O T T A W A July 15th, 1941.

R E P O R T

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1051.

Concentration of Chromite from the Sterrett Property, St. Cyr, Richmond County, Quebec.

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:

One 25-ton carload of chromite ore was received on May 20th, 1941, from CHROMITE LIMITED, 404 Notre Dame Street West, Montreal, Quebec. This shipment came from the Sterrett property, St. Cyr, Richmond county, Quebec.

As the erection of a concentrator is contemplated, it was desired to obtain data on recovery and grade of concentrate that could be obtained from ore of this character, and to determine a suitable flow-sheet.

Characteristics of the Ore:

This ore is somewhat more disseminated than that investigated and reported on as Investigation No. 865, July 15th, 1940. No large proportion of barren gangue was noticed as was evident in the former shipment.

Investigation Work:

The flow-sheet most suited to the concentration of chromite ores is one embodying crushing and grinding to avoid excessive fines, followed by table concentration of classified products. Regrinding of the coarse sand table middling is required for maximum recovery.

This procedure indicated that a recovery of approximately 87 per cent of the Cr_2O_3, with a grade of over 48 per cent, can be obtained.

Sink-and-float tests made on samples of the shipment showed an elimination of 27.6 per cent of the weight of feed in a product containing 1.11 per cent Cr_2O_3. A concentrate assaying 30.73 per cent Cr_2O_3, representing 32.1 per cent of the weight of feed, was recovered. This separation was made on a feed ranging from 1 inch to 4 mesh in size.

Experimental Procedure:

No separate feed sample was taken of the carload lot. The feed to each run was taken, and the average value of the carload thus arrived at contained 18.13 per cent Cr_2O_3, 7.7 per cent Fe.

The ore was broken in a jaw breaker and Symons cone crusher to approximately 3 inch size and fed at the rate of 1 ton per hour to a 3 ft. x 6 ft. rod mill. The mill discharge was screened on a 14-mesh Hum-mer screen and the oversize was returned to the rod mill for further grinding. The minus 14 mesh product was classified in a 2-spigot launder hydraulic

(Continued on next page)

(Experimental Procedure, cont'd) -

classifier. The first spigot fed a Butchart $\frac{1}{4}$-deck table and the second fed a Deister $\frac{1}{4}$-deck table. The classifier fines were thickened in a Callow cone and the cone discharge was passed over a full-size Wilfley table. The middling from this table was re-concentrated on a $\frac{1}{4}$-deck Wilfley table. The middling from this small table was returned to the feed of the large Wilfley table.

Part of the tailing from the Butchart table, together with the middling, was dewatered in a Dorr classifier and returned to the rod mill for further grinding. The middling from the second sand table (Deister) was re-circulated to the launder classifier.

The tailing from each table was sampled at regular intervals throughout each day's run. All tailing entered a common discharge where a main tailing sample was obtained.

Details of Mill Runs:

The first three runs were devoted mainly to obtaining a circuit in which circulating loads were being built up and mechanical defects eliminated.

Samples taken during these periods showed that a concentrate of from 48.5 to 50 per cent Cr_2O_3 could easily be obtained. It also was established that part of the coarse sand table tailings, assays from 2.48 per cent to 2.85 per cent Cr_2O_3, could be advantageously discarded without further grinding.

After the circuit had been adjusted a continuous run was made, with the following results:

Run No. 4.

Feed rate	=	1,980 lb./hour
Weight of ore fed	=	9,040 pounds
+14 mesh return to rod mill	=	8,010 lb./hour
Butchart table middling returned to rod mill	=	760 "
Circulating load dry sand to rod mill	=	8,770 "
	=	448 per cent

(Continued on next page)

(Details of Mill Runs, cont'd) -

The products from the classifier were weighed for a period of time and the distribution to the three tables was found to be in the following proportions: Butchart, 1.7; Deister, 2.0; Wilfley, 1.0.

Screen analyses were made of the various mill products. These are incorporated in the table toward the end of the report.

Assays	Cr_2O_3, per cent
Rod mill feed	17.30
Butchart table feed	29.05
" " concentrate	47.80
" " tailing to waste	3.38
Deister table feed	19.05
" " concentrate	48.22
" " tailing to waste	2.90
Hydraulic classifier fines = cone feed	9.88
Wilfley table feed	10.12
" " concentrate	49.12
" " tailing to waste	5.71
Wilfley table middling = Pilot table feed	22.69
" " concentrate	46.10
" " tailing to waste	3.73
Main tailing	4.26

The concentrate produced by each table was dried and weighed, with the following results:

Butchart	853 pounds
Deister	505 "
Wilfley	427 "
Pilot	100 "

These weights, together with the respective assays, give an average grade of 48.12 per cent Cr_2O_3 for the total concentrate.

Recovery by formula = 82.7 per cent

Ratio of concentration = 3.4:1.

(Details of Mill Runs, cont'd) -

Mill Run No. 5.

In this and succeeding runs, the 14-mesh screen taking the rod mill discharge was replaced by a 10-mesh screen. The minus 10 mesh product was screened on a 16-mesh Hum-mer screen and the plus 16 mesh portion was fed to a two-compartment James jig. These jigs had a 20-mesh screen and were operated to make both gate concentrates and hutch concentrates. The jig tailing was elevated to the dewatering classifier and then returned to the rod mill.

The minus 16 mesh material was classified and tabled as in the previous flow-sheet.

Mill Run No. 5 was devoted to tuning up the circuit and was followed next day by a continuous run.

Mill Run No. 6.

Feed rate	-	2,100 lb./hour
Weight of ore fed	-	3,560 pounds
+10 mesh return to rod mill	-	1,280 lb./hour
Jig tailing return to rod mill	-	920 "
Butchart middling return to rod mill	-	320 "
Circulating load dry sand	-	120 per cent

Proportions of feed to jigs and tables:

Jig	-	3.2
Butchart table	-	1.6
Deister "	-	1.0
Wilfley "	-	1.5

Assays		Cr_2O_3, per cent
Mill feed	-	18.69
Jig feed	-	20.67
Jig Concentrate No. 1	-	47.70
" " No. 2	-	45.19
Hutch " No. 1	-	50.40
" " No. 2	-	48.18

(Continued on next page)

Examination of jig concentrates under the microscope showed the individual grains to be composed of particles of chromite cemented together by gangue.

(Mill Run No. 6, cont'd) -

Assays		Cr_2O_3, per cent
Jig tailing	-	18.84
Butchart table feed	-	29.18
" " concentrate	-	48.27
" " tailing to waste	-	3.28
Deister table feed	-	20.09
" " concentrate	-	48.44
" " tailing to waste	-	3.13
Cone feed	-	11.90
Wilfley table feed	-	13.64
" " concentrate	-	50.29
" " tailing to waste	-	4.00
Pilot table feed = Wilfley middling	-	31.70
Pilot table concentrate	-	46.15
" " tailing to waste	-	5.49
Main tailing	-	4.24

The weights of the various concentrates recovered together with their assays give a calculated value for the combined concentrates of 47.75 per cent Cr_2O_3.

By calculation

Recovery - 84.8 per cent

Ratio of concentration - 3.0:1.

Mill Run No. 7.

This run is a continuation of the preceding day's operation. The flow-sheet is similar, with the exception that instead of re-circulating the middling from the Deister table, this product was dewatered together with the jig tailing and Butchart table middling and was returned for regrinding. No gate concentrate was taken from the second jig compartment and practically no hutch concentrate was produced by the first compartment.

(Continued on next page)

(Mill Run No. 7, cont'd) -

Feed rate	=	2,125 lb./hour
Weight of ore fed	=	12,570 pounds
+10 mesh return to rod mill	=	240 lb./hour
Jig tailing return to rod mill	=	605 "
Butchart middling to rod mill	=	465 "
Deister middling to rod mill	=	220 "
Circulating load, dry sand to rod mill	=	91 per cent.

Proportions of feed to jigs and tables:

Jig	=	1.9
Butchart	=	3.1
Deister	=	2.0
Wilfley	=	3.6
Pilot	=	1.0

Assays		Cr_2O_3, per cent
Feed	=	18.40
Jig Concentrate No. 1	=	44.90
Jig Hutch No. 2	=	49.53
Jig tailing	=	16.70
Butchart table feed	=	30.06
" " concentrate	=	49.63
" " tailing to waste	=	5.20
Deister table feed	=	21.87
" " concentrate	=	49.14
" " tailing to waste	=	2.90
Cone feed	=	12.38
Wilfley table feed	=	18.05
" " concentrate	=	49.53
" " tailing	=	5.25
Pilot table feed = Wilfley table middling	=	26.73
Pilot table concentrate	=	49.14
" " tailing to waste	=	24.35[Φ]
Main tailing	=	7.65[Φ]

[Φ] Due to including too much middling from the pilot table in the table tailing, these assays are not representative of continuous operational results.

(Continued on next page)

(Mill Run No. 7, cont'd) -

The weights of the concentrates, exclusive of the jig concentrate, together with their respective assays give a calculated value of the concentrate as 49.16 per cent Cr_2O_3.

The operation of the ½-deck Wilfley pilot table re-concentrating the middling from the large Wilfley table could be dispensed with. By returning this table product to the circuit, a main tailing of 5.55 per cent can be expected.

By calculation

Recovery - 87.0 per cent

Ratio of concentration - 3.1:1.

A composite sample of the concentrates, exclusive of that from the jig, contained:

49.48	per cent	Cr_2O_3
11.46	"	Fe
2.12	"	SiO_2.

As users of chromite are prejudiced against the presence of fines, an attempt was made to sinter some of the concentrates.

The attempt was not successful.

(NOTE: Pages 9 and 10 following comprise Screen Analysis Tabulations referred to earlier in this report.)

SCREEN ANALYSIS (Sheet 1)

MESH	- Weight, per cent - ROD MILL FEED Run No. 4	6	7	OVERSIZE TO ROD MILL Run No. 4	6	7	10 MESH UNDERSIZE Run No. 6	7	Dorr Classifier SANDS Run No. 7	BUTCHART TABLE FEED Run No. 4	6	7	DEISTER TABLE FEED Run No. 4	6	7	
+3"	3.0	2.1	3.7													(Cont'd (on (Sheet 2)
-3" +1½"	14.0	6.3	11.7													
-1½" +2mesh	21.2	15.0	19.1													
- 2 + 3	17.5	12.7	14.3													
- 3 + 4	10.5	10.6	10.1		0.8											
- 4 + 6	7.9	8.1	7.3	1.7	4.4											
- 6 + 8	5.4	6.6	5.6	6.0	13.8	0.4										
- 8 + 10	4.0	6.1	5.0	15.5	34.0	4.5										
- 10 + 14	2.2	3.5	3.5	18.6	21.7	7.0	5.5	1.5	3.0							
- 14 + 20	2.7	5.0	3.8	28.2	16.2	22.3	27.4	15.5	23.8	9.2	8.1	3.5	3.2	2.3	0.6	
- 20 + 28	2.3	4.2	3.2	13.9	5.7	22.4	23.3	22.2	34.0	25.9	35.9	25.9	12.1	17.1	10.3	
- 28 + 35	2.0	4.1	3.2	7.5	2.0	16.0	13.8	22.1	24.3	29.1	32.1	29.2	22.2	26.4	28.2	
- 35 + 48	1.6	3.4	2.7	3.3	0.5	8.6	7.6	12.7	11.1	18.2	13.2	18.7	24.0	18.8	28.5	
- 48 + 65	1.2	2.6	1.6	1.7	0.3	4.8	5.5	8.5	2.9	9.3	5.6	16.1	17.8	12.8	16.2	
- 65 +100	1.1	2.3	1.4	0.9	0.2	3.0	4.6	5.5	0.5	4.0	2.5	2.8	9.5	8.2	7.6	
-100 +150	1.0	2.0	1.4	0.7)		2.7	4.4	4.5	0.4	2.0	1.5	2.5	5.4	6.2	4.0	
-150 +200	0.7	1.8	1.0	0.6)	0.4	2.8	2.5	3.1		0.8	0.6	0.7	2.5	3.4	2.1	
-200	1.7	3.6	1.4	1.4)		5.5	5.4	4.4		1.5	0.5	0.6	3.3	4.8	2.5	
Totals	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	

SCREEN ANALYSIS (Sheet 2)

MESH	- Weight, per cent -										
	CONE FEED			WILFLEY TABLE FEED			PILOT TABLE FEED			JIG FEED	
	Run No.			Run No.			Run No.			Run No.	
	4	6	7	4	6	7	4	6	7	6	7
-½" +⅜" -⅜" +¼" -¼" + 2 mesh										9.9	7.9
- 2 + 3										56.8	44.3
- 3 + 4										26.3	34.8
- 4 + 6										5.7	10.2
- 6 + 8										1.0	1.5
- 8 + 10											0.3
- 10 + 14										- 0.3	
- 14 + 20											- 1.0
- 20 + 28	1.2	2.4		1.0	2.3				1.2		
- 28 + 35	4.2	7.7	4.6	4.5	7.8	4.9	1.7	6.9	6.8		
- 35 + 48	8.2	16.1	9.8	8.3	14.6	10.9	4.6	12.5	13.6		
- 48 + 65	15.3	17.8	15.4	13.2	19.8	10.9	11.1	17.3	20.1		
- 65 +100	17.6	16.5	16.9	13.8	16.9	17.3	17.5	19.8	20.0		
-100 +150	19.3	15.1	18.6	19.8	15.9	18.5	27.7	21.8	18.3		
-150 +200	12.2	6.5	13.3	14.4	9.5	17.8	18.9	9.7	10.0		
-200	22.0	17.9	21.4	25.0	13.2	19.7	18.5	12.0	10.0		
Totals	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Summary:

It is apparent from a study of the results obtained that the ore must be crushed to at least minus 14 mesh to obtain a concentrate over 48 per cent Cr_2O_3. In Runs Nos. 6 and 7, where a 10-mesh screen was used and a jig concentrate was made of the -10+16 mesh size, although the concentrate to the eye looked clean microscopic examination of the particles of concentrate showed them to consist of chromite grains cemented together with gangue. In Run No. 7, a continuation of Run No. 6, the grade of jig concentrate fell off, due probably to a build-up of these middling particles in the grinding circuit.

The rod mill in closed circuit with a screen appears well suited for grinding this type of ore. Circulating loads of sands returned to the mill ranged from 91 per cent to 448 per cent of the weight of feed. More uniform grade of concentrate and a somewhat finer grind was obtained in Mill Run No. 7 where the circulating load was low. This, however, increased the proportion of finer-sized material fed to the Wilfley table. This also is indicated in the table of screen analysis.

A comparison of the weights of feeds to the three tables is of interest:

	Full-size Wilfley	½-size Butchart	¼-size Deister
Mill Run No. 4	1.0	1.7	2.0
" " " 6	1.0	1.0	0.75
" " " 7	1.0	0.8	0.6

In all these runs, there was an accumulation of fines in the thickening cone feeding the Wilfley table. The running time of this table was approximately 1.3 times that of the smaller sand tables.

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(Summary, cont'd) -

The feed to the slime table in Run No. 7 contained 44 per cent of material coarser than 100 mesh. The need for a third hydraulic classifier was very evident during all the runs. Removal of these finer sands would lessen the burden on the slime table. This, then, would place the number of tables required at 3 full-size sand tables and 3 full-size slime tables.

The use of a second table to concentrate the middling from the slime table could be dispensed with by re-circulating these table middlings.

Conclusions:

The flow-sheet indicated for the concentration of ore as represented by the sample furnished would consist of a rod mill in closed circuit with a screen not coarser than 14 mesh. A fairly high circulating load can be carried as the gangue crushes easily. The pulp passing through the screen should then be classified into at least three sand products and slimes. The middlings from the first two sand tables should be dewatered and returned to the grinding mill. The middlings from the last sand table and those from the slime tables should be re-circulated over their respective tables. The classifier slimes should be thickened prior to concentration. This will ensure a minimum of fine chromite being carried off the table at the head end.

To obtain maximum recovery of chromite with a grade of over 48 per cent Cr_2O_3, at least three slime tables should be installed for each set of three sand tables.

A flow-sheet such as outlined should recover approximately 90 per cent of the chromite in a feed such as this shipment under investigation.

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