gold by zinc dust. Cycle cyanidation tests would have to be conducted in order to determine the effect of nickel on gold dissolution during cyanidation, the precipitation of gold from pregnant solutions and the effect of barium chloride on gold precipitation by zinc dust. As the amount of ore received was very small, this investigation was not conducted.

With nickel and copper present in pregnant solutions high zinc dust consumption can be expected as well as high copper and nickel contents in the precipitate.

Fouling of the cyanide solution can be expected. The reducing powers of the solutions from cyanidation of copper flotation tailings and the pyrite-arsenopyrite concentrates were as high as 312 and 720 c.c. of N/10 $KMnO_4$ per litre respectively.

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