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## AMIS0275

### *Certified Reference Material*

### Rare Earth Elements TRE Project, Madagascar

### *Certificate of Analysis*

### Recommended Concentrations and Limits<sup>1, 2</sup> (at two Standard Deviations)

#### *Certified Concentrations*

Ce FUS	381	±	27	ppm
Ce M/ICP	367	±	48	ppm
Dy FUS	22.0	±	1.6	ppm
Er FUS	12.4	±	1.0	ppm
Eu FUS	3.4	±	0.3	ppm
Gd FUS	25.2	±	2.7	ppm
Ho FUS	4.4	±	0.3	ppm
La FUS	294	±	20	ppm
La M/ICP	285	±	38	ppm
Lu FUS	1.7	±	0.2	ppm
Nb M/ICP	239	±	25	ppm
Nd FUS	188	±	12	ppm
Pr FUS	56.1	±	4.0	ppm
Sm FUS	31.7	±	2.8	ppm
Sr M/ICP	20.1	±	1.7	ppm
Tb FUS	4.0	±	0.3	ppm
Tm FUS	1.8	±	0.2	ppm
U Fus	11.5	±	0.7	ppm
Yb FUS	11.2	±	0.7	ppm
Specific Gravity	2.6	±	0.1	

1. Manufacturers recommended limits for use of the material as control samples, based on two standard deviations, calculated using "Between Laboratory" statistics for treatment of the data for trivial, non-trivial and technically invalid results. See sections 1, 9 and 12.
2. There is additional certified major element data presented on p2 and uncertified trace element data presented as an appendix.
3. CREO =  $(Nd+Eu+Tb+Dy+Y)_2O_3 = 399$  ppm (see Appendix 2)

## ***Provisional Concentrations***

Nb Fus	239	±	36	ppm
Sc M/ICP	7.8	±	1.0	ppm
Sr FUS	21.2	±	2.7	ppm
Tb M/ICP	3.3	±	0.6	ppm
Th Fus	56.9	±	6.5	ppm
Th M/ICP	47.2	±	9.0	ppm
U M/ICP	7.6	±	1.3	ppm
Y FUS	115	±	16	ppm
Y M/ICP	83.1	±	20.5	ppm
Yb M/ICP	6.6	±	1.7	ppm

## ***Indicated Means***

Lu M/ICP 0.9 ppm

## **Major Element Recommended Concentrations and Limits (at two Standard Deviations)**

### ***Certified Concentrations***

Al <sub>2</sub> O <sub>3</sub>	26.2	±	0.4	%
CaO	0.4	±	0.02	%
Cr <sub>2</sub> O <sub>3</sub>	0.09	±	0.01	%
Fe <sub>2</sub> O <sub>3</sub>	9.7	±	0.2	%
K <sub>2</sub> O	1.9	±	0.1	%
MgO	0.86	±	0.02	%
MnO	0.15	±	0.01	%
Na <sub>2</sub> O	0.52	±	0.04	%
P <sub>2</sub> O <sub>5</sub>	0.08	±	0.01	%
SiO <sub>2</sub>	47.6	±	0.7	%
TiO <sub>2</sub>	0.7	±	0.02	%
LOI	11.0	±	0.3	%

1. **Intended Use:** AMIS0275 can be used to check analysis of samples of rare earth element bearing rocks with a similar grade and matrix.

It is a matrix matched Certified Reference Material, fit for use as control samples in routine assay laboratory quality control when inserted within runs of samples and measured in parallel to the unknown. Its purpose is to monitor inter-laboratory or instrument bias and within lab precision. It can be used, indirectly, to establish the traceability of results to an SI system of units.

The recommended concentrations and limits for this material are property values based on a measurement campaign (round robin) and reflect consensus results from the laboratories that participated in the round robin.

Slight variations in analytical procedures between laboratories will reflect as slight biases to the recommended concentrations (see 19). Good laboratories will report results within the two standard deviation levels with a failure rate of <10 %.

The material can also be used for method development and for the calibration of equipment.

**2. Origin of Material:** AMIS0275 is a commissioned CRM made up of material supplied by Tantalus Rare Earths from the TRE Project situated on the Ampasindava Peninsula in the Antsiranana Province of northern Madagascar, approximately 40km south-west of the regional administrative centre, Ambanja.

**3. Mineral and Chemical Composition:** The concession area, comprises rare earth- tantalum-niobium-zirconium-hafnium enriched dykes, sills and argillaceous laterites.

**4. Appearance:** The material is a very fine Yellowish Brown powder (Corstor colour chart – 10YR 5/8).

**5. Handling instructions:** The material is packaged in Laboratory Packs and Explorer Packs that must be shaken or otherwise agitated before use. Normal safety precautions for handling fine particulate matter are suggested, such as the use of safety glasses, breathing protection, gloves and a laboratory coat.

**6. Method of Preparation:** The material was crushed, dry-milled and air-classified to <54um. Wet sieve particle size analysis of random samples confirmed the material was 98.5% <54um. It was then blended in a bi-conical mixer, systematically divided and then sealed into 1kg Laboratory Packs. Explorer Packs are subdivided from the Laboratory packs as required. Samples were randomly selected for homogeneity testing and third party analysis. Statistical analysis of both homogeneity and consensus test results were carried out by an independent statistician.

**7. Methods of Analysis requested:**

1. Multi-acid digest, including HF, ICP- OES or ICP-MS. Multi element scan.
2. Fusion, ICP- OES or ICP-MS. Multi element scan to include REE's, Nb, Y, Sr, U and Th.
3. XRF. Multi element scan to include REE's, Nb, Y, Sr, U and Th.
4. XRF fusion. Majors ( Al<sub>2</sub>O<sub>3</sub>, CaO, Cr<sub>2</sub>O<sub>3</sub>, Fe<sub>2</sub>O<sub>3</sub>, K<sub>2</sub>O, MgO, MnO, Na<sub>2</sub>O, P<sub>2</sub>O<sub>5</sub>, SiO<sub>2</sub>, TiO<sub>2</sub>. LOI. )
5. SG ( gas pycnometer ).

**8. Information requested:**

1. State and provide brief description of analytical techniques used.
2. State aliquots used for all determinations.
3. Results for individual analyses to be reported ( not averages )
4. All results for Rare Earth Elements to be reported in ppm ( not as oxides).
5. All results for multi-element scans to be reported in ppm.
6. All results for major elements to be reported in %, as oxides.
7. Report all QC data, to include replicates, blanks and certified reference materials used.

**9. Method of Certification:** Nineteen laboratories were each given eight randomly selected packages of sample. Seventeen of the laboratories submitted results in time for certification.

Final limits were calculated after first determining if all data was compatible within a spread normally expected for similar analytical methods done by reputable laboratories. Data from any one laboratory was then removed from further calculations when the mean of all analyses from that laboratory failed a "t test" of the global means of the other laboratories. The means and standard deviations were then re-calculated using all remaining data.

Any analysis that fell outside of the new two standard deviations was removed from the ensuing data base. The mean and standard deviations were again calculated using the remaining data.

The "between-laboratory" standard deviation is used in the calculation to eliminate technically and statistically invalid data. Upper and lower limits are based on the standard deviation of the remaining data, which reflect individual analyses and can be used to monitor accuracy in routine laboratory

quality control. This is different to limits based on standard deviations derived from grouped set of analyses (see 12), which provide important measures for precision and trueness, but which are less useful for routine QC.

Standards with an RSD of near or less than 5 % are termed "Certified", RSD's of between near 5 % and 15 % are termed "Provisional", and RSD's over 15 % are termed "Informational".

**10. Participating Laboratories:** The 17 out of 19 laboratories that provided results timeously were (not in same order as in the table of assays):

1. ACME Analytical Laboratories Ltd CA
2. AGAT Laboratories
3. ALS Chemex Laboratory Group Brisbane Australia
4. ALS Chemex Laboratory Group Johannesburg SA
5. ALS Chemex Laboratory Group Perth WA
6. ALS Chemex Laboratory Group Vancouver CA
7. ALS OMAC (Ireland)
8. BV Amdel (Australia)
9. Genalysis Laboratory Services (W Australia P)
10. Intertek Utama Services (Indonesia)
11. Set Point Laboratories (Isando) SA
12. SGS Geosol Laboratories Ltda (Brazil)
13. SGS Mineral Services Callao (Peru)
14. SGS Mineral Services Lakefield (Canada)
15. SGS South Africa (Pty) Ltd - Booyens JHB
16. SGS Vancouver (Canada)
17. Ultra Trace (Pty) Ltd WA

**11. Assay Data:** Data as received from the laboratories for the important certified elements listed on p1 is set out below.

#### Assay data - Economic Elements

Lab Code	Ce Fusion ppm	Ce M/ICP ppm	Dy Fusion ppm	Er Fusion ppm	Eu Fusion ppm	Gd Fusion ppm	Ho Fusion ppm	La Fusion ppm	La M/ICP ppm	Lu Fusion ppm	Lu M/ICP ppm	Nb Fusion ppm	Nb M/ICP ppm	Nd Fusion ppm	Pr Fusion ppm
A	416	398	24.6	13.2	3.77	29.7	4.79	318	292	1.86	0.92	246	250	205	62.8
A	380	391	22.7	12.2	3.45	27.5	4.40	293	289	1.67	0.94	240	251	189	58.6
A	379	369	22.5	12.3	3.45	26.9	4.46	290	272	1.63	0.89	232	235	189	58.7
A	386	386	22.8	12.4	3.52	27.7	4.48	295	284	1.69	0.96	235	248	191	59.7
A	384	393	23.2	12.4	3.50	27.7	4.47	295	287	1.63	0.97	231	246	191	59.4
A	390	395	23.2	12.5	3.50	28.1	4.45	296	291	1.70	0.96	236	249	194	59.8
A	416	386	24.6	13.4	3.82	29.4	4.80	312	286	1.84	0.90	235	241	203	62.6
A	390	405	22.7	12.4	3.56	27.3	4.47	296	296	1.70	1.00	222	257	192	59.6
C	410	290	22.4	13.6	3.18	24.9		291	190	1.75		219	231	185	55.2
C	400	308	21.5	13.5	3.25	24.6		295	205	1.66		216	242	188	55.5
C	403	326	21.9	13.3	3.14	24.9		290	222	1.69		218	243	182	55.3
C	398	319	22.6	12.9	3.24	24.6		293	219	1.77		223	237	188	55.3
C	398	322	21.3	12.6	3.25	24.0		286	221	1.71		221	231	188	54.8
C	392	330	21.5	13.1	2.97	24.1		285	227	1.65		214	231	181	53.9
C	408	329	22.3	12.7	3.21	24.9		296	228	1.74		217	239	188	55.3
C	396	317	21.1	12.7	3.10	24.0		286	216	1.66		209	233	177	53.6
D	383	375	22.4	12.0	2.05	28.9	4.16	295	312	1.75	0.63	214	228	182	56.0
D	389	407	22.9	11.7	1.97	27.7	4.31	290	346	1.76	0.71	218	242	173	52.7
D	371	390	21.7	11.5	1.97	29.6	4.36	298	323	1.80	0.66		239	174	53.8
D	375	349	22.0	11.2	1.94	28.6	4.34	279	336	1.82	0.64	218	252	172	51.4
D	362	375	21.2	10.6	2.12	31.1	4.76	300	313	1.94	0.70	242	232	180	54.6
D		400				29.3	4.53		330	1.84	0.62	228	224		
D		378				30.1	4.58		313	1.85	0.67	232	224		
D		390				34.0	4.83		325	2.08	0.71	258	247		
E	378	207	21.5	12.0	3.15	26.0	4.26	293	156	1.49	0.72	221	245	179	53.3
E	362	269	21.6	11.4	3.00	25.0	4.06	282	156	1.47	0.87	204	229	176	51.5
E	367	225	21.3	11.5	3.10	25.1	4.12	284	167	1.45	0.79	214	245	179	52.5
E	371	218	21.3	11.7	3.11	25.2	4.11	288	169	1.47	0.72	219	241	180	52.7
E	377	202	21.6	12.0	3.23	25.5	4.24	295	167	1.53	0.71	215	233	181	53.7
E	371	192	21.5	12.1	3.18	25.5	4.26	294	158	1.50	0.68	213	222	190	52.8
E	374	187	21.7	12.1	3.29	25.9	4.24	287	144	1.55	0.67	219	237	184	53.4
E	370	182	21.5	12.2	3.22	25.9	4.18	289	133	1.59	0.65	213	214	181	52.7

### Assay data - Economic Elements (cont)

Lab Code	Ce Fusion ppm	Ce M/ICP ppm	Dy Fusion ppm	Er Fusion ppm	Eu Fusion ppm	Gd Fusion ppm	Ho Fusion ppm	La Fusion ppm	La M/ICP ppm	Lu Fusion ppm	Lu M/ICP ppm	Nb Fusion ppm	Nb M/ICP ppm	Nd Fusion ppm	Pr Fusion ppm
F	390	358	22.2	12.0	3.20	24.5	4.50	296	232	1.66		247	229	189	55.5
F	380	259	22.8	12.1	3.31	26.2	4.24	304	166	1.63		252	220	192	57.3
F	384	242	23.1	12.6	3.45	27.2	4.25	307	167	1.64		250	216	198	57.0
F	371	306	22.6	12.0	3.45	26.0	4.27	300	211	1.62		247	220	192	56.7
F	376	299	22.8	12.5	3.34	26.2	4.38	302	202	1.62		247	231	194	56.5
F	389	324	22.4	12.3	3.07	26.3	4.42	291	218	1.58		247	225	188	56.5
F	382	295	22.8	12.3	3.53	26.9	4.25	309	194	1.52		255	230	198	57.5
F	384	253	22.5	12.7	3.39	26.6	4.23	309	167	1.65		248	219	196	58.0
G		375							292		1.10		249		
G		392							304		1.12		240		
G		383							299		1.04		235		
G		375							289		1.04		237		
G		386							300		1.06		237		
G		371							293		1.02		235		
G		376							294		1.00		240		
G		370							294		1.04		241		
H	413	201	23.0	13.3	3.40	25.5	4.52	316	136	1.75		249	249	186	56.9
H	430	225	24.3	13.8	3.75	28.0	4.89	328	156	1.85		260	224	203	61.3
H	438	196	25.2	14.4	3.70	28.6	5.10	337	135	1.87		267	237	205	62.5
H	413	193	22.5	13.1	3.49	25.3	4.42	315	130	1.69		244	231	185	57.5
H	395	182	22.8	12.5	3.37	25.4	4.37	302	122	1.60		236	228	181	55.4
H	391	184	21.7	12.6	3.24	24.3	4.30	297	122	1.57		231	237	175	53.9
H	409	254	23.1	13.0	3.58	26.8	4.68	314	177	1.70		244	235	188	58.0
H	443	237	24.5	14.1	3.75	27.2	4.87	338	161	1.81		266	240	201	61.1
I	384	382	23.9	13.2	3.59	29.4	4.49	286	286	1.68	0.80	275	282	182	55.7
I	382	373	24.7	13.1	3.67	31.6	4.79	285	278	1.79	0.79	290	284	192	58.7
I	373	377	24.8	12.5	3.50	28.8	4.44	294	284	1.71	0.78	287	276	186	56.9
I	376	383	23.2	12.5	3.53	28.6	4.62	286	286	1.67	0.81	275	271	189	58.0
I	384	384	24.8	12.9	3.74	30.3	4.90	285	291	1.83	0.80	281	274	196	57.8
I	378	382	24.1	13.2	3.47	29.6	4.54	297	279	1.74	0.81	283	274	185	56.9
I	384	378	24.4	12.0	3.44	30.7	4.68	284	279	1.77	0.84	291	273	183	58.9
I	386	385	24.2	13.0	3.60	30.6	4.65	294	276	1.81	0.84	289	277	191	58.2
J		378							297		1.06		257		
J		375							293		1.05		255		
J		377							294		1.03		255		
J		375							296		1.02		254		
J		376							292		1.03		249		
J		378							292		1.06		259		
J		379							291		1.04		248		
J		374							293		1.05		247		
K	360	345	21.1	11.8	3.34	23.6	4.21	279	274	1.66	1.02	239		181	54.0
K	362	343	22.0	11.9	3.43	24.3	4.37	282	280	1.67	0.99	239		183	55.4
K	357	358	21.4	11.8	3.34	23.7	4.26	276	272	1.63	0.99	235		180	54.5
K	360	344	21.5	11.8	3.39	24.1	4.25	280	275	1.65	0.90	236		181	54.4
K	360	359	21.1	11.8	3.40	23.4	4.27	275	269	1.68	0.86	240		177	54.0
K	362	360	21.5	11.7	3.38	24.0	4.29	280	271	1.64	0.92	242		182	54.8
K	357	353	21.0	11.8	3.23	23.1	4.27	274	259	1.64	0.89	234		175	54.3
K	363	356	21.8	12.1	3.34	24.5	4.34	283	269	1.68	0.93	243		182	54.9
L	402	196	22.7	12.6	3.43	26.0	4.43	310		1.56		262	242	194	57.8
L	405	211	22.5	12.4	3.45	26.5	4.48	314		1.57		270	246	195	58.6
L	412	214	22.7	12.8	3.47	26.4	4.50	318		1.58		270	242	197	59.3
L	402	215	22.2	12.4	3.40	25.9	4.44	310		1.57		264	249	193	57.8
L	401	235	22.7	12.3	3.40	25.8	4.45	311		1.54		265	247	191	57.6
L	402	224	22.5	12.3	3.43	26.1	4.45	309		1.60		263	255	192	57.3
L	379	199	21.1	11.5	3.19	24.8	4.12	294		1.50		251	248	183	54.6
L	395	231	22.3	12.0	3.39	25.7	4.37	308		1.52		261	251	189	57.0
N	385		20.5	12.0	3.00	24.0	5.00	297		2.00		300		187	55.0
N	386		21.5	12.0	3.00	23.0	6.00	298		2.00		310		194	55.0
N	378		20.5	13.0	3.00	23.0	6.00	290		2.00		305		189	54.0
N	385		21.5	12.0	3.00	24.0	6.00	290		2.00		310		190	54.0
N	387		20.5	12.0	3.00	23.0	6.00	295		2.00		320		190	54.0
N	381		20.5	12.0	3.00	24.0	5.00	295		2.00		300		186	55.0
N	380		20.5	12.0	3.00	23.0	6.00	295		2.00		315		188	54.0
N	386		20.5	12.0	3.00	23.0	6.00	295		2.00		310		191	54.0
O	394	371	22.5	12.7	3.47	24.7	4.48	303	276	1.69		237	227	193	58.6
O	403	367	23.0	13.1	3.48	25.3	4.55	311	273	1.71		244	226	197	59.7
O	389	382	22.3	12.6	3.41	24.5	4.41	301	281	1.66		234	232	193	58.1
O	393	353	22.4	12.7	3.46	24.8	4.48	302	262	1.66		239	224	194	58.4
O	385	388	22.2	12.4	3.31	24.5	4.40	295	287	1.65		236	232	189	56.9
O	386	370	22.4	12.6	3.36	24.5	4.32	298	274	1.64		234	231	190	57.4
O	381	375	22.2	12.7	3.30	24.2	4.32	296	277	1.68		233	230	188	56.9
O	381	383	21.8	12.3	3.31	24.2	4.31	291	288	1.65		228	237	188	56.6
P	390		23.4	12.1	3.50	26.5	4.10	289		1.60		273	256	193	57.9
P	362		22.6	12.4	3.30	24.8	4.20	279		1.70		270	263	191	55.5
P	370		22.7	12.2	3.30	25.2	4.10	281		1.70		267	261	192	56.2
P	374		22.6	12.3	3.40	25.8	4.20	284		1.70		270	262	195	56.4
P	355		22.7	12.1	3.30	25.5	4.20	280		1.70		267	265	195	55.9
P	351		22.5	11.7	3.10	24.3	4.10	269		1.60		261	262	185	54.1
P	379		23.6	12.0	3.50	25.9	4.30	285		1.60		270	263	192	56.9
P	367		22.8	12.2	3.20	25.2	4.20	276		1.70		268	263	191	56.1
Q		325							230				223		
Q		348							254				232		
Q		320							235				216		
Q		350							245				242		
Q		317							236				218		
Q		300							224				219		
Q		311							222				213		
Q		349							248				234		

**Assay data – Economic Elements (cont)**

Lab Code	Ce Fusion ppm	Ce M/ICP ppm	Dy Fusion ppm	Er Fusion ppm	Eu Fusion ppm	Gd Fusion ppm	Ho Fusion ppm	La Fusion ppm	La M/ICP ppm	Lu Fusion ppm	Lu M/ICP ppm	Nb Fusion ppm	Nb M/ICP ppm	Nd Fusion ppm	Pr Fusion ppm
R	376		19.0			22.0		295						175	55.0
R	370		19.0			24.0		309						170	56.0
R	355		19.0			23.0		297						171	59.0
R	370		20.0			23.0		297						166	53.0
R	370		19.0			24.0		297						164	55.0
R	366		20.0			23.0		290						171	54.0
R	387		19.0			23.0		293						175	57.0
R	365		19.0			23.0		297						171	57.0
S	340		20.6	10.7	3.40	26.2	4.22	258		1.47		235		186	63.1
S	340		21.0	11.1	3.44	26.9	4.31	259		1.47		238		185	62.5
S	341		21.4	11.3	3.52	27.3	4.45	263		1.52		232		191	64.9
S	327		20.0	10.5	3.16	25.5	4.15	249		1.40		225		176	59.2
S	332		20.4	10.6	3.27	25.7	4.20	254		1.41		224		179	59.4
S	352		21.1	11.3	3.41	27.1	4.40	265		1.49		235		186	62.4
S	360		21.3	11.2	3.42	26.8	4.41	272		1.52		237		183	65.2
S	355		20.8	10.9	3.28	25.8	4.26	267		1.50		231		180	60.5

**Assay data – Economic Elements (cont)**

Lab Code	Sc M/ICP ppm	Sm Fusion ppm	Sr Fusion ppm	Sr M/ICP ppm	Tb Fusion ppm	Tb M/ICP ppm	Th Fusion ppm	Th M/ICP ppm	Tm Fusion ppm	U Fusion ppm	U M/ICP ppm	Y Fusion ppm	Y M/ICP ppm	Yb Fusion ppm	Yb M/ICP ppm
A	8.90	36.2	30.0	19.1	4.37	3.85	62.6	50.7	2.05	12.5	7.88	126	83.9	12.3	6.80
A	8.70	33.1	30.0	19.3	3.98	3.79	58.0	50.6	1.87	11.5	7.84	116	85.2	11.1	7.00
A	8.20	33.6	20.0	18.3	3.94	3.65	55.9	47.8	1.86	11.2	7.43	110	80.7	11.1	6.60
A	8.50	34.6	30.0	19.1	4.04	3.78	57.1	50.9	1.91	11.4	7.79	113	84.2	11.3	6.90
A	8.50	33.8	30.0	19.5	4.07	3.86	56.1	51.2	1.90	10.9	8.02	111	83.5	11.3	7.20
A	8.50	34.2	20.0	19.3	4.13	3.88	57.4	52.0	1.91	11.2	8.22	113	84.5	11.3	7.20
A	8.20	36.3	30.0	19.0	4.26	3.78	58.9	50.9	2.04	11.9	8.09	120	80.2	11.9	6.90
A	8.70	33.9	20.0	20.3	4.07	4.02	56.5	53.5	1.90	11.0	8.35	111	86.8	11.3	7.30
C	7.00	31.3	20.9	21.0	4.18		58.6	39.8	1.93	11.6	7.60	114	63.5	12.4	
C	7.00	30.5	20.5	22.0	4.11		56.5	40.9	1.90	11.3	7.80	114	68.6	11.7	
C	7.00	30.2	21.2	22.0	4.12		54.8	42.5	1.90	11.3	7.80	114	72.2	11.8	
C	7.00	29.5	20.5	22.0	4.13		54.4	41.2	1.99	11.3	7.60	116	71.0	11.8	
C	7.00	30.3	20.7	21.0	4.03		55.9	41.5	1.88	10.8	7.70	115	70.7	12.2	
C	7.00	30.4	21.5	22.0	4.06		55.1	41.7	1.87	11.2	7.70	113	71.2	11.4	
C	7.00	30.8	21.9	21.0	4.13		55.7	41.6	1.91	11.1	7.70	113	70.9	11.8	
C	7.00	29.4	21.2	22.0	4.00		54.2	41.6	1.87	11.4	7.70	108	70.1	11.5	
D	6.40	32.2	27.0	19.6	2.90	3.26	50.1	41.2	1.73	11.6	6.39	131	74.6	10.5	5.00
D	6.70	31.1	28.0	20.6	2.54	3.44	48.6	42.2	1.72	10.4	6.52	123	72.8	9.90	5.70
D	6.80	31.2	27.0	21.6	2.56	3.42	47.5	43.0	1.74	10.3	6.69	126	72.0	9.70	5.50
D	6.50	30.6	27.0	18.9	2.45	3.28	47.3	41.0	1.74	11.1	6.16	123	69.6	9.90	5.00
D	6.30	32.1	26.0	21.0	2.62	3.30	51.7	40.2	1.89	10.8	6.40	137	69.8	10.2	5.60
D	6.60		27.0	21.4		3.29		39.8	1.83		6.39	129	71.5		4.90
D	6.80		25.0	21.0		3.34		40.9	1.87		6.23	133	71.0		5.50
D	6.70		26.0	21.0		3.46		41.7	2.05		6.80	146	73.0		5.80
E	6.45	30.6	13.0		3.96	3.03	50.6	26.1	1.69	10.2	6.42	104	53.3	10.8	5.73
E	8.68	29.4	13.0		3.83	3.64	49.2	33.3	1.62	9.78	6.55	98	53.3	10.3	6.67
E	6.56	29.4	16.0		3.78	3.26	50.7	27.6	1.68	9.94	6.44	101	57.6	10.7	6.16
E	6.56	30.3	16.0		3.91	3.19	50.8	27.7	1.64	10.0	6.32	104	56.6	10.5	5.82
E	5.37	30.6	16.0		3.86	3.04	51.8	24.5	1.66	10.2	6.04	100	54.3	10.8	5.73
E	5.96	30.6	16.0		3.98	2.92	51.2	25.4	1.73	10.1	6.17	102	52.3	10.6	5.41
E	5.00	30.7	13.0		3.91	2.87	52.2	23.5	1.71	9.94	6.17	103	49.4	10.9	5.36
E	4.74	30.3	14.0		4.02	2.69	52.5	22.6	1.71	10.18	6.07	103	49.4	10.7	5.15
F	8.40	29.7	20.7	20.1	3.89		58.4	46.1	1.80	10.9	7.30	121	85.0	10.9	
F	7.50	31.3	21.3	18.4	3.84		59.2	38.3	1.76	11.5	7.20	121	68.7	11.2	
F	6.50	32.4	22.1	16.9	4.17		61.0	35.5	1.86	11.7	6.80	122	62.1	10.8	
F	7.60	32.7	21.1	18.3	4.11		59.9	42.1	1.81	11.5	7.10	119	72.0	11.1	
F	8.00	31.7	20.8	20.1	4.10		60.1	41.5	1.79	11.7	7.30	120	79.1	11.0	
F	8.00	30.4	21.1	19.6	3.53		58.5	43.7	1.79	11.3	7.10	122	82.0	11.0	
F	8.00	32.9	20.8	19.2	4.11		60.9	40.2	1.86	11.6	7.20	122	75.0	10.9	
F	7.40	32.6	21.5	18.4	4.09		59.8	40.3	1.78	11.2	7.30	120	67.5	10.6	
G	8.00			20.5		3.30		51.6			8.50		98.5		7.95
G	8.00			20.0		3.42		52.4			8.60		101.0		7.90
G	8.00			20.0		3.36		49.8			8.50		102.0		8.15
G	8.00			19.0		3.34		51.6			8.20		93.6		7.40
G	8.00			20.5		3.30		52.0			8.60		101.0		7.95
G	8.00			19.5		3.20		53.3			7.90		94.3		6.85
G	8.00			19.0		3.34		51.1			8.30		95.4		7.00
G	8.00			19.0		3.28		51.6			8.30		95.8		7.10
H	7.90	30.7	23.7	18.8	3.94		60.9	34.6	1.78	11.3	8.30	130	53.6	11.4	
H	7.50	33.7	25.0	16.9	4.16		66.0	36.0	1.94	11.9	7.70	136	56.4	12.1	
H	6.90	34.1	25.1	16.3	4.34		67.6	32.0	1.99	12.7	7.90	140	49.7	12.5	
H	7.00	31.1	23.3	16.7	3.82		60.8	31.8	1.81	11.4	7.70	129	49.4	11.4	
H	7.00	30.9	22.3	16.3	3.85		59.7	31.9	1.69	11.3	7.90	122	46.9	11.0	
H	7.20	29.4	22.6	16.9	3.66		57.4	31.1	1.62	10.8	7.60	124	49.3	10.9	
H	8.10	31.5	23.4	18.0	3.98		62.4	40.5	1.81	11.6	8.10	129	62.7	11.5	
H	7.60	34.3	25.2	17.7	4.13		65.2	37.4	1.91	12.2	8.10	141	58.1	11.8	
I	8.00	29.8		21.5	3.75	2.87	56.0	47.1	1.74	11.3	7.40	123	76.0	11.7	6.00
I	7.60	30.8		21.7	3.96	2.73	59.0	48.3	1.90	11.1	7.20	128	76.0	12.0	5.70
I	7.70	31.2		22.3	3.68	2.82	57.0	46.3	1.80	11.1	7.20	127	77.0	11.3	6.00
I	7.60	29.4		22.0	3.62	2.91	59.0	47.1	1.72	10.6	7.40	124	79.0	10.9	6.10
I	8.00	31.1		22.7	3.95	2.98	60.0	47.9	1.85	11.4	7.50	126	79.0	11.4	6.30
I	7.80	31.5		23.1	3.73	3.02	59.0	48.5	1.83	11.6	7.60	128	80.0	11.6	6.00
I	7.80	29.7		22.9	3.76	3.02	55.0	49.3	1.75	10.6	7.50	127	77.0	11.1	6.30
I	7.50	31.9		22.4	3.81	2.83	58.0	49.0	1.88	11.7	7.70	129	78.0	12.0	6.30

## Assay data – Economic Elements (cont)

Lab Code	Sc M/ICP ppm	Sm Fusion ppm	Sr Fusion ppm	Sr M/ICP ppm	Tb Fusion ppm	Tb M/ICP ppm	Th Fusion ppm	Th M/ICP ppm	Tm Fusion ppm	U Fusion ppm	U M/ICP ppm	Y Fusion ppm	Y M/ICP ppm	Yb Fusion ppm	Yb M/ICP ppm
J	8.00			19.7		3.40		50.5			8.85		98.3		7.30
J	8.00			20.3		3.35		49.2			8.54		99.8		7.20
J	8.00			20.7		3.36		48.3			8.41		98.3		7.20
J	8.00			20.4		3.31		48.0			8.37		97.3		7.20
J	8.00			20.0		3.30		47.0			8.22		97.8		7.20
J	8.00			20.1		3.39		47.9			8.24		96.2		7.60
J	8.00			20.1		3.33		48.3			8.57		94.9		7.20
J	8.00			19.7		3.37		48.3			8.72		96.9		7.20
K	8.30	29.7	30.0	20.0	3.71	3.56	58.0	50.9	1.69	11.8	9.21	112	93.2	11.1	7.50
K	8.40	30.2	40.0	20.2	3.79	3.47	59.6	51.5	1.71	11.9	9.07	112	93.7	11.2	7.50
K	8.20	30.0	30.0	19.8	3.78	3.55	59.4	51.0	1.69	12.0	8.98	112	92.3	11.2	7.40
K	8.30	29.8	30.0	19.9	3.72	3.37	58.3	52.3	1.71	11.7	9.18	111	89.7	11.0	7.20
K	8.00	30.3	30.0	19.8	3.69	3.36	59.6	50.0	1.71	11.8	9.68	111	85.0	11.3	6.60
K	8.30	29.9	30.0	20.8	3.70	3.33	58.9	52.2	1.72	11.8	9.95	114	92.9	11.3	7.40
K	8.20	29.3	30.0	20.0	3.72	3.17	58.3	52.8	1.66	11.7	9.70	110	89.3	11.3	7.10
K	8.40	30.2	40.0	19.5	3.86	3.34	60.1	52.1	1.73	11.9	9.84	114	93.9	11.3	7.30
L	7.20	32.7	21.3	18.8	4.03		54.7	31.1	1.78	12.0	7.00	121	51.8		11.6
L	7.40	33.5	23.1	20.2	3.95		54.5	34.1	1.77	11.8	7.00	122	56.6		11.6
L	7.40	33.2	21.6	20.3	4.03		56.1	34.0	1.83	12.1	6.90	124	57.3		11.7
L	7.60	32.8	20.8	20.8	3.99		54.2	35.0	1.81	11.8	7.20	120	57.7		11.4
L	7.90	33.1	21.4	20.9	4.00		54.7	37.6	1.85	11.6	7.40	121	60.9		11.5
L	7.80	32.8	21.8	21.3	3.96		54.4	36.3	1.81	11.9	7.40	121	59.4		11.6
L	7.30	30.7	19.8	20.3	3.80		51.2	32.8	1.74	10.9	7.20	114	55.7		10.8
L	7.70	32.1	21.7	20.9	3.97		53.6	37.0	1.83	11.6	7.30	121	60.1		11.4
N		32.5	20.0		3.50		59.0		2.00	11.0		110			10.0
N		33.0	20.0		3.50		61.0		2.00	12.0		110			11.0
N		32.5	20.0		4.00		60.0		2.00	11.5		110			11.0
N		33.0	20.0		3.50		60.0		2.00	11.5		110			11.0
N		34.5	20.0		4.00		62.5		2.00	11.5		112			10.0
N		32.0	20.0		3.50		60.0		2.00	12.0		110			10.0
N		33.0	20.0		3.50		61.5		2.00	12.0		112			11.0
N		33.0	20.0		4.00		62.5		2.00	12.0		111			11.0
O	7.80	31.6	21.9	20.0	3.92		53.6	50.4	1.79	11.9	7.90	122	87.5		11.3
O	7.60	33.0	22.6	20.0	3.96		54.0	49.8	1.76	12.0	7.80	125	86.2		11.7
O	8.10	31.8	21.7	20.3	3.81		52.4	50.9	1.68	11.7	8.00	120	90.1		11.3
O	7.60	32.1	22.2	19.5	3.88		52.9	48.0	1.72	11.7	7.60	122	85.8		11.6
O	8.20	31.4	21.9	20.2	3.78		52.0	52.0	1.72	11.4	8.10	120	91.0		11.2
O	7.90	31.8	21.9	19.7	3.82		52.2	49.6	1.73	11.7	7.80	121	88.6		11.3
O	8.10	31.3	21.5	19.9	3.79		51.9	51.1	1.71	11.5	7.90	121	88.5		11.3
O	8.30	30.5	21.6	20.4	3.75		51.5	51.6	1.69	11.5	8.00	119	91.5		11.1
P	7.00	33.3	25.0		4.00		58.7	29.5	1.80	11.4	7.53	118	80.6		11.1
P	8.00	33.6	23.0	20.0	3.90		56.9	51.7	1.90	11.2	8.19	117	90.8		10.6
P	8.00	32.3	24.0	20.4	4.00		59.0	51.7	1.90	11.1	8.14	117	89.8		11.0
P	8.00	33.2	23.0	20.0	3.90		58.3	50.4	1.90	11.3	8.03	119	86.1		11.0
P	8.00	33.1	22.0	20.7	4.00		55.8	51.5	1.80	11.3	8.32	116	90.0		11.1
P	8.00	31.7	22.0	19.6	3.90		55.9	51.5	1.80	10.9	8.16	119	86.2		10.8
P	6.00	33.4	23.0	19.3	4.00		58.2	47.4	1.80	11.5	7.23	119	48.0		11.2
P	8.00	32.1	22.0	19.9	3.90		57.9	54.2	1.80	11.2	8.53	118	88.9		11.0
Q	7.70			20.2				42.6			6.90		73.7		
Q	8.00			21.0				44.9			7.30		79.0		
Q	7.40			20.2				40.8			6.90		73.8		
Q	8.30			22.7				45.5			7.50		81.2		
Q	7.50			20.0				41.7			6.80		73.6		
Q	7.30			19.7				39.7			6.70		70.9		
Q	7.30			19.7				41.4			6.90		71.9		
Q	8.00			21.5				45.3			7.40		80.1		
R		28.0										99.0			
R		31.0										107			
R		34.0										109			
R		32.0										118			
R		30.0										111			
R		31.0										113			
R		31.0										113			
R		28.0										101			
S		32.1	19.5		4.21		26.9		1.68	10.1		99.1		9.79	
S		32.2	19.2		4.27		27.2		1.71	10.0		100		9.78	
S		33.2	19.2		4.37		27.8		1.78	10.3		100		10.1	
S		30.5	18.3		4.09		51.1		1.63	9.75		95.7		9.42	
S		30.9	18.6		4.17		26.1		1.66	9.77		96.2		9.47	
S		32.3	19.2		4.35		27.7		1.75	10.3		101		9.85	
S		32.4	19.4		4.30		28.1		1.75	10.3		102		10.0	
S		31.4	18.8		4.21		27.6		1.73	10.3		100		9.90	

## Assay data Major Oxides

Lab Code	Al2O3 XRF %	CaO XRF %	Cr2O3 XRF %	Fe2O3 XRF %	K2O XRF %	MgO XRF %	MnO XRF %	Na2O XRF %	P2O5 XRF %	SiO2 XRF %	TiO2 XRF %	LOI %	SG pyc
A	6.80	0.40	0.09	9.97	1.94	0.91	0.15	0.49	0.08	48.0	0.78	10.7	2.53
A	7.00	0.40	0.09	9.98	1.96	0.88	0.15	0.49	0.09	48.2	0.78	10.9	2.55
A	6.60	0.40	0.09	10.0	1.95	0.89	0.15	0.54	0.08	48.3	0.78	10.6	2.55
A	6.90	0.42	0.09	10.0	1.95	0.89	0.15	0.48	0.09	48.3	0.78	10.7	2.54
A	7.20	0.40	0.09	9.97	1.96	0.89	0.15	0.55	0.08	48.1	0.78	10.8	2.55
A	7.20	0.41	0.09	10.00	1.95	0.90	0.15	0.49	0.08	48.2	0.78	10.7	2.55
A	6.90	0.41	0.10	10.00	1.95	0.92	0.15	0.54	0.09	48.1	0.77	10.8	2.55
A	7.30	0.40	0.09	9.94	1.96	0.90	0.15	0.54	0.08	48.0	0.78	11.1	2.55

**Assay data Major Oxides (cont)**

Lab Code	Al2O3 XRF %	CaO XRF %	Cr2O3 XRF %	Fe2O3 XRF %	K2O XRF %	MgO XRF %	MnO XRF %	Na2O XRF %	P2O5 XRF %	SiO2 XRF %	TiO2 XRF %	LOI %	SG pyc
C		0.41	0.09	9.72	1.96	0.87	0.15	0.48	0.07	47.7	0.77	10.9	2.52
C		0.41	0.09	9.81	1.97	0.86	0.15	0.49	0.08	48.0	0.77	10.9	2.51
C		0.40	0.10	9.70	1.96	0.85	0.15	0.49	0.08	47.9	0.77	10.9	2.49
C		0.40	0.09	9.69	1.95	0.85	0.15	0.48	0.08	47.5	0.76	10.9	2.49
C		0.40	0.09	9.71	1.96	0.86	0.15	0.49	0.08	47.9	0.77	10.8	2.50
C		0.41	0.09	9.69	1.99	0.88	0.15	0.50	0.08	48.4	0.78	10.8	2.49
C		0.40	0.09	9.71	1.95	0.86	0.15	0.50	0.08	47.8	0.76	10.9	2.49
C		0.40	0.09	9.79	1.96	0.86	0.15	0.49	0.08	47.9	0.77	10.9	2.49
D	5.00	0.38	0.09	9.34	1.83	0.83	0.14	0.61	0.08	46.0	0.73	11.1	2.64
D	5.70	0.38	0.09	8.89	1.81	0.85	0.14	0.63	0.08	45.2	0.72	11.1	2.65
D	5.50	0.38	0.09	9.39	1.85	0.81	0.14	0.63	0.08	45.8	0.73	11.1	2.63
D	5.00	0.38	0.09	9.45	1.85	0.80	0.15	0.60	0.08	46.2	0.74	11.1	2.63
D	5.60	0.38	0.09	9.41	1.85	0.79	0.14	0.60	0.08	46.2	0.74	11.1	2.65
D	4.90	0.38	0.10	9.41	1.85	0.83	0.14	0.58	0.08	46.2	0.74	11.1	2.64
D	5.50	0.35	0.09	9.41	1.85	0.79	0.13	0.61	0.08	46.2	0.73	11.1	2.64
D	5.80	0.41	0.18	9.19	1.82	0.83	0.14	0.59	0.08	45.8	0.73	11.1	2.64
E	5.73	0.40	0.09	9.79	1.92	0.83	0.14	0.55		47.5	0.76	12.1	2.50
E	6.67	0.40	0.09	9.85	1.93	0.85	0.15	0.55		48.3	0.77	12.4	2.53
E	6.16	0.40	0.09	9.79	1.91	0.86	0.14	0.53		47.9	0.75	12.5	2.53
E	5.82	0.40	0.09	9.78	1.92	0.87	0.15	0.58		47.9	0.75	12.4	2.55
E	5.73	0.40	0.09	9.90	1.94	0.85	0.15	0.57		48.0	0.74	12.2	2.53
E	5.41	0.41	0.09	9.80	1.93	0.87	0.15	0.53		47.7	0.75	12.0	2.52
E	5.36	0.40	0.09	9.85	1.93	0.89	0.15	0.54		47.7	0.75	12.1	2.50
E	5.15	0.41	0.09	9.86	1.94	0.88	0.15	0.57		47.8	0.75	11.7	2.49
F		0.40	0.10	9.80	1.92	0.87	0.15	0.52	0.08	47.3	0.74	11.4	
F		0.40	0.09	9.78	1.92	0.86	0.15	0.52	0.08	47.3	0.75	11.8	
F		0.40	0.09	9.72	1.91	0.86	0.15	0.52	0.08	47.1	0.74	11.8	
F		0.40	0.09	9.74	1.90	0.86	0.15	0.52	0.08	47.2	0.74	12.0	
F		0.39	0.09	9.72	1.91	0.86	0.15	0.52	0.08	47.1	0.74	11.9	
F		0.39	0.09	9.71	1.90	0.86	0.15	0.51	0.08	47.0	0.74	11.8	
F		0.40	0.10	9.79	1.92	0.86	0.15	0.51	0.08	47.3	0.75	11.8	
F		0.40	0.09	9.80	1.92	0.86	0.15	0.52	0.08	47.4	0.75	11.7	
G	7.95	0.40		9.82		0.89	0.15		0.08	48.0	0.74	11.0	2.75
G	7.90	0.39		9.75		0.89	0.16		0.08	47.7	0.74	11.1	2.73
G	8.15	0.39		9.72		0.88	0.15		0.08	47.7	0.73	11.1	2.75
G	7.40	0.40		9.78		0.89	0.15		0.08	47.9	0.74	11.1	2.72
G	7.95	0.40		9.80		0.88	0.15		0.08	47.9	0.74	11.0	2.72
G	6.85	0.40		9.78		0.88	0.15		0.08	47.8	0.74	11.0	2.73
G	7.00	0.40		9.82		0.87	0.16		0.08	48.1	0.75	11.0	2.70
G	7.10	0.39		9.78		0.88	0.15		0.08	47.9	0.74	11.0	2.72
H		0.39	0.08	9.72	1.90	0.85	0.15	0.53	0.08	47.1	0.73	11.2	
H		0.40	0.09	9.77	1.92	0.87	0.15	0.55	0.08	47.3	0.74	11.2	
H		0.40	0.08	9.75	1.92	0.86	0.15	0.55	0.08	47.1	0.74	11.2	
H		0.40	0.09	9.76	1.92	0.86	0.15	0.54	0.08	47.3	0.74	11.2	
H		0.40	0.08	9.72	1.92	0.86	0.15	0.55	0.08	47.2	0.74	11.2	
H		0.39	0.09	9.71	1.91	0.86	0.15	0.54	0.08	47.1	0.74	11.2	
H		0.40	0.09	9.77	1.93	0.86	0.15	0.54	0.08	47.3	0.74	11.2	
H		0.39	0.08	9.70	1.91	0.86	0.15	0.54	0.08	47.2	0.74	11.2	
I	6.00												2.60
I	5.70												2.61
I	6.00												2.63
I	6.10												2.63
I	6.30												2.63
I	6.00												2.63
I	6.30												2.61
I	6.30												2.61
J	7.30	0.41	0.10	9.76	1.93	0.88	0.14	0.53	0.08	47.7	0.75	11.0	
J	7.20	0.39	0.10	9.75	1.95	0.88	0.15	0.52	0.08	47.7	0.74	11.1	
J	7.20	0.40	0.11	9.74	1.91	0.88	0.15	0.52	0.08	47.7	0.74	11.1	
J	7.20	0.40	0.10	9.76	1.91	0.89	0.14	0.52	0.08	47.6	0.75	11.1	
J	7.20	0.40	0.10	9.71	1.90	0.89	0.14	0.53	0.08	47.6	0.73	11.1	
J	7.60	0.40	0.10	9.75	1.92	0.88	0.14	0.52	0.08	47.4	0.73	11.1	
J	7.20	0.40	0.10	9.74	1.91	0.88	0.14	0.53	0.08	47.6	0.74	11.1	
J	7.20	0.40	0.10	9.74	1.91	0.88	0.14	0.52	0.08	47.7	0.75	11.1	
K	7.50	0.40	0.10	9.68	1.92	0.87	0.14	0.52	0.08	46.8	0.74	12.5	
K	7.50	0.41	0.10	9.70	1.91	0.85	0.15	0.52	0.08	46.7	0.75	12.6	
K	7.40	0.41	0.10	9.71	1.92	0.85	0.14	0.52	0.08	47.0	0.75	12.6	
K	7.20	0.41	0.09	9.74	1.91	0.88	0.15	0.51	0.08	46.8	0.74	12.5	
K	6.60	0.41	0.10	9.69	1.91	0.84	0.14	0.50	0.08	46.6	0.75	12.5	
K	7.40	0.41	0.09	9.75	1.92	0.88	0.14	0.51	0.08	47.0	0.76	12.6	
K	7.10	0.40	0.10	9.69	1.91	0.85	0.14	0.51	0.08	46.6	0.74	12.4	
K	7.30	0.41	0.10	9.69	1.90	0.85	0.13	0.50	0.07	46.8	0.74	12.5	
L		0.40	0.09	9.76	1.92	0.86	0.15	0.54	0.08	47.4	0.74	11.2	2.59
L		0.40	0.09	9.77	1.92	0.86	0.15	0.54	0.08	47.4	0.74	11.2	2.63
L		0.40	0.09	9.72	1.90	0.86	0.15	0.53	0.08	47.2	0.73	11.1	2.59
L		0.41	0.09	9.80	1.92	0.87	0.15	0.54	0.08	47.5	0.74	11.2	2.62
L		0.40	0.09	9.70	1.91	0.86	0.15	0.53	0.08	47.3	0.73	11.1	2.62
L		0.40	0.09	9.76	1.92	0.86	0.15	0.53	0.08	47.5	0.74	11.2	2.60
L		0.40	0.10	9.74	1.92	0.86	0.15	0.54	0.08	47.2	0.73	11.2	2.67
L		0.41	0.09	9.80	1.92	0.87	0.15	0.54	0.08	47.5	0.74	11.2	2.62



## Assay data Major Oxides

Lab Code	Al2O3 XRF %	CaO XRF %	Cr2O3 XRF %	Fe2O3 XRF %	K2O XRF %	MgO XRF %	MnO XRF %	Na2O XRF %	P2O5 XRF %	SiO2 XRF %	TiO2 XRF %	LOI %	SG pyc
N		0.40	0.09	9.66	1.85	0.87	0.15	0.51	0.08	48.1	0.73	10.8	2.57
N		0.40	0.09	9.71	1.86	0.87	0.15	0.51	0.08	48.1	0.74	10.8	2.75
N		0.40	0.09	9.71	1.86	0.87	0.15	0.51	0.08	48.0	0.74	10.8	2.58
N		0.40	0.09	9.68	1.85	0.87	0.15	0.51	0.08	48.1	0.74	10.8	2.58
N		0.40	0.09	9.71	1.85	0.87	0.15	0.50	0.08	48.0	0.73	10.9	2.58
N		0.40	0.09	9.68	1.85	0.87	0.15	0.51	0.08	47.9	0.73	10.9	2.58
N		0.40	0.09	9.69	1.85	0.87	0.15	0.51	0.08	48.0	0.73	10.9	2.60
N		0.40	0.09	9.71	1.85	0.87	0.15	0.51	0.08	48.0	0.73	11.0	2.57
P		0.41		9.66	1.92	0.86	0.15	0.45		47.8	0.75		
P		0.41		9.63	1.92	0.87	0.15	0.45		47.7	0.75		
P		0.41		9.65	1.91	0.86	0.15	0.46		47.6	0.75		
P		0.41		9.67	1.92	0.86	0.15	0.46		47.8	0.76		
P		0.41		9.64	1.92	0.86	0.15	0.47		47.7	0.76		
P		0.41		9.61	1.91	0.86	0.15	0.46		47.6	0.76		
P		0.41		9.62	1.92	0.86	0.15	0.45		47.6	0.76		
P		0.41		9.59	1.92	0.87	0.15	0.46		47.6	0.76		
Q		0.40	0.09	9.74	1.92	0.86	0.15	0.52	0.08	47.6	0.74	11.3	
Q		0.40	0.09	9.79	1.92	0.87	0.15	0.53	0.08	47.8	0.74	11.2	
Q		0.40	0.09	9.75	1.90	0.86	0.15	0.53	0.08	47.6	0.73	11.2	
Q		0.40	0.10	9.77	1.92	0.86	0.15	0.53	0.08	47.7	0.74	11.2	
Q		0.40	0.09	9.71	1.91	0.85	0.15	0.52	0.08	47.4	0.74	11.2	
Q		0.40	0.09	9.80	1.92	0.86	0.15	0.53	0.08	47.8	0.74	11.3	
Q		0.40	0.09	9.71	1.91	0.86	0.15	0.52	0.08	47.4	0.73	11.3	
Q		0.40	0.09	9.80	1.92	0.86	0.15	0.53	0.08	47.8	0.74	11.2	
R		0.42	0.09	9.55	1.87	0.77	0.16		0.07	45.9	0.72	13.7	
R		0.42	0.09	9.45	1.85	0.65	0.16		0.07	45.3	0.71	13.7	
R		0.42	0.09	9.57	1.88	0.71	0.16		0.07	46.1	0.72	13.7	
R		0.43	0.09	9.53	1.87	0.68	0.16		0.07	46.0	0.72	13.7	
R		0.41	0.09	9.55	1.86	0.70	0.16		0.07	46.0	0.72	13.7	
R		0.42	0.09	9.57	1.87	0.68	0.16		0.07	46.1	0.72	13.7	
R		0.42	0.09	9.54	1.87	0.74	0.16		0.07	45.9	0.72	13.7	
R		0.42	0.09	9.58	1.87	0.72	0.16		0.07	46.1	0.72	13.6	
S		0.40	0.08	9.56	1.84	0.83	0.15	0.50	0.07	45.1	0.74	14.3	2.58
S		0.39	0.09	9.56	1.87	0.84	0.14	0.49	0.07	46.0	0.74	14.3	2.58
S		0.38	0.09	9.56	1.84	0.84	0.15	0.48	0.07	45.4	0.74	14.3	2.63
S		0.39	0.09	9.55	1.84	0.84	0.14	0.49	0.07	45.8	0.73	14.4	2.61
S		0.39	0.10	9.53	1.85	0.84	0.15	0.49	0.07	45.0	0.73	14.4	2.60
S		0.39	0.09	9.51	1.84	0.83	0.15	0.48	0.07	45.6	0.72	14.3	2.58
S		0.38	0.09	9.56	1.86	0.84	0.14	0.50	0.07	45.5	0.74	14.4	2.58
S		0.39	0.09	9.60	1.86	0.84	0.14	0.48	0.08	45.7	0.74	14.3	2.63

### 12. Measurement of Uncertainty :( ref Dr Hugh Bartlett, Hugh Bartlett Consulting CC.)

The samples used in the certification process were selected in such a way as to represent the entire batch of material and were taken from the final packaged units; therefore all possible sources of uncertainty (sample uncertainty and measurement uncertainty) are included in the final combined standard uncertainty determination.

The uncertainty measurement takes into consideration the between lab and the within lab variances and is calculated from the square roots of the variances of these components using the formula:

$$\text{Combined standard uncertainty} = \sqrt{(\text{between lab.var/no of labs}) + (\text{mean square within lab.var /no of assays})}$$

These uncertainty measurements may be used, by laboratories, as a component for calculating the total uncertainty for method validation according to the relevant ISO guidelines.

Analyte	Method	Unit	S <sup>1</sup>	$\sigma_L$ <sup>2</sup>	Sw <sup>3</sup>	CSU <sup>4</sup>
Ce	Fusion	ppm	13.30	9.22	7.03	2.76
Ce	M/ICP	ppm	23.79	20.71	10.57	7.02
Dy	Fusion	ppm	0.81	0.56	0.42	0.17
Er	Fusion	ppm	0.52	0.33	0.33	0.10
Eu	Fusion	ppm	0.14	0.08	0.10	0.03
Gd	Fusion	ppm	1.36	1.00	0.63	0.30
Ho	Fusion	ppm	0.17	0.11	0.12	0.03
La	Fusion	ppm	10.0	6.4	5.65	1.87
La	M/ICP	ppm	19.2	18.4	6.34	6.55
Lu	Fusion	ppm	0.10	0.07	0.06	0.02
Lu	M/ICP	ppm	0.15	0.16	0.04	0.06
Nb	Fusion	ppm	17.79	14.28	7.47	4.38
Nb	M/ICP	ppm	12.62	8.92	6.90	2.67
Nd	Fusion	ppm	5.88	3.38	4.24	1.07
Pr	Fusion	ppm	1.95	1.26	1.08	0.37
Sc	M/ICP	ppm	0.50	0.34	0.26	0.10
Sm	Fusion	ppm	1.40	0.79	0.93	0.23
Sr	Fusion	ppm	1.33	1.23	0.56	0.44
Sr	M/ICP	ppm	0.87	0.54	0.61	0.18
Tb	Fusion	ppm	0.16	0.11	0.10	0.03
Tb	M/ICP	ppm	0.28	0.28	0.12	0.11
Th	Fusion	ppm	3.23	2.54	1.37	0.78
Th	M/ICP	ppm	4.51	3.74	1.50	1.14
Tm	Fusion	ppm	0.09	0.06	0.06	0.02
U	Fusion	ppm	0.35	0.15	0.30	0.06
U	M/ICP	ppm	0.67	0.50	0.24	0.14
Y	Fusion	ppm	8.18	6.03	3.01	1.70
Y	M/ICP	ppm	10.23	8.50	3.49	2.59
Yb	Fusion	ppm	0.36	0.22	0.25	0.07
Yb	M/ICP	ppm	0.86	0.90	0.34	0.34
Al <sub>2</sub> O <sub>3</sub>	XRF	%	0.213	0.156	0.083	0.044
CaO	XRF	%	0.006	0.003	0.004	0.001
Cr <sub>2</sub> O <sub>3</sub>	XRF	%	0.005	0.002	0.004	0.001
Fe <sub>2</sub> O <sub>3</sub>	XRF	%	0.077	0.056	0.031	0.016
K <sub>2</sub> O	XRF	%	0.035	0.026	0.009	0.007
LOI		%	0.162	0.147	0.064	0.049
MgO	XRF	%	0.013	0.008	0.008	0.003
MnO	XRF	%	0.004	0.002	0.002	0.001
Na <sub>2</sub> O	XRF	%	0.020	0.015	0.011	0.005
P <sub>2</sub> O <sub>5</sub>	XRF	%	0.002	0.002	0.001	0.000
SiO <sub>2</sub>	XRF	%	0.372	0.285	0.147	0.084
TiO <sub>2</sub>	XRF	%	0.010	0.007	0.006	0.002
SG	pyc		0.064	0.060	0.016	0.020

1. S - Std Dev for use on control charts.
2.  $\sigma_L$  - Betw Lab Std Dev, for use to calculate a measure of accuracy.
3. Sw - Within Lab Stc Dev, for use to calculate a measure of precision.
4. CSU - Combined Standard Uncertainty, a component for use to calculate the total uncertainty in method validation.

**13. Certified values:** The Certified, Provisional and Informational values listed on p1 and p2 of this certificate fulfill the AMIS statistical criteria regarding agreement for certification and have been independently validated by Ms Margaret Fairhurst.

**14. Metrological Traceability:** The values quoted herein are based on the consensus values derived from statistical analysis of the data from an inter laboratory measurement program. Traceability to SI units is via the standards used by the individual laboratories, the majority of which are accredited, who have maintained measurement traceability during the analytical process.

**15. Certification:** AMIS0275 is a new material.

**16. Period of validity:** The certified values are valid for this product, while still sealed in its original packaging, until notification to the contrary. The stability of the material will be subject to continuous testing for the duration of the inventory. Should product stability become an issue, all customers will be notified and notification to that effect will be placed on the [www.amis.co.za](http://www.amis.co.za) website.

**17. Minimum sample size:** The majority of laboratories reporting used a 0.5g sample size for the ICP. This is the recommended minimum sample size for the use of this material.

**18. Availability:** This product is available in Laboratory Packs containing 1kg of material and Explorer Packs containing custom weights (from 50g to 250g) of material. The Laboratory Packs are sealed bottles delivered in sealed foil pouches. The Explorer Packs contain material in standard geochem envelopes, vacuum sealed in foil pouches.

**19. Recommended use:** The data used to characterize this CRM has been scrutinized using outlier treatment techniques. This, together with the number of participating laboratories, should overcome any "inter-laboratory issues" and should lead to a very accurate measure for the given methods, notwithstanding the underlying assumption that what the good inter-laboratory labs reported was accurate. However an amount of bad data might have had an effect, resulting in limits which in some situations might be too broad for the effective monitoring of a single analytical method, laboratory or production process. Users should set their own limits based on their own data quality objectives and control measurements, after determining the performance characteristics of their own particular method, using a minimum of 20 analyses using this CRM. User set limits should normally be within the limits recommended on p1 and 2 of this certificate.

**20. Legal Notice:** This certificate and the reference material described in it have been prepared with due care and attention. However AMIS, Set Point Technology (Pty) Ltd, Mike McWha and Margaret M. Fairhurst; accept no liability for any decisions or actions taken following the use of the reference material.

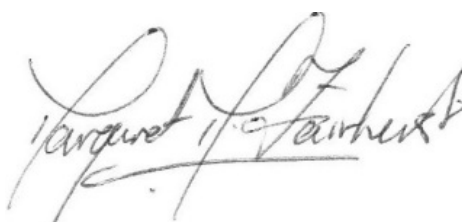
17 October 2014

**Certifying Officers:**



**African Mineral Standards:** \_\_\_\_\_

**Mike McWha**  
**BSc (Hons), FGSSA, MAusIMM, Pr.Sci.Nat**



**Geochemist:** \_\_\_\_\_

**Margaret M. Fairhurst, PG, MAusIMM**  
**Oreval**

### Appendix 1. – Uncertified element statistics

Analyte	Method	Unit	Mean	2SD	RSD%	n
Ag	M/ICP	ppm	0.46	0.90	98.4	73
Al	M/ICP	%	12.4	1.97	7.93	113
As	M/ICP	ppm	13.7	3.59	13.1	119
Ba	M/ICP	ppm	195	22.5	5.78	105
Be	M/ICP	ppm	5.09	1.31	12.9	119
Bi	M/ICP	ppm	0.54	0.08	7.48	108
Ca	M/ICP	%	0.27	0.04	7.97	113
Cd	M/ICP	ppm	0.15	0.15	48.5	106
Co	M/ICP	ppm	14.7	1.98	6.73	128
Cr	M/ICP	ppm	473	260	27.5	109
Cs	M/ICP	ppm	5.22	1.08	10.3	108
Cu	M/ICP	ppm	53.1	6.38	6.01	129
Fe	M/ICP	%	6.41	0.73	5.72	124
Ga	M/ICP	ppm	45.8	4.37	4.77	103
Ge	M/ICP	ppm	0.67	0.74	54.9	80
Hf	M/ICP	ppm	6.87	2.08	15.1	107
In	M/ICP	ppm	0.14	0.03	10.6	116
K	M/ICP	%	1.50	0.14	4.82	118
La	M/ICP	ppm	235	128	27.3	96
Li	M/ICP	ppm	24.5	4.81	9.82	120
Mg	M/ICP	%	0.46	0.10	10.5	108
Mn	M/ICP	ppm	1070	130	6.06	110
Mo	M/ICP	ppm	9.87	0.88	4.46	120
Na	M/ICP	%	0.38	0.04	4.86	112
Ni	M/ICP	ppm	65.1	7.88	6.05	128
P	M/ICP	ppm	323	57.9	8.96	120
Pb	M/ICP	ppm	53.3	5.85	5.49	115
Rb	M/ICP	ppm	100	18.9	9.41	112
Re	M/ICP	ppm	0.02	0.07	227	41
S	M/ICP	%	0.04	0.01	10.4	115
Sb	M/ICP	ppm	1.26	0.21	8.44	122
Se	M/ICP	ppm	2.83	1.40	24.8	64
Si	M/ICP	%	22.4	0.17	0.37	8
Sn	M/ICP	ppm	10.9	1.52	6.97	120
Ta	M/ICP	ppm	15.6	5.29	17.0	120
Te	M/ICP	ppm	0.12	0.09	37.0	81
Th	M/ICP	ppm	44.9	13.1	14.6	105
Ti	M/ICP	%	0.41	0.05	6.01	112
Tl	M/ICP	ppm	0.85	0.10	5.74	119
V	M/ICP	ppm	43.2	5.73	6.64	112
W	M/ICP	ppm	5.54	0.91	8.23	120
Zn	M/ICP	ppm	119	15.6	6.56	114
Zr	M/ICP	ppm	296	180	30.4	115

## Appendix 2. – Rare Earth Oxide Content

AMIS0275 Rare Earth Element content by different reporting conventions (Total, Critical, Light, Medium, Heavy).

TREE	978	ppm	La+Ce+Pr+Nd+Sm+Eu+Gd+Tb+Dy+Ho+Er+Tm+Yb+Lu+Y
CREE	332	ppm	Nd+Eu+Tb+Dy+Y
LREE	919	ppm	La+Ce+Pr+Nd
MREE	60	ppm	Sm+Eu+Gd
HREE	173	ppm	Tb+Dy+Ho+Er+Tm+Yb+Lu+Y

AMIS0275 Rare Earth Oxide content by different reporting conventions.

TREO	1358	ppm	(La+Ce+Pr+Nd+Sm+Eu+Gd+Tb+Dy+Ho+Er+Tm+Yb+Lu+Y) <sub>2</sub> O <sub>3</sub>
CREO	399	ppm	(Nd+Eu+Tb+Dy+Y) <sub>2</sub> O <sub>3</sub>
LREO	1076	ppm	(La+Ce+Pr+Nd) <sub>2</sub> O <sub>3</sub>
MREO	70	ppm	(Sm+Eu+Gd) <sub>2</sub> O <sub>3</sub>
HREO	212	ppm	(Tb+Dy+Ho+Er+Tm+Yb+Lu+Y) <sub>2</sub> O <sub>3</sub>

Ref: *Rare-Earth Terminology - A Quick Refresher On The Basics*, by Gareth Hatch, December 11, 2012; <http://www.techmetalsresearch.com/2012/12/rare-earth-terminology-a-quick-refresher-on-the-basics/>