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OTTAWA September 4th, 1942.

REPORT of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1292.

Concentration and Roasting Tests on a Sample of Arsenical Gold Ore from the Wampum Gold Mines Limited, at Flin Flon, Manitoba.

(Copy No. 1.)



DEPARTMENT

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

OF MINES AND RESOURCES MINES AND GEOLOGY BRANCH

OTTAWA

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Investigation No. 1292.

Concentration and Roasting Tests on a Sample of Arsenical Gold Ore from the Wampum Gold Mines Limited, at Flin Flon, Manitoba.

Shipment:

Fourteen sacks of ore, total weight 2,000 pounds, were received on July 5th, 1942. The shipment was submitted by A. J. McLaren, Consulting Engineer, 231 Glengrove Avenue West, Toronto, Ontario.

Location of Property:

This property is located at Douglas Lake, three miles west of Flin Flon, Manitoba.

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Character of the Ore:

No microscopic examination was made of the present shipment but a former shipment of ore from this property was examined and described in Report of Investigation No. 675, issued in 1936. The character of the samples appears to be the same although the first sample was higher grade than the present one. They contain arsenopyrite, pyrite, chalcopyrite, and sphalerite. The two latter minerals appear to some extent in fractures in the arsenopyrite.

Sampling and Assaying:

The shipment was sampled, assayed, and reported as follows:

| Gold | ಳವಳ | 0.47 | oz./ton | |
|---------|------------|-------|----------|-----|
| Silver | C 2 | 1.05 | 11 | |
| Copper | 9 | | per cent | |
| Zinc | = | 3.75 | 11 | . • |
| Iron | - | 18,00 | rq | |
| Arsenic | 649 | 13.24 | 17 | |
| Sulphur | - ج | 11.60 | 10 | |

Experimental Tests:

Concentration tests were conducted on samples of the ore to see how much of the gold, arsenic, and zinc could be recovered. The tests have shown that the arsenic and zinc are intimately associated and that a zinc concentrate of marketable grade cannot be produced. They also show that the gold, the majority of it at least, is not associated with the arsenic. About 90 per cent of the gold and almost 90 per cent of the arsenic can be recovered in a concentrate by flotation with the ore ground about 80 per cent finer than 200 mesh. By table concentration, with the ore ground through 20 mesh, 70 per cent of the gold and 75 per cent of the arsenic are recovered in the concentrate.

Details of Tests:

The following tests, typical of a number conducted, are described in detail as follows:

Test No. 1. - Flotation.

A sample of the ore was ground 70 per cent finer than 200 mesh and floated with the following reagents:

Charge to Ball Mill -

| | Ore Weter | e9 | • | grems grems | -]4 | məsh. |
|-------|---|----------|------------|---------------------|-----|-------|
| | | | <u>I.b</u> | /ton | | |
| | Sodium cyanid Zinc sulphate Aerofloat No. | | 1 | .10 .0 .07 | | |
| | Sode ash | | | 0 | | |
| Coppe | Pr-Arsenic Flo | tetio | n = | | | |
| | Amyl xanthate Pine oil | 5 5 | | .20 .05 | | |
| Arson | nic Cleaning C | 0]] | • | ı | | |
| | Pine oil | 83 | 0 | °02 | | |
| Zinc | Flotation - | | | х | | |
| | Copper sulpha Amyl xanthate Fine oll Sodium aerofl | ຍ ຍ ຍ | 0. | 0 10 05 10 | | |

| Summary | of Results: | |
|---|--|---|
| Ender (Ch offen der meinen bisternannen fersteren). (Ch | Weight,: Assays, : Distribution, | |
| Product | per (Exton: Per cent : per cent | |
| e we di an avenue su vez recent divert a the este sum and the second second second second second second second | dent'; Au ; Cu ; Zn ; As ; Au ; Cu ; Zn ; As | • |
| | | |
| Cu-As conc. | 40.34:1.30 11.01: 5.46:27.54: 92.71: 85.62: 47.47: 79.34 | |
| Cu-As midd. | 5,38:0,19:10,03: 3,49:12,93: 1,80: 0,34: 4,05: 4,97 | |
| Zine conc. | 10,56:0,19;0,26:18,57:16,13: 3,56: 5,77: 42,26: 12,16 | |
| Tailing | 43,72:0,025:0,09: 0,66: 1,13: 1,93: 8,27: 6,22: 3,53 | |
| | | |
| Contrast for al of an End And End And Contrast a fee | | |
| Feed (cal.) | : 100.00:0.57 ;0.48: 464:14.00:100.00:100.00:100.00:100.00 | |
| NAMES AND AND AND ADDRESS A | | |

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(Details of Tests, cont'd) -

Test No. 2. - Flotation.

A sample of the ore was ground 70 per cent finer than 200 mesh and then floated. The products were assayed for gold, copper, zinc, and arsenic.

| | Ore Water | • | ی د | | | grams at grams . | : -14 | mesh. |
|-------------|---------------|--------------------------------------|---------------|------------------|------------|------------------------|-------|-------|
| | | | | | <u>I.b</u> | ./ton | | |
| ، ، ر | Zinc | m cyani sulphat loet No ash | 8 | ස ධ ආ භ | 1 | 。10 。0 。07 。0 | | |
| Coppe | r-Ars | enic Fl | <u>otat</u> i | . <u>on</u> - | | | | |
| | Amyl Pî.ne | xanthat oil | 0 | 43 43 | | °50 °50 | | |
| Zinc | <u>Flota</u> | tlon = | | | | | | |
| | | r sul.ph xanthat | | - | | 。0 。10 | | |

| Summary | of | Resi | ults: | |
|---------|----|------|-------|--|
| | | | | |

| and in the second second second second second second | :Weight | | Asseys, | 00128-201000137-20100144 Million 00 | 23.0-24.9+ 6.04.22.2224-0+240 66078-052.0772.224 J j | Distri | bution, | activities with the desired of the second |
|---|-------------|---|--|--|--|-------------------------------|-------------------------------------|---|
| Product | ; per | ¿Oz./ton | | ont : | - | per | cont | |
| | : cent | s Au | : Cu ; Zn | : AS : | ; Au : | Cu : | Zn : | As |
| entration de la contrata de la contr | 0 5 | ANALASIAN SALASIAN ANALASIAN ANALASIAN ANALASIAN ANALASIAN ANALASIAN ANALASIAN ANALASIAN ANALASIAN ANALASIAN ANA | 0 | .0 0 0 | 00120403001800000000000000000000000000000000 | CALLERINGER CONTENTION AFARES | 2419111122001100290480040 9 9 | VALUE AND A AND A AND A |
| Cu-As conc. | : 14.40 | | :2.56: 6.4 | | | | | |
| Zn conc. | : 37,28 | 8: 0,38 | :0.14:10.9 | 8:30,06; | ; 25.60; | 11,95: | 74.84: | 80.36 |
| Tailing | : 48.2 | 6: 0,11 | :0.03: 0.9 | 1: 1.35; | ; 9.59; | 3,31: | 8 °03 ° | 4.67 |
| | C D | ŝ | 3 0 8 0 | 0 0 | | | | |
| 44 of Carrier and Carrier and Carrier and Carrier and | n n n | C 2) 20 Construction of the second se | 0 0 0 0 | 0 0 0 | , 0 | ¢ | 3 | |
| Feed (cal.) | : 1.00,0 | 0: 0.55 | :0.44: 5.4 | 7:13.96: | :100.00: | 100.00: | 100.00: | 100.00 |
| | | 0 | | is in the second | | | 0 0 | |

The higher soda ash seems to have depressed the arsenopyrite and carried the zinc and part of the gold with it.

(Details of Tests, cont'd) -

Test No. 3. - Flotation.

A sample of the ore was ground 80 per cent finer than 200 mesh and floated with the following reagents:

Charge to Ball Mill -

| Ore | e7 | 2,000 grams at -14 | mesh. |
|-------|----|--------------------|-------|
| Water | e7 | 1,500 grams. | |
| | | Lb./ton | - |

| Coal | tar creoso | to | |
|------|------------|------------------|------|
| | No. 634 | . a a | 0.07 |
| Caus | tic soda | e3) | l.O |

Copper-Iron and Arsenic Flotation -

| Amyl Pine | xanthate oil | , 55 | 0.20 0,05 |
|--------------|--------------------------|---------|--------------|
| Flote | tion - | | |
| | r sulphate m acrofica | | 1.0 |
| SOUTAN | nBu nBu | ت ب | 0,20 |

Summary of Results:

| | 10 A. | J. 6 5 J. 6 5 5 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 | | <u>و</u> ليد | | | | | | | | | |
|--|-------|--|----|--------------|----------------------------------|----------------------------|--------------------|--------|--|---|-------------------------------|---------------|-------------------------------------|
| | s Wr | eight, | S, | P | lssays | 3 , | | | | Distri | buti | on, | |
| Product | - | | | Oz /tan; | | | | | Contractor and a second second second | per | cent | WHERE ADDRESS | |
| a Branchimali Yaharing gang yang sang sang sang sing talah sang sang sang sang sang sang sang sang | ; (| cent : | 8 | <u>Au</u> : | ; Cu | ; Zr | 1 ; | AS : | Au : | : Cu | ; Zi | Ω ; | As |
| | 8 | And the second sec | 8 | 9 | / / / | ρ 0 | e D | ° 0 | f |)) | 0 | ő | |
| Cu-Fe-As conc. | | | | | | | | | | | | | |
| Zinc conc. | s , | 15°00 | 8 | 0.40 | :0.1.5 | :13.6 | 38 : 1 | 18.83: | 9,66; | : 4.32 | :: 30 | 。59 ; | 17.91 |
| Tailing | ; ; | 52,78 | 0 | 0,01; | ,0.04 | : 0.] | .5 ;] | 13.05; | 1.06: | 3.08 | 8] | .48: | 54.59 |
| and and the second standard the second s | 0 | | ç | C. | ; 3 | 3 | 0 8 | 0 0 | |)) | 0 . D | ¢ 0 | |
| | ç | | å | ç | 5 | 0 2 | 0 | b o | f | 1 | 0 | ş | |
| Feed (cal.) | :10 | 00.00 | 20 | 0.50 | :0.42 | : 5.2 | <i>5</i> 7 : T | 12.62: | 100.00; | ;1.00.00 | /:100 | °00 °. | 100.00 |
| | 0 | *********** | 0 | |) 3 #310971-07237121(6/607 | 0 0 5125-1123/2012/2 | A U Lawrence | 0 D | 7 • • • • • • • • • • • • • • • • • • • |) 3 Marilan estambalan iserangia. | 0 0 2017111111111111111 | 0 0 | TRANSMERSON AND ADDRESS (TRANSMERS) |

These tests have been conducted for the purpose of producing a zinc concentrate of marketable grade and a goldarsenic product for roasting, the arsenic to be recovered and the calcines to be treated for their gold content. The tailing assay in Test No. 3 seems to indicate that the gold and arsenopyrite are not associated, while the first concentrates in Tests Nos. 1, 2 and 3 indicate some relationship between the - Pago 6 -

(Details of Tests, cont'd) - .

gold and the chalcopyrite. The apparent copper-gold association, however, may be incidental to the occurrence of chalcopyrite in fractures in the arsenopyrite, as explained in the microscopic examination.

The majority of the zinc seems to occur in this manner also making it impossible to produce a zinc concentrate of marketable grade.

Test No. 4. - Flotation.

The caustic soda appeared to depress the arsenic in Test No. 3, so in the following test the arsenic was floated in a natural circuit and the zinc in an acid circuit.

Charge to Ball Mill -

| Ore Water Coal Tar Creosote | ยั อิ | 2,000 grams at -14 mesh. 1,500 grams. |
|-----------------------------------|------------|--|
| No. 634 | C 3 | 0.07 lb./ton. |
| Arsenopyrite Flotation | 3 | Lb./ton |
| Amyl xanthate Pine oil | er æ | 0.20 |
| Zinc Flotation - | | · |

| Copper sulphate | CD | 1°0 |
|---------------------|-------------|------|
| Sodium Acrofloat "B | 11 <u> </u> | 0°50 |
| Pine oil | 53 | 0.10 |
| Sulphuric acid | Ð | 3.0 |

| Summary of Results: | | | | | | | | |
|---|--|-------------------------------------|-------------------|---|----------|-------------------------------|--|---------|
| | .Weight,: | A: | ssays, | 0 | | Distri | bution, | |
| | oor i | 02/2022 : | Par can | | | per | cent | |
| | cent : | Au : | Chi : Zri | 3 AS 3 | Au : | Cu : | Zn : | As |
| anaith in neona an gnath bailtean an an tha bhaile an | Contraction of a sector of a sector of a | Andrican Alexandra Andria Q E | O O | 0 0 | 2 0 | 0 | 0 | |
| Cu-Fe-As conc. | 35,20 | 1.29 ;1 | .01; 8.83 | ໍ 29 . 08: | 89,93; | 85,12: | 60.01; | .87,08, |
| Zinc conc. | ໍ 8,95. | 0,35 :0 | .32,20.75 | 0.56; | .6,20; | 6.86: | 36,68; | 0,43 |
| Tailing | ໍ 55 85 ໍ | 0.035:0 | ຸດຣໍ ດ ້ອດ |); 2,63; | 3.87: | 8.02: | 3.31, | 15.28 |
| _ | ° | . 8 | n 0 | 200 | 0 | 0 | 0 | |
| CALIFORNIA CONTRACTOR AND | 0 0 | 0 | 0 | 6 0 0 D | ŝ | 0 | 0 | • |
| Feed (cal.) | : 100.00:0 | 0,51 :0 | .42: 5.06 | :11.76: | 100,00:1 | L00,00; | 100.00: | 100.00 |
| | | 0 0 | 0 0 | 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 | | o o Cardinationorialite | 0 0 0010000000000000000000000000000000 | |

This test shows a reasonably good recovery of gold

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(Test No. 4, cont'd) -

and arsenic in the concentrate but unfortunately the majority of the zinc is there also.

Tests Nos. 5 and 6. - Table Concentration.

Table concentration tests were conducted on samples of the ore ground through 10 and 20 mesh respectively. The finer sample gave a slightly higher grade concentrate with appreciably higher recoveries. A roasting and cyanidation test was conducted on a sample of the finer concentrate.

The sample to be reasted was placed in a cold muffle furnace and heated up to 480° C. as quickly as possible. The temperature was kept there till all fuming had ceased, about 40 minutes, and then raised to 750° C. to break up sulphates. The total reasting period was about $2\frac{1}{2}$ hours. The calcine was assayed and a sample reground and agitated in cyanide solution, 2.0 pounds NaCN per ton, for 48 hours at 2:1 dilution.

| Summary of Test | No. 5 (Gri | nd, -10 mesh). | | |
|---|--|-----------------------|--|--------------|
| | | ASSOVS, | | bution, |
| Product | per :0z./ | ton: Per cent | er per | Cent |
| ם הייקר הייקר הייקר היי | cont : An | 2 ; As ; Zn | : All : A | s ; Zn |
| g | | | | |
| Conc. $-10+20$ mesh : | | 39 : 27 .54 : 3 . 14 | | 4,96; 10,35 |
| -20435 " | | 98 : 88° 88 : 3° 34 : | | 8.04: 7.75 |
| -35 ⁿ | 9,13 : 1.; | 36 :33,78; 3,54; | | 2.43: 8.55 |
| Middling -10+20 mosh: | 8,90 : 0,8 | 54 :10,52; 5,06; | ; 8ູ95: | 6.81; 11.91 |
| -20+35 " ; | 3,59:0.4 | 12 : 9.79; 4.75; | : 2,81: | 2.56; 4.51 |
| -35 ⁿ | 7.16 : 0.4 | 16 : 9,98; 7,08; | . 6,14: | 5,20: 13,41 |
| Tailing | 49,99 : 0,2 | 25 : 5,50: 3,29: | : 23,28: 2 | 0.00: 43.52 |
| | 8 | A 3 3 | 9 0 0 | ა ი |
| ייידער אודייעראלא ישרעה אינער אינעראינעראינעראינעראינעראינעראינעראינער | 2027/2022/2020 auge trigging digine (1922/2020/2020/2020/2020) O Q | 0 0 0) () () | j D De la far an Alexandra (Alexandra (A | |
| Feed (cal.) | : 100.00: 0.1 | 54 :13.75: 3.78: | : 100.00: 10 | 0.00: 100.00 |
| ם ס עריקעיין אינגע אינגע אינגענטיבענטיבינע אינגעאעראיני אינגע אינגע אינגע אינגע אינגע אינגע אינגע אינגענטיבי גענ | 14 6 6 7 7 7 | | | |
| | ů o | | 0 0 | 9 5 |
| Average concs. | 30.36; 1.0 |)4 ;29.63: 3.32: | : 58,82: 6 | 5.43: 26.65 |
| | | | | 0 3 |

(Continued on next page)

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

| Summary of | | | | | esh). | | | | |
|---|-------------|---|---|-------------------------------|--|---|---|---|-----------------------|
| | 0 | Weight, | | | | ; Dis | tribut: | ion, | |
| Product | 00 | per | :03./ton: | <u>Per c</u> | ent | 3 | r cent | י אין ג'בינ לעיר אנה המאנה הוא איני לי איי איני אייני איינ | |
| <u>, </u> | 3 | cent | s Au | AS | : Zn | <u>3 AU 1</u> | As | <u>: Zn</u> | |
| | 0 0 | 2343.2453.4453.4454.4553.4473.4674.4664.444 | | Kr | 0 V | 0 4 | and a second | 0 0 0 | an ar far in the st |
| Table conc. | 3 | 34.40 | : 1.07 : | 29,34 | \$ 3.74 | : 70.45: | 75.01 | : 36,37 | |
| Table middling | 20 | 11,91 | : 0.44 ; | 14.80 | : 4.,65 | : 10.03: | 13.10 | : 15.66 | |
| Table tailing | 40 | 53,69 | : 0.19 : | 2,98 | :3,16 | : 19,52: | 11.89: | : 47.97 | |
| | ŝ | | 6 g 6 D | | 0 0 | ç 50 9 30 | | 0 0 | |
| | å | | 5 d | | 0 2 | n 0 0 | | () () | |
| Feed (cal.) | 6 5 | 100.00 | : 0,52 ; | 13,46 | :3.54 | :100.00: | 100.00 | : 100.00 | |
| anan maana ka sa | ម រ រ | and and the second states to second states | | T UP 31 E LIPPEL TZ EARLOWNED | Q Q X Delay Lickellan Quinty 7.7 | | 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 | 0 0 11 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 | Martin and the second |
| | 30 | | | | 0 0 | 3 03 | | e n | |
| Conc. roasted | 00 | 22.44 | : 1,58 ; | 0,85 | \$ 5 .77 | : 67.87: | 0.64 | ° == | |
| ಕೆ ಬಿಲ್ಲೆ ಗಾಗಿ ಸಿಲ್ಲಿ ಮಾಲ್ಯಾನ ಬಾಹಕ ಸ್ಥಾನ ಸ್ವಾಚಿಸಲ್ಲಿ ಕಾಗ್ರಡಲ್ಲಿ ಕಾಗ್ರ ಕೆಟ್ಗಳು ಸಿಲ್ಲಿಸಿಗಳು ಸೇಹಿನ ಸಹಾಗಳು ಗ್ರಾ ಕಾರ್ಯಗಳು | 8 5 | 3 | 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 | FRUERA ALEXTENNIC ZZENTE | 0 0 | 0 0 0 0 0 0 0 | 19942217-2020-61624-18-36-18-56-18-56-18-56- | 6 () () | ***** |
| ~ 7 ^ ^ ^ ^ ^ | 0 | — — — — — — — — — — | | | 5 . 5 | | • | 0 | |
| Calcine cyanided | i s | 22.44 | : 0,13 : | ŧ | ° ~ | : 5,59; | e 5 | 0 m | |
| HAM DINI DIN KATANA TAMADA MANJARANA MANJARANA MANJARANA MANJARANA MANJARANA MANJARANA MANJARANA MANJARANA MANJ | | ALLEN STOCK SHARE ST | 0 0 7.2010/J.N.101/J.H.101/11/10/10 | FAMESISTATI | o O Nasharanan | 9 6 6 0 8 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 | a and a state of the second | o D HANDESPISIALENSEDENSE | |

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The difference between this figure and the gold content of the table concentrate represents the amount unaccounted for in roasting.

Extraction of gold by cyanidation - 62.28 per cent total Recovery of arsenic by reasting - 74.37 " " Loss in weight by reasting - 34.76 per cent.

Reagents -

| Final Titration, | | <u>lb./ton solution:</u> |
|------------------|----|--------------------------|
| ne.Cn | 5 | 1.80 |
| Ca.o | 9 | 0.24 |
| Consumed, | | lb./ton cslcine: |
| Nacn | e: | 9 <i>~</i> 4 |
| Cao | g | 13,5 |

The following additional assays were made on the table concentrate and calcine:

| | Table | Calcine from |
|------------------|-------------|-------------------|
| | concentrate | table concentrate |
| Silver, oz./ton | 1.74 | 2 , 5 9 |
| Copper, per cent | 0.37 | 0.61 |
| Iron, " | 30,65 | 45 . 90 |
| Sulphur, " | 21,06 | 1。55 |
| Insoluble, " | 11,39 | e |
| Silica, " | - | 78°58 |

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Conclusions:

The foregoing tests have shown that the gold and arsenic can be concentrated. After reasting, to recover the arsenic as the oxide, the calcines can be treated for their gold content, either by smelting or in a cyanide plant. A zinc concentrate of marketable grade cannot be produced either from the ore direct or from the calcines.

Concentrates of approximately equal grade can be made by either flotation or tabling but higher recoveries of both gold and arsenic will be obtained by flotation. In view of the limited tonnage of ore to be treated, however, table concentration may be more practical owing to the lower capital expenditure.

Good practice in roasting arsenical ores is to bring the temperature up to 460°C, as quickly as possible and hold it there till all fuming ceases. This gives an efficient roast and prevents the formation of ferric arsenates. The temperature should then be raised quickly to 750°C, to break up sulphates. In this way, 99 per cent of the arsenic in the roaster feed will be recovered as the oxide. The oxide so recovered will be impure and will have to be refined further to produce the white oxide.

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