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O T T A W A March 13th, 1941.

# R E P O R T

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 969.

## Concentration and Cyanidation of an Arsenical Gold Ore from the Domineer Claims, Mount Washington, Vancouver Island, British Columbia.

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

CANADA
DEPARTMENT
OF
MINES AND RESOURCES
MINES AND GEOLOGY BRANCH

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Shipment:

One box of assay sample rejects, weight 27 pounds, was received on November 30th, 1940, from Dr. D. F. Kidd, Mining Geologist, Birks Building, Vancouver, British Columbia.

Location of the Property:

The Domineer claims, from which the shipment was obtained, are situated on Mount Washington, Vancouver Island, 14 miles northwest of Courtney in the Nanaimo mining division, British Columbia.

Sampling and Assaying:

After crushing, cutting and grinding by standard methods a representative sample of the shipment was obtained which assayed as follows:

| | | |
|---|---|---|
| Gold | - | 0.34 oz./ton |
| Silver | - | 6.29 " |
| Arsenic | - | 5.48 per cent |
| Copper | - | 1.74 " |
| Iron | - | 15.33 " |
| Sulphur | - | 13.88 " |
| Zinc | - | 0.45 " |
| Lead | - | 0.76 " |

Acid insoluble - 58.50 per cent.

This analysis indicates that the shipment contains approximately 36 per cent sulphides.

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 consists essentially of slightly fractured, white to grey quartz which exhibits a few local light-brown stains of iron oxides.

Metallic Minerals -

Metallic minerals form at least one-half of the contents of the polished sections and, in their approximate

(Characteristics of the Ore, cont'd) -

order of decreasing abundance, consist of: pyrite, arsenopyrite, chalcopyrite, sphalerite, tetrahedrite, and covellite.

Pyrite occurs as coarse to fine irregular grains and small masses scattered through gangue. It is rather extensively fractured and the fractures filled with gangue. Gangue is also visible as occasional small inclusions in apparently dense sulphide.

Arsenopyrite has the same modes of occurrence as pyrite with which it is often very intimately admixed. In general, however, it is much more finely grained than the pyrite.

Chalcopyrite is quite prevalent as coarse to fine irregular grains and small masses in gangue, as well as tiny inclusions in pyrite, arsenopyrite, and sphalerite. It contains small grains of gangue and rare tiny flakes of covellite.

Sphalerite and tetrahedrite are present in comparatively small but appreciable amounts, largely as medium to fine irregular grains disseminated in gangue. Both minerals are frequently associated with chalcopyrite; the latter is included in sphalerite as numerous tiny dots and rods. Sphalerite also occurs as small inclusions in pyrite, arsenopyrite, and chalcopyrite.

Covellite is visible in practically negligible quantity as rare tiny scales in chalcopyrite, sphalerite and gangue.

(Continued on next page)

(Characteristics of the Ore, cont'd) -

Conclusions from Microscopic Examination -

Since no native gold or silver, or gold or silver minerals, were observed in the sections, nothing was learned as to how these metals occur. It is probable, however, that the tetrahedrite carries silver. Also, since a chemical analysis shows lead to be present in the sample, it is possible that the ore contains silver-bearing galena, although this mineral is not visible in the polished sections.

Investigational Work:

It was requested by Dr. D. F. Kidd that the following information be obtained in the test work on the ore shipment:

1. Is the ore likely to prove amenable to cyanidation.
2. What ratio of concentration could be secured by bulk flotation.
3. Would such a concentrate be sufficiently high in arsenic to avoid the arsenic penalty and get paid for it at the Tacoma smelter.
4. If not, could two concentrates be made -- one high in arsenic and the other low in arsenic.

The test work on the shipment gave the following answers to these inquiries:

1. The ore is not likely to prove amenable to cyanidation.
2. The ratio of concentration secured by bulk flotation was 3.6:1, after cleaning the primary concentrate.
3. Owing to the comparatively large amounts of pyrite and chalcopyrite in the ore, which would be included

(Investigational Work, cont'd) -

in the bulk concentrate, such a concentrate would not be sufficiently high in arsenic to avoid an arsenic penalty at the Tacoma smelter.

4. By selective flotation methods two concentrates can be made, one high in arsenic and the other low in arsenic.

Details of the Test Work:

Test No. 1 (A, B, and C). - Cyanidation.

Portions of the ore at minus 14 mesh were treated as follows:

In Test No. 1-A the ore was ground in cyanide solution of 1 pound NaCN per ton strength and the pulp agitated for 24 hours.

In Test No. 1-B the ore was ground in water and the pulp was filtered and washed prior to agitation.

In Test No. 1-C the ore was ground in a lime pulp and agitated in cyanide solution.

The fineness of grinding was 89.0 per cent minus 200 mesh. Sufficient lime was added to the cyanidation to maintain alkalinity.

Results of Cyanidation:

(Feed = Au, 0.34 oz./ton; Ag, 6.29 oz./ton)

| Test No. | Agitation, hours | Grind, % -200 mesh | Tailing assays, oz./ton Au | Tailing assays, oz./ton Ag | Extractions, per cent Au | Extractions, per cent Ag | Titrations; Reagents lb./ton solution NaCN | Titrations; Reagents lb./ton solution CaO | Reagents consumed, lb./ton ore NaCN | Reagents consumed, lb./ton ore CaO |
|---|---|---|---|---|---|---|---|---|---|---|
| 1-A | 24 | 89.0 | 0.14 | 4.73 | 58.8 | 24.8 | 0.6 | 0.20 | 4.6 | 23.8 |
| 1-B | 24 | 89.0 | 0.15 | 4.95 | 55.9 | 21.3 | 0.5 | 0.15 | 5.8 | 17.7 |
| 1-C | 24 | 89.0 | 0.15 | 4.81 | 55.9 | 23.5 | 0.5 | 0.15 | 6.0 | 23.7 |

(Continued on next page)

(Test No. 1, cont'd) -

In order to give an indication of the degree of fouling of the final cyanide solutions, determinations of the reducing power were made in each test and resulted as follows:

| Test No. | Reducing power, ml. N/10 $KMnO_4$ per litre |
|---|---|
| 1-A | 620 |
| 1-B | 680 |
| 1-C | 520 |

The results in this test show high reagent consumption, fouling of the cyanide solutions, and a low percentage of extraction of both gold and silver contents.

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Test No. 2. - Concentration and Cyanidation.

In this test an attempt was made to float off a high-grade copper-gold concentrate in a lime pulp and to extract the gold remaining in the flotation tailing by cyanidation.

The ore at minus 14 mesh was ground in a ball mill to pass 75.8 per cent minus 200 mesh. Two pounds of lime per ton of ore was added to the grind. After grinding the pulp was transferred to a Denver flotation machine and a flotation concentrate obtained by the additions of 0.03 pound butyl xanthate and 0.04 pound pine oil per ton. This concentrate was cleaned in a smaller machine.

The flotation tailings were divided into three parts (A, B, and C). Part A was agitated in cyanide solution of 1 pound NaCN per ton strength for 24 hours with a

(Test No. 2, cont'd) -

low lime titration. Part B was treated similarly to Part A but with 48 hours' agitation. Part C was agitated for 24 hours in cyanide solution of 1 pound NaCN per ton strength with a high lime titration.

Results:

Flotation.

| Product | Weight, per cent | Assays Oz./ton Au | Assays Oz./ton Ag | Assays Per cent Cu | Assays Per cent As | Distribution, per cent Au | Distribution, per cent Ag | Distribution, per cent Cu | Distribution, per cent As |
|---|---|---|---|---|---|---|---|---|---|
| Feed | 100.00 | 0.34* | 5.95* | 1.83* | 5.77* | 100.0 | 100.0 | 100.0 | 100.0 |
| Flot. conc. | 12.44 | 1.20 | 25.14 | 10.18 | 6.92 | 43.9 | 52.6 | 69.3 | 14.9 |
| Flot. middling | 13.67 | 0.64 | 7.28 | 2.10 | 11.58 | 25.7 | 16.7 | 15.7 | 27.4 |
| Flot. tailing | 73.89 | 0.14 | 2.47 | 0.37 | 4.51 | 30.4 | 30.7 | 15.0 | 57.7 |

* Calculated.

The ratio of concentration was 8:1. pH = 8.6.

Cyanidation of Flotation Tailing.

(Feed = 0.14 Au oz./ton; 2.47 Ag oz./ton.)

| Test No. | Agitation, hours | Tailing assays, oz./ton Au | Tailing assays, oz./ton Ag | Extraction, per cent Au | Extraction, per cent Ag | Titration, lb./ton solution NaCN | Titration, lb./ton solution CaO | Reagents consumed, lb./ton ore NaCN | Reagents consumed, lb./ton ore CaO |
|---|---|---|---|---|---|---|---|---|---|
| A | 24 | 0.12 | 1.65 | 14.3 | 33.2 | 0.8 | 0.10 | 3.5 | 8.8 |
| B | 48 | 0.06 | 1.73 | 57.1 | 30.0 | 0.9 | 0.10 | 4.3 | 9.9 |
| C | 24 | 0.09 | 1.70 | 35.7 | 31.2 | 0.9 | 0.55 | 3.3 | 18.9 |

Summary of Test No. 2:

| | (Per cent) Au | Ag |
|---|---|---|
| Recovered by flotation concentration - | 55.2 | 61.8 |
| Extracted from flotation tailing (48-hour agitation) - | 25.6 | 11.6 |
| Overall recovery - | 80.8 per cent. | 73.4 per cent. |

(Continued on next page)

(Test No. 2, cont'd) -

The flotation concentrate obtained in this test was hardly suitable for shipment and the extraction of gold and silver from the flotation tailings was poor. The oxidized condition of the shipment was a factor in these results.

Test No. 3. - Bulk Flotation.

The ore at minus 14 mesh was ground in a ball mill to pass 75.8 per cent minus 200 mesh. Six pounds of soda ash, 0.10 pound of potassium amyl xanthate and 0.07 pound of Aerofloat No. 31 per ton were added to the grind. The pulp was then transferred to a Denver flotation machine and a bulk concentrate obtained by the addition of 0.05 pound potassium amyl xanthate, 1.0 pound of copper sulphate and 0.07 pound of pine oil per ton. This concentrate was cleaned in a smaller machine.

Results of Flotation:

| Product | Weight, per cent | Assays | | | | Distribution, per cent | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Oz./ton | | Per cent | | | | | |
| | | Au | Ag | Cu | As | Au | Ag | Cu | As |
| Feed | 100.00 | 0.375* | 6.31* | 1.73* | 5.46* | 100.0 | 100.0 | 100.0 | 100.0 |
| Flot. conc. | 28.10 | 0.98 | 16.82 | 5.58 | 7.82 | 73.1 | 74.9 | 90.4 | 40.2 |
| Flot. middling | 9.60 | 0.60 | 6.30 | 0.82 | 15.49 | 15.3 | 9.6 | 4.6 | 27.2 |
| Flot. tailing | 62.30 | 0.07 | 1.57 | 0.14 | 2.86 | 11.6 | 15.5 | 5.0 | 32.6 |

* Calculated.

The ratio of concentration was 3.6:1.
pH = 8.6.

Test No. 4. - Selective Flotation Concentration.

In this test an attempt was made to produce a fairly high-grade concentrate low in arsenic and a second concentrate high in arsenic.

The ore at minus 14 mesh was ground in a ball mill to pass 77.6 per cent minus 200 mesh. Two pounds of soda ash per ton was added to the grind. The pulp was then transferred to the flotation machine and a concentrate obtained by the addition of 0.04 pound butyl xanthate and 0.035 pound of pine oil per ton. The pulp was then further conditioned with 6 pounds of soda ash per ton and a second concentrate obtained by the addition of 1.0 pound of copper sulphate, 0.15 pound of potassium amyl xanthate and 0.08 pound of pine oil per ton. The concentrates were cleaned in a smaller machine.

Results of Flotation:

| Product | Weight, per cent | Assays: Oz./ton Au | Assays: Oz./ton Ag | Assays: Per cent Cu | Assays: Per cent As | Distribution, per cent Au | Distribution, per cent Ag | Distribution, per cent Cu | Distribution, per cent As |
|---|---|---|---|---|---|---|---|---|---|
| Feed | 100.00 | 0.30* | 6.15* | 1.83* | 6.49* | 100.0 | 100.0 | 100.0 | 100.0 |
| Copper conc. | 4.09 | 0.68 | 38.52 | 25.70 | 1.13 | 11.3 | 37.4 | 69.9 | 0.9 |
| Copper middling | 3.17 | 0.74 | 22.38 | 5.53 | 6.13 | 7.8 | 13.6 | 9.6 | 3.0 |
| Pyrite conc. | 23.40 | 0.78 | 5.30 | 0.92 | 16.54 | 60.8 | 24.1 | 11.7 | 59.6 |
| Pyrite middling | 7.56 | 0.40 | 6.34 | 0.94 | 13.53 | 10.0 | 9.3 | 3.9 | 15.7 |
| Tailing | 60.88 | 0.05 | 1.32 | 0.15 | 2.22 | 10.1 | 15.6 | 4.9 | 20.8 |

* Calculated.

The ratios of concentration were 20:1 in the 1st concentrate and 4.3:1 in the second. The final pH of the pulp was 9.0.

It is apparent from these results that the major portion of the gold does not occur in the chalcopyrite, the copper concentrate recovering 70 per cent of the copper in the ore but only 11 per cent of the gold.

Test No. 5. - Selective Flotation Concentration.

In this test an attempt was made, by adding sodium sulphide to the grind, to counteract the oxidized condition of the ore and aid in the recovery of the gold and silver.

The ore at minus 14 mesh was ground in a ball mill to pass 78.1 per cent minus 200 mesh. Two pounds of sodium sulphide per ton was added to the grind. The pulp was then transferred to a flotation machine and an initial concentrate obtained by the additions of 0.03 pound of butyl xanthate, 0.03 pound of pine oil and 0.02 pound of cresylic acid per ton. The pulp was then further conditioned by addition of 7 pounds of soda ash per ton and a second concentrate obtained by the additions of 1.2 pound copper sulphate, 0.10 pound potassium amyl xanthate and 0.05 pound pine oil per ton. Both of these concentrates were cleaned in a smaller machine.

Results of Flotation:

| Product | Weight, per cent | Assays: Oz./ton Au | Assays: Oz./ton Ag | Assays: Per cent Cu | Assays: Per cent As | Distribution, per cent: Au | Ag | Cu | As |
|---|---|---|---|---|---|---|---|---|---|
| Feed | 100.00 | 0.35* | 6.11* | 1.75* | 5.54* | 100.0 | 100.0 | 100.0 | 100.0 |
| Copper conc. | 6.55 | 1.56 | 49.84 | 16.84 | 3.16 | 28.9 | 53.4 | 62.9 | 3.8 |
| Copper middling | 9.65 | 0.82 | 7.06 | 2.80 | 9.56 | 22.4 | 11.1 | 15.4 | 16.7 |
| Pyrite conc. | 18.05 | 0.68 | 5.28 | 1.40 | 14.96 | 34.7 | 15.6 | 14.4 | 48.8 |
| Pyrite middling | 6.38 | 0.22 | 5.12 | 0.80 | 7.58 | 3.9 | 5.3 | 2.9 | 8.8 |
| Tailing | 59.37 | 0.06 | 1.50 | 0.13 | 2.03 | 10.1 | 14.6 | 4.4 | 21.9 |

* Calculated.

The ratios of concentration were 15.3:1 in the first concentrate and 5.5:1 in the second. pH of final pulp = 9.3.

The addition of the sodium sulphide to the grind has a beneficial effect in raising the grade and increasing the recovery of both the gold and the silver in the copper concentrate.

Summary and Conclusions:

The test work on the shipment showed that the ore is of a refractory nature and that the gold is amenable neither to cyanidation nor to bulk flotation concentration. The ore contains 1.74 per cent copper, mostly in the form of chalcopyrite, and this mineral fouls the cyanide solutions and results show a poor extraction of the gold and a high reagent consumption. As the ore contains about 36 per cent sulphides, which would report in the bulk concentrate, the ratio of concentration was only 5.6:1 after cleaning the primary concentrate. This method did not succeed in producing a bulk concentrate which would be suitable for shipment to the smelter.

In Test No. 5, selective flotation methods of concentration produced an initial concentrate assaying 1.56 ounce gold per ton, 49.84 ounces silver per ton, 16.84 per cent copper, and 3.16 per cent arsenic, the recoveries being 35.5 per cent of the gold, 59.3 per cent of the silver, 72.6 per cent of the copper and 4.4 per cent of the arsenic when the middlings products were included. A second concentrate was made assaying 0.68 ounce gold per ton, 5.28 ounces silver per ton, 1.40 per cent copper and 14.96 per cent arsenic, the recoveries being 36.0 per cent of the gold, 16.4 per cent of the silver, 14.8 per cent of the copper and 53.1 per cent of the arsenic.

The reagent consumption and subsequent tailing assays were high in all tests. This is due largely to the oxidized condition of the sample shipment and would not

(Summary and Conclusions, cont'd) -

necessarily apply to a shipment of freshly broken ore.

While the test work on the ore shipment is by no means conclusive, the results obtained indicate that a method of selective flotation seems to offer the best possibilities for treatment of this ore. These results should be improved upon by further test work on a freshly broken shipment.

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