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O T T A W A

June 19th, 1942.

R E P O R T

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1239.

Cyanidation and Flotation Tests
on Two Shipments of Mill Tailing
from Trout Lake, British Columbia.

THIS REPORT WAS PREPARED BY THE CANADIAN MINISTRY OF TECHNICAL INVESTIGATION, ORE DRESSING AND METALLURGICAL LABORATORIES, OTTAWA, ONTARIO, CANADA.

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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SECTION I. - First Shipment.

Shipment:

A shipment of 185 pounds of material similar to that investigated in 1941 and reported upon in Investigation No. 1119 (dated November 17th, 1941) was received on January 29th, 1942. The sample was submitted by J. M. Tillen, Trout Lake, British Columbia.

The former material was stated to be from the Silver Cup-Nettie P mill, situated at Five Mile on Lardeau Creek in

(Shipment, cont'd) -

the Lardeau mining division of British Columbia. This plant has not been operated since the year 1903-4. The tailing has been lying on the dump since that time.

Characteristics of the Sample:

The sample was received in a moist condition and consisted mainly of black sand and lumps of fines. The sand varied from coarse to fine. A screen test showed 52 per cent minus 200 mesh. Oxidized sulphides were present in the sample.

Purpose of the Investigation:

The sample was submitted for the purpose of having cyanidation tests made, both on the material as received and on flotation concentrates recovered from the material.

Investigative Procedure:

Cyanidation tests were made on the dump tailing as received.

The material was concentrated by flotation and the flotation concentrates were cyanided.

Results of the Test Work:

The highest recoveries obtained by straight cyanidation were 44 per cent of the gold and 56 per cent of the silver with a consumption of 8.7 pounds of NaCN and 70 pounds of lime per ton of material. The feed in this test was water washed.

Flotation recovered 90.7 per cent of the gold and 71.7 per cent of the silver in a concentrate assaying 0.6 ounce of gold and 97.3 ounces of silver per ton, with a ratio of concentration of 5:1. The concentrate was reground to 99 per cent minus 325 mesh and cyanided for 48 hours. The extraction in terms of feed was 77 per cent of the gold and

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

42 per cent of the silver. The reagents consumed were 6.6 pounds of NaCN and 21.0 pounds of CaO per ton of original feed.

Increasing the period of agitation to 72 hours resulted in raising the recovery of silver to 68.5 per cent.

The consumption of reagents increased to 13.2 pounds of NaCN and 59 pounds of CaO per ton of feed.

The solutions show extremely high fouling as indicated by the reducing power of 3280 ml. of 1/10 normal potassium permanganate solution (KMnO_4) per litre.

The same fouling conditions were noted in the case of the straight cyanidation tests.

Sampling and Analysis:

The shipment was sampled by standard methods and was found to contain:

| | | |
|-------------|---|----------------|
| Gold (Au) | - | 0.125 oz./ton. |
| Silver (Ag) | - | 26.72 " |
| Lead (Pb) | - | 3.56 per cent. |
| Zinc (Zn) | - | 2.13 " " |
| Sulphur (S) | - | 6.94 " " |
| Iron (Fe) | - | 5.42 " " |

A moisture sample showed 14.1 per cent water in the sample.

A screen sizing test was made on a sample of the shipment as received;

| <u>Mesh No.</u> | | <u>Weight, per cent.</u> |
|-----------------|---|--------------------------|
| + 20 | - | 0.5 |
| - 20 + 28 | - | 2.0 |
| - 28 + 35 | - | 3.8 |
| + 35 + 48 | - | 3.8 |
| - 48 + 65 | - | 3.4 |
| - 65 + 100 | - | 6.2 |
| - 100 + 150 | - | 12.8 |
| - 150 + 200 | - | 15.7 |
| - 200 | - | 51.8 |
| | | 100.0 |

Details of Tests:

Tests Nos. 1 to 16. - Straight Cyanidation.

Preliminary cyanidation tests followed standard practice in which the ore was agitated in a 1.0 pound NaCN per ton solution for 24 hours at a dilution of 1 part solids to $1\frac{1}{2}$ parts of solution.

The results of the tests indicated high consumption of reagents accompanied by heavy fouling of the solutions, and a low recovery of silver.

Various tests were made in which the ore was subjected to washing prior to cyanidation, then agitated in a 1.0 pound NaCN solution for 24 hours.

In other tests the period of agitation was varied from 2 to 48 hours to note the effect on the recovery of silver.

In some tests the ore was reground in cyanide solution prior to agitation. The grind was made at a dilution of four parts of solids to three parts of 1.0 pound NaCN per ton solution. The pulp, after grinding, was diluted to 1 to $1\frac{1}{2}$ for agitation and the solutions were brought up to the required strength of NaCN. The strength of the solution was varied from 1.0 to 3.0 pounds NaCN per ton to note the effect of stronger solutions.

(Continued on next page)

Results of Tests Nos. 1 to 16, Straight Cyanidation.

| Test No. | Hrs. of agitation | Assays, oz./ton. | | | | Extraction, per cent | | Final titration, lb/ton solution | | Reagents consumed, lb/ton ore | | R. P., ml. N/10 KMnO4/litre | Remarks |
|----------|-------------------|------------------|-------|---------|-------|----------------------|------|----------------------------------|------|-------------------------------|------|-----------------------------|---|
| | | Feed | | Tailing | | | | | | | | | |
| | | Au | Ag | Au | Ag | Au | Ag | NaCN | CaO | NaCN | CaO | | |
| 1 | 2 | 0.125 | 26.72 | 0.09 | 15.78 | 28.0 | 40.9 | 0.1 | 0.05 | 3.8 | 24.9 | 20.0 | No grind. |
| 2 | 2 | " | " | 0.10 | 15.50 | 20.0 | 42.0 | 0.1 | 0.05 | 3.8 | 24.9 | 20.0 | 1.0 lb/ton PbO added to the solution. |
| 3 | 2 | " | " | 0.105 | 20.29 | 16.0 | 24.1 | 2.5 | 1.25 | 15.0 | 72.5 | 104.0 | |
| 4 | 2 | " | " | 0.105 | 19.95 | 16.0 | 25.3 | 2.5 | 1.15 | 15.0 | 72.7 | 132.0 | 2.0 lb/ton PbO added to the solution. |
| 5 | 4 | " | " | 0.10 | 14.85 | 20.0 | 44.4 | 0.3 | 0.20 | 3.4 | 49.6 | 20.0 | |
| 6 | 4 | " | " | 0.10 | 15.50 | 20.0 | 42.0 | 0.1 | 0.05 | 3.8 | 24.9 | 24.0 | 1.0 lb/ton PbO added to the solution. |
| 7 | 5 | " | " | 0.09 | 19.13 | 28.0 | 28.4 | 2.0 | 0.25 | 7.0 | 49.6 | 520.0 | |
| 8 | 6 | " | " | 0.08 | 13.55 | 36.0 | 49.3 | 2.0 | 0.15 | 6.0 | 64.8 | 240.0 | |
| 9 | 24 | " | " | 0.11 | 14.34 | 12.0 | 46.3 | 0.44 | 0.04 | 4.2 | 61.8 | 508.0 | Lime added until soln. alkaline then 1.0 lb/ton NaCN added. |
| 10 | 24 | " | " | 0.07 | 14.40 | 44.0 | 46.1 | 0.44 | 0.04 | 4.2 | 62.4 | 510.0 | Similar to Test No. 9. |
| 11 | 24 | " | " | 0.07 | 11.73 | 44.0 | 56.1 | 2.76 | 0.28 | 8.7 | 70.3 | 1490.0 | Washed pulp until pH was from 2.5 to 5.2. |
| 12 | 24 | " | " | 0.07 | 11.87 | 44.0 | 55.6 | 2.60 | 0.32 | 9.0 | 69.6 | 1420.0 | Similar to Test No. 11. |
| 13 | 24 | " | " | 0.11 | 17.29 | 12.0 | 35.3 | 2.10 | 3.25 | 12.9 | 95.1 | 3088.0 | Grind 92 per cent minus 200 mesh. |
| 14 | 24 | " | " | 0.11 | 18.48 | 12.0 | 30.8 | 2.0 | 2.9 | 13.1 | 95.6 | 3416.0 | Grind 86 per cent minus 200 mesh. |
| 15 | 24 | " | " | 0.08 | 20.37 | 36.0 | 23.8 | 2.6 | 2.9 | 12.2 | 95.6 | 3024.0 | No grind. |
| 16 | 48 | " | " | 0.06 | 20.01 | 52.0 | 25.1 | 1.7 | 0.45 | 16.2 | 97.7 | 3152.0 | Grind 84 per cent minus 200 mesh. |

Test No. 17. - Flotation in Natural Pulp; Cyanida-
tion of the Flotation Concentrate.

A sample of the material was treated by flotation.

The material was not reground and no alkaline reagents were added.

The pulp in the flotation machine had a pH of 3.5.

Reagents added to the flotation cell were:

| | | | | |
|-------------------|------|------|---|---|
| | | | | <u>Lb./ton</u> |
| Aerofloat reagent | # 25 | - | | 0.3 |
| " | " | #208 | - | 0.3 |
| " | " | #301 | - | 0.45, added in stages, |
| | | | | with pine oil as a frother, 0.10 lb./ton. |

The concentrate was recovered in about eight minutes.

The concentrate was not recleaned.

The flotation tailing was sampled and a screen analysis was made.

The flotation concentrate was filtered and repulped in cyanide solution containing 3.0 pounds of NaCN per ton with lime for protective alkalinity. The agitation was continued for 48 hours. The solution was kept up to strength.

Test No. 17. - Results of Flotation.

| Products: | Weight, per cent | Assays, oz./ton | | Distribution, per cent | | Ratio of con- centration |
|-------------------|------------------------|--------------------|-------|---------------------------|--------|--------------------------------|
| | | Au | Ag | Au | Ag | |
| Feed ^o | 100.00 | 0.144 | 27.20 | 100.00 | 100.00 | |
| Conc. | 21.44 | 0.60 | 87.74 | 89.12 | 69.16 | 4.7:1. |
| Tailing | 78.56 | 0.02 | 10.68 | 10.88 | 30.84 | |

^o Feed assay calculated from the products.

Screen Analysis of Flotation Tailing.

| | | | | | |
|------------|-------|-------|-------|-------|-------|
| Feed | 78.56 | 0.02 | 10.68 | 10.88 | 30.84 |
| - 20 + 65 | 8.38 | 0.04 | 5.62 | 2.63 | 1.73 |
| - 65 + 100 | 6.65 | 0.015 | 6.09 | 0.78 | 1.49 |
| -100 + 150 | 9.58 | 0.015 | 5.46 | 1.13 | 1.92 |
| -150 + 200 | 10.31 | 0.015 | 5.95 | 1.21 | 2.25 |
| -200 | 43.64 | 0.015 | 14.62 | 5.13 | 25.45 |

(Continued on next page)

(Test No. 17, cont'd) -

Cyanidation of the Flotation Concentrate.

| Assays, oz./ton | | | | Extraction, per cent | | Final titre, lb./ton | | Reagents consumed, lb./ton | |
|-----------------|-------|---------|-------|----------------------|-------|----------------------|-----|----------------------------|-------|
| Feed | | Tailing | | | | solution | | of concentrate | |
| Au | Ag | Au | Ag | Au | Ag | NaCN | CaO | NaCN | CaO |
| 0.60 | 87.74 | 0.11 | 33.79 | 81.67 | 61.49 | 3.0 | 0.2 | 30.6 | 109.0 |

Reagents consumed in terms of pounds per ton of original feed:

NaCN, 6.5 pounds.
CaO, 23.2 "

Reducing power of the cyanide solution, 2020 ml. of N/10 KMnO₄ per litre.

Summary of Test No. 17:

| <u>Recovery of Gold -</u> | | | | <u>Per cent</u> |
|--|---|-------|---------|-----------------|
| Recovery of gold in the flotation concentrate | - | | | 89.12 |
| Extraction of gold by cyanidation from the flotation concentrate | - | 81.67 | | |
| Overall recovery of gold | - | .8167 | x 89.12 | 72.78 |
| Loss in cyanide tailing | - | .1833 | x 89.12 | 16.34 |
| Loss in flotation tailing | - | | | 10.88 |
| Total | - | | | 100.00 |

| <u>Recovery of Silver -</u> | | | | |
|---|---|-------|---------|--------|
| Recovery of silver in the flotation concentrate | - | | | 69.16 |
| Extraction of silver by cyanidation | - | 61.49 | | |
| Overall recovery of silver | - | .6149 | x 69.16 | 42.53 |
| Loss in cyanide tailing | - | .3851 | x 69.16 | 26.63 |
| Loss in flotation tailing | - | | | 30.84 |
| Total | - | | | 100.00 |

Test No. 18. - Flotation in Natural Pulp; Cyanida-
of the Flotation Concentrate.

A sample of the dump tailing was conditioned in a flotation machine for 20 minutes with the following reagents:

Aerofloat #31 - 0.24 lb./ton.
Coal tar creosote - 0.10 "
Denver sulphidizer - 0.15 "

Then 0.4 pound of butyl xanthate per ton was added in stages, with an addition of 0.10 pound of pine oil per ton.

(Test No. 18, cont'd) -

A black slimy froth was formed, which floated rather slowly, requiring about 20 minutes flotation time.

The concentrate was filtered and repulped in cyanide solution at a dilution of one part solids to three parts of solution, made up to 2.0 pounds NaCN per ton of solution. The pulps were agitated for 24, 48, and 72 hours. Lime was used to give protective alkalinity to the pulps.

Results: -

| Flotation. | | | | | | |
|------------|------------------------|----------------------|-------|-----------------------------|-------|---------------------------|
| Products: | Weight, : per cent: | Assays, : oz./ton | | Distribution, : per cent | | Ratio of Concentration |
| | | Au | Ag | Au | Ag | |
| Feed | 100.00 | 0.14 | 31.04 | 100.0 | 100.0 | |
| Conc. | 27.6 | 0.43 | 91.11 | 82.4 | 80.9 | 3.6:1. |
| Tailing | 72.4 | 0.035 | 8.18 | 17.6 | 19.1 | |

Assay of Screen Test of Flotation Tailing

| Mesh | Weight, : per cent | Assay, oz./ton | |
|-------|-----------------------|----------------|------|
| | | Au | Ag |
| + 200 | 41.8 | 0.05 | 6.52 |
| - 200 | 58.2 | 0.02 | 9.15 |

Test No. 18 - Results:

Cyanidation of Flotation Concentrate.

| Hours : agita- tion | Assays, oz./ton | | | | Extraction, : per cent | | Final ti- on, : ton soln. | | Reagents Consumed : lb/ton con- : cencrate. : feed. | | R.F. : N/10 KMnO ₄ |
|---------------------------|-----------------|-----------------|--------------|-----------------|---------------------------|-----|---------------------------------|------|--|-----|-------------------------------------|
| | Feed : Au | Tailing : Ag | Feed : Au | Tailing : Ag | Au | Ag | NaCN | CaO | NaCN | CaO | |
| 24 | 0.43 | 0.16 | 62.8 | 40.50 | 55.6 | 2.3 | 18.1 | 5.0 | | | |
| 48 | 0.43 | 0.08 | 81.4 | 35.38 | 61.3 | 1.9 | 33.7 | 9.3 | | | |
| 72 | 0.43 | 0.03 | 95.0 | 13.94 | 84.7 | 2.4 | 48.0 | 13.2 | | | |

(Continued on next page)

(Test No. 18, cont'd) -

Recovery, in Terms of Original Feed: (Per cent)

| | Au | Ag |
|--------------|------|------|
| 24-hr. test: | 51.7 | 45.0 |
| 48- " " | 67.1 | 49.6 |
| 72- " " | 76.6 | 68.5 |

The recoveries are made at the expense of heavy consumption of reagents. The solutions show a very great amount of fouling.

A considerable amount of froth formed on the cyanide solution, which would be difficult to handle if it built up this amount in mill practice.

Test No. 19. - Flotation in Natural Pulp;
Cyanidation of Flotation Concentrate.

A sample of the dump tailing was conditioned in a flotation machine for 20 minutes with the following reagents:

| | Lb./ton |
|-------------------------|---------|
| Aerofloat #31 | 0.24 |
| Potassium amyl xanthate | 0.20 |

Pine oil was added and a concentrate was recovered in about 20 minutes.

The concentrate was reground to 99 per cent minus 325 mesh in a 3.0 pounds NaCN per ton solution, and cyanided for 48 hours.

Results:

| Flotation. | | | | | | |
|------------|------------------|-----------------|------------------------|------------------------|--|--|
| Products | Weight, per cent | Assays, oz./ton | Distribution, per cent | Ratio of concentration | | |
| | | Au : Ag | Au : Ag | | | |
| Feed | 100.0 | 0.13 : 26.70 | 100.0 : 100.0 | | | |
| Conc. | 19.7 | 0.60 : 97.32 | 90.7 : 71.7 | 5.1:1. | | |
| Tailing | 80.3 | 0.015 : 9.40 | 9.3 : 28.3 | | | |

| Cyanidation of Concentrate. | | | | | | | | | |
|-----------------------------|---------|----------------------|--------------------------------|-------------------|--------------|------|-----|------|-----|
| Assays, oz./ton | | Extraction, per cent | Final titration, lb./ton soln. | Reagents consumed | | | | | |
| Feed | Tailing | | | Lb./ton conc. | Lb./ton feed | | | | |
| Au : Ag | Au : Ag | Au : Ag | NaCN : CaO | NaCN | CaO | NaCN | CaO | NaCN | CaO |
| 0.60 : | 0.09 : | 85.0 : | 2.7 : | 33.5 : | 6.6 : | | | | |
| 97.32 : | 39.88 : | 59.0 : | 0.25 : | 106.4 : | 21.0 : | | | | |

(Test No. 19, cont'd) -

Recovery, in Terms of Original Feed:

Au, 77.1 per cent - Ag, 42.3 per cent

Reducing power of cyanide solution after 48 hours' agitation: 3096 ml. N/10 KMnO₄ per litre.

Test No. 20. - Flotation in Natural Pulp;
Cyanidation of Flotation Concentrate.

A sample of the dump tailing was reground to 86 per cent minus 200 mesh with the following reagents:

| | | Lb./ton |
|---------------|---|---------|
| Aerofloat #31 | = | 0.24 |
| Amyl xanthate | = | 0.20 |

The pulp was put in a flotation machine and conditioned 5 minutes with 0.1 pound of pine oil per ton. 0.2 pound of amyl xanthate per ton was added in stages until the black concentrate was recovered. The amount of pine oil required was 0.15 pound per ton.

The concentrate was reground 98 per cent minus 325 mesh and was agitated in a 2.0 pounds NaCN per ton solution for 24 hours.

Results:

| Flotation. | | | | | | |
|------------|------------------------|-----------------------------------|--|---|---------------------------|--|
| Products: | Weight, : per cent: | Assays, : oz./ton : Au : Ag | Distribution, : per cent : Au : Ag | | Ratio of concentration | |
| Feed | : 100.0 | : 0.13 : 27.0 | : 100.0 : 100.0 | : | 4.2:1. | |
| Conc. | : 23.8 | : 0.50 : 80.3 | : 91.3 : 71.0 | : | | |
| Tailing | : 76.2 | : 0.015 : 10.3 | : 8.7 : 29.0 | : | | |

| Cyanidation of Concentrate. | | | | | | | | | | | |
|-----------------------------|---------|--------|----|---------------------------|----|---|-----|---|-----|------|-----|
| Assays, : oz./ton | | | | Extraction, : per cent | | Final li- tration, : lb./ton soln.: | | Reagents consumed Lb./ton conc. : Lb./ton feed | | | |
| Feed | Tailing | Au | Ag | Au | Ag | NaCN | CaO | NaCN | CaO | NaCN | CaO |
| 0.50 | : 0.09 | : 82.0 | : | 2.0 | : | 29.5 | : | 7.0 | : | : | : |
| : 80.3 | : 31.13 | : 61.2 | : | 0.20 | : | 84.7 | : | 20.2 | : | : | : |

Recovery, in Terms of Original Feed:

Au, 74.8 per cent - Ag, 43.4 per cent

Reducing power of solution: 3432 ml. N/10 KMnO₄ per litre.

(Section I, concluded) -

Summary and Conclusions:

The results of the investigation indicate that the recovery of gold and silver from the dump tailing by straight cyanidation will be low. The consumption of reagents to obtain the indicated recoveries was very high. Regrinding the material did not appreciably increase the extraction.

Flotation of the dump tailing indicates that the values in the slimes are difficult to recover. A screen analysis of the flotation tailing shows that 23 per cent of the silver in the feed remains in the minus 200 mesh flotation tailing.

A flotation concentrate assaying 97 ounces of silver per ton was reground and cyanided for 48 hours, resulting in a recovery of only 59 per cent of the silver in the concentrate. The consumption of reagents was 33.5 pounds of NaCN and 106 pounds of CaO per ton of concentrate. The solution had a reducing power of 3096 ml. of 1/10 normal KMnO_4 per litre, after precipitation of silver the fouled barren solution would have to be discarded and fresh solution used for a subsequent charge of concentrate. This would result in a further loss of reagents.

The normal procedure of cyanidation would not be satisfactory for material similar to that submitted for the investigation, and the results indicate that this material is not amenable to straight cyanidation or to cyanidation of a flotation concentrate.

SECTION II. - Second Shipment.

A further shipment, of 40 pounds of dump tailing, from the Silver Cup Mine dump was received on April 20th, 1942.

This shipment was made to determine the recovery of zinc by flotation.

The material in this shipment contained fines and coarse pieces requiring crushing. Considerable pyrite was present.

The shipment was sampled by standard methods and was found to contain:

| | | |
|-------------|---|----------------|
| Gold (Au) | - | 0.065 oz./ton. |
| Silver (Ag) | - | 9.35 " |
| Lead (Pb) | - | 2.26 per cent. |
| Zinc (Zn) | - | 2.30 " |
| Copper (Cu) | - | 0.09 " |

Investigative Procedure:

The shipment was tested by both selective and bulk flotation.

Results of Tests:

Using selective flotation, a zinc concentrate assaying 52.8 per cent zinc with a recovery of 59.8 per cent was obtained. The lead concentrate assayed 1.0 ounce of gold, 143 ounces of silver, 37.8 per cent of lead and 7.7 per cent of zinc per ton.

Using bulk flotation a concentrate assaying 0.52 ounce of gold, 60.7 ounces of silver, 15.7 per cent lead, and 19.5 per cent of zinc was obtained. The recoveries were 72 per cent of gold and silver, 80 per cent of the lead and 84 per cent of the zinc.

Details of Tests:

Preliminary tests indicated that the shipment contained a considerable amount of acid forming ingredients and a high consumption of soda ash was noted, 30 pounds of soda ash per ton were added to bring the pH to 8.2.

(Details of Tests, cont'd) -

In some of the tests the ore was ground in water, filtered, washed, and repulped in the flotation machine and the various reagents were added to the flotation machine.

It was noted that washing decreased the amount of soda ash required. At a pH of 8.2 the soda ash used was 12 pounds per ton.

Test No. 1. - Selective Flotation.

A sample of ore was ground to 77 per cent minus 200 mesh in a ball mill at a dilution of 4:3.

The pulp was filtered, washed, and repulped in a flotation machine.

Reagents to Flotation -

| | | Lb./ton |
|-----------------------------|---|---------------|
| Soda ash | - | 20.0 (pH 8.5) |
| Zinc sulphate | - | 1.0 |
| Ferrous sulphate | - | 1.0 |
| Sodium cyanide | - | 0.2 |
| Conditioned for 20 minutes. | | |
| Ethyl xanthate | - | 0.05 |
| Cresylic acid | - | 0.10 |

A lead concentrate was recovered which was recleaned.

The pulp was then conditioned to float zinc.

| <u>Reagents</u> | | <u>Lb./ton</u> |
|-----------------|---|----------------|
| Copper sulphate | - | 0.2 |
| Butyl xanthate | - | 0.05 |
| Cresylic acid | - | 0.15 |

A zinc concentrate was recovered which was recleaned with 10 pounds of lime per ton.

Results:

| Products | Weight, per cent | Assays, | | | | Distribu- | | Ratio of concen- tration |
|---------------|------------------------|---------|-------|----------|-------|-------------------|-------|--------------------------------|
| | | Oz./ton | | Per cent | | tion, per cent | | |
| | | Au | Ag | Au | Ag | Pb | Zn | |
| Feed | 100.0 | | | | | 100.0 | 100.0 | |
| Lead conc. | 4.2 | 1.18 | 158.8 | 43.19 | 5.27 | 79.3 | 10.6 | 23.9:1. |
| Lead middling | 3.0 | | | 2.85 | 2.19 | 3.7 | 3.1 | 33.4:1. |
| Zinc conc. | 5.9 | | | 1.28 | 27.47 | 3.3 | 77.6 | 17:1. |
| Zinc middling | 8.0 | | | 0.74 | 1.78 | 2.6 | 6.8 | 12.5:1. |
| Flot. tailing | 78.9 | | | 0.32 | 0.05 | 11.1 | 1.9 | |

(Test No. 1, cont'd) -

The grade of zinc concentrate was not satisfactory. The zinc in the lead concentrate is below 6 per cent, the maximum accepted without penalty by a smelter.

This test indicates the results obtained when the pulp was not made up to pH 10 with lime for the zinc flotation.

Zinc sulphate was added to depress zinc from the lead concentrate.

Ferrous sulphate was added to depress iron sulphide minerals, mostly pyrite. Sodium cyanide also depresses pyrite.

Test No. 2. - Selective Flotation.

Test No. 1 was repeated using a finer grind. The pulp was ground in water to 88 per cent minus 200 mesh.

Reagents to Lead Flotation -

| <u>To flotation</u> | <u>Lb./ton</u> | |
|-----------------------------|----------------|----------|
| Soda ash | 10.0 | (pH 7.5) |
| Zinc sulphate | 1.0 | |
| Ferrous sulphate | 1.0 | |
| Sodium cyanide | 0.1 | |
| Conditioned for 20 minutes. | | |
| Sodium ethyl xanthate | 0.02 | |
| Cresylic acid | 0.20 | |
| Flotation period 7 minutes. | | |
| Lead rougher concentrate. | | |

Recleaned with 0.04 pound of cresylic acid per ton.

Reagents to Zinc Flotation -

| | <u>Lb./ton</u> | |
|-------------------------------------|----------------|-----------|
| Lime | 11.0 | (pH 10.2) |
| Copper sulphate (CuSO_4) | 0.1 | |
| Sodium ethyl xanthate | 0.03 | |
| Cresylic acid | 0.05 | |

A concentrate was recovered, designated Zinc Concentrate No. 1. A further addition of reagents was made, as follows:

| | <u>Lb./ton</u> |
|-----------------|----------------|
| CuSO_4 | 0.1 |
| Butyl xanthate | 0.05 |
| Cresylic acid | 0.05 |

A concentrate was recovered, designated Zinc Concentrate No. 2.

(Continued on next page)

(Test No. 2, cont'd) -

Both concentrates were recleaned with lime to give a pH of 10. The cleaner tailings were combined as zinc middling.

Results:

| Products | Weight: | | Assays | | | | Distribution, | | | | Ratio of |
|---------------|---------|---|---------|---------|----------|--------|---------------|--------|----------|--------|---------------|
| | per | | Oz./ton | | Per cent | | per cent | | per cent | | |
| | cent | : | Au: | Ag | Pb | Zn | Au | Ag | Pb | Zn | concentration |
| Feed | 100.0 | : | 0.11: | 9.57: | 2.16: | 3.02: | 100.0: | 100.0: | 100.0: | 100.0: | : |
| Lead conc. | 3.8 | : | 1.38: | 160.36: | 43.59: | 4.74: | 48.6: | 63.9: | 77.0: | 6.0: | 26:1. |
| Lead middling | 2.8 | : | 0.12: | 24.58: | 4.33: | 3.31: | 3.1: | 7.2: | 5.6: | 3.0: | 36:1. |
| Zinc Conc. #1 | 1.2 | : | 0.40: | 24.02: | 2.16: | 37.28: | 4.6: | 3.1: | 1.2: | 15.3: | 80.6:1. |
| Zinc Conc. #2 | 2.0 | : | 0.04: | 10.06: | 0.20: | 51.46: | 0.7: | 2.1: | 0.2: | 34.5: | 49:1. |
| Zinc middling | 10.6 | : | 0.14: | 10.36: | 0.69: | 5.15: | 13.6: | 11.4: | 3.4: | 18.0: | 9.5:1. |
| Flot. tailing | 79.6 | : | 0.04: | 1.48: | 0.34: | 0.88: | 29.4: | 12.3: | 12.6: | 23.2: | : |

Test No. 3. - Selective Flotation.

This test was made to show the effect of grinding the reagents in the ball mill and omitting zinc sulphate and ferrous sulphate from the pulp.

Lb./ton

Reagents to Ball Mill -

Soda ash - 10.0
Sodium cyanide - 0.10

Grind, 87 per cent minus 200 mesh.

pH of pulp in flotation machine, 7.3.

Reagents to Flotation -

Sodium ethyl xanthate - 0.05, added in stages.
Cresylic acid - 0.22, " " "

A lead concentrate was recovered in 10 minutes.

Recleaned with 0.02 pound NaCN and 0.05 pound of cresylic acid per ton.

Zinc Flotation -

Reagents to Flotation - Lb./ton

Lime - 10.0 (pH, 10.1)
Copper sulphate - 0.20
Sodium ethyl xanthate - 0.4, added in stages.
Cresylic acid - 0.20, " " "

(Continued on next page)

(Test No. 3, cont'd) -

A zinc concentrate was recovered in 7 minutes. Lime was added to the concentrate in the cleaner cell until pH of 10 was reached. The concentrate received two cleaning operations with an addition of lime to each to hold the pH at 10.

The two cleaner tailings were combined and designated zinc middling.

Results:

| Products | Weight: | | Assays | | | | Distribution, | | | | Ratio of |
|---------------|---------|------|---------|----------|----------|----------|---------------|----------|----------|----------|---------------|
| | per | cent | Oz./ton | Per cent | Per cent | Per cent | per cent | per cent | per cent | per cent | |
| | cent | cent | Au | Ag | Pb | Zn | Au | Ag | Pb | Zn | concentration |
| Lead | 100.0 | 0.07 | 9.63 | 2.34 | 2.38 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | |
| Lead conc. | 4.8 | 1.02 | 143.14 | 37.88 | 7.77 | 69.1 | 71.3 | 77.6 | 15.6 | 20.8 | 1 |
| Lead middling | 3.7 | 0.24 | 20.96 | 2.16 | 6.35 | 12.6 | 8.1 | 3.4 | 9.9 | 26.8 | 1 |
| Zinc conc. | 2.7 | 0.03 | 7.19 | 0.25 | 52.84 | 1.1 | 2.0 | 0.3 | 59.8 | 37.1 | |
| Zinc middling | 4.7 | 0.08 | 11.36 | 1.43 | 3.00 | 5.3 | 5.5 | 2.9 | 5.9 | 21.1 | |
| Flot. tailing | 84.1 | 0.01 | 1.49 | 0.44 | 0.25 | 11.9 | 13.1 | 15.8 | 8.8 | | |

Copper in the lead concentrate, 1.17 per cent.
 " " " zinc " , 0.25 "

The omission of zinc sulphate appeared to increase zinc in the lead concentrate and resulted in a lower grade of lead concentrate.

Test No. 4: - Bulk Flotation.

A sample of the ore was ground in a ball mill, with lime. The grind was 88 per cent minus 200 mesh. The alkalinity of the pulp was 10.5.

Lb./ton

Reagents to Ball Mill -

Lime - 10.0

Reagents to Flotation -

(pH in cell, 8.5)

Lime - 10.0 (pH of pulp, 10.5)

Copper sulphate - 0.2

Sodium ethyl xanthate - 0.07

Cresylic acid - 0.35

Lead and zinc floated together.

The concentrate was recleaned in a pulp of pH 10.0 with lime.

(Continued on next page)

(Test No. 4, cont'd) -

Results:

| Products: | Weight: | | Assays: | | | | Distribution, | | | | Ratio |
|-----------|---------|---------|----------|----------|----------|----------|---------------|----------|----------|----------|-------|
| | per | Oz./ton | Per cent | per cent | per cent | per cent | per cent | per cent | per cent | per cent | |
| | cent | Au | Ag | Pb | Zn | Au | Ag | Pb | Zn | conc. | of |
| Feed | 100.0 | 0.08 | 9.41 | 2.17 | 2.61 | 100.0 | 100.0 | 100.0 | 100.0 | | |
| Conc. | 11.2 | 0.52 | 60.72 | 15.69 | 19.53 | 72.1 | 72.4 | 80.9 | 84.0 | 9:1 | |
| Middling | 7.9 | 0.08 | 16.76 | 2.26 | 1.58 | 7.9 | 14.1 | 8.3 | 4.8 | 13:1 | |
| Tailing | 80.9 | 0.02 | 1.57 | 0.29 | 0.36 | 20.0 | 13.5 | 10.8 | 11.2 | | |

Summary and Conclusions, for Section II:

The investigation indicates that the material submitted for treatment has been severely weathered and oxidized.

A large amount of either lime or soda ash was required to reduce the acidity of the pulp to the correct pH for the flotation of the various products.

It was noted that the addition of 10 pounds of soda ash per ton in the grind produced a pH of 7.3, or barely alkaline. From this pulp most of the gold, silver, and lead was recovered. Then the pulp was made up to an alkalinity of pH 10 or higher with lime and the zinc was reactivated with copper sulphate and floated. Too much of the reagents activated pyrite and reduced the grade of the zinc concentrate. Better results were obtained by using zinc sulphate to depress zinc from the lead concentrate.

However, selective flotation produces a lead concentrate assaying 1.02 ounces of gold, 143 ounces of silver, 37.8 per cent of lead and 7.7 per cent of zinc per ton, with recoveries of 69, 71, 77 and 15 per cent respectively, and a zinc concentrate assaying 0.03 ounce of gold, 7.2 ounces of silver, 0.25 per cent of lead and 52.8 per cent of zinc, with

(Summary and Conclusions for Section II, concluded) -

recoveries of 1.1, 2.0, 0.3, and 59.8 per cent respectively.

In bulk flotation the products were recovered in one concentrate without separating lead from zinc. 72 per cent of the gold and silver reported with this concentrate. In making the bulk concentrate in a lime circuit the use of soda ash is avoided; this may result in a more economical operation.

It was observed that close control of the alkalinity of the pulp and the addition of the various reagents was essential in order to produce the results obtained.

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