

O T T A W A

May 23rd, 1942.

R E P O R T

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1232.

Concentration of Graphite Ore from the  
Rainy Lake Area, near Fort Frances, Ontario.



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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Shipment:

Three samples of ore, marked Nos. 1, 2 and 3,  
weighing 4,  $6\frac{1}{2}$ , and 20 pounds respectively, were received  
on February 3rd, 1942. The samples were submitted by Dr.  
Donald R. Young, Emo, Ontario.

Location of the Claims:

The claims are on Rainy Lake, about 15 miles from the town of Port Frances, Ontario.

Characteristics of the Ore:

The ore consists of fine flake graphite and siliceous gangue. A small amount of mica is present.

Sampling and Analysis:

The samples of ore were crushed to minus 14 mesh and sampled by the standard methods. The analyses were as follows:

<u>Sample No.</u>		<u>Carbon, per cent</u>
1	-	20.61
2	-	16.96
3	-	27.16

Experimental Tests:

The investigation was conducted on Samples Nos. 2 and 3 and consisted of flotation and table concentration of flotation concentrate.

Flotation concentration gave low-grade graphite concentrates. On Sample No. 3 ore, concentrates were obtained which analysed from 50 to 55 per cent carbon and contained from 60 to 63 per cent of the carbon in the ore. On Sample No. 2, the concentrate analysed 64.15 per cent carbon and contained 52.8 per cent of the carbon in the ore. By tabling the flotation concentrates, the grades of concentrates were increased to 71.06 per cent carbon on Sample No. 3 ore and 79.53 per cent carbon on Sample No. 2 ore, and the concentrates contained 43.1 and 35.9 per cent, respectively, of the carbon in the ore (Tests Nos. 3 and 4). The cleaner tailings and the table sands contained from 55 to 63 per cent of the carbon in the ore. In mill practice these products would be returned to the grinding

(Experimental Tests, cont'd) -

circuit, thus increasing the recovery.

The table concentrates obtained were low grade, the impurities being gangue embedded in the graphite flakes in the coarser sizes and middling particles in the finer sizes.

As the ores contained fine flake graphite and fine grinding was necessary to liberate the minerals, the table concentrates obtained contained very small amounts of No. 1 and No. 2 flakes (No. 1 flakes, +65 mesh; No. 2 flakes, -65+120 mesh).

Details of Tests:

FLOTATION CONCENTRATION ON SAMPLE NO. 3.

Test No. 1.

A sample of ore was ground, using steel balls with 0.48 pound of kerosene and 2.0 pounds of water glass per ton of ore. The pulp was transferred to a flotation cell and the graphite was floated using 0.12 pound of pine oil per ton of ore. The pulp density in the flotation cell was around 22 per cent solids.

The graphite rougher concentrate was cleaned twice by refloating, using 2.0 pounds of water glass per ton of ore in each operation.

The flotation concentrate was screened wet on 65- and 120-mesh screens.

(Continued on next page)

(Test No. 1, cont'd) -

Results of Flotation:

Product	Weight, per cent	Carbon, per cent	Ratio of concentration
	: Analysis	: Distribution	
Feed	: 100.00	: 26.09 <sup>Ⓢ</sup>	: 100.0
Flotation concentrate	: 43.08	: 46.11 <sup>Ⓢ</sup>	: 2.32:1.
1st cleaner tailing	: 17.86	: 10.70	: 7.4
2nd " "	: 14.92	: 27.15	: 15.5
Rougher flot. tailing	: 24.14	: 1.09	: 1.0
Flot. conc., +65 mesh	: 8.73	: 42.58	: 14.2
" " -65+120 "	: 18.47	: 38.68	: 27.4
" " -120 "	: 15.88	: 56.70	: 34.5

<sup>Ⓢ</sup> Calculated values.

Microscopic Observations on Flotation Concentrates.

+65 mesh product: An appreciable amount of middling particles were present, also some graphite flakes with gangue embedded. No mica was observed.

-65+120 mesh product: Similar to +65 mesh product.

-120 mesh product: An appreciable amount of middling particles were present, also some free gangue.

Screen Tests.

Mesh	Weight - per cent		
	Rougher flot. tailing	1st cleaner tailing	2nd cleaner tailing
+ 48	: 0.3	: 1.2	: 2.4
- 48 + 65	: 2.5	: 4.6	: 6.5
- 65 +100	: 9.6	: 9.8	: 11.3
-100 +150	: 15.9	: 10.5	: 10.8
-150 +200	: 13.3	: 5.3	: 5.0
-200	: 58.4	: 68.6	: 64.0
Total	: 100.0	: 100.0	: 100.0

Test No. 2.

As steel balls in the grinding circuit tend to break the graphite flakes into finer sizes more readily than flint pebbles, in this test pebbles were used in grinding the ore.

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(Test No. 2, cont'd) -

A sample of ore was ground with 0.48 pound of kerosene per ton of ore and the graphite floated at 22 per cent solids using 0.12 pound of pine oil per ton of ore.

As the rougher flotation concentrate contained an appreciable amount of middling particles in the coarser sizes, it was reground in order to unlock the mineral particles. The reground rougher flotation concentrate was cleaned three times by refloating. No additional reagents were used in the cleaning treatment.

The final flotation concentrate was screened wet on 65- and 120-mesh screens.

Results of Flotation:

Product	Weight, per cent	Carbon, per cent		Ratio of concentration
		Analysis	Distribution	
Feed	100.00	27.26 <sup>Ⓢ</sup>	100.0	
Flotation concentrate	29.04	55.86 <sup>Ⓢ</sup>	59.5	3.44:1.
1st cleaner tailing	23.73	7.01	6.1	
2nd " "	12.36	27.95	12.7	
3rd " "	12.16	44.90	20.0	
Rougher flot. "	22.71	2.01	1.7	
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Flot. conc., +65 mesh:	1.91	60.54	4.2	
" " -65+120 "	8.79	52.03	16.8	
" " -120 "	18.34	57.21	38.5	

<sup>Ⓢ</sup> Calculated values.

Microscopic Observations on Flotation Concentrates.

+65 mesh product: Some middling particles were present; also some graphite with fine gangue embedded.

-65+120 mesh product: Similar to +65 mesh product.

-120 mesh product: Contained an appreciable amount of middling particles.

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(Test No. 2, cont'd) -

The flotation tailings contained an appreciable amount of aggregate particles composed of fine graphite and fine gangue in the plus 100 mesh products. This would indicate that a fairly fine grind is necessary in order to unlock the mineral particles.

It was observed microscopically that the graphite flakes had the edges rounded off, which was not the case when the ore was ground with steel balls. This would indicate that in small-scale laboratory grinding the pebbles give an abrasive grinding rather than the crushing that was obtained when steel balls were used. This effect may not be obtained in a mill-size flint mill, as the height of the drop of the pebbles is quite great and that would give more of a crushing effect.

#### FLOTATION AND TABLE CONCENTRATION ON SAMPLE NO. 3.

##### Test No. 3.

In this test the flotation operation was conducted at a low pulp density, as less gangue is lifted mechanically at high pulp dilution.

A sample of ore was ground with 0.48 pound of kerosene and 0.19 pound of pine oil per ton of ore. The pulp in the flotation cell was about 12 per cent solids. After removing the froth for about 5 minutes, 0.06 pound of pine oil per ton of ore was added and the froth was taken off for another 5 minutes.

The graphite rougher concentrate was reground with 2.0 pounds of water glass per ton of ore and cleaned by refloating for 6 minutes at a pulp dilution of less than 10

(Test No. 3, cont'd) -

per cent solids. The first cleaner concentrate was cleaned by refloating. Two pounds of water glass per ton of ore was added to the second cleaner circuit.

The final flotation concentrate was further concentrated by tabling.

Results of Flotation and Tabling.

Product	Weight,		Carbon,		Ratio of
	per	cent	per cent	per cent	
	cent		Analysis	Distribution	concentration
Feed	100.00	:	25.13 <sup>Ⓞ</sup>	100.0	:
Flotation concentrate	31.54	:	50.75 <sup>Ⓞ</sup>	63.7	: 3.17:1.
1st cleaner tailing	25.70	:	10.92	11.2	:
2nd " "	16.32	:	36.43	23.6	:
Rougher flot. "	26.44	:	1.40	1.5	:

Table Concentration of Flotation Concentrate.

Table fines	15.24	:	71.06	43.1	: 6.56:1.
Table sands	16.30	:	31.77	20.6	:

<sup>Ⓞ</sup> Calculated values.

Screen Analysis on Table Fines.

Mesh	Weight,		Carbon,	
	per	cent	per cent	per cent
	cent		Analysis	Distribution
+ 48	0.3	)		
- 48 + 65	1.7	)	72.56	12.8
- 65 +100	10.5	)		
-100 +150	17.0		72.40	17.3
-150 +200	14.4		70.48	14.3
-200	55.1		70.46	55.6
Total	100.0		71.06	100.0

(Continued on next page)



(Test No. 3, cont'd) -

Microscopic Observations on Table Fines.

+48 mesh product: Contained some graphite flakes with gangue embedded. No free gangue was present.

-48+65 mesh product: Similar to +48 mesh product.

-65+100 mesh product: Contained some graphite flakes with gangue embedded, also some middling particles. No free gangue was present.

-100+150 mesh product: Contained some middling particles. No free gangue was observed.

-150+200 mesh product: Contained some middling particles and some free gangue.

-200 mesh product: Some free gangue was present.

Graphite concentrate, obtained by tabling the flotation concentrate, analysed 71.06 per cent carbon and contained 43.1 per cent of the carbon in the ore. In mill practice, the cleaner tailings and the table sands would be returned to the grinding circuit. This would appreciably increase the recovery.

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FLOTATION AND TABLE CONCENTRATION ON SAMPLE NO. 2.

Test No. 4.

A sample of ore was ground with 0.48 pound of kerosene and 0.19 pound of pine oil per ton of ore. The graphite was floated for 10 minutes using 0.06 pound of pine oil per ton in the flotation circuit. The pulp in the flotation cell was about 12 per cent solids.

The graphite rougher concentrate was reground with 2.0 pounds of water glass per ton of ore and cleaned twice

(Test No. 4, cont'd) -

by refloating. Two pounds of water glass per ton of ore was used in the second cleaner circuit.

The flotation concentrate was concentrated further by tabling.

Results of Flotation and Tabling.

Product	Weight, per cent	Carbon, per cent Analysis	Ratio of concentration Distribution
Feed	100.00	15.30 <sup>Ⓞ</sup>	100.0
Flotation concentrate	13.00	64.15 <sup>Ⓞ</sup>	52.8 : 7.68:1.
1st cleaner tailing	19.08	7.46	9.0
2nd " "	11.87	48.77	36.6
Rougher flot. tailing	56.05	0.45	1.6

Table Concentration of Flotation Concentrate.

Table fines	7.14	79.53	35.9	14.01:1.
Table sands	5.86	45.42	16.9	

<sup>Ⓞ</sup> Calculated values.

Concentrate obtained analysed 79.53 per cent carbon and contained 35.9 per cent of the carbon in the ore. The cleaner tailings and the table sands contained 62.5 per cent of the carbon in the ore. An appreciable amount of the graphite in these products would be recovered in mill practice.

CONCLUSIONS:

The results of the tests showed that it will be difficult to obtain even an inferior flake grade (containing 82 per cent carbon) on ores represented by the samples on which these tests were conducted.

The concentrates obtained were low grade due to gangue being embedded in some of the coarser size flakes and some middling particles in the finer sizes.

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(Conclusions, cont'd) -

As the ore contains fine flake graphite, fine grinding will be necessary to liberate the minerals; hence the concentrate obtained will contain mostly fines, a product which sells for less than No. 1 or No. 2 flakes.

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