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OTTAWA November 26th, 1942.

R E P O R T

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1329.

Sink-and-Float Tests on Samples of Chromite
Ore from Bird River, Manitoba.

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Shipments:

A shipment of 12 sacks of ore, weighing 660 pounds, was received on August 27th, 1942. A second shipment, of 58 sacks of ore, total weight 5,820 pounds, was received on October 1st, 1942. A third shipment, of 7 sacks of rock, total weight 460 pounds, was received on October 13th, 1942. The second and third shipments were intended to be mixed together to give a composite sample of the whole width of

(Shipments, cont'd) -

the vein. The samples were submitted by R. J. Jowsey, Godd's Lake-Gunnar Chrome Project, Suite 1405, 302 Bay Street, Toronto, Ontario.

Location of Property:

The property from which this ore was taken is located two miles north of Bird River, Manitoba, and about 26 miles northeast of Lac du Bonnet.

Sampling and Assaying:

Samples were cut from each of the shipments, assayed, and reported as follows:

	Cr_2O_3, per cent	Iron, per cent	Al_2O_3, per cent	MgO, per cent	SiO_2, per cent
Shipment No. 1 -	20.88	11.62	10.56	16.42	14.74
Shipment No. 2 -	21.27	12.38	6.59	20.60	16.82
Shipment No. 3 -	0.28	7.63	28.51	32.29	23.32

Character of the Ore:

Three samples were selected from the first shipment received. This shipment did not include any of the barren rock which occurs in one band of the vein, this material having been excluded by selective mining or hand sorting. Three polished sections, one from each sample, were prepared and examined under the ore-microscope.

Sample No. 1, Zones 1, 2, and 3 North -

The polished surface consists of more or less rounded crystals of chromite abundantly and evenly dissem-inated throughout gangue. The largest grain measured 760

(Character of the Ore, cont'd) -

microns (-20+28 Tyler mesh), the smallest 10 microns (-1100 Tyler mesh), the average size being about 160 microns (-65+100 Tyler mesh). Most grains contain tiny inclusions of gangue too fine to be economically eliminated, and have serrated, corroded edges which appear to be the result of attack and replacement by gangue. A few grains are slightly fractured and the fractures filled with gangue material. An average field is shown in Figure 1.

It is to be noted also that many grains have narrow borders of a lighter grey material around their edges and along fractures. These rims average less than ten microns in width but in places are somewhat wider (see photomicrograph, Figure 1). It is impossible to identify this material, which is probably an alteration product. In a previous report (664-E, Sept. 16th, 1939) made on a sample of another chromite ore, borders of similar-looking material were suggested as being reaction shells of magnetite. This suggestion was made because a light-brown tarnish was left on the light-grey border material after long etching with stannous chloride in 1:1 HCl, while the chromite was unaffected. Similar tests made on the sections from this ore gave no results. However, after an attempt was made to remove some of this border material with a needle-point, one small particle stood on end at the approach of a magnet, but it is not known with certainty whether this particle came from the rim or not. In any case, if magnetite is present it appears to be in very small amount.

In the polished surface the gangue is composed of soft, fine-textured, dark-grey material, which presents a sort of "ice-cake" pattern in a few places and probably represents a serpentinized peridotite or other ultrabasic

(Character of the Ore, cont'd) -

rock.

<u>Sample No. 2, Zone 4 North</u> -

The polished section of this sample is similar to that of Sample No. 1, with the following differences:

<u>1</u>. Gangue material predominates and varies in character. It presents a mottled appearance or pseudo-porphyritic texture in which the phenocrysts, composed of comparatively hard, coarse, light-green, and more or less rounded blebs up to about three millimetres in size, are in a ground-mass of the same soft, grey fine-textured material which forms the gangue in Sample No. 1.

<u>2</u>. The chromite content is much lower and occurs largely, if not entirely, in the soft, grey, fine-textured matrix.

<u>3</u>. A practically negligible amount of pyrite is visible as rare tiny grains, up to 18 or 20 microns (800 Tyler mesh) in size, in the light-green phenocrysts.

<u>Sample No. 3, Zone 5 North</u> -

This sample is similar to Sample No. 2, both as to gangue and metallics, except that

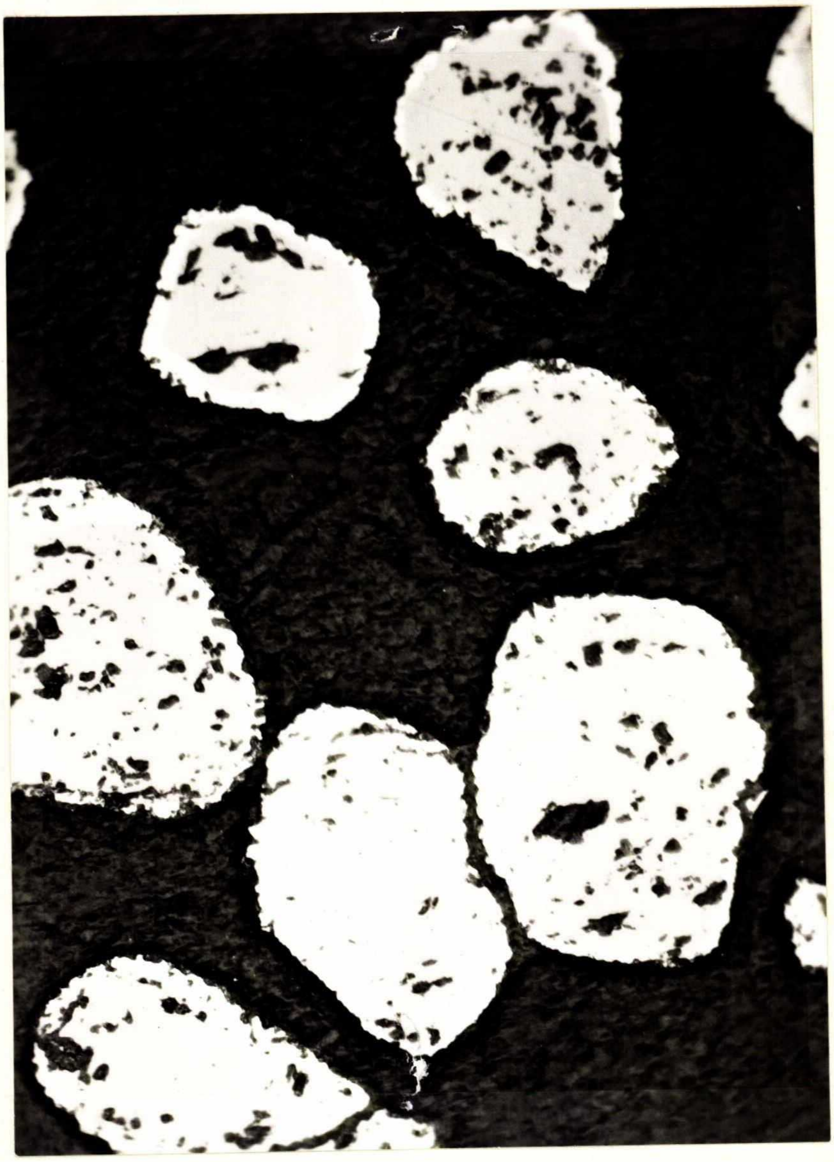
<u>1</u>. Chromite is more abundant; and

<u>2</u>. Pyrite is very rare, almost nil.

(Continued on next page)

(Character of the Ore, cont'd) -

Figure 1.



Photomicrograph of polished section of Sample No. 1, showing chromite grains with narrow, light coloured rims. Note also the tiny inclusions of gangue in the chromite grains and the corroded edges of the latter.

Borders - almost white.
Chromite - light grey.
Gangue - grey.

Magnification - X200.

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Experimental Tests:

These tests were conducted in an attempt to raise the grade of the ore to a point where it would be suitable feed to a process to improve the chromium-to-iron ratio. It was considered probable that 22 per cent grade would be acceptable.

A series of small-scale sink-and-float tests were conducted on samples of the ore to determine its suitability or otherwise for treatment by this process. The object of the process is to beneficiate the ore by rejecting a low-grade fraction of it at a coarsely crushed size. This is accomplished by making a density separation in a bath of substantially stable galena-water suspension wherein the heavier fraction of the ore settles to the bottom while the lighter fraction floats and is skimmed off.

Material finer than 8 mesh can not be treated by this process at any time, and for any given ore the size range that may be treated successfully must be determined by a preliminary test which is known as a size-density analysis. For this ore the size range-- 1½"+3 mesh has been found satisfactory. There is still no very definite indication that the maximum size has been reached, but a noticeable decrease in the amount rejected along with a decrease in the assay of the sink at 3.10 medium density for the maximum size treated, seems to indicate that this is at least very near the maximum size that can be treated successfully.

(Continued on next page)

(Experimental Tests, cont'd) -

The tests will be described in detail, as follows:

Test No. 1.

The ore used in this test was from the first shipment and, as already stated, it did not contain any of the barren rock that occurs in one band of the deposit.

The ore was already crushed to somewhere in the neighbourhood of minus ¾ inch when it was decided to investigate the possibilities of the sink-and-float method of treatment. Ordinarily a size-density analysis would be conducted on a more coarsely crushed sample. As a preliminary test, however, a density separation was made in bulk on everything coarser than 8 mesh with a medium density of 3.00. The products were then screened on ½", 3/8", 3-, 4- and 6-mesh screens. The different sizes were weighed and assayed separately. The results of this test are laid down in the following tables:

(Continued on next page)

(Test No. 1, cont'd)

Results of Test No. 1. - Size-Density Analysis.

Product	Weight, per cent	Assays, per cent Cr_2O_3	Assays, per cent Fe	Distribution, per cent Cr_2O_3	Distribution, per cent Fe
-8 mesh fines	19.38	21.17	11.22	19.73	18.10
Float @ 3.00					
-6+8 mesh	1.99	17.87	10.84	1.71	1.79
-4+6 mesh	2.44	16.91	10.78	1.98	2.19
-3+4 mesh	2.36	15.86	10.01	1.80	1.97
-3/8"+3 mesh	3.41	8.11	8.64	1.33	2.45
-1/2"+3/8"	4.67	5.78	7.92	1.30	3.08
-3/4"+1/2"	1.55	3.59	7.26	0.27	0.94
Total float @ 3.00	16.42	10.63	9.09	8.39	12.42
Sink @ 3.00					
-6+8 mesh	1.90	21.78	12.87	1.99	2.04
-4+6 mesh	3.51	22.60	12.87	3.81	3.76
-3+4 mesh	3.77	23.34	12.60	4.23	3.95
-3/8"+3 mesh	16.78	24.34	13.42	19.64	18.75
-1/2"+3/8"	26.82	22.88	12.87	29.51	28.74
-3/4"+1/2"	11.42	23.13	12.87	12.70	12.24
Total sink @ 3.00	64.20	23.29	13.00	71.88	69.48
Sink-and-float feed	80.62	20.71	12.20	80.27	81.90
Total ore	100.00	20.80	12.01	100.00	100.00

Summary of Results Test No. 1.

(Separating @ 3.00 sp.gr., -3/4"+8 mesh.)

-8 mesh fines	19.38	21.17	11.22	19.73	18.10
Sink	64.20	23.29	13.00	71.88	69.48
Sink and fines	83.58	22.79	12.59	91.61	87.58
Float	16.42	10.63	9.09	8.39	12.42
Total ore	100.00	20.80	12.01	100.00	100.00

(Separating @ 3.00 sp.gr., -3/4"+3 mesh.)

-3 mesh fines	35.35	20.74	11.49	35.25	33.80
Sink	55.02	23.38	13.04	61.85	59.73
Sink and fines	90.37	22.35	12.43	97.10	93.53
Float	9.63	6.25	8.07	2.90	6.47
Total ore	100.00	20.80	12.01	100.00	100.00

(Continued on next page)

(Test No. 1, cont'd) -

The size-density analysis shows a high loss in the float on everything finer than 3 mesh. The two summaries show recovery and grade of products to be expected by screening out 8-mesh- and 3-mesh-fines from this sample of ore. In this case the beneficiation was slight but the absence of barren rock left little to be done by sink-and-float. It indicates, however, that a separation can be made.

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Test No. 2.

This test was conducted on a composite sample of Shipments Nos. 2 and 3 mixed together in the proportion of 175 pounds of ore and 22 pounds of barren rock. The sample was crushed all through one inch and material finer than 8 mesh was screened out. The -1"+8 mesh material was then fractionated on the following screens: 7/8", ¾", 5/8", ½", and 3/8", and a series of density separations were made on each fraction. The sink product from each separation was progressively re-treated at a higher density until three densities had been used, thus dividing each of the original fractions into four density fractions. The density fractions -3/8"+8 mesh were screened on 3-, 4- and 6- mesh screens, giving, in all, nine sizes. The results of this test are as follows:

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(Test No. 2, cont'd) -

Results of Test No. 2. - Size-Density Analysis.

Product	Weight, per cent	Assays, per cent Cr_2O_3	Assays, per cent Fe	Distribution, per cent Cr_2O_3	Distribution, per cent Fe
-8 mesh fines	15.74	19.34	11.52	16.30	15.65
Float @ 2.80					
-6+8 mesh	0.91	13.00	8.21	0.63	0.65
-4+6 mesh	0.77	8.22	8.00	0.34	0.53
-3+4 mesh	0.61	3.82	6.32	0.12	0.33
-3/8"+3 mesh	0.40	2.00	6.10	0.04	0.21
-½"+3/8"	0.51	1.34	6.52	0.04	0.29
-5/8"+½"	0.77	1.44	6.52	0.06	0.43
-¾"+5/8"	0.44	1.24	6.32	0.03	0.24
-7/8"+¾"	0.34	1.24	6.10	0.02	0.18
-1"+7/8"	0.18	1.52	9.58	0.02	0.15
Total float @ 2.80	4.93	4.93	7.07	1.30	3.01
Float @ 2.90; sink @ 2.80					
-6+8 mesh	0.72	16.34	11.16	0.63	0.70
-4+6 mesh	0.67	13.70	10.11	0.49	0.58
-3+4 mesh	0.71	10.13	9.16	0.39	0.56
-3/8"+3 mesh	0.61	5.35	7.05	0.17	0.37
-½"+3/8"	1.50	5.17	6.95	0.42	0.90
-5/8"+½"	1.20	2.82	6.53	0.18	0.68
-¾"+5/8"	2.14	1.33	5.89	0.15	1.09
-7/8"+¾"	1.65	1.19	6.32	0.11	0.90
-1"+7/8"	1.27	1.39	4.95	0.09	0.54
Total float @ 2.90; sink @ 2.80	10.47	4.69	6.99	2.63	6.32
Float @ 3.00; sink @ 2.90					
-6+8 mesh	0.46	20.17	12.11	0.50	0.48
-4+6 mesh	0.68	20.74	11.58	0.76	0.68
-3+4 mesh	0.85	19.68	11.58	0.90	0.85
-3/8"+3 mesh	0.92	16.87	10.64	0.83	0.84
-½"+3/8"	0.83	10.03	12.64	0.45	0.91
-5/8"+½"	1.31	8.22	7.69	0.57	0.87
-¾"+5/8"	0.68	5.16	7.37	0.19	0.43
-7/8"+¾"	1.27	5.78	7.37	0.39	0.81
-1"+7/8"	1.40	3.39	5.90	0.25	0.71
Total float @ 3.00; sink @ 2.90	8.40	10.75	9.08	4.84	6.58

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(Test No. 2, cont'd) -

Results of Test No. 2. - Size-Density Analysis (cont'd).

Product	Weight, per cent	Assays, per cent		Distribution, per cent	
		Cr_2O_3	Fe	Cr_2O_3	Fe
Sink @ 3.00					
-6+8 mesh	0.99	22.51	12.95	1.19	1.10
-4+6 mesh	2.00	23.09	13.90	2.47	2.40
-3+4 mesh	3.17	23.28	12.95	3.95	3.54
-3/8"+3 mesh	5.00	23.36	13.37	6.26	5.77
-½"+3/8"	9.00	23.38	13.48	11.27	10.47
-5/8"+½"	8.49	23.18	13.47	10.54	9.87
-¾"+5/8"	11.40	23.36	12.95	14.26	12.74
-7/8"+¾"	11.28	23.04	12.85	13.92	12.51
-1"+7/8"	9.13	22.63	12.74	11.07	10.04
Total sink @ 3.00	60.46	23.14	13.12	74.93	68.44
Sink-and-float feed	84.26	18.55	11.60	83.70	84.35
Total ore	100.00	18.67	11.59	100.00	100.00

Summary of Results Test No. 2.

(Separating @ 3.00 sp.gr., -1"+8 mesh)

-8 mesh fines	15.74	19.34	11.52	16.30	15.65
Sink	60.46	23.14	13.12	74.93	68.44
Sink and fines	76.20	22.36	12.79	91.23	84.09
Float	23.80	6.88	7.74	8.77	15.91
Total ore	100.00	18.67	11.59	100.00	100.00

(Separating @ 3.00 sp.gr., -1"+3 mesh)

-3 mesh fines	28.28	18.93	11.50	28.67	28.05
Sink	54.30	23.15	13.10	67.32	61.40
Sink and fines	82.58	21.70	12.55	95.99	89.45
Float	17.42	4.31	7.02	4.01	10.55
Total ore	100.00	18.67	11.59	100.00	100.00

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(Test No. 2, cont'd) -

This test indicates, as did Test No. 1, that the feed to sink-and-float should be screened on 3 mesh at least but it still does not indicate that -1" is the maximum size that can be treated successfully. Comparing Test No. 1 with Test No. 2 and bearing in mind the difference between the two samples of ore, it will be noted that the amount of barren rock present will not affect the grade of sink produced from the fraction treated but it will directly effect the grade of the final product in so much as it will dilute the untreatable fines which, when added to the final sink product, will give a lower-grade product for further treatment. It would be possible, however, to treat the fines by gravity concentration and overcome this objection.

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Test No. 3.

This test was conducted on ore crushed -1½"+3 mesh, for which purpose it was divided into 3 parts, as follows: -1½"+1¼", -1¼"+1", and -1"+3 mesh. Each of these parts was treated separately the object being, in the case of the coarser fractions, to determine the upper size limit of the feed to the process.

The densities used in this test were 3.00 and 3.10. It will be noted from the size-density table that the intermediate fraction floated at 3.10 is much too high grade to be discarded and this seems to indicate that the most suitable separating density will be somewhere in the neighbourhood of 3.00.

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(Test No. 3, cont'd) -

Results of Test No. 3. - Size-Density Analysis.

Product	Weight, per cent	Assays, per cent		Distribution, per cent	
		Cr_2O_3	Fe	Cr_2O_3	Fe
-3 mesh fines	22.00	19.40	11.21	22.35	21.96
Float @ 3.00					
-1"+3 mesh	12.32	6.02	7.57	3.88	8.30
-1¼"+1"	3.28	2.80	6.61	0.48	1.93
-1½"+1¼"	4.27	2.98	6.97	0.67	2.65
Total float @ 3.00	19.87	4.84	7.28	5.03	12.88
Float @ 3.10; sink @ 3.00					
-1"+3 mesh	3.77	17.34	13.83	3.42	4.64
-1¼"+1"	1.21	10.36	8.38	0.66	0.90
-1½"+1¼"	1.79	11.19	8.38	1.05	1.34
Total float @ 3.10; sink @ 3.00	6.77	14.47	11.41	5.13	6.88
Sink @ 3.10					
-1"+3 mesh	25.37	25.74	13.02	34.20	29.40
-1¼"+1"	9.52	25.22	12.78	12.57	10.83
-1½"+1¼"	16.47	24.03	12.31	20.72	18.05
Total sink @ 3.10	51.36	25.10	12.75	67.49	58.28
Sink-and-float feed	78.00	19.01	11.24	77.65	78.04
Total ore	100.00	19.10	11.23	100.00	100.00

Summary of Results Test No. 3.

(Separating @ 3.00 sp.gr., -1½"+3 mesh)

-3 mesh fines	22.00	19.40	11.21	22.35	21.96
Sink	58.13	23.86	12.59	72.62	65.16
Sink and fines	80.13	22.63	12.21	94.97	87.12
Float	19.87	4.84	7.28	5.03	12.88
Total ore	100.00	19.10	11.23	100.00	100.00

(Separating @ 3.10 sp.gr., -1½"+3 mesh)

-3 mesh fines	22.00	19.40	11.21	22.35	21.96
Sink	51.36	25.10	12.75	67.49	58.28
Sink and fines	73.36	23.39	12.29	89.84	80.24
Float	26.64	7.28	8.33	10.16	19.76
Total ore	100.00	19.10	11.23	100.00	100.00

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(Test No. 3, cont'd) -

This test indicates that a satisfactory separation can be made up to 1½" in size. While recovery in sink+fines is about 1 per cent less than that obtained on ore crushed through one inch, the grade of final product, sink and fines, is better in grade by one per cent for separations made at 3.00 sp.gr. on feed screened on 3 mesh. The higher grade is due to the higher ratio of sink to untreatable fines resulting from the coarser crushing.

CONCLUSIONS:

On the basis of the samples submitted it is possible to recover 95 per cent of the chromium in a product assaying 22.5 per cent Cr_2O_3, or slightly better, from ore crushed through 1.5 inches, by sink-and-float separation alone. If the proportion of barren rock should be increased over that in the samples treated the above would not hold unless the fines be beneficiated by some form of gravity concentration, for the reason already given earlier in this report.

A sink product assaying 25 per cent Cr_2O_3 could be made by separating at 3.10 specific gravity, but in order to maintain this grade and get a satisfactory recovery it will be necessary to treat the fines by gravity concentration even in the samples submitted. This is approximately the maximum grade of product that can be obtained by sink-and-float.

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