OTTAWA August 19th, 1941.

REPORT

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1068.

Concentration of Chromite from
the Belanger Chrome Mine,
Thetford Mines, Quebec.

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Shipment:

Twenty-four bags of chrome ore, weight 2,529 pounds, were received by the Bureau of Mines, Ottawa, Ontario, on May 20th, 1941. The shipment was submitted by Lucien Lavigne, Inspector of Mines, Thetford Mines, Quebec, for the attention of G. C. Bateman, Metals Controller, Department of Munitions and Supply, Room 220, No. 3 Temporary Building, Ottawa, Ontario.

The shipment consisted of five samples of ore. The sketch-map (Figure No. 1) gives the locations where the various samples were taken.

SKETCH

BELANGER CHROME MINE

LOCATION: LOT 11½ S.E. RANGE X
COLERAINE, P.Q.

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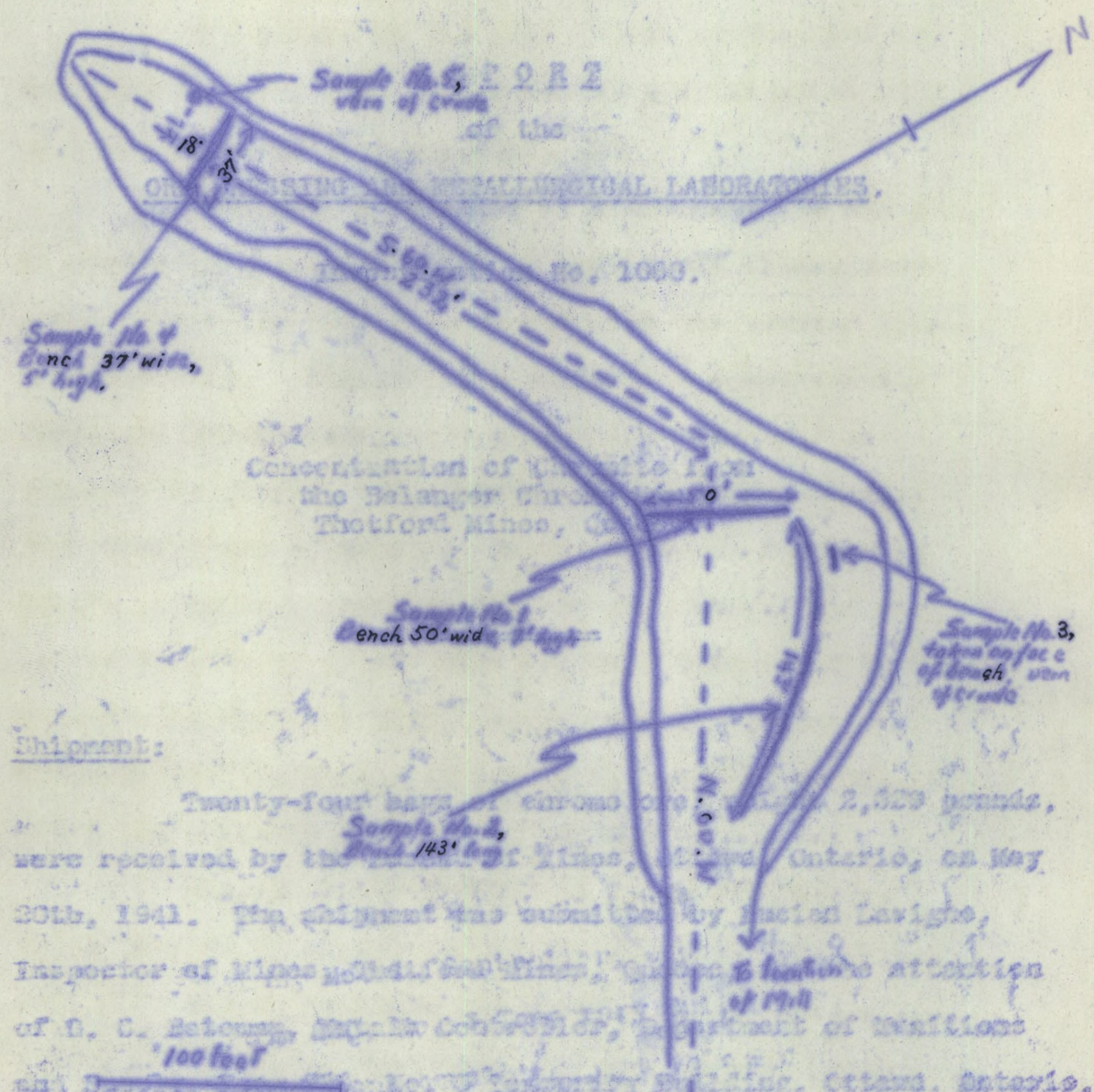

Samples of Run of Mine
Taken on May 5th, 1941.

FIGURE No. 1.

Location of Property:

The property is situated in Lot $19\frac{1}{2}$ S.E., Range X, Coleraine township, Quebec.

Characteristics of the Ore:

Ten polished sections, two from each sample, were prepared and examined microscopically for the purpose of determining the characteristics of the ore.

General Description -

The gangue is the same in all samples and is composed of soft, dull dark greenish grey material which probably represents a serpentine rock.

Chromite is the only abundant metallic mineral. It occurs in gangue as granular masses and disseminated grains coarse to fine in size but with the coarser sizes predominating. Although some grains are comparatively dense and homogeneous, most grains are fractured and veined with gangue, and almost always contain numerous tiny inclusions of gangue. Replacement of chromite by gangue is quite prominent, and, in some places has proceeded to such an extent that all that remains of the chromite is numerous tiny, ragged remnants in gangue. The numerous inclusions of gangue in chromite mentioned above are probably chiefly due to such replacement.

Magnetite and pyrite are present in two or three samples in almost negligible amounts. The former occurs as narrow veinlets and margins in and around the grains of chromite; the latter as rare, small, irregular grains in gangue.

A short description of each sample follows:

(Continued on next page)

(Characteristics of the Ore, cont'd) -

Sample No. 1.

Consists of irregular grains of chromite disseminated in gangue. Magnetite is visible as comparatively rare, narrow veinlets in chromite. The chromite grains are moderately abundant and compose about one-half the area of the polished surfaces.

Sample No. 2.

Disseminated type like Sample No. 1, but chromite grains are not so abundant and their sizes are a little smaller. Magnetite is somewhat more prevalent than in the previous sample as narrow veinlets and rims averaging 10-12 microns in width, in and around grains of chromite.

Sample No. 3.

Metallic mineralization is heaviest in the sections taken from this sample and consists of comparatively coarse-grained masses of chromite which are extensively fractured and replaced by gangue.

Sample No. 4.

Same as Sample No. 1 but chromite is not quite so abundant and, on the whole, is not so extensively fractured and replaced by gangue. Pyrite is visible in one section as occasional, tiny, irregular grains in gangue.

Sample No. 5.

These sections are similar to those of Sample No. 3 but are not quite so high-grade, due to the fact that the chromite has been replaced by gangue to a greater extent. Also, pyrite is present in very small amount as rare, tiny grains in gangue.

(Continued on next page)

(Characteristics of the Ore, cont'd) -

Grain Size and Conclusions from Microscopical Examination -

The two higher-grade samples (Nos. 3 and 5) consist of relatively coarse granular masses of chromite, and should present no particular difficulty to concentrate, except for those grains which are replaced by gangue to such an extent that all that remains of them is numerous tiny, jagged residuals of chromite in gangue. It would be economically impossible to grind sufficiently fine to free these small fragments.

The other three samples (Nos. 1, 2 and 4) are composed of disseminated chromite which should be easy to free and concentrate by gravity methods. For this purpose, a microscopical analysis of the grain sizes in these samples has been made and is set down in the composite table below. After grinding, however, the grain sizes may be somewhat smaller than indicated in the table, due to the extensive fracturing of the chromite as already mentioned.

It should be noted also that, since most grains are intimately contaminated with tiny inclusions of gangue, any concentrate made may not be so high-grade as it otherwise would be.

Composite Microscopical Grain Size Analysis of Samples 1, 2 and 4.

Tyler Mesh	Amounts, per cent	Cumulative percentage.
+ 10	7.6	7.6
- 10 + 14	12.5	20.1
- 14 + 20	13.7	33.8
- 20 + 28	19.4	53.2
- 28 + 35	12.3	65.5
- 35 + 48	18.6	84.1
- 48 + 65	4.6	88.7
- 65 +100	3.1	91.8
-100 +150	3.1	94.9
-150 +200	1.8	96.7
-200	3.3	100.0
	100.0	

-

Sampling and Analysis:

The samples were crushed to ½-inch and sampled by standard methods. The analyses were as follows:

Sample No.	Weight of sample, pounds	Cr_2O_3, per cent	Fe, per cent
1.	710	11.43	6.37
2.	1,298	8.42	6.31
3.	120	50.97	12.76
4.	320	14.13	6.31
5.	81	43.70	10.13

Results of Investigation:

The investigation was conducted on a mixture of the low-grade samples, i.e., Nos. 1, 2, and 4. The high-grade ore was not included. This mixture assayed 10.61 per cent Cr_2O_3.

As the quantity of ore available was not enough for a continuous run, a flow-sheet comprised of tabling sized products was adopted. Each product was concentrated individually, producing a concentrate, a middling, and a tailing.

The results obtained indicated that the ore had to be ground to at least 28 mesh before a marketable grade of concentrate could be produced.

In practice the middling products would be returned to the grinding circuit for further reduction in size. A recovery of about 80 per cent of the Cr_2O_3 content is indicated, with a concentrate containing over 48 per cent Cr_2O_3 and about 14.5 per cent Fe, a tailing of about 2.2 per cent Cr_2O_3 and ratio of concentration of about 5.5:1.

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DETAILS OF EXPERIMENTAL TESTS:

Samples Nos. 1, 2, and 4, that is, samples of low-grade ore which were crushed to ½ inch prior to sampling, were combined for test work. The composite sample was screened on a 6-mesh screen. The plus 6 mesh product was put through the rolls till all passed through the 6-mesh screen. As there were no free particles of chromite in the coarser sizes, that is, in sizes to 14 mesh, the ore was screened on the 14-mesh screen. The oversize was put through the rolls till all passed through the 14-mesh screen.

The minus 14 mesh product was then screened to obtain various screen sizes. The following distributions were obtained:

Mesh	Weight, per cent
-14+28	39.8
-28+45	23.6
-45+70	12.5
-70	24.1
	100.0

Concentration by Tabling.

Mill Run No. 1.

A portion (445 pounds) of -14+28 mesh material was fed to a Wilfley table at a rate of about 150 pounds per hour. The tailing from the Wilfley table was the feed to a ¼-deck Wilfley pilot table.

Results:

-14+28 Mesh Material.

Product	Weight, per cent	Analysis Cr_2O_3, per cent	Distribution of Cr_2O_3, per cent
Feed	100.00	10.30	100.0
Wilfley table conc.	5.17	43.59	21.9
Pilot " "	8.20	26.60	21.2
" table tailing	86.63	6.77⊕	56.9

⊕ Calculated value.

Ratio of concentration = 19.3:1.

(Mill Run No. 1, cont'd) -

Microscopical Observations on Products -

Wilfley table concentrate: Some gangue attached to chromite particles; some white mineral (probably spinel) was present.

Mill Run No. 2.

The sized material (-28+45 mesh) was fed to a Wilfley table at a rate of about 400 pounds per hour. The Wilfley table middling was the feed to the ½-deck Wilfley pilot table. The pilot table concentrate was cleaned by re-tabling.

Results:

-28+45 Mesh Material.

Product	Weight, per cent	Analysis per cent Cr_2O_3	Analysis per cent Fe	Cr_2O_3 distribution, per cent	Cr:Fe ratio
Feed	100.00	12.75		100.0	
Wilfley table conc.	7.92	50.75	13.60	31.5	2.55:1.
Pilot table cleaner conc.	1.45	45.09	12.25	5.1	2.52:1.
" " " tailing	5.31	39.23	12.46	16.4	2.15:1.
" " middling	41.31	12.36		40.0	
" " tailing	)44.01	1.93		) 7.0	
Wilfley " "	)	2.07		)	
Pilot table conc.	6.76	40.48⊕		21.5	

⊕ Calculated value.

The Wilfley table concentrate and the pilot table cleaner concentrate combined calculated to 49.88 per cent Cr_2O_3.

The ratio of concentration was 10.7:1.

(Continued on next page)

(Mill Run No. 2, cont'd) -

Microscopical Observations on Products -

Wilfley table concentrate: some gangue attached to chromite. Some white mineral was present.

Pilot table concentrate: appreciable amount of unliberated particles were present.

Pilot table middling: chromite attached to gangue.

Wilfley table tailing: fine chromite attached to gangue.

Pilot table tailing: fine chromite attached to gangue. No free particles of chromite were present.

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Mill Run No. 3.

The -45+70 mesh material was fed to the Wilfley table at a rate of about 250 pounds per hour. The middling from the Wilfley table passed to the Wilfley pilot table. The pilot table tailing was returned to the head of the circuit.

Results:

-45+70 Mesh Material.

Product	Weight, per cent	Analysis, per cent Cr_2O_3	Analysis, per cent Fe	Cr_2O_3 distribution, per cent	Cr:Fe ratio
Feed	100.00	11.32		100.0	
Wilfley table conc.	16.54	51.30	14.32	75.0	2.45:1.
Pilot " "	2.39	46.49	14.43	9.8	2.20:1.
Wilfley table tailing	81.07	2.12		15.2	

The Wilfley table and pilot table concentrates, combined, calculated to 50.70 per cent Cr_2O_3.

Ratio of concentration = 5.3:1.

Microscopical Observations on Products -

Pilot table concentrate: some unliberated particles were present.

Wilfley table tailing: fine chromite attached to coarse gangue.

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(Details of Experimental Tests, cont'd) -

Mill Run No. 4.

The flow-sheet for concentrating minus 70 mesh material was similar to that of Mill Run No. 3. The rate of feed was about 150 pounds per hour.

Results:

-70 Mesh Material

Product	Weight, per cent	Analysis per cent Cr_2O_3	Analysis per cent Fe	Cr_2O_3 distribution, per cent	Cr:Fe ratio
Feed	100.00	8.18		100.0	
Wilfley table conc.	6.93	51.96	15.57	44.0	2.28:1.
Pilot " "	5.12	53.09	14.43	33.2	2.52:1.
Wilfley table tailing	87.95	2.12		22.8	

Ratio of concentration = 8.3:1.

Microscopical Observations on Products -

Wilfley table concentrate: some brown and white minerals were present.

Wilfley table tailing: fine chromite attached to coarse gangue. Small amount of very fine particles of free chromite were present.

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Test No. 1.

A portion of Wilfley pilot table tailing from Mill Run No. 1, (-14+28 mesh product) was pulverized to minus 28 mesh. The screen test on the pulverized product (minus 28 mesh) was as follows:

Mesh	Weight, per cent
-28+35	22.6
-35+48	27.8
-48+65	14.1
-65+100	8.3
-100+150	6.7
-150+200	4.4
-200	16.1
Total	100.0

(Test No. 1, cont'd) -

The minus 28 mesh material was concentrated by Wilfley table (laboratory size). Four products were made, namely: concentrate, first middling, second middling, and a tailing. The first middling was cleaned by re-tabling.

Results:

Pilot Table Tailing from Mill Run No. 1
Pulverized to Minus 28 Mesh.

Product	Weight, per cent	Analysis per cent Cr_2O_3	Analysis per cent Fe	Cr_2O_3 distribution, per cent	Cr:Fe ratio
Table feed	100.00	7.07		100.0	
Concentrate	3.81	45.55	13.91	24.5	2.24:1.
Cleaner concentrate	0.51	47.90	14.32	3.5	2.29:1.
Cleaner tailing	11.64	26.78		44.1	
2nd middling	24.40	3.02		10.4	
Table tailing	59.64	2.07		17.5	

Ratio of concentration = 23.1:1.

Microscopical Observations on Products -

Table concentrates: some unliberated particles were present.

Table cleaner tailing: some unliberated chromite was present.

Second middling: fine chromite attached to gangue.

Table tailing: fine chromite attached to coarse gangue.

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Summary of Table Concentration:

The summarized results for combined Mill Runs Nos. 1, 2, 3, 4 and Test No. 1 were as follows:

Results:

Product	Weight, per cent	Cr_2O_3 analysis: per cent	Distribution of Cr_2O_3, per cent
Feed	100.0	10.61	100.0
Concentrate	11.0	49.20	51.0
Middling	18.3	19.80	34.2
Tailing	70.7	2.23	14.8

(Continued on next page)

(Summary of Table Concentration, cont'd) -

An appreciable amount of the chromite was in the middling. This chromite is not completely liberated. A large portion of this chromite would be recovered in mill practice by regrinding the middling and returning it to the head of the circuit.

When this is done, crushing to minus 28 mesh and re-treating all middlings, a concentrate assaying over 48 per cent Cr_2O_3 and about 14.5 per cent Fe should be obtained. A tailing of about 2.2 per cent is indicated with a recovery of about 80 per cent, and a ratio of concentration of about 5.5:1.

Concentration by Jigging.

Test No. 2.

A portion of -14+28 mesh material was fed to a two-compartment Harz Jig (laboratory size) equipped with a 20-mesh screen at the bottom of the compartments. No gate-discharge product of the second compartment was taken. The rate of feed to the jig was about 100 pounds per hour.

Results:

-14+28 Mesh Material

Product	Weight, per cent	Cr_2O_3 analysis, per cent	Distribution of Cr_2O_3, per cent
Feed	100.00	10.47	100.0
1st hutch concentrate	1.29	51.26	6.3
2nd " "	1.52	48.28	7.0
1st gate "	2.22	40.27	8.5
Jig tailing	91.12	8.12	70.7
" bed	3.85	20.29	7.5

Microscopical Observations on Products -

1st hutch concentrate: some chromite particles have gangue attached.

1st gate concentrate: unliberated particles are quite abundant.

Jig tailing: some gangue particles have chromite attached.

(Details of Experimental Tests, cont'd) -

Magnetic Separation.

Test No. 3.

About a hundred grams of concentrates (composite sample of concentrates from Mill Runs Nos. 2, 3 and 4) was put through a Davis magnetic tube concentrator.

Results:

Product	Weight, per cent	Analysis, per cent Cr_2O_3	Fe	Ni	Distribution Cr_2O_3, per cent	Cr:Fe ratio
Feed	100.00	48.75	14.23	0.10	100.0	2.34:1.
Non magnetic product	87.65	49.98	13.49		89.9	2.53:1.
Magnetic product	12.35	39.98	19.51		10.1	1.40:1.

Conclusions:

The results of the tests show that the ore has to be ground to at least minus 28 mesh. Even then there is an appreciable amount of chromite which is not completely liberated. Concentration of -14+28 mesh and -28+45 mesh materials gave recoveries of 21.9 and 36.6 per cent, the concentrates analysing 43.59 and 49.88 per cent Cr_2O_3 respectively. An appreciable amount of chromite was in the middling products. In mill practice, the middlings would be reground and returned to the head of the tabling circuit; this would increase the recovery appreciably. Tabling the -45+70 mesh and minus 70 mesh materials the recoveries were 84.8 and 77.2 per cent respectively; the concentrates analysed over 50 per cent Cr_2O_3, and the tailings assayed 2.12 per cent Cr_2O_3. By grinding the ore containing around 10 per cent Cr_2O_3 to at least minus 28 mesh, and regrinding the middlings and returning them to the head of the tabling circuit, a concentrate of over 48 per cent Cr_2O_3, a tailing of about 2.2 per cent

(Conclusions, cont'd) -

Cr_2O_3, a ratio of concentration of 5.5:1 and a recovery of about 80 per cent should be attained.

In the coarser sizes, small pieces of gangue were attached to the chromite; also fine chromite was attached to the gangue. This would be expected when the ore is ground by rolls, but would be partly eliminated by grinding in a rod mill.

The chromium-iron ratio in the concentrates is somewhat low, ranging from 2.55:1 to 2.24:1. This would be expected, as the magnetite occurs as narrow veinlets and margins in and around the grains of chromite. The ratio could be increased slightly by magnetic concentration. In Test No. 3, a concentrate of Cr-Fe ratio of 2.34:1 was raised to 2.53:1. The magnetic product contained 10.1 per cent of the Cr_2O_3 in the feed to the magnetic concentrator. The chromium-iron ratio of the magnetic product was 1.40:1.

A flow-sheet suitable for the concentration of ore of this character is as follows:

The ore from the secondary crusher, broken to about $\frac{3}{4}$-inch, is fed to a rod mill in closed circuit with a 28-mesh screen. The screen undersize should be classified into three sand products and slimes. Each product should be concentrated on separate tables and the middling from each table recirculated through the classifier. The coarse sand tailing, if high enough in Cr_2O_3, should be dewatered and returned to the mill for further grinding.

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