O T T A W A May 11th, 1943.

R E P O R T

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1404.

Concentration Tests on a Tin Ore from the Snowflake Property of Regal Silver Mines Limited, Albert Canyon, British Columbia.

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Shipment:

During 1942, these Laboratories received for analysis some 72 channel samples taken from the Snowflake mine by Dr. C. S. Lord of the Geological Survey Division, Mines and Geology Branch, Department of Mines and Resources, Ottawa, Ontario.

After the analysis, Dr. Lord picked 42 of the assay rejects for a mill test. These particular samples represented the ore-shoot of tin-bearing ground at the Snowflake property. Their weight was some 400 pounds.

On June 26th, 1929, a shipment of copper-tin ore had been received from this property and the test work on it was covered by Report of Investigation No. 337 in the 1929 edition of "Investigations in Ore Dressing and Metallurgy."

Location of the Property:

The Snowflake property of the Regal Silver Mines Limited is situated in Albert Canyon, Revelstoke mining division, British Columbia.

Sampling and Analysis:

The selected assay reject samples were mixed and a composite head sample was cut out for assay, giving the following results:

Silver	-	8.48 oz./ton.
Lead	-	1.25 per cent.
Copper	-	1.42 "
Tin	-	0.89 "
Zinc	-	2.28 "

Characteristics of the Ore:

Six polished sections were prepared and examined microscopically for the purpose of determining the character of the ore. These samples are high grade and distinct from the 400 pounds of assay rejects used in the mill test work.

Gangue -

Gangue material is a mixture of translucent white quartz and rather hard, black, finely foliated rock. In hand specimens the latter has a slaty texture and appears to contain some finely divided graphite.

Metallic Minerals -

Metallization is strong in the polished sections and is represented by stannite, pyrite, sphalerite, chalcopyrite, and galena, listed in their order of abundance. For the most part these minerals occur in complex admixture, as follows:

Stannite. - Largely massive and, in many places, forms the matrix for the other metallic minerals. A small percentage is present also as coarse to fine irregular grains

(Characteristics of the Ore, cont'd) -

in gangue and in other sulphides, particularly pyrite.

Pyrite. - Small granular masses and disseminated grains in gangue and in other metallics. The grain sizes range from coarse to fine, with the coarser sizes predominating. It contains occasional small inclusions of gangue and grains of the other sulphides.

Sphalerite. - Common as medium-coarse to fine grains mixed with the other metallic minerals.

Chalcopyrite. - Largely as small irregular grains and tiny dots in gangue, stannite, and sphalerite. The total quantity of this mineral is comparatively small.

Galena. - Small amount visible, all of which is closely associated with pyrite, mostly as small inclusions and irregular veinlets in the iron sulphide.

Investigative Work:

The test work on the composite sample consisted of bulk flotation of the valuable minerals, followed by a selective float in order to separate the galena from the stannite.

By these methods a lead concentrate was obtained assaying 54.5 per cent lead, 0.9 per cent copper, 1.2 per cent tin and 110.4 ounces silver per ton, at a ratio of concentration of 65:1. A recovery of 89 per cent of the lead was shown in the concentrate and middling products. A copper-tin concentrate was made assaying 20.8 per cent tin, 23.2 per cent copper, 0.3 per cent lead and 77.0 ounces silver per ton, at a ratio of concentration of 22:1. A recovery of 86 per cent of the tin was shown in the concentrate and middling products. The grind in these tests was

(Investigative Work, cont'd) -

68 per cent and 85 per cent minus 200 mesh.

An attempt was also made to separate the galena in the ore by table concentration prior to flotation of the table tailings. Owing, probably, to the small amount of galena in the ore, it was not found possible to accomplish this satisfactorily in the small-scale laboratory tests.

In the following details of test work consist of:
The test work consisted of the following:

Tests Nos. 1, 2 and 3, bulk flotation concentration;

Tests Nos. 4, 5 and 6, selective flotation concentration; and

Tests Nos. 7 and 8, table and flotation concentration.

DETAILS OF TESTS:

Test No. 1. - Bulk Flotation Concentration.

In this test a portion of the ore was ground in a ball mill to pass 85 per cent minus 200 mesh. The pulp was then transferred to a Denver flotation machine and a bulk flotation concentrate was obtained. This concentrate was cleaned once in a smaller cell.

Results:

Product	Weight, per cent	ASSAY Oz./ton: Ag	Per cent: Pb	Cu	Sn	Zn
Feed	100.00	8.40*	0.96*	1.30*	1.12*	2.30*
Flot. conc.	7.33	50.74	9.86	3.87	3.20	3.58
" middling	9.00	27.28	0.52	6.29	5.49	3.73
" tailing	83.67	2.66	0.23	0.54	0.47	2.04

		DISTRIBUTION, per cent: Ag	Pb	Cu	Sn	Zn
Feed	100.00	100.0	100.0	100.0	100.0	100.0
Flot. conc.	7.33	44.3	75.2	21.8	20.9	11.4
" middling	9.00	29.2	4.9	43.5	44.0	14.6
" tailing	83.67	26.5	19.9	34.7	35.0	74.0

* Calculated.
Ratio of concentration, 13.6:1.

(Continued on next page)

(Test No. 1, cont'd) -

Reagents Added: (lb./ton)

To Grind -

Soda ash	-	5.0
NaCN	-	0.3

To Cell -

Pine oil	-	0.10
Amyl xanthate	-	0.15

pH, 8.5.
Time of flotation, 5 minutes.

The recoveries and grade of concentrate were poor in this test, probably owing to the quantities of flotation reagents added.

Test No. 2. - Bulk Flotation.

In this test a portion of the ore was ground, concentrated, and cleaned twice. As noted below, the amounts of reagents added to the grinding and flotation were changed, with beneficial results. A screen test showed the grinding as follows:

Mesh		Weight, per cent
+100	-	0.2
-100+150	-	4.2
-150+200	-	10.5
-200	-	85.1

63.0 per cent screened minus 325 mesh.

(Continued on next page)

(Test No. 2, cont'd) -

Results:

Product	Weight, per cent	Assays Oz./ton: Ag	Assays Per cent: Pb	Cu	Sn	Zn
Feed	100.00	8.88◆	1.26◆	1.41◆	1.26◆	2.07◆
Flot. conc.	11.99	63.40	7.70	10.72	9.44	5.97
" middling	15.06	5.93	1.16	0.58	0.50	2.64
" tailing	72.95	0.53	0.22	0.05	0.07	1.25

	DISTRIBUTION, per cent: Ag	Pb	Cu	Sn	Zn
Feed	100.00	100.0	100.0	100.0	100.0	100.0
Flot. conc.	11.99	85.6	73.3	91.1	90.0	34.5
" middling	15.06	10.1	13.9	6.2	6.0	19.1
" tailing	72.95	4.3	12.8	2.7	4.0	46.4

◆ Calculated.

Ratio of concentration, 8.3:1.

Reagents Added: (lb./ton)

To Grind -

Soda ash	-	6.0
NaCN	-	0.3

To Cell -

Pine oil	-	0.125
Cresylic acid	-	0.13
Amyl xanthate	-	0.30

pH, 8.8.
Time of flotation, 7 minutes.

-

Test No. 3. - Bulk Flotation.

This test was made similarly to Test No. 2, A coarser grind was used, as follows:

Mesh		Weight, per cent
+100	-	2.8
-100+150	-	8.1
-150+200	-	19.0
-200	-	70.1

(Continued on next page)

(Test No. 3, cont'd) -

43 per cent of the grind screened minus 325 mesh.

Results:

Product	Weight, per cent	Assays Oz./ton Ag	Assays Per cent Pb	Assays Per cent Cu	Assays Per cent Sn	Assays Per cent Zn
Feed	100.00	8.82*	1.26*	1.45*	1.19*	2.17*
Flot. conc.	6.20	106.60	14.98	19.37	16.76	7.89
" middling	14.96	11.86	1.37	1.38	1.01	4.83
" tailing	78.84	0.57	0.17	0.03	Nil	1.22

	DISTRIBUTION, per cent				
	Ag	Pb	Cu	Sn	Zn
Feed	100.0	100.0	100.0	100.0	100.0
Flot. conc.	74.9	73.5	84.2	87.3	22.5
" middling	20.0	16.2	14.2	12.7	33.3
" tailing	5.1	10.3	1.6	Nil	44.2

* Calculated.

Ratio of concentration, 16.1:1.

Reagents Added: (lb./ton)

To Grind -

Soda ash	6.0
NaCN	0.3

To Cell -

Pine oil	0.125
Cresylic acid	0.09
Amyl xanthate	0.30

pH, 8.8.
Time of flotation, 6 minutes.

This test concluded the bulk flotation concentrations of the ore. The grade of concentrate and the recoveries appear to be as high as can be expected.

(Continued on next page)

(Test No. 3, cont'd) -

An examination of the products of this test under the binocular microscope showed:

The flotation concentrate: Dense black, composed of galena, stannite and graphite, with a few particles of quartz and pyrite. The stannite and galena are distinguishable only by their crystal structure.

The flotation middling: The lead and tin minerals are free of adhering matter. Some very fine stannite was seen, together with pyrite and a little quartz.

The flotation tailing: Mostly quartz; some pyrite, and a few odd pieces of stannite.

* * *

In the bulk flotations in Tests Nos. 1, 2 and 3, it was indicated that the reagent combination of cresylic acid, pine oil and amyl xanthate is effective in floating the valuable minerals and gives a better froth than just the pine oil and xanthate. The addition of NaCN to the grind depresses the large amount of pyrite in the ore, together with the sphalerite. A grind of some 70 per cent minus 200 mesh is apparently fine enough to produce a flotation tailing that can be discarded, as shown in Test No. 3.

Test No. 4. - Selective Flotation.

In this test the ore was first treated in a similar manner as in the previous tests and the ensuing bulk concentrate was cleaned twice. Six pounds of lime per ton of original feed was then added and the cleaned concentrate was agitated for a 10-minute period. A No. 1 concentrate was then floated and the flotation tailings were called the No. 2 concentrate. The grind was 85 per cent minus 200 mesh as in

(Test No. 4, cont'd) -

Test No. 2.

Results:

Product	Weight, per cent	Assays Oz./ton: Ag	Assays Per cent: Pb	Cu	Sn	Zn
Feed	100.00	8.65*	1.07*	1.50*	1.26*	2.25*
No. 1 conc.	4.90	88.80	12.18	19.64	17.23	6.70
No. 2 "	2.21	83.30	5.28	12.76	11.36	6.25
Flot. middling	14.49	12.20	1.59	1.45	1.12	3.42
" tailing	78.40	0.70	0.17	0.06	Nil	1.29

	DISTRIBUTION, per cent: Ag	Pb	Cu	Sn	Zn	Ratio of concentration
Feed	100.00	100.0	100.0	100.0	100.0	100.0	
No. 1 conc.	4.90	50.3	56.0	64.0	67.1	14.6	20:1.
No. 2 "	2.21	21.3	11.0	18.7	20.0	6.1	45:1.
Flot. middling	14.49	20.4	21.6	14.0	12.9	22.0	
" tailing	78.40	8.0	11.4	3.3	-	57.3	

* Calculated.

Reagents Added: (lb./ton)

To Grind -

Soda ash	-	6.0
NaCN	-	0.3

To Cell -

Pine oil	-	0.12
Cresylic acid	-	0.10
Amyl xanthate	-	0.30

6.0 pounds of lime per ton of original feed was added in the selective flotation.

From the above it can be seen that the addition of lime to the selective flotation cell is not effective in producing a separation of the galena and stannite.

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(Details of Tests, cont'd) -

Test No. 5. - Selective Flotation.

This test follows the same idea as does Test No. 4. A strong cyanide solution replaced the lime used in the previous test in order to effect the separation of the stannite and galena. A coarser grind, 68.4 per cent minus 200 mesh, was used. Conditions otherwise were similar to Test No. 4. A screen test showed the grinding as follows:

Mesh		Weight, per cent
+ 65	-	0.3
- 65+100	-	3.4
-100+150	-	11.3
-150+200	-	16.6
-200	-	68.4

Results:

Product	Weight, per cent	Assay: Oz./ton Ag	Assay: Per cent Pb	Assay: Per cent Cu	Assay: Per cent Sn	Assay: Per cent Zn
Feed	100.00	8.84◆	1.10◆	1.39◆	1.32◆	2.14◆
No. 1 conc.	1.54	110.40	54.50	0.93	1.19	2.03
No. 2 "	6.73	81.50	0.82	18.85	17.30	9.46
Flot. middling	13.37	8.30	1.13	0.61	0.64	3.41
" tailing	78.36	0.70	0.07	0.03	0.07	1.30

	DISTRIBUTION, per cent Ag	Pb	Cu	Sn	Zn	Ratio of concentration
Feed	100.00	100.0	100.0	100.0	100.0	100.0	
No. 1 conc.	1.54	19.2	76.3	1.0	1.4	1.4	65:1.
No. 2 "	6.73	62.0	5.0	91.4	88.0	29.7	14.8:1.
Flot. middling	13.37	12.6	13.7	5.9	6.4	21.3	
" tailing	78.36	6.2	5.0	1.7	4.2	47.6	

◆ Calculated.

Reagents Added: (lb./ton)

To Grind -

Soda ash	-	6.0
NaCN	-	0.3

To Cell -

Pine oil	-	0.13
Cresylic acid	-	0.11
Amyl xanthate	-	0.30

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(Test No. 5, cont'd) -

1.0 pound of NaCN per ton of original feed was added in the selective flotation. A 10-minute period of agitation was used. The No. 1 concentrate was cleaned.

In this test the separation was more satisfactory, although the stannite (No. 2 concentrate) was rather low grade.

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Test No. 6. - Selective Flotation.

In this test a finer grind (85 per cent minus 200 mesh) was used. The primary flotation concentrate was cleaned twice and agitated for 10 minutes in cyanide solution of 1.0 pound per ton of original feed strength, as in the previous test. A lead concentrate (No. 2) was then floated off and the resultant tailing was the tin concentrate (No. 3). In addition to the above, a zinc concentrate (No. 1) was obtained from the primary flotation tailing. This concentrate was cleaned once.

Results:

Product	Weight, per cent	Assays: Oz./ton Ag	Assays: Per cent Pb	Assays: Per cent Cu	Assays: Per cent Sn	Assays: Per cent Zn
Feed	100.00	8.58◆	0.98◆	1.46◆	1.30◆	2.34◆
Zn Conc. No. 1	0.97	6.20	0.10	0.86	0.15	51.85
Pb " No. 2	2.42	10.10	30.94	6.42	5.68	4.24
Sn " No. 3	4.58	76.86	0.30	23.20	20.78	8.48
Zn middling	4.30	2.40	0.10	0.24	0.05	17.47
Flot. "	15.16	11.92	0.95	1.27	1.15	2.99
" tailing	72.57	0.66	0.10	0.05	0.05	0.18

Product	DISTRIBUTION, per cent Ag	Pb	Cu	Sn	Zn	Ratio of concentration
Feed	100.00	100.0	100.0	100.0	100.0	100.0	
No. 1 conc.	0.97	0.7	0.1	0.5	0.1	22.1	100:1.
No. 2 "	2.42	30.7	76.0	10.5	10.4	4.3	42:1.
No. 3 "	4.58	40.9	1.4	72.7	73.2	16.6	22:1.
Zn middling	4.30	1.2	0.4	0.7	0.2	32.0	
Flot. "	15.16	20.9	14.7	13.1	13.4	19.4	
" tailing	72.57	5.6	7.4	2.5	2.7	5.6	

◆ Calculated.

(Continued on next page)

(Test No. 6, cont'd) -

Reagents Added: (lb./ton)

To Grind -

Soda ash	-	6.0
NaCN	-	0.3

To Cell -

For Pb-Cu-Sn Flotation -

Pine oil	-	0.125
Cresylic acid	-	0.13
Amyl xanthate	-	0.30

For Zinc Flotation -

Lime	-	6.0
NaCN	-	0.10
$CuSO_4$	-	1.5
Pine oil	-	0.03
Amyl xanthate	-	0.10

The lead-copper-tin concentrate was agitated for 10 minutes in cyanide solution of 1.0 pound per ton of original feed strength, prior to the flotation of the galena. In the cleaning of the zinc concentrate (No. 1), 0.1 pound of NaCN per ton was used.

Examination of the products of Test No. 6 under the binocular microscope showed:

No. 1 zinc concentrate: Shows the sphalerite in clearly defined crystals. The impurities were mostly quartz plus a little pyrite.

No. 2 lead concentrate: No apparent impurities were visible except graphite and a little stannite. The galena crystals were clean and easily distinguishable by their cubic form.

No. 3 tin concentrate: A very few pieces of galena and odd bits of pyrite constituted the impurities. The stannite crystals were easily apparent by their angular shapes.

Zinc middlings: Some free sphalerite plus a large amount of pyrite.

Flotation middling: The lead and tin minerals appear free. Quartz and pyrite form the bulk of this product.

Flotation tailing: Quartz gangue predominates. Some pyrite and a few odd crystals of sphalerite and stannite make up the remainder.

* * *

(Test No. 6, cont'd) -

The results of the selective flotation tests indicate that agitation in strong cyanide solution is effective in separating the cleaned flotation concentrate into its major constituents, galena and stannite. Agitation in lime solution did not succeed in making a clean-cut separation. It was shown, in Test No. 6, that comparatively fine grinding is necessary to produce a high-grade copper-tin concentrate with a good recovery. In Test No. 5 it was shown that a fairly high-grade galena concentrate can be obtained by recleaning. In Test No. 6, some 54 per cent of the zinc reported in the zinc concentrate and zinc middling products with a 51.8 per cent zinc grade in the concentrate. It is probable that some of the iron in the stannite is replaced by zinc.

Test No. 7. - Table and Flotation Concentration.

In this test an attempt was made to table out the galena prior to flotation concentration of the stannite in the ore.

A portion of the ore was crushed through a set of rolls to pass 100 per cent minus 35 mesh. The pulp was then concentrated on a Wilfley table and a galena concentrate obtained. The table tailings were dewatered and transferred to a Denver flotation cell. The ensuing bulk concentrate was cleaned twice in a smaller machine.

(Continued on next page)

(Test No. 7, cont'd) -

Results:

TABLE CONCENTRATION.

Product	Weight, per cent	Assays Oz./ton Ag	Assays Per cent Pb	Assays Per cent Cu	Assays Per cent Sn
Feed	100.00	8.46◆	0.99◆	1.50◆	1.27◆
Table conc.	4.08	30.20	11.12	2.16	2.13
" middling	9.10	21.20	2.57	3.74	3.47
" tailing	86.82	6.10	0.35	1.23	1.00

	DISTRIBUTION, per cent Ag	Pb	Cu	Sn	Ratio of concentration
Feed	100.00	100.0	100.0	100.0	100.0	
Table conc.	4.08	14.6	45.8	5.9	6.8	24.5:1.
" middling	9.10	22.8	23.6	22.7	24.9	
" tailing	86.82	62.6	30.6	71.4	68.3	

◆ Calculated.

FLOTATION OF TABLE TAILING.

Product	Weight, per cent	Assays Oz./ton Ag	Assays Per cent Pb	Assays Per cent Cu	Assays Per cent Sn
Feed	100.00	6.24◆	0.25◆	1.15◆	1.07◆
Flot. conc.	5.04	73.60	1.92	14.31	13.28
" middling	11.56	16.10	0.48	2.82	2.65
" tailing	84.40	0.80	0.11	0.12	0.12

	DISTRIBUTION, per cent Ag	Pb	Cu	Sn	Ratio of concentration
Feed	100.00	100.0	100.0	100.0	100.0	
Flot. conc.	5.04	59.4	39.6	62.8	62.2	19.8:1.
" middling	11.56	29.8	22.5	28.4	28.4	
" tailing	84.40	10.8	37.9	8.8	9.4	

◆ Calculated.

Reagents Added: (lb./ton)

To Cell -

Soda ash	-	4.0
NaCN	-	0.3
Pine oil	-	0.07
Cresylic acid	-	0.05
Amyl xanthate	-	0.15

pH of pulp, 8.9.
Time of flotation, 5 minutes.

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(Test No. 7, cont'd) -

Summary of Distribution, Test No. 7:

In this summary, 50 per cent of the percentage recovery in the middling products is taken as eventually reporting in the concentrate.

	Ag	Pb	Cu	Sn
	- Per cent -			
Recovery by table concentration -	26.0	57.6	17.3	19.3
" " flotation " -	46.5	15.6	55.0	52.4
Overall recovery -	72.5	73.2	72.3	71.7

Test No. 8. - Table and Flotation Concentration.

In this test a portion of the ore was crushed through a set of rolls to pass 100 per cent minus 35 mesh. The pulp was then passed over a Wilfley table and a rough table concentrate obtained. This table concentrate was then treated on a Haultain superpanner. The resulting panner concentrate was weighed and assayed and the panner tailing combined with the original table tailing. This product was dewatered and transferred to a Denver flotation cell, where a bulk flotation concentrate was obtained. This concentrate was cleaned twice in a smaller machine.

Results of Table Concentration:

Product	Weight, per cent	Assay Oz./ton Ag	Assay Per cent Pb	Assay Per cent Cu	Assay Per cent Sn	Assay Per cent Zn
Feed	100.00	8.54	1.25	1.42	1.20	2.28
Table conc.	12.35	39.41*	8.57*	7.38*	5.89*	10.60*
" tailing	87.65	4.19	0.36	0.58	0.54	1.11
		DISTRIBUTION, per cent				
		Ag	Pb	Cu	Sn	Zn
Feed	100.00	100.0	100.0	100.0	100.0	100.0
Table conc.	12.35	57.0	74.8	64.2	60.6	57.5
" tailing	87.65	43.0	25.2	35.8	39.4	42.5

* Calculated.

Ratio of concentration, 8.1:1.

(Continued on next page)

(Test No. 8, cont'd) -

The rougher table concentrate was treated on the superpanner. The resultant panner concentrate was weighed and assayed:

Silver	-	63.7 oz./ton.
Lead	-	42.7 per cent.
Copper	-	0.61 "
Tin	-	0.61 "
Zinc	-	0.81 "

This panner concentrate was 0.92 per cent of the weight of the original feed; giving a ratio of concentration of 109:1.

The panner tailing was combined with the table tailing, dewatered, and concentrated by flotation.

Results of Flotation:

Product	Weight, per cent	Assays Oz./ton: Ag	Assays Per cent: Pb	Assays Per cent: Cu	Assays Per cent: Sn
Feed	100.00	8.77◆	0.61◆	1.44◆	1.18◆
Flot. conc.	6.56	92.40	6.35	17.70	14.10
" middling	14.41	11.40	1.00	1.31	1.19
" tailing	79.03	1.35	0.06	0.07	0.10

	DISTRIBUTION, per cent: Ag	Pb	Cu	Sn	Ratio of concentration
Feed	100.00	100.0	100.0	100.0	100.0	
Flot. conc.	6.56	69.1	68.6	80.5	78.3	15.2:1.
" middling	14.41	18.7	23.7	13.1	14.5	
" tailing	79.03	12.2	7.7	6.4	7.2	

◆ Calculated.

Reagents Added to Cell: (lb./ton)

Soda ash	-	4.0
NaCN	-	0.3
Pine oil	-	0.10
Cresylic acid	-	0.10
Amyl xanthate	-	0.30

pH, 9.0.
Time of flotation, 6 minutes.

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(Test No. 8, cont'd) -

Summary of Distribution, Test No. 8:

	Ag	Pb	Cu	Sn
	- Per cent -			
Recovered in panner concentrate -	6.9	31.4	0.4	0.5
Recovered in flotation concentrate plus flotation middling -	73.1	55.2	86.7	85.2
Overall recoveries -	80.0	86.6	87.1	85.7

In this summary 50 per cent of the percentage recovery in the middling products is taken as eventually reporting in the concentrate.

An examination of the various products of Test No. 8 under the binocular microscope shows:

In the panner concentrate: The galena crystals can easily be distinguished by their typical cubic crystal form. The principal other constituent was pyrite.

In the flotation concentrate: Stannite predominates in angular-shaped crystals. A little graphite and some pyrite and quartz form the bulk of the concentrate.

In the flotation middling: Abundance of pyrite was visible with a few scattered grains of quartz. The stannite is free from adhering material.

In the tailing: Consists of quartz and coarse pyrite. A very few particles of galena and stannite are visible.

...

In Tests Nos. 7 and 8 an attempt was made to separate the galena in the ore by table concentration prior to flotation of the table tailing. Owing to the small amount of lead in the ore it was not found possible to make a clean-cut separation in the small-scale test work. The use of the superpanner on the table concentrate, in Test No. 8, demonstrated by a laboratory method that such a procedure might work out satisfactorily in a large-scale operation.

SUMMARY AND CONCLUSIONS:

The test work showed that high recoveries of the valuable minerals can be made quite easily by using the common type of flotation reagents. Soda ash sufficient to produce an alkaline reaction in the flotation circuit, together with enough cyanide to depress the iron pyrite in the ore, is essential.

Under these primary conditions a high-grade silver-lead-copper-tin concentrate can be obtained by the addition of pine oil, cresylic acid, and xanthate.

In the selective flotation procedure on this concentrate, a strong cyanide solution and 10 minutes' agitation was used in order to depress the stannite and at the same time permit the galena in the concentrate to float. By cleaning this galena concentrate a fairly high-grade lead concentrate was produced (Test No. 5) which was comparatively free of stannite. The flotation tailing from the galena-stannite cyanide agitation would constitute the tin concentrate.

An attempt was also made, in Test No. 6, to float the zinc remaining in the pulp after the removal of the galena and stannite minerals. While this procedure, by standard methods, did succeed in producing a fairly high-grade zinc concentrate, the recovery was low, as a large percentage of the zinc reported in the galena-stannite products. It is probable that part of the iron in the stannite mineral is replaced by zinc.

The grind used in these flotation tests screened from 68.4 to 85 per cent minus 200 mesh. While it was shown, in Test No. 5, that the coarser grind of 68 per cent will produce a flotation tailing that can be discarded, it appears, from the results obtained in Test No. 6, that a finer grind is

(Summary and Conclusions, cont'd) -

essential in order to permit a clean-cut separation of the galena-stannite minerals and at the same time obtain a high-grade tin concentrate.

In Tests Nos. 7 and 8, table concentration prior to flotation of the table tailings was tried in order to see whether it was possible to retain the bulk of the galena in the table concentrate. By this method 57 per cent of the lead reported in the table concentrate and middling products together with 26.0 per cent of the silver, 17.3 per cent of the copper, and 19.3 per cent of the tin. In Test No. 8, where the table concentrate was superpanned, a grade of lead concentrate assaying 63 ounces silver per ton, 42.7 per cent lead, 0.6 per cent copper, and 0.6 per cent tin was secured. It is possible that in a large-scale operation this method of procedure might be satisfactory. Owing to the small amount of galena in the ore it was not found possible to determine this definitely in the small-scale tests.

The microscopic study of the polished sections was conducted on specimen samples from the stannite ore body. The different minerals were identified and their close association and dissemination were noted.

The recoveries and grade of lead and copper-tin concentrates, produced by selective flotation in Tests Nos. 5 and 6, were as follows:

A lead concentrate assaying 110.4 ounces per ton Ag, 54.5 per cent Pb, 0.9 per cent Cu and 1.19 per cent Sn was obtained in Test No. 5 with recoveries of 31.8 per cent of the silver and 90.0 per cent of the lead in the concentrate and middling products. The ratio of concentration was 65:1.

A copper-tin concentrate assaying 76.8 ounces per ton Ag, 23.2 per cent Cu and 20.8 per cent Sn was obtained in Test No. 6 with recoveries of 61.8 per cent of the silver, 85.8 per cent of the copper and 86.6 per cent

(Summary and Conclusions, cont'd) -

of the tin in the concentrate and middling products, The ratio of concentration was 22:1. This grade of tin concentrate is probably as high as can be expected as pure stannite mineral assays 29.5 per cent copper and 27.5 per cent tin.

From the above summary of the results obtained, the flow-sheet applicable to this ore would comprise a ball mill and classifier, grinding to 85 per cent minus 200 mesh. The classifier overflow would be pumped to a conditioning tank and from there to the primary flotation cells, where a bulk flotation concentrate would be obtained. This concentrate would be cleaned twice and would recover some 90 per cent of the silver, 90 per cent of the lead, 90 per cent of the copper, and 90 per cent of the tin in the ore. The flotation tailings would be discarded, as only some 9 pounds of zinc per ton could be recovered from this product. The copper-tin-lead-silver bulk concentrate would then be pumped to a conditioning tank and agitated in cyanide solution of a strength of one pound NaCN per ton of original feed. After agitation the pulp would go to a second set of flotation cells, where a lead concentrate would be obtained assaying about 54 per cent lead and 110 ounces of silver per ton with a recovery of 85 per cent of the lead and 25 per cent of the silver in the ore. The flotation tailings from this operation would comprise the copper-tin concentrate with recoveries of 85 per cent of the copper, 85 per cent of the tin, and 55 per cent of the silver in the ore. This concentrate should assay 23 per cent copper, 20 per cent tin and 75 ounces of silver per ton.

The disposal or subsequent treatment of the copper-tin concentrate is a problem not touched upon in this investigation.

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