

O T T A W A November 26th, 1940.

R E P O R T

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 923.

Amalgamation and Concentration of a
Gold-Copper-Tungsten Ore from the
Slave Lake Gold Mines Limited,
Great Slave Lake, Northwest Territories.

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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Great Slave Lake, Northwest Territories.

Shipment:

Two bags of ore, total weight 115 pounds, were received on July 26th, 1940, from Mr. J. J. Byrne, Vice-President, Slave Lake Gold Mines Limited, 80 King Street West, Toronto, Ontario.

A shipment of ore from this property had previously

been received, on February 24th, 1937, and had been reported on in Ore Dressing and Metallurgical Laboratories Investigation No. 713 of that year.

Location of the Property:

The property of the Slave Lake Gold Mines Limited from which this shipment was received is situated on Outpost Island, Great Slave Lake, Northwest Territories.

Sampling and Analysis:

After cutting, crushing and grinding by standard methods, a representative sample of the shipment was obtained which assayed as follows:

Gold	=	2.36 oz./ton
Silver	=	0.11 "
WO ₃	=	2.01 per cent
Copper	=	3.01 "
Iron	=	11.74 "
Sulphur	=	8.39 "
Arsenic	=	1.20 "
Tin	=	trace.

The above analysis indicates that the ore contains approximately 23 per cent sulphides.

Characteristics of the Ore:

Six polished sections were prepared and examined under the reflecting microscope. Since the general microscopic character of this ore had previously been reported (1937), the particular purpose of this examination was to determine the grain size and modes of occurrence of the tungsten mineral.

Gangue -

The gangue consists essentially of fine-textured, smoky-grey quartz containing small streaks and patches of dark

greenish-grey chloritic material.

Metallic Minerals -

Metallic minerals, listed in their approximate order of abundance, are: chalcopyrite, pyrite, marcasite, ferberite, cassiterite(?), bornite, and native gold.

Chalcopyrite preponderates largely as small masses and coarse irregular grains in gangue. Pyrite and marcasite are common, predominantly as coarse irregular grains and subhedral crystals usually associated with each other and with chalcopyrite. A very small quantity of a mineral resembling cassiterite is visible as small rounded grains in gangue. Bornite is present in negligible amount as rare tiny grains associated with chalcopyrite. One small particle of native gold was observed in the sections. It occurs alone in quartz and is about 20 microns in size.

A comparatively small quantity of ferberite is present as small masses and irregular grains in gangue. These are infrequently associated with chalcopyrite. Ferberite is being replaced by a gangue mineral to such an extent that most grains and masses present a lace-like pattern consisting of small, irregular residual particles of ferberite down to the limits of the microscope (about 1 micron) in size, in a groundmass of gangue. (See Figure 1).

(Figure 1 is on the next page)

Figure 1.

Showing fine grains of ferberite in a groundmass of gangue and the impossibility of economically making a complete separation.

Ferberite - white;
Quartz - Q;
Gangue mineral - G; and
Pits and fractures - black.

Magnification - X 115.

A 200-mesh grid is superimposed.

Investigative Work:

The greater part of the work on the shipment was confined to concentration tests on the tungsten contents of the ore. Table concentration of the ferberite gave a recovery of about 45 per cent of the mineral in the concentrate and middling products with a grade of up to 51 per cent WO_3 in the table concentrate. Flotation concentration of the table slimes showed a recovery of some 50 per cent of the tungsten in this product, the flotation concentrate assaying 20 per cent WO_3 , an overall recovery of 67.5 per cent of the tungsten being included in the table concentrate, table middlings and flotation concentrate.

Details of Test Work:

Test No. 1. - Amalgamation and Concentration.

The ore at minus 14 mesh was ground in a ball mill to pass 57.2 per cent minus 200 mesh. The pulp was then passed through a Denver jig and the jig tailing passed over a corduroy blanket. The combined jig and blanket concentrates were then amalgamated with mercury and the amalgam residue added to the blanket tailing. This product was then concentrated on a Wilfley table. The table tailings were dewatered, transferred to a flotation machine, conditioned with 2 pounds of lime per ton, and floated with the additions of 0.03 pound amyl xanthate and 0.025 pound pine oil per ton. The flotation concentrate was cleaned in a smaller machine.

(Continued on next page)

(Test No. 1, cont'd) -

Results:

Jig and Blanket Concentration.

Product	:Weight, : per : cent	A s s a y s			:Distribution, : per cent			:Ratio of :concen- :tration
		:oz./ton:	Au : Cu	: per cent : WO ₃	: Au : Cu	: per cent : WO ₃		
Feed	:100.00	2.36	-	2.01	100.0	-	100.0	
Jig and blanket conc.	: 8.50	20.65 [Ⓢ]	-	5.78 [Ⓢ]	74.4	-	24.5	11.7:1.
Blanket tailing:	91.50	0.66	3.00	1.66	25.6	-	75.5	

The amalgam residue from the jig and blanket concentrates was added to the blanket tailings. This product assayed 0.73 ounce gold per ton and showed a recovery of 69.1 per cent of the gold by amalgamation.

Table Concentration of Blanket Tailing + Amalgam Residue.

Feed	:100.00	0.73 [Ⓢ]	2.98 [Ⓢ]	2.29 [Ⓢ]	100.0	100.0	100.0	
Table conc.	: 2.56	4.04	3.41	24.82	14.2	2.9	27.7	39:1.
Table middling	: 4.71	1.46	5.34	5.45	9.4	8.4	11.2	
Table tailing	: 92.73	0.60	2.85	1.51	76.4	88.7	61.1	

Flotation of Table Tailings.

Feed	:100.00	0.53 [Ⓢ]	2.85 [Ⓢ]	-	100.0	100.0	-	
Flot. conc.	: 6.36	3.26	32.42	-	38.9	72.3	-	15.7:1.
Flot. middling	: 2.92	3.38	13.40	-	18.5	13.7	-	
Flot. tailing	: 90.72	0.25	0.44	-	42.6	14.0	-	

[Ⓢ] Calculated.

Summary of Test No. 1:

	Per cent
Gold recovered by amalgamation and flotation, 69.1 + 13.5	= 82.6
Copper recovered by flotation concentration	= 76.3
WO ₃ recovered by table concentration	= 38.9

Test No. 2. - Amalgamation and Concentration.

In this test the ore at minus 14 mesh was ground in a ball mill to pass 52.6 per cent minus 200 mesh. The pulp was then concentrated on a jig and blankets and the concentrates amalgamated as in Test No. 1. A bulk flotation concentrate was then made of the blanket tailing and amalgam residue. This flotation bulk concentrate was cleaned on a smaller machine. The flotation tailing was passed over a Wilfley table and a portion of the table slimes concentrated on a Haultain superpanning machine.

Results:

Jig and Blanket Concentration.

Product	Weight, : per : cent :	A s s a y s			Distribution, : per cent :			Ratio of : concent- : ration :
		Au, : oz./ton :	Per cent : Cu :	WO ₃ :	Au : per cent :	Cu : per cent :	WO ₃ :	
Feed	:100.00	2.36	-	-	100.0	-	-	
Jig and blanket conc.	: 5.50	30.19 [Ⓞ]	-	-	70.4	-	-	18.2:1.
Blanket tailing:	: 94.50	0.74	-	-	29.6	-	-	

[Ⓞ] Calculated.

The amalgam residues + blanket tailing assayed

0.82 ounce gold per ton, giving a recovery of 65.3 per cent of the gold by amalgamation.

Bulk Flotation of Blanket Tailing + Amalgam Residue.

Feed	:100.00	0.82 [Ⓞ]	2.99 [Ⓞ]	-	100.0	100.0	-	
Flot. conc.	: 23.21	2.84	12.16	-	80.3	94.3	-	4.3:1.
Tailing	: 76.79	0.21	0.22	2.29	19.7	5.7	-	

[Ⓞ] Calculated

The pulp was conditioned with 2.0 pounds of soda ash per ton and floated with 0.10 pound amyl xanthate and 0.07 pound pine oil per ton.

(Continued on next page)

(Test No. 2, cont'd) -
Results, cont'd -

Cleaning of Bulk Flotation Concentrate.

Product	Weight, : per : cent	A s s a y s			Distribution, : per cent			Ratio of : concen- : tration
		: Au, : : oz./ton:	: Per cent : : Cu : : WO ₃ :	: Au : : Cu : : WO ₃ :				
Feed	:100.00	2.70 [Ⓢ]	12.16 [Ⓢ]	=	100.0	100.0	=	
Concentrate	: 80.54	2.98	13.93	=	88.8	92.3	=	
Middling	: 19.46	1.56	4.84	=	11.2	7.7	=	

Table Concentration of Primary Flotation Tailings.

Feed	:100.00			2.22 [Ⓢ]	=	=	100.0	
Concentrate	: 4.06	0.76	=	23.86	=	=	43.5	24.6:1.
Middling	: 7.41	=	=	5.11	=	=	17.0	
Sands	: 44.93	=	=	0.26	=	=	5.2	
Slimes	: 43.60	0.10	=	1.75	=	=	34.3	

Superpanning of Table Slimes.

Feed	:100.00	0.10	=	1.75 [Ⓢ]	100.0	=	100.0
Concentrate	: 0.20	5.80	=	11.70	11.6	=	1.4
Sands	: 71.45	0.10	=	1.41	71.4	=	57.5
Slimes	: 28.35	0.06	=	2.54	17.0	=	41.1

Ⓢ Calculated.

Summary of Test No. 2:

	Per cent
Gold recovered by amalgamation and flotation, 65.3 + 27.8	= 93.1
Copper recovered by flotation concen- tration,	= 94.3
WO ₃ recovered by table concentration	= 60.5

Tests Nos. 1 and 2 give a comparison of somewhat different methods of concentrating the gold, copper and tungsten. In both tests the ore was ground in a ball mill and the gold concentrated in a Denver jig and corduroy

(Continued on next page)

(Comments on Tests Nos. 1 and 2, cont'd) -

blankets. The combined jig and blanket concentrates were then amalgamated, giving a recovery of 69.1 per cent of the gold in Test No. 1 when the primary grind was 57.2 per cent minus 200 mesh and a recovery of 65.3 per cent of the gold in Test No. 2 when the grind was 52.6 per cent minus 200 mesh.

In both tests the amalgam residues were added to the blanket tailing. In Test No. 1 this product was then passed over a Wilfley table where some 39 per cent of the tungsten was recovered in the concentrates and middlings. In Test No. 2 a bulk flotation was made of the sulphides prior to concentrating the flotation tailing on a Wilfley table; in this test some 60 per cent of the tungsten was recovered in the table concentrates and middlings. In both tests the grade of tungsten was low, however.

In Test No. 1 a flotation concentration of the table tailing in a lime pulp gave a cleaner product assaying 32 per cent copper and 3.2 ounces gold per ton and in the bulk flotation in a soda ash pulp of Test No. 2 a cleaner concentrate was obtained assaying 13.9 per cent copper and 2.9 ounces gold per ton. In both flotations there was a tendency for a large percentage of the gold to report in the middling product.

A superpanning test on the table slimes of Test No. 2 showed that the large portion of the tungsten was in the paner slimes and a microscopic examination of the paner concentrate showed some free gold remaining which did not respond to either amalgamation or flotation concentration.

Test No. 3. - Amalgamation and Concentration.

The mode of procedure in this test was asked for by the mine management and was as follows: After removing the jig and blanket concentrates for amalgamation the blanket tailings were to be conditioned and a bulk flotation concentrate made of the sulphides in the ore, this concentrate to be reground and amalgamated along with the jig and blanket concentrates. After amalgamation the combined amalgam residues are returned to the cells where a high-grade copper concentrate is taken off. The tailing from the primary flotation to be passed over a Wilfley table and the tungsten concentrates obtained.

Acting on this advice the ore was ground in a ball mill to pass 50.4 per cent minus 200 mesh, and the pulp was treated as described. Prior to amalgamation the combined jig, blanket and bulk flotation concentrates were reground to pass 80.0 per cent minus 200 mesh.

Results:

Jig and Blanket Concentration.

Product	:Weight, : per : cent	: A s s a y s			: Distribution,			:Ratio of : concen- : tration
		: oz./ton:	: Au, : Per cent	: Cu : WOs	: Au : Cu : WOs	: per cent		
Feed	:100.00	2.56	-	2.01	100.0	-	100.0	
Jig and blanket conc.	: 5.50	29.16 [Ⓒ]	-	6.30 [Ⓒ]	67.9	-	17.3	18:1.
Blanket tailing:	: 94.50	0.80	-	1.76	32.1	-	82.7	

[Ⓒ] Calculated.

The blanket tailings were conditioned with 2.5 pounds of soda ash per ton and floated with 0.15 pound amyl xanthate, 0.10 pound pine oil and 1.0 pound copper sulphate per ton.

(Continued on next page)

(Test No. 3, cont'd) -
Results, cont'd -

Bulk Flotation of Blanket Tailing.

Product	: Weight, : : per : : cent :	: A s s a y s :			: Distribution, :			: Ratio of : concen- : tration :
		: Au, : : oz./ton :	: Per cent : : Cu : : WO ₃ :	: Au : : Cu : : WO ₃ :	: per cent : : Au : : Cu : : WO ₃ :			
Feed	:100.00	0.80	-	-	100.0	-	-	
Flot. conc.	: 20.83	2.91 [Ⓢ]	-	-	75.7	-	-	4.8:1.
Flot. tailing:	79.17	0.245	0.21	1.76	24.3	-	-	

After regrinding and amalgamation of the jig, blanket and bulk flotation concentrates the amalgam residue assayed 2.57 ounces gold per ton, giving a recovery of 66.7 per cent by amalgamation. This amalgam residue was then conditioned with 2 pounds of lime per ton and floated by the addition of 0.03 pound of butyl xanthate and 0.025 pound pine oil per ton.

Flotation of Amalgam Residue.

Feed	:100.00	2.57	11.00 [Ⓢ]	-	100.0	100.0	-	
Flot. conc.	: 49.67	3.77	20.40	-	73.0	91.9	-	2:1.
Flot. tailing:	50.33	1.375	1.75	-	27.0	8.1	-	

[Ⓢ] Calculated.

Table Concentration of Bulk Flotation Tailing.

Product	: Weight, : : per : : cent :	: Assays, :		: Distribution: : of WO ₃ , : : per cent :	: Ratio of : concen- : tration :
		: WO ₃ , : : per cent :	: : : per cent :		
Feed	:100.00	1.73 [Ⓢ]		100.0	
Table concentrate	: 2.06	15.28		17.7	48.5:1.
Table middling	: 3.58	8.96		18.0	
Table sands	: 9.92	0.93		5.2	
Table slimes	: 84.44	1.24		59.1	

[Ⓢ] Calculated.

Summary of Test No. 3:

	<u>Per cent</u>
Gold recovered by amalgamation and flotation, 66.7 + 24.3	= 91.0
Copper recovered by flotation concentration	= 91.9
WO ₃ recovered by table concentration	= 29.5

(Continued on next page)

(Test No. 3, cont'd) -

Commenting on the results and flow-sheet of this test, it might be pointed out that the ore contains about 23 per cent sulphides, which would report mainly in the bulk flotation concentrate. This concentrate, together with the jig and blanket concentrate, forms a rather large amount of material to handle in the amalgamation barrel, and the results obtained by amalgamation were only about 1 per cent greater than in amalgamating the jig and blanket concentrates separately as in the previous test. It might also be noted that the handling of gold-copper flotation concentrates by barrel amalgamation is not a simple procedure, owing to the fouling produced by the flotation reagents and copper contents of the concentrate, necessitating a complicated washing.

The low recovery of the tungsten in the table concentration is in part accounted for by the fact that the tailing from the amalgamation residues was not passed over the table due to the fine grinding of this residue rendering such an operation futile.

Test No. 4. - Amalgamation and Concentration.

The ore at minus 14 mesh was ground in a ball mill to pass 58.4 per cent minus 200 mesh. The pulp was then passed through a jig and blanket and the combined concentrates amalgamated without regrinding. The amalgam residue was then added to the blanket tailing, conditioned with 2 pounds of soda ash per ton and floated by the additions of 0.075 pound pine oil and 0.15 pound amyl xanthate

(Continued on next page)

(Test No. 4, cont'd) -

per ton. The resulting flotation tailings were then passed over a Wilfley table. The table concentrates and middlings product were combined and passed over the table a second time in order to raise the grade of concentrates.

Results:

Product	Jig and Blanket Concentration.							
	: Weight, : : per : : cent	: A s s a y s			: Distribution, :			: Ratio of : concen- : tration
		: Au, : : oz./ton:	: Per cent : : Cu :	: W03 : : Au :	: per cent : : Cu :	: W03 : : Au :		
Feed	: 100.00	2.36	3.01	2.01	100.0	-	-	
Jig and blanket conc.	: 8.50	20.00 [Ⓞ]	4.95 [Ⓞ]	6.53 [Ⓞ]	72.1	-	-	11.8:1.
Blanket tailing:	: 91.50	0.72	2.83	1.59	27.9	-	-	

The amalgamation of the concentrates, without regrinding, showed a recovery of 61 per cent of the gold by amalgamation, giving an assay of 0.92 ounce gold per ton to the amalgam residue plus blanket tailing.

Bulk Flotation of Amalgam Residue + Blanket Tailing.

Feed	: 100.00	0.92	3.01	2.01	100.0	100.0	100.0	
Flot. conc.	: 22.88	2.30	12.45	0.73	57.3	94.6	8.3	4.4:1.
Flot. tailing	: 77.12	0.51	0.21	2.39	42.7	5.4	91.7	

Table Concentration of Flotation Tailing.

Feed	: 100.00	-	-	2.29 [Ⓞ]	-	-	100.0	
Table conc.	: 1.35	-	-	48.12	-	-	28.4	74:1.
Table middling	: 2.51	-	-	14.96	-	-	16.4	
Table sands	: 51.22	-	-	0.46	-	-	10.3	
Table slimes	: 44.92	-	-	2.29	-	-	44.9	

Ⓞ Calculated.

(Continued on next page)

(Test No. 4, cont'd) -

Summary of Test No. 4:

	<u>Per cent</u>
Gold recovered by amalgamation and flotation concentration, 61.0 + 22.3 =	83.3
Copper recovered by flotation concentration =	94.6
WO ₃ recovered by table concentration =	41.0

In this test the grade of tungsten concentrate was raised to 48 per cent WO₃ by re-treatment. The gold recovery by amalgamation was lower due to the jig and blanket concentrates being amalgamated without regrinding.

Test No. 5. - Table Concentration.

This test was made in order to see what grade of tungsten it was possible to obtain on the laboratory-size Wilfley table and at the same time obtain a recovery approximating that of the previous tests.

The ore was ground in a ball mill to pass 52.2 per cent minus 200 mesh and the gold amalgamated and the sulphides floated off as in the previous test. The flotation tailings were then passed over the Wilfley table with the following results:

Product	Weight, : per : cent	Assay, : WO ₃ , : per cent	Distribution : of WO ₃ , : per cent	Ratio of : concen- : tration
Feed	:100.00	2.37 [Ⓢ]	100.0	
Table conc.	: 1.22	52.74	27.1	83:1.
Table middling:	3.24	12.48	17.0	
Table sands	: 37.46	0.55	8.7	
Table slimes	: 58.08	1.93	47.2	

[Ⓢ] Calculated.

(Continued on next page)

(Test No. 5, cont'd) -

The test shows the probable limit that is possible in raising the grade of concentrate on a laboratory-size Wilfley table. The recovery is low due to the slime losses of the ferberite.

Test No. 6. - Table and Flotation Concentration.

In order to avoid the slime losses as much as possible a portion of the ore at minus 14 mesh was dry-ground to pass 100 per cent through a 35-mesh screen. The gold was then amalgamated and the sulphides floated off as in previous tests. The pulp was then passed over a Wilfley table and the tungsten in the table slimes concentrated by flotation.

Results:

Table Concentration of Flotation Tailing.

Product	Weight, : per : cent	Assay, : WO ₃ , : per cent	Distribution : of WO ₃ , : per cent	Ratio of : concen- : tration
Feed	: 100.00	2.38 [⊗]	100.0	
Table conc.	: 1.35	44.12	24.8	74:1.
Table middling:	3.91	14.56	23.8	
Table sands	: 56.03	0.52	12.2	
Table slimes	: 38.71	2.43	39.2	

[⊗] Calculated.

The slime product from the table concentration was conditioned with 0.3 pound of sodium silicate and 0.03 pound of lead nitrate per ton and floated by the further additions of 0.5 pound of sodium oleate and 0.085 pound of cresylic acid per ton. The resulting concentrate was cleaned in a smaller machine.

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(Test No. 6, cont'd) -
 Results, cont'd -

Flotation of Table Slimes.				
Product	Weight, per cent	Assay, WO ₃ , per cent	Distribution of WO ₃ , per cent	Ratio of concentration
Feed	100.00	2.44 [Ⓢ]	100.0	
Flot. conc.	4.94	19.10	38.7	20:1.
Flot. middling	11.58	4.64	22.0	
Flot. tailing	83.48	1.15	39.3	

[Ⓢ] Calculated.

Summary:

	Per cent
WO ₃ recovered by table concentration	= 48.6
WO ₃ " " flotation	= 23.8
Overall recovery	= 72.4 per cent.

In this test the amount of slime is reduced somewhat by avoiding laboratory ball mill grinding which produces a product similar to a classifier overflow in mill practice. The summary includes the middling products in both table and flotation concentration.

The primary table concentrate was passed over the Wilfley table a second time in order to bring up the grade.

Test No. 7. - Concentration and Infrasing.

The ore at minus 14 mesh was dry-ground to pass 100 per cent through a 35-mesh screen. The sample was then pulped and the gold removed by amalgamation. The amalgam residue was added to the blanket tailing, conditioned with 2 pounds of lime per ton, and floated by the further additions

(Continued on next page)

(Test No. 7, cont'd) -

of 0.05 pound butyl xanthate and 0.08 pound of cresylic acid per ton. The flotation tailing was then passed over a Wilfley table and the minus 200 mesh portion of the table slimes infrasized on a Haultain infrasizer.

The amalgam residue + blanket tailing assayed 1.02 ounces gold per ton, giving a recovery of 56.8 per cent by amalgamation.

Flotation of Amalgam Tailing + Blanket Tailing.								
Product	Weight, per cent	Assays			Distribution, per cent			Ratio of concentration
		Au, oz./ton	Per cent Cu	Per cent WO ₃	Au	Cu	WO ₃	
Feed	100.00	1.02	3.31 [®]	-	100.0	100.0	-	
Flot. conc.	15.77	3.04	15.54	-	47.0	73.9	-	6.3:1.
Flot. middling	4.65	3.28	6.83	-	15.0	9.6	-	
Flot. tailing	79.58	0.49	0.69	-	38.0	16.5	-	

Probably owing to the coarse grind and the lime pulp, a rather large amount of copper and gold reported in the flotation tailing.

Table Concentration of Flotation Tailing.								
	Weight	Au	Cu	WO ₃	Au	Cu	WO ₃	Ratio
Feed	100.00	-	-	2.24 [®]	-	-	100.0	
Table conc.	3.16	-	6.46	29.08	-	-	40.9	31.6:1.
Table middling	3.73	-	-	5.60	-	-	9.4	
Table sands	57.27	-	-	0.33	-	-	8.4	
Table slimes	35.84	-	-	2.59	-	-	41.3	

[®] Calculated.

The table slimes screened 87.8 per cent minus 200 mesh. The plus 200 mesh portion assayed 0.37 per cent WO₃. The minus 200 mesh product infrasized as follows:

(Continued on next page)

(Test No. 7, cont'd) -

Infrasizing.			
Size, in microns	Weight, per cent	Assay, WO ₃ , per cent	Distribution of WO ₃ , per cent
+56	0.3)	0.70	2.4
56 to 40	9.6)		
40 to 28	19.3	1.31	8.7
28 to 20	17.7	2.37	14.3
20 to 14	16.2	3.54	19.6
14 to 10	8.5	4.26	12.4
-10	28.4	4.39	42.6
Totals	100.0	2.92	100.0

This infrasizer test on the table slimes emphasizes the tendency of the ferberite to report in the finer sizes of the slime product, the assay going from 0.70 per cent WO₃ in the coarsest size to 4.39 per cent WO₃ in the minus 10 micron product.

Test No. 8. - Magnetic Concentration.

A portion of the ore at minus 14 mesh was pulped and a bulk concentrate obtained in a Denver flotation machine by the addition of 2.0 pounds of soda ash, 0.20 pound amyl xanthate and 0.15 pound of pine oil per ton. The flotation tailing was then passed over a Wilfley table and a large low-grade table concentrate secured. This concentrate was then dried and passed through a Dings High Intensity Magnetic Separator machine. The different products of flotation, table concentration, and magnetic concentration were assayed for WO₃.

(Continued on next page)

(Test No. 8, cont'd) -

Results:

Flotation Concentration.				
Product	Weight, : : per : cent	Assay, : : WO ₃ , : per cent	Distribution : : of WO ₃ , : per cent	Ratio of : concen- : tration
Feed	:100.00	2.01	100.0	
Flot. conc.	: 16.84	0.70	5.9	5.9:1.
Flot. tailing	: 83.16	1.89	94.1	

Table Concentration of Flotation Tailing.				
Product	Weight, : : per : cent	Assay, : : WO ₃ , : per cent	Distribution : : of WO ₃ , : per cent	Ratio of : concen- : tration
Feed	:100.00	1.89	100.0	
Table conc.	: 14.61	6.50	42.4	6.8:1.
Table middling	: 12.64	1.42	8.0	
Table sands	: 44.94	0.55	11.0	
Table slimes	: 27.81	3.11	38.6	

Magnetic Concentration of Table Concentrate.					
Product	Weight, : : per : cent	Assay, : : WO ₃ , : per cent	Distribution : : of WO ₃ , : per cent	Amperage	Voltage
1st conc.	: 4.36	0.10	125	15.18	10.2
2nd conc.	: 6.32	1.10	125	26.74	26.0
3rd conc.	: 6.32	2.10	125	25.36	24.7
Tailings	: 83.00	-	-	4.27	54.6

Possibly owing to the small quantity of concentrate available, the products produced on the Dings machine were comparatively low in tungsten and the recovery incomplete.

Test No. 9. - Magnetic Concentration.

Portions of table concentrates and table tailing from previous work were dried and a "Little Giant Crucible" hand magnet repeatedly passed over the pulp. The resulting concentrates and tailings were assayed for WO₃.

(Continued on next page)

(Test No. 9, cont'd) -
(Magnetic concentration)

Results:

Product	Table Concentrate. (Feed, 48.1 per cent WO ₃)			
	Weight, : : per : cent	Assay, : : WO ₃ , : per cent	Distribution : : of WO ₃ , : per cent	Ratio of : concen- : tration
Feed	:100.00	48.43 [Ⓢ]	100.0	
Magnetic conc.:	9.44	8.48	1.7	10.6:1.
Tailing	: 90.56	52.60	98.3	

Product	Table Tailings. (Feed, 1.21 per cent WO ₃)			
	Weight, : : per : cent	Assay, : : WO ₃ , : per cent	Distribution : : of WO ₃ , : per cent	Ratio of : concen- : tration
Feed	:100.0	1.20 [Ⓢ]	100.0	
Magnetic conc.:	11.3	1.46	13.7	8.9:1.
Tailing	: 88.7	1.17	86.3	

Another portion of table concentrates assaying 48.1 per cent WO₃ was flash roasted at a temperature of 500° C. The calcine was then cooled and treated with the hand magnet in a similar manner as above. Prior to roasting, the table concentrate assayed 44.1 per cent WO₃. The calcine showed a loss in weight of 2.7 per cent after roasting.

Calcine from Roasting.

Feed	:100.00	44.70 [Ⓢ]	100.0	
Magnetic conc.:	9.90	3.19	0.7	10.1:1.
Tailing	: 90.10	49.26	99.3	

[Ⓢ] Calculated.

A microscopic examination of the magnetic concentrates from the above tests showed the material to be largely composed of magnetite.

Test No. 10. - Table and Flotation Concentration.

The ore at minus 14 mesh was ground in a ball mill to pass 63.2 per cent minus 200 mesh. The pulp was then amalgamated and the sulphides floated by the additions of 2.0 pound of soda ash, 0.10 pound amyl xanthate, 0.075 pound pine oil, and 0.045 pound Barrett No. 4 oil per ton. The resulting flotation concentrate was cleaned on a smaller machine. The flotation tailings were then passed over a Wilfley table and the ferberite remaining in the table slimes concentrated by flotation. The amalgamation resulted in a recovery of 76.3 per cent of the gold, probably due to the finer grinding (63.2 per cent minus 200 mesh).

Results:

Flotation of the Sulphides.

Product	Weight, : per : cent :	A s s a y s			Distribution, : per cent :			Ratio of :concen- :tration
		Au, : oz./ton :	Per cent Cu :	Per cent WO ₃ :	Au : per cent :	Cu : per cent :	WO ₃ : per cent :	
Feed	:100.00	0.56	3.01	2.01	100.0	100.0	100.0	
Flot. conc.	: 13.36	1.50	17.80	Nil	35.8	79.0	-	7.5:1.
Flot. middling	: 9.84	1.81	5.81	1.45	31.8	19.0	7.1	
Flot. tailing	: 76.80	0.24 [Ⓢ]	0.08 [Ⓢ]	2.43 [Ⓢ]	32.4	2.0	92.9	

Table Concentration of Flotation Tailing.

Feed	:100.00	-	-	2.42 [Ⓢ]	-	-	100.0	
Table conc.	: 1.68	-	-	51.44	-	-	35.7	87.2:1.
Table middling	: 1.38	-	-	17.56	-	-	10.0	
Table sands	: 44.80	-	-	0.55	-	-	10.2	
Table slimes	: 52.14	-	-	2.05	-	-	44.1	

[Ⓢ] Calculated.

The slimes were conditioned with 0.4 pound sodium silicate and 0.04 pound of lead nitrate, and a flotation concentrate obtained by the further additions of 0.7 pound sodium oleate and 0.03 pound of Dupont No. B-23 frother per

(Continued on next page)

(Test No. 10, cont'd) -
Results, cont'd -

ton. The concentrate was cleaned in a smaller machine.

Flotation of Table Slimes.			
Product	Assay, WO ₃ , per cent	Distribution of WO ₃ , per cent	Ratio of concentration
Feed	1.91 [⊗]	100.0	
Flot. conc.	20.00	49.5	21:1.
Flot. middling	3.19	23.2	
Flot. tailing	0.64	27.3	

⊗ Calculated.

A hand magnet was passed over the table concentrate, with the following results:

Product	Weight, per cent	Assay, WO ₃ , per cent	Distribution of WO ₃ , per cent	Ratio of concentration
Feed	100.00	51.23 [⊗]	100.0	
Magnetic conc.	11.24	25.13	5.5	9:1.
Tailings	88.76	54.54	94.5	

⊗ Calculated.

Summary of Test No. 10:

	<u>Per cent</u>
Gold recovered by amalgamation and flotation, 76.3 + 16.0	92.3
Copper recovered by flotation concentration	98.0
WO ₃ recovered by table concentration and flotation, 42.4 + 29.8	<u>72.2</u>

In this test the amount of gold recovered by amalgamation (76.3 per cent) was due to the fineness of grinding used and a laboratory method of amalgamation which could not be duplicated in milling practice. The WO₃ recovery of 72.2 per cent included 6.8 per cent in the flotation middling product, not all of which would report in the flotation cleaner concentrate.

Test No. 11. - Table and Flotation Concentration.

This test was made in order to determine the effect of comparatively fine grinding on ferberite concentration. The ore was ground in a ball mill to pass 60.2 per cent minus 200 mesh. The gold was then amalgamated and a bulk flotation concentrate made of the sulphides in the ore. This concentrate, which was 25.93 per cent of the feed, assayed 2.32 ounces gold per ton, 11.4 per cent copper and 0.78 per cent WO_3 , giving an occlusion of 10 per cent of the ferberite in the concentrate. The bulk flotation tailings were passed over a Wilfley table with the following results:

Table Concentration.				
Product	Weight, : : per : cent	Assay, : : WO_3 , : per cent:	Distribution : : of WO_3 , : per cent	Ratio of : concen- : tration
Feed	:100.00	2.72	100.0	
Concentrate	: 1.11	55.04	22.4	90:1.
Middling	: 2.34	29.74	25.5	
Sands	: 35.47	0.78	10.2	
Slimes	: 61.08	1.87 [Ⓢ]	41.9	

The table slimes were thickened, conditioned with 0.8 pound of sodium silicate and 0.07 pound of lead nitrate per ton and a flotation concentrate obtained by the further addition of 1.0 pound of sodium oleate and 0.05 pound of No. B-23 frother per ton. This concentrate was cleaned in a smaller machine.

Feed	:100.00	1.87 [Ⓢ]	100.0	
Concentrate	: 4.05	22.30	48.2	25:1.
Middling	: 14.63	3.39	24.9	
Tailing	: 81.32	0.62	26.9	

[Ⓢ] Calculated.

(Continued on next page)

(Test No. 11, cont'd) -

The quantities of flotation reagents added to the table slimes would amount to 0.36 pound sodium silicate, 0.03 pound lead nitrate, 0.46 pound sodium oleate and 0.025 pound of Dupont reagent No. B-23 per ton, when figured on a basis of ball mill feed.

Summary of Test No. 11:

	<u>Per cent</u>
WO ₃ recovered in table conc. + middling	- 43.1
WO ₃ recovered in flot. conc. + middling	- <u>27.6</u>
Overall recovery of WO ₃	- 70.7 per cent.

The table concentrate assayed 1.85 per cent tin.

This test shows that a higher grade of table and flotation concentrates is produced by the finer grind, but that the losses of tungsten in the bulk flotation concentrate and table sands, and the larger amount of tungsten in the table slimes, lower the overall recovery of the ferberite.

Summary and Conclusions:

The test work indicated that 65 per cent of the gold can be recovered by amalgamation and 25 per cent in a flotation concentrate of the amalgam residue and blanket tailings. Over 90 per cent of the copper can be recovered in the flotation concentrate. Some 45 per cent of the tungsten was recovered in the table concentrate and middlings products and an additional 20 per cent in the flotation concentrate of the table slimes.

Commenting on the gold recovery, it is apparent, from the test work that finer grinding augments the recovery of the gold both by amalgamation and flotation. In the flotation concentration of the amalgam residues and blanket tailings there is a tendency for the gold to report in the middling products and dissociate itself from the copper concentrate. In previous microscopic work on a former

(Summary and Conclusions, cont'd) -

shipment it was shown that 97.6 per cent of the gold was in quartz and only 2.4 per cent in chalcopyrite.

While a high-grade cleaner copper concentrate (32.4 per cent copper, as shown in Test No. 1) is obtainable, a large percentage of the gold remaining after amalgamation reports in the middling and tailing products. A bulk flotation concentrate assaying 12.1 per cent copper and 2.8 ounces gold per ton and which contains 94.3 per cent of the copper and 80.3 per cent of the remaining gold was obtained in Test No. 2.

Tungsten table concentrates assaying well over 50 per cent WO_3 should easily be obtained. A somewhat higher grade can then be made by removing the magnetite in the concentrate by magnetic concentration. A recovery of well over 50 per cent of the tungsten in the ore should be obtained on the larger-sized Wilfley table in mill practice. Flotation of the table slimes recovered about 50 per cent of the tungsten in this product with a grade of 20 per cent WO_3 . This concentrate could be shipped and treated by a modification of the Oxland process for extracting the tungsten by chemical methods. This flotation recovery of the ferberite should be improved upon by further tests. Unfortunately, owing to the depletion of the ore shipment it was not possible to proceed further along these lines.

The test work on this shipment indicates that

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(Summary and Conclusions, cont'd) -

the mill flow-sheet presently being installed on the Slave Lake Gold Mines Limited property and which consists of amalgamation of the gold, followed by flotation concentration of the copper and remaining gold, and table concentration of the tungsten, might be amplified to include another set of flotation cells in order to recover the tungsten slime losses.

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