J. D. Johnston

OTTAWA October 25th, 1941.

# REPORT

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1110.

Sink-and-Float Tests on a Sample of
Lead-Zinc Ore from the Bluebell Mine at
Riondel, British Columbia.

BUREAU OF MINES
DIVISION OF METALLIC MINERALS

ORE DRESSING AND
METALLURGICAL LABORATORIES

CANADA
DEPARTMENT
OF
MINES AND RESOURCES
MINES AND GEOLOGY BRANCH

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Shipment:

Two sacks of ore, net weight 214 pounds, were received on June 24th, 1941. The shipment was submitted by the late C. T. Oughtred, succeeded by S. Gray, Superintendent of Outside Mills, The Consolidated Mining and Smelting Company of Canada, Limited, Sullivan Concentration, Chapman Camp, British Columbia.

Location of Property:

The property from which this ore is taken is located at Riondel, on the shore of Kootenay Lake, in the Ainsworth mining division of British Columbia.

Character of the Ore:

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

Gangue -

The gangue consists of milky white to clear glassy quartz which bears deep brown stains of iron oxides and is transected by narrow sinuous fractures.

Metallic Minerals -

In their approximate order of decreasing abundance, the metallic minerals in the polished sections are: pyrrhotite, sphalerite, galena, pyrite, chalcopyrite, arsenopyrite, "limonite", and marcasite. These minerals are abundant and intimately admixed. A short description of their modes of occurrence follows:

Pyrrhotite.

Largely massive and, in four sections, forms the matrix throughout which the others are scattered. A small percentage occurs as coarse to fine irregular grains in gangue, chalcopyrite, and sphalerite.

Sphalerite.

The bulk of the sphalerite is present as small masses and coarse irregular grains in gangue and in pyrrhotite; a small but considerable amount, however, occurs in smaller grain sizes. It contains numerous inclusions of gangue and grains of the other sulphides, particularly

(Character of the Ore, cont'd) -

(Sphalerite, cont'd) -

tiny blebs of chalcopyrite which are in perfect alignment in some places.

Galena.

Has the same modes of occurrence as sphalerite, but not so much of this mineral is distributed in the finer sizes. Also, it is compartively free of inclusions.

Pyrite.

Largely as small granular patches and veins which ramify through massive pyrrhotite; also visible as narrow rims along the edges of some pyrrhotite and arsenopyrite grains.

Chalcopyrite.

Occasional, medium to small, irregular grains in gangue and in pyrrhotite as well as tiny blebs in sphalerite already mentioned. The greater portion of this mineral, however, is visible in one section as a small mass containing numerous inclusions of pyrrhotite, pyrite, sphalerite and gangue.

Arsenopyrite.

Small amount as an occasional, medium to coarse, isolated crystal or group of crystals scattered through the other sulphides.

"Limonite".

Mostly as numerous reddish-brown stains in gangue but is also visible as narrow rims along the edges of some sulphides.

(Continued on next page)

(Character of the Ore, cont'd) -

Marcasite.

A very small quantity as narrow, feathery, replacement veinlets in pyrrhotite.

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The sample submitted was highly oxidized, probably as a result of surface weathering, and contained 62 pounds of material finer than 8 mesh. This material is too fine to be treated by the sink-and-float process and the abnormally high amount is believed to be due to the oxidized condition of the ore.

The sample contained 76 pounds of rock coarser than one inch and up to 3 inches in size. This fraction was crushed through one inch and produced an additional 9 pounds of material finer than 8 mesh.

Sampling and Assaying:

Owing to the nature of the test to be conducted, which requires a coarse product, no assay sample was cut from the shipment.

Head sample assays calculated from the products of a test are as follows:

| | | |
|---|---|---|
| Gold | - | 0.0036 ounce per ton |
| Silver | - | 2.08 " |
| Copper | - | 0.22 per cent |
| Lead | - | 8.42 " |
| Zinc | - | 7.99 " |
| Iron | - | 20.51 " |
| Sulphur | - | 15.88 " |

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EXPERIMENTAL TESTS:

The ore, crushed and screened to a size-range of minus 1 inch plus 8 mesh, was divided into four approximately equal parts by coning and quartering. On one of these quarters a size-density analysis was made, as follows:

The sample of ore was fractionated on a series of screens at 1/8-inch intervals starting with 7/8-inch and going down to 3/8-inch-sized openings, the finest fraction being minus 3/8 inch plus 8 mesh. This fraction was separated in bulk and the products re-screened on 3-, 4-, and 6-mesh screens.

Density separations were made on each of these fractions, as follows:

The first separation was made using a medium density of 2.775, giving a "float" and a "sink" product. The float was assayed while the first sink was retreated at a higher density, in this case 2.85, to give an intermediate product and a final sink product.

According to its value as determined by assay the intermediate product may be directed either into the sink or into the float by altering the density of the separating medium. The medium density at which the first separation is to be made in a size-density analysis must be determined by:

(Continued on next page)

(Experimental Tests, cont'd) -

(1) Knowledge gained by visual examination of the materials to be separated.

(2) The method of trial and error, supplemented by visual examination of the products obtained.

The actual weights and assays of a completed size-density analysis are then used to determine both the size range and the medium density which seem best suited to the ore and at which further confirmatory tests should be carried out.

Density separations are made under static conditions in a batch of substantially stable galena medium.

The medium is a suspension of fine galena and water and its density can be controlled to an accuracy of 0.01 by altering the proportions of galena and water.

The medium is the same as would be used in a large-scale plant test.

The results of the size-density analysis are laid down in the following table:

(See SIZE-DENSITY ANALYSIS tabulation on Pages 7 and 8.)

## SIZE-DENSITY ANALYSIS.

(S.F. Test No. 28 - Bluebell)

| Size Fractions | -6+8 Mesh | | -4+6 Mesh | | -3+4 Mesh | | -3/8"+3 Mesh | | -½+3/8" | |
|---|---|---|---|---|---|---|---|---|---|---|
| | - Weight Proportions - | | | | | | | | | |
| DENSITY FRACTIONS | % Size fraction | % S.F. feed | % Size fraction | % S.F. feed | % Size fraction | % S.F. feed | % Size fraction | % S.F. feed | % Size fraction | % S.F. feed |
| Float @ 2.775 | 30.34 | 2.37 | 30.25 | 2.32 | 27.48 | 2.50 | 25.50 | 2.54 | 22.63 | 2.79 |
| Float @ 2.85; sink @ 2.775 | 10.25 | 0.80 | 7.22 | 0.56 | 6.23 | 0.57 | 5.18 | 0.52 | 3.49 | 0.43 |
| Sink @ 2.85 | 59.41 | 4.65 | 62.53 | 4.80 | 66.29 | 6.04 | 69.32 | 6.91 | 73.88 | 9.11 |
| TOTAL - | 100.00 | 7.82 | 100.00 | 7.68 | 100.00 | 9.11 | 100.00 | 9.97 | 100.00 | 12.33 |
| | Assays, per cent | | Assays, per cent | | Assays, per cent | | Assays, per cent | | Assays, per cent | |
| | Pb | Zn | Pb | Zn | Pb | Zn | Pb | Zn | Pb | Zn |
| Float @ 2.775 | 0.90 | 4.80 | 0.50 | 4.00 | 0.20 | 1.70 | 0.20 | 5.50 | 0.16 | 0.65 |
| Float @ 2.85; sink @ 2.775 | 1.91 | 11.70 | 0.91 | 5.00 | 1.20 | 11.30 | 0.30 | 4.70 | 0.40 | 1.20 |
| Sink @ 2.85 | 9.54 | 20.90 | 10.34 | 20.00 | 10.40 | 19.70 | 8.63 | 18.00 | 8.03 | 8.63 |

SIZE DENSITY ANALYSIS.

(S.F. Test No. 28 - Bluebell, cont'd)

| Size Fractions | -5/8"+½" | | -¾"+5/8" | | -7/8"+¾" | | -1"+7/8" | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|
| | - Weight Proportions - | | | | | | | | | |
| DENSITY FRACTIONS | % Size fraction | % S.F. feed | % Size fraction | % S.F. feed | % Size fraction | % S.F. feed | % Size fraction | % S.F. feed | % Size fraction | % S.F. feed |
| Float @ 2.775 | 31.28 | 3.41 | 27.02 | 3.05 | 24.01 | 4.74 | 16.23 | 1.81 | 25.53 | 25.54 |
| Float @ 2.85; sink @ 2.775 | 1.61 | 0.18 | 3.15 | 0.36 | 7.56 | 1.49 | 4.87 | 0.54 | 5.45 | 5.44 |
| Sink @ 2.85 | 67.11 | 7.31 | 69.83 | 7.89 | 68.45 | 13.51 | 78.90 | 8.80 | 69.02 | 69.02 |
| TOTAL - | 100.00 | 10.90 | 100.00 | 11.30 | 100.00 | 19.74 | 100.00 | 11.15 | 100.00 | 100.00 |
| | Assays, per cent | | Assays, per cent | | Assays, per cent | | Assays, per cent | | | |
| | Pb | Zn | Pb | Zn | Pb | Zn | Pb | Zn | | |
| Float @ 2.775 | 0.08 | 1.31 | 0.05 | 0.40 | 0.15 | 0.50 | 0.05 | 0.65 | | |
| Float @ 2.85; sink @ 2.775 | 1.05 | 2.75 | 0.50 | 2.10 | 1.00 | 2.60 | 0.70 | 1.45 | | |
| Sink @ 2.85 | 7.88 | 9.29 | 4.42 | 10.44 | 9.89 | 10.69 | 9.29 | 7.58 | | |

(Experimental Tests, cont'd) -

At first sight the figures contained in this table indicate that best results will be obtained under the following conditions:

(1) Density of separating medium should be in the neighbourhood of 2.80 and certainly less than 2.85.

(2) Upper size limit of feed to sink-and-float process should be minus 7/8 inch, since elimination falls off sharply in the one coarser size treated.

(3) The lower size limit may be plus 3/8 inch, since all rejects below this size are too rich in zinc to be discarded. At this point, however, it should be recalled that everything in the size range -3/8 inch +8 mesh was separated in bulk, the products being screened later.

Separating conditions may not have been ideal under these circumstances, owing to the possibility of material that should sink becoming mechanically entangled with fine float material spread over the surface of the medium and thus being prevented from sinking.

Calculations made from the figures in the size-density analysis show that, if sink-and-float feed is limited to the size range -7/8 inch +3/8 inch, nearly 60 per cent of the ore would be fines untreatable by sink-and-float, and that treatment of the remaining 40 per cent would result in the elimination of about 11 per cent of the total ore. This would be decidedly unattractive.

It was therefore decided to try a bulk separation on the full size range of a sample of ore crushed through 7/8 inch with the minus 4 mesh material screened out, with the idea in mind that there would be less chance of fine sink material becoming mechanically entangled with float material when coarse and fine ores were being fed to

(Experimental Tests, cont'd) -

the process simultaneously and that therefore the size range of feed to the process might be extended below 3/8 inch.

The results of this test show that while some improvement was noted in the grade of the fine size rejects in the bulk separation as compared with the size-density analysis, the fine rejects still assay too high in zinc to be discarded.

Owing to the oxidized condition of the ore the products of this test were assayed for total zinc and oxidized zinc to find out if any appreciable quantity of the zinc in the reject was oxidized and so not recoverable by subsequent flotation. The assays showed, however, that only an insignificant quantity of the zinc was in this form.

The results of this test are given in the following table:

| Product | Weight, per cent | Assays - Per cent Lead | Zinc (total) | Zinc (oxidized) | Silver, oz./ton |
|---|---|---|---|---|---|
| -4 mesh fines | 44.27 | 11.54 | 8.72 | 0.41 | 2.62 |
| Float @ 2.80, -3/8"+4 mesh | 4.72 | 0.43 | 1.30 | 0.20 | 0.30 |
| Float @ 2.80, -7/8"+3/8" | 11.64 | 0.20 | 0.65 | 0.10 | 0.12 |
| Sink @ 2.80, -3/8"+4 mesh | 9.96 | 8.90 | 9.34 | 0.25 | 2.36 |
| Sink @ 2.80, -7/8"+3/8" | 29.41 | 9.21 | 9.34 | 0.30 | 2.13 |
| Feed (cal.) | 100.00 | 8.75 | 7.68 | 0.32 | 2.05 |

(Continued on next page)

(Experimental Tests, cont'd) -

It is evident that the finer fraction of the reject is too high-grade in zinc to be rejected and this means that the feed to the sink-and-float process will be limited to a size range of -7/8"+3/8", the finer material having to be screened out as untreatable fines.

On this basis the following tables have been compiled:

Table I. - Distribution of Products from Crushing.

| Product | Weight, per cent | Assays Per cent Pb | Assays Per cent Zn | Ag, oz./ton | Distribution, per cent Pb | Distribution, per cent Zn | Distribution, per cent Ag |
|---|---|---|---|---|---|---|---|
| S.F. feed | 41.05 | 6.66 | 6.88 | 1.56 | 31.24 | 36.78 | 31.25 |
| Fines -3/8" | 58.95 | 10.20 | 8.23 | 2.39 | 68.76 | 63.22 | 68.75 |
| Feed sample (cal.) | 100.00 | 8.75 | 7.67 | 2.05 | 100.00 | 100.00 | 100.00 |

Table II. - Distribution of Products from S.F. Separation.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| S.F. conc. | 71.64 | 9.21 | 9.34 | 2.13 | 99.15 | 97.32 | 97.82 |
| S.F. tailing | 28.36 | 0.20 | 0.65 | 0.12 | 0.85 | 2.68 | 2.18 |
| S.F. feed (cal.) | 100.00 | 6.66 | 6.88 | 1.56 | 100.00 | 100.00 | 100.00 |

Table III. - Summary of Products from Pre-Concentration.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| S.F. conc. | 29.41 | 9.21 | 9.34 | 2.13 | 30.97 | 35.79 | 30.57 |
| Fines -3/8" | 58.95 | 10.20 | 8.23 | 2.39 | 68.76 | 63.22 | 68.75 |
| Product to further treatment | 88.36 | 9.87 | 8.60 | 2.30 | 99.73 | 99.01 | 99.32 |
| S.F. tailing | 11.64 | 0.20 | 0.65 | 0.12 | 0.27 | 0.99 | 0.68 |
| Feed sample (cal.) | 100.00 | 8.75 | 7.67 | 2.05 | 100.00 | 100.00 | 100.00 |

(Continued on next page)

(Experimental Tests, cont'd) -

The foregoing results may be summarized as follows:

Proportion of ore available for sink-and-float feed - 41.05 per cent.

Proportion of ore available to further treatment - 88.36 per cent.

**Assays:**

| | | Lead, per cent | Zinc, per cent | Silver, oz./ton |
|---|---|---|---|---|
| Ore received | - | 8.75 | 7.67 | 2.05 |
| S. F. feed | - | 6.66 | 6.88 | 1.56 |
| S. F. tailing | - | 0.20 | 0.65 | 0.12 |
| S. F. concentrate | - | 9.21 | 9.34 | 2.13 |
| Ore to further treatment | - | 9.87 | 8.60 | 2.30 |

Elimination by weight of sink-and-float feed - 28.36 per cent.

Elimination by weight of whole ore - 11.64 per cent.

**Metal recovery:**

| | | -(Per cent)- Lead | Zinc | Silver |
|---|---|---|---|---|
| From S. F. feed | - | 99.15 | 97.32 | 97.82 |
| From whole ore | - | 99.73 | 99.01 | 99.32 |

Conclusions:

The sample submitted appears to be unsuitable for concentration by the sink-and-float process, for the following reasons:

1. The oxidized condition of the sample is responsible for an abnormally high amount of fines which cannot be treated by the process under any circumstances. When the ore is crushed through 7/8 inch, about 36 per cent of it is finer than 8 mesh.
2. Owing to the disseminated character of the ore, particularly with respect to the sphalerite, the lower size limit of ore treatable by the process is raised from 8 mesh to 3/8 inch, leaving nearly 60 per cent of it as untreatable fines. The behaviour of the galena is more favourable than that of the sphalerite.
3. The ore has a high iron content, chiefly as massive pyrrhotite and limonite, which cannot be eliminated by this process and this is responsible for the low elimination on the fraction treated and for the low-grade concentrate produced.

If, in these respects, the sample submitted is representative of the ore to be treated, this process will not be at all suitable.

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