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MINES BRANCH INVESTIGATION REPORT

IR 72-48

October 1972

DEVELOPMENT OF A FLOWSHEET TO PRODUCE IRON AND COPPER CONCENTRATES FROM ORE OF PAULPIC GOLD MINES LIMITED, NEAR ATIKOKAN, ONTARIO

Ъy

I. B. Klymowsky

Mineral Processing Division

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DEVELOPMENT OF A FLOWSHEET TO PRODUCE IRON AND COPPER CONCENTRATES FROM ORE OF PAULPIC GOLD MINES LIMITED, NEAR ATIKOKAN, ONTARIO

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SUMMARY OF RESULTS

The two types of ore, high-sulphide (47.7% Fe, 0.54% Cu, 17.9% S) and low-sulphide (38.4% Fe, 0.17% Cu, 2.8% S) were similar mineralogically, but differed widely in magnetite:sulphide ratio.

Marketable iron concentrates were produced by conventional treatment (magnetic separation and flotation) of each ore separately and of a 45:55 composite of the two ores, as shown by the following results:

| Ome Read | Concen | Conc'n | | |
|-----------------|--------|-------------|------------|-------|
| Ofe Feed | % Fe | <u>% Cu</u> | <u>%</u> S | Ratio |
| ligh-Sulphide | 71.2 | 0.01 | 0.31 | 8:1 |
| Low-Sulphide | 66.9 | 0.01 | 0.33 | 2.7:1 |
| 45:55 Composite | 69.3 | 0.01 | 0.17 | 4.5:1 |

Satisfactory copper flotation concentrates (18.9% Cu) were produced from the high-sulphide ore and from the composite ore with recoveries above 70%.

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INTRODUCTION

Paulpic Gold Mines Limited holds 3,300 acres of mining land near the town of Atikokan, Ontario, about 140 miles northwest of Thunder Bay. Iron ore was mined on the property prior to 1912 by the Atikokan Iron Company, but the operation was short-lived because the ore had a high sulphur content and could not be treated profitably at that time. Paulpic optioned this property for exploration in 1970 and did some geophysical surveying and diamond drilling which indicated a large tonnage of low-grade iron and base metal ore on the property. Further drilling on the property was deferred until some metallurgical testing could be done on the ore.

Purpose of Investigation

The Mines Branch was asked to develop procedures for treating the Paulpic ore to produce a high-grade iron concentrate (with less than 1% sulphur) suitable for pelletizing; a marketable copper concentrate and, if practical, to recover the nickel and cobalt minerals.

Ore Shipment

On November 5, 1970, two samples of drill core were received at the Mines Branch from Mr. E. W. Bazinet, consultant at that time for Paulpic Gold Mines Limited. One sample, weighing about 225 lb,was sulphide-rich; the other, approximately 275 lb, was low in sulphides. Sampling and Analysis

The high-sulphide ore sample was crushed to minus 10 mesh and riffled into smaller (2,000-gram) portions, one of which, selected at random, was ground to minus 100 mesh and sampled for analysis.

The low-sulphide drill core was crushed to minus 1/2 inch for cobbing. The products from this operation were crushed to minus 10 mesh and riffled into smaller (2,000-gram) portions which were ground to minus 100 mesh and sampled for analysis.

Results of chemical analysis are given below.

TABLE 1

Results of Chemical Analysis of Ore Samples

| | <u>Wt %</u> | Total Fe % | Mag Fe % | Sol <u>Fe %</u> | <u>Cu %</u> | <u>Ni %</u> | <u>Co %</u> | <u> </u> | <u> </u> |
|-------------------|-------------|---------------|-------------|--------------------|-------------|-------------|-------------|----------|----------|
| Low-Sulphide Ore* | 55.0 | 41.5 | 26.5 | 38.4 | 0.17 | 0.02 | 0.02 | 2.8 | 0.21 |
| High-Sulphide Ore | 45.0 | 50.2 | 36.0 | 47.7 | 0.54 | 0.08 | 0.08 | 17.9 | - |
| Composite Ore ** | 100.0 | 45.4 | 30.8 | 42.6 | 0.33 | 0.05 | 0.05 | 9.6 | - |

* calculated from results of cobbing test. ** calculated.

MINERALOGICAL EXAMINATION⁺

Sixteen representative pieces of drill core (eight from the highsulphide ore, eight from the low-sulphide ore) were sent to the Mineralogical Section of the Mineral Sciences Division for examination. Both high- and low-sulphide ores were found to have similar mineralogical characteristics except for variation in the magnetite:sulphide ratio.

Magnetite, the principal iron mineral, occurred as large clusters of grains in pyrrhotite and as remnants intimately associated with pyrrhotite. Pyrrhotite, also magnetic, occurred throughout the ore and was the host mineral for inclusions of copper, nickel, and cobalt.

Chalcopyrite, the only copper mineral detected, occurred over a wide range of sizes from large grains to fine inclusions in gangue, magnetite, pyrite, and pyrrhotite.

+ From Mineral Sciences Division Report IR 71-44, by R. G. Pinard.

Nickel and cobalt occurred in too small quantities for economic recovery.

Gangue minerals were chiefly talc, chlorite, quartz, and dolomite.

OUTLINE OF INVESTIGATION

Because of the marked difference in sulphur content between the highsulphide ore (17.9% S) and the low-sulphide ore (2.8% S), laboratory tests were done separately on the two samples in the initial stage of the investigation.

For the high-sulphide ore, ground to minus 100 mesh , two general procedures were followed.

(1) Flotation of a copper rougher concentrate followed by successive cleaning; flotation of pyrrhotite from the copper flotation tailing; and magnetic separation of an iron concentrate from the final flotation tailing.
 (2) Magnetic separation of a magnetite-pyrrhotite concentrate; flotation of pyrrhotite from the magnetic concentrate to leave an iron concentrate; and flotation of a copper rougher concentrate from the non-magnetic portion followed by successive cleaning of the copper concentrate.

The second procedure was selected as the basis for subsequent detailed investigation of the high-sulphide ore.

Magnetic cobbing was done on the low-sulphide ore at minus 1/2 inch, and procedures similar to those used on the high-sulphide ore were applied to the products of the cobbing operation.

At the beginning of the investigation, the idea of separate treatment of the high-sulphide and low-sulphide ores appeared promising, especially with regard to cobbing of low-sulphide ore; however, the practicability of mining the two types of ores separately was uncertain and this approach was not followed through. For the remainder of the investigation, composite ore was used to assess the best procedures indicated in previous tests and to integrate them into a practical flowsheet.

DETAILS OF INVESTIGATION

Full details of the procedures, reagents used, analytical results and metallurgical balances are provided by the Mines Branch Flotation Test Reports in the Appendix (Tests 1-18).

The difficulties intreating the high-sulphide ore were: (1) reducing sulphur to a satisfactory level (below 1%) in the iron concentrate, and

(2) overcoming the interference of slimes (talc and chlorite) in copper flotation.

The principal source of sulphur in the iron concentrate was pyrrhotite. To provide uniform feed for tests to determine the best conditions for flotation of pyrrhotite, a large sample of ore (ground to minus 100 mesh) was treated by magnetic separation, and the magnetic concentrate so produced was split into several portions. The effects of soda ash and sulphuric acid on pyrrhotite flotation (in the presence of copper sulphate) were compared. The effect of regrinding the magnetic iron concentrate before flotation was investigated and the effect of pyrrhotite cleaner flotation on iron recovery was also investigated.

Similarly, the large non-magnetic fraction of the sample was split into several portions for copper flotation tests. Some tests were done to determine whether the interference of the slimes could be overcome by incorporating a slime flotation stage prior to copper flotation. Other tests were done to see if the copper would float better in a sulphuric acid circuit, and

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to compare different collectors, Minerec 27 and Z-200.

The best procedures were then incorporated in a final test on a sample of high-sulphide ore to confirm a tentative flowsheet for production of a magnetic iron concentrate and a copper concentrate.

When the results of the Davis Tube tests on the products of the lowsulphide ore cobbing operation indicated good recovery of iron in the cobber concentrate, it was decided to treat the cobber concentrate and cobber tailing separately. High-grade iron concentrates were made from the cobber concentrate by magnetic separation, and the small amount of sulphur in the iron concentrate was removed by flotation. Several attempts were made at recovering the small amount of copper in the cobber tailing, but none were successful.

A composite of 45% high-sulphide ore and 55% low-sulphide ore, ground to minus 48 mesh, was treated along the lines of procedure (2), namely:

- (a) wet magnetic separation;
- (b) regrinding of the magnetic fraction to minus 100 mesh and flotation of pyrrhotite;
- (c) regrinding of the non-magnetic fraction to minus 100
 mesh and flotation of a copper concentrate.

To reduce the loss of copper in the magnetic fraction separated at minus 48 mesh, the composite ore was ground to minus 100 mesh and treated by the same procedure, but without regrinding of the rougher concentrates.

Finally, to check the encouraging results of the preliminary cobbing, a composite ore made up of 60% high-sulphide ore and 40% cobber concentrate was treated by procedure (2) as outlined above.

In the initial test on the high-sulphide ore using procedure (1), a copper concentrate was made assaying 23.16% Cu with a copper recovery of 56.0%, and an iron concentrate was made assaying 67.3% Fe, 5.1% S, and 0.03% Cu

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with an iron recovery of 24.1%.

In Test 2, by the alternative procedure, namely magnetic separation, pyrrhotite flotation from the magnetic fraction and copper flotation from the non-magnetic tailing, a copper concentrate was made assaying 21.75% Cu with a recovery of 59.6% and an iron concentrate assaying 67.0% Fe, 7.1% S, and 0.02% Cu with an iron recovery of 28.4%.

The minimal loss of copper in the magnetic fraction and slightly greater recovery of magnetite by the second procedure prompted its selection as the basis for subsequent investigation, particularly since the prior removal of the magnetic fraction (61.8% of the feed) sharply reduced the amount of material for copper flotation.

In Test 3, the flotation of pyrrhotite from the magnetic fraction at minus 100 mesh, using soda ash and an increased amount of copper sulphate (0.5 lb per ton of ore) at pH 8.5, produced a 66.3% iron concentrate with 5.8% S. The results of screen analysis of the iron concentrate (Table 2) suggest that regrinding to minus 400 mesh might result in a lower sulphur content. In Test 4, regrinding of the feed to flotation resulted in a higher grade of iron concentrate (69.4% Fe), but not in any significant reduction in the sulphur content (5.0% S). However, in Test 5, without regrinding, and using a combination of sulphuric acid and copper sulphate, flotation at pH 6.0 facilitated the separation of pyrrhotite and produced an iron concentrate containing only 0.6% S with 68.0% Fe. By hydroseparation, that iron concentrate was upgraded to 68.9% Fe (21.2% recovery).

In an attempt to increase the recovery of iron, the pyrrhotite was floated in three stages and the third stage cleaned to leave a magnetite-rich tailing (Test 6). Although the latter contributed an additional 3.5% recovery of iron for a total of 25.8%, the sulphur content of the iron concentrate increased sharply from 0.7% to 1.5%.

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In Tests 1 and 2, copper flotation was done at a pH of 10.0 using Z-200 as collector and satisfactory copper concentrates were produced, but difficulties were encountered in obtaining a clean separation of the copper from the slimes inspite of the fact that a slime depressant (causticized starch) was used.

In Test 7, slime flotation was tried prior to copper flotation, using pine oil to float the slimes. A loss of 46% of the copper was incurred in the slimes. In Test 8, slime flotation was tried again, but this time using sodium cyanide to control copper losses in the slimes. The losses were reduced to 8.4% while 84.7% was recovered in the rougher concentrate, assaying 6.3% Cu.

In Test 9, flotation was done using Minerec 27 as collector and sulphuric acid to adjust the pH to 6.0. A high-grade rougher concentrate was made assaying 11.9% Cu with a recovery of 81.9% of the copper. Scavenger flotation, using Z-6 as collector, separated another 12.2% of the copper at only 0.8% copper grade due to inclusions of copper in pyrite. In a similar test (Test 10), using sulphuric acid to adjust the pH to 6.0 and Z-200 as collector, 87.1% of the copper was recovered in the rougher concentrate, but the grade was only 7.22%. The slimes appeared to float more readily with Z-200 and a grade of only 9.5% was obtained after one cleaning.

In the final test on the high-sulphide ore ground to minus 100 mesh (Test 11), a magnetic iron concentrate assaying 71.2% Fe and only 0.3% S, at a concentration ratio of 8:1, was obtained using sulphuric acid copper sulphate as modifiers in pyrrhotite flotation. Increasing the xanthate (Z-6) conditioning time to 5 minutes favored rapid flotation of the pyrrhotite. By flotation from the non-magnetic fraction, which contained 89.6% of the copper in the original ore, 71.7% recovery was achieved at 18.9% copper grade after two clean-

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ings, using sulphuric acid and Minerec 27. Again, scavenging proved ineffective as a means of recovering more copper. The scavenger concentrate consisted mainly of pyrite, comprised 7.9% of the weight, contained 0.64% Cu, and represented 9.5% of the original copper. Another 10.2% of the copper was irrecoverably tied up in the pyrrhotite. The procedure used in Test 11, but without the final scavenger step, was adopted as the standard test procedure.

Because of the much higher magnetite:gangue ratio in the low-sulphide ore, dry magnetic cobbing at the 1/2-inch size was used to separate magnetic iron from copper minerals. Results of cobbing and Davis Tube tests (Tables 3 and 4) show that 93% of the magnetic iron was retained in the cobber concentrate. After crushing it to minus 10 mesh, separating magnetically, and grinding to minus 100 mesh for another stage of magnetic separation a 67.6% iron concentrate was produced, containing only 0.02% Cu, but with 1.6% sulphur (Test 12). However, in Test 13, magnetic separation at minus 100 mesh, followed by flotation of the pyrrhotite from the magnetic iron concentrate, reduced the sulphur content to 0.33% and the copper to 0.01% in a 66.9% iron concentrate.

Copper flotation from the cobber tailing was less successful. Using the best procedure developed for the high-sulphide ore, only 36.9% of the copper was recovered in Test 14, using Minerec 27 and Z-6 as collectors; while in Test 15, with Z-6 alone, copper recovery was 52.8%. Cleaner concentrate grades were only 7.9% Cu and 8.7% Cu respectively. Despite the ease with which a marketable iron concentrate could be produced from the low-sulphide ore by coarse cobbing and magnetic separation after regrinding, this approach was not followed through because of the uncertainty of mining the two types of ores separately.

In Test 16, on the composite ore (45% high-sulphide, 55% low-sulphide), the initial magnetic separation was done at minus 48 mesh. However, some 22.7% of the copper was retained in the magnetic fraction and was thus almost irrecoverably lost. As a result, after regrinding the non-magnetic tailing, flotation gave a copper recovery of only 57.9% in the cleaner concentrate. After regrinding

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the magnetic fraction, pyrrhotite was floated off without the addition of copper sulphate, and an iron concentrate assaying 64.8% Fe was produced containing only 0.3% S. Subsequent magnetic separation yielded a high-grade iron concentrate assaying 69.7% Fe and 0.33% S.

In Test 17, the "standard" treatment was applied to another portion • of composite ore (45:55) ground initially to minus 100 mesh. Only 9% of the copper was lost in the magnetic fraction. From the non-magnetic tailing, a copper concentrate was produced assaying 18.9% Cu with a recovery of 74.0% of the copper in the original feed. By floating pyrrhotite from the magnetic fraction a 69.3% iron concentrate containing only 0.17% S was produced.

Finally, in Test 18, to check the encouraging results of preliminary cobbing, the successful "standard" procedure was applied to a composite ore made up of 60% high-sulphide ore and 40% cobber magnetic concentrate, i.e., after removal of about 25% of the original low-sulphide feed as a non-magnetic tailing containing little recoverable iron. Consequently, recovery of iron was about the same as in Test 17, although the grade of the concentrate dropped to 67.3% Fe and the sulphur content increased to 0.88% S. Grade of the copper concentrate was well maintained at 18.8% Cu, but overall recovery fell to 64.6% because of the copper discarded in the non-magnetic cobber tailing.

For comparison, the results of the final three tests are summarized below:

| (1) t | Feed Iron Concentrate | | | | | | | | Copper Concentrate | | | |
|-------|-----------------------|------|------|----------|------|------|------------------|----------|--------------------|-------------------|--|--|
| Test | | 1 | Mesh | Analysis | | Conc | % Distn | Analysis | Recovery | | | |
| NO. | Hi-S | Lo-S | Size | % Fe | % Cu | % S | Ratio | Fe | % Cu | % | | |
| 16 | 45% | 55% | - 48 | 69.7 | 0.01 | 0.33 | 4.3 | 38.3 | 19.9 | 57 .9 | | |
| 17 | 45% | 55% | -100 | 69.3 | 0.01 | 0.17 | 4.5 | 36.3 | 18.9 | 75.2. | | |
| .18 | 45% | 30%* | -100 | 67.3 | 0.01 | 0.88 | 3.6 ^e | 37.3 | 18.8 | 64.6 ^x | | |

* cobber magnetic concentrate

e excluding cobber non-magnetic tailing

x original ore basis.

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| TABLE | 2 |
|-------|---|
| | |

| Mach Cino | 1.14 7 | Analysis, % | | | | |
|---------------|---------|-------------|-------|--|--|--|
| Mesh Size | WL /0 - | Fe | S | | | |
| -100+200 | 5.4 | 50.99 | 17.19 | | | |
| -200+270 | 11.5 | 60.91 | 18.72 | | | |
| -270+325 | 17.1 | 12.78 | | | | |
| -325+400 | 3.5 | 67.06 | 8.77 | | | |
| -400+500 | 25.7 | 69.84 | 2.66 | | | |
| -500 | 36.8 | 70.63 | 1.16 | | | |
| Total (Calcd) | 100.0 | 67.2 | 6.7 | | | |

Screen Analysis of Iron Concentrate, Test 2

TABLE 3

Metallurgical Results of Cobbing, Low-Sulphide Ore

| Product | LI+ 9 | Ana | alysis, % | | Distribution, % | | | | |
|----------------------------|--------------|----------------|---------------|------|-----------------|-------------|--------------|--|--|
| FIOUUCL | WL % | Sol Fe | Mag Fe | Cu | Sol Fe | Mag Fe | Cu | | |
| Cobber conc Cobber tail | 55.0 45.0 | 53.27 20.28 | 44.91 4.12 | 0.12 | 76.2 23.8 | 93.0 7.0 | 40.0 60.0 | | |
| Feed (calcd) | 100.0 | 38.43 | 26.55 | 0.17 | 100.0 | 100.0 | 100.0 | | |

TABLE 4

| Results of Davis fube fests on Cobber Concentrate and |
|---|
|---|

| Draduat | L1+ 9/ | Analysis | Dist'n | | |
|-------------------------|--------|----------|----------|--|--|
| rioduce | WL /a | % Sol Fe | % Sol Fe | | |
| Cobber Conc - D.T. Mags | 67.6 | 66.43 | 85.2 | | |
| D.T. Non-mags | 32.4 | 24.16 | 14.8 | | |
| Feed (calcd) | 100.0 | 52.73 | 100.0 | | |
| Cobber Tail - D.T. Mags | 7.8 | 52.87 | 20.7 | | |
| D.T. Non-mags | 92.2 | 17.08 | 79.3 | | |
| Feed (calcd) | 100.0 | 19.87 | 100.0 | | |

CONCLUSIONS

A procedure for treating the Paulpic ore has been developed as follows:

- (1) grinding to minus 100 mesh (70-75% minus 325 mesh);
- (2) conventional low-intensity magnetic separation;
- (3) flotation of pyrrhotite from the magnetic fraction without regrinding, using Z-6 as collector, Dow Froth 250 frother, and sulphuric acid to adjust the pH to 6.0;
- (4) flotation of a copper concentrate from the non-magnetic portion, without regrinding, using Minerec 27 as collector, and sulphuric acid to adjust the pH to 6.0; successive cleaning of the rougher concentrate.

Marketable iron concentrates can be made from either the highsulphide ore or the low-sulphide ore or a composite of the two ores.

A satisfactory copper concentrate (18% Cu) can be made from the high-sulphide ore with a recovery above 70%, and the high-sulphide ore can be blended with the relatively copper-poor (0.17% Cu) low-sulphide ore for treatment without significantly affecting the overall recovery and grade.

If the two types of ore can be mined separately, then coarse cobbing (at minus 1/2 inch) should be considered in the treatment of the low-sulphide ore, as 45% of the weight of this type of ore can be rejected with little loss of recoverable iron.

Separate treatment of the low-sulphide cobber tailing for copper does not appear to be practical because of the small quantity of copper involved and the intimate association of the copper with pyrite. Recovery of cobalt and nickel does not appear to be practical because the cobalt and nickel minerals occur in too small quantities and are not concentrated in any of the products.

The pyrrhotite concentrate (60% Fe and 22% S) can be used as a source of iron or sulphur, or can be stockpiled for possible use in the future.

ACKNOWLEDGEMENTS

All chemical analyses in connection with this investigation were done by the Analytical Chemistry Sub-Division of the Mineral Sciences Division.

The author wishes to express his appreciation to Mr. R. P. Bailey of the Mineral Processing Division for his assistance in the preparation of this report.

APPENDIX

Mines Branch Flotation Test Reports

Abbreviations Used in Test Reports

| CS | Caustic starch - aqueous solution of caustic soda and starch in the ratio 1:2 |
|--------------------------------|--|
| Z-2 00 | Carbamate, made by Dow Chemical Co. |
| DF 250 | Dow Froth 250 |
| H ₂ SO ₄ | Sulphuric Acid |
| CuSO4 | Copper Sulphate Pentahydrate |
| Z6 | Potassium Amyl Xanthate, made by Dow Chemical Co. |
| Ca0 | Lime, 85% pure |
| Na_2CO_3 | Soda Ash, Laboratory grade |
| РО | Pine Oil |
| Min 27 | Minerec 27, made by Minerec Corporation. |

IBK/am

| TEST NO. 1 SAMP | MPLE: High-Sulphide Ore DATE: | | | | | | | | | | | | | | |
|-----------------------|-------------------------------|---------|------------|----------|---------------|----------|--------|-------|---------|----------------|------------|-------|-------------------|----------|----------|
| OBJECT OF TEST: To in | vestig | ate ti | ne flo | tation | of cop | per fr | om the | ore p | rior to | 2 | | СНА | RGE: 20 | 00 gra | ms |
| magnetic separation | | | | | | | | | TES | TED BY | <u>':</u> | | | | |
| | Time | % | | υ | nit | | | | Rea | gents, | lb per | ton c | f High- | Sulphi | de Ore |
| OPERATION | min | Solids | рн | u | sed | CS | Z-200 | DF250 | H2S04 | CuSO4 | Z-6 | CaO | | <u> </u> | |
| Grinding to -100 mesh | 30 | 57.1 | | Ball | . Mill | | | | | | | | | | |
| Conditioning | 5 | 33.3 | 10.0 | 1000 |)-g cell | 0.6 | | | | | | | | ļ | |
| Cu Rougher Flotation | 5 | | | 11 | | | 0.04 | 0.008 | | | | | | | ļ |
| Conditioning | 5 | | 7.0 | 11 | | | | | 2.4 | 0.20 | | | | | |
| Pyrrhotite Flotation | 10 | | | 1 | | | | 0.008 | | | 0.10 | | | | |
| Magnetic Separation | | | | Sala | | ļ | | | | | | | | | |
| | | | | | | | | | | | | | | | <u> </u> |
| Regrinding | | | | | | | | | | | | | | | |
| Cu Rougher Conc | 1 5 | 57.1 | 11.0 | Ball | . <u>Mill</u> | | | | | | | 0.33 | 8 | | |
| Cu Cleaner No. 1 | | | | 250- | g cell | | | | | | | | | | ļ |
| " No. 2 | | | | <u> </u> | 11 | | | | | | | | | | ļ |
| " No. 3 | | | | | 31 | <u> </u> | | | | | | | | <u> </u> | |
| | W | т | ANALYSIS % | | | | | | | DISTRIBUTION % | | | | | |
| PRODUCI | 9 | 6 | 7e | C11. | s | | | | | F | e(| Cu | | | |
| | | | | 00.16 | 22 21 | | | | | | 0 | 56 0 | 23 | | |
| Cu Cleaner Conc | | | | 1 22 | 17 21 | | | | | 5 | .6 1 | 19.5 | 8.2 | | |
| Gu Cleaner Tails | | | 1 31 | 4.10 | 19.19 | | | - | | | | 75.5 | 10.5 | | |
| Burrhotite Conc | 5 | 3.9 5 | 5,31 | 0.20 | 27.87 | | | | | 62 | .1 | 20.0 | 83.4 | l | |
| Flotation Conc* | 6 | 2.8 5 | 2.40 | 0.82 | 26.94 | | | | | 68 | .6 9 | 95.5 | 93.9 | | |
| | | | | | | | | | | | | | | ļ | |
| Magnetic Iron Conc | 1 1 | 7.2 6 | 7.32 | 0.03 | 5.11 | | | | | 24 | •1 | 1.0 | 4.9 | | |
| Magnetic Sep'n Tail | 1 | 9.0 1 | 8.41 | 0.10 | 1.11 | | | | | 7 | <u>·</u> 3 | 3.5 | $\frac{1.2}{1.2}$ | | |
| Final Flot'n Tail* | 3 | 6.2 4 | 1.66 | 0.07 | 3.01 | | | | | 31 | •4 | 4.5 | 6.1 | | |
| | | | | 0 / | | | | | | 100 | | | 100.0 | | |
| Feed* | 10 | 0.0 4 | 7.99 | 0.54 | 18.01 | | | | | 100 | •0 I | 0.0 | 100.0 | Ì | |
| | | | | | | | | | | | | ļ | | | |
| | | | | | | | | | | | | | | | |
| * Calculated | | | | | 1 | | | | | | | | 1 | Ì | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |

REMARKS:

| TEST NO. 2 | T NO. 2 SAMPLE: High Sulphide Ore DATE: | | | | | | | | | | | | | | | |
|--|---|--------|-------|--------|---------|----------------|--------|---------|--------|--------|---------|----------|-------|--------|---------|--------|
| OBJECT OF TEST | To ii | nvesti | gate | the a | ternat | ive proc | edure | - magn | etic s | eparat | ion fo | llowed | CHA | RGE: | 4000 gr | ams |
| by flot'n of pyrr. the non-magnetic | notite tailing | rom | cne m | agneti | .c irac | tion of | the or | re, and | ITOL. | n or c | opper | ITOM | TES | TED B | Y: | |
| | | Time | % | 1 | | Jnit | [| | | , Rea | igents, | lb per | tono | f High | Sulphi | de Ore |
| OPERATION | | min | Solid | s pH | t | used | Na2CO3 | CuSO4 | Z-6 | CS | Z-200 | DF250 | CaO | | | |
| Grinding to -100 | mesh | 30 | 57.1 | | Bal | .1 Mill | · · · | | | | | | 1 | | | |
| Magnetic Separat | ion | | 1 | | Sa1 | a | | | | | | | | | | |
| Magnetics-Condit | ioning | 5 | 33.3 | 8. | 5 100 | 0-g cel1 | 0.5 | | | | | | | | | |
| 17 | | 5 | | | | 11 | | 0.20 | | | | | | | | |
| Pyrrhotite Flota | tion | 15 | | | | זז | | | 0.10 | | | 0.02 | | | | |
| Non-Mags-Conditi | oning | 5 | 25.0 | 10.0 |) | 11 | | | | 0.6 | | | | | | |
| Cu Rougher Flota | tion | 5 | | | | 11 | l | | | | 0.04 | 0.008 | · · · | | | |
| Regrinding | | | | | | | | | | | | | | | | |
| Cu Rougher Conc | | 15 | 57.1 | 11.(|) Bal | <u>1 Mill</u> | | | | | | <u> </u> | 0.3 | 3 | | |
| <u>Cu Cleaner Conc</u> | No. 1 | | | | 250 | <u>-g_cell</u> | | | | | | | | | | |
| tt - | No. 2 | × | | | | 11 . | | | | | | • | | | | |
| 11 | No. 3 | | | | | ţı. | | | | | | | | | | |
| PRODUCT | | W. | т | • | | ANAL | YSIS | % | | | | DI | STRI | BUTIO | N % | |
| FRODUCT | | % | ó | Fe | Cu | S · | | | | | Fe | | Cu | S | | |
| | | | | | | | | | | | | | | | | |
| Iron Conc | | 2 | 0.4 | 66.96 | 0.02 | 7.06 | ł | | | 1 | 28 | 3.4 | 0.8 | 8.0 | | |
| Pyrrhotite Float | | 4 | 1.4 | 59.92 | 0.12 | 29.30 | · · | | | | 51 | •6 | 9.7 | 67.3 | | |
| Total Magnetics | × | 6 | 1.8 | 52.25 | 0.09 | 21.96 | · ·] | | | | 80 | 1.0 | 0.5 | 15.3 | | |
| Cu Cleaner Conc | | . | 1.4 | 27.28 | 21.75 | 26.54 | | | | | 1 0 | 0.8 | 59.6 | 2.1 | | |
| Gu Cleaner Tails | | | 5.2 | 24.81 | 1.31 | 11.15 | | | | | | .7 1 | 3.3 | 3.2 | •. | |
| Cu Rougher Conc* | • | | 6.6 | 25.32 | 5.66 | 14.45 | · | | | | | 3.5 7 | 12.9 | 5.3 | | |
| Cu Rougher Tail | | 3 | 1.6 | 25.08 | 0.27 | 11.09 | · | | | | 16 | 5.5 1 | 16.6 | 19.4 | | |
| Total Non-Magnet | ics* | 3 | 8.2 | 25.12 | 1.20 | 11.67 | | | | | 20 | 0.0 | 39.5 | 24.7 | | |
| • · | | · | | | | | | | | | | | | | | |
| | | | | | | | Ì | | | | | | - | { | | |
| Feed* | | 10 | 0.0 | 48.07 | 0.51 | 18.03 | | | | | 100 | 0.0 10 | 0.00 | 100.0 | | |
| • | | | | | | | | | | | | | | | | |
| * Coloristo | | | | | | | | | | | | | | | | |
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| KEMARKS: | | | | | | | | | | • . | | | | | | |

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| TEST NO. 3 SAME | EST NO. 3 SAMPLE: High-Sulphide Ore, Magnetic Iron Concentrate DATE: DEVECT OF TEXT DATE: CHARGE: 1262 errors | | | | | | | | | | | | | | |
|------------------------|---|-------------|----------|--------|--|---------|---------|--------|---------|------------------|--------------|---------|-------|----------|----------|
| OBJECT OF TEST: To it | nvesti | gate t | he ef | fect o | f soda a | ash and | l coppe | r sulp | hate of | n | | СН | ARGE: | 1262 gi | ams |
| pyrrl | hotite | flota | tion | | | | | | | | | TE | STED | BY: | |
| | Time | % | | ι ι | Jnit | 1 | | | Rea | gents, | Ip t | per ton | of Hi | gh-Sulpl | nate Ore |
| OPERATION | min | Solids | рп | 1 | used | Na2CO2 | CuSO4 | Z-6 | DF 250 | | | | | | |
| Conditioning | 5 | 33.3 | 8.5 | 500 | -g cell | 0.5 | | | | | | | | | |
| T! | 10 | 1 | · · | | !! | 1 | 0.5 | | | | | | | | |
| 11 | 1 | | | | 11 | | | 0.05 | | | | | | | |
| | | | | | | | | | | | | | | | |
| Pyrrhotite Flotation | 5 | | | | ** | | | | 0.024 | | | | | | |
| 11 | 3 | | | | | | | 0.05 | 0.016 | | | | | | |
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| PRODUCT | w. | т | | | ANAL | YSIS | % | | | | | DISTR | BUTI | DN % | |
| | % | 6 | Fe | S | | | | | | Fe | | S | | <u> </u> | |
| | | | | | | | | | | | | | | | |
| Final Iron Conc | 26 | .6 66 | •27 | 5.80 | 3.11 | | | | | 28 | .4 | 6.9 | | | |
| Total Pyrrhotite Float | 73 | <u>4</u> 60 | •69 | 28.10 | | | | | | $\frac{71}{100}$ | •6 | 93.1 | | | |
| Feed* | 100 | •0 62 | •18 | 22.17 | | | | | | I TOC | ••• | 100.0 | | | |
| | | | | | | | | | | | | | | | |
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| * Calculated | | | | | | | | | | | { | | | | |
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| REMARKS | [] | U | i | | · · · · · · · · · · · · · · · · · · · | | | | | | . <u></u> 1. | | | | |

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| TEST NO. 4 SAME | PLE: H | High-Sulphide Ore, Magnetic Tron Concentrate | | | | | | | | | | | | | |
|------------------------|--------|--|-------|----------|----------|----------|---------|--------|----------|---------|------------|---------------------|-------|----------|--------|
| OBJECT OF TEST: To i | nvesti | gate t | he ef | fect | of regri | nding | the mag | gnetic | concen | trate | | CHAI | RGE:1 | 262 gra | ms |
| befo | re flo | tation | | | | | | | | | | TEST | ED B | Y: | |
| OPERATION | Time | % | 54 | 1 1 | Jnit | | | | Rea | gents, | lb pe | ^{r ton} of | High | Sulphi | de Ore |
| | min | Solids | | | used | Na2Co. | 3CuS04 | Z-6 | DF 250 | | | | | | |
| Regrinding | 15 | 57.1 | | Bal | Mi11 | • | | | | | | 1 | | | |
| | | 1 | | | | | | | | | | | | | |
| Conditioning | 5 | 33.3 | 8.5 | 500. | g cell | 0.5 | | | | | | | | | |
| *1 | 10 | | | | 17 | | 0.5 | | | - | | | | | |
| 11 | 1 | | | _ | 11 | <u> </u> | | 0.05 | | | | | | | |
| · · | | | | | <u></u> | | | | | | | | | | 1 |
| Pyrrhotite Flotation | 5 | | | · . | 11 | | ļ | | 0.024 | | | | | | |
| | 7 | 7 | | | | | | | | | | | | | |
| | | · | | | | | | | <u> </u> | | | - | | | |
| Hydroseperation | | Wade | | | | | | | | | | · | | | |
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| | 1 | I T | | 1 | | <u> </u> | <u></u> | L | <u> </u> | <u></u> | | | 1 | 1 | |
| PRODUCT | | . ∥ | | | ANAL | | % | | | | <u> </u> | | | <u> </u> | |
| | | <u> </u> | re | <u> </u> | S102 | | | | _ | F.e | <u> </u> | <u>S</u> | | | |
| | | | | | | | | | | | | | | | |
| Final Iron Conc | 22 | .5 69 | •42 | 4.96 | 1.12 | | | | | 25 | 5.1 | 5.0 | | | |
| Hydroseperator Overflo | w 1 | .3 35 | .97 | 3.00 | | | | | | c | .8 | 0.2 | | | 1 |
| Total Pyrrhotite Float | 76 | <u>.2</u> 60 | •50 | 27.60 | | | | | | 74 | <u>+.1</u> | 94.8 | | | |
| Feed* | 100 | .0 62 | .19 | 22.19 | | • | | | | 100 | 0.0 1 | 00.0 | • | | |
| • | | | | | | | | | | | | | 1 | | |
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| * Calculated | | | | | | | | | | | | | | | |
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| REMARKS. | | | | | | | | | | | | | | | |

Flotation was considerably slower.

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| TEST NO. 5 | SAMP | -E: | High-S | Sulphi | de Ore, | Magne | etic Ir | on Con | centra | te | | | DA | TE: | | | |
|------------------|----------|----------|----------|----------|----------------|--------|----------|--------|--------|---------|--------|-----------|------------------|-------|--------|-------|-----|
| OBJECT OF TEST | : To i | nvest | igate | the e | ffect o | f sulp | huric | acid a | nd cop | per sul | phate | on | CH | ARGE | : 1288 | grams | |
| | pyrı | hotit | e flot | ation | l• | | | | | | | | TE | STED | BY: | | |
| | | Time | % | | Un | it | 1 | | | Rea | gents, | lb pe | r ton | of Hi | gh-Sul | hide | Öre |
| OPERATION | | min | Solids | рп | use | ed | H2S04 | CuS04 | Z-6 | DF 250 | | | 1 | | | | |
| Conditioning | | 10 | 33 3 | 6.0 | 500-0 | ce11 | 1.8 | 0.5 | | 1 | | | | | 1 | | |
| 31 | | .1 | | | <u> 200-g</u> | | 1.0 | 0.5 | 0.10 | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| Pyrrhotite Flota | ation | 5 | | | 11 | | | 1 | | 0.024 | | | | | | | |
| 11 | | 3 | | | 11 | | 1 | | 0.05 | 0.016 | | | | | | | |
| | | | | | | | | | | | | | | | | - | |
| Hydroseperation | | | | | Wad | e | | | | | | | | | | | |
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| | | | <u> </u> | | <u> </u> | | L | L | | | | | | | | | |
| PRODUCT | | W. | т [| | | ANAL | YSIS | % | | | | D | ISTR | IBUT | ION % | | |
| | | % | Fe | e | S | | | | | | Fe | | S | | | | |
| | | 1 | | | | Í | | | | - | | | | | | | |
| Final Iron Conc | | 19. | 3 68 | 3.88 | 0.58 | | | | | | 21 | 2 | 0.5 | | | | |
| Hydroseperator C |)verilow | | 2 34 | +.93 | - 00 | | ĺ | | | | | .3 5 0 | - | | | | |
| Food * | Float | 100 | | 2.78 | 2.49 | | | | | | 100 | | $\frac{1}{1000}$ | | | | |
| 1660 | | | | | | | | | | | 200 | | | | | | |
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| * Calculated | | | | | | | | | | | | | | | | | |
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| REMARKS: | | | | | | | | | | | | | | | | | 1 |

DATE: TEST NO. 6 SAMPLE: High-Sülphide Ore, Magnetic Iron Concentrate CHARGE: 1272 grams OBJECT OF TEST: To study the effect of pyrrhotite cleaner flotation on iron recovery TESTED BY: Reagents, 1b per ton of High-Sulphide Ore % Time Unit pН . OPERATION used min Solids H2S04 GuS04 Z-6 DF 250 500-g cell_ 10 33.3 6.0 11.8 0.5 Conditioning 11 0.05 ** 1 Pyrrhotite Flot'n: No. 1 stage 0.024 2 11 0.016 11 3 No. 2 stage 0.05 0.016 No. 3 stage 5 11 Cleaning No. 3 500-g cell Pyrrhotite Float. 5 Wade Hydroseperation WT DISTRIBUTION % ANALYSIS % PRODUCT % Fe S Fe S 68.57 0.73 22.3 0.7 Final Iron Conc 20.3 0.4 Hydroseperator Overflow 0.8 32.68 -60.43 30.71 22.8 32.8 No. 1 Stage Float 23.6 11.0 15.8 No. 2 Stage Float 11.3 60.93 30.95 49.7 No. 3 Stage Cleaner Float 40.6 61.38 27.05 40.0 3.5 1.0 65.11 6.17 No. 3 Stage Cleaner Tail 3.4 100.0 100.0 62.46 22.09 Feed * 100.0 Final Iron Conc + No. 3 25.8 1.7 68.06 1.52 Stage Cleaner Tail* 23.7 * Calculated REMARKS:

| TEST NO. 7 SAME | EST NO. 7 SAMPLE: High-Sulphide Ore, Non-Magnetic Fraction DATE: | | | | | | | | | | | | | |
|----------------------|--|----------|--------|---------------|-----------|----------|--|---------|--------|------------|----------|--------|------------|--------|
| OBJECT OF TEST: To | leterm | ine th | e effe | ct of slime f | lotat | ion, wi | thout | cyanide | e to | | CHAR | RGE: 7 | 38 gran | nS |
| Con | trol c | opper | losses | prior to cop | per f | lotatio | n | | | | TEST | ED BY | /: | |
| | Time | % | | Unit | | | | Reag | jents, | lb per | tonof | High- | Sulphic | le Ore |
| OPERATION | min | Solids | рН | used | Ca0 | Pine | Z-200 | | | | [| 1 | | Ī |
| Conditióning | 10 | 25.0 | 10.0 | 500-g cell | 0.5 | | | | | | | | | |
| <u>_</u> | | | • | | | | | | | | | | | |
| Slime Flotation | 5 | | | 91 | | 0.04 | | | | | | | | |
| | | | | | <u> </u> | | | | | | | | | |
| Cu Rougher Flotation | 2 | | | ** | | | 0.02 | | | | | ļ | | |
| 12 | 3 | | | | l | | 0.02 | | | | | | | |
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| PRODUCT | W | т | | ANAL | YSIS | % | ······································ | | | DI | STRIB | UTION | <u> </u> | |
| | % | | u | | | | | | Cu | L | | | | |
| Cu Rougher conc | 11 | .3 5 | .18 | | | | | | 46 | .8 | | | | |
| Rougher Tail | 75 | .1 0 | .12 | | | | | | 7 | •2 | | | | |
| Slimes | 13 | .6 4 | •22 | | | | | | 46 | •0 | | | | |
| Feed * | 100 | •0 1 | .25 | | | | | | 100 | 0.0 | | 1 | | |
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| * Calculated | | | | | | | | | | | | | | |
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| REMARKS: | | | | | | | | | | | | | | |
| High copper losses | High copper losses were incurred in slime flotations in this test. | | | | | | | | | | | | | |

| TEST NO. 8 SA | MPLE: | High-St | lohide | Ore, Non-Ma | onetic | Fract | ion | | | | DAT | E: | | |
|----------------------|----------|----------|----------|--|--------|---------|--------------|---------|-----------|--------|-------------------|--------|--|--------|
| OBJECT OF TEST: To | determ | ine the | effec | t of slime f | lotati | on, wit | h cyai | nide to | | | CHA | RGE: | 748 gra | ms |
| co | ntrol c | opper 1 | osses, | prior to co | pper f | lotatio | on | | | | TES | TED B | Y: | |
| | Time | % | | Unit | | | | Rea | gents, | lb per | ^{ton} ot | E High | -Sulphi | de Ore |
| OPERATION | min | Solids | рп | used | Coo | NaCN | Pine. 011 | Z-200 | | | | | | |
| Conditioning | 10 | 25.0 | 10.0 | 500-g cell | 0.5 | 0.25 | | | | | | | | |
| | | | • | | | ļ | | | | | | | | |
| Slime Flotation | 5_ | | | 11 | | ļ | 0.04 | | | | | | | |
| | | | | | | | | | | | | | | |
| Cu Rougher Flotation | 2 | | | ŢŢ | | | | 0.02 | . <u></u> | | | | | |
| | 3 | | | · · · · | | | | 0.02 | | | | | | |
| Cu Cleaner No. 1 | | | | 250-g cell | | | | | | | | | | |
| " No. 2 | | | | 11 | | | | | | | | | | |
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| PRODUCT | N N | /T | | ANAL | YSIS | % | | | | D | ISTRIE | BUTIO | N % | |
| | | <u>~</u> | <u>u</u> | | | | | | Cu | | | | | |
| Cu Cleaner Conc | 5 | .2 19 | .32 | | | | | | 76. | 7 | | | | |
| Cu Cleaner Tails | 12 | •4 C | .85 | | | | | | 8. | 0 | | | | |
| Slime Float | 12 | .3 0 | .89 | | | | | | 8. | 4 | | | | |
| Cu Rougher Tail | 70 | 1 0 | .13 | | | | | | 6. | 2 | | | | |
| Feed * | 100 | .0 1 | 31 | · · · | | | · · | | 100. | 0 | | | | |
| Cu Rougher Conc | 17 | .6 6 | .30 | | | | | | 84. | 7 | | | | |
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| REMARKS: | <u>H</u> | <u>H</u> | <u>I</u> | <u>1, , , , , , , , , , , , , , , , , </u> | 1 | | <u> </u> | | | | <u> </u> | | ······································ | |

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| TEST NO. 9 SA | SAMPLE: High-Sulphide Ore, Non-Magnetic Fraction DATE: | | | | | | | | | | | | | | |
|---|--|------------------|----------------------|------------------------------|--------------|---------|--------|--------|---------|----------------------|----------------------|-------|---------|-----------|----------|
| OBJECT OF TEST: | To det | ermi | ne the | e effe | ct of sulphu | ric ac: | id and | Minere | ee 27 o | n copp | er | CHAI | RGE: 73 | 6 gram | S |
| | flotat | ion | | | | | | | | | | TEST | ED BY | <u>′:</u> | |
| | Tir | me | % | 5 4 | Unit | | | | Rea | gents, | lb per | tonof | High- | Sulphi | de Ore |
| . OF LIKATION | m | in S | Solids | | used | H2804 | Min27 | Z-6 | DF250 | | | | | | |
| Conditioning | 5 | | 25.0 | 6.0 | 500-g cell | 1.8 | 0.04 | | | | | | | | |
| Cu Flotation | | | | | 11 | | | | 0.008 | | | | | | |
| | | | | | | | | | 0.000 | | | | | | |
| Conditioning | 5 | | | | ** | | | 0.05 | 0.05 | | | | | | |
| Scavenging | 5 | | | | 11 | | | | 0.008 | | | | | | |
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| 5000LIOT | | WT | - | | ANAL | YSIS | % | ···· | | 1 | DI | STRIE | UTION | 1 % | |
| PRODUCT | | % | Cu | 1 | | | ~ | | | Cu | | | | | |
| Cu Conc Scavenger conc Final tail Feed * * Calculated | | 9. 20. 70. | 2 1.: 8 (0 0 1 | L.94).79).11 L.34 | | | | | | 81 12 5 100 | .9 .2 .9 .0 | | | | |

REMARKS:

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| TEST NO. 10 | SAMF | LE: Hi | gh-Sul | phide | Ore, Non-Mag | netic | Fractio | on . | | <u> </u> | | DATI | Ξ: | | |
|---------------------------------------|-------|--------|--------|------------|---------------------|----------|---------|---------|---------|----------|-------|----------|----------|------------|--------|
| OBJECT OF TEST | To d | etermi | ne the | effec | ct of sulphur | ic aci | d and Z | Z-200 c | on copp | er | | CHAP | RGE: | 738 g | rams |
| | flot | ation | | | · . | : | | | | | | TEST | ED B | Y: | |
| | | Time | % | | Unit | | | | Rea | gents, | lb pe | r ton of | High | -Sulphi | de Ore |
| OPERATION | | min | Solids | ΡŪ | used | H2S04 | Z-200 | DF250 | | | | | | | |
| Conditioning | | 10 | 25.0 | 6.0 | 500-g ce11 | 1.8 | | | | | | | | | |
| | | | | • | | - | | | | | | | | _ | |
| Cu Rougher Flot | ation | 2 | | | 11 | | 0.02 | 0.008 | | | | | | | |
| | | 3 | | | | | 0.02 | | | | · · · | | | | |
| | 1 | | | | 05011 | | | | | | | | | | - |
| Cu Cleaner No. | 1 | | | | <u> 250-g_cell</u> | | | | | | | | • | | |
| 5 | | | | <u> </u> | <u>1</u> | | | | | | | | - | | |
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| PRODUCT | | W | т | | ANAL | YSIS | % | ····· | · | | D | ISTRIE | UTIO | <u>v %</u> | |
| | | 90 | ° C | <u>u </u> | | | | | | Cu | | | | | |
| 0. 01 | | 1 1 1 | 2 0 | 55 | | | | | | 8/1 | | | | | |
| Cu Cleaner Conc | | | -2 0 | .96 | | | | | | 3 | 1 | | | | |
| Cu Rougher Tail | | 84 | .5 0 | .20 | | | | | | 12 | .9 | | | | |
| Feed * | | 100 | .0 1 | •29 | | | | | | 100 | •0 | | 1 | | |
| | | 1 1 5 | | 22 | | | | | | 87 | 1 | | | | |
| Cu Rougner Conc | ÷. | 15 | • 5 1 | • 2 2 | | | • • | | | 01 | • 1 | | | | |
| | | | | | | | | | | | | | 1 | | |
| *Calculated | | | | | | | | | | | | | | | |
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| · · · · · · · · · · · · · · · · · · · | | | | | • | | | | | | ۹ | | | | |
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| | | | | | | | | | | | | | | | |
| REMARKS | | | | | | | | | | | | | | | |

| TEST NO. 11 SAMP | LE: H | igh-S | ulphic | le Ore | | | | | | | | DAT | E: | | |
|------------------------|--------|--------|------------|--------|------------------|-----------|-----------|--------|----------|---------|---------|----------|---------|---------|----------|
| OBJECT OF TEST To inc | corpor | ate t | he bes | ţ pro | cedures | of the | previo | ous te | sts to | cónfi | m a | CHA | RGE: | +000 gr | ams |
| concentrate. | p | rouuc | | | agnetic | 1ron C | oncenti | race a | | opper | | TES | TED B | Y: | |
| OPERATION | Time | % | | 1 | Jnit | | | | Rea | igents, | lb per | tono | f High- | -Sulphi | de Ore |
| | min | Solid | 5 | | used | H2S04 | CuS04 | Z-6 | Min27 | DF250 | | | | | |
| Grinding to -100 mesh | 30 | 57.1 | | Bal | 1 Mill | | | | | | | | | | |
| Magnetic Separation | | | <u> </u> | Sal | a | | | | | | | | | | |
| Magnetics Conditioning | 10 | 33.3 | 6.0 | 100 | <u>)-g cell</u> | 1.8 | 0.5 | | | | | | | | |
| 11 | 5 | ļ | | | 11 | ļ | | 0.10 | L | ļ | | | | | |
| Pyrrhotite Flotation | 5 | ļ | | | 11 | | | | | 0.56 | | | | | <u> </u> |
| Non-Mags-Conditioning | 5 | 25.0 | 6.0 | 100 | 0 <u>-g cell</u> | 1.8 | | | 0.04 | | | | | | |
| Cu Rougher Flotation | 5 | | - | | 11 | | ļ | | ļ | | | <u> </u> | | | |
| Scavenging | 5 | ļ | _ _ | | 11 | | | 0.05 | | 0.008 | | | | | ļ |
| | | | | | | - | | | l | | | | | | |
| Cu cleaner No. 1 | | | | 500 | <u>-g cell</u> | | ļ | | | | | | | | |
| NO• 2 | | | | 250 | -g cell | | | | | | | | | | |
| <u>_</u> | - d | 1 | 1 | | | 1 | | | | 1 | | | | | 1 |
| PRODUCT | | ⊤ | | | | YSIS | % | | | | | STRI | BUTION | 1 % | |
| | | • · | Ee | Cu | <u> </u> | <u>Ni</u> | <u>Co</u> | | _ | Fe | | Cu | S | | |
| Iron Conc | 12 | .5 7 | 1.17 | 0.01 | 0.31 | | | | | 18. | 5 | 0.2 | 0.2 | | |
| Pyrrhotite Float | 49 | .2 6 | 1.69 | 0.11 | 27.92 | 0.14 | 0.09 | | | 63 | 1 _ | 10.2 | 75.9 | ł | |
| Total Magnetics* | 61 | •7 6 | 3.61 | 0.09 | 22.33 | | | | | 81 | .6 | 10.4 | 76.1 | | |
| | | | | 10 07 | | 0.00 | 0.07 | | | | | | 0.5 | | |
| Gu Gleaner Conc | 2 | .0 2 | 4.27 | 1 25 | 22.28 | 0.00 | 0.07 | | | | .U 8 | 2 8 | 2.5 | | |
| Cu Bougher Conc* | | .6 2 | 3.61 | 11.02 | 17.78 | | | | | | | 75.5 | 3.5 | | |
| ou nougher conce | | | | 11.02 | 11.10 | | | | | | | 1303 | 5.5 | | |
| Scavenger Conc | 7 | .9 3 | 9.24 | 0.64 | 37.97 | 0.12 | 00.15 | | | 6 | 4 | 9.5 | 16.6 | | |
| Scavenger Tail | 26 | .8 1 | 8.28 | 0.09 | 2.54 | | | | | 10 | .2 | 4.6 | 3.8 | | |
| Cu Rougher Tail* | 34 | .7 2 | 3.05 | 0.21 | 10.60 | | | | | 16. | .6 | 14.1 | 20.4 | | |
| | | | | 1 00 | 11 00 | | | | | 10 | | 00 (| | | |
| Total Non-Magnetics* | 38 | • 3 2 | 3.10 | 1.23 | 11.28 | | | | | | == | 89.0 | | | |
| | 100 | | 0 10 | 0 52 | 10 10 | | | | | 100 | 0 1 | | 100 0 | | |
| reeu^ | 100 | •• 4 | 0.10 | 0.05 | 10.10 | | | | <u> </u> | | | 00.9 | 100.0 | | |
| REMARKS: | | | | | | | | | | | | | | | |

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The Scavenger Concentrate consisted mainly of pyrite. Recovery of Nickel and Cobalt was impractical.

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| TEST NO. 12 | EST NO. 12 SAMPLE: Low-Sulphide Ore, Cobber Concentrate DATE: | | | | | | | | | | | | | | | |
|---------------------------------------|---|--------------------------------|--------------|----------|----------|--|----------|----------------|---------------------|---------------------------------------|-----------|---------|----------|----------|------------|-----|
| OBJECT OF TEST | To f | inves | tigate | the | recove | erv of | iron fr | om the | magnet | ic cobb | | (| CHAR | GE: | 2000 gr | ams |
| | conc | entr | ate by | magn | etic | separat | ion | | | | | | TEST | ED B | Y: | |
| | | Fime | % | | 1 1 | Jnit | | | | Reag | ents, l | b per t | on | | | |
| . OPERATION | | min | Solids | рп | 1 | used | | | | | | | | | | |
| Magnetic Separat: | ion | | | | Sala | a | · · | | | | | | | | - | |
| | | | } | | | | | | | | | | | | | |
| Grinding of the | | | [| | | | | | | | | | | | | |
| Magnetic Fract: | ion | 30 | 57.1 | | Ball | L Mill | | | | | | | | | | |
| | | | | | 1 | | | | | | | | | | | |
| Magnetic Separat: | ion | | L | | Sala | <u>a</u> | | | | | | | | | | |
| · · · · · · · · · · · · · · · · · · · | | <u></u> | ļ | | | ······································ | <u> </u> | ļ | | | | | . | | | |
| Hydro Separation Wade | | | | | | | | | | | | | | | · . | |
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| · · · · · · · · · · · · · · · · · · · | | | | | | | | | | | | | | | | |
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| | | | <u> </u> | <u> </u> | <u> </u> | | | | | | | | | <u> </u> | <u> </u> | |
| PRODUCT | | W | | | | ANA | LYSIS | % | | r | <u> </u> | DIS | TRIB | UTIO | <u>N %</u> | |
| | | 9% | > F | e | <u></u> | <u> </u> | | | | | Fe | | | | | |
| Magnetic Iron Cor | nc. | 72 | .2 67 | .56 | 0.02 | 1.59 | | | | | 90.1 | | | | | |
| Hydroseparator ov | verflow | 0 | .8 43 | .05 | | | | | | | 0.7 | | | | | |
| No. 2 Non-Magneti | ic tail | 19 | •4 15 | .87 | | | | | | | 5.7 | | | | | |
| No. 1 Non-Magneti | ic tail | $\left\ \frac{7}{7} \right\ $ | <u>.6</u> 25 | •20 | | | | | | | 3.5 | . | | | | |
| Original Feed* | | 100 | •0 54 | •12 | | | • | | | | 100.0 | | | | | |
| _ | | | | | | | : | · . | | | | | | | | |
| | | | | | | | | | | | | | | | | |
| * Calculated | | | | | | | | | | | | | | | | |
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| REMARKS: | | | | | | | | | | · · · · · · · · · · · · · · · · · · · | | | | | | |
| Conce | entratio | n rai | tio on | orig | inal o | re base | es: 1/72 | 2.2×5 | $\frac{5}{2} = 2$. | 5:1 | | | | | | |
| • | 100 | | | | | | | | | | | | | | | |

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| TEST NO. 13 SAMPI | ST NO. 13 SAMPLE: Low-Sulphide Ore, Cobber Conc DATE: | | | | | | | | | | | | |
|-------------------------------------|---|------------------|------------|---------------|---------|-------|---------------------|---------|------------|----------|----------|---------|----|
| OBJECT OF TEST: | | | | har iron oor | | | flatati | | mento a to | CH | IARGE: 2 | 000 gra | ms |
| from from | the | e a 10 magnet | ic cor | ncentrate. | centrat | e by | | on or p | yrrnot: | TE | STED B | Y: | |
| | Time | % | <u>~</u> ⊔ | Unit | | | | Reage | ents, Ib | per tor | | | |
| OPERATION | min | Solids | | used | H2SO4 | Z-6 | DF250 | | | | | | |
| Grinding to -100 mesh | 30 | 57.1 | | Ball Mill | · | | | | | | | | |
| | | | | | | | - | | | | | | |
| Magnetic Separation | | 1 | | Sala | | | <u> </u> | | | | | _ | |
| | | | 6.0 | 1 1 0 0 0 1 1 | 1.0 | 0 1 | | | · | | | | |
| Gonditioning | 5 | | 0.0 | 1000-g cell | 1.8 | 0.1 | | | | | | | |
| Pyrrhotite Elotation | 5 | <u> </u> | | | | | 0.04 | | | | | | |
| | | | | | | | | | | | | | |
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| | | | | | | | <u> </u> | | | l | | | |
| PRODUCT | W | Т | | ANAI | YSIS | % | | | | DISTI | RIBUTIO | N % | |
| | % | 6 F | e | Cu S | | | | | Fe | Cu | S | | |
| | 67 | 5 66 | 01 | 0.01 0.22 | | | | | 00 | 0 /. 1 | 0.6 | | |
| Final from Conc Pyrrhotite Float | 5 | .0 59 | .06 | 0.27 17.61 | | | | | 5. | 5 9.6 | 40.6 | | |
| Magnetic Separation Tai | 1 27 | .5 24 | .68 | 0.42 3.60 | | | | | 13. | 86.3 | 49.8 | | |
| Feed * | 100 | .0 53 | .84 | 0.15 2.17 | | | | | 100.0 | 0 100.0 | 100.0 | | |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| * Calculated | | | 1 | | | | | | | | | | |
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| | | !! | | | | | <u> </u> | 1 | 11 | <u> </u> | 1 | | |
| REMARKS: Concentratio | n Rat | io on | origi | nal ore basis | : 1/67 | 7.5 x | $\frac{55}{22} = 2$ | 7:1 | | | | | |
| | | | | | | 1 | 00 | | | | | | |

| TEST NO. 14 SAMP | PLE: T | .ow-Su1 | nhide | Ore, Cobber | Tailin | · | | <u></u> | | DA | ГE: | | |
|-----------------------|----------|-------------------|----------|---------------------------------------|--------|--------|----------|----------|------------|----------|---------|---------|----------|
| OBJECT OF TEST: To | invest | igate | the re | ecovery of co | pper u | sing M | inerec | 27 and | · · · | СНА | ARGE: | 2000 gr | ams |
| xon | thate | (2-6) | | | | 0 | | · | | TES | TED B | Y: | × |
| | Time | % | | Unit | | | | Reag | ents. Ib p | er ton (| of Low- | Sulphid | e Ore |
| OPERATION | min | Solids | рп | used | H2S04 | Min 27 | Z-6. | DF 250 | | | | | |
| Grinding to -100 mesh | 30 | 57.1 | ` ` | Ball Mill | · · · | | | | | | | | |
| | | | • | | | | | | | | | | |
| Conditioning | 5 | 33.3 | 6.0 | 1000-g cell | 1.8 | 0.04 | 0.05 | | | | | | |
| | | | <u></u> | | | | | | | | | | |
| Cu Rougher Flot'n | 5 | | | 17 | | | | 0.008 | | | | | |
| | <u> </u> | | | | | | | | | | | | |
| Cu Cleaner No. 1 | | | | 250-g cell | | | | | | | | | 1 |
| " No. 2 | | | | 1.1 | | | | | | | | | |
| | | | | · · · · · · · · · · · · · · · · · · · | | | | <u> </u> | | | | | |
| · | | | | } | | | | | | | | | |
| | | <u> </u> | | | l | | | | | | | | |
| | 1 10/ | <u> </u> | | | Vele | 0/ | l | | <u></u> | | BUTIO | N % | <u>.</u> |
| PRODUCT | | · | | | .1313 | | 1 | · | <u> </u> | | | | |
| | _ | <u> C</u> | <u>u</u> | | | | | | <u>Gu</u> | | | | |
| Cu Cleaner Conc | 1 1 | 0 7 | 86 | | | | ł | | 26 0 | | | | |
| Cleaner Tails | 3 | .7 0 | .58 | | | | | | 9.8 | | | | |
| Rougher Tail | 95 | .3 0 | .12 | | | | | | 53.3 | | | | |
| Feed* | 100 | .0 0 | •21 | | | | | | 100.0 | | | | |
| | | | | | - | | 1 | | | | | | |
| <u>.</u> | | | | | | | | | | | | | |
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| * Calculated | (| | | | | | | | | | | | |
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| REMARKS: | | | | | | | | η, ' | | | | | |

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| TEST NO. 15 | SAMP | LE: L | ow-Sul | phide | Ore, Cobber 1 | Cailing | <u> </u> | | | | | DATE | : | | |
|--|----------------|--------------------------------------|--|--|---------------|----------|------------|-------------|-------|---|----------------------------------|---------|----------|--------|----------|
| OBJECT OF TEST: | To i | nvest | igate | the re | covery of con | oper us | sing x | anthate | (Z-6) | | | CHAR | GE: 20 | 00 gra | ns |
| | | | | | | | | | | | | TEST | ED BY | (: | |
| | | Time | % | | Unit | | | | Reag | ents. | lb per | tonof | Low-S | ulphid | e Ore |
| . UPERATION | | min | Solids | pri | used | H2S04 | <u>Z-6</u> | DF250 | | | | | | | |
| Grinding | | 30 | 57.1 | | Ball Mill | | | | | | | | | | |
| | 1 | | | • | | | | | | | | | | | |
| Conditioning | | 10 | 33.3 | 6.0 | 1000-g ce11 | 1.8 | | | | | | | | | ļ |
| | | | | | | | | | | | | ļ | | | |
| Cu Rougher Flot'r | n | 1 | | | 11 | | .01 | •032 | | | | | ļ | | |
| 11 | | 1 | | | 11 . | | .01 | | | | | | ļ | | ļ |
| 11 | | 1 | | | 11 | | .01 | | | | | ļ | | | |
| 11 | | 2 | | | 11 | | .01 | .008 | | | | | ļ | | ļ |
| | | | | | | | | ļ | | | | | <u> </u> | _ | |
| Cu Cleaner No. 1 | | | | | 250-g ce11 | | | <u> </u> | | | | | | | |
| " No. 2 | | | | | | | | | | | | | | | |
| NO• 3 | | | <u> </u> | | | <u> </u> | | <u> </u> _ | | | | <u></u> | <u> </u> | | <u> </u> |
| PRODUCT | | w- | т | | ANAL | YSIS | % | | | | DI | STRIB | UTION | 1 % | |
| 1.1000001 | | % | | u | | | | | | Cu | | | | | |
| Cu Cleaner Conc No. 3 Cleaner Tai No. 2 Cleaner Tai No. 1 Cleaner Tai Cu Rougher Tail Feed* * Calculated | il il il | 1 0 2 5 <u>89</u> 100 | .3 8 .9 1 .2 0 .7 0 .9 0 .0 0 | .73 .18 .65 .26 .07 .21 | | | | | | 52. 5. 6. 7. <u>28.</u> 100. | .8 .1 .6 .0 .5 .0 | | | | |
| REMARKS: | | | | | | | | | | | | | | | |

| OBJECT OF TEST: To investigate the recovery of iron and copper after magnetic separation at minus 48 mesh CHARGE: 4000 grams TESTED BY: TESTED BY: TESTED BY: OPERATION Time % olds PH Unit used Reagents. Ib per ton of Composite Ore compo | EST NO. 16 SAMPLE: Composite - 45% High-Sulphide: 55% Low-Sulphide DATE: | | | | | | | | | | | | | | | | | | | |
|--|---|-------|--------|------------------|----------------|-----------|----------------|----------|-------------------------------------|----------|---------|---------|-----------|----------|----------|----------|------|--|--|--|
| TESTED BY: TESTED BY: OPERATION TESTED BY: OPERATION TESTED BY: OPERATION TESTED BY: Crinding to -48 mesh 15 Solide PERagenis. Is per ton of Composite Ore Magnetic Separation Sala Non-2000 Solide Ore Magnetic Fraction 20 Solide TESTED BY: Magnetic Fraction Sala Solide One-06 Magnetic Flotation Sala One-0.056 Magnetic Fraction 20 Solide One-0.056 Magnetic Flotation Sala One-0.056 Magnetic Fraction Solide OISTRIBUTION % Probuct WT AnALYSIS % DISTRIBUTION % Primail Tron Conc 2.6 Out on and and and and and and and and and an | OBJECT OF TEST: To investigate the recovery of iron and copper after magnetic separation at minus 48 mesh CHARGE: 4000 gram TESTED BY: TESTED BY: | | | | | | | | | | | | ams | | | | | | | |
| OPERATION Time % No Dut Solids Unit used Time % H2304 Z-6 Min27 DP230 Composite Ore Grinding to -48 mesh 1.5 57.1 Ball Mill Image: Composite Ore | | separ | ration | at m | inus 4 | 8 mes | h . | | | | _ | | | TES | TED BY | : | | | | |
| Original Solids min Solids Principal Solids H2S04 Z=6 Min27 DF250 Solids Solids Grinding to -48 mesh 15 57.1 3all Mill Solids Solids </td <td colspan="2">OPERATION</td> <td>Time</td> <td>%</td> <td></td> <td></td> <td colspan="2">Unit</td> <td colspan="12">Reagents, Ib per ton of Composite O</td> | OPERATION | | Time | % | | | Unit | | Reagents, Ib per ton of Composite O | | | | | | | | | | | |
| Grinding to -48 mesh 15 57.1 Ball Mill Image: Separation Sala Image: Separation Image: Separati | OPERATION | | min | Solids | p., | | used | H2S04 | Z-6 | Min27 | DF250 | | | | | | | | | |
| Magnetic Separation Sala Image of the second s | Grinding to -48 m | nesh | 15 | 57.1 | | Ball | Mill | | | | | | | | | · . | | | | |
| Regrinding Image: Conditioning 20 57.1 Ball Mill Image: Conditioning 100 | Magnetic Separation | | | | · | · Sala | | | | | | | | | | | | | | |
| Magnetic Fraction 20 57.1 Ball Mill Image: Conditioning 10 33.3 6.0 1000-g cell 1.8 0.10 Magnetic Floation 5 " 0.056 100 10 < | Regrinding | | | | | | | | | | | | | | | | | | | |
| Conditioning 10 33.3 6.0 100-g cell 1.8 0.10 | Magnetic Fraction Conditioning Pyrrhotite Flotation Magnetic Separation | | 20 | 57.1 | | | Ball Mill | | | | | | | | | | l | | | |
| Pyrhotite Flotation 5 " 0.056 | Conditioning | | 10 | 33.3 | 6.0 | 1000 | 1000-g cell | | 0.10 | | | | | | | l | | | | |
| Magnetic Separation Sala | Pyrrhotite Flotation | | 5 | ļ | ļ | | 11 | | | ļ | 0.056 | | ļ | | | [| | | | |
| Regrinding 20 57.1 Ball Mill 000-4 | Magnetic Separation | | | | <u> </u> | Sala | Sala | | | | | | | _ | | ļ | | | | |
| Non-Magnetic Fraction 20 57.1 Ball Mill Image: Stress of the str | Regrinding | | | | . | | | ļ | | | | | | | | | | | | |
| Conditioning 5 33.3 6.0 1000-g cell 1.8 0.04 Cu Rougher Flotation 5 - " - < | Non-Magnetic Frac | tion | 20 | 57.1 | | Ball | <u>Mill</u> | | | | | | | | | | | | | |
| Cu Rougher Flotation 5 " Output Distribution Cu Cleaner No. 1,2,3 250-g cel1 Distribution PRODUCT WT ANALYSIS % Distribution Final Iron Conc 23.4 69.66 0.01 0.03 38.3 0.6 0.8 Magnetic Finisher Tail 2.6 20.48 0.01 0.30 39.6 0.9 Pyrrhotite Float 2.0 57.62 C.26 22.62 39.3 21.8 67.3 Cu Cleaner Conc 1.0 24.50 19.89 23.20 0.6 57.9 2.4 Cu Rougher Tail 2.3 20.00 0.75 9.56 11.1 4.9 2.2 Cu Rougher Conc* 3.3 21.50 6.54 13.63 11.4 4.9 2.4 Cu Rougher Tail 19.78 0.12 6.38 100.0 100.0 100.0 100.0 Feed* 100.0 42.50 0.34 9.75 100.0 100.0 100.0 100.0 Regrinding was done to minus 100 mesh. Copper sulphatè was not Regrinding was | Conditioning | | 5 | 33.3 | 6.0 | 1000 | <u>-g cell</u> | 1.8 | ļ | 0.04 | | | | | | | | | | |
| Cu Gleaner No. 1,2,3 VT ANALYSIS % DISTRIBUTION % PRODUCT $\frac{WT}{\%}$ $\frac{ANALYSIS %}{Fe}$ $DISTRIBUTION %$ Final Iron Conc 23.4 69.66 0.01 0.03 38.3 0.6 0.8 Magnetic Finisher Tail 2.6 20.48 0.04 0.20 1.3 0.3 - - Rougher Iron Conc* 2.6.0 64.78 0.01 0.30 39.6 0.9 - - - 68.1 - <t< td=""><td colspan="2">Cu Rougher Flotation</td><td>5</td><td>ļ</td><td></td><td></td><td>11</td><td></td><td>ļ</td><td> </td><td></td><td></td><td></td><td>-</td><td></td><td> </td><td> </td></t<> | Cu Rougher Flotation | | 5 | ļ | | | 11 | | ļ | | | | | - | | | | | | |
| PRODUCT WT ANALYSIS % DISTRIBUTION % Final Iron Conc 23.4 69.66 0.01 0.03 38.3 0.6 0.8 Magnetic Finisher Tail 2.6 20.48 0.04 0.20 1.3 0.3 - Rougher Iron Conc* 26.0 64.78 0.01 0.30 39.6 0.9 0.8 Pyrrhotite Float 29.0 57.62 C.26 22.62 39.3 21.8 67.3 Total Magnetics* 55.0 60.98 0.14 12.07 78.9 22.7 68.1 Cu Cleaner Conc 1.0 24.50 19.89 23.20 0.6 57.9 2.4 Cu Rougher Conc* 3.3 21.50 6.54 13.63 1.1 4.9 2.2 Cu Rougher Tail 41.7 19.78 0.12 6.38 1.9.4 14.5 27.3 Total Non-Magnetics* 45.0 20.00 0.59 6.91 100.0 100.0 100.0 Feed* 100 | Cu Cleaner No. 1, | 2,3 | | <u> </u> | <u> </u> | 1250- | <u>g_cel1</u> | <u> </u> | <u> </u> | <u> </u> | | | <u> </u> | <u> </u> | | <u> </u> | | | | |
| % Fe Cu S Fe Cu S Final Iron Conc 23.4 69.66 0.01 0.03 38.3 0.6 0.8 Magnetic Finisher Tail 2.6 20.48 0.04 0.20 39.6 0.9 0.8 Rougher Iron Conc* 26.0 64.78 0.01 0.30 39.6 0.9 0.8 Pyrrhotite Float 29.0 57.62 C.26 22.62 39.3 21.8 67.3 Total Magnetics* 55.0 60.98 0.14 12.07 78.9 22.7 68.1 Cu Cleaner Conc 1.0 24.50 19.89 23.20 0.6 57.9 2.4 Cu Rougher Tails 2.3 20.00 0.75 9.56 11.1 4.9 2.2 Cu Rougher Tail 41.7 19.78 0.12 6.38 11.7 62.8 4.6 Gu Rougher Tail 41.7 19.78 0.12 6.38 100.0 100.0 100.0 100.0 </td <td colspan="2">PRODUCT</td> <td>W</td> <td>т </td> <td></td> <td></td> <td>ANAL</td> <td>YSIS</td> <td>%</td> <td></td> <td></td> <td></td> <td>D</td> <td>ISTRIE</td> <td>BUTION</td> <td>%</td> <td></td> | PRODUCT | | W | т | | | ANAL | YSIS | % | | | | D | ISTRIE | BUTION | % | | | | |
| Final Iron Conc 23.4 69.66 0.01 0.03 Magnetic Finisher Tail 2.6 20.48 0.04 0.20 Rougher Iron Conc* 26.0 64.78 0.01 0.30 Pyrrhotite Float 29.0 57.62 C.26 22.62 Total Magnetics* 55.0 60.98 0.14 12.07 Cu Cleaner Conc 1.0 24.50 19.89 23.20 Cu Cleaner Tails 2.3 20.00 0.75 9.56 Cu Rougher Tail 41.7 19.78 0.12 6.38 Cu Rougher Tail 41.7 19.78 0.12 6.38 Feed* 100.0 42.50 0.34 9.75 100.0 100.0 Regrinding was done to minus 100 mesh. Copper sulphatè was not used in pyrrhotite flotation. 100.0 100.0 100.0 | | | 9 | 6 · _] | ^r e | Cu | S | | | <u> </u> | _ | _ F | e | Ju | <u>s</u> | | | | | |
| Magnetic Finisher Tail 2.6 20.48 0.04 0.20 Rougher Iron Conc* 26.0 64.78 0.01 0.30 Pyrrhotite Float 29.0 57.62 0.26 22.62 Total Magnetics* 55.0 60.98 0.14 12.07 Gu Cleaner Conc 1.0 24.50 19.89 23.20 Cu Cleaner Tails 2.3 20.00 0.75 9.56 Cu Rougher Tail 41.7 19.78 0.12 6.38 Total Non-Magnetics* 45.0 0.34 9.75 100.0 100.0 Feed* 100.0 42.50 0.34 9.75 100.0 100.0 100.0 REMARKS: Regrinding was done to minus 100 mesh. Copper sulphatè was not used in pyrrhotite flotation. Copper sulphatè was not | Final Tron Conc | | 23 | .4 6 | .66 | 0.01 | 0.03 | | | | | 38 | 3 | 0.6 | 0.8 | | | | | |
| Rougher Iron Conc* 26.0 64.78 0.01 0.30 Pyrrhotite Float 29.0 57.62 C.26 22.62 Total Magnetics* 55.0 60.98 0.14 12.07 Cu Cleaner Conc 1.0 24.50 19.89 23.20 Cu Cleaner Tails 2.3 20.00 0.75 9.56 Cu Rougher Conc* 3.3 21.50 6.54 13.63 Cu Rougher Tail 41.7 19.78 0.12 6.38 Total Non-Magnetics* 40.0 42.50 0.34 9.75 Feed* 100.0 42.50 0.34 9.75 100.0 100.0 Regrinding was done to minus 100 mesh. Copper sulphatè was not used in pyrrhotite flotation. 100.0 100.0 | Magnetic Finisher | Tail | 2 | 2.6 20 | | 0.04 0.20 | | | | | | 1 | .3 | 0.3 | _ | | | | | |
| Pyrrhotite Float Total Magnetics* 29.0 57.62 C.26 22.62 Total Magnetics* 55.0 60.98 0.14 12.07 78.9 21.8 67.3 Cu Cleaner Conc Cu Cleaner Tails Cu Rougher Conc* 1.0 24.50 19.89 23.20 0.6 57.9 2.4 Cu Rougher Conc* 2.3 20.00 0.75 9.56 1.1 4.9 2.2 Gu Rougher Tail 41.7 19.78 0.12 6.38 1.1 4.4.5 27.3 Total Non-Magnetics* 45.0 20.00 0.59 6.91 100.0 100.0 100.0 100.0 Regrinding was done to minus 100 mesh. Copper sulphate was not 100.0 100.0 100.0 | Rougher Iron Conc | * | 26 | 26.0 64 | | 0.01 | 0.30 | ĺ | | | | 39 | .6 | 0.9 | 8.0 | | | | | |
| Total Magnetics* 55.0 60.98 0.14 12.07 78.9 22.7 68.1 Cu Cleaner Conc 1.0 24.50 19.89 23.20 0.6 57.9 2.4 Cu Cleaner Tails 2.3 20.00 0.75 9.56 0.6 1.1 4.9 2.2 Cu Rougher Conc* 3.3 21.50 6.54 13.63 1.1 4.9 2.2 Gu Rougher Tail 41.7 19.78 0.12 6.38 19.4 14.5 27.3 Total Non-Magnetics* 40.0 42.50 0.34 9.75 100.0 100.0 100.0 REMARKS: Regrinding was done to minus 100 mesh. Copper sulphatè was not 100.0 100.0 100.0 | Pyrrhotite Float | | 29 | 29.0 57 | | C,26 | 22.62 | | | | | 39 | <u>.3</u> | 21.8 | 67.3 | Ĭ | | | | |
| Cu Cleaner Conc 1.0 24.50 19.89 23.20 Cu Cleaner Tails 2.3 20.00 0.75 9.56 Cu Rougher Conc* 3.3 21.50 6.54 13.63 Gu Rougher Tail 41.7 19.78 0.12 6.38 Total Non-Magnetics* | Total Magnetics* | | 55 | •0 60 | .98 | 0.14 | 12.07 | | | | | 78 | .9 | 22.7 | 68.1 | | | | | |
| Cu Cleaner Tails 2.3 20.00 0.75 9.56 1.1 4.9 2.2 Cu Rougher Conc* 3.3 21.50 6.54 13.63 1.11 4.9 2.2 Gu Rougher Tail 41.7 19.78 0.12 6.38 1.11 4.9 2.2 Total Non-Magnetics* 45.0 20.00 0.59 6.91 1.11 14.5 27.3 Feed* 100.0 42.50 0.34 9.75 100.0 100.0 100.0 100.0 REMARKS: Regrinding was done to minus 100 mesh. Copper sulphate was not used in pyrrhotite flotation. | Cu Cleaner Conc | • | 1 | 1.0 24 | | 9.89 | .89 23.20 | | | | | 0 | .6 | 57.9 | 2.4 | | | | | |
| Cu Rougher Conc* 3.3 21.50 6.54 13.63 Cu Rougher Tail 41.7 19.78 0.12 6.38 Total Non-Magnetics* 45.0 20.00 0.59 6.91 Image: Feed* 100.0 42.50 0.34 9.75 100.0 100.0 100.0 REMARKS: Regrinding was done to minus 100 mesh. Copper sulphate was not used in pyrrhotite flotation. | Cu Cleaner Tails | | 2 | 2.3 20 | | 0.75 | .75 9.56 | | | | | 1 | .1 | 4.9 | 2.2 | | | | | |
| Cu Rougher Tail 41.7 19.78 0.12 6.38 19.4 14.5 27.3 Total Non-Magnetics* 45.0 20.00 0.59 6.91 100.0 100.0 100.0 100.0 Feed* 100.0 42.50 0.34 9.75 100.0 100.0 100.0 100.0 REMARKS: Regrinding was done to minus 100 mesh. Copper sulphate was not used in pyrrhotite flotation. Copper sulphate was not | Cu Rougher Conc* | | 3 | •3 21 | . 50 | 6.54 | 13.63 | | | | | 1 | .7 | 62.8 | 4.6 | | | | | |
| Total Non-Magnetics* 45.0 20.00 0.59 6.91 21.1 77.3 31.9 Feed* 100.0 42.50 0.34 9.75 100.0 100.0 100.0 100.0 REMARKS: Regrinding was done to minus 100 mesh. Copper sulphate was not used in pyrrhotite flotation. | Cu Rougher Tail | | 41 | <u>.7</u> 19 | .78 | 0.12 | 6.38 | | | | | 19 | .4 | 14.5 | 27.3 | | | | | |
| Feed* Image: The second se | Total Non-Magneti | .cs* | 45 | •0 20 | 00.00 | 0.59 | 6.91 | | | | | 21 | •1 | 77.3 | 31.9 | | | | | |
| Feed* 100.0 42.50 0.34 9.75 100.0 100.0 100.0 REMARKS: Regrinding was done to minus 100 mesh. Copper sulphate was not used in pyrrhotite flotation. Copper sulphate was not used in pyrrhotite flotation. Image: Copper sulphate was not used in pyrrhotite flotation. | | | | · | | | | | | | | | _ | | | | | | | |
| REMARKS: Regrinding was done to minus 100 mesh. Copper sulphate was not used in pyrrhotite flotation. | Feed* | | 100 | .0 42 | .50 | 0.34 | 9.75 | | | | | 100 | .0 1 | .00.0 | 100.d | | | | | |
| REMARKS: Regrinding was done to minus 100 mesh. Copper sulphate was not used in pyrrhotite flotation. | | • | | | | | | | | | | | | | | ł | | | | |
| REMARKS: Regrinding was done to minus 100 mesh. Copper sulphate was not used in pyrrhotite flotation. | | | | | | | | | | <u> </u> | | | | | | | | | | |
| used in pyrrhotite flotation. | REMARKS: | Rea | rindi | na was | done | to | inue 100 | mech | Conne | | hatà w | | - | | | | | | | |
| | • | · use | d in | ng was pyrrhc | tite | flota | lion. | me911• | 00556 | ~r ourļ | Juace W | 43 1101 | •• | | | | • | | | |

| TEST NO. 17 SAMP | PLE: C | omposi | .te - 4 | +5% Hig | gh-Sulpl | nide: | 55% Lo | ow-Sul | ohide | | | DA | TE: | | | | | |
|-----------------------------|----------|-----------------|----------|-----------------|---------------|----------------------|---------|----------|------------|-----|-------------|------------|----------|------------|----------|--|--|--|
| OBJECT OF TEST: To | inves | tigate | the r | ecover | ry of in | on and | l coppe | er usin | ng the | | | CHA | ARGE: 4 | 000 gr | ams | | | |
| ¹¹ S | tandar | d" pro | cedure | 2. | | | | | | | | TES | STED BY | <i>'</i> : | | | | |
| | Time | . % | ~~ | Unit | | Reagents, Ib per ton | | | | | | | | | | | | |
| | min | Solids | | , u | sed | H2S04 | Z-6 | Min27 | DF250 | | | 1 | | | | | | |
| Grinding to -100 mesh | 30 | 57.1 | | Ball | Mi11 | | | | | | | | | | | | | |
| Magnetic Separation | | | • | Sala | | | | | | | | | | 1 | | | | |
| | Į | [| ļ | | | | | | | | | | | | | | | |
| Magnetics-Conditioning | 10 | 33.3 | 6.0 | 1000- | 1000-g cell | | 0.10 | | | | | | | | | | | |
| Pyrrhotite Flotation | 5 | | ļ | l | | | | | 0.056 | | | | | | | | | |
| | <u> </u> | | | 1000 | | | | | | | | _ | | | | | | |
| Non-Mags-Conditioning | 5 | 33.3 | 6.0 | 1000- | -g cell | 1.8 | <u></u> | 0.04 | | | | | | | | | | |
| <u>Cu Rougher Flotation</u> | 5 | | | ļ | 11 | | | | | | | | | ļ | | | | |
| 0 | l | | | 500 | | | | · | | | | - | | | | | | |
| <u>Cu Cleaner No. 1</u> | | | <u> </u> | <u> 500-</u> g | <u>z cell</u> | | | | | | ,,,,,,,,,,, | - | | | | | | |
| " No. 3 | l | | | 20-8 | 7 Cell 11 | | | | | | | | | | | | | |
| | 1 | | <u> </u> | 1 | | | | <u> </u> | | | | | | | <u> </u> | | | |
| PRODUCT | vv | . ╟── | | T | ANAL | Y515 1 | /0 | r | - <u>r</u> | | | | BUTION | 1 % | | | | |
| | | <u> </u> | e | <u>Cu</u> | _ <u>_S</u> | | | | | Fe | | <u>C11</u> | S | | | | | |
| Iron Conc | 22 | .4 69 | •29 | 0.01 | 0.17 | | | | | 36 | .3 | 0.6 | 0.4 | | | | | |
| Pyrrhotite Float | 27 | .6 61 | •30 | 0.10 2 | 23.90 | | | | | 39 | <u>.5</u> | 8.4 | 68.2 | | | | | |
| Total Magnetics * | 50 | .0 64 | • 88 | 0.06 | 3.28 | | | | | 75 | •8 | 9.0 | 68.6 | | | | | |
| Cu Clasper Conc | 1 1 | 3 25 | 38 1 | 8 92 2 | 3 08 | | | | | | 8 7 | 1 0 | 3 1 | | | | | |
| Cu Cleaner Tails | 3 | .9 20 | .25 | 0.42 | 7.69 | | | | | 1 | .8 | 4.9 | 3.1 | | | | | |
| Cu Rougher Conc* | 5 | .2 21 | .50 | 5.05 1 | 1.54 | | | | | 2 | .6 7 | 8.9 | 6.2 | | | | | |
| Cu Rougher Tail | 44 | <u>.8</u> 20 | .63 | 0.09 | 5.45 | | | | | 21 | .6 1 | 2.1 | 25.2 | | | | | |
| Total Non-Magnetics* | 50 | •0 20 | .72 | 0.60 | 6.08 | | | | | 24 | •2 9 | 1.0 | 31.4 | | 1 | | | |
| • | | | | Ì | | | | | | | == | | | | | | | |
| Feed* | 100 | .0 42 | .80 | 0.33 | 9.68 | | : | | | 100 | .0 10 | 0.0 | 100.d | | | | | |
| | | | | | | | | | | | • | | | | | | | |
| | | | | | | | | | | | | | | | | | | |
| * Calculated | | | | | | | | | | | | | | | | | | |
| | | | | | <u> </u> | | | l | | 1 | | | <u> </u> | 1 | | | | |
| REMARKS: F | inal I | ron Co | nc: 9 | 6.4% m | ninus 20 | 0 mesh | | | · · | | | | | | | | | |
| | | | 7 | 5.5% n | ninus 32 | 5 mesh | L | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | |

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| TEST NO. | 18 | SAMF | LE: | Compos | ite 60 |)% Hig | sh-Sulph | ide: 40 |)% Magi | netic (| Cobber (| Conc | | DAT | ۲E: | | | | | |
|---------------------------------------|--------------------|--------|--------|-----------|---------|----------|--|--------------|----------|---------|----------|-----------------------|---------------|------------------|--------|--------------------|--------|--|--|--|
| OBJECT C | OF TEST: | To : | invest | igate | the re | ecover | overy of iron and copper from a composite made | | | | | | | | | CHARGE: 6000 grams | | | | |
| | | wit | nout t | he Cob | ber Ta | iling | g using | the "st | andaro | l' proc | cedure. | | | TES | TED E | 3Y: | | | | |
| . OPE | RATION | Time | ime % | | ι | Jnit | | - | . | Reag | gents. | lb per | ton | of Con | posite | Ore | | | | |
| | | | | Solids | | L L | used | H2S04 | Z-6 | Min27 | DF250 | | | <u> </u> | | | | | | |
| Grinding | to -100 | mesh | | 57.1 | | Ball | Ball Mill | | | | | | • | | | | | | | |
| Magnetic | Separati | .on | | | ļ | Sala | | <u> </u> | | | | | | | | | | | | |
| · · · · · · · · · · · · · · · · · · · | ····· | | | | ļ | | | | | | | | | | | _ | | | | |
| Magnetics | -Conditi | oning | 10 | 33.3 | 6.0 | 2000 | l <u>-g cell</u> | 1.8 | 0.10 | | | | | | | | | | | |
| Pyrrhotit | <u>e Flotat</u> | ion | 10 | | ļ | <u> </u> | 11 | | | | 0.04 | | ····· | | | | | | | |
| | 011+1- | | | 00.0 | | 1000 | · · · · · | | | | - | | | | | | | | | |
| NON-Mags- | r Flotat | ion | 5 | 33.3 | 6.0 | 1 1000 | <u>-g celi</u> n | 1.8 | | 0.04 | | | | | | · | | | | |
| | | · IOII | | | | | | · | | | | | | | | | | | | |
| Cu Cleane | r No. 1 | | | | · · · · | 500- | | | | | | | | | | | | | | |
| 71 | No. 2 | | | | | | g cell | | | | | | | | | | | | | |
| 11 | No. 3 | ĺ | | | | | 51 | | | | | | | | | | | | | |
| PRODUCT | | w- | τ | | | ANAL | YSIS | % | | | 1 | DI | STRI | BUTIO | N % | j | | | | |
| | | | % | | Fe | | Cu S | | | | 1 | Fe | (| Cu | S | | T | | | |
| | | | | | | | | | | | | | | | | | | | | |
| Iron Conc | | | 28 | •0 6 | 7.32 | 0.01 | 0.88 | | | | | 37. | .3 | 8.0 | 2.1 | | | | | |
| Total Mag | netics * | | 66 | 0.5 | 3.41 | 0.13 | 13 /0 | | | | | 40. | 2 | 2.9 | 74.2 | | | | | |
| IOCUI IIUg | IIC LLCO | | | • • • • • | J•+1 | 0.00 | 13.47 | | | | | 05 | | | 10.5 | | | | | |
| Cu Cleane | r Conc | | 1 1 | .5 2 | 7.33 1 | 8.83 | 24.00 | | | | | 0. | .8 | 72.9 | 3.1 | | | | | |
| Cu Cleane | r Tails | | 2 | 4 2 | 2.00 | 0.65 | 8.33 | | | | | 1 | 1 | 4.1 | 1.7 | | | | | |
| Cu Roughe | r Conc* | | 3. | .9 2 | 4.10 | 7.64 | 14.36 | | | | | 1 1. | .9 | 7.0 | 4.8 | | | | | |
| Gu Kougne: | r Tall -Magneti | e e X | 29 | 29.6 24.8 | | 1 00 | / . 50 | | | | | 14. | <u>6</u> - | 9.3 | 18.9 | | | | | |
| · | -Hagneer | C3. | | • 5 2 | 4•70 | 1.00 | 0.50 | | | | | 10. | | 50.5 | 23•1 | | | | | |
| Feed* | | | 100 | .0 5 | 0.47 | 0.39 | 11.75 | | | | | 100. | $\frac{1}{0}$ | $\frac{1}{1000}$ | 100.0 | | | | | |
| | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | ł | | | | | | | |
| * Calcul | ated | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | <u> </u> | 1 | | | | | | | | |
| REMARKS: | Final | Iron C | oncent | rate: | 96.3% | minu | s 200 me | sh <u>Co</u> | pper I | Recover | y (on c | origina | al or | e bas | is): | | | | | |
| | | | | | 70.2% | minu | s 325 me | esh 72 | .9% (F | Rec) x- | 75% Wt | $x \frac{0.39}{0.39}$ | Cu Cu | (in T | est) | 1 | = 64.6 | | | |
| | * | • | | | | | | | | | .UU% WE | 0.3. | o uu | (1n 0) | rigina | L reed. | / < • | | | |