CANADA

DEPARTMENT OF MINES

HON. CHARLES STEWART, MINISTER; CHARLES CAMSELL, DEPUTY MINISTER

MINES BRANCH

JOHN MCLEISH, DIRECTOR.

INVESTIGATIONS IN 1920

ORE DRESSING AND METALLURGY

(Testing and Research Laboratories)

Ores tested, and Reports thereon: by W. B. Timm and R. K. Carnochan.

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ORE DRESSING AND METALLURGICAL DIVISION

I

ORES TESTED, AND REPORTS THEREON

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The following ores have been tested, and reports made thereon, during the calendar year, 1920:—

No. of Test	Material	Locality	Shipper	Weight Pounds
129	Graphite	Blake Township, Quebec	W. F. Hadley, Hull, Quebec	65
130	Magnesite	Calumet, Que.	North American Magnesite Company, Calumet, Que.	5,849
131	Copper	Eastman, Que.	Eastern Mining & Milling Co., Eastman, Que.	50,000
132	Gold	Bingo Mine, Man.	J. Myers, Winnipeg, Man.	1,000
133	Molybdenite	Cardiff Township, Haliburton, Ont.	W. E. Joiner, Toronto, Ont.	59,026
134	Lead-zinc	Ptarmigan Mine, Wilmer, B.C.	Ptarmigan Mines, Wilmer, B.C.	6
135	Gold	Little Rice Lake, Man.	J. E. Cole, Winnipeg, Man.	2,572
136	Celestite	Calabogie, Ont.	Heber Bambrick, Calabogie, Ont.	2,000
137	Gold	Sesikinika Lake, Ont.	Golden Summit Mining Co. Ltd., Sesikinika, Ont.	100
138	Tin	Bolivia, S.A.	Electro-Tin Products, Ltd., Brantford, Ont.	30
139	Graphite	Waltham, Que.	H. P. H. Brumell, Buckingham, Que.	32
140	Copper	Anyox, B.C.	Granby Consolidated Mining, Smelting & Power Co., Ltd., Anyox, B.C	50,560

REPORTS ON ORES TESTED

June 15, 1920.

Test No. 129

A shipment of graphite ore of approximately 65 pounds was received on December 13, 1919, from W. F. Hadley, 17 Main street, Hull, Que. The ore came from Blake township, Quebec, and consisted of flake graphite of fair size in a gangue of quartz with a small amount of pyrite, the whole being gneiss-like, and somewhat weathered.

The ore was crushed to 20 mesh and sampled. An analysis of the sample obtained in this way gave 15·80 per cent carbon.

A number of tests were made on a small Janney and a small Ruth flotation machine, to determine the adaptability of the ore to the flotation method of concentration.

The results of these tests are contained in the table following.

Run No. 1.—Ore crushed to 20 mesh; pine oil and coal oil used; ground for five minutes in a pebble mill; floated in a small Janney machine; refloated the concentrates in the same machine.

Run No. 2.—Ore crushed to 20 mesh; pine oil and coal oil used; ground for five minutes in a pebble mill; floated in a small Janney machine; refloated the concentrates three times in the same machine.

Run No. 3.—Ore crushed to 20 mesh; pine oil and coal oil used; ground for five minutes in a pebble mill; floated in a small Ruth machine; reground concentrates in a pebble mill for fifteen minutes and then refloated them twice in the same machine.

Test No. 129

CONCENTRATES

Run No.	Wt. of ore taken, grms.	Analysis % C.	Content grams C.	+35 mesh				−35+65				−65 +150				−150			
				Wt. grams	Analysis % C.	Content grams C.	% of C. values	Wt. grams	Analysis % C.	Content grams C.	% of C. values	Wt. grams	Analysis % C.	Content grams C.	% of C. values	Wt. grams	Analysis % C.	Content grams C.	% of C. values
1	1000	15·80	158·0	43·9	76·00	33·4	22·7	89·8	51·05	45·8	31·1	64·2	51·25	32·9	22·4	47·1	59·90	28·2	19·2
2	600	15·80	94·8	21·2	92·45	19·6	21·4	41·2	73·90	30·4	33·2	30·0	64·35	19·3	21·1	15·6	75·80	11·8	12·9
3	1200	15·80	189·6	63·6	87·50	55·6	28·8	106	57·70	61·2	31·7	107·8	34·80	37·5	19·5	63·6	51·55	32·8	17·0

Middlings

Tailings

No. 1				No. 2				No. 3							
Wt. grams	Analysis % C.	Content grams C.	% of C. values	Wt. grams	Analysis % C.	Content grams C.	% of C values.	Wt. grams	Analysis % C.	Content grams C.	% of C. values	Wt. grams	Analysis % C.	Content grams C.	% of C. values
111	2·35	2·6	1·8	.....	.....	.....	.....	.....	.....	.....	.....	580	·70	4·1	2·8
20	26·50	5·3	5·8	20	13·80	2·8	3·0	46	2·80	1·3	1·4	378	·30	1·1	1·2
44	3·65	1·6	·8	166	·80	1·3	·7	.....	.....	.....	.....	631	·45	2·8	1·5

SUMMARY AND CONCLUSIONS

From the results of the test work conducted, the following conclusions can be deduced:—

First.—The ore is adaptable to concentration by flotation of the graphite from its gangue.

Second.—A high-grade flake can be made, as Run No. 2 shows that the + 35 concentrates gave an assay of 92·45 per cent carbon. Flotation may have to be assisted by table concentration and by finishing machines, to obtain marketable products. This would require further test work on a larger scale.

Third.—A high recovery is obtainable. The laboratory tests show recoveries of the carbon content of about 95 per cent.

December 31, 1920.

Test No. 130

Ten barrels of crude magnesite, net weight 5,849 pounds, were received March 26, 1920, at the Ore Dressing and Metallurgical Laboratories, from the North American Magnesite Company, Calumet, Quebec.

The magnesite is a mixture of magnesite and dolomite, the magnesite predominating; the dolomite being present in sufficient quantity that the lime content of the crude makes it compare unfavourably with the Austrian and Grecian magnesites, or with that from the States of Washington and California.

The shipment received showed the following analysis:—

CaO	12·85%
MgO	34·94%

Investigation is being carried on to obtain a separation of the lime from the magnesia and to obtain a product that will compare favourably with the foreign material.

A number of tests have been conducted by calcining the crude in a stack furnace at a temperature of from 950° C. to 1100° C., slacking the calcines with a moderate amount of water, and then classifying and washing the lime from the calcined magnesite.

The crude magnesite containing 13 per cent CaO on being calcined gave 25 per cent CaO in the calcines. The test work so far conducted shows that this can be reduced to 9 per cent CaO in the magnesite product by classification and washing. These results, however, are much higher than desired, and further work is being carried on to improve the methods of calcining, as it is in this part of the operations upon which the success of the process will depend.

December 31, 1920.

Test No. 131

A carload of copper ore was received from F. G. Connell, of the Eastern Mining and Milling Co., Eastman, Quebec, February 8, 1920. The ore consisted of chalcopyrite and iron sulphides in a silicious gangue.

Test work was conducted on this ore to see if it was adaptable to flotation using the Luckenbach re-agents instead of oil. The flotation concentrates being produced by oil flotation gave an analysis of 15 per cent to 20 per cent copper, and the Luckenbach re-agents were used to determine whether a higher grade product could be obtained with as good a recovery of the copper content.

Experimental work was carried on from February 11 to May 8, 1920. About thirty tests were conducted, and from these tests it was proven that by the use of the Luckenbach re-agents a higher grade concentrate could be produced than was being

obtained; but to obtain this high grade concentrate with a high recovery of the copper values, the cost of re-agents would be higher than the cost of oil. This higher cost may be balanced by the higher grade product, depending on the cost of marketing the concentrate.

The following is a description of some of the tests with the results obtained:—

Test No. 24.

Ore crushed in a jaw crusher, ground in Hardinge ball mill to 60 mesh, floated in Callow cells, making a rougher concentrate, and tailings to waste.

Crude ore	1·35% Cu
Concentrates	7·80% Cu
Tailings	0·28% Cu
Recovery	82·2 %

Test No. 25.

Four separate runs were made the same as Test 24, only pebbles instead of balls were used for grinding in the Hardinge mill.

	Run No. 1	Run No. 2	Run No. 3	Run No. 4
Crude ore	1.35% Cu	1.35% Cu	1.35% Cu	1.35% Cu
Concentrates	11.80% Cu	12.85% Cu	13.15% Cu	15.55% Cu
Tailings	0.08% Cu	0.15% Cu	0.13% Cu	0.15% Cu
Recovery	94.7 %	89.9 %	91.3 %	89.7 %

Test No. 27.

The rougher concentrates from the four runs of Test 25, were re-cleaned in the Callow cells.

Rougher concentrates	12.23% Cu
Cleaner concentrates	21.60% Cu
Tailings	1.60% Cu

This tailing would be considered a middling product and returned to the circuit in practice.

Test No. 26.

The same procedure as Test 25, with change in amounts of re-agents used.

Crude ore	1.35% Cu
Concentrates	23.85% Cu
Tailings	0.45% Cu
Recovery	67.9 %

Test No. 29.

Eight separate runs were made using varying amounts of re-agents. Balls were used for grinding instead of pebbles, otherwise runs same as Test 25.

	Run No. 1	Run No. 2	Run No. 3	Run No. 4
Crude ore	1.70% Cu	1.70% Cu	1.70% Cu	1.70% Cu
Concentrates	25.95% Cu	10.60% Cu	11.70% Cu	12.62% Cu
Tailings	0.40% Cu	0.32% Cu	0.20% Cu	0.14% Cu
Recovery	77.7 %	83.7 %	89.7 %	92.7 %
	Run No. 5	Run No. 6	Run No. 7	Run No. 8
Crude ore	1.70% Cu	1.70% Cu	1.70% Cu	1.70% Cu
Concentrates	8.40% Cu	11.55% Cu	8.10% Cu	13.85% Cu
Tailings	0.25% Cu	0.25% Cu	0.12% Cu	1.20% Cu
Recovery	87.9 %	87.1 %	94.4 %	32.2 %

Run No. 8 was made on some badly oxidized ore. This test shows that the Luckenbach re-agents cannot be used on this class of ore.

Test No. 30.

The concentrates from Test 29 were recleaned by passing them through the Callow cells.

Rougher concentrates	12.85% Cu
Cleaner concentrates	25.45% Cu
Tailings	6.40% Cu

The tailings would be considered a middling product and returned to the circuit in practice.

April 20, 1920.

Test No. 132

A shipment of approximately 1,000 pounds of gold ore was received from J. Myers, Winnipeg, Manitoba. This shipment was sent as a representative sample of the ore from the Bingo mine, the Pas District, Manitoba.

The ore consisted of white vein quartz, disseminated through which was small amounts of galena, sphalerite, chalcopyrite, and arsenopyrite. These sulphides and arsenides represent between one per cent and two per cent of the weight of the ore. Free gold was visible.

The object of the test work was to ascertain what recovery of the gold values could be obtained by amalgamation, and what further processes were necessary to recover the remaining values in the tailings after amalgamation.

The ore was crushed to 10 mesh, and a 14-pound sample cut out, which gave an assay of 4·22 ounces per ton.

Gross weight of ore received	992 pounds
Net weight of ore after crushing	967.5 "
Assay value per ton ..Au	4.22 oz.
Gold content in shipment	2.0414 oz.

Test No. 1.

A small preliminary test was made on the 14-pound sample which was crushed to 40 mesh and amalgamated with the following results:—

Before amalgamation ..Au	4.22 oz. per ton
After amalgamation ..Au	1.50 "
Recovery by amalgamation	64.5%

Test No. 2.

The remaining portion of the ore was crushed to pass 40 mesh, and amalgamated by passing it through an amalgamator and over plates. The tailings from amalgamation were run over a Wilfley concentrator. The results of this test were as follows:—

Net weight of ore treated	953.5 pounds
Assay value per ton ..Au	4.22 oz.
Gold content	2.012 "
Amalgamation and Concentration products—	
Bullion—fine gold from Test No. 2	2.066 "
Concentrates—11.5 lb.—assay 45.11 oz. per ton	0.259 "
Tailings—784.5 lb.—assay 0.59 oz. per ton	0.231 "
Total	2.556 "
Recovery by amalgamation	80.8%
Recovery by concentration	10.1%
Gold values in tailings	9.1%
Weight of bullion produced from shipment	2.403 oz.
Fineness	872.3
Fine gold in bullion, produced	2.096 "

SUMMARY

The amount of gold in the products is slightly greater than that figured from the original assay. This is due to the difficulty in getting an absolutely correct sample of the ore on account of the metallics encountered in grinding up the sample for assay.

The test shows that 80·8 per cent of the gold is recoverable by amalgamation; that 10·1 per cent of the gold is recoverable in concentrates, and 9·1 per cent still remains in the tailings. From previous work on this ore the greater proportion of what is left in the tailings can be recovered by cyanidation.

July 23, 1920.

Test No. 133

A carload shipment of molybdenite ore was received on April 3, 1920, from W. E. Joiner, 75 Sun Life Building, Toronto, Ont. The shipment was from his property on Lot 3, Concession XX, Township of Cardiff, Haliburton Co., Ontario.

The shipment represented a considerable tonnage of low grade ore from one portion of the property. Ore of a much better grade is supposed to have been found on another portion of the property. The low grade ore consisted of flake molybdenite up to one-half inch diameter, in a pyroxenite gangue rock.

Net dry weight of ore before treatment	59,026 pounds
Analysis—MoS_2	0.308%
Content—MoS_2	181.80 pounds

The ore was crushed in a jaw crusher to 1½ inch, sampled by passing through a Vezin sampler, the main flow going to a Hardinge ball mill, on to a Callow screen, the oversize being returned to the mill, the undersize to a Callow flotation unit.

The oil used was pine oil and coal oil, at the rate of ¾-pound per ton of crude ore treated.

The tailing assay showed	0.115% MoS_2
The concentrate produced gave an assay of	89.65 % MoS_2
Recovery of molybdenite values	62.7 %

This ore was adaptable to the oil flotation process. The results show that a high grade concentrate can be made. The recovery was low, but in practice under good milling conditions this should be improved considerably and a very low tailing made.

June 15, 1920.

Test No. 134

A small sample of lead-zinc (sand-carbonate) ore weighing 5½ pounds, was received on April 6, 1920, from the Ptarmigan mines, Wilmer, B.C.

The ore consisted of galena, lead and zinc carbonates, and zinc silicate.

Small laboratory tests were made to obtain a separation of the lead and the zinc into different products of commercial value.

The sample as received was crushed to 40 mesh and sampled for analysis, which gave the following:—

Lead	Pb	24.30%
Zinc	Zn	21.40%
Iron	Fe	5.00%
Sulphur	S	1.04%
H_2O, CO_2, etc.		11.50%
Silica	SiO_2	20.35%
Manganese	Mn	1.25%

The ore after the removal of the sample was screened on 100 mesh and each portion weighed, as follows:—

—40 +100	1,086 grams, representing 45.12%
—100	1,321 grams, representing 54.88%

Each of these sizes was sampled for analysis. The coarser material was then run over a laboratory Wilfley table using a sand deck, making a concentrate, middling and tailing. The fine material (—100) was run over the same table using a slime deck, making besides the concentrate, middling and tailing, a slime product, which was collected in a tank underneath the table. All the products were dried, weighed and sampled for analysis.

The results of the tests are given in the following table:—

+100 MESH MATERIAL

Product	Weight	% Pb.	% Zn.	Gms. Pb.	Gms. Zn.	% Pb. Value	% Zn. Value
Concentrate	260	69·50	7·65	180·7	19·9	71·1	7·1
Middling	302	18·40	34·05	55·6	102·8	21·9	36·5
Tailing	418	4·25	38·00	17·8	158·8	7·0	56·4
Heads	980	25·65	24·70	254·1 251·4	281·5 242·1	100·0	100·0

−100 MESH MATERIAL

Product	Weight	% Pb.	% Zn.	Gms. Pb.	Gms. Zn.	% Pb. Value	% Zn. Value
Concentrate	245	67·10	7·95	164·4	19·5	60·1	8·8
Middling	87	34·30	23·90	29·8	20·8	10·9	9·3
Tailing	403	8·10	27·75	32·6	111·8	11·9	50·2
Slime	281	11·55	18·30	32·5	51·4	11·9	23·1
Loss	197	7·21	9·69	14·2	19·1	5·2	8·6
Heads	1,213	22·5	18·35	273·5	222·6	100·0	100·0

SUMMARY AND CONCLUSIONS

The results of the laboratory test work show that the ore as submitted can be concentrated by gravity water concentration.

In the case of the coarser material, a high grade lead product, assaying 69·50 per cent lead, has been made with a recovery of 71·1 per cent of the lead values. This recovery would be increased by further treatment of the middling which contains 21·9 per cent of the lead values. A fair grade of zinc products, assaying 38·00 per cent zinc has been made, with a recovery of 56·4 per cent of the zinc values. This recovery would also be increased considerably by the retreatment of the middling product, which contains 36·5 per cent of the zinc values.

In the case of the fine material (—100 mesh) a high grade lead product assaying 67·10 per cent lead has been made, with a recovery of 60·1 per cent of the lead values. This recovery would be increased by further treatment of the middling product, which contains 10·9 per cent of the lead values. The zinc product is low grade, assaying only 27·75 per cent zinc, but with more careful manipulation of the concentrating machinery employed, the grade should be increased. The recovery of the zinc values is also low, namely 50·2 per cent, but this should also be increased by more careful manipulation of machinery.

From the results obtained on the small sample submitted a properly designed concentrating plant should give a lead product of grade 65 per cent Pb. with a recovery approaching 80 per cent of the lead values, and a zinc product of grade 35 per cent zinc, with a recovery approaching 70 per cent of the zinc values.

In the test work conducted, no attention has been paid to the silver values in the ore.

June 6, 1920.

Test No. 135

A shipment of 38 sacks of gold ore, net weight 2,572 pounds, was received from J. E. Cole, Esq., care A. G. Meindle, M.D., Winnipeg, Manitoba. The ore was from the Little Rice Lake district, Manitoba, and on examination was shown to contain chalcopyrite and some oxidized copper minerals, and iron pyrites in a quartz gangue. Free gold was visible in small amounts, but no free silver was noticeable.

The ore was crushed to ¼-inch size and cut down in a Jones riffled sampler, to a 35 pound sample for small test work. This 35 pound sample was further reduced by crushing to 30 mesh and sampled for assay, which gave the following:—

Gold	1.07 oz. per ton
Silver	1.50 " " "
Copper	1.43%

The test work conducted can be subdivided under the following heads:—

1. Amalgamation, tabling, and flotation.
2. Amalgamation, tabling, and cyaniding.
3. Straight flotation.
4. Amalgamation and tabling.
5. Amalgamation and flotation.

(1) Amalgamation, Tabling, and Flotation. (Small scale test.)

A small sample of 998 grams of the ore was cut from the 40 mesh sample and put in a pebble jar with 100 grams of mercury and 400 c.c. of water. The jar was rotated for three hours and the mercury was panned from the pulp. The amalgamation tailing was run over a small Wilfley table and a concentrate and tailing were made. The table tailing was ground wet to pass 100 mesh and floated in a laboratory Callow flotation machine, making a concentrate, a middling, and a tailing. The resultant products from this test were dried, sampled and assayed, giving results as shown in the following table:—

Product	Weight grams	Assay		Content		% of Values	
		Ozs. Au.	% Cu.	Au. Weight × Assay	Cu. grams	Au.	Cu.
Amalgamated	.....	.....	.....	899·10	.....	84·2	.....
Table concentrate	157	0·44	4·37	69·08	6·86	6·5	42·5
Flotation concentrate	55	0·38	12·42	20·90	6·83	2·0	42·3
Flotation middling	74	0·41	1·47	30·34	1·09	2·8	6·7
Flotation tailing	692	0·07	0·20	48·44	1·38	4·5	8·5
Ore	998	1·07	1·43	1,067·86	14·27	100·0	100·0

(2) Amalgamation, Tabling, and Cyaniding. (Small scale test.)

A small sample of 914 grams of the ore was cut from the 40 mesh sample and put in a pebble jar with 100 grams of mercury and 400 c.c. of water. The jar was rotated for three hours and the mercury panned from the pulp. The amalgamation tailing was run over a small Wilfley table, making a concentrate and tailing. The table tailing was ground wet to pass 100 mesh and treated with the cyanide solution. The result of this test work is given in the following table:—

Product	Weight grams	Assay		Content		% of Values	
		Ozs. Au.	% Cu.	Au. Weight × Assay	Cu. grams	Au.	Cu.
Amalgamated and cyanided	.....	.....	.....	893·34	.....	91·3	.....
Table concentrate	125	0·56	4·10	70·00	.....	7·2	.....
Cyanide tailing	732	0·02	0·95	14·64	.....	1·5	.....
Ore	914	1·07	1·43	977·98	.....	100·0	.....

(3) Straight Flotation. (Small scale test.)

A small sample of 885 grams of the ore was cut from the 40 mesh sample and further reduced to 100 mesh. It was then mixed with 1 c.c. of oil mixture—30 per cent hardwood oil, 15 per cent coal tar and 55 per cent tar creosote and floated in the laboratory Callow flotation machine. A concentrate, middling and tailing were made. In crushing down the sample a small amount of metallics was caught on the screens. These were assayed separately. The results from this test are given in the table below:—

Product	Weight grams	Assay		Content		% of Values	
		Ozs. Au.	% Cu.	Au. Weight × Assay	Cu. gms.	Au.	Cu.
Metallics	.....	.....	.....	172·78	.....	27·9	.....
Concentrate	74	4·15	11·72	307·10	8·67	49·6	70·4
Middling	45	0·72	2·50	32·40	1·12	5·2	9·1
Tailing	766	0·14	0·33	107·24	2·53	17·3	20·5
Ore	885	1·07	1·43	946·95	12·66	100·0	100·0

(4) Amalgamation and Tabling. (Large scale test.)

The remaining portion of the ore not used in making the small scale tests was crushed to 40 mesh and run through an amalgamator and over plates. The tailing from amalgamation was sampled and the remaining portion after sampling run over a Wilfley table, making a concentrate and tailing. The results of this test work are shown in the following tables:—

AMALGAMATION TEST

Product	Weight pounds	Assay			Content			% of Values		
		Ozs. Au.	Ozs. Ag.	% Cu.	Ozs. Au.	Ozs. Ag.	Lbs. Cu.	Au.	Ag.	Cu.
Metallics	.....	.....	.....	.....	·0647	.....	.....	6·4	.....	.....
Amalgam	.....	.....	.....	.....	·5683	0·3284	.....	55·8	18·2	.....
Tailing	2,484·5	0·31	1·19	1·43	·3851	1·4783	.....	37·8	81·8	.....
Ore	2,484·5	1·07	1·50	1·43	1·3292	1·8634	.....	100·0	100·0	.....

TABLE TEST ON AMALGAMATION TAILING

Product	Weight pounds	Assay			Content			% of Values		
		Ozs. Au.	Ozs. Ag.	% Cu.	Ozs. Au.	Ozs. Ag.	Lbs. Cu.	Au.	Ag.	Cu.
Concentrate	171	3·06	12·40	15·30	·2616	1·060	26·16	66·0	91·7	74·4
Tailing	1,924	0·14	0·10	0·25	·1347	·096	4·81	34·0	8·3	13·7
Loss	363·5	.....	.....	1·15	.....	.....	4·19	.....	.....	11·9
Amalgamation tailing	2,458·5	0·31	1·19	1·43	·3810	1·463	35·16	100·0	100·0	100·0

These results show the following recoveries:—

	By Amalgamation	In Concentrates	Total Recoveries	Loss in Tailing
	%	%	%	%
Au	62·2	25·0	87·2	12·8
Ag	18·2	75·0	93·2	6·8
Cu	None	74·4	74·4	25·6

The amalgam from this test from the clean up of the plates was retorted and reduced to bullion with the following weight and fineness:—

Weight of bullion	28·2312 grams	0·9077 ozs.	18·15 dwts.
Fineness	Au. 633·3	Ag. 366	Cu. trace

(5) Amalgamation and Flotation. (Large and small scale tests.)

A sample of the amalgamation tailing from test No. 4 was ground wet in a pebble jar to 100 mesh, mixed with 1 c.c. of oil mixture as per test No. 3 and floated in the laboratory Callow flotation machine, with the following results:—

Product	Weight grams	Assay			Content			% of Values		
		Ozs. Au.	Ozs. Ag.	% Cu.	Au. Weight × Assay	Ag. Weight × Assay	Cu. gms.	Au.	Ag.	Cu.
Concentrate	84	1·48	11·12	12·70	124·3	934·1	10·67	53·5	95·8	72·5
Middling	67	1·00	0·37	4·20	67·0	24·8	2·81	28·8	2·5	19·1
Tailing	825	0·05	0·02	0·15	41·2	16·5	1·24	17·7	1·7	8·4
Amalgamation tailing	976	0·31	1·19	1·43	302·6	1,161·4	13·96	100·0	100·0	100·0

These results show the following recoveries:—

	By Amalgamation	In Concentrate and Middling	Total Recoveries	Loss in Tailing
	%	%	%	%
Au	62·2	31·1	93·3	6·7
Ag	18·2	80·4	98·6	1·4
Cu	None	91·6	91·6	8·4

SUMMARY AND CONCLUSIONS

The results of the above test work show that the ore as submitted is amenable to treatment. Over 60 per cent of the gold values can be recovered by amalgamation, but a very small percentage of the silver values is recoverable by this method. The silver must, therefore, be for the most part in the form of the sulphide, and tabling or flotation is necessary to recover the silver and copper values. To make a high recovery of the silver and copper values and the remaining gold values after amalgamation, a combination of tabling and flotation would give the better results.

By amalgamation, tabling, and flotation, it is possible to make a 95 per cent recovery of the gold and silver values, and a 90 per cent recovery of the copper values in the ore.

From the above tables the concentrate from tabling and flotation would carry the greater proportion of the silver and copper values of a grade—gold, 3 ounces—silver, 12 ounces—and copper, 15 per cent. This would be an ideal shipping product for the smelters.

October 4, 1920.

Test No. 136

A shipment of 2,000 pounds of strontium ore was received June 21, 1920, from Heber Bambrick, Calabogie, Ontario.

This shipment represented a considerable tonnage of mixed celestite and gangue which requires concentration to remove the gangue and furnish a high grade celestite product. The gangue material is a light brownish calcite.

In conducting the concentration tests on this ore it was thought advisable to obtain as much clean celestite as possible in a coarse form, and as the celestite crushed much more easily than the gangue, care was taken in the crushing so as to make a minimum amount of fines.

The ore was crushed to 2 inches in a jaw breaker and run over a Ferraris screen fitted with 1-inch and ¼-inch screens. A head sample was cut out by a Vezin sampler, through which the flow passed onto the screen. The oversize + 1 inch was run over a picking belt and the clean celestite picked out. The + 1 inch was then returned to the rolls and crushed to pass the 1-inch screen. From the above operation the following products were obtained:—

Product	Weight lbs.	Analysis %		Content lbs.		% of Values	
		Ba & $SrSo_4$	$CaCo_3$	Ba & $SrSo_4$	$CaCo_3$	Ba & $SrSo_4$	$CaCo_3$
Handpicked	163	89·52	9·50	145·9	15·5	16·5	2·0
1 inch	802	35·62	58·88	285·7	472·2	32·3	60·7
¼ inch	741	57·83	36·60	428·5	271·2	48·5	34·8
Dust loss	43·5	54·25	45·06	23·6	19·6	2·7	2·5
Ore	1,749·5	50·51	44·50	883·7	778·5	100·0	100·0
Head sample	205·0	50·51	44·50				
To crusher	1,954·5	50·51	44·50				

Both the one-inch and quarter-inch products were concentrated by passing them through a James jig.

JIG TEST ON QUARTER-INCH PRODUCT

Products	Weight lbs.	Analysis %		Content lbs.		Percentages of Values			
						Ba & $SrSO_4$		$CaCO_3$	
		Ba & $SrSO_4$	$CaCO_3$	Ba & $SrSO_4$	$CaCO_3$	¼″	Crude	¼″	Crude
Concentrate No. 1 jig	25·5	91·40	5·85	23·3	1·5	5·7	2·8	0·6	0·2
Concentrate No. 2 jig	77	92·06	4·31	70·9	3·3	17·4	8·4	1·3	0·4
Concentrate table	287	83·48	14·73	239·6	42·3	58·6	28·4	16·3	5·7
Tailing—table	2·5	38·07	54·09	1·0	1·4	0·2	0·1	0·5	0·2
Tailing—jig	275	22·59	71·40	62·1	196·3	15·2	7·4	75·5	26·3
Jig bed	20	60·32	33·07	12·1	6·6				
Slime loss	41	29·27	36·59	12·0	15·0	2·9	1·4	5·8	2·0
Totals	728	57·83	36·60	421·0	266·4	100·0	48·5	100·0	34·8

NOTE—The Hutch products from the jig were tabled to determine whether they could not be improved. Results were unsatisfactory. With the jigs in proper adjustment, a 90 per cent Hutch product should be made. The small amount run through the jig did not allow proper adjustment to be made.

JIG TEST ON ONE-INCH PRODUCT

Products	Weight lbs.	Analysis %		Content lbs.		Percentages of Values			
						Ba & $SrSO_4$		$CaCO_3$	
		Ba & $SrSO_4$	$CaCO_3$	Ba & $SrSO_4$	$CaCO_3$	1"	Crude	1"	Crude
Concentrate No. 1 jig	51·5	91·73	6·32	47·2	3·3	18·3	5·9	0·7	0·4
Concentrate No. 2 jig	86	90·33	8·19	77·7	7·0	30·1	9·7	1·6	1·0
Hutch No. 1 jig	59·5	86·20	12·20	51·3	7·3	19·8	6·4	1·7	1·0
Hutch No. 2 jig	10	76·88	20·64	7·7	2·1	3·0	1·0	0·5	0·3
Tailing—jig	506	14·72	79·38	74·5	401·7	28·8	9·3	92·0	55·9
Jig bed	22	56·40	40·38	12·4	8·9				
Slime loss	22	0·00	70·00	0·0	15·4			3·5	2·1
Totals	757	35·62	58·88	269·6	445·7	100·0	32·3	100·0	60·7

SUMMARY OF PRODUCTS

Product	Analysis % Ba & $SrSO_4$	Percentage of total Ba & $SrSO_4$
Handpicked	89·52	16·5
Concentrate jig No. 1—¼"	91·40	2·8
Concentrate jig No. 2—¼"	92·06	8·4
Table concentrate—¼"	83·48	28·4
Concentrate jig No. 1—1"	91·73	5·9
Concentrate jig No. 2—1"	90·33	9·7
Hutch jig No. 1—1"	86·20	6·4
Hutch jig No. 2—1"	76·88	1·0
Total Recovery		79·1

CONCLUSIONS

Handpicking should be resorted to as the celestite breaks away quite freely from the gangue, and a clean celestite product can be obtained representing 16·5 per cent of the values.

By jigging the 1-inch and ¼-inch material after handpicking, the jig concentrates obtained were equally as good as the handpicked product, and with careful manipulation of the jigs, after obtaining the proper adjustments, a hutch product should be made practically as good as the concentrates.

The recovery on an ore of the grade submitted should be between 75 per cent and 80 per cent.

September 10, 1920.

Test No. 137

A small shipment of 100 pounds of gold ore was received July 29, 1920, from the Golden Summit Mining Company, Ltd., Sesikinika, Ontario.

The ore contained free gold with small amounts of iron and copper sulphides. Telluride was also supposed to be present.

The shipment was crushed down to ¼ inch and a 6·25 pound sample was cut out for assay and preliminary test work.

The assay of the shipment showed it to contain:—

Gold	2·73 oz. per ton
Silver	0·18 "
Copper	0·06%

A series of small laboratory tests were made to obtain its adaptability to amalgamation, concentration and cyanidation.

Test Run No. 1

Amalgamation.—Six pounds of the ore was crushed to 40 mesh and amalgamated by mixing in a pebble jar with 10 per cent by weight of mercury. The mercury was panned from the pulp and the tailing assayed.

Before amalgamation	Au—2·73 oz.	Ag—0·18 oz.
After amalgamation	Au—0·20 "	Ag—0·08 "
Recoveries	Au—92·6%	Ag—55·5%

This test gives the total amount that could be amalgamated under the best conditions.

Concentration.—A small amount of the tailing from amalgamation was run over a Wilfley table, where a concentrate and tailing were made. The concentrate gave an assay of Au — 7·10 oz: Ag — 1·22 oz, and the tailing Au — trace, an almost complete separation of the gold values.

A 500-gram sample of the tailing from amalgamation ground to 100 mesh and run through a laboratory flotation machine gave similar results.

Cyanidation.—A sample of the tailing from amalgamation ground to 100 mesh was cyanided in 0·17 per cent solution, giving a tailing assay of Au — trace, an almost complete separation of the gold values remaining after amalgamation.

Test Run No. 2

Amalgamation.—The remainder of the ore, 93 pounds, was crushed to 40 mesh and run through an amalgamator over plates. The amalgam was collected, retorted and the sponge refined. The tailings were sampled and assayed:—

Before amalgamation	Au—2·73 oz.	Ag—0·18 oz.
After amalgamation	Au—0·62 "	Ag—trace
Recoveries	Au—77·3%	Ag—practically a total

Bullion recovered from amalgam—3.0772 grams=1·98 dwts.=0·099 oz.

This test gives the recovery that could be expected in milling practice on this class of ore, which is between 75 per cent and 80 per cent of the gold values in the ore.

Concentration.—82·5 pounds of the tailings from amalgamation were run over a large Wilfley table and three products were made as follows:—

Concentrate	Weight 6 oz.	Assay	Au—49·8 oz.
Middling	" 8·5 lb.	"	Au— 2·5 "
Tailing	" 56 "	"	Au—trace

This test shows practically a complete recovery of the gold values remaining in the amalgamation tailing.

A flotation test on the tailings from amalgamation ground to 100 mesh gave similar results.

Cyanidation.—A number of cyanide tests were made on the tailing from amalgamation with results that no assay of the cyanide tailing gave over a trace of gold, showing an almost complete recovery of the gold values remaining in the tailing from amalgamation.

A cyanide test was made on the middling from the Wilfley table which assayed 2·50 oz. in gold, with similar results.

CONCLUSIONS

The ore, as submitted for test purposes, is amenable to treatment, 75 per cent to 80 per cent of the values can be recovered by amalgamation, and an almost complete recovery made of the values remaining by concentration or by cyanidation.

December 31, 1920.

Test No. 138

Three samples of tin barilla weighing about ten pounds each were received at the Ore Dressing and Metallurgical Laboratories on May 25, 1920, from Mr. H. G. Cobb of the Electro-Tin Products, Limited, Brantford, Ont. These samples were marked Nos. 51, 55 and 59, and consisted of cassiterite and impurities in the form of a number of different sulphides and arsenides.

Test work was carried out only on sample No. 51, which was first ground to 60 mesh and a sample cut out, which gave the following analysis:—

Sn	59·90%
Sb	trace
Bi	1·15%
Fe	5·60%
Cu	trace
As	0·49%
S	4·98%
SiO_2	7·35%

The object of the test work was to remove the impurities and raise the grade of the barilla, thereby obtaining a more desirable product for reduction to tin metal. As the impurities were for the most part in the form of sulphides, it was thought possible that they could be floated from the barilla by flotation.

Two small tests were made on the laboratory Janney flotation machine, the results of which are tabulated below:—

Test No. 1—Using hardwood creosote, coal tar, and coal tar creosote.

Product	Weight grams	Analysis Percent					Content gms Sn	Percentage of Sn values
		As	S	Bi	Fe	Sn		
Floated	144	0·83	13·20	3·65	11·50	44·00	63·36	20·9
Unfloated	356	0·36	1·60	0·08	3·50	67·40	239·94	79·1
Heads	500	0·49	4·98	1·15	5·60	59·90	299·50	100·0

Test No. 2—Using pine oil, crude turpentine, and coal oil.

Product	Weight grams	Analysis Percent					Content gms. Sn.	Percentage of Sn values
		As	S	Bi	Fe	Sn		
Floated	118	1·23	12·90	3·90	11·40	31·45	37·71	12·7
Unfloated	382	0·27	2·55	0·24	3·55	66·75	254·98	87·3
Heads	500	0·49	4·98	1·15	5·60	59·90	299·50	100·0

CONCLUSIONS

The results of the above tests show that the impurities can be removed to a large extent by flotation, and with further experimental work on the reagents to be used, much better results could be obtained. Although a considerable proportion of the tin values floated with the impurities, by regrinding and floating, using other reagents, the greater proportion of this would likely be recovered. A higher grade tin product could also be made by refloating.

December 31, 1920.

Test No. 139

A 32-pound sample of graphite ore was received on November 15, 1920, at the Ore Dressing and Metallurgical Laboratories from Mr. H. P. H. Brumell, Buckingham, Que. The shipment was made from Waltham, Que., from an occurrence on Lot 27, Range B, Bryson township, Pontiac county, Quebec, and consisted of flake graphite of a fair size in a gneiss-like gangue.

A concentration test was desired to obtain a high recovery of the graphite in the form of a high grade flake, without injuring the flake to any appreciable extent.

The whole sample was crushed to pass 10 mesh, and a sample cut out for analysis, which showed it to contain 2·50 per cent carbon.

A test was conducted on the laboratory flotation machines, the Ruth and the Janney, and on the laboratory Wilfley table, to determine the grade of concentrate that could be produced from the ore and the recovery of the graphitic content.

Five lots of the ore, ground to pass 10 mesh, each of 500 grams, were floated in the laboratory Ruth flotation machine, making a concentrate and tailing. The concentrates were mixed and the tailings mixed, so as to obtain sufficient products for further treatment. The concentrates were screened on a 100 mesh screen. The + 100 mesh concentrate was tabled on a laboratory Wilfley concentrator, making a concentrate and a tailing, and the — 100 mesh material was floated in a laboratory Janney flotation machine, making a concentrate and tailing.

The following table shows the products, and results of this test:—

Product	Wt. grams	% C.	Grams C.	% C. value
Table concentrate	53	85·30	45·21	76·0
Janney concentrate	28	11·00	3·08	5·2
Table tailing	33	10·30	3·40	5·7
Janney tailing	34	·90	·31	·5
Ruth tailing	2,352	·32	7·53	12·6
			59·53	
Heads	2,500	2·50	62·50	100·0

CONCLUSIONS

The shipment was very low grade, 2·50 per cent carbon, and under present conditions could not be worked commercially.

The results of the test work showed that the ore, as represented by this shipment, is very amenable to concentration, that a high grade flake could be produced with a high recovery of the carbon values in the coarse flake.

The Janney concentrates and table tailings would be returned to the circuit in milling operations, and a percentage of their carbon values recovered in the form of a higher grade product.

December 31, 1920.

Test No. 140

A carload of copper ore, shipping weight 50,760 pounds, was received September 4, 1920, at the Ore Dressing and Metallurgical Laboratories from the Granby Consolidated Mining, Smelting & Power Co., Anyox, B.C. The ore was a representative shipment of their low grade Hidden Creek No. 2, and consisted of chalcopyrite and pyrite in a greenstone gangue.

Concentration tests were desired to determine its adaptability to flotation by the various processes, to make a high grade concentrate with a high recovery of the copper values. To accomplish this necessitated a selective separation of the copper and iron sulphides.

During the latter part of the year a number of small scale tests and seven larger scale tests were made on the pneumatic and mechanical agitation type of flotation machines, using flotation reagents such as oil, Luckenbach reagents, and X-Y reagents.

The results obtained to date have been good, showing that the ore can be successfully concentrated. Further work is being carried on and the results of comparative tests will be embodied in a report as soon as completed during the following year.

December 31, 1921.

OTHER TEST WORK

A sample of graphite concentrates was received from the Quebec Graphite Company, Buckingham, Quebec, March 18, 1920, for the purpose of conducting some grinding tests using a disc pulverizer. It was found that this method of grinding and pulverizing was inefficient.

On October 11, 1920, several samples of graphite mill products were received from the Timmins graphite mine, Stanleyville, Ontario. Table tests were desired on these products to obtain data as to the use of tables in connexion with the flotation of graphite in their mill.

A number of samples of shale and clay were prepared for the Ceramic Division.

Samples of barite and serpentine were received from W. D. Holmes, Ottawa, for grinding tests, to obtain a suitable product for the market.

A small sample of allanite was received June 24, 1920, from the Mineralogical Division, Geological Survey, Department of Mines. Table tests were made on this sample and the products returned for investigation and analysis.

Two carloads of phonolite rock were received on August 24, 1920, and September 9, 1920, from the Dominion Glass Company, Montreal, Quebec. The first shipment consisted of 68,813 pounds, and the second of 55,534 pounds. It was desired that the rock be crushed to 8 mesh, making the minimum amount of fines. The crushed rock was to be used for the continuation of experimental work being carried on by the Dominion Glass Company, in the manufacture of their products.