MAR 19540003: PEACE RIVER

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Mines Branch

Division of
Mineral Dressing
and
Process Metallurgy

DEPARTMENT
OF
MINES AND TECHNICAL SURVEYS

552 Booth Street,
Ottawa, Ontario
June 24, 1954.

Mr. D. B. McDougall
Room 2, 901 - 8th Avenue West
Calgary, Alberta

Interim Report

Re: Your sample of Iron Ore Drill Cores from Peace River.

Dear Mr. McDougall:

Mineragraphic Examination of the Ore:

Examination of hand specimens showed them to be aggregates of numerous small brown globules or oolites, which average almost 0.5 mm. (-28+35 mesh) in diameter and are rather loosely consolidated in a ground mass of quartz and a dark brown to black mineral. Scattered throughout this material are a few small patches of soft, earthy, dull grey siderite. X-ray diffraction patterns of the other constituents identify both the oolites and the darker matrix to be goethite.

Examination of Polished Sections:

The globules or oolites of goethite are characteristic in appearance. While most show a concentric banded structure, some are composed of more or less homogeneous material. Many display no nuclei but others do have silica cores. The X-ray powder pattern of apparently clean oolites exhibits extra quartz lines. Although some cores are more or less round, others are quite angular in shape.

A photomicrograph will be included in the final report.

Acid Digested Ore:

A sample of ore (-10+14 mesh) was leached in hot hydrochloric acid and the residue remaining after this treatment was examined microscopically.

The residue contained soft, porous, grey sinter-like particles as the most abundant constituent. An X-ray powder pattern of some of these particles identifies them as illite

(a clay mineral) and quartz. Quartz is present as irregular, clear, vitreous particles, dense grey to white grains, fine powdery masses and tiny dull light-coloured globules. The latter are thought to be the cores from oolites.

Analysis of the Head Sample:

Total iron (Fe)	-	34.26 per cent	
Acid soluble iron (Fe)	-	34.03 " "	
Iron as Fe_2O_3	-	48.62 " "	(calculated)
Silica (SiO_2)	-	23.88 " "	
Insoluble	-	25.80 " "	
Aluminium Oxide (Al_2O_3)	-	5.94 " "	
Magnesium Oxide (MgO)	-	1.17 " "	
Calcium Oxide (CaO)	-	1.75 " "	
Phosphorus (P)	-	0.62 " "	
Sulphur (S)	-	Trace	
Manganese (Mn)	-	0.10 " "	
Molybdenite (MoS_2)	-	None detected	
Carbon dioxide (CO_2)	-	5.22 per cent	
Loss on ignition	-	12.00 " "	

A portion of the head sample was used for a qualitative spectrographic analysis.

The elements present in the order of decreasing abundance were reported as follows:

1. Major Constituent, Fe.
2. Minor " Si.
3. Strong trace, p, Na.
4. Trace, Mn, Mg, Pb, Al, V, Ni, Zn, As.
5. Faint trace, B, Cr, Ca, Cu, Ag, Ti, Co, Sn, Mo.

The investigative tests include magnetic roasting followed by magnetic separation, and gravity concentration of raw ore on the Wilfley table. The ore was crushed to various sizes for both magnetic and gravity tests.

Test #1 - Magnetic Concentration:

Analysis of Magnetic Concentrate -

Fe	-	55.0 per cent
Insoluble	-	10.3 " "
SiO_2	-	8.58 " "
CaO	-	2.14 " "

Recovery of iron, 16.76 per cent
Ratio of Concentration, 8.58:1

Analysis of Non-magnetic Tailing -
Fe - 36.05 per cent
Insoluble - 32.0 " "
Iron in tailing, - 83.24 " "
Calculated analysis of the feed, Fe, 38.26 per cent, Insoluble, 29.47 per cent.

Test #2 - Magnetic Concentration:

Fe - 50.2 per cent
Insoluble - 15.6 " "
SiO_2 - 13.0 " "
Recovery of iron, 50.2 per cent
Ratio of Concentration, 2.58:1

Non-magnetic Tailing -
Fe - 31.46 per cent
Insoluble - 38.17 " "
Iron in tailing - 49.8 " "

Calculated analysis of the feed, Fe 38.71 per cent, insoluble 29.43 per cent.

Gravity concentration made with sized feed of fractions from minus 48 to minus 200 mesh indicated some separation of iron from gangue at the size -100+150 mesh.

The analysis of the table products was reported as follows:

Product	Analysis, per cent		
	Fe	SiO_2	Insol
Feed (Calculated)	32.46	24.93	29.14
Conc -48+65 mesh	33.55	24.7	29.5
" -65+100 "	36.05	18.7	22.9
" -100+150 mesh	41.70	7.47	9.90
" -150+200 "	40.20	8.90	11.9
" -200 "	40.0	8.09	11.5
Middling + 200 "	31.05	28.8	32.6
Tailing + 200 "	30.52	22.28	27.87
Middling -200 "	34.8	19.3	22.6
Tailing -200 "	32.8	22.32	26.17

The results of magnetizing roasting and magnetic separation, so far obtained, are not very satisfactory as to grade and recovery of iron.

However, these results indicate that a magnetizing roast, followed by magnetic separation offer the best method of concentrating the ore.

The results of magnetic concentration of several tests show that the amount of magnetic material formed during the roasting period varies considerably.

The reducing agent used in these tests was charcoal, ground to minus 20 mesh, and mixed with the ore. The amount of charcoal was varied from 2 to 3 per cent of the weight of the feed.

It is proposed to use city gas as a reducing agent which should indicate the results to be expected if natural gas, available near your deposit, could be used.

As nearly all of the ore has been used up in the tests, it will be necessary for you to ship us about 100 pounds of ore as soon as possible to enable us to complete the investigation.

The results of tests underway will be forwarded to you as interim reports and the final report will be issued when the investigation has been completed.

Yours very truly,

W. S. Jenkins,
for R. J. Traill,
Chief of Division.

DEPARTMENT
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Mines Branch

Division of
Mineral Dressing
and
Process Metallurgy

552 Booth Street,
Ottawa, Ontario
August 6, 1954.

Mr. D. B. McDougall
Room 2, 901 - 8th Avenue West
Calgary, Alberta

Interim Report No. 2 - Re: Your sample of Iron Ore Drill Cores from Peace River.

Dear Mr. McDougall:

In our letter dated June 24th, the results of several tests were given and additional tests have been completed in which charcoal and city gas as reducing agents have been used.

The amount of charcoal used was varied from 2 to 4 per cent. The increased amounts of charcoal above 2 per cent did not result in any appreciable increase in recovery of iron.

Two flotation tests were made.

Reducing with Gas

Tests Nos. 1, 2, 3.

Samples of ore crushed to pass 20, 48 and 65 mesh were placed in a retort which was heated to 1100°F. City gas passed through the retort and the excess was burned at the outlet.

The reduced ore was magnetically concentrated.

The 20 mesh roasted ore was ground in a ball mill prior to magnetic concentration.

Magnetic Concentration

Test No. 1 - Minus 20 Mesh Ore

Product	Weight, Per Cent	Analysis, Per Cent		Distribution, Per Cent		Ratio of Concentration
		Fe	Insol.	Fe	Insol.	
Feed*	100.0	40.38	34.93	100.0	100.0	
Mag.Conc.	11.5	58.50	14.59	16.6	4.8	8.7:1
Tailing	88.5	38.03	37.56	83.4	95.2	

Loss in weight by roasting 27.2%

Test No.2 - Minus 48 Mesh Ore

Product	Weight, per cent	Analysis, per cent		Distribution, per cent		Ratio of Concentration
		Fe	Insol.	Fe	Insol.	
Feed*	100.0	41.17	32.76	100.0	100.0	
Mag.Conc.	32.5	52.10	19.02	41.2	18.9	3.1:1
Tailing	67.5	35.9	39.39	58.8	81.1	

Loss in weight by roasting 23.7%

Test No.3 - Minus 65 Mesh Ore

Feed*	100.0	30.36	33.23	100.0	100.0	
Mag.Conc.	15.6	58.0	15.6	29.8	7.3	6.4:1
Tailing	84.4	25.25	36.49	70.2	92.7	

*Calculated Loss in weight by roasting 24.6%

A microscopic examination of concentrate showed that the individual particles were all quite black; lighter coloured particles appeared to be obscured by black coloured fines (dust). Gangue particles were not easily distinguished.

A portion of the concentrates were acid leached and the residues were white with occasional small black grains.

Much gangue was seen as fine white particles and also as grains of clear glassy quartz. The quartz grains did not appear to have any inclusions of iron. The quartz may have been brought into the concentrate by being trapped among magnetic particles or else the fine layer of magnetic oxide adhered to the surface causing the particle to report in the concentrate. Acid leaching would remove the iron from the surface of the particle.

The fineness of most of the gangue makes its separation from the iron minerals very difficult.

Examination of the reground roasted ore indicated that part of the iron present appeared unreduced, which indicated that the interior of the particle may not be magnetic.

Test No. 4 - Roasting in air prior to reducing roast

A sample of minus 20 mesh ore was roasted at 600°F. in an open dish. The roasted ore became red, the colour of hematite. This material was placed in the retort for a reducing roast at 1100°F. After grinding the reduced ore, it was magnetically concentrated.

Test No. 4 - Minus 20 Mesh Ore

Product	Weight per cent	Analysis, per cent		Distribution, per cent		Ratio of Concentration
		Fe	Insol.	Fe	Insol.	
Feed*	100.0	41.17	33.20	100.0	100.0	
Mag.Conc.	30.4	53.0	18.32	39.2	16.8	3.3:1
Tailing	69.6	36.0	39.71	60.8	83.2	

*Calculated Loss in weight by roasting 28.3%

Test No. 5 - (1) Grinding Ore in a ball mill,
(2) Roasting in air,
(3) Reducing roast with city gas.

A sample of the ore was ground in a ball mill to 85 per cent minus 200 mesh, filtered and dried.

The ground ore was roasted in air in an open dish at 600°F. followed by a reducing roast with city gas. The roasted ore was magnetically concentrated.

A sample of the non-magnetic tailing was given a second reducing roast to find out if more magnetic iron could be obtained from it.

Results:

Product	Weight, per cent		Analysis per cent		Distribution of iron, per cent		Ratio of Concentration
	In test	In orig. feed	Fe	Insol.	In test	In orig. feed	
Feed*	100.0	--	40.05	--	100.0	--	
Mag.Conc.	26.8	--	49.20	18.9	32.9	--	3.7:1
Tailing	73.2	--	36.7	--	67.1	--	

Loss in weight by roasting 28.3%

Re-roast of Tailing

Feed*	100.0	73.2	36.0	--	100.0	67.1	
Mag.Conc.	4.85	3.6	52.0	16.0	7.0	4.7	20.6:1
Tailing	95.15	69.6	35.2	--	93.0	62.4	

Loss in weight by roasting, 3.1%

Combined Conc.*	--	30.4	49.53	18.5	--	37.6	3.3:1

*Calculated

Test No. 6 - Magnetic Concentration of Reground Magnetic Concentrate

(1) Roasting in air of minus 1/4 inch ore,
Loss in weight by roasting, 15.3%.
(2) Grinding to minus 65 mesh,
(3) Reducing roast with charcoal (4%),
(4) Magnetic concentration at minus 65 mesh,
(5) Magnetic concentration of samples of magnetic concentrate (from 4) ground to minus 100, 150 and 200 mesh.

Results of Magnetic Concentration of Roasted Product at minus 65 mesh

Product	Weight, per cent		Analysis, per cent		Distribution, per cent				Ratio of concentration
					In test		In orig. feed		
	In test	in orig. feed	Fe	Insol.	Fe	Insol.	Fe	Insol.	
Feed*	100.0	--	38.73	28.40	100.0	100.0	--	--	
Conc.	24.9	--	49.40	15.1	31.7	13.2	--	--	4.0:1
Tailing	75.1	--	35.20	32.8	68.3	86.8	--	--	

Loss in weight by roasting, 7.6%

Magnetic Concentration of Concentrate at Minus 100 Mesh

Feed*	100.0	24.9	48.58	15.54	100.0	100.0	31.7	13.2	
Conc.	76.	18.9	51.90	12.05	81.2	58.9	25.7	7.8	1.3:1
Tailing	24.	5.9	38.05	26.60	18.8	41.1	6.0	5.4	

Magnetic Concentration of Concentrate at Minus 150 Mesh

Feed*	100.0	24.9	49.54	15.06	100.0	100.0	31.7	13.2	
Conc.	57.	14.2	55.45	9.0	63.8	34.1	20.2	4.5	1.75:1
Tailing	43.	10.7	41.70	23.1	36.2	65.9	11.5	8.7	

Magnetic Concentration of Concentrate at Minus 200 Mesh

Feed*	100.0	24.9	49.54	14.91	100.0	100.0	31.7	13.2	
Conc.	48.	11.9	56.25	8.15	54.5	26.2	17.3	3.5	
Tailing	52.	12.9	43.35	21.15	45.5	73.8	14.4	9.7	

*Calculated

The tests shown above indicate the recoveries and grades of concentrates to be expected from ore represented by the shipment, by the method of a reducing roast followed by magnetic concentration.

The tests included air roasting followed by magnetic or reducing roasts with both charcoal and gas used as reducing agents on ore samples crushed to varying sizes.

Two flotation tests did not show satisfactory results, but if a larger supply of ore becomes available more flotation tests will be tried.

The gangue minerals are extremely fine and will prove difficult to separate from the iron minerals by magnetic concentration. More tests will have to be made to determine the maximum amount of magnetic iron that can be obtained and the highest grade of concentrate that can be expected by this process.

The supply of ore, 46 lb., has been all used up in the test work to date.

Yours very truly,

W. S. Jenkins,
for R. J. Traill,
Chief of Division.