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GREENPATCH IRON ORE INVESTIGATION

by

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CONTENTS

	Page
SUMMARY	1
1. INTRODUCTION	3
2. MATERIAL EXAMINED	3
3. EQUIPMENT	4
4. ANCILLIARY MATERIALS	4
4.1 Anionic Flotation Reagents	4
4.2 Cationic Flotation Reagent	6
4.3 Frothing Agent	6
5. EXPERIMENTAL PROCEDURE AND RESULTS	6
5.1 Sample A	6
5.1.1 General	6
5.1.2 Grinding and Screening	6
5.1.3 Magnetic Concentration	7
5.1.4 Gravity Concentration	7
5.1.5 Flotation	7
5.1.6 Pelletizing	7
5.2 Sample B	8
5.2.1 General	8
5.2.2 Grinding and Screeing	8
5.2.3 Magnetic Concentration	9
5.2.4 Gravity Concentration	9
5.2.5 Pelletizing	9
5.2.6 Discussion	9
5.3 Sample C	10
5.3.1 General	10
5.3.2 Grinding and Screening	10
5.3.3 Magnetic Concentration	10
5.3.4 Gravity Concentration	10
5.3.5 Pelletizing	11
5.3.6 Discussion	11
6. CONCLUSIONS	11
7. RECOMMENDATIONS	11
8. ACKNOWLEDGEMENTS	12

CONTENTS

	Page
TABLES 1 TO 23	
FIGURES 1 TO 3	
APPENDIX A	A-1 to A-7
APPENDIX B	B-1 to B-2
APPENDIX C	C-1 to C-2

SUMMARY

History

Geophysical exploration revealed iron bearing mineralisation in the Greenpatch area near Pt Lincoln on Eyre Peninsular. Three geophysical anomalies were drilled and portion of the cores submitted for upgrading investigations. The samples from each of the cores were kept separate as they represented geographically different areas and had different mineralogical characteristics. All work on the samples had to be done at the smallest scale of testing possible due to the limited weights of core available.

Objective

The aim of the work was to establish the feasibility of producing marketable iron oxide concentrate and to assess pelletising characteristics of such concentrates.

Summary of Work Done

Sample A. Sample A which represented diamond drill hole GD7 (70-170 ft) was not readily amenable to beneficiation. Further work is warranted on flotation as a method for concentrating the iron.

Magnetic separation gave a magnetic product assaying only 41.4% Fe.

Haultain Superpanner tests produced a heavy fraction assaying 61.9% Fe with a recovery of 46.9% Fe contained in the feed.

Anionic flotation gave a concentrate assaying 54.6% Fe. Cationic flotation gave a rougher tailing assaying 60.7% Fe and the recovery was 54.4% of the iron contained in the feed.

Preliminary pelletising tests indicated that satisfactory pellets can be formed using 0.75-1.0% bentonite and 15-30% moisture.

Sample B. Sample B which represented diamond drill hole GD5 (240-350 ft) gave quite high concentrate grades but the recovery of iron was low. Flotation should be investigated for improving overall recovery.

Screen analysis did not show any marked difference in iron content of the various fractions.

Magnetic separation gave high grade concentrates assaying 66.9% Fe and 66.4% Fe, with iron recoveries of 25.6% Fe and 24.2% respectively.

Haultain superpanner tests produced concentrates assaying 62.6% Fe and 63.6% Fe, but recoveries were low, namely 24.9% and 16.6% respectively of the iron contained in the feed.

Heavy liquid separations were unsuccessful. The highest grade product contained 41.2% Fe.

Pelletising tests indicated that satisfactory pellets can be formed using 0.75-1.0% bentonite and 15-30% moisture.

Sample C. Sample C which represented diamond drill hole GD3 (220-300 ft) was readily amenable to magnetic concentration.

Magnetic separation gave good results. Wet magnetic separation gave magnetic products assaying 67.6% Fe and 68.3% Fe containing 87.1 and 84.5% of the iron contained in the sample.

Dry magnetic separation gave a magnetic fraction assaying 55.1% Fe with 89.0% recovery.

A screen analysis and heavy liquid separations did not show any marked difference in the iron content of the various products.

Pelletising tests indicated that satisfactory pellets can be formed using 0.75-1.0% bentonite and 15-30% moisture.

Conclusions

Sample A is not amenable to magnetic separation but cationic flotation probably could be developed to give satisfactory grade and recovery.

Sample B contains approximately 25% of iron which can be recovered as a marketable magnetic concentrate. Gravity concentration was somewhat inferior. Due to insufficient weight of sample flotation was not investigated. This is the only process considered to have any possibility of recovering the remainder of the iron but the feasibility was not established.

Sample C can be readily upgraded by wet magnetic separation to give a high grade product. The feasibility study utilised a very fine grind and the grades and recoveries reported are probably near maximum possible.

Recommendations

Larger quantities of material are required for further investigations on the upgrading of the three iron bearing areas at Greenpatch.

The following recommendations are made:

Sample A. Cationic flotation requires to be extensively examined to determine optimum conditions for grade and recovery;

The investigation should cover

1. mesh of grind
2. collector type and quantity
3. effect of pH
4. effect of circuit variations.

Sample B. Flotation has not been applied to this sample and its feasibility should be examined both for anionic and for cationic systems.

Larger scale work is required on both magnetic and gravity separation to determine the effect of mesh of grind on metallurgical efficiency and to assess the value of each process as a preconcentration stage before flotation.

Sample C. Larger scale tests are required to establish optimum mesh of grind and separation conditions and to confirm feasibility results using equipment more comparable with plant operation.

1. INTRODUCTION

Metallurgical work on a 200 lb sample from the iron deposit of Greenpatch area, near Port Lincoln on Eyre Peninsula has been described in previous reports[1, 2]. Based on recommendations given in these reports further experimental work was conducted on additional samples of diamond drill cores.

Because only limited quantities of core were available, work was conducted wherever possible on a miniature scale.

2. MATERIAL EXAMINED

Core samples from diamond drill holes GD2, GD3, GD4, GD5, GD6 and GD7 in the Greenpatch area, Eyre Peninsula, were received during April and May, 1964. Chemical analyses of individual footages in the total drill core are shown in Appendix A.

From the quarter-core assay rejects of Samples from GD7, GD5 and GD3, specified footages were bulked to give samples designated Samples A, B and C respectively.

Sample A. Footage: 70-170 (28.4% Fe)
Samples: A1795-1804/64
Hole: GD7

Mineragraphic examination showed that predominant iron minerals were goethite and hematite, derived from magnetite. These comprised 20-30% of the sample. The goethite was extremely fine grained but aggregates up to 1.0 mm in diameter also occurred (see Appendix B). Siliceous gangue comprised 70% of the sample.

Sample B (Higher Grade with Low Lime). Footage: 240-350 (28.9% Fe)
Samples: A1755-1765/64
Hole. GD5

Mineragraphic examination showed this sample to contain 5-10% by volume of magnetite as the only iron-bearing mineral. The grains ranged from 0.01 to 0.5 mm and averaged approximately 0.1 mm. The magnetite occurred as course grains interstitial to the gangue. Siliceous gangue (50-60%) and carbonate gangue (30-40%) were the major constituents of the sample (see Appendix B).

A semiquantitative spectrographic analysis was made and results are shown in Appendix C.

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1. LORENZ, R., (1963), "Examination of Iron Ore from Greenpatch Area", Part 1, AMDL Report 261.

2. McPHEAT, I. W., (1964), "Examination of Iron Ore from Greenpatch Area", Part 2, AMDL Report 316.

Sample C (Lower Grade with High Lime). Footage: 220-300 (20% Fe)
Samples: A1070-1077/64
Hole: GD3

Mineragraphic examination showed that the predominant iron mineral was magnetite (10%) occurring as grains 0.01 mm to 0.7 mm in diameter. The gangue minerals were feldspar, quartz, garnet and ferro-magnesian materials, totalling 80 to 90%. A trace of pyrite was also present (see Appendix B).

A semiquantitative spectrographic analysis is given in Appendix C.

3. EQUIPMENT

The equipment used during the investigation included:

1. Rotap sieve shaker and British Standard (BSS) laboratory screens.
2. Davis Tube wet magnetic separator.
3. Jones wet magnetic separator.
4. Stearns disc type dry magnetic separator.
5. Haultain Superpanner
6. Laboratory stainless steel rod-mill:
   $7\frac{1}{2}$-inch dia, 10 inches long,
   with 15 1-inch dia rods.
7. Laboratory Fagergren flotation cell:
   speed: 1650 rpm.

4. ANCILLARY MATERIALS

4.1 Anionic Flotation Reagents

The anionic reagents are listed in the following tabulation:

Reagent	Supplier	Cost/lb[(a)] approx. $
Linseed Fatty Acids: linolenic acid 48% linoleic acid 12% oleic acid 12% saturated acids 28%	Meggit Ltd, Adelaide	0.167
Tall Oil Fatty Acids: (Pamak 4) linoleic acid 43.2% oleic acid 46.3% rosin acid 4.5%	A.C. Hatrick Pty Ltd Adelaide	0.117
Sulphonated Sperm Whale Oil:	Gardinol Chemical Co. (A/asia) Pty Ltd, Adelaide	0.183
Triton X-100: (octyl phenol oxyethylene condensate)	Robert Bryce and Co Ltd, Adelaide	0.25
Cresylic Acid TD:	Union Carbide Aust. Ltd, Adelaide	0.192
Naphthenic Acid SP230:	Shell Chemical (Aust.) Pty Ltd, Adelaide	0.183
Light Grade Fuel Oil:	Shell Company of Aust. Ltd	0.017

(a) Adelaide prices.

Linseed fatty acids and tall oil fatty acids were emulsified and the compositions of the emulsifiable mixtures were:

	Weight, %
Linseed fatty acids	30
Sulphonated whale oil	20
Cresylic acid	13
Fuel oil	37

This emulsion henceforth is called "Collector A".

	Weight, %
Tall oil fatty acids (Pamak 4)	56
Naphthenic acids	4
Triton X-100	2
Fuel oil	38

This emulsion henceforth is called "Collector B".

4.2 Cationic Flotation Reagent

The following cationic reagent was used:

Reagent	Supplier	Cost/lb[(a)] approx. $
Duomeen S (An aliphatic diamine converted to acetate in the laboratory by adding the stoichiometric amount of acetic acid)	Armour Chemical Division Chicago, Illinois	0.575

(a) Adelaide prices.

4.3 Frothing Agent

The following frothing agent was used.

Reagent	Supplier	Cost/lb[(a)] approx. $
Aerofroth 65 (Non-promoting water soluble polyglycol)	Cyanamid (Aust) Pty Ltd, Melbourne	0.283

(a) Adelaide prices.

5. EXPERIMENTAL PROCEDURE AND RESULTS

5.1 Sample A

5.1.1 General

Sample A from "Hole GD7" is described in Section 2 (Sample A). The head assay of this sample is 28.4% Fe.

5.1.2 Grinding and Screening

Sample A was ground to minus 72 mesh and sized fractions were screened from the ground material for magnetic and gravity separations.

Separate 500-g minus 10-mesh charges were ground in a laboratory stainless steel rod mill for 12 minutes. This material served as feed for flotation tests. A screen analysis of flotation feed is shown in Table 1.

5.1.3 Magnetic Concentration

A charge of 500 g passing 300 mesh was passed through the Jones high intensity wet magnetic separator at maximum field current. Test conditions were as follows:

Field current:	30 amperes
Reverse current:	9 amperes
Water pressure:	wash 22 psi pulse 27 psi
Plate gap:	0.022 in.
Plates (type):	Salient

Results are shown in Table 2.

5.1.4 Gravity Concentration

Gravity concentration using the "Haultain-Superpanner" produced a concentrate containing 61.9% Fe and a tailing containing 6.7% Fe after repeated treatment of the gravity middling. The results are summarised in Table 3.

5.1.5 Flotation

Anionic and cationic flotation tests were conducted in pulp at room temperature.

Preliminary flotation tests in hot pulp were also done, but work was curtailed before any data were obtained.

Anionic Flotation. Two tests were carried out using Collector A and one test using Collector B. In all tests distilled water was used and the temperature was maintained at 22°C. Reagent additions and results are shown in Table 4.

Cationic Flotation. A test was conducted using Duomeen S on deslimed ore. Desliming was done by two decantations. In each stage 8 minutes settling time was allowed. The temperature of the water was 60°C. Sodium hydroxide and sodium silicate were added to prevent flocculation. Results are shown in Table 4. The rougher tailing was mineralogically examined.

5.1.6 Pelletizing

High grade concentrates from tests were combined and used as feed for pelletizing. The sample was moistened, rolled and dried. Results of pellet-formation are shown in Table 5.

Abrasion-Tests. Dried pellets were abraded in a small vibratory mill for 1 minute. Plus and minus 36-mesh fractions were weighed. Results are shown in Table 6.

Impact Tests. Dried pellets were dropped from a height of 15 inches onto a stainless steel tray. Plus and minus 10-mesh fractions were weighed. Results are shown in Table 6.

5.1.7 Discussion

Wet magnetic separation gave a magnetic product assaying 41.4% Fe containing 64.1% iron of the feed.

Haultain Superpanner tests gave better results than magnetic separation. A heavy product assaying 61.9% Fe was obtained with a recovery of 46.9% Fe contained in the feed.

Anionic flotation was not successful; a concentrate assaying 54.6% Fe was produced and the corresponding recovery was 21.8% Fe.

Cationic flotation gave superior results to those achieved by anionic flotation. An iron product was obtained assaying 60.7% Fe and containing 54.4% Fe of the feed. This product contained flakes of a micaceous substance which is probably biotite or stilpnomelane. More definite identification would only be possible after further detailed x-ray diffraction and chemical analysis.

Pelletizing tests indicated that satisfactory pellets can be formed using 0.75-1.0% bentonite and 15-30% moisture.

5.2 Sample B

5.2.1 General

Sample B from "Hole GD5" is described in Section 2 (Sample B (Higher Grade with Low Lime)).

A representative assay sample was riffled out from the minus 10-mesh material and a partial chemical analysis was made. Results are as follows:

		%
Acid soluble	Fe	29.0
Insolubles		36.4
Phosphorus	P	0.16
Calcium	Ca	1.40
Ferrous	Fe	22.6
Sulphur	S	0.035
Acid insoluble	Fe	1.7
Undetermined		8.7
Total		100.0

5.2.2 Grinding and Screening

Sample B was ground to minus 10 mesh and some of the minus 10-mesh material was pulverised to pass 36 mesh.

Screen sizing of both products was done and results are shown in Table 7.

A screen analysis was made on combined fractions and results are presented in Table 8.

5.2.3 Magnetic Concentration

Wet magnetic separations were conducted using a Davis Tube as only a small amount of sample was available.

One test was carried out on minus 200-mesh material and another test was conducted on minus 300-mesh material.

The conditions of the the tests were:

Coil current:	3.0 amp
Field strength:	8300 gauss
Stroke frequency:	70 cycles per minute

Results are shown in Table 9.

5.2.4 Gravity Concentration

Heavy Liquid Separation. Bulked fractions of minus 10-mesh material and minus 36-mesh material were separated in tetrabromoethane (TBE), using tapered separating funnels. The results are shown in Tables 10 and 11.

Haultain Superpanner. Gravity separation was made using the Haultain Superpanner on minus 72 plus 150 mesh, minus 150 plus 300 mesh and minus 300-mesh material.

The results are shown in Table 12.

5.2.5 Pelletizing

High grade concentrates from tests were combined and used as feed for pelletizing. The sample was moistened, rolled and dried.

Results of pellet-formation are shown in Table 13.

Abrasion-Tests. Dried pellets were abraded in a small vibratory mill for 1 minute. Plus and minus 36-mesh fractions were weighed. Results are shown in Table 14.

Impact Tests. Dried pellets were dropped from a height of 15 inches onto a stainless steel tray. Plus and minus 10-mesh fractions were weighed. Results are shown in Table 14.

5.2.6 Discussion

Screen analyses of minus 10-mesh material and minus 36-mesh material have not shown any marked differences in iron content of the various fractions.

Magnetic separations of minus 200-mesh and minus 300-mesh material gave high grade magnetic products assaying 66.9% Fe and 66.4% Fe respectively, but recoveries were low: 25.6% and 24.2%

Haultain superpanner tests on minus 150 plus 300-mesh and minus 300-mesh feed yielded concentrates assaying 62.6% Fe and 63.6% Fe respectively, but recoveries were even lower than those attained by magnetic separations.

Heavy liquid separations were unsuccessful. Highest grade product contained 41.2% Fe only.

Pelletizing tests indicated that satisfactory pellets can be formed using 0.75-1.0% bentonite and 15-30% moisture.

5.3 Sample C

5.3.1 General

Sample C from "Hole GD3" is described in Section 2.3.

A respective assay sample was riffled out from the minus 10-mesh material and a partial chemical analysis was made. Results are as follows:

		%
Acid soluble Fe		19.9
Insolubles		50.7
Phosphorus	P	0.13
Calcium	Ca	6.0
Ferrous	Fe	7.7
Sulphur	S	0.010
Acid Insoluble Fe		-
Undetermined		15.6
Total		100.0

5.3.2 Grinding and Screening

Sample C was ground to minus 10-mesh and some of the minus 10-mesh material was pulverised to pass 30 mesh.

Screen sizing of both products was done and results are shown in Table 15.

A screen analysis was made on combined fractions and results are shown in Table 16.

5.3.3 Magnetic Concentration

Wet Magnetic Separation. Magnetic separation was conducted on minus 10-mesh material using a handmagnet. The magnetic fraction was reground to pass 36 mesh and magnetically separated using the Davis Tube. The magnetic fraction was ground to pass 150 mesh. The minus 150-mesh magnetic fraction was used as feed for a further magnetic separation. The minus 150-mesh magnetic product was reduced to minus 300 mesh and separated into magnetic and non magnetic fractions using the Davis Tube.

This procedure was repeated with increased amperages. Results of both runs are shown in Tables 17 and 18 and in Figures 1 and 2.

Dry Magnetic Separation. Magnetic separation was conducted on minus 10-mesh material using the Stearns Disc Type Separator. The procedure was similar to that of wet magnetic separation. Test conditions and test results are given in Table 19 and Figure 3.

5.3.4 Gravity Concentration

Heavy liquid separations using tetrabromoethane were made on minus 10-mesh and minus 36-mesh material using separating funnels. Results are shown in Tables 20 and 21.

5.3.5 Pelletizing

High grade concentrates from tests were combined and used as feed for pelletizing. The sample was moistened, rolled and dried.

Results of pellet-formation are shown in Table 22.

Abrasion Tests. Dried pellets were abraded in a small vibratory mill for 1 minute. Plus and minus 36-mesh fractions were weighed. Results are shown in Table 23.

Impact Tests. Dried pellets were dropped from a height of 15 inches onto a stainless steel tray. Plus and minus 10 mesh fractions were weighed. Results are shown in Table 23.

5.3.6 Discussion

Screen analysis of minus 10-mesh and minus 36-mesh materials did not show any marked differences in iron content of the various fractions.

Wet magnetic separations gave excellent results. Concentrates assaying 67.6% Fe and 68.3% Fe were produced and the corresponding recoveries were 87.1% and 84.5% of the iron contained in the feed.

Dry magnetic separation gave inferior results to those of wet magnetic separation. Grade of concentrate was 55.1% Fe and the recovery was 89.0%.

Heavy liquid separations did not show any marked differences in iron content of the various fractions.

Pelletizing tests indicated that satisfactory pellets can be formed using 0.75-1.0% bentonite and 15-30% moisture.

6. CONCLUSIONS

Sample A is not amenable to magnetic separation but cationic flotation probably could be developed to give satisfactory grade and recovery.

Sample B contains approximately 25% of iron which can be recovered as a marketable magnetic concentrate. Gravity concentration was somewhat inferior. Due to insufficient weight of sample flotation was not investigated. This is the only process considered to have any possibility of recovering the remainder of the iron but the feasibility was not established.

Sample C can be readily upgraded by wet magnetic separation to give a high grade product. The feasibility study utilized a very fine grind and the grades and recoveries reported are probably near maximum possible.

7. RECOMMENDATIONS

Larger quantities of material are required for further investigations on the upgrading of the three iron bearing areas at Greenpatch.

The following recommendations are made:

Sample A. Cationic flotation requires to be extensively examined to determine optimum conditions for grade and recovery.

The investigation should cover

1. mesh of grind
2. collector type and quantity
3. effect of pH
4. effect of circuit variations.

Sample B. Flotation has not been applied to this sample and its feasibility should be examined both for anionic and for cationic systems.
Larger scale work is required on both magnetic and gravity separation to determine the effect of mesh of grind on metallurgical efficiency and to assess the value of each process as a preconcentration stage before flotation.

Sample C. Larger scale tests are required to establish optimum mesh of grind and separation conditions and to confirm feasibility results using equipment more comparable with plant operation.

7. ACKNOWLEDGEMENTS

Most of the experimental work including magnetic separation, Haultain Superpanner tests and pelletizing was conducted by D. J. Stroud.
Heavy liquid separations were carried out by P. C. Lawson.

APPENDIX A

CHEMICAL ANALYSIS OF INDIVIDUAL FOOTAGES IN THE TOTAL DRILL CORES

Chemical analysis of samples representing individual footages from Greenpatch diamond drill cores and identified in the following tabulation are set out in Table A-1.

Identification		
A1422-1461/64	Hole GD2,	33 ft - 430 ft
A1059-1078/64	" GD3,	110 ft - 310 ft
A1079-1086/64	" GD3	310 ft - 383 ft
A1857-1890/64	" GD3	383 ft - 712 ft 6 in.
A1920-1924/64	" GD4	0 - 24 ft
A1717-1744/64	" GD4	24 ft - 291 ft
A1745-1793/64	" GD5	80 ft - 627 ft 8 in.
A1906-1913/64	" GD6	80 ft - 156 ft
A1593-1617/64	" GD6	156 ft - 392 ft
A1914-1919/64	" GD6	392 ft - 441 ft 6 in.
A1794-1814/64	" GD7	60 ft - 270 ft

TABLE A-1: CHEMICAL ANALYSES OF INDIVIDUAL FOOTAGES IN TOTAL DRILL CORES

Sample Mark	Acid Soluble Iron Fe %	Insolubles %	Calcium Ca %	Magnesium Mg %
A1059/64	5.5	39.2	15.5	4.55
A1060	9.25	42.3	13.5	3.25
A1061	12.9	64.8	6.20	0.95
A1062	18.9	54.6	6.75	0.95
A1063	19.2	54.7	6.55	0.40
A1064	20.9	56.8	5.20	0.45
A1065	13.6	57.2	7.70	1.75
A1066	13.5	48.9	9.60	2.55
A1067	16.9	49.3	6.75	1.70
A1068	17.2	53.3	5.90	1.05
A1069	19.5	56.6	5.20	0.80
A1070	19.9	60.2	4.30	0.25
A1071	24.3	56.8	3.10	0.30
A1072	18.4	37.0	10.4	2.70
A1073	19.5	47.1	7.0	1.35
A1074	19.3	50.8	6.55	1.35
A1075	21.5	51.0	6.05	0.95
A1076	17.9	55.2	5.70	1.35
A1077	19.2	47.4	6.90	2.10
A1078	21.1	40.6	8.65	2.50
A1079	21.0	36.2	10.0	2.80
A1080	27.2	33.7	8.85	1.85
A1081	21.7	30.9	11.6	3.10
A1082	29.5	37.5	7.75	0.65
A1422	20.9	65.4	0.03	0.01
A1423	25.2	56.6	nd(a)	0.01
A1424	29.8	50.3	nd	0.01
A1425	24.4	61.0	0.03	0.01
A1426	29.1	51.8	0.04	0.02
A1427	23.6	62.7	0.05	0.01
A1428	20.6	67.1	0.18	0.03
A1429	22.8	56.8	3.80	0.35
A1430	19.1	58.3	4.95	0.65
A1431	15.8	44.0	9.70	2.25
A1432	10.4	47.6	11.0	2.90
A1433	19.4	41.1	9.05	2.50
A1434	20.4	53.2	5.60	1.20
A1435	21.7	51.6	5.30	1.10
A1436	23.7	55.9	3.25	0.65
A1437	24.7	49.2	4.75	1.25

(Contd.)

TABLE A-1: CONTINUED

Sample Mark	Acid Soluble Iron Fe %	Insolubles %	Calcium Ca %	Magnesium Mg %
A1438/64	22.0	38.2	8.95	2.40
A1439	20.2	37.0	9.40	3.20
A1440	19.0	37.7	9.70	3.65
A1441	19.6	44.8	8.40	2.10
A1442	25.8	42.6	6.9	1.25
A1443	13.6	41.2	11.3	3.70
A1444	5.0	63.7	8.2	3.25
A1445	5.1	65.0	8.0	2.80
A1446	5.4	62.4	8.5	3.00
A1447	2.1	82.7	4.6	1.15
A1448	2.0	70.3	7.6	2.95
A1449	1.6	79.0	5.6	1.75
A1450	7.3	18.1	17.9	7.45
A1451	8.3	63.8	7.35	2.10
A1452	4.2	43.6	13.5	5.20
A1453	7.1	59.9	8.10	2.90
A1454	10.9	43.6	10.7	3.75
A1455	9.5	35.8	13.2	5.20
A1456	9.1	55.0	8.95	3.20
A1457	9.3	55.8	8.65	2.60
A1458	13.4	61.6	6.05	1.60
A1459	12.9	45.0	10.6	3.55
A1460	9.3	51.6	10.0	3.35
A1461	8.65	39.3	11.9	5.10
A1083	33.4	37.3	5.70	0.40
A1084	28.6	38.3	7.25	1.05
A1085	25.3	32.7	9.35	2.90
A1086	26.9	38.6	7.60	1.75
A1717	0.91	93.5	nd	0.02
A1718	21.5	59.6	nd	0.02
A1719	18.8	67.2	nd	0.02
A1720	30.2	51.3	nd	0.02
A1721	32.8	43.3	nd	0.02
A1722	34.7	43.9	nd	0.03
A1723	25.4	59.1	nd	0.03
A1724	20.1	64.7	nd	0.04
A1725	18.3	71.4	nd	0.01
A1726	20.2	69.1	nd	0.03
A1727	12.9	80.3	nd	0.01
A1728	23.6	61.8	nd	0.03
A1729	36.4	35.6	nd	0.03

(Contd.)

TABLE A-1: CONTINUED

Sample Mark	Acid Soluble Iron Fe %	Insolubles %	Calcium Ca %	Magnesium Mg %
A1730/64	36.2	42.1	nd	0.03
A1731	22.2	64.4	nd	0.03
A1732	4.7	92.0	nd	0.01
A1733	20.1	67.1	nd	0.03
A1734	2.15	96.3	nd	0.01
A1735	41.5	33.1	nd	0.03
A1736	32.7	46.3	nd	0.03
A1737	29.9	50.9	nd	0.01
A1738	21.3	63.5	nd	0.01
A1739	39.3	32.5	nd	0.02
A1740	14.1	65.6	0.24	0.26
A1741	24.2	54.3	0.22	0.34
A1742	18.0	55.0	0.17	0.84
A1743	4.25	81.7	1.75	0.05
A1744	5.35	89.4	nd	0.05
A1593	18.0	56.5	4.55	0.80
A1594	22.6	54.9	3.65	0.80
A1595	19.9	55.5	5.40	0.60
A1596	20.8	56.4	4.30	0.60
A1597	21.1	55.9	4.10	0.60
A1598	23.9	51.5	4.75	0.55
A1599	23.1	46.9	6.15	1.10
A1600	18.5	38.2	9.95	2.75
A1601	21.5	37.4	9.85	2.10
A1602	22.9	42.6	8.65	0.95
A1603	30.1	38.3	6.70	0.45
A1604	21.5	42.3	7.90	1.45
A1605	26.7	39.4	6.50	1.00
A1606	16.5	44.1	8.65	2.20
A1607	8.2	61.5	6.05	3.15
A1608	5.4	76.6	2.25	2.05
A1609	12.7	60.1	5.20	2.20
A1610	1.15	93.0	1.05	0.50
A1611	10.0	81.2	1.20	0.10
A1612	14.0	73.0	2.35	0.30
A1613	17.5	52.1	6.80	1.65
A1614	17.0	51.7	7.45	1.75
A1615	9.25	76.2	3.65	0.10
A1616	16.4	58.3	5.80	1.10
A1617	20.2	58.8	3.95	0.70
A1745	5.9	82.8	0.01	0.25
A1746	15.8	65.0	0.04	0.15

(Contd.)

TABLE A-1: CONTINUED

Sample Mark	Acid Soluble Iron Fe %	Insolubles %	Calcium Ca %	Magnesium Mg %
A1747/64	16.8	62.3	0.16	0.15
A1748	14.3	66.4	0.20	0.14
A1749	12.3	70.4	0.01	0.11
A1750	27.2	55.0	0.18	0.12
A1751	30.3	50.0	0.30	0.14
A1752	26.8	56.8	0.22	0.10
A1753	2.55	89.5	0.22	0.03
A1754	5.55	81.8	0.13	0.66
A1755	30.1	38.5	0.65	0.35
A1756	19.7	56.3	0.45	0.35
A1757	32.9	27.7	0.85	0.35
A1758	22.3	42.3	1.90	1.15
A1759	35.1	22.1	1.05	0.65
A1760	35.0	20.8	1.20	0.85
A1761	37.4	19.8	1.45	1.10
A1762	29.3	41.9	1.20	0.90
A1763	32.6	30.6	1.65	1.30
A1764	23.2	33.7	4.75	2.35
A1765	20.1	51.8	2.75	1.25
A1766	14.3	32.2	11.1	3.95
A1767	6.90	27.8	15.9	6.8
A1768	7.95	3.8	18.7	9.2
A1769	7.55	9.0	17.1	8.8
A1770	30.8	30.0	1.05	0.45
A1771	32.0	20.7	2.35	0.35
A1772	33.0	25.0	0.85	1.15
A1773	34.9	26.5	0.85	0.70
A1774	20.7	44.2	1.40	1.00
A1775	6.75	75.4	1.30	0.60
A1776	18.7	53.9	1.50	0.80
A1777	27.1	41.0	1.40	0.70
A1778	14.7	45.5	8.30	2.50
A1779	15.8	51.4	7.80	2.0
A1780	2.15	71.7	8.0	1.45
A1781	7.05	38.0	16.0	3.15
A1782	16.2	56.4	6.05	1.35
A1783	15.2	60.8	5.70	0.75
A1784	22.4	49.7	5.70	1.3
A1785	19.0	60.7	4.1	0.40
A1786	23.2	56.8	3.4	0.4
A1787	18.0	51.2	6.6	1.4
A1788	17.6	51.7	7.1	1.2

(Contd.)

TABLE A-1: CONTINUED

Sample Mark	Acid Soluble Iron Fe %	Insolubles %	Calcium Ca %	Magnesium Mg %
A1789/64	21.1	45.0	7.8	1.4
A1790	24.3	45.6	6.6	1.0
A1791	6.25	75.3	4.9	1.1
A1792	3.75	53.2	11.1	4.4
A1793	18.0	39.0	8.2	3.1
A1794	18.0	66.4	nd	0.03
A1795	27.2	55.3	nd	0.01
A1796	23.8	61.4	nd	0.01
A1797	21.2	66.3	nd	0.01
A1798	36.4	37.7	nd	0.02
A1799	26.1	57.0	nd	0.01
A1800	37.5	40.4	nd	0.02
A1801	36.8	39.9	nd	0.03
A1802	21.0	66.4	nd	0.01
A1803	33.5	34.0	nd	0.25
A1804	20.7	53.3	0.06	0.60
A1805	15.2	62.7	0.06	0.50
A1806	1.28	96.7	nd	0.02
A1807	7.55	87.1	nd	0.01
A1808	9.15	84.1	nd	0.01
A1809	17.3	70.0	nd	0.03
A1810	20.6	64.6	nd	0.03
A1811	5.45	89.6	nd	0.09
A1812	23.7	53.8	nd	0.04
A1813	35.8	40.5	nd	0.06
A1814	4.90	81.4	nd	1.55
A1857	15.3	42.2	10.1	3.10
A1858	4.90	43.2	11.3	5.60
A1859	17.9	45.6	8.6	2.10
A1860	27.1	39.3	7.8	0.90
A1861	21.5	36.7	8.7	2.55
A1862	5.25	43.8	13.1	5.05
A1863	3.50	53.6	11.1	4.50
A1864	2.00	48.7	12.3	5.35
A1865	6.25	44.4	12.3	4.60
A1866	9.35	47.9	10.8	3.70
A1867	8.35	42.5	12.3	4.50
A1868	13.6	48.9	9.0	3.05
A1869	8.05	37.4	13.3	5.65
A1870	4.10	40.9	11.4	4.85
A1871	9.55	54.7	8.90	3.40

(Contd.)

TABLE A-1: CONTINUED

Sample Mark	Acid Soluble Iron Fe %	Insolubles %	Calcium Ca %	Magnesium Mg %
A1872/64	13.0	50.3	8.90	2.90
A1873	5.30	42.2	13.3	5.05
A1874	14.7	55.7	6.30	2.14
A1875	13.0	48.8	9.00	3.05
A1876	9.05	50.4	9.50	3.65
A1877	20.9	58.9	3.70	0.80
A1878	21.1	65.4	1.40	0.50
A1879	29.0	55.9	1.05	0.40
A1880	24.1	63.7	1.00	nd
A1881	16.1	74.1	1.40	nd
A1882	23.3	59.1	3.00	nd
A1883	25.1	56.6	3.10	0.20
A1884	24.2	52.3	4.2	0.50
A1885	11.1	43.0	11.6	3.35
A1886	8.40	31.4	14.7	5.15
A1887	8.10	33.5	14.7	4.80
A1888	9.60	39.7	12.3	3.95
A1889	7.80	28.0	15.1	5.80
A1890	10.2	30.9	14.9	5.25
A1906	14.3	66.3	0.06	0.11
A1907	14.7	68.8	nd	0.10
A1908	20.2	58.0	0.02	0.39
A1909	11.2	70.6	0.29	0.34
A1910	13.4	54.5	1.3	3.15
A1911	25.1	53.7	0.52	0.40
A1912	20.3	63.9	0.52	0.40
A1913	14.1	73.6	1.45	0.35
A1914	23.5	58.8	2.25	0.50
A1915	16.5	69.8	2.25	0.20
A1916	19.0	64.8	2.60	0.40
A1917	16.0	63.4	4.60	0.70
A1918	21.5	55.0	4.50	0.85
A1919	14.8	67.9	3.80	0.50
A1920	37.6	36.9	0.17	0.08
A1921	37.7	37.3	0.04	0.03
A1922	27.3	45.3	nd	0.03
A1923	27.2	42.2	nd	0.05
A1924	26.2	53.8	nd	0.02

(a) nd – indicates not detected.

Analysis by: C.N. Robinson and M.R. Hanckel

Officer in Charge, Analytical Section: T.R. Frost

APPENDIX B

MINERALOGY OF GREENPATCH IRON ORE

Representative portions of four samples were briquetted for mineragraphic examination. The gangue minerals were identified as far as possible from observation under the binocular microscope and their characteristics in reflected light.

Sample A. Iron minerals predominant in this sample are goethite and hematite. These comprise approximately 20 to 30 per cent of the sample. Goethite aggregates contain hematite grains (actually completely martitised magnetite) which have altered to goethite also. In part the goethite is extremely fine-grained and occurs as colloform aggregates encrusting some gangue. Elsewhere it occurs as irregular replacements along grain boundaries and around hematite and in aggregates with siliceous gangue and partly altered hematite. The goethite is extremely fine-grained but aggregates free of gangue and up to 1.0 mm in diameter do occur. Mostly, however, clean goethite aggregates or hematite grains are less than 0.1 mm in diameter. Siliceous gangue comprises approximately 70 per cent of the sample. Graphite, as irregular laths up to 0.13 by 0.05 mm (most are less than 0.05 mm) occurs in trace amounts included in some goethite.

Sample B. Magnetite, which comprises 5 to 10 per cent of the sample, is the only iron mineral present. The grains range in diameter from 0.01 to 0.5 mm and average approximately 0.1 mm. The magnetite occurs as coarser grains interstitial to gangue (carbonate or quartz and ferromagnesian mineral aggregates) or minute inclusions in gangue. Siliceous gangue (50-60%) and carbonate gangue (30-40%) are the major constituents of the sample. Pyrite is present in trace amounts as minute inclusions (less than 0.02 mm diameter) in the carbonate gangue.

Sample C. Magnetite, comprising approximately 10 per cent of the sample, is the predominant iron mineral. It occurs mostly as rounded anhedral grains generally interstitial to or as inclusions in garnet (?), feldspar or quartz gangue. Magnetite is also present as abundant oriented inclusions in some ferromagnesian grains. The magnetite grains range from minute inclusions of 0.01 mm diameter to coarser grains of 0.7 mm diameter. They average 0.05 to 0.1 mm diameter in some fragments and 0.2 mm diameter in others. Some magnetite contains minute spindle-shaped gangue inclusions (max 0.015 by 0.002 mm) which are oriented along crystallographic planes. Gangue minerals, which comprise 80 to 90 per cent of the specimen, are feldspar, quartz, garnet and ferromagnesian minerals. These are generally of similar size or coarser than the magnetite. Pyrite is an accessory present in trace amounts.

Tailings from Sample B from Davis Tube Separations

Minus 300 Mesh. This sample consists predominantly of silicate gangue minerals. Hematite and pyrite are the most abundant opaque minerals present, comprising at the most 10 per cent of the sample. They occur in approximately equal amounts. The maximum grain-size of these two minerals is 0.06 mm; however, the majority of the grains are between 0.03 mm and 0.005 mm in diameter. Grains less than 0.005 mm in diameter are numerous. Hematite is present free or composite with gangue, pyrite occurs free. Chalcopyrite and magnetite occur very rarely as free grains.

Minus 200 Mesh. This sample consists predominantly of silicate gangue and a maximum of 10 per cent of hematite and pyrite. These two minerals occur in approximately equal amounts. Their maximum grain-size is 0.05 mm and most grains are in the range 0.05 to 0.01 mm. Grains less than 0.005 mm in diameter are numerous. Some hematite has obviously formed by alteration of magnetite. Hematite is present as free or composite grains. Pyrite is generally free. Chalcopyrite and magnetite are rare free grains.

Although hematite and pyrite grains less than 0.005 mm in diameter are abundant in these samples, they would comprise only a small proportion by weight of the total amount of these minerals.

Investigation and Report by: D.E. Ayres

Officer in Charge, Mineralogy Section: H.W. Fander

APPENDIX C

QUALITATIVE ANALYSIS BY EMISSION SPECTROGRAPHY OF SAMPLES B AND C

Qualitative analysis of Samples B and C by emission spectrography gave the results set out in Table C-1.

TABLE C-1: QUALITATIVE ANALYSIS BY EMISSION SPECTROGRAPHY

Approximate Ranges	Sample B	Sample C
Major components	Si, Fe	Si, Fe
Minor components	Ca, Mg	Ca, Mg, Mn
Heavy trace 0.1-1%	Na, K, Al, Mn	K, Al
Trace 0.01-0.1%	---	Na
Faint trace 0.001-0.01%	Li, Rb, Cu, Pb, Zn, Ni, Be, Zr, Ti, Ba, Y, B	Li, Cu, Pb, Zn, Ni Zr, Ti, Ba, Sr, Y, B
Very faint trace 0.0001-0.001%	Co, Mo, Sn, Bi, Ge, Sr, Cr, V	Co, Be, Mo, Sn, Bi, Ga, Ge, Cr, V

Note: Element not sought - P

Other elements not detected at limits quoted in attached sheet.

Spectrographic Analysis by: G. R. Holden

Officer in Charge, Analytical Section: T. R. Frost

SPECTROGRAPHIC ANALYSES

Detection-Limit Concentrations of Elements
DC Arc Excitation

Element	%	ppm	Element	%	ppm
Ag	0.00005	0.5	Na	0.00005	0.5
Al	0.0002	2	Nb	0.003	30
As	0.01	100	Nd	0.001	10
Au	0.001	10	Ni	0.0002	2
B	0.001	10	Os	0.005	50
Ba	0.0002	2	P	0.02	200
Be	0.0005	5	Pb	0.0002	2
Bi	0.0005	5	Pd	0.001	10
Ca	0.0002	2	Pr	0.001	10
Cd	0.001	10	Pt	0.005	50
Ce	0.04	400	Rb	0.0001	1
Co	0.0002	2	Re	0.01	100
Cr	0.0001	1	Rh	0.001	10
Cs	0.0002	2	Ru	0.001	10
Cu	0.00005	0.5	Sb	0.002	20
Dy	0.001	10	Sc	0.0002	2
Er	0.001	10	Si	0.002	20
Eu	0.001	10	Sm	0.05	500
Fe	0.0005	5	Sn	0.001	10
Ga	0.0003	3	Sr	0.0001	1
Gd	0.02	200	Ta	0.01	100
Ge	0.0002	2	Tb	0.001	10
Hf	0.01	100	Te	0.02	200
Hg	0.01	100	Th	0.01	100
Ho	0.001	10	Ti	0.001	10
In	0.0001	1	Tl	0.0001	1
Ir	0.005	50	Tm	0.001	10
K	0.0002	2	U	0.02	200
La	0.001	10	V	0.0005	5
Li	0.0001	1	W	0.005	50
Lu	0.001	10	Y	0.001	10
Mg	0.0002	2	Yb	0.001	10
Mn	0.001	10	Zn	0.0025	25
Mo	0.0005	5	Zr	0.001	10

TABLES 1 TO 23

FIGURES 1 TO 3

TABLE 1: SCREEN ANALYSIS OF FLOTATION FEED
Sample A

Nominal Aperture μ	Mesh BSS	Weight %	Analysis Fe, %	Distribution Fe, %
+ 125	+ 120	0.3	17.4	0.8
- 125 + 90	- 120 + 170	1.1		
- 90 + 63	- 170 + 240	18.5	24.0	14.8
- 63 + 45	- 240 + 350	18.0	27.1	6.5
- 45	- 350	62.1	32.1	67.9
Feed		100.0	29.5	100.0

TABLE 2: RESULTS OF WET MAGNETIC SEPARATION
Sample A

Product	Weight %	Analysis Fe, %	Distribution Fe, %
Magnetic	45.2	41.4	64.1
Non-magnetic	37.3	13.3	17.1
Slimes	17.5	31.3	18.8
Feed	100.0	29.2	100.0

TABLE 3: HAULTAIN SUPERPANNER TEST
Sample A

Product	Weight %	Analysis Fe, %	Distribution Fe, %
Heavy	21.5	61.9	46.9
Middling	9.1	33.5	11.1
Light	30.2	6.7	7.6
Slime	39.2	31.7	34.4
Feed	100.0	28.9	100.0

TABLE 4: FLOTATION TESTS
Sample A

Reagent Type	Reagent lb/ton	Reagent Addition	Product	Weight %	Analysis Fe, %	Distribution Fe, %
Collector A	4.0	cell	Recleaner concentrate	11.4	49.2	18.7
			Recleaner tailing	21.0	34.9	24.6
			Cleaner tailing	39.6	26.5	35.4
			Rougher tailing	28.0	22.4	21.3
			Feed	100.0	29.7	100.0
Collector A	4.0	mill	Recleaner concentrate	13.2	54.0	24.3
			Recleaner tailing	29.6	38.1	38.6
			Cleaner tailing	25.0	22.5	19.3
			Rougher tailing	32.2	16.1	17.8
			Feed	100.0	29.2	100.0
Collector B	6.0	mill	4th cleaner concentrate	11.8	54.6	21.8
			4th cleaner tailing	28.6	36.0	34.8
			3rd cleaner tailing	18.7	24.0	15.2
			2nd cleaner tailing	6.4	29.1	6.3
			1st cleaner tailing	17.9	20.8	12.6
			Rougher tailing	16.6	16.5	9.3
			Feed	100.0	29.6	100.0
Duomeen S	2.75[(a)]	cell	Slimes	6.5	30.8	6.7
Aerofroth 65	0.2		Concentrate 1	6.4	29.9	8.5
			Concentrate 2	2.0		
			Concentrate 3	7.1	30.6	7.3
			Concentrate 4	39.0	8.6	11.7
			Concentrate 5	12.6	26.4	11.4
			Rougher tailing	26.4	60.7	54.4
			Feed	100.0	29.5	100.0

(a) Stagewise added in five amounts (approximately 0.26 lb/ton).

TABLE 5: PELLET FORMATION
Sample A

Test No.	Moisture Content %	Bentonite Addition Weight, %	Observation
1	5	0.1	No pelletizing
2	15	0.1	No pettletizing
3	30	0.1	Weak pellets
4	5	0.5	Little pelletizing
5	15	0.5	Better pelletizing
6	30	0.5	Weak pelletizing
7	5	1.0	Little pelletizing
8	15	1.0	Good pellets
9	30	1.0	Good pellets

TABLE 6: ABRASION AND IMPACT TEST RESULTS
Sample A

Test Method	Particle Size Mesh	Test 3[(a)]	Test 6	Test 9
Abrasion	+ 36	13.3	19.1	55.0
	- 36	86.7	80.9	45.0
Impact	+ 10	69.9	86.6	89.8
	- 10	30.1	13.4	10.2

(a) Refer to Table 5.

TABLE 7: SIZE-DISTRIBUTION OF GROUND PRODUCTS
Sample B

Nominal Aperture μ	Mesh BSS	Minus 10-Mesh Material		Minus 36-Mesh Material	
		Weight %	Cumulative Weight, %	Weight %	Cumulative Weight, %
+ 1670	+ 10	3.8	3.8	-	-
- 1670 + 1200	- 10 + 14	8.8	12.6	-	-
- 1200 + 850	- 14 + 18	15.1	27.7	-	-
- 850 + 600	- 18 + 25	15.0	42.7	-	-
- 600 + 420	- 25 + 36	10.0	52.7	-	-
- 420 + 300	- 36 + 52	7.6	60.3	18.9	18.9
- 300 + 211	- 52 + 72	7.4	67.7	15.8	34.7
- 211 + 152	- 72 + 100	5.2	72.9	11.3	46.0
- 152 + 105	- 100 + 150	7.2	80.1	14.4	60.4
- 105 + 76	- 150 + 200	3.0	83.1	5.8	66.2
- 76 + 53	- 200 + 300	3.6	86.7	6.9	73.1
- 53	- 300	13.3	100.0	26.9	100.0
		100.0		100.0	

TABLE 8: SCREEN ANALYSIS
Sample B

Nominal Aperture μ	Mesh BSS	Weight %	Analysis Fe, %	Distribution Fe, %
	Minus 10-Mesh Material			
- 1670 + 1200	- 10 + 14	12.6	27.3	12.2
- 1200 + 1600	- 14 + 36	30.1	28.7	29.6
- 600 + 211	- 36 + 72	25.0	29.4	25.1
- 211 + 53	- 72 + 300	19.0	30.0	19.5
- 53	- 300	13.3	29.9	13.6
Feed		100.0	29.2	100.0
	Minus 36-Mesh Material			
- 420 + 211	- 36 + 72	34.7	28.7	34.5
- 211 + 53	- 72 + 300	38.4	28.0	37.3
- 53	- 300	26.9	30.3	28.2
Feed		100.0	28.9	100.0

TABLE 9: MAGNETIC SEPARATION
Sample B

Feed Mesh	Product	Weight %	Analysis Fe, %	Distribution Fe, %
- 200	Magnetic	10.8	66.9	25.6
	Non-magnetic	89.2	23.9	74.4
	Feed	100.0	28.4	100.0
- 300	Magnetic	10.5	66.4	24.2
	Non-magnetic	89.5	24.4	75.8
	Feed	100.0	28.8	100.0

TABLE 10: HEAVY LIQUID SEPARATION
Sample B - Minus 10 mesh

Nominal Aperture μ	Mesh BSS	Fraction	Weight %	Fe %	Distribution Fe, %
- 1670 + 1200	- 10 + 14	Heavy	75.7	34.3	95.3
		Light	24.3	5.3	4.7
		Feed (calc)	-	27.3	100.0
- 1200 + 600	- 14 + 25	Heavy	85.5	32.7	97.6
		Light	14.5	4.7	2.4
		Feed (calc)	-	28.7	100.0
- 600 + 211	- 25 + 72	Heavy	75.0	37.8	96.6
		Light	25.0	4.05	3.4
		Feed (calc)	-	29.4	100.0
- 211 + 53	- 72 + 300	Heavy	68.1	41.2	96.6
		Light	31.9	2.95	3.4
		Feed (calc)	-	30.0	100.0
- 53 +	- 300	Heavy	99.67	30.0	99.8
		Light	0.33	11.7	0.2
		Feed (calc)	-	29.9	100.0

TABLE 11: HEAVY LIQUID SEPARATION
Sample B - Minus 36 mesh

Nominal Aperture μ	Mesh BSS	Fraction	Weight	Fe %	Distribution Fe, %
- 420 + 211	- 36 + 72	Heavy	74.4	37.3	96.8
		Light	25.6	3.55	3.2
		Feed (calc)	-	28.7	100.0
- 211 + 53	- 72 + 300	Heavy	68.4	39.6	96.7
		Light	31.6	3.0	3.3
		Feed (calc)	-	18.0	100.0
- 53	- 300	Heavy	99.56	30.4	99.9
		Light	0.44	8.75	0.1
		Feed (calc)	-	30.3	100.0

TABLE 12: HAULTAIN SUPERPANNER TESTS
Sample B

Particle Size	Product	Weight %	Analysis Fe, %	Disbribution Fe, %
- 72 + 150	Heavy	4.6	54.5	9.0
	Middling	77.2	31.3	86.6
	Light	18.2	6.7	4.4
	Feed	100.0	27.9	100.0
- 150 + 300	Heavy	11.5	62.6	24.9
	Middling	65.3	30.3	68.4
	Light	23.2	8.3	6.7
	Feed	23.2	29.0	100.0
- 300	Heavy	7.8	63.6	16.6
	Middling	52.4	28.5	50.0
	Light	39.8	25.2	33.4
	Feed	100.0	29.9	100.0

TABLE 13: PELLET FORMATION
Sample B

Test	Moisture Content %	Bentonite Addition Weight, %	Observations
10	5	0.1	Very little effect
11	15	0.1	No rolling
12	30	0.1	No rolling
13	5	0.5	Little pelletizing
14	15	0.5	Small pellets only
15	30	0.5	Weak pellets
16	5	1.0	No pelletizing
17	15	1.0	Good pellets
18	30	1.0	Good pellets

TABLE 14: ABRASION AND IMPACT TEST RESULTS
Sample B

Method	Particle Size Mesh	Test 17	Test 18
Abrasion	+ 36	16.0	69.5
	- 36	84.0	30.5
Impact	+ 10	40.0	90.2
	- 10	60.0	9.8

TABLE 15: SIZE DISTRIBUTION OF GROUND PRODUCTS
Sample C

Nominal Aperture μ .	Mesh BSS	Minus 10-Mesh Material Weight %	Minus 10-Mesh Material Cumulative Weight, %	Minus 36-Mesh Material Weight %	Minus 36-Mesh Material Cumulative Weight, %
+ 1670	+ 10	5.5	5.5	-	-
- 1670 + 1200	- 10 + 14	14.9	20.4	-	-
- 1200 + 850	- 14 + 18	17.9	38.3	-	-
- 850 + 600	- 18 + 25	13.2	51.5	-	-
- 600 + 420	- 25 + 36	8.4	59.9	-	-
- 420 + 300	- 36 + 52	6.4	66.3	17.4	17.4
- 300 + 211	- 52 + 72	6.0	72.3	18.8	36.2
- 211 + 152	- 72 + 100	4.8	77.1	11.7	47.9
- 152 + 105	- 100 + 150	6.6	83.7	15.4	63.3
- 105 + 76	- 150 + 200	2.9	86.6	6.4	69.7
- 76 + 53	- 200 + 300	3.6	90.2	7.6	77.3
- 53	- 300	9.8	100.0	22.7	100.0
		100.0		100.0	

TABLE 16: SCREEN ANALYSIS
Sample C

Nominal Aperture	Mesh BSS	Weight %	Analysis Fe, %	Distribution Fe, %
	Minus 10-Mesh Material			
- 1670 + 1200	- 10 + 14	20.4	19.2	19.4
- 1200 + 600	- 14 + 25	31.1	19.1	29.5
- 600 + 211	- 25 + 72	20.8	19.5	20.3
- 211 + 53	- 72 + 300	17.9	22.9	20.4
- 53	- 300	9.8	20.5	10.4
Feed		100.0	20.0	100.0
	Minus 36-Mesh Material			
- 420 + 211	- 36 + 72	36.2	19.0	34.3
- 211 + 53	- 72 + 300	41.1	21.0	43.1
- 53	- 300	22.7	19.9	22.6
Feed		100.0	20.0	100.0

TABLE 17: WET MAGNETIC SEPARATION
Davis Tube Test Results
Sample C - First Run

Test	Product	Amp	Weight			Assay	Recovery, Fe	
			gram	Test Recovery %	Overall Recovery %	Fe %	Test %	Overall %
T 1	Magnetic	0.5	81.7	81.7	81.7	23.6	96.8	96.8
	Non-magnetic	(1900 gauss)	18.3	18.3	18.3	3.45	3.2	3.2
	Feed		100.0	100.0	100.0	19.9	100.0	100.0
T 3	Magnetic	2.0	19.3	64.8	52.9	34.4	95.0	91.9
	Non-magnetic	(7000 gauss)	10.5	35.2	28.8	3.34	5.0	4.9
	Feed		29.8	100.0	81.7	23.5	100.0	96.8
T 7	Magnetic	1.3	10.4	56.8	30.0	58.6	96.1	88.3
	Non-magnetic	(5000 gauss)	7.9	43.2	22.9	3.16	3.9	3.6
	Feed		18.3	100.0	52.9	34.4	100.0	91.9
T11	Magnetic	0.5	8.7	85.3	25.6	67.6	98.7	87.1
	Non-magnetic	(1900 gauss)	1.5	14.7	4.4	5.3	1.3	1.2
	Feed		10.2	100.0	30.0	58.6	100.0	88.3

TABLE 18: WET MAGNETIC SEPARATION
Davis Tube Test Results
Sample C - Second Run

Test No.	Product	Amp	Weight			Assay Fe		
			gram	Test Recovery %	Overall Recovery %	%	Test %	Overall %
T 1	Magnetic	0.5	81.7	81.7	81.7	23.6	96.8	96.8
	Non-magnetic		18.3	18.3	18.3	3.45	3.2	3.2
	Feed		100.0	100.0	100.0	19.9	100.0	100.0
T 5	Magnetic	3.0	19.8	66.0	53.9	34.2	95.7	92.6
	Non-magnetic		10.2	34.0	27.8	3.08	4.3	4.2
	Feed		30.0	100.0	81.7	23.6	100.0	96.8
T 9	Magnetic	2.0	11.1	53.7	29.0	58.7	92.4	85.5
	Non-magnetic		9.6	46.3	24.9	5.38	7.6	7.1
	Feed		20.7	100.0	53.9	34.2	100.0	92.6
T15	Magnetic	1.3	9.0	84.9	24.9	68.3	98.9	84.5
	Non-magnetic		1.6	15.1	4.4	3.98	1.1	1.0
	Feed		10.6	100.0	29.0	58.7	100.0	85.5

TABLE 19: DRY MAGNETIC SEPARATION
Stearns Disc Separator Test Results
Sample C

Test No.	Product	Amp	Weight			Assay Fe	Recovery, Fe	
			gram	Test Recovery %	Overall Recovery %	%	Test %	Overall %
31	Magnetic	1.25	3156	94.85	94.85	20.85	99.4	99.4
	Non-magnetic		177	5.15	5.15	2.4	0.6	0.6
	Feed		3333	100.00	100.00	19.9	100.0	100.0
33	Magnetic	0.25	1653	60.1	56.95	32.6	93.9	93.4
	Non-magnetic		1093	39.9	37.9	3.2	6.1	6.0
	Feed		2746	100.0	94.85	20.85	100.0	99.4
35	Magnetic	0.25	814	65.1	37.05	48.8	97.6	91.0
	Non-magnetic		436	34.9	19.9	3.2	2.4	2.4
	Feed		1250	100.0	56.95	32.6	100.0	93.4
39	Magnetic	0.25	608	86.8	32.15	55.1	98.0	89.0
	Non-magnetic		92	13.2	4.9	7.4	2.0	2.0
	Feed		700	100.0	37.05	48.8	100.0	91.0

TABLE 20: HEAVY LIQUID SEPARATION
Sample C - Minus 10-Mesh

Nominal Aperture μ	Mesh BSS	Fraction	Weight %	Fe %	Distribution Fe, %
- 1670 + 1200	- 10 + 14	Heavy	84.1	21.6	95.0
		Light	15.9	5.95	5.0
		Feed (calc)	-	19.2	100.0
- 1200 + 600	- 14 + 25	Heavy	83.5	21.8	95.3
		Light	16.5	5.35	4.7
		Feed (calc)	-	19.1	100.0
- 600 + 211	- 25 + 72	Heavy	84.5	22.3	96.5
		Light	15.5	4.35	3.5
		Feed (calc)	-	19.5	100.0
- 211 + 53	- 72 + 300	Heavy	69.8	31.8	97.1
		Light	30.2	2.25	2.9
		Feed (calc)	-	22.9	100.0
- 53	- 300	Heavy	99.25	20.6	99.95
		Light	0.75	2.65	0.05
		Feed (calc)	-	20.5	100.0

TABLE 21: HEAVY LIQUID SEPARATION
Sample C - Minus 36-Mesh

Nominal Aperture μ	Mesh BSS	Fraction	Weight %	Fe %	Distribution Fe, %
- 420 + 211	- 36 + 72	Heavy	75.9	23.8	95.2
		Light	24.1	3.9	4.8
		Feed	-	19.0	100.0
- 211 + 53	- 72 + 300	Heavy	67.3	30.0	95.5
		Light	32.7	2.5	4.5
		Feed	-	21.0	100.0
- 53	- 300	Heavy	98.97	20.1	99.8
		Light	1.03	2.85	0.2
		Feed	-	19.9	100.0

TABLE 22: PELLET FORMATION
Sample C

Test No.	Moisture Content %	Bentonite Addition Weight, %	Observations
19	5	0.1	Very little pelletizing
20	15	0.5	Good appearance and size
21	30	1.0	Wet surface
22	5	0.1	Small pellets only
23	15	0.5	Good appearance and size
24	30	1.0	Good appearance and size
25	5	0.1	No pelletizing
26	15	0.5	Good appearance
27	30	1.0	Good appearance

TABLE 23: ABRASION AND IMPACT TEST RESULTS
Sample C

Method	Particle Size Mesh	Test 20	Test 24	Test 26
Abrasion	+ 36	33.3	59.8	75.1
	- 36	66.7	40.2	24.9
Impact	+ 10	48.2	82.2	90.9
	- 10	51.8	17.8	9.1

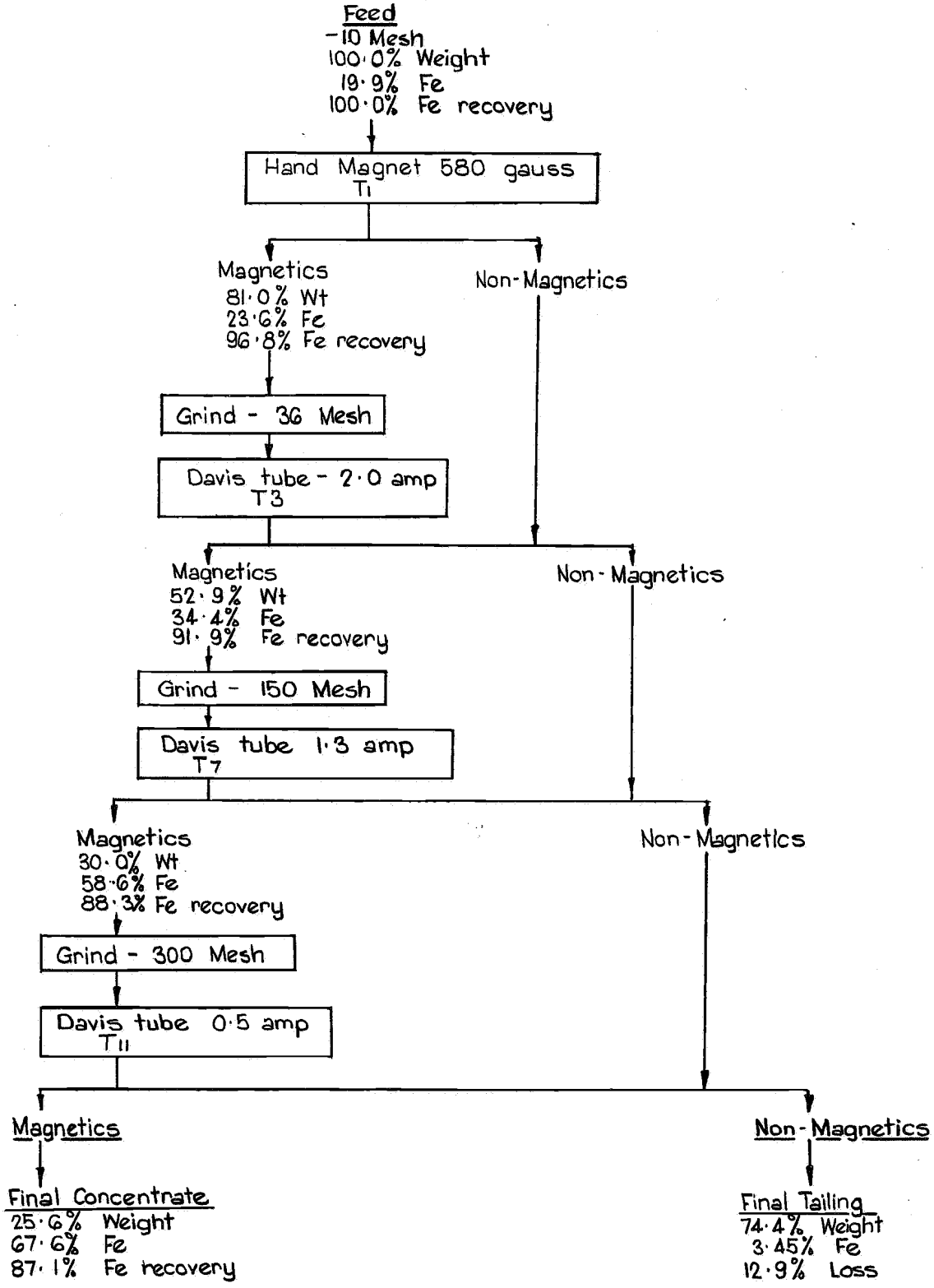

FIG. 1: WET MAGNETIC SEPARATION OPERATION FLOWSHEET
Sample C — First Run

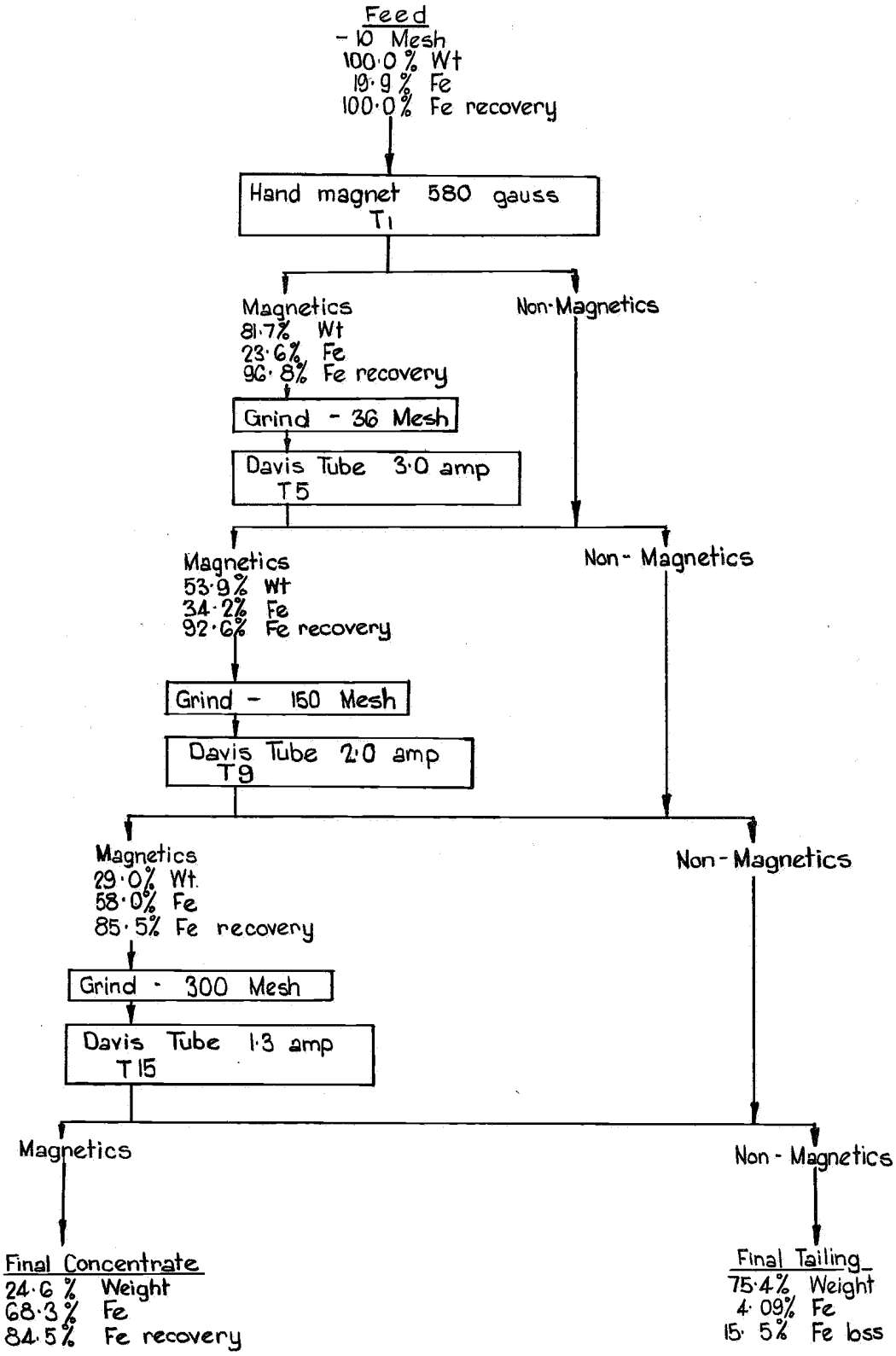

FIG. 2: WET MAGNETIC SEPARATION OPERATION FLOWSHEET
Sample C — Second Run

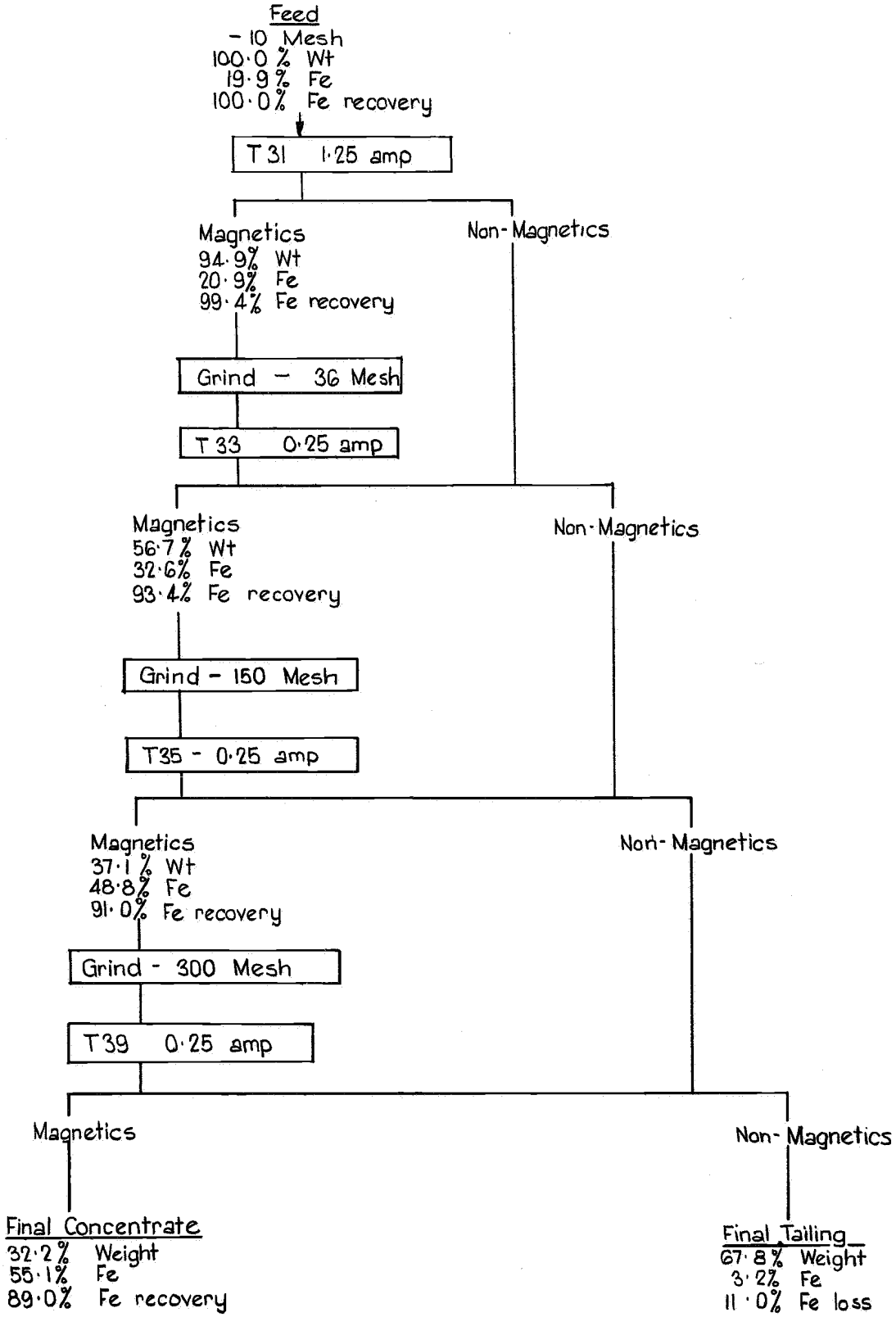

FIG. 3: STEARNS DISC DRY MAGNETIC SEPARATION OPERATION FLOWSHEET
Sample C