

# RELATÓRIO DE CARATERIZAÇÃO DAS AREIAS DO VALE DA GAIA

## 1. Introdução

No âmbito do estudo geológico das areias do Vale da Gaia, foram caracterizadas e analisadas as areias dos depósitos aluvionares e antigas zonas de dragagem mineira. Para este fim, foram seleccionadas amostras representativas e criada uma amostra compósita para ensaio, esta foi identificada com o código B393386 e enviada para a Austrália (Laboratório interno de Metalurgia da ALS Global – Laboratório certificado) para ensaios de caracterização, entre os quais foram avaliados os parâmetros granulometria e química.

## 2. Classificação

A amostra foi peneirada a seco sobre uma pilha de telas de laboratório num agitador do tipo Rotap durante 10 minutos. Os dados de dimensionamento, granulometrias e curva granulométrica são apresentados na tabela e figura abaixo, e os dados totais no relatório oficial da ALS em anexo.

Tabela 1 Granulometrias recuperadas nas areias do Vale da Gaia.

Sample ID	SCREEN SIZE (um)	SCREEN WT(g)	% WT Distribution	% WT Passing
B393386 + 1400um	1400	1,9	0,37	99,63
B393386 + 1000um	1000	3,5	0,68	98,95
B393386 + 710um	710	15,4	3,01	95,94
B393386 + 500um	500	36,2	7,07	88,87
B393386 + 355um	355	54,0	10,54	78,32
B393386 + 250um	250	81,6	15,93	62,39
B393386 + 180um	180	75,5	14,74	47,65
B393386 + 125um	125	84,2	16,44	31,20
B393386 + 90um	90	49,5	9,67	21,54
<b>B393386 + 63um</b>	<b>63</b>	<b>35,6</b>	<b>6,95</b>	<b>14,59</b>
B393386 -63um	-63	74,7	14,59	

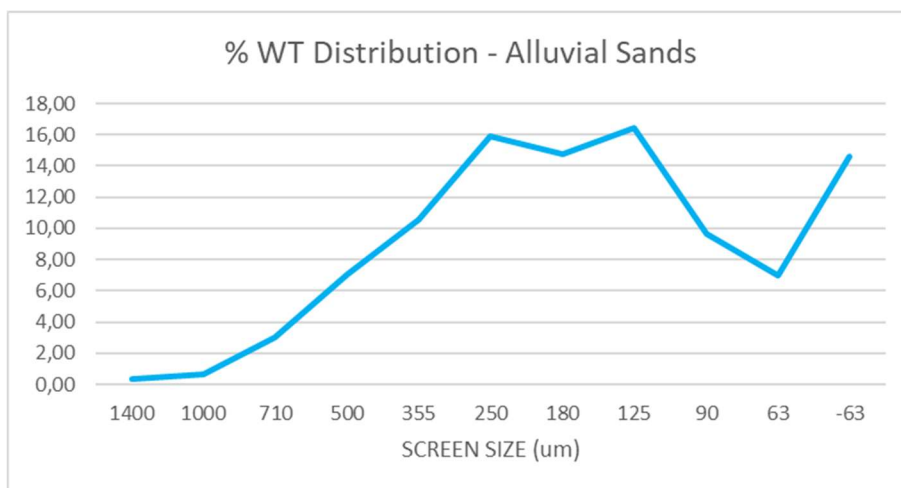


Figura 1 - Curva Granulométrica das areias do Vale da Gaia.

Cada fração foi objeto de análise química de elementos maiores e elementos traço, tendo-se encontrados uma distribuição equivalente em todos os elementos exceto o cálcio (CaO), como se pode observar na imagem seguinte. Os resultados globais podem ser consultados no relatório oficial da ALS em anexo.

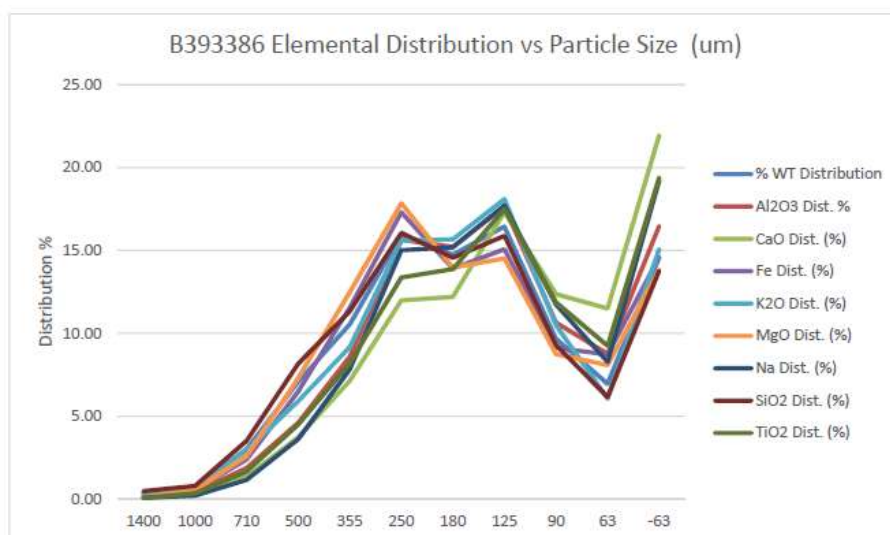


Figura 2 – Distribuição dos elementos principais encontrados nas várias frações das areias do Vale da Gaia.

## 5. Análise Mineralógica

Uma fração da mesma amostra foi submetida ao laboratório de mineralogia da ALS Metallurgy na Austrália para análise semi-quantitativa por difração de raios X (tabela abaixo) e no relatório oficial da ALS em anexo.

Tabela 2 – Mineralogia das areias do Vale da Gaia.

Mineral or mineral group	Sample 3
	B393386
Clay mineral	2
Chlorite	< 1
Kaolinite	4
Serpentine	1
Stilpnomelane and/or sepiolite	1
Annite - biotite - phlogopite	2
Lepidolite	13
Muscovite	4
Sodic plagioclase	43
K-feldspar	16
Topaz	< 1
Beryl	< 1
Quartz	13
Dolomite and/or epidote	0
Calcite	< 1
Anatase	< 1

## 3. RESULTADOS

As areias do Vale da Gaia podem ser descritas como arcoseas (+25% de feldspatos), baixo conteúdo argiloso, composta maioritariamente por fragmentos de litologias de origem ígnea, com fragmentos de minerais de rochas ígneas mais evoluídas (pegmatitos e/ou aplitos) contendo valores consideráveis de lepidolite. Não se tendo encontrado na amostra cassiterite.

John Morris Vale Pereira (Geólogo)



**Metallurgical Testwork**  
conducted upon  
**Crushed Quartz and Quartz Sand**  
for  
**SOPRED S.A.**



**Report No. A22066**

**April 2021**

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## 1. INTRODUCTION

Three (3) samples were received for sizing, assay, mineralogy, and magnetic separation to determine if significant quantities of feldspar were present and if the feldspar concentrations could be upgraded and/or impurities removed.

The testwork was controlled by Mr John Morris Pereira, on behalf of SOPRED S.A., with Mr Russell Philip supervising the program on behalf of ALS Metallurgy Services. Testwork results were communicated to the client immediately when available, which enabled the program to progress on a fully informed basis.

The purpose of this report is to describe the testwork program and present results together with some commentary and observations.

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**HAMID SHERIFF**  
Group General Manager - Metallurgy Services

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**RUSSELL PHILIP**  
Manager - Iron Ore Support Services

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**KARSTEN WINTER**  
Mineralogy Manager - Metallurgy

## 2. THE SAMPLES

Three samples labelled, B393012, B393029, and B393386 were received.

Sub-samples of each sample were split for sizing, mineralogy, and magnetic separation.

## 3. SIZING

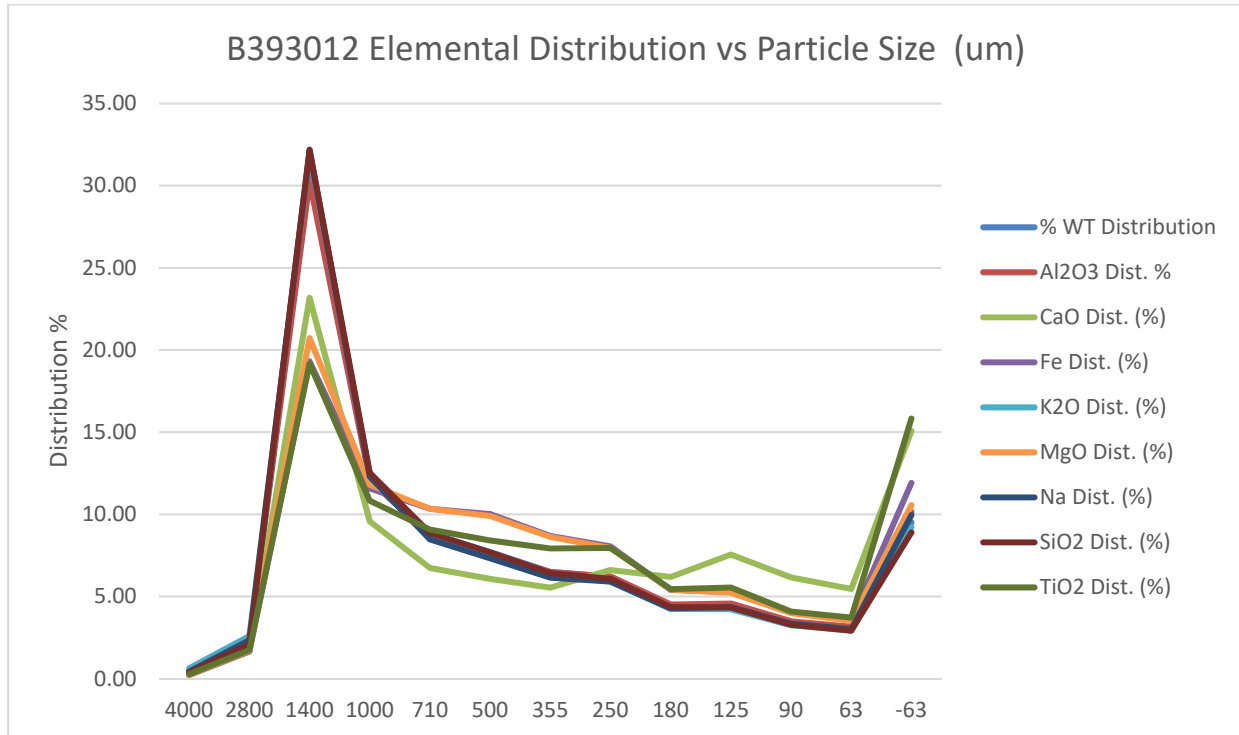
Each sample was dry-screened over a stack of laboratory screens on a *Rotap* screen shaker for 10 minutes. The various fractions were recovered and sent for assay at the ALS Metallurgy in-house laboratory.

The sizing data are appended below. Combined sizing and assay data are attached as Appendix I.

Sample #	Sample ID	Screen Size (µm)	Screen Wt (g)	Wt Distribution (%)
HL65553	B393012 + 4000 µm	4000	2.1	0.40
HL65554	B393012 + 2800 µm	2800	11.2	2.15
HL65555	B393012 + 1400 µm	1400	161.2	30.93
HL65556	B393012 + 1000 µm	1000	64.4	12.36
HL65557	B393012 + 710 µm	710	46.1	8.84
HL65558	B393012 + 500 µm	500	40.2	7.71
HL65559	B393012 + 355 µm	355	33.9	6.50
HL65560	B393012 + 250 µm	250	32.3	6.20
HL65561	B393012 + 180 µm	180	23.3	4.47
HL65562	B393012 + 125 µm	125	23.3	4.47
HL65563	B393012 + 90 µm	90	17.8	3.42
HL65564	B393012 + 63 µm	63	15.9	3.05
HL65565	B393012 -63 µm	-63	49.5	9.50
<b>TOTAL</b>			<b>521.2</b>	<b>100.00</b>



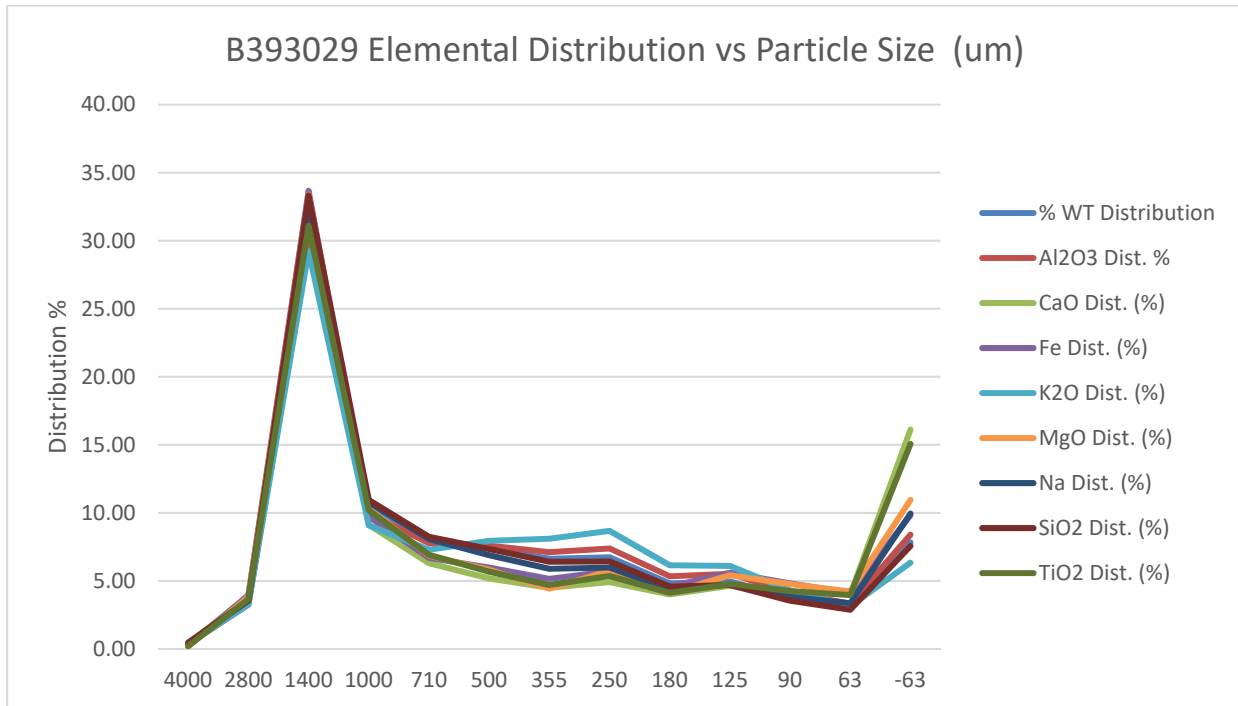
The following chart shows that the distribution of Al, K, Na, and Si closely follows the mass distribution for B939012. This is a relatively coarse sample with ~46% of the mass found in the +1 mm fractions.



Sample #	Sample ID	Screen Size (µm)	Screen Wt (g)	Wt Distribution (%)
HL65566	B393029 + 4000 µm	4000	2.4	0.42
HL65567	B393029 + 2800 µm	2800	19.8	3.49
HL65568	B393029 + 1400 µm	1400	183.3	32.33
HL65569	B393029 + 1000 µm	1000	60.1	10.60
HL65570	B393029 + 710 µm	710	45.7	8.06
HL65571	B393029 + 500 µm	500	41.8	7.37
HL65572	B393029 + 355 µm	355	37.6	6.63
HL65573	B393029 + 250 µm	250	38.2	6.74
HL65574	B393029 + 180 µm	180	27.3	4.81
HL65575	B393029 + 125 µm	125	28.1	4.96
HL65576	B393029 + 90 µm	90	21.2	3.74
HL65577	B393029 + 63 µm	63	17.1	3.02
HL65578	B393029 -63 µm	-63	44.4	7.83
<b>TOTAL</b>			<b>567.0</b>	<b>100.00</b>



For sample B393029, the distribution of elements trends to the mass distribution, but is not as closely aligned as observed in B393012, particularly in the -1 mm fractions. The sample is similar in size distribution to B393012, with ~48% of the sample found in the +1 mm fractions.



Sample #	Sample ID	Screen Size (µm)	Screen Wt (g)	Wt Distribution (%)
HL65579	B393386 + 1400 µm	1400	1.9	0.37
HL65580	B393386 + 1000 µm	1000	3.5	0.68
HL65581	B393386 + 710 µm	710	15.4	3.01
HL65582	B393386 + 500 µm	500	36.2	7.07
HL65583	B393386 + 355 µm	355	54.0	10.54
HL65584	B393386 + 250 µm	250	81.6	15.93
HL65585	B393386 + 180 µm	180	75.5	14.74
HL65586	B393386 + 125 µm	125	84.2	16.44
HL65587	B393386 + 90 µm	90	49.5	9.67
HL65588	B393386 + 63 µm	63	35.6	6.95
HL65589	B393386 -63 µm	-63	74.7	14.59
<b>TOTAL</b>			<b>512.1</b>	<b>100.00</b>





## 4. MAGNETIC SEPARATION TESTWORK

### 4.1 Test Procedure

The test procedure was as follows:

- (1) Sub-samples of each sample were crushed to P<sub>100</sub> 1 mm and dry-screened at 63 µm.
- (2) The -1/+0.063 mm fractions were subjected to magnetic separation at 1,000, 5,000, 10,000, and 15,000 gauss utilising a *Mecal* Disc Magnet.
- (3) The non-magnetic fraction from each separation was passed forward to the next higher field strength.
- (4) Sub-samples of each magnetic fraction were assayed at the ALS Metallurgy in-house laboratory.
- (5) For calculation purposes, the -63 µm assays from the original head sizing have been used.

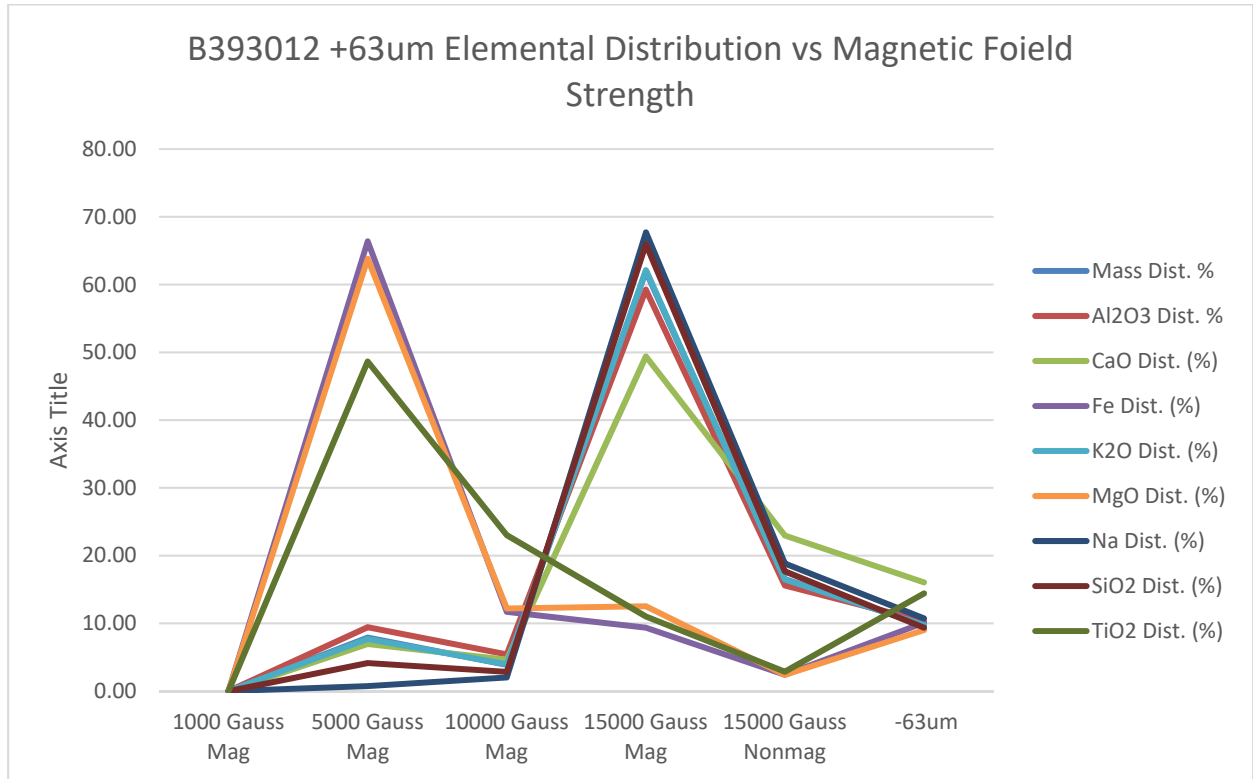
### 4.2 Test Results

The magnetic separation results are tabulated below. The combined magnetic separation and assay data are attached as Appendix II.

Sample #	Sample ID	Mass	%
HL65590	B393012 +63 µm 1,000 gauss Mag	0.08	0.01
HL65591	B393012 +63 µm 5,000 gauss Mag	76.97	7.90
HL65592	B393012 +63 µm 10,000 gauss Mag	37.72	3.87
HL65593	B393012 +63 µm 15,000 gauss Mag	603.64	61.95
HL65594	B393012 +63 µm 15,000 gauss Non-mag	161.12	16.54
HL65595	B393012 -63 µm	94.8	9.73
<b>TOTAL/CALCULATED HEAD</b>		<b>974.33</b>	<b>100.00</b>

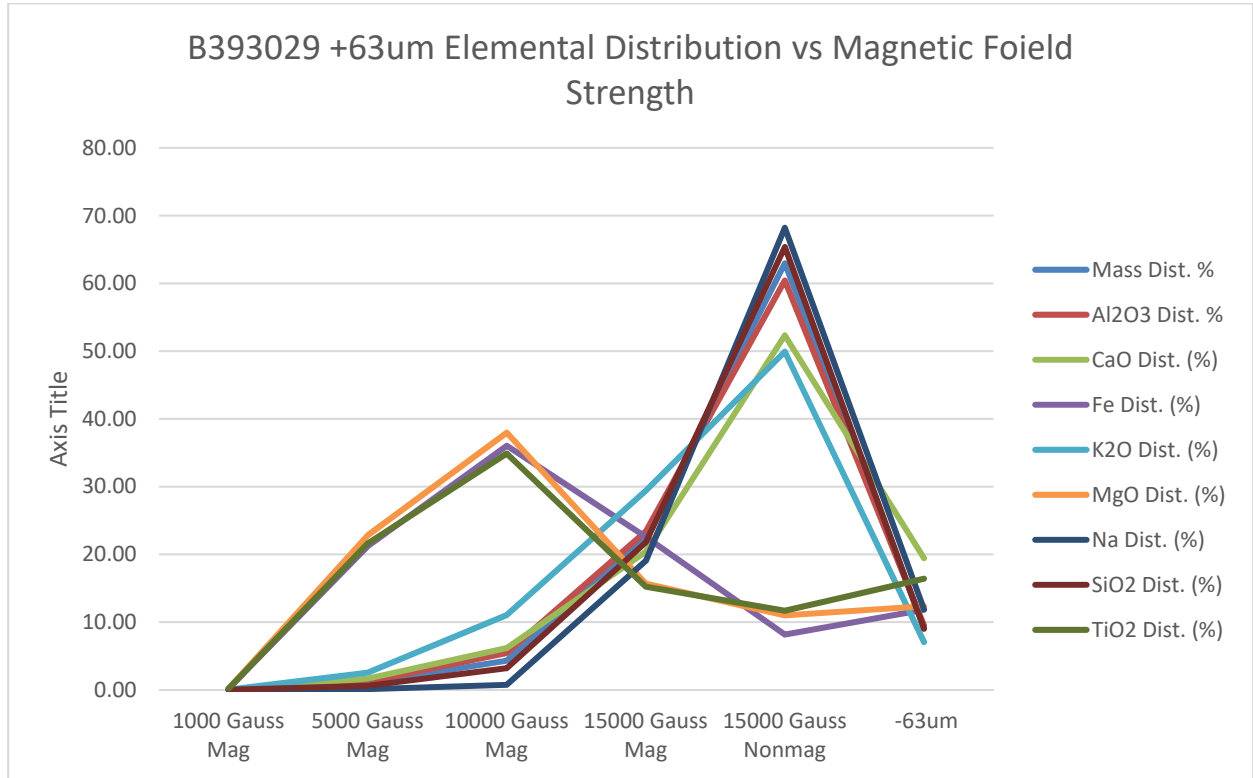


There was minimal recovery to the 1,000 gauss magnetics. This fraction was combined with the 5,000 gauss magnetic fraction for assay. Separations up to 10,000 gauss recovered ~75% of the Fe, Mg, and Ti to the magnetic fraction.



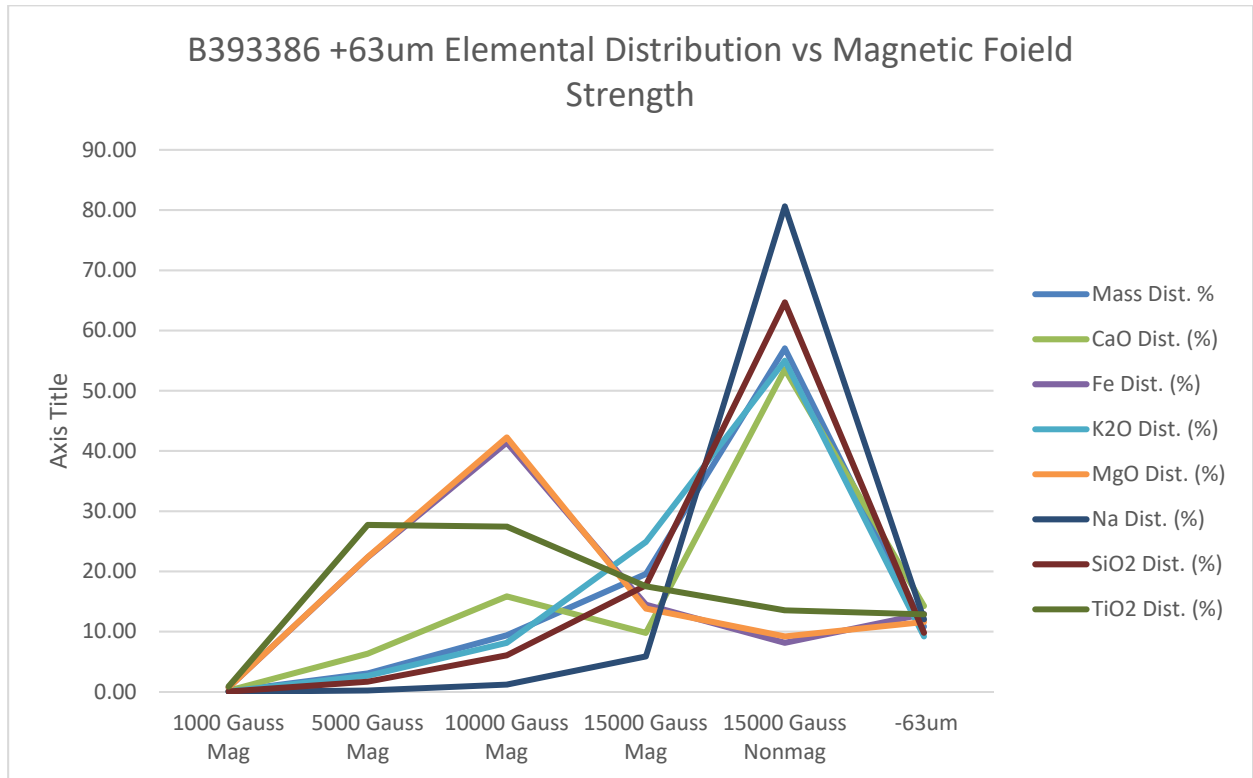
Sample #	Sample ID	Mass	%
HL65596	B393029 +63 µm 1,000 gauss Mag	0.09	0.01
HL65597	B393029 +63 µm 5,000 gauss Mag	10.08	1.03
HL65598	B393029 +63 µm 10,000 gauss Mag	42.32	4.32
HL65599	B393029 +63 µm 15,000 gauss Mag	219.81	22.45
HL65600	B393029 +63 µm 15,000 gauss Non-mag	616.6	62.96
HL65601	B393029 -63 µm	90.4	9.23
<b>TOTAL/CALCULATED HEAD</b>		<b>979.3</b>	<b>100.00</b>

There was minimal recovery to the 1,000 gauss magnetics. This fraction was combined with the 5,000 gauss magnetic fraction for assay. The magnetic separation of this sample was slightly less effective, removing approximately 58-60% of the Fe, Mg, and Ti to the magnetics at 10,000 gauss.



Sample #	Sample ID	Mass	%
HL65602	B393386 +63 µm 1,000 gauss Mag	0.98	0.10
HL65603	B393386 +63 µm 5,000 gauss Mag	30.61	3.06
HL65604	B393386 +63 µm 10,000 gauss Mag	93.77	9.38
HL65605	B393386 +63 µm 15,000 gauss Mag	195.66	19.58
HL65606	B393386 +63 µm 15,000 gauss Non-mag	569.88	57.03
HL65607	B393386 -63 µm	108.3	10.84
<b>TOTAL/CALCULATED HEAD</b>		<b>979.3</b>	<b>100.00</b>

The 1,000 gauss magnetic fraction was destroyed in assay. For the purposes of calculation, it has been assumed to be the same as the 5,000 gauss magnetic fraction. Approximately 65% of the Fe and Mg and 56% of the Ti were removed to magnetics at 10,000 gauss.



On receiving the results of the magnetic separations, the client requested an additional separation on B393012 in the size range 2.8/+1.4 mm. A sub-sample was recovered from the original particle size distribution test products. Due to equipment limitations with the *Mecal*, the sample was separated by WHIMS at 10,000 gauss using a 6 mm matrix and a 150 RPM pulse rate.

Sample ID - WHIMS Testwork	Mass (g)	%
B393012 -2800/+ 1400 µm 10,000 gauss Mag	15.93	10.75
B393012 -2800/+ 1400 µm 10,000 gauss Non-Mag	132.25	89.25
<b>TOTAL/CALCULATED HEAD</b>	<b>148.18</b>	<b>100.00</b>

Results were similar to those found on the finer fraction, with just under 11% reporting to the 10,000 gauss magnetic fraction containing approximately 62.5% of the Fe and Ti, and 56.6% of the Mg.

The complete separation and assay data are attached as Appendix III.

## 5. MINERALOGICAL ANALYSIS

A head fraction for each sample was submitted to the ALS Metallurgy in-house mineralogy laboratory for semi-quantitative XRD analysis. The mineralogy report MIN4892 is attached as Appendix IV.

On completion of the magnetic separation testwork, the client requested that the 15,000 gauss magnetics and non-magnetics for each sample be submitted for semi-quantitative XRD analysis. The mineralogy report MIN4935 is attached as Appendix V.

## 6. ANALYTICAL

All analytical testwork was undertaken at the ALS Metallurgy in-house laboratory. Results are tabulated in the various appendices.

# APPENDICES

# **APPENDIX I**

## **Sizing Testwork Details and Results**





Sample #	Sample ID	SCREEN SIZE (um)	SCREEN WT(g)	% WT Distribution	% WT Passing	Al2O3(%)	Al2O3 Dist. %	CaO(%)	CaO Dist. (%)	Cl(%)	Cl Dist. (%)	Cr(%)	Cr Dist. (%)	Cu(%)	Cu Dist. (%)	Fe(%)	Fe Dist. (%)	K2O(%)	K2O Dist. (%)	MgO(%)	MgO Dist. (%)	Mn(%)	Mn Dist. (%)	Na(%)	Na Dist. (%)	SiO2(%)	SiO2 Dist. (%)	Sn(%)	Sn Dist. (%)	TiO2(%)	TiO2 Dist. (%)
HL65553	B393012 + 4000um	4000	2.1	0.40	99.60	18.7	0.48	0.45	0.23	0.004	0.20	0.0005	0.12	0.002	0.37	1.08	0.22	10	0.62	0.39	0.22	0.014	0.22	2.39	0.44	64.2	0.38	0.003	0.38	0.31	0.27
HL65554	B393012 + 2800um	2800	11.2	2.15	97.45	17.0	2.32	0.60	1.64	0.007	1.83	0.0005	0.64	0.0005	0.49	1.54	1.67	7.81	2.60	0.56	1.72	0.022	1.86	2.41	2.34	67.1	2.10	0.001	0.67	0.38	1.75
HL65555	B393012 + 1400um	1400	161.2	30.93	66.52	15.4	30.27	0.59	23.17	0.01	37.72	0.0005	9.19	0.002	28.32	1.24	19.31	6.67	31.94	0.47	20.72	0.016	19.51	2.30	32.14	71.6	32.20	0.001	9.60	0.29	19.17
HL65556	B393012 + 1000um	1000	64.4	12.36	54.16	15.4	12.09	0.61	9.57	0.009	13.56	0.0005	3.67	0.0005	2.83	1.86	11.57	6.5	12.44	0.67	11.80	0.023	11.20	2.20	12.28	69.7	12.52	0.004	15.34	0.41	10.83
HL65557	B393012 + 710um	710	46.1	8.84	45.32	15.4	8.66	0.60	6.74	0.008	8.63	0.001	5.25	0.003	12.15	2.32	10.33	6.43	8.81	0.82	10.34	0.028	9.76	2.12	8.47	68.9	8.86	0.001	2.75	0.48	9.08
HL65558	B393012 + 500um	500	40.2	7.71	37.61	15.5	7.60	0.62	6.07	0.009	8.47	0.0005	2.29	0.001	3.53	2.58	10.02	6.33	7.56	0.9	9.90	0.029	8.82	2.10	7.32	68.6	7.69	0.001	2.39	0.51	8.41
HL65559	B393012 + 355um	355	33.9	6.50	31.10	15.7	6.49	0.67	5.53	0.008	6.35	0.0005	1.93	0.002	5.96	2.65	8.68	6.23	6.27	0.93	8.62	0.031	7.95	2.09	6.14	67.9	6.42	0.004	8.08	0.57	7.92
HL65560	B393012 + 250um	250	32.3	6.20	24.90	15.8	6.22	0.84	6.61	0.007	5.29	0.001	3.68	0.002	5.67	2.58	8.05	6.15	5.90	0.9	7.95	0.032	7.82	2.11	5.91	67.4	6.07	0.001	1.92	0.6	7.95
HL65561	B393012 + 180um	180	23.3	4.47	20.43	15.9	4.52	1.09	6.19	0.007	3.82	0.002	5.31	0.002	4.09	2.4	5.40	6.13	4.24	0.85	5.42	0.032	5.64	2.12	4.28	67	4.35	0.001	1.39	0.57	5.45
HL65562	B393012 + 125um	125	23.3	4.47	15.96	16.1	4.57	1.33	7.55	0.008	4.36	0.005	13.28	0.003	6.14	2.34	5.27	6.1	4.22	0.82	5.23	0.033	5.82	2.16	4.36	66.6	4.33	0.003	4.16	0.58	5.54
HL65563	B393012 + 90um	90	17.8	3.42	12.55	16.1	3.49	1.42	6.16	0.007	2.92	0.002	4.06	0.002	3.13	2.34	4.02	6.15	3.25	0.82	3.99	0.033	4.44	2.17	3.35	66	3.28	0.007	7.42	0.56	4.09
HL65564	B393012 + 63um	63	15.9	3.05	9.50	16.3	3.16	1.41	5.46	0.006	2.23	0.003	5.44	0.004	5.59	2.3	3.53	6.2	2.93	0.81	3.52	0.032	3.85	2.19	3.02	65.7	2.91	0.008	7.58	0.57	3.72
HL65565	B393012 -63um	-63	49.5	9.50		16.8	10.14	1.25	15.08	0.004	4.63	0.008	45.14	0.005	21.74	2.49	11.91	6.26	9.21	0.78	10.56	0.035	13.10	2.32	9.95	64.4	8.89	0.013	38.33	0.78	15.83
	TOTAL		521.2	100.00	Calculated Head	15.7	100.0	0.79	100.0	0.008	100.0	0.002	100.0	0.002	100.0	1.99	100.0	6.46	100.0	0.70	100.0	0.025	100.0	2.213	100.0	68.8	100.0	0.003	100.0	0.47	100.0

Sample #	Sample ID	SCREEN SIZE (um)	SCREEN WT(g)	% WT Distribution	% WT Passing	Al2O3(%)	Al2O3 Dist. %	CaO(%)	CaO Dist. (%)	Cl(%)	Cl Dist. (%)	Cr(%)	Cr Dist. (%)	Cu(%)	Cu Dist. (%)	Fe(%)	Fe Dist. (%)	K2O(%)	K2O Dist. (%)	MgO(%)	MgO Dist. (%)	Mn(%)	Mn Dist. (%)	Na(%)	Na Dist. (%)	SiO2(%)	SiO2 Dist. (%)	Sn(%)	Sn Dist. (%)	TiO2(%)	TiO2 Dist. (%)
HL65566	B393029 + 4000um	4000	2.4	0.42	99.58	13.5	0.34	0.34	0.37	0.004	0.52	0.0005	0.13	0.002	0.49	0.3	0.22	2.73	0.36	0.07	0.18	0.15	0.44	3.07	0.42	74.9	0.46	0.057	0.10	0.058	0.21
HL65567	B393029 + 2800um	2800	19.8	3.49	96.08	15.6	3.26	0.43	3.91	0.004	4.25	0.0005	1.10	0.004	8.05	0.64	3.94	2.96	3.26	0.18	3.82	0.12	2.88	3.11	3.55	70.7	3.58	0.088	1.25	0.12	3.67
HL65568	B393029 + 1400um	1400	183.3	32.33	63.76	15.4	29.83	0.39	32.84	0.004	39.35	0.001	20.31	0.001	18.63	0.59	33.66	2.87	29.23	0.17	33.40	0.12	26.62	3.05	32.20	71	33.32	0.17	22.39	0.11	31.10
HL65569	B393029 + 1000um	1000	60.1	10.60	53.16	15.7	9.97	0.33	9.11	0.004	12.90	0.0005	3.33	0.0005	3.05	0.52	9.73	2.72	9.08	0.16	10.31	0.12	8.73	3.11	10.77	71.1	10.94	0.25	10.80	0.11	10.20
HL65570	B393029 + 710um	710	45.7	8.06	45.10	16.1	7.77	0.3	6.30	0.003	7.36	0.0005	2.53	0.002	9.29	0.47	6.69	2.87	7.29	0.14	6.86	0.13	7.19	3.07	8.08	70.4	8.24	0.28	9.19	0.098	6.91
HL65571	B393029 + 500um	500	41.8	7.37	37.72	17.2	7.60	0.27	5.18	0.001	2.24	0.0005	2.32	0.002	8.50	0.46	5.98	3.42	7.94	0.13	5.82	0.17	8.60	2.86	6.89	68.7	7.35	0.24	7.21	0.088	5.67
HL65572	B393029 + 355um	355	37.6	6.63	31.09	17.9	7.11	0.26	4.49	0.002	4.04	0.0005	2.08	0.001	3.82	0.44	5.15	3.88	8.11	0.11	4.43	0.2	9.10	2.72	5.89	66.5	6.40	0.27	7.29	0.081	4.70
HL65573	B393029 + 250um	250	38.2	6.74	24.36	18.3	7.39	0.28	4.91	0.004	8.20	0.0005	2.12	0.0005	1.94	0.48	5.71	4.09	8.68	0.14	5.73	0.21	9.71	2.72	5.98	65.7	6.43	0.28	7.69	0.091	5.36
HL65574	B393029 + 180um	180	27.3	4.81	19.54	18.5	5.34	0.32	4.01	0.002	2.93	0.0005	1.51	0.001	2.78	0.54	4.59	4.05	6.14	0.14	4.10	0.21	6.94	2.77	4.36	65.5	4.58	0.28	5.49	0.098	4.13
HL65575	B393029 + 125um	125	28.1	4.96	14.59	18.6	5.52	0.36	4.65	0.004	6.03	0.001	3.11	0.003	8.57	0.64	5.60	3.91	6.11	0.18	5.42	0.2	6.80	2.92	4.73	65.3	4.70	0.33	6.66	0.11	4.77
HL65576	B393029 + 90um	90	21.2	3.74	10.85	18.5	4.14	0.42	4.09	0.002	2.28	0.002	4.70	0.002	4.31	0.73	4.82	3.65	4.30	0.21	4.77	0.18	4.62	3.14	3.83	65.4	3.55	0.35	5.33	0.13	4.25
HL65577	B393029 + 63um	63	17.1	3.02	7.83	18.4	3.32	0.51	4.01	0.003	2.75	0.004	7.58	0.002	3.48	0.77	4.10	3.32	3.15	0.23	4.22	0.15	3.10	3.41	3.36	65.8	2.88	0.39	4.79	0.15	3.96
HL65578	B393029 -63um	-63	44.4	7.83		17.9	8.40	0.79	16.11	0.003	7.15	0.01	49.19	0.006	27.08	0.71	9.81	2.57	6.34	0.23	10.95	0.098	5.27	3.89	9.95	66.5	7.56	0.37	11.80	0.22	15.07
	TOTAL		567.0	100.00	Calculated Head	16.7	100.0	0.38	100.0	0.003	100.0	0.002	100.000	0.002	100.0	0.57	100.0	3.17	100.0	0.16	100.0	0.146	100.0	3.062	100.0	68.9	100.0	0.245	100.0	0.11	100.0

Sample #	Sample ID	SCREEN SIZE (um)	SCREEN WT(g)	% WT Distribution	% WT Passing	Al2O3(%)	Al2O3 Dist. %	CaO(%)	CaO Dist. (%)	Cl(%)	Cl Dist. (%)	Cr(%)	Cr Dist. (%)	Cu(%)	Cu Dist. (%)	Fe(%)	Fe Dist. (%)	K2O(%)	K2O Dist. (%)	MgO(%)	MgO Dist. (%)	Mn(%)	Mn Dist. (%)	Na(%)	Na Dist. (%)	SiO2(%)	SiO2 Dist. (%)	Sn(%)	Sn Dist. (%)	TiO2(%)	TiO2 Dist. (%)
HL65579	B393386 + 1400um	1400	1.9	0.37	99.63	6.76	0.14	0.06	0.17	0.003	0.28	0.003	1.33	0.003	0.39	1.39	0.27	3.9	0.26	0.11	0.09	0.025	0.06	0.26	0.08	85.2	0.48	0.001	0.02	0.092	0.07
HL65580	B393386 + 1000um	1000	3.5	0.68	98.95	11.2	0.44	0.06	0.31	0.005	0.85	0.0005	0.41	0.004	0.96	1.56	0.56	5.93	0.73	0.37	0.54	0.043	0.20	0.37	0.20	77	0.80	0.009	0.30	0.25	0.35
HL65581	B393386 + 710um	710	15.4	3.01	95.94	10.9	1.87	0.06	1.36	0.005	3.74	0.001	3.60	0.002	2.12	1.51	2.39	5.44	2.94	0.4	2.59	0.047	0.95	0.48	1.15	77.3	3.51	0.015	2.18	0.27	1.66
HL65582	B393386 + 500um	500	36.2	7.07	88.87	11.4	4.60	0.07	3.72	0.006	10.54	0.002	16.90	0.002	4.98	1.74	6.48	4.64	5.90	0.48	7.31	0.078	3.70	0.64	3.61	76.4	8.16	0.005	1.71	0.31	4.48
HL65583	B393386 + 355um	355	54.0	10.54	78.32	14.3	8.60	0.09	7.14	0.006	15.72	0.001	12.61	0.002	7.43	2.08	11.56	4.84	9.18												

## **APPENDIX II**

### **Magnetic Separation Testwork**

#### **Details and Results**



Sample #	Sample ID	Mass	Mass Distribution %	Al2O3(%)	Al2O3 Dist. %	CaO(%)	CaO Dist. (%)	Cl(%)	Cl Dist. (%)	Cr(%)	Cr Dist. (%)	Cu(%)	Cu Dist. (%)	Fe(%)	Fe Dist. (%)	K2O(%)	K2O Dist. (%)	MgO(%)	MgO Dist. (%)	Mn(%)	Mn Dist. (%)	Na(%)	Na Dist. (%)	SiO2(%)	SiO2 Dist. (%)	Sn(%)	Sn Dist. (%)	TiO2(%)	TiO2 Dist. (%)
HL65590	B393012 +63um 1000 Gauss Mag	0.08	0.01	18.7	0.01	0.64	0.01	0.030	0.02	0.008	0.04	0.005	0.00	16.7	0.07	6.30	0.01	5.59	0.07	0.18	0.06	0.20	0.00	35.9	0.00	0.007	0.02	2.91	0.05
HL65591	B393012 +63um 5000 Gauss Mag	76.97	7.90	18.7	9.42	0.64	6.95	0.030	16.86	0.008	36.22	0.005	4.61	16.7	66.39	6.30	7.70	5.59	63.82	0.18	56.01	0.20	0.73	35.9	4.15	0.007	18.06	2.91	48.64
HL65592	B393012 +63um 10000 Gauss Mag	37.72	3.87	21.9	5.41	0.87	4.63	0.011	3.03	0.001	2.22	0.006	2.71	6.00	11.69	6.60	3.95	2.18	12.20	0.069	10.52	1.13	2.01	50.3	2.85	0.010	12.64	2.81	23.02
HL65593	B393012 +63um 15000 Gauss Mag	603.64	61.95	15.0	59.26	0.58	49.40	0.013	57.31	0.0005	17.75	0.007	50.58	0.30	9.35	6.48	62.13	0.14	12.53	0.007	17.08	2.38	67.71	72.8	65.96	0.003	60.70	0.084	11.01
HL65594	B393012 +63um 15000 Gauss Nonmag	161.12	16.54	14.8	15.61	1.01	22.96	0.017	20.00	0.0005	4.74	0.003	5.79	0.29	2.41	6.44	16.48	0.10	2.39	0.008	5.21	2.48	18.83	73.1	17.68	0.001	5.40	0.082	2.87
HL65595	B393012 -63um	94.8	9.73	16.6	10.30	1.20	16.05	0.004	2.77	0.007	39.03	0.032	36.31	2.06	10.09	6.46	9.73	0.64	9.00	0.029	11.11	2.40	10.72	65.8	9.36	0.001	3.18	0.70	14.41
Total/Calculated Head		974.33	100.00	15.7	100.0	0.73	100.0	0.014	100.0	0.002	100.0	0.009	100.0	1.99	100.0	6.46	100.0	0.69	100.0	0.025	100.0	2.18	100.0	68.4	100.0	0.003	100.0	0.47	100.0

Sample #	Sample ID	Mass	Mass Distribution %	Al2O3(%)	Al2O3 Dist. %	CaO(%)	CaO Dist. (%)	Cl(%)	Cl Dist. (%)	Cr(%)	Cr Dist. (%)	Cu(%)	Cu Dist. (%)	Fe(%)	Fe Dist. (%)	K2O(%)	K2O Dist. (%)	MgO(%)	MgO Dist. (%)	Mn(%)	Mn Dist. (%)	Na(%)	Na Dist. (%)	SiO2(%)	SiO2 Dist. (%)	Sn(%)	Sn Dist. (%)	TiO2(%)	TiO2 Dist. (%)
HL65596	B393029 +63um 1000 Gauss Mag	0.09	0.01	19.7	0.01	0.62	0.01	0.019	0.02	0.018	0.11	0.004	0.01	12.7	0.19	7.97	0.02	3.81	0.20	0.20	0.01	0.32	0.00	40.6	0.01	0.015	0.00	2.60	0.19
HL65597	B393029 +63um 5000 Gauss Mag	10.08	1.03	19.7	1.20	0.62	1.66	0.019	2.65	0.018	12.63	0.004	1.11	12.7	21.20	7.97	2.54	3.81	22.82	0.20	1.37	0.32	0.11	40.6	0.61	0.015	0.04	2.60	21.61
HL65598	B393029 +63um 10000 Gauss Mag	42.32	4.32	21.3	5.45	0.55	6.17	0.004	2.34	0.0005	1.47	0.002	2.32	5.14	36.03	8.26	11.05	1.51	37.97	0.29	8.32	0.52	0.74	50.6	3.21	0.043	0.52	1.00	34.89
HL65599	B393029 +63um 15000 Gauss Mag	219.81	22.45	17.6	23.40	0.35	20.40	0.010	30.37	0.0005	7.65	0.003	18.09	0.62	22.57	4.23	29.40	0.12	15.67	0.26	38.74	2.57	19.05	66.2	21.79	0.26	16.26	0.084	15.22
HL65600	B393029 +63um 15000 Gauss Nonmag	616.6	62.96	16.2	60.42	0.32	52.33	0.007	59.63	0.0005	21.47	0.002	33.83	0.08	8.17	2.56	49.92	0.03	10.99	0.11	45.98	3.28	68.21	70.8	65.37	0.42	73.67	0.023	11.69
HL65601	B393029 -63um	90.4	9.23	17.4	9.51	0.81	19.42	0.004	5.00	0.009	56.66	0.018	44.64	0.79	11.83	2.47	7.06	0.23	12.35	0.091	5.58	3.90	11.89	66.6	9.02	0.37	9.51	0.22	16.40
Total/Calculated Head		979.3	100.00	16.9	100.0	0.39	100.0	0.007	100.0	0.001	100.0	0.004	100.0	0.62	100.0	3.23	100.0	0.17	100.0	0.151	100.0	3.03	100.0	68.2	100.0	0.359	100.0	0.12	100.0

Sample #	Sample ID	Mass	Mass Distribution %	Al2O3(%)	Al2O3 Dist. %	CaO(%)	CaO Dist. (%)	Cl(%)	Cl Dist. (%)	Cr(%)	Cr Dist. (%)	Cu(%)	Cu Dist. (%)	Fe(%)	Fe Dist. (%)	K2O(%)	K2O Dist. (%)	MgO(%)	MgO Dist. (%)	Mn(%)	Mn Dist. (%)	Na(%)	Na Dist. (%)	SiO2(%)	SiO2 Dist. (%)	Sn(%)	Sn Dist. (%)	TiO2(%)	TiO2 Dist. (%)
HL65602	B393386 +63um 1000 Gauss Mag	0.98	0.10	19.6	0.11	0.33	0.20	0.034	0.37	0.007	0.73	0.006	0.20	14.3	0.72	4.91	0.09	3.62	0.72	0.29	0.20	0.10	0.01	35.4	0.05	0.007	0.03	4.95	0.89
HL65603	B393386 +63um 5000 Gauss Mag	30.61	3.06	19.6	3.33	0.33	6.33	0.034	11.43	0.007	22.81	0.006	6.26	14.3	22.34	4.91	2.68	3.62	22.39	0.29	6.19	0.10	0.23	35.4	1.68	0.007	0.94	4.95	27.71
HL65604	B393386 +63um 10000 Gauss Mag	93.77	9.38	24.1	12.54	0.27	15.86	0.013	13.39	0.003	29.95	0.006	19.18	8.65	41.39	4.87	8.15	2.23	42.25	0.23	15.05	0.17	1.20	41.8	6.09	0.010	4.12	1.60	27.44
HL65605	B393386 +63um 15000 Gauss Mag	195.66	19.58	21.2	23.03	0.08	9.81	0.010	21.49	0.0005	10.41	0.002	13.34	1.45	14.48	7.13	24.88	0.35	13.84	0.39	53.25	0.40	5.89	58.2	17.68	0.015	12.88	0.49	17.53
HL65606	B393386 +63um 15000 Gauss Nonmag	569.88	57.03	15.1	47.77	0.15	53.55	0.007	43.81	0.0005	30.33	0.002	38.86	0.28	8.14	5.41	54.99	0.08	9.21	0.049	19.49	1.88	80.61	73.1	64.68	0.029	72.53	0.13	13.55
HL65607	B393386 -63um	108.3	10.84	22.0	13.23	0.21	14.25	0.008	9.52	0.0005	5.76	0.006	22.15	2.34	12.93	4.77	9.21	0.53	11.60	0.077	5.82	1.48	12.06	58.4	9.82	0.020	9.51	0.65	12.88
Total/Calculated Head		999.2	100.00	18.0	100.0	0.16	100.0	0.009	100.0	0.001	100.0	0.003	100.0	1.96	100.0	5.61	100.0	0.50	100.0	0.143	100.0	1.33	100.0	64.5	100.0	0.023	100.0	0.55	100.0

Samples highlighted in orange combined for assay

Sample lost in assay. Insufficient for repeat. For calculation assume same as HL65603

For the purposes of calculation samples reporting less than the detection limit have been set to half of the detection limit

## **APPENDIX III**

### **Combined Magnetic Separation and Assay Data Details and Results**



Sample #	Sample ID - WHIMS Testwork	Mass (g)	%			Al2O3(%)	Al2O3 Dist. %	CaO(%)	CaO Dist. (%)	Cl(%)	Cl Dist. (%)	Cr(%)	Cr Dist. (%)	Cu(%)	Cu Dist. (%)	Fe(%)	Fe Dist. (%)	K2O(%)	K2O Dist. (%)	MgO(%)	MgO Dist. (%)	Mn(%)	Mn Dist. (%)	Na(%)	Na Dist. (%)	SiO2(%)	SiO2 Dist. (%)	Sn(%)	Sn Dist. (%)	TiO2(%)	TiO2 Dist. (%)
HL65682	B393012 -2800/+ 1400um 10000 Gauss Mag	15.93	10.75			16.6	11.49	1.09	19.85	0.018	41.95	0.005	54.64	0.007	62.77	8.03	62.51	6.16	9.90	2.6	56.61	0.091	61.03	1.38	6.43	54.3	8.36	0.002	19.41	2.37	62.68
HL65683	B393012 -2800/+ 1400um 10000 Gauss NonMag	132.25	89.25			15.4	88.51	0.53	80.15	0.003	58.05	0.0005	45.36	0.0005	37.23	0.58	37.49	6.75	90.10	0.24	43.39	0.007	38.97	2.42	93.57	71.7	91.64	0.001	80.59	0.17	37.32
	Total/Calculated Head	148.18	100.00			15.53	100.0	0.59	100.0	0.005	100.0	0.0010	100.0	0.001	100.0	1.38	100.0	6.69	100.0	0.49	100.0	0.016	100.0	2.31	100.0	69.8	100.0	0.001	100.0	0.41	100.0

For the purposes of calculation samples reporting less than the detection limit have been set to half of the detection limit

## **APPENDIX IV**

### **Mineralogical Analysis**

#### **Report MIN4892**



## **A22066 (MIN4892)** **SOPRED**

### **SAMPLES RECEIVED**

Three samples were submitted to ALS Metallurgy for semi-quantitative XRD analysis.

Sample 1	B393012
Sample 2	B393029
Sample 3	B393386

### **SAMPLE PREPARATION**

The samples were pressed into a back-packed sample holder to minimise preferred orientation of the particles. Powder X-ray diffraction (XRD) was used to analyse each sample and a combination of matrix flushing and reference intensity ratio (RIR) derived constants was used in the quantification of the minerals identified in each sample.

### **ANALYTICAL PROCEDURES**

The XRD traces were collected under the following instrument conditions:

<b>XRD</b>	<b>Panalytical Empyrean</b>
Radiation	Co K $\alpha$ 1.789
Generator	40 kV 40 mA
Angular Range	5° to 77° 2 $\theta$
Time/Step	120 s
Step Size	0.0131° 2 $\theta$
Divergence Slit	0.5 °
Anti-Scatter Slit	7.5 mm
Slit Type	Fixed
Detector	PIXcel in linear mode
Rotation Speed	60 rpm

### **SAMPLES SUBMITTED BY**

Russell Philip (ALS Metallurgy)

### **ANALYSIS UNDERTAKEN BY**

Karsten Winter & Amy Hoppenbrouwers (ALS Metallurgy Mineralogy)

### **REPORTED BY**

Karsten Winter & Amy Hoppenbrouwers (ALS Metallurgy Mineralogy)

### **REPORT DATE**

13th April 2021



## RESULTS

The quantitative results shown in the table below have been normalised to 100 %, and the values shown represent the relative proportion of the crystalline material in the sample. Totals greater or smaller than 100 % are due to rounding errors.

Results in the table preceded by an asterisk indicate normally a larger than usual uncertainty in regard to the quantity of the phase reported; for some of the minor and trace phases it might also indicate an uncertainty in regard of the phase itself, or both.

Mineral or mineral group	Sample 1	Sample 2	Sample 3
	B393012	B393029	B393386
	Mass %		
Clay mineral	1	< 1	2
Chlorite	2	< 1	< 1
Kaolinite	< 1	< 1	4
Serpentine	< 1	0	1
Stilpnomelane and/or sepiolite	0	0	1
Annite - biotite - phlogopite	12	4	2
Lepidolite	3	12	13
Muscovite	4	3	4
Sodic plagioclase	21	57	43
K-feldspar	32	1	16
Topaz	< 1	1	< 1
Beryl	0	< 1	< 1
Quartz	25	20	13
Dolomite and/or epidote	0	0	0
Calcite	1	0	< 1
Anatase	0	1	< 1

## COMMENTS

Sample B393012 might contain a trace of hematite and/or pyrite.  
Some amorphous material is possibly present.



# **APPENDIX V**

## **Mineralogical Analysis**

### **Report MIN4935**



## **A22066 (MIN4935) SOPRED**

### **SAMPLES RECEIVED**

Six samples were submitted to ALS Metallurgy for semi-quantitative XRD analysis.

Sample 1	HL65593
Sample 2	HL65594
Sample 3	HL65599
Sample 4	HL65600
Sample 5	HL65605
Sample 6	HL65606

### **SAMPLE PREPARATION**

The samples were pressed into a back-packed sample holder to minimise preferred orientation of the particles. Powder X-ray diffraction (XRD) was used to analyse each sample and a combination of matrix flushing and reference intensity ratio (RIR) derived constants was used in the quantification of the minerals

### **ANALYTICAL PROCEDURES**

The XRD traces were collected under the following instrument conditions:

XRD	Panalytical Empyrean
Radiation	Co K $\alpha$ 1.789
Generator	40 kV 40 mA
Angular Range	5° to 77° 2 $\theta$
Time/Step	120 s
Step Size	0.0131° 2 $\theta$
Divergence Slit	0.5°
Anti-Scatter Slit	7.5 mm
Slit Type	Fixed
Detector	PIXcel in linear mode
Rotation Speed	60 rpm

### **SAMPLES SUBMITTED BY**

Russell Philip

### **ANALYSIS UNDERTAKEN BY**

Amy Hoppenbrouwers (ALS Metallurgy Mineralogy)

### **REPORTED BY**

Amy Hoppenbrouwers (ALS Metallurgy Mineralogy)

### **REPORT DATE**

13th April 2021



## RESULTS

The quantitative results shown in the table below have been normalised to 100 %, and the values shown represent the relative proportion of the crystalline material in the sample. Totals greater or smaller than 100 % are due to rounding errors.

Results in the table preceded by an asterisk indicate normally a larger than usual uncertainty in regard to the quantity of the phase reported; for some of the minor and trace phases it might also indicate an uncertainty in regard of the phase itself, or both.

Mineral or mineral group	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Sample 6
	HL65593	HL65594	HL65599	HL65600	HL65605	HL65606
Mass %						
Clay Mineral	<1	<1	0	0	0	0
Chlorite	<1	<1	<1	<1	1	<1
Kaolinite	0	< 1	0	0	4	1
Serpentine	0	0	0	0	1	<1
Stilpnomelane and/or Sepiolite	0	0	0	0	1	0
Annite - biotite - phlogopite	2	1	6	0	5	2
Lepidolite	1	1	10	6	24	6
Muscovite	4	1	0	0	0	1
Sodic Plagioclase	24	25	61	70	6	41
K-feldspar	37	43	2	1	8	26
Topaz	0	1	0	1	0	1
Quartz	29	23	21	22	18	19
Dolomite and/or epidote	0	1	0	0	0	0
Calcite	1	1	0	0	0	0

## COMMENTS

'Mica' represents micas from both the biotite - annite - phlogopite group, muscovite (+/- Li) and also lepidolite.

'Clay mineral' seems to be predominantly vermiculite and smectite, with some palygorskite possibly present.

Samples HL65599 and HL65600 might contain a trace of beryl.

Some amorphous likely present in all samples.