Australian Abrasive Minerals Pty Ltd (AAM)

Harts Range Garnet Project

Project Bi-Product Investigation

Project 5497
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1 EXECUTIVE SUMMARY

During the course of the Harts Range Garnet project development, it was identified that further potentially economic minerals and grade fractions were geologically present in situ.

Australian Abrasive Minerals approached Independent Metallurgical Operations (IMO) to undertake a testwork program in order to identify and indeed quantify which minerals components could be metallurgically upgraded to a probable market specification and how much could be produced per annum.

It was also requested by AAM that the feed ore and heavy mineral concentrate characteristics be updated from this test program as per the below comparison table.

Component	**Feasibility Study**	**Bi-Product Test Program**	**IMO Recommended Figures**
Feed Ore			
Clay	15 %	8 %	12 %
Oversize	7 %	23.5 %	10 %
Quartz (rejects)	33 %	35.5 %	36 %
Heavy Mineral	45 %	33 %	42 %
Total	100 %	100 %	100 %
Heavy Mineral Concentrate			
Garnet A Grade	3.90 %	3.8 %	4 %
Garnet B Grade	5.65 %	7.4 %	6 %
Garnet C Grade	12.52 %	13.8-16.0 %	15 %
Garnet D Grade	3.93 %	5.8 %	5 %
AMH	69.0 %	62.18 %	65 %
Ilmenite	2-5 %	4.01 %	4 %
Magnetite	N/A	0.8 %	1 %
Total	100 %	100 %	100 %

It must be stated that the Feasibility sample mass was far greater (12.5 t) than the 400 kg utilised in this diagnostic program. For this reason, IMO deem the test sample unrepresentative in respect to the coarse rejects mass percentage and the recommended actual produciton percentages are heavily weighted towards the feasibility figures. This in turn directly effects the “actual” heavy mineral content reported within the overall feed, thus the weighting towards the feasibility numbers.

“D” grade was not fully characterised in the feasibility given the 250 um cut-off applied, what was estimated didn’t fully investigate the tailings size distribution, given there was no market at that time – fully warranted. A considerable amount of garnet resides within this stream, and whilst the recovery to final grade was not realised in this program, the potential to recover a product has been proven.

The IMO spiralling rejected considerable more AMH in the primary stage, albeit with a loss of garnet recovery (6-8 %). This resulted in a higher grade garnet within the collected heavy minerals concentrate which is to be expected, thus the discrepancy in total garnet in HM observed.

It does however display that by manipulating the hydrosizers operating line, more “C” grade garnet can be produced than previously expected, particularly around the lower 250 um limit.

Annual Production

The below table summary displays the minerals that were identified to upgrade using minimal alteration to the current Harts Range process flowsheet and the estimated annual production figures for each.

Mineral	Product size	Testwork Results (tpa)	IMO Production Projection (tpa)
Fine Magnetite	-250 µm, +45 µm	371	371
Coarse Magnetite	-425 µm, +250 µm	950	950
Fine Ilmenite	-250 µm, +125 µm	3100	3100
Coarse Ilmenite	-425 µm, +250 µm	7500	7500
“D” Grade Garnet	-250 µm, +125 µm	4560	9-10,000
Garnet Blend	-425 µm, +250 µm	51,000	>250,000

The above reported figures have been generated using the Feasibility Study plant availability of 85 %. IMO deem this as a conservative operating figure for this style of plant and estimate a further 10 % can be achieved in a well managed, steady state operation.

The basis for the above assessments can be viewed in of this report, titled Metallurgical and Market Interpretation and Appendix C, Mass Balance and Product Deportment.

2 INTRODUCTION

Independent Metallurgical Operations Pty Ltd (IMO) was requested by Mr Robert Brand of Australian Abrasive Minerals Pty Ltd to conduct testwork to determine the potential to produce a fine garnet (-250+150µm) product from the Harts Range Garnet Project. This will enable potential gains that could be made by generating a by-product from the tails/reject stream to be determined.

The testwork program is designed to determine recoveries and product quality for the production of ilmenite and zircon bi-products also. The project also contains levels of ilmenite and zircon in situ and it has always been presumed these minerals can be produced at marketable grades also.

The Harts Range Garnet Project (Spinifex Ridge) is located approximately 140 kilometres northeast of Alice Springs.

Australian Abrasive Minerals Pty Ltd provided IMO with approximately 500 kg of ROM ore from the Floodplain pit for metallurgical testwork. This sample was delivered to IMO contained within two 44 gallon drums.

2.1 Program Purpose Clarification

It must be clearly stated that the purpose of this investigation was in no way to repeat, nor verify the Feasibility Study performance through the front end of the flowsheet (ie. Spiral recovery of garnet). IMO focused on obtaining a representative -250 um bulk mass from which the bi-product investigation could commence.

Thus the Feasibility Study figures stand and no correlation should be made from the results seen within this report in respect to overall performance. Some commentary is made in comparison to the Feasibility Study figures for reference as to this 500 kg samples representivity in relation to the many tonnes previously treated. Figures reported in the main section of the report are the detailed analysis taken from sub-splits by which assays directly correlate. An overall mass balance on the whole bulk sample is contained in Appendix C. For clarity as to how the test figures have been related to Feasibility Study mass splits for plant production, this detail is shown in Section 8 and the Executive Summary.

The tests displayed below are entirely diagnostic in nature and the grades determined within this report do not entirely reflect the number of stages present within the current design, nor the absolute final quality of product that can be achieved in an optimised operational plant.

Some degree of interpretation from significant industry experience has been utilised in the conclusions contained within this report to correlate the single pass test data in order to provide an indicative real plant performance potential.

3 SCOPE OF WORK

IMO is undertaking the below SOW to determine the potential to produce a fine garnet (-250+150µm) product from the reject tails stream as well as define the recovery and grade of ilmenite and zircon bi-products for project economics confirmation. This work will consist of:

1. Generation of a metallurgical testwork program suitable to determine the potential to produce a fine garnet (-250+150µm) product from the reject tails stream.
2. Management of metallurgical testwork.
3. Update of mineralogy, metallurgical testwork and analytical results as they become available. This will include a brief (embedded in an email) summary.
4. A weekly progress report of IMO and metallurgical testwork activities which includes an IMO reimbursable time summary, metallurgical testwork progress and any critical issues.
5. Final report and detailed analysis of all testwork completed by IMO. This will include a detailed analysis of beneficiation testwork and product chemical and physical properties.

4 METALLURGICAL TESTWORK FLOWSHEET GENERATION

A detailed metallurgical testwork flowsheet used to generate the fine garnet (-250+150µm) product from the reject tails stream in located in APPENDIX A. A simplified flow diagram is detailed in Figure 1.

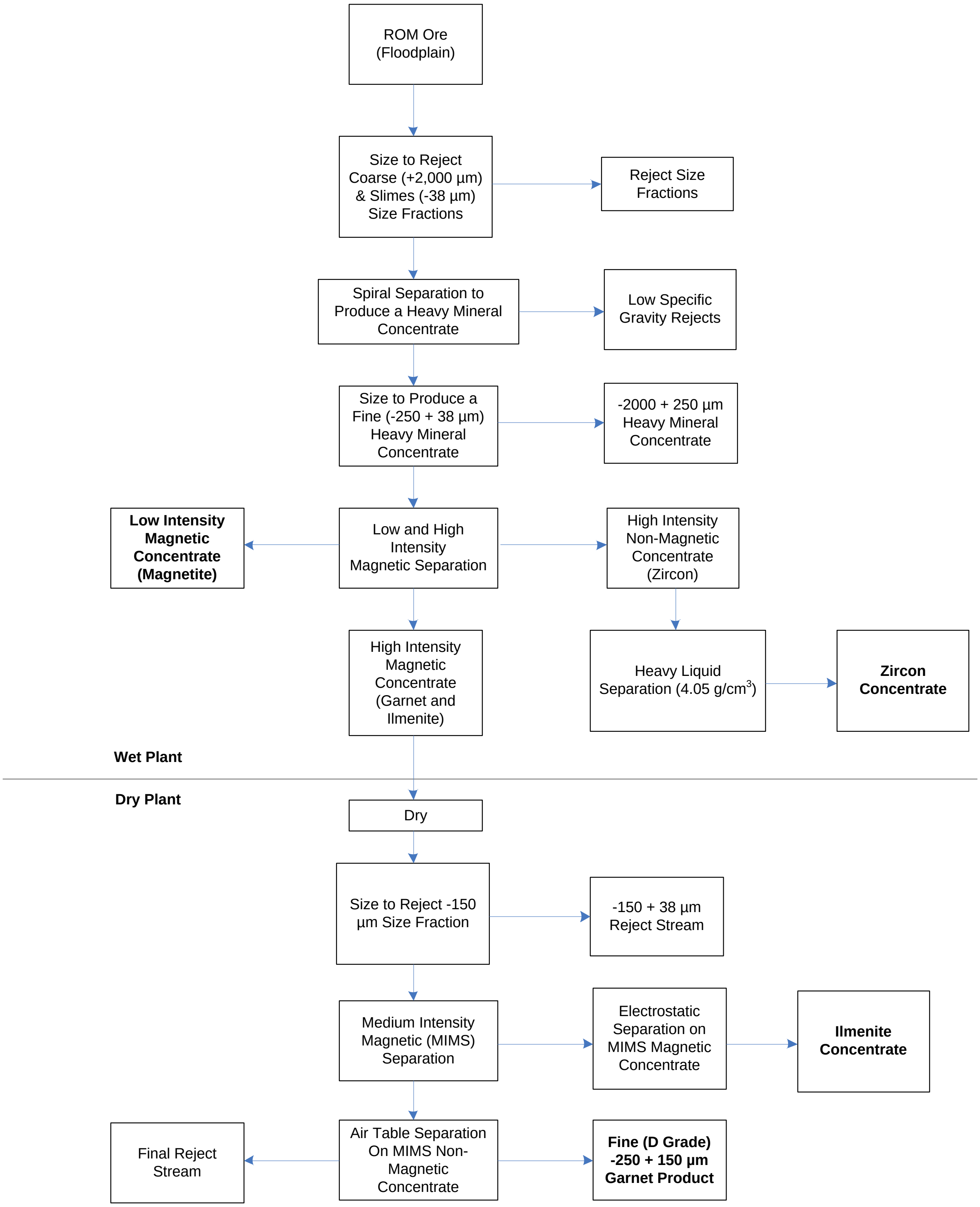

Figure 1 – Testwork Flow Diagram

5 TESTWORK RESULTS – WET PLANT UNIT OPERATIONS

5.1 Sample Preparation

Once the sample had been received and logged, material from both 44 gallon drums was blended to form a homogenous sample. A representative sub-sample was split for a head assay by XRF, mineralogical analysis by XRD and a size by assay analysis.

5.2 Head Assay and Head Size by Assay Results

Selected results from the size by assay results and head assay are detailed in Table 1.

Table 1: Head Size by Assay Results

Size	Mass	TiO_2		Fe_2O_3		ZrO_2		SiO_2		Al_2O_3	
µm	%	Grade (%)	% Dist	Grade (%)	% Dist	Grade (%)	% Dist	Grade (%)	% Dist	Grade (%)	% Dist
6300	11.2	0.52	7.32	5.09	7.65	0.01	4.79	42.2	7.18	7.85	8.22
2000	8.09	0.40	4.08	4.50	4.91	0.02	6.94	72.9	9.00	9.87	7.50
850	13.5	0.36	6.14	5.42	9.88	0.01	5.80	77.9	16.1	8.12	10.3
500	15.5	0.43	8.43	6.92	14.5	0.02	13.3	75.3	17.9	8.60	12.5
300	19.2	0.57	13.8	7.62	19.7	0.02	16.5	70.2	20.6	10.8	19.5
212	12.5	0.98	15.4	9.19	15.5	0.02	10.7	63.5	12.1	12.7	14.9
125	8.44	1.84	19.6	11.0	12.5	0.03	10.9	57.6	7.41	13.5	10.7
45	6.56	2.35	19.4	9.97	8.81	0.08	22.5	59.7	5.97	12.9	7.94
-45	4.99	0.92	5.79	9.81	6.59	0.04	8.56	50.7	3.86	18.0	8.43
Calc. Head	100.0	0.79	100	7.42	100	0.02	100	65.6	100	10.7	100
Assay Head		0.81		7.61		0.02		68.2		10.9	

Results from the size by assay and head assay correlate well with each other.

Individual size fractions from the above analysis were dispatched to Diamantina Laboratories for heavy liquid separation (HLS) prior to conducting grain counting on the sinks fraction. The +6,300 µm material was excluded from this analysis due to the visible high gangue mineral content and the – 45 µm material was excluded due to the material being too fine for HLS separation.

Results from the grain counting on the remaining individual size fractions are detailed in Table 2.

Table 2: Diamantina Grain Counting and HLS Results

Size	Mass	Heavy Minerals (HM)		Garnet in HM		Ilmenite in HM		Zircon in HM	
µm	% Dist	HM%	%Dist	Grade (%)	%Dist	Grade (%)	%Dist	Grade (%)	%Dist
850	17.9	18.3	10.8	40.4	16.3	--	--	--	--
500	20.5	25.3	17.1	35.0	22.4	--	--	--	--
300	25.4	31.0	25.9	29.0	28.0	1.30	17.8	--	--
212	16.5	38.0	20.6	27.3	21.0	0.40	4.36	--	--
125	11.1	47.2	17.3	15.3	9.89	3.20	29.3	1.80	90.5
45	8.66	28.7	8.19	8.20	2.50	11.2	48.5	0.40	9.50
Calc. Head	100.0	30.3	100.0	28.7	100.0	1.72	100.0	0.235	100.0

HLS was also conducted by Metallurgy on a – 2,000 + 150 µm fraction of the head sample. This yielded a HM concentrate mass of 30.4 %. The HLS separation on the – 2,000 + 125 µm fraction detailed in Table 2 resulted in a calculated HM concentrate mass of 30.5 %, almost identical to the Metallurgy result. These results have been used to calculate the run of mine HM grade, which is detailed in Table 3.

Table 3: HM Grades of Ore Fractions

Sample ID	HM Grade (%)
Run-of-mine	23.5
-2.0mm with slimes	26.1
-2.0mm+0.15mm	30.5

An analysis was conducted on the HM concentrate (HLS sinks product) generated by Metallurgy, results are detailed in Table 4

Table 4: Analysis of the Metallurgy – 2mm + 150 µm HLS Sinks (HM Concentrate)

Sample	TiO_2	Fe_2O_3	ZrO_2	SiO_2	Al_2O_3
ID	Grade (%)				
HLS (SG = 2.85 kg/L) Sinks	1.82	21.9	0.03	42.3	14.3

There is a significant difference between the ZrO_2 (zircon) content determined by the grain counting with the calculated zircon grade from the grain counting approximately ten times higher than the assayed (XRF) grade. Ilmenite grades from the grain counting and XRF analysis are comparable.

A photo of the HLS sinks (HM concentrate) is shown in Figure 2.

Figure 2 – -2mm + 150 µm HLS Sinks (HM Concentrate) Fraction wet.

5.3 Size Rejection

All material remaining from the head sampling was dry screened at 2,000 µm prior to the – 2,000 µm material being wet screened at 38 µm to remove the slimes. Material at both + 2,000 µm and - 38 µm is set to be rejected in the full scale plant. Both reject and gravity circuit streams were assayed. Assays and metal recoveries from these streams are detailed in Table 5.

Table 5: Size Separation Assays

Size	Mass	TiO_2		Fe_2O_3		ZrO_2		SiO_2		Al_2O_3	
µm	% Dist	Grade (%)	% Dist	Grade (%)	% Dist	Grade (%)	% Dist	Grade (%)	% Dist	Grade (%)	% Dist
+ 2,000	23.5	0.62	17.4	5.70	17.5	0.02	17.4	66.1	23.1	10.7	22.6
- 2,000 + 38	70.4	0.91	76.3	8.11	74.5	0.03	78.1	69.2	72.3	10.6	67.1
- 38	6.08	0.88	6.37	10.1	8.01	0.02	4.50	51.2	4.62	18.8	10.3
Calc. Head	100	0.84	100	7.66	100	0.03	100	67.4	100	11.1	100

Based on the size by assay and associated grain counting analysis it is expected that rejection of the coarse and fines fractions has upgraded the HM concentration from 23.5 % to 30.3 %.

This separation also enables the subsequent gravity (spiral) concentration to operate more effectively as the size distribution range has been reduced by rejecting the coarse and fine size fractions. If included both size fractions would interfere with the gravity separation and reduce both the HM grade and recovery to the gravity concentrate.

5.4 Wet Gravity Separation

The – 2000 µm + 38 µm fraction was passed over a Mineral Technologies HG3 cleaner spiral. This was conducted in batches of ~ 20 kg solids re-constituted with water to form a ~ 23 % w/w slurry. Once a homogenous slurry was established it was fed over the spiral until it had reached steady state. Once at steady state the concentrate and tailings streams were redirected and collected simultaneously until the solids content of the spiral products was too dilute and spiral performance was insufficient. At this time the product streams were redirected back into the feed tank and the feed tank recharged with – 2000 µm + 38 µm material and the required water volume.

During the spiral separation a survey sample was taken whilst the spiral was deemed to be operating at optimum conditions. Mass flows on the product streams were recorded during this survey and are presented in the tables below. Full assay results from this spiral survey are detailed in Appendix B – Testwork Results.

Table 6: Spiral Mass Flow Calculations

ID	Slurry Mass (t/h)	% Solids (w/w)	Solids Mass (t/h)	Mass % Dist
Con	1.07	52.9	0.56	36.4
Tails	5.58	17.7	0.99	63.6
Calc. Head	6.36	23.3	1.55	100

Table 7: Spiral Recovery Assays

ID	Mass	TiO_2		Fe_2O_3		ZrO_2		SiO_2		Al_2O_3	
	% Dist	Grade (%)	% Dist	Grade (%)	% Dist	Grade (%)	% Dist	Grade (%)	% Dist	Grade (%)	% Dist
Con	36.4	1.47	68.9	17.7	73.8	0.03	63.2	52.4	27.5	14.0	48.6
Tails	63.6	0.38	31.1	3.59	26.2	0.01	36.8	79.1	72.5	8.5	51.4
Calc. Head	100	0.78	100	8.73	100	0.02	100.	69.4	100	10.5	100

Grain counting was conducted on the spiral products to determine the heavy mineral and garnet recoveries and grades to the spiral concentrate. Results from the grain counting of the spiral products are detailed in Table 8.

Table 8: Spiral Recovery Grain Count

ID	Mass	Heavy Mineral		Garnet		Ilmenite		Pyribole	
	% Dist	Grade (%)	% Dist	Grade (%)	% Dist	Grade (%)	% Dist	Grade (%)	% Dist
Con	36.4	64.2	70.9	32.5	91.0	4.10	84.8	62.2	63.6
Tails	63.6	15.1	29.1	7.80	8.95	1.80	15.2	87.0	36.4
Calc. Head	100.0	32.9	100.0	25.3	100.0	3.43	100.0	69.4	100.0

5.5 Size Separation

The spiral concentrate was wet screened at 250 µm to generate a – 250+ 38 µm product for production of a specific "D Grade" garnet product (with further size separation) and to determine what other by products could be produced from this stream.

Table 9: 250 um Screening Distributions

ID	Mass % Dist	TiO_2		Fe_2O_3		ZrO_2		SiO_2		Al_2O_3	
		Grade (%)	% Dist	Grade (%)	% Dist	Grade (%)	% Dist	Grade (%)	% Dist	Grade (%)	% Dist
+250 µm	70.0	1.73	60.9	17.0	75.7	0.04	56.4	52.7	68.3	13.7	72.0
-250 µm	30.0	2.59	39.1	12.7	24.3	0.07	43.6	57.0	31.7	12.4	28.0
Calc. Head	100.0	1.99	100	15.66	100	0.05	100	54.0	100	13.3	100

5.6 Wet Low Intensity and High Intensity Magnetic Separation

The – 250 + 38 µm fraction was passed through a wet low intensity magnetic separation (LIMS, 1200 gauss) unit with the LIMS non-magnetic stream then fed through a wet high intensity magnetic separation (WHIMS) unit. The LIMS magnetic stream was kept separate and assayed. The WHIMS unit produced a magnetic concentrate, middlings stream and non-magnetic stream. Results from the LIMS magnetic separation are detailed in Table 10.

Table 10: LIMS Separation performance

ID	Mass % Dist	TiO_2		Fe_2O_3		ZrO_2		SiO_2		Al_2O_3	
		Grade (%)	% Dist	Grade (%)	% Dist	Grade (%)	% Dist	Grade (%)	% Dist	Grade (%)	% Dist
Mag	0.55	1.59	0.35	92.7	3.91	0.01	0.06	52.7	0.51	13.7	0.61
NM	99.4	2.56	99.7	12.7	96.1	0.07	99.9	57.0	99.5	12.4	99.4
Calc. Head	100	2.55	100	13.1	100	0.07	100	57.0	100	12.4	100

A micrograph on the LIMS magnetic concentrate is illustrated in Figure 3.

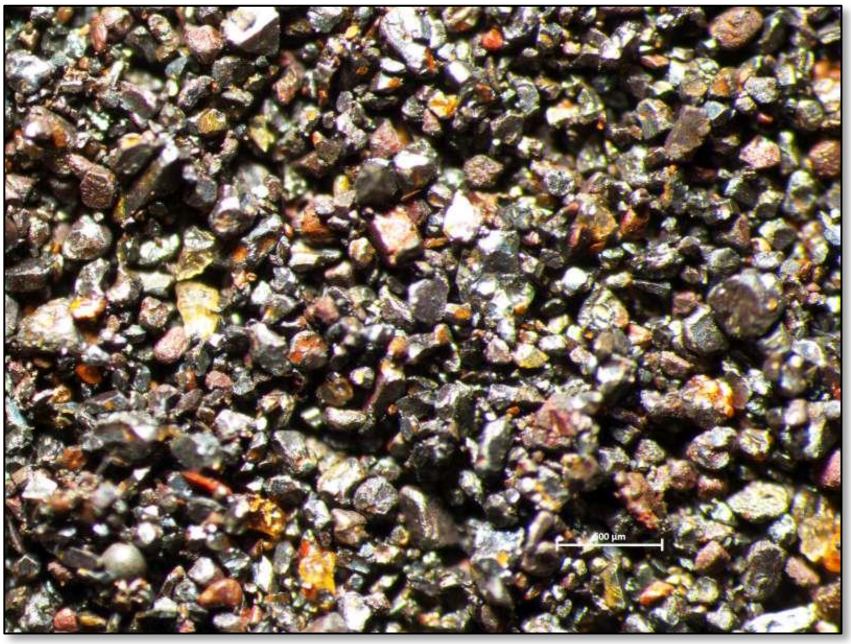

Figure 3 – -250µm + 38 µm magnetic concentrate.

Results from the WHIMS magnetic separation are detailed in Table 11

Table 11: 10,000 Gauss Wet High Intensity Magnetic Separation Assays

ID	Mass	TiO_2		Fe_2O_3		ZrO_2		SiO_2		Al_2O_3	
	% Dist	Grade (%)	% Dist	Grade (%)	% Dist	Grade (%)	% Dist	Grade (%)	% Dist	Grade (%)	% Dist
Mag	52.5	3.55	74.2	17.23	74.0	0.055	40.9	49.6	45.4	12.6	52.7
Mids	26.2	1.57	16.4	9.66	20.7	0.07	27.1	60.7	27.7	12.5	26.2
NM	21.3	1.11	9.42	3.0	5.29	0.11	31.9	72.7	26.9	12.4	21.1
Calc. Head	100	2.51	100	12.23	100	0.07	100	57.4	100	12.5	100

Based on these assays IMO combined the magnetic and middling stream for garnet and ilmenite production and trialled a HLS separation on the non-magnetic stream to determine the possibility of producing a zircon product. Grain counting was conducted on each of these streams to determine the garnet and ilmenite recovery to the WHIMS products with results presented in Table 12

Table 12: 10,000 Gauss Wet High Intensity Magnetic Separation Grain Counting Results

ID	Mass	Heavy Mineral		Garnet		Ilmenite		Pyribole	
	% Dist	Grade (%)	% Dist	Grade (%)	% Dist	Grade (%)	% Dist	Grade (%)	% Dist
Mag	52.5	72.5	70.0	15.5	80.7	14.2	91.8	67.1	66.6
Mids	26.2	48.9	23.6	10.4	18.2	3.10	6.75	78.9	26.4
NM	21.3	16.3	6.38	2.30	1.09	2.40	1.41	78.1	7.06
Calc. Head	100	54.3	100	13.5	100	10.8	100	70.6	100

The grain counting data justified IMO's decision to combine the WHIMS magnetic and middlings streams.

5.7 HLS Separation on WHIMS Non-Magnetic Stream

An attempt was made on the WHIMS to produce a zircon product though given the low ZrO_2 grade of the WHIMS non-magnetic stream a 118 times upgrade would be required to produce a saleable > 65% ZrO_2 grade concentrate. The HLS separation was conducted using a Clorici solution at an SG of 4.05 kg. Results are detailed in Table 13.

Table 13: Non-Mags Heavy Liquid Separation Assays

ID	Mass	TiO_2		Fe_2O_3		ZrO_2		SiO_2		Al_2O_3	
	% Dist	Grade (%)	% Dist	Grade (%)	% Dist	Grade (%)	% Dist	Grade (%)	% Dist	Grade (%)	% Dist
+4.05	0.44	28.2	11.2	31.9	4.44	13.61	62.4	19.0	0.11	4.7	0.17
-4.05	99.6	0.98	88.8	3.0	95.6	0.04	37.6	72.8	99.9	12.4	99.8
Calc. Head	100	1.10	100	3.1	100	0.10	100	72.6	100	12.4	100

Based on the above HLS separation, producing a saleable zircon product would not be possible without multiple unit operations.

5.8 Size Separation

The combined WHIMS magnetic and non-magnetic stream was dry screened at 150 µm to remove the -150 µm material and enable production of a -250 + 150 µm "D Grade" garnet product. Results from the screening are detailed in Table 14.

Table 14: "D" Grade Product Screen Separation Performance

Size (µm)	Mass	TiO_2		Fe_2O_3		ZrO_2		SiO_2		Al_2O_3	
	% Dist	Grade (%)	% Dist	Grade (%)	% Dist	Grade (%)	% Dist	Grade (%)	% Dist	Grade (%)	% Dist
-250 +150	73.3	2.10	52.0	14.3	70.3	0.03	35.6	54.5	74.8	12.8	75.3
-150	26.7	5.34	48.0	16.6	29.7	0.16	64.4	50.3	25.2	11.5	24.7
Calc. Head	100	2.97	100	14.9	100	0.07	100	53.4	100	12.5	100

For all intensive purposes there is no upgrade in respect to the major constituents, only ilmenite and zircon concentrate into the fines fraction.

6 TESTWORK RESULTS – DRY PLANT UNIT OPERATIONS

6.1 Medium Intensity Dry Magnetic Separation

The wet plant material defined as the combined wet magnetic concentrate and middlings is fed to the dry plant. A 3300 Gauss medium intensity dry magnet was used attempt a better ilmenite / garnet separation than that observed in the wet plant. Results are detailed in Table 15.

Table 15: Medium Intensity Dry Magnetic Separation Performance

Size (µm)	Mass	TiO_2		Fe_2O_3		ZrO_2		SiO_2		Al_2O_3	
	% Dist	Grade (%)	% Dist	Grade (%)	% Dist	Grade (%)	% Dist	Grade (%)	% Dist	Grade (%)	% Dist
Mag	1.4	11.55	8.5	34.3	3.7	0.03	1.4	33.9	0.9	10.5	1.2
NM	98.6	1.83	91.5	13.2	96.3	0.03	98.6	55.6	99.1	12.9	98.8
Calc. Head	100	1.97	100	13.5	100	0.03	100	55.3	100	12.8	100

The wet plant 10,000 Gauss magnet only achieved a 2 times upgrade whereas the dry plant magnet achieved a 6 times upgrade in respect to TiO_2 content.

6.2 Electrostatic Separation

A single pass electrostatic separation was conducted to evaluate the further upgrade of ilmenite to product potential. Results are detailed in Table 16.

Table 16: Ilmenite Product Electrostatic Performance

ID	Mass	TiO_2		Fe_2O_3		ZrO_2		SiO_2		Al_2O_3	
	% Dist	Grade (%)	% Dist	Grade (%)	% Dist	Grade (%)	% Dist	Grade (%)	% Dist	Grade (%)	% Dist
Cond 1	16.5	26.3	37.3	62.93	30.0	0.024	12.3	7.1	3.5	2.7	4.3
Cond 2	9.54	23.6	19.4	56.61	15.6	0.02	6.8	12.0	3.4	5.0	4.5
NC	74.0	6.82	43.4	25.4	54.4	0.04	80.8	42.6	93.2	12.9	91.2
Calc. Head	100	11.63	100	34.56	100	0.03	100	33.8	100	10.5	100

It can be observed that a significant upgrade in ilmenite and rejection of gangue silicates was achieved in a single 28,000 V pass. The micrograph of the conductor 1 product is illustrated in Figure 4.

Figure 4 – -250µm + 150 µm Conductor 1 Ilmenite Concentrate.

The final magnetic / electrostatic concentrate grain count figure summary is below. The three primary constituents make up 92 % of the contained mineral.

Table 14 : Ilmenite Product Grain Count Assessment

ID	Garnet	Ilmenite	Hematite/Magnetite
	Grade (%)		
Combined Conductor 1 and 2	4.8	76.6	10.7

6.3 Air Table Separation

The non-magnetic material from the 3300 Gauss separation was forwarded to an air table. Results from the air table separation are detailed in Table 17.

Table 17: Air Table Product Assays

ID	Mass % Dist	TiO_2		Fe_2O_3		ZrO_2		SiO_2		Al_2O_3	
		Grade (%)	% Dist	Grade (%)	% Dist	Grade (%)	% Dist	Grade (%)	% Dist	Grade (%)	% Dist
Con	4.71	8.78	21.7	34.4	11.9	0.17	30.9	31.4	2.70	16.2	5.96
Mids	22.3	2.78	32.5	19.0	31.1	0.03	26.7	46.5	18.9	13.6	23.6
Tails	73.0	1.19	45.8	10.6	57.0	0.02	42.4	58.9	78.4	12.4	70.5
Calc. Head	100	1.90	100	13.61	100	0.03	100	54.8	100	12.8	100

Grain counting was also conducted on each of the air table product streams with results detailed in Table 18.

Table 18: Air Table Product Assays

ID	Mass % Dist	Heavy Mineral		Garnet		Ilmenite		Pyribole	
		Grade (%)	% Dist	Grade (%)	% Dist	Grade (%)	% Dist	Grade (%)	% Dist
Con	4.71	100.0	6.96	60.6	19.9	35.2	35.2	0	0.0
Mids	22.3	100.0	32.9	30.5	47.3	8.60	40.6	53.9	26.6
Tails	73.0	55.7	60.1	11.6	32.9	2.80	24.2	81.5	73.4
Calc. Head	100	67.6	100	21.2	100	6.96	100	66.7	100

A micrograph of the air table concentrate is detailed in Figure 5

Figure 5 – -250µm + 150 µm final Garnet concentrate.

An attempt was made to determine if further garnet product could be generated by re-passing the middlings fraction over the air table. A micrograph of the air table concentrate generated from this test is illustrated in Figure 6. No further analysis was conducted on this stream.

Figure 6 – Scavenger Mids Retreat Feed

7 C Grade (+250 µm, -425 µm) Bi – Product Assessment

As an addendum to the Bi-product Investigation program, a further screening and dry run was conducted to finalise the magnetite, ilmenite and potential garnetblende product yields on the "C" grade size fraction.

Considerable amounts of magnetite and ilmenite are genuine bi-products from the existing system, or designed flowsheet. These as well as garnetblende must be removed in order for the "C" grade garnet to be on sale specification.

The "C" grade test run followed the same path as the intial "D" grade investigation. Results are reported below.

7.1 Screening and Plant Feed

Table 19: Screen distributions A/B Grade and C Grade Feed

ID	Mass	TiO_2		Fe_2O_3		Al_2O_3		SiO_2	
	% Dist	Grade (%)	% Dist	Grade (%)	% Dist	Grade (%)	% Dist	Grade (%)	% Dist
+ 425 µm	29.77	0.917	17.8	25.98	42.28	17.23	36.11	43.01	24.90
- 425 µm	70.23	1.796	82.2	14.91	57.52	12.92	63.89	54.99	75.10

Direct Screening saw 70 % of the coarse material report to the "C" grade fraction. This can be further increased by optimising / manipulating the hydrosizer cut points during operation.

7.2 Magnetic Performance

The magnetic removal of ilmenite was poor during the 3200 guass operation. A further run was conducted at 4400 guass.

The ilmenite removal dramatically increased, however the threshold between ilmenite and garnet separation was broken having recoverd considerable amounts of garnet to the ilmenite concentrate.

The optimum separation point for the magnetic circuit lies in between 3200 and 4400 guass and can be refined by furhter testwork or on the plant during commissioning given the design caters for variable magnetic strength machines.

It also highlights that the "D" and "C" grade materials due to grain size would require significant changes (splitter position, guass strengths) between product runs for maximum efficiency.

Table 20: C Grade Magnetic Separation @ 4400 guass

ID	Mass	TiO_2		Fe_2O_3		Al_2O_3		SiO_2	
	% Dist	Grade (%)	% Dist	Grade (%)	% Dist	Grade (%)	% Dist	Grade (%)	% Dist
Mags	42.62	1.632	39.91	22.33	66.07	14.31	46.59	41.80	31.16
Middlings	5.68	9.508	31.73	36.15	14.60	15.15	6.50	30.50	3.10
Non Mags	52.69	0.916	28.35	5.16	19.33	11.66	46.81	69.66	65.73

Magnetic Concentrate @ 4400 guass showing predominant ilmenite with entrained garnet.

Figure 7 – Magnetic Concentrate

7.3 Electrostatic Performance

The magnetic concentrate was further subjected to an electrostatic pass by which an upgrade in TIO2 was observed, all be it into a very small mass fraction. The rejects from here would be returned to the air tabling circuit in order to recover the remaining garnet content.

Results can be seen in the full testwork data Appendix B.

7.4 Air Tabling Performance

The magnetic test middlings and tailings were passed over an air table to separate C grade garnet and the garnetblende potential bi-product, albeit still containing significant amounts of ilmenite.

Table 21: Air Table Product Results

ID	Mass	TiO_2		Fe_2O_3		Al_2O_3		SiO_2	
	% Dist	Grade (%)	% Dist	Grade (%)	% Dist	Grade (%)	% Dist	Grade (%)	% Dist
Cons	5.22	5.735	26.46	31.763	19.70	16.165	7.21	37.138	2.88
Middlings	25.33	1.637	36.34	12.526	37.69	12.062	26.15	59.779	22.49
Tails	69.45	0.601	36.89	5.165	42.61	11.251	66.64	72.338	74.63

Air Table concentrate showing predominant garnet with emtrained ilmenite.

Figure 8 – Magnetic Concentrate

It is clear that the process is required to pull far more ilmenite than has been recovered in this testwork program. Via the full mass balance from testwork contained in Apeendix C, IMO have estimated the required bi-product produciton in Section 8 below.

8 METALLURGICAL & MARKET INTERPRETATION

This section takes the raw testwork data and correlates it to the current plant design and projects the probable bi-product annual production figures.

Given the nature of heavy minerals processing, these bi-products in general must be removed in order for the main garnet production to achieve specification and are predominantly covered within the existing flowsheet. It must be stated that mineral grain counting is **NOT** an exact science and quite often the “representation” displayed does not reflect the reality. IMO have conducted their program mass balance with this in mind

8.1 “D” grade Garnet Production

The testwork programs main focus was to produce a heavy mineral concentrate in the size fraction of -250 µm, + 150 µm size fraction in order to assess the probable production scenario for sale of a “D” grade garnet product.

The separation of garnet from pyribole (hornblende) was the key focus. Whilst the air table concentrate returned a lower than desired concentrate figure of 61 % contained garnet, the aim of garnet and pyribole separation was achieved as the air table concentrate grain counting could not detect pyribole.

The failure of the process is perceived to be in the dry magnetic circuit. The one pass at 3200 guass was ineffective in removing a large portion of the ilmenite and titanium / iron associated minerals. This should not cause concern or jeopardise a “D” grade garnet production case as the flowsheet contains three targeted removal points and flexibility to address this issue.

IMO recommend that a 3800 and 4400 Gauss test be conducted for future proofing the “D” grade production case for greater magnetic removal efficiencies. When modelled, if the magnetic circuit had worked efficiently then the garnet content of the test pass air table concentrate would have achieved 89.77 %.

IMO would also like to refer to the grain counting mass balance in Appendix C. Utilising the grain counted figures reported for the air table test, there is no mineral upgrade observed and an associated mineral accountability of 31 % has been calculated.

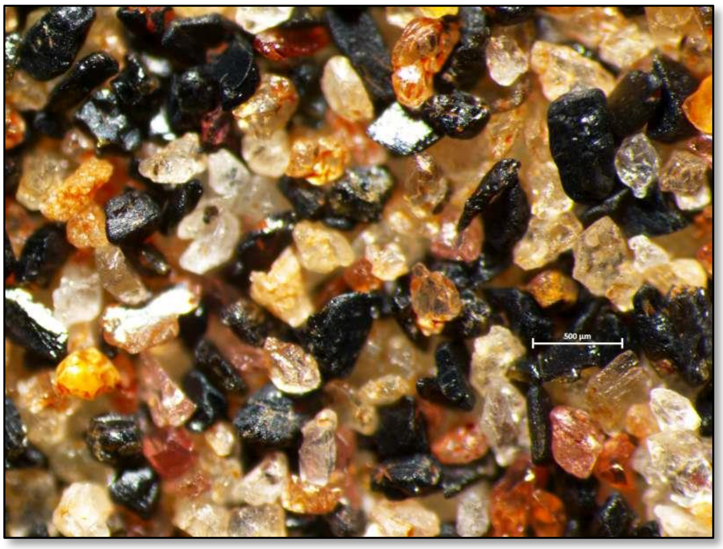

Figure 9 – Air table Feed

Figure 10 – Air Table Concentrate

Obviously the concentrate grade has been grossly understated and the concentrate grade is much higher than that reported.

The implications of including "D" grade production in the current project requires the dry plant front end (primary dryer, magnetics) capacity to be increased by 12.5 tph in order to protect the Feasibility A/B/C production scenario. The direct testwork results correlate to an annual production of 4600 tpa. Taking into account that the air table was cut very hard to reject pyribole (hornblende), the mids retreat showed a significant upgrade in garnet content and these test were one pass and un-optimised, IMO reasonably project that double (9000-10000 tpa) this figure is a greater reflection of the operation.

8.2 Magnetite Production

Section 5.6 and Table 8 display the performance of including a 1200 Gauss LIMS unit in the flowsheet to treat the 250 µm hydrosizer overflow and the 250 um wet plant product screen underflow streams.

This stream requires a maximum treatment rate of approximately 22 tph and equates to an annual production of ~ 950 tonnes (118 kg/hr) of -250 µm, + 38 µm of a clean, relatively coarse grained magnetite product.

This stream contains 92.6 % Fe_2O_3 and the negative loss on ignition confirms it's speciation as magnetite. Magnetite is defined by its loss of oxygen at 1000 degrees, whereas hematite has no mass loss.

A similar first pass LIMS on the C grade material yielded a near identical product at 89.7 % contained Fe_2O_3. This is reflective of the first roll magnet in the dry plant and a further 370 tpa (46 kg/hr) of -425 µm, + 250 µm coarse magnetite will be produced within the current dry plant design.

These products carry a Platt's index market grade of $ 107-$ 125 per tonne. At this stage no penalty elements have been applied, nor has any increase in value due to the coarse grain size been indicated as this is generally market and customer specific. A summary of the quality is provided below with the full speciation available in Appendix B Nagrom Results LIMS 1.

Table 22: Magnetite Product Quality

Product	tpa	Fe_2O_3 %	TiO_2 %	SiO_2 %	Al_2O_3 %	SO_3 %	P_2O_5 %
Wet Fine	**950**	92.66	1,59	3.33	1.66	0.156	0.027
Dry Coarse	**370**	89.72	1.12	5.77	2.52	0.087	0.030

8.3 Ilmenite Production

8.3.1 Fine Ilmenite Associated With "D" Grade Production Scenario

Initially it was presumed that the fine ilmenite could be removed in the wet circuit via Wet High Intensity Magnetic Separation (WHIMS). This is often the practice when separating ilmenite from true non-magnetics like rutile and zircon.

In reference to Section 5.6 and Table 12, it can be seen that the magnetic response of ilmenite and garnet in wet processing are of very similar response with 80 % of the garnet and 90 % of the ilmenite responding at 10,000 Gauss.

Thus in theory the bulk of the fine ilmenite does travel with the "D" grade wet concentrate that is proposed for production. The 125 µm screening process sees 46 % of the recovered ilmenite lost to tails with the fines. Thus only 50 % of the -250 µm entering ilmenite is recovered for retrieval in the dry plant.

The Medium Intensity Dry Magnet (MIMS) operated at 3200 Gauss failed to remove as much of the contained ilmenite as desired with only 8 % recovered. This is unusual as this gauge is used effectively on actual ilmenite production plants.

At a 90 % magnetic recovery using 4400 Gauss, a "D" grade introduction will have an accompanying 3100 tpa of fines ilmenite production associated.

Whilst the electrostatic separator proved the upgrade potential, the recovery of 54 % was low. A typical industrial machine has 3 passes or "plates" that can be configured as either scavengers or concentrate cleaners. Further potential to recover here can improve the production to 4000 tpa.

8.3.2 Coarse "C" Grade Ilmenite Production

Encompassed within the current flowsheet, ilmenite will be produced as a bi-product just like magnetite.

The same calculations have been applied and the tests have yielded a projected 7500 tpa of ilmenite from the coarser "C" grade feed.

Looking at the testwork ratio of Titanium to Iron in the product achieved, it would appear to contain 10 % magnetite with ilmenite. A theoretical ratio of 0.46 of TiO_2 to FeO is expected, the ratio obtained suggests that the higher elevation is due to magnetite, especially given the proof of discreet coarse grained magnetite achieved from the LIMS testwork. Table 23 indicates the specification achieved in the testwork and that which is projected for a plant saleable product.

Table 23: Testwork Product Ilmenite Grade

Product	Tpa	TiO_2	Fe_2O_3	SiO_2	Cr_2O_3	Al_2O_3
Test	1500	26.308	62.938	7.094	0.102	2.721
Projection	7500	36.41	55.86	3.5	0.10	23.25

8.4 Garnetblende Production

The flowsheet gathers several constituent streams to comprise the overall "Garnetblende" product. The current stream being generated is the "C" grade product table tails.

Given the mass balance from this program does not take into account the constituent streams that contribute from the A, B and water jet sales components IMO have reverted to the Feasibility projections for the production masses of these streams.

"C" grade enters the dry plant at the highest grade of garnet and generates the cleanest production. The IMO projection is that 50-60,000 tonnes per annum of potential garnetblende product. Thus it is reasonable to presume 200,000 tpa can be produced on the basis of the Feasibility. If "D" grade production is included to the project this figure is far greater than 250,000 and IMO concur with the financial model projection up to 300,000 tpa can be produced.

Below is the grain counting quality estimated derived from the "D" tails stream tested in this program, the 'C" grade product sample is in generation and will be reported in the future outside of this report.

Table 24: Preliminary Garnetblende Quality Estimate

Stream	Garnet %	Pyribole %	Ilmenite %	Kyanite %	Zircon %	Titanite %
"D" grade Table Tails	11.6	81.5	2.8	1.6	0.5	0.7

APPENDIX A METALLURGICAL TESTWORK FLOWSHEET

APPENDIX B TESTWORK RESULTS

APPENDIX C MASS BALANCE & PRODUCT DEPORTMENT