O T T A W A April 20th, 1943.

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of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1389.

Flotation Concentration of a Lead-Zinc Ore from the Reco Mountain Base Metals Mines Limited, Sandon, British Columbia.

(Copy No. 20.)

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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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Flotation Concentration of a Lead-Zinc Ore from the Reco Mountain Base Metals Mines Limited, Sandon, British Columbia.

Shipment:

Three boxes of ore, total net weight 284 pounds, were received from the Reco Mountain Base Metals Mines Limited, per A. H. Honsberger, manager, on March 16th, 1943.

A letter accompanying the shipment enclosed some data on previous mill results and requested suggestions for improvement in extraction and operation.

Some correspondence was exchanged in this respect.

Characteristics of the Ore:

Six polished sections were prepared from the sample and examined under the reflecting microscope for the purpose of determining the character of the ore.

Gangue -

Gangue material is a mixture of white to grey quartz and soft, greenish to slaty-grey rock. It forms the smaller part of the six polished surfaces as coarse to fine irregular grains and small patches scattered through the sulphides.

Metallic Minerals -

Metallization is strong and, named in their approximate order of abundance, is represented by: pyrite, galena, sphalerite, arsenopyrite, and chalcopyrite. These minerals form a very complex admixture. In general, inclusions of each occur in the others and, although on the whole the metallics occur in the coarser grain sizes, an appreciable percentage of the inclusions are too small to be economically released by grinding. Keeping in mind these general remarks, a short description of each sulphide's mode of occurrence follows:

Pyrite. - Disseminated through gangue, galena, and sphalerite as coarse to very fine irregular grains which, in places, are sufficiently abundant to form small granular masses. Few inclusions of gangue and arsenopyrite are to be seen but small inclusions of galena and sphalerite are common. Some grains are shattered and the fractures filled with gangue and/or galena, less often with sphalerite.

Galena and Sphalerite. - Occur in almost equal amounts; largely massive but also disseminated as medium to fine irregular grains in gangue, pyrite, and each other. Besides inclusions of sphalerite, galena contains grains of gangue and pyrite; sphalerite encloses numerous inclusions of gangue,

(Characteristics of the Ore, cont'd) -

galena, pyrite, chalcopyrite, and infrequent crystals of arsenopyrite. As already mentioned, many of these inclusions are too small to be eliminated economically.

Arsenopyrite. - Moderately abundant as uneven grains and euhedral crystals in gangue, less often in sphalerite. Although its grain sizes range from coarse to fine, these are generally smaller than those of pyrite, with which it is usually associated.

Chalcopyrite. - Only a small amount observed, all in sphalerite as tiny dots and dashes which are usually lined up in straight, beaded stringers, apparently following crystallographic directions in the host mineral.

Conclusions from Microscopic Examination -

The following are indicated:

1. Small amounts of the ore minerals (galena and sphalerite) will be lost as tiny inclusions in pyrite.

2. Due to small grains of galena in sphalerite, any zinc concentrate produced will not be free of lead.

3. For a similar reason, the lead concentrates will contain zinc.

4. Both (lead and zinc) concentrates will most likely be high in iron.

5. The concentrates of zinc will probably carry a little copper and arsenic.

It must be remembered that the conclusions listed above are drawn from the examination of only six polished sections and, therefore, are likely to be true only in so far as the sections are representative of the ore as a whole.

Sampling and Analysis:

The ore from the three boxes was combined and crushed to minus 14 inch and a sample was taken for investigation and analysis.

The analysis of the ore was as follows:

Lead	=	3.59	per cent
Zinc	=	3.48	"
Iron	=	10.37	"
Copper	=	0.08	"
Arsenic	=	0.70	"
Bismuth	=	0.06	"
Antimony	=	0.41	"
Gold	=	0.01	oz./ton.
Silver	=	7.24	"

Preliminary Tests:

Due to results of the microscopic examination of the ore and due to the high percentage of iron shown by the analysis, some preliminary flotation tests were made in normal flotation circuits, with a view to ascertaining which concentrates could be expected to carry appreciable amounts of other minerals and to form some basis of operation for controlling these.

These preliminary tests showed that flotation testing of the ore presented no appreciable difficulties with, perhaps, the exception of making a clean lead concentrate free from zinc and controlling the pyrite in the various products. Obtaining a low tailing loss of the lead, zinc and silver appeared less difficult.

Several simple reagent combinations with a high pH value in both the lead and zinc circuits appeared to give somewhat similar results.

Details of Investigative Tests:

Test No. 1.

Grinding, 87.2 per cent minus 200 mesh.

Reagents Added: (lb./ton)

	Lead Circuit	Zinc Circuit
To Grinding -		
$Ca(OH)_2$	4	-
To Conditioning -		
NaCN	0.5	-
CaO	-	3
$CuSO_4$	-	1
To Flotation -		
Potassium ethyl xanthate	0.2	0.1
Cresylic acid	0.12	0.08
pH	9.5	10.5

Results:

Product	Weight, per cent	Assays, per cent			Distribution, per cent		
		Pb	Zn	Fe	Pb	Zn	Fe
Feed	100.00	3.59	3.42	10.37	100.00	100.00	100.00
Lead cleaner conc.	4.34	57.84	7.34	5.81	77.97	8.32	2.73
" " tailing	2.52	17.50	3.73	11.96	13.70	2.33	3.25
Zinc cleaner conc.	4.09	1.76	59.84	4.49	2.24	67.89	1.98
" " tailing	2.52	3.67	13.47	8.57	2.87	9.43	2.54
Flotation tailing	86.53	0.12	0.47	9.61	3.22	11.29	89.70
Total	100.00	3.22	3.61	9.27	100.00	100.00	100.00

Silver Assays:

	Ag, oz./ton
Lead cleaner concentrate	- 105.20
Zinc " "	- 8.32
Lead " tailing	- 39.06
Zinc " "	- 10.30
Flotation tailing	- 0.495

Distribution of Silver:

	Per cent
In lead concentrate	- 69.3
In zinc "	- 5.2
In flotation tailing	- 6.5

Lead concentrate cleaned once; no reagents added.

Zinc concentrate cleaned twice; 0.5 pound $Ca(OH)_2$ per ton added each time.

(Details of Investigative Tests, cont'd) -

Test No. 2.

Grinding, 83.8 per cent minus 200 mesh.

Reagents Added: (lb./ton)	Lead Circuit	Zinc Circuit
To Grinding -		
Soda ash	14	-
To Conditioning -		
NaCN	0.5	-
$Ca(OH)_2$	-	10
$CuSO_4$	-	1
To Flotation -		
Potassium ethyl xanthate	0.1	0.1
Cresylic acid	0.12	0.08
pH	9.4	10.0

Results:

Product	Weight, per cent	Assays, per cent Pb	Zn	Fe	Distribution, per cent Pb	Zn	Fe
Feed	100.00	3.59	3.42	10.37	100.00	100.00	100.00
Lead cleaner conc.	6.09	48.76	7.64	12.46	88.01	13.48	7.73
Zinc " "	4.32	1.07	55.24	7.75	1.38	69.35	3.42
Lead " tailing	2.48	7.19	1.55	15.39	5.28	1.11	3.88
Zinc " "	7.36	0.82	4.64	32.77	1.79	9.90	24.62
Flotation tailing	79.75	0.15	0.27	7.43	3.54	6.16	60.35
Total	100.00	3.37	3.44	9.82	100.00	100.00	100.00

Silver Assays:

	Ag. oz./ton
Lead cleaner concentrate	= 97.89
Zinc " "	= 7.12
Lead " tailing	= 16.34
Zinc " "	= 3.45
Flotation tailing	= 0.315

Distribution of Silver:

	Per cent
In lead concentrate	= 82.5
In zinc "	= 4.3
In flotation tailing	= 3.6

Lead concentrate cleaned once; no reagents added.

Zinc concentrate cleaned twice; 1.0 pound $Ca(OH)_2$ per ton added each time.

(Details of Investigative Tests, cont'd) -

Test No. 3.

Grinding, 83.2 per cent minus 200 mesh.

Reagents Added: (lb./ton)

	Lead Circuit	Zinc Circuit
To Grinding -		
Soda ash	3	-
To Conditioning -		
NaCN	0.7	-
$Ca(OH)_2$	-	8
$CuSO_4$	-	1
To Flotation -		
Potassium ethyl xanthate	0.2	0.1
Cresylic acid	0.12	0.08
pH	9.2	10.5

Results:

Product	Weight, per cent	Assays, per cent Pb	Zn	Fe	Distribution, per cent Pb	Zn	Fe
Feed	100.00	3.59	3.42	10.37	100.00	100.00	100.00
Lead cleaner conc.	5.57	52.30	5.29	15.18	87.80	8.76	8.74
Zinc " "	4.19	1.16	57.72	4.82	1.43	71.45	2.08
Lead " tailing	5.91	3.29	4.97	20.84	5.81	8.72	12.72
Zinc " "	2.05	2.13	8.85	8.06	1.29	5.40	1.70
Flotation tailing	82.28	0.15	0.23	8.79	3.67	5.67	74.76
Total	100.00	3.32	3.37	9.67	100.00	100.00	100.00

Silver Assays:

	Ag, oz./ton
Lead cleaner concentrate	103.02
Zinc " "	6.52
Lead " tailing	9.36
Zinc " "	5.14
Flotation tailing	0.27

Distribution of Silver:

	Per cent
In lead concentrate	83.3
In zinc "	3.9
In flotation tailing	3.2

Lead concentrate cleaned once; 0.1 pound NaCN per ton added. Zinc concentrate cleaned once; 1.0 pound $Ca(OH)_2$ per ton added.

(Details of Investigative Tests, cont'd) -

Test No. 4.

Grinding, 82.4 per cent minus 200 mesh.

Reagents Added: (lb./ton)

	Lead Circuit	Zinc Circuit
To Grinding -		
$Ca(OH)_2$	6	-
To Conditioning -		
NaCN	0.4	-
$Ca(OH)_2$	-	4
$ZnSO_4$	1.0	-
$CuSO_4$	-	1
To Flotation -		
Potassium ethyl xanthate	0.1	0.1
Crosylic acid	0.12	0.08
pH	9.6	10.0

Results:

Product	Weight, per cent	Assays, per cent Pb	Zn	Fe	Distribution, per cent Pb	Zn	Fe
Feed	100.00	3.59	3.42	10.37	100.00	100.00	100.00
Lead cleaner conc.	5.38	51.64	4.14	8.21	85.73	6.50	5.00
Zinc " "	3.33	0.44	60.84	4.33	0.44	59.22	1.33
Lead " tailing	9.50	3.33	4.14	16.31	9.75	11.49	17.57
Zinc " "	3.36	0.73	17.19	8.24	0.74	16.87	3.13
Flotation tailing	78.43	0.14	0.26	8.17	3.34	5.92	72.67
Total	100.00	3.25	3.43	8.82	100.00	100.00	100.00

Silver Assays:

	Ag, oz./ton
Lead cleaner concentrate	- 99.1
Zinc " "	- 5.15
Lead " tailing	- 9.38
Zinc " "	- 3.51
Flotation tailing	- 0.25

Distribution of Silver:

	Per cent
In lead concentrate	- 79.4
In zinc "	- 2.7
In flotation tailing	- 2.9

Lead concentrate cleaned once; 0.1 pound NaCN per ton added. Zinc concentrate cleaned twice; 1.0 pound $Ca(OH)_2$ per ton added each time.

(Details of Investigative Tests, cont'd) -

Test No. 5.

Grinding, 83.5 per cent minus 200 mesh.

Reagents Added: (lb./ton)

	Lead Circuit	Zinc Circuit
To Grinding -		
No. 31 Aerofloat	0.14	-
$Ca(OH)_2$	5	-
To Conditioning -		
NaCN	0.5	-
$Ca(OH)_2$	-	3
$CuSO_4$	-	1
To Flotation -		
Potassium ethyl xanthate	-	0.1
Cresylic acid	0.04	0.08
pH	9.6	10.5

Results:

Product	Weight, per cent	Assays, per cent			Distribution, per cent		
		Pb	Zn	Fe	Pb	Zn	Fe
Feed	100.00	3.59	3.42	10.37	100.00	100.00	100.00
Lead cleaner conc.	6.45	45.54	5.51	9.21	93.25	11.05	6.64
Zinc " "	4.15	0.66	56.33	5.65	0.87	72.61	2.60
Lead " tailing	4.88	2.38	3.68	11.73	3.69	5.59	6.37
Zinc " "	5.74	0.51	4.78	28.27	0.93	8.53	18.10
Flotation tailing	78.78	0.05	0.09	7.54	1.26	2.22	66.29
Total	100.00	3.15	3.22	8.96	100.00	100.00	100.00

Silver Assays:

	Ag, oz./ton
Lead cleaner concentrate	86.88
Zinc " "	6.18
Lead " tailing	6.64
Zinc " "	2.66
Flotation tailing	0.25

Distribution of Silver:

	Per cent
In lead concentrate	85.6
In zinc "	3.9
In flotation tailing	3.0

Lead concentrate cleaned once; 0.1 pound NaCN per ton added. Zinc concentrate cleaned twice; 1.0 pound $Ca(OH)_2$ per ton added each time.

(Details of Investigative Tests, cont'd) -

Test No. 6.

Grinding, 83.0 per cent minus 200 mesh.

Reagents Added: (lb./ton)

	Lead Circuit	Zinc Circuit
To Grinding -		
$Ca(OH)_2$	5	-
No. 31 Aerofloat	0.14	-
To Conditioning -		
NaCN	0.4	-
$Ca(OH)_2$	-	3
$ZnSO_4$	1.0	-
$CuSO_4$	-	1
To Flotation -		
Cresylic acid	0.04	0.08
pH	9.6	10.5

Results:

Product	Weight, per cent	Assays, per cent Pb	Zn	Fe	Distribution, per cent Pb	Zn	Fe
Feed	100.00	3.59	3.42	10.37	100.00	100.00	100.00
Lead cleaner conc.	8.10	37.85	3.35	12.40	92.08	8.25	10.78
Zinc " "	4.00	0.54	58.22	4.38	0.65	70.78	1.88
Lead " tailing	5.14	1.61	3.41	9.22	2.48	5.33	5.09
Zinc " "	6.24	0.71	7.02	9.32	1.33	13.31	6.25
Flotation tailing	76.52	0.15	0.10	9.25	3.46	2.33	76.00
Total	100.00	3.33	3.29	9.31	100.00	100.00	100.00

Silver Assays:

	Ag, oz./ton
Lead cleaner concentrate	65.18
Zinc " "	8.14
Lead " tailing	7.32
Zinc " "	6.72
Flotation tailing	0.43

Distribution of Silver:

	Per cent
In lead concentrate	78.3
In zinc "	4.9
In flotation tailing	4.7

Lead concentrate cleaned once; 0.1 pound NaCN per ton added. Zinc concentrate cleaned twice; 1.0 pound $Ca(OH)_2$ per ton added each time. No additional promoter reagent used in zinc rougher circuit.

Most of the above tests indicate the advisability of another stage of cleaning the lead concentrate to lower the zinc and iron content.

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(Details of Investigative Tests, cont'd) -

Test No. 7.

Grinding, 82.5 per cent minus 200 mesh.

Reagents Added: (lb./ton)

	Lead Circuit	Zinc Circuit
To Grinding -		
$Ca(OH)_2$	6	"
No. 31 Aerofloat	0.14	"
To Conditioning -		
NaCN	0.4	"
$Ca(OH)_2$	"	3
$ZnSO_4$	1.0	"
$CuSO_4$	"	1
To Flotation -		
Cresylic acid	0.04	0.04
pH	10.2	10.3

Results:

Product	Weight, per cent	Assays, per cent			Distribution, per cent		
		Pb	Zn	Fe	Pb	Zn	Fe
Feed	100.00	3.59	3.42	10.37	100.00	100.00	100.00
Lead cleaner conc.	5.27	54.64	4.16	3.59	84.91	6.21	4.53
Zinc " "	4.15	0.56	59.51	5.34	0.66	69.98	2.22
Lead " tailing	6.30	6.22	5.64	12.46	11.53	10.09	7.86
Zinc " "	4.27	0.46	8.51	20.42	0.57	10.31	8.73
Flotation tailing	80.01	0.10	0.15	9.58	2.33	3.41	76.66
Total	100.00	3.39	3.53	10.00	100.00	100.00	100.00

Silver Assays:

	Ag, oz./ton
Lead cleaner concentrate	96.72
Zinc " "	6.38
Lead " tailing	16.30
Zinc " "	4.69
Flotation tailing	0.43

Distribution of Silver:

	Per cent
In lead concentrate	73.5
In zinc "	3.8
In flotation tailing	5.0

Lead concentrate cleaned twice; 0.05 pound NaCN per ton added each time. Zinc concentrate cleaned twice; 1.0 pound $Ca(OH)_2$ added each time. No additional promoter reagent used in zinc rougher circuit.

(Details of Investigative Tests, cont'd) -

Test No. 8.

Grinding, 80.0 per cent minus 200 mesh.

Reagents Added: (lb./ton)

To Grinding -	Lead Circuit	Zinc Circuit
Soda ash	3	-
To Conditioning -		
NaCN	0.7	-
$Ca(OH)_2$	-	8
$CuSO_4$	-	1
To Flotation -		
Potassium ethyl xanthate	0.1	0.05
Cresylic acid	0.12	0.08
pH	9.3	10.5

Results:

Product	Weight, per cent	Assays, per cent Pb	Zn	Fe	Distribution, per cent Pb	Zn	Fe
Feed	100.00	3.59	3.42	10.37	100.00	100.00	100.00
Lead cleaner conc.	4.55	59.91	4.62	9.53	83.39	5.86	5.16
Zinc " "	3.72	0.86	60.38	5.28	0.99	62.58	2.34
Lead " tailing	6.62	5.97	6.16	17.20	12.14	11.36	13.54
Zinc " "	10.13	0.15	4.57	27.62	0.49	12.89	33.27
Flotation tailing	74.98	0.13	0.35	5.12	2.99	7.31	45.69
Total	100.00	3.27	3.59	8.41	100.00	100.00	100.00

Silver Assays:

	Ag, oz./ton
Lead cleaner concentrate	111.76
Zinc " "	5.68
Lead " tailing	14.39
Zinc " "	2.18
Flotation tailing	0.24

Distribution of Silver:

	Per cent
In lead concentrate	70.2
In zinc "	3.0
In flotation tailing	2.5

Lead concentrate cleaned twice; 0.05 pound NaCN per ton added each time. Zinc concentrate cleaned twice; 1.0 pound $Ca(OH)_2$ added each time.

(Details of Investigative Tests, cont'd) -

Taking the lead and zinc concentrates from Test No. 8 as typical, an analysis of them was made, to ascertain what portion of the metals shown in the analysis of the head sample was in the concentrates.

The result of the analysis indicated the following distribution:

	Lead concentrate	Zinc concentrate
	- Per cent -	
Lead -	59.91	0.86
Zinc -	4.62	60.38
Iron -	9.53	5.28
Silver -	70.20	3.00
Copper -	0.53	0.50
Arsenic -	0.15	Nil.
Bismuth -	Trace.	Trace.
Antimony -	0.18	0.71

CONCLUSIONS:

A lime circuit with a comparatively high pH value, which should, however, be kept as low as results warrant, appeared to be best for controlling the pyrite in the lead circuit, although somewhat similar results were secured when soda ash was used with a higher-than-usual amount of sodium cyanide.

In view of the close association of the galena and sphalerite, as shown in the microscopic examination, some degree of fine grinding may be necessary, the economic limit of which can be determined in the plant.

Cleaning capacity should be provided in both lead and zinc circuits and ample time arranged for conditioning in the zinc circuits after the addition of copper sulphate.

A simple reagent combination is indicated and

(Conclusions, cont'd) -

satisfactory results were secured in testing with several different groups of reagents.

Testing in the laboratory showed results superior to those submitted from previous operations in the plant. Certain proposed changes in the mill to provide for more continuous operation may assist in securing better overall results.

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