O T T A W A May 1, 1945.

R E P O R T

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1835. c.2

Flotation Tests on a Sample of Gold-Silver-Copper-Lead-Zinc Ore from the Big Bull Property on Taku River, Northern British Columbia.

(Copy No. 6 .)

Bureau of Mines
Division of Metallic
Minerals
—
Physical Metallurgy
Research Laboratories

CANADA
DEPARTMENT
OF
MINES AND RESOURCES
Mines and Geology Branch

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Shipment:

Two samples of ore were received on October 3, 1944. The samples were numbered 1 and 2. Sample No. 1 weighed 190 pounds and Sample No. 2 weighed 280 pounds. The samples were submitted by K. J. Springer, Leta Explorations Limited, 67 Yonge Street, Toronto, Ontario.

Location of Property:

These samples were taken from a property located on the Taku river, in northern British Columbia, at a point a few miles from the Alaskan border.

Sampling and Assaying:

The samples were assayed as received and later mixed together in the same proportions (190:280) and the mixture assayed. These results were reported as follows:

	Sample No. 1	Sample No. 2	Mixed Samples
Gold,	0.27	0.54	0.47
Silver, oz/ton	8.90	16.67	13.02
Copper, per cent	2.82	1.95	2.35
Lead, "	4.12	6.85	5.80
Zinc, "	20.50	27.47	24.14
Iron, "	17.82	8.91	12.72
Arsenic, "	0.42	0.57	0.54
Antimony, "	0.11	0.25	0.32
Silica, "	1.31	14.67	8.92
Alumina, "	1.82	5.36	
Lime, "	Nil.	Nil.	
Magnesia, "	Nil.	0.47	
Barite, "	20.67	6.44	11.82
Sulphur not present in barite, per cent	30.04	24.25	27.19

Experimental Tests:

A series of flotation tests was conducted on samples of this ore to try to concentrate the copper, lead and zinc minerals. Very fine grinding is necessary to free the minerals from each other, and a long conditioning period with lime is needed in the zinc circuit to keep the pyrite from floating with the sphalerite. The silver concentrates pretty well with the lead minerals but the gold spreads out through all the products and does not concentrate particularly well with any of them.

Conclusions:

The tests indicate that 80 to 85 per cent of the

(Conclusions, cont'd) -

zinc can be recovered in a concentrate assaying up to 60 per cent zinc and from 70 to 80 per cent of the copper and lead recovered in a concentrate of fair grade. They indicate, further, that some of the zinc is very fine and is associated with the copper and lead minerals (see Figure 1), and also that some of the light-coloured sphalerite though free is hard to depress and floats with the copper and lead minerals no matter what depressant may be used.

Tests Nos. 3 and 4 indicate that when the zinc is heavily depressed, copper and lead minerals are depressed with it, and when it is not so heavily depressed copper and lead recovery increases in the copper-lead concentrate but zinc recovery in the copper-lead concentrate rises at the same time.

The ore, of course, has a decidedly unfavourable zinc:lead ratio and this will in some measure account for the zinc in the copper-lead concentrate.

It has also been found that in order to bring the zinc concentrate up to grade a long conditioning period with lime at pH 10.6, probably 20 to 30 minutes, is necessary in order to keep pyrite from floating with the zinc. With good, fresh lime, however, things might be different.

The sample submitted is a very heavy sulphide ore and probably much above milling grade. In order to produce a low sulphide tailing it is necessary to float 80 per cent or more of this sample and then the tailing assays anything up to 0.40 ounce per ton in gold. It would, therefore, be wise to conduct further tests on lower-grade samples at some time in the future and the wisdom or otherwise of making a pyrite concentrate might then be decided.

Character of the Ore:

Ore

Six polished sections were prepared from the specimens and examined under a reflecting microscope.

Gangue -

Gangue material is soft, very fine-grained rock with a foliated texture. Under the binocular microscope a pearly or silky lustre is visible on cleavage surfaces in hand specimens and it is thought to be a talcose or sericitic schist.

Metallic Minerals -

Metallization is heavy in the polished sections and is represented by sphalerite, pyrite, chalcopyrite, grey copper, and galena. All these minerals are abundant and, in general, form a complex admixture with inclusions of each visible in the others (see Figure 1). A more detailed description of each ore mineral follows:

Sphalerite is very light-coloured under crossed nicols and probably contains very little combined iron. It occurs as coarse to fine grains and small masses rather evenly distributed throughout gangue. Inclusions of gangue and the other metallics are numerous in the zinc sulphide but most of them are large enough to be released by grinds coarser than 200-mesh.

Pyrite is evenly disseminated as coarse to fine irregular grains, which range from about 400 microns (-35 +48 mesh) down to 10 or 12 microns in size, with the coarser sizes predominant. It contains occasional small inclusions of gangue and sulphides.

Chalcopyrite has the same modes of occurrence as pyrite but is unevenly disseminated in somewhat smaller grain sizes. In some sections it appears to have crystallized in bands, giving a distinct striped appearance to the polished surfaces. Like pyrite, too, it encloses occasional small

(Character of the Ore, cont'd) -

grains of gangue and sulphides.

Grey Copper (tetrahedrite-$5Cu_2S.2(Cu,Fe,Zn)S.2Sb_2S_3$)
(tennantite-$5Cu_2S.2(Cu,Fe,Zn)S.2As_2S_3$)

is abundant as small irregular grains, which average probably about 70 microns (-200 +200 mesh) in size, scattered fairly evenly throughout the other metallic minerals. The surfaces of most grains observed in the sections, however, are almost free of inclusions.

Galena occurs in the same manner as grey copper, with which mineral it is sometimes associated.

Concentrates

Four polished sections were prepared, two each from samples of copper-lead concentrate and zinc concentrate, and examined for the presence of combined minerals.

Copper-Lead Concentrate (Figure 2):

A microscopic examination of the two polished surfaces made from this concentrate reveals that:

1. Combined grains of the different ore minerals are abundant.
2. The greater portion of the sphalerite is probably present as attached particles.
3. While much of the pyrite is combined with other minerals, many grains of the iron sulphide appear to be free in the mounting medium.

Zinc Concentrate (Figure 3):

A microscopic examination of the two polished sections prepared from this concentrate reveals that:

1. Combined grains of the ore minerals are not so abundant as in the previous (copper-lead) concentrate.
2. Most of the unwanted minerals observed are attached to sphalerite.
3. Statement 2 probably holds true for pyrite also--at

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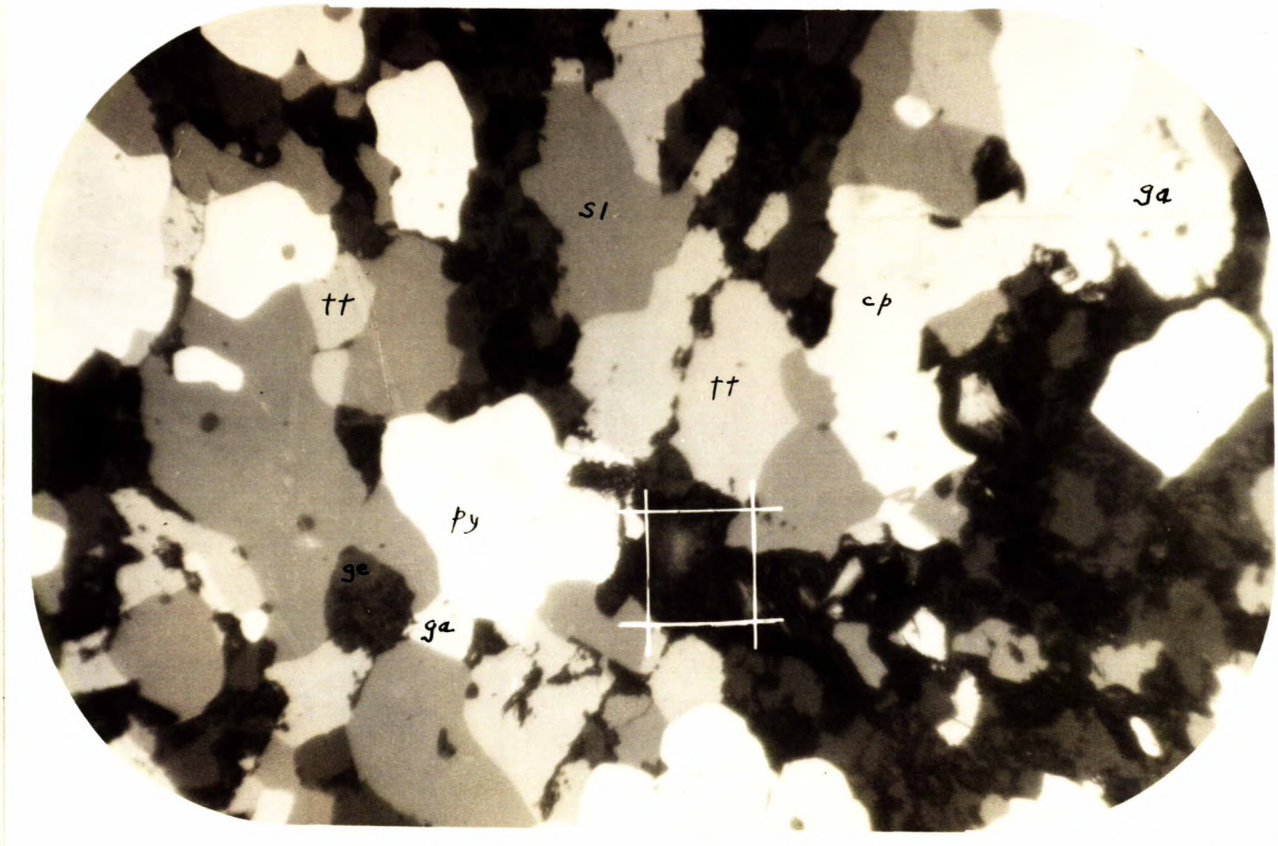
(Character of the Ore, cont'd) -

least, not nearly so many grains of apparently free iron sulphide are visible in these sections as in those made from the copper-lead concentrate.

Figure 1.



PHOTOMICROGRAPH OF POLISHED SECTION, SHOWING THE GENERAL RELATIONSHIPS OF THE ORE MINERALS IN HAND SAMPLES FROM BIG BULL PROPERTY, TAKU RIVER, B.C.

A 200-mesh opening is superimposed.

Pyrite (py), white smooth surface.
Chalcopyrite (cp), dirty white, smooth surface
Galena (ga), dirty white, rough surface.
Grey Copper (tt), light grey.
Sphalerite (sl), medium grey.
Gangue (ge), dark grey.
Pits, black.
Magnification, X200.

(Character of the Ore, cont'd) -

Figure 2.

PHOTOMICROGRAPH OF POLISHED SECTION OF
TWICE CLEANED COPPER-LEAD CONCENTRATE.

A 200-mesh Tyler screen opening is superimposed.

Pyrite	-	light yellow.
Chalcopyrite	-	deep yellow.
Galena	-	white.
Grey copper	-	light grey.
Sphalerite	-	medium grey.
Mounting medium	-	dark grey.
Pits	-	black.

Magnification, X200.

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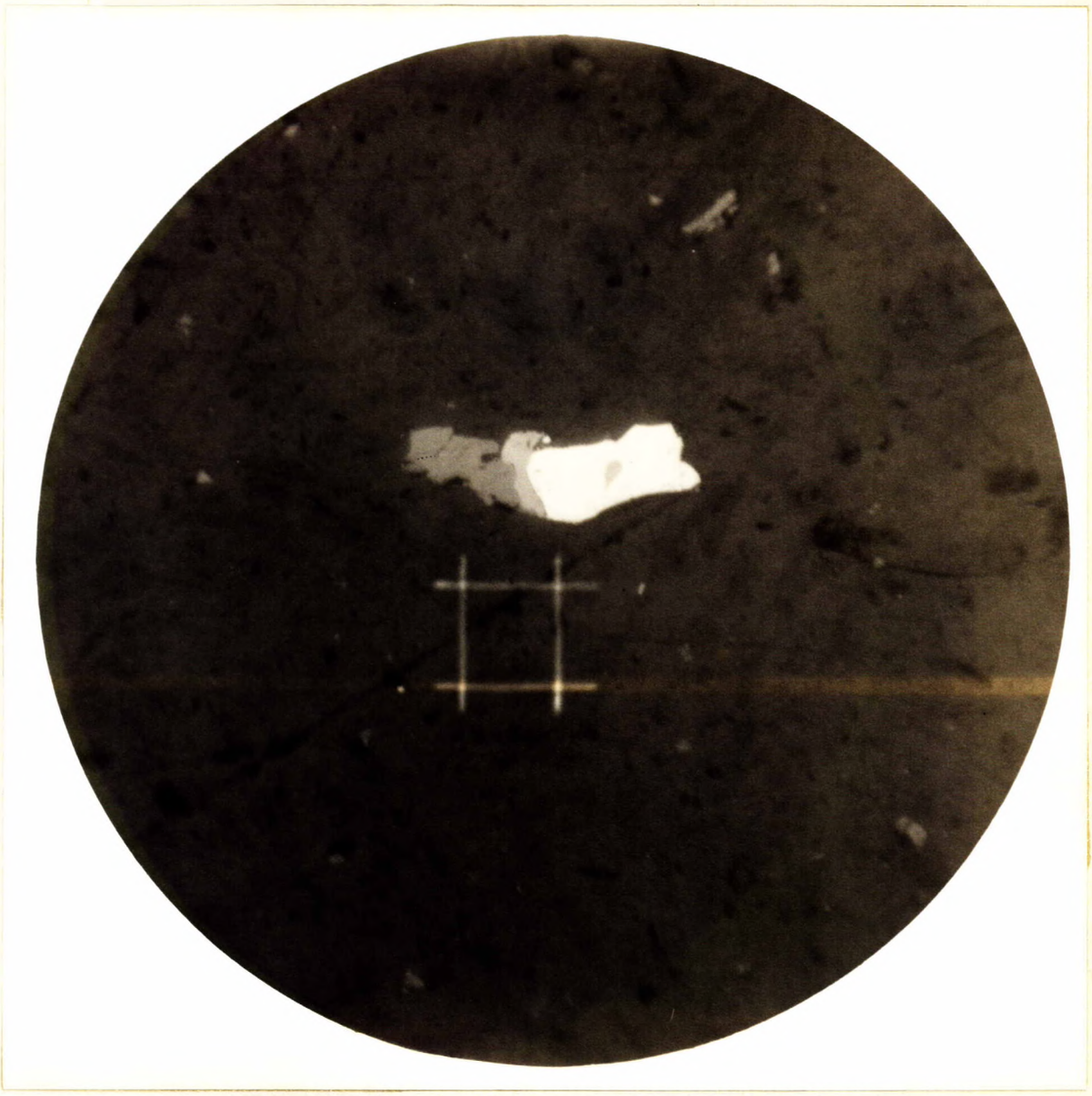
(Character of the Ore, cont'd) -

Figure 3.



PHOTOMICROGRAPH OF POLISHED SURFACE, SHOWING A COMBINED GRAIN OF PYRITE, GREY COPPER AND SPHALERITE IN A CLEANED ZINC CONCENTRATE.

Note the tiny pear-shaped inclusion of sphalerite in pyrite.

A 200-mesh Tyler screen opening is shown.

Pyrite	-	white.
Grey copper	-	light grey.
Sphalerite	-	medium grey.
Mounting medium	-	dark grey.
Pits	-	black.

Magnification, X200.

DETAILS OF INVESTIGATION:

Test No. 1.

A sample of ore was ground 98 per cent finer than 200 mesh and floated as follows:

Charge to Ball Mill -

Ore	-	2,000 grams at -14 mesh.
Water	-	1,500 grams.
Lime	-	4.0 lb./ton
$ZnSO_4$	-	2.0 "
pH	-	10.45.

Reagents to Cu-Pb Cells -

Butyl xanthate	-	0.05 lb./ton
Cresylic acid	-	0.20 "

The Cu-Pb concentrate was cleaned without additional reagents.

Reagents to Zinc Cell -

$CuSO_4$	-	1.0 lb./ton
Sodium ethyl xanthate	-	0.20 "
Pine oil	-	0.05 "

The zinc concentrate was cleaned without additional reagents.

Reagents to Pyrite Cell -

Soda ash	-	6.0 lb./ton
Potassium amyl xanthate	-	0.20 "
Pine oil	-	0.10 "

Results of Test No. 1:

(These results are shown on Page 14.)

In this test, too much copper and lead has been depressed with the zinc and has floated in the zinc circuit, keeping the zinc concentrate low grade in zinc although the recovery is good.

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(Details of Investigation, cont'd) -

Test No. 2.

In this test a different reagent combination was tried, but the results were much the same as those obtained in Test No. 1 although tailing losses were higher.

Charge to Ball Mill -

Ore	-	2,000 grams at -14 mesh.
Water	-	1,500 grams.
Lime	-	1.0 lb./ton
$ZnSO_4$	-	1.0 "
Sodium cyanide	-	0.20 "
pH	-	8.3.

Reagents to Cu-Pb Cell -

Butyl xanthate	-	0.05 lb./ton
Cresylic acid	-	0.18 "

The concentrate was cleaned without additional reagents.

Reagents to Zinc Cell -

Lime	-	3.0 lb./ton
$CuSO_4$	-	1.0 "
Sodium ethyl xanthate	-	0.20 "
Pine oil	-	0.05 "

The concentrate cleaned without additional reagents.

Reagents to Pyrite Cell -

Soda ash	-	6.0 lb./ton
Potassium amyl xanthate	-	0.20 "
Pine oil	-	0.10 "

Results of Test No. 2:

(These results are shown)
(on Page 14.)

If the above copper-lead concentrate were free of zinc it would assay 16.8 per cent copper and 41.6 per cent lead, which means approximately a 1:1 mixture of copper concentrate assaying 30.9 per cent copper and lead concentrate assaying 81.2 per cent lead. The zinc concentrate assays about 10 per cent iron, which means that it carries considerable pyrite.

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(Details of Investigation, cont'd) -

Test No. 3.

In this test the reagent combination was further changed. Soda ash replaced lime in the copper-lead circuit, with a pH value of 6.7. Sodium cyanide was reduced to 0.10 pound per ton. $CuSO_4$ was reduced in the zinc circuit to 0.50 pound per ton, which was perhaps too great a reduction since more than 10 per cent of the zinc stayed with the pyrite. Reagent 242 was used as a frother collector in place of sodium ethyl xanthate and pine oil in the zinc circuit. The feed to zinc flotation was conditioned for 30 minutes in lime pulp at pH 10.6 to thoroughly depress the pyrite. These are the outstanding differences between this and Test No. 2.

Results of Test No. 3:

(These results are shown)
(on Page 14.)

The zinc concentrate is of good grade, but recovery is low due to more zinc floating in the copper lead circuit and more remaining with the pyrite. The higher amount of zinc with pyrite may have been caused more by the reduction in the $CuSO_4$ than by combined sphalerite and pyrite, because this did not happen in Test No. 4 although it also was given a long conditioning period in lime pulp but the $CuSO_4$ was brought back to 1.0 pound per ton.

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(Details of Investigation, cont'd) -

Test No. 4.

The ore has been found to contain soluble ferric sulphate, which has no doubt been activating the pyrite. The object in this test was to neutralize the ferric sulphate with lime, thereby producing calcium sulphate which in turn is an activator for zinc when present in the grinding circuit. The further addition of sodium sulphite was intended to change the calcium sulphate to calcium sulphite and thereby make it a zinc depressant.

Charge to Ball Mill -

Ore	-	2,000 grams.
Water	-	1,500 "
Lime	-	1.0 lb./ton
Sodium cyanide	-	0.10 "
$ZnSO_4$	-	1.0 "
Sodium sulphite	-	1.0 "

Reagents to Cu-Pb Cell -

Potassium ethyl xanthate	-	0.05 lb./ton
Cresylic acid		0.18 "

The concentrate was cleaned with the addition of some lime and cresylic acid. The action in the cleaning cell was unsatisfactory, as too much of the copper and lead remained in the cleaner tailing.

Reagents to Zinc Cell -

Lime	-	4.0 lb./ton	pH, 10.6
$CuSO_4$	-	1.0 "	
Sodium ethyl xanthate	-	0.20 "	
Reagent 242	-	0.15 "	(in stages)

Conditioning period - 30 minutes.

Reagents to Pyrite Cell -

Soda ash	-	6.0 lb./ton
Potassium amyl xanthate	-	0.20 "
Pine oil	-	0.08 "

Results of Test No. 4:

(These results are shown on Page 14.)

This test was unsatisfactory, inasmuch as the reagent combination appeared to depress too much of the copper into the

(Details of Investigation, cont'd) -

copper tailing. At the same time, a fair amount of zinc floated with the copper rougher concentrate but it seems that this could be largely eliminated in the copper cleaners. It would seem that under these conditions, calcium sulphite is a depressant for copper minerals. The reagent combinations used in Tests Nos. 1 and 2 would therefore seem better.

(Tables 1 to 4 follow)
(on Page 14.)

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RESULTS OF TESTS.

Results of Tests Nos. 1 to 4.

Test No.	Product	Weight, per cent	Assays: Oz./ton Au	Assays: Oz./ton Ag	Assays: Per Cent Cu	Assays: Per Cent Pb	Assays: Per Cent Zn	Distribution, per cent Au	Distribution, per cent Ag	Distribution, per cent Cu	Distribution, per cent Pb	Distribution, per cent Zn
1.	Cu-Pb concentrate	13.91	0.90	75.76	12.54	29.77	13.93	30.97	77.43	77.50	76.16	8.07
	Cu-Pb cleaner tailing	0.82	0.47	11.93	1.26	6.11	19.80	0.95	0.72	0.46	0.92	0.68
	Zn concentrate	38.54	0.20	5.48	1.08	2.90	52.63	19.07	15.52	18.49	20.56	84.41
	Zn cleaner tailing	3.06	0.58	3.78	0.99	1.18	10.97	4.39	0.85	1.35	0.66	1.40
	Pyrite concentrate	18.59	0.66	3.34	0.24	0.24	6.18	30.35	4.56	1.98	0.82	4.78
	Flotation tailing	25.09	0.23	0.50	0.02	0.19	0.63	14.27	0.92	0.22	0.88	0.66
	Feed (cal.)	100.00	0.40	13.61	2.25	5.44	24.03	100.00	100.00	100.00	100.00	100.00
2.	Cu-Pb concentrate	12.62	1.40	71.00	13.24	32.76	14.26	46.81	67.75	72.18	76.26	7.48
	Cu-Pb cleaner tailing	0.63	1.75	20.12	3.30	11.65	22.92	2.92	0.96	0.90	1.35	0.60
	Zn concentrate	41.65	0.20	6.66	0.99	1.99	49.20	22.07	20.97	17.81	15.29	85.16
	Zn cleaner tailing	1.37	1.76	10.24	1.59	3.14	12.83	6.39	1.06	0.94	0.79	0.73
	Pyrite concentrate	11.63	0.57	3.77	0.55	0.79	6.46	17.56	3.31	2.76	1.69	3.12
	Flotation tailing	32.10	0.05	2.45	0.39	0.78	2.18	4.25	5.95	5.41	4.62	2.91
	Feed (cal.)	100.00	0.38	13.23	2.31	5.42	24.06	100.00	100.00	100.00	100.00	100.00
3.	Cu-Pb concentrate	15.75	0.70	54.28	10.62	23.01	18.01	32.11	67.17	70.26	75.74	11.85
	Cu-Pb cleaner tailing	6.60	0.46	35.02	5.72	12.12	15.72	8.84	18.16	15.86	16.72	4.34
	Zn concentrate	27.58	0.32	3.98	0.74	0.71	60.02	35.70	8.62	8.57	4.09	69.18
	Zn cleaner tailing	9.12	0.28	2.40	0.38	0.82	8.36	7.44	1.72	1.46	1.56	3.19
	Pyrite concentrate	18.61	0.31	2.30	0.36	0.33	13.60	16.80	3.36	2.82	1.28	10.58
	Flotation tailing	22.34	0.14	0.55	0.11	0.13	0.93	9.11	0.97	1.03	0.61	0.86
	Feed (cal.)	100.00	0.34	12.73	2.38	4.79	23.93	100.00	100.00	100.00	100.00	100.00
4.	Cu-Pb concentrate	8.09	1.26	58.22	10.20	42.96	11.22	22.24	36.34	37.21	66.76	3.87
	Cu-Pb cleaner tailing	9.10	0.72	44.42	8.32	12.42	25.33	14.29	31.19	34.14	21.71	9.83
	Zn concentrate	37.51	0.10	8.10	1.56	1.14	52.71	8.18	23.44	26.39	8.21	84.30
	Zn cleaner tailing	14.70	0.74	5.74	0.01	0.71	2.76	23.73	6.51	0.07	2.00	1.73
	Pyrite concentrate	10.00	0.54	1.70	0.28	0.48	0.65	11.78	1.31	1.26	0.92	0.26
	Flotation tailing	20.60	0.44	0.76	0.10	0.10	0.01	19.78	1.21	0.93	0.40	0.01
	Feed (cal.)	100.00	0.46	12.96	2.22	5.21	23.46	100.00	100.00	100.00	100.00	100.00

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