



Tel: +27 (0) 11 923 0800, Fax: +27 (0) 11 392 4715, web: www.amis.co.za
11 Gewel Street (off Hulley Road), D1 Isando Business Park, Kempton Park, 1609
P.O. Box 856, Isando, 1600, Gauteng, South Africa, a division of the Set Point Group

AMIS0276

Certified Reference Material

Rare Earth Elements TRE Project, Madagascar

Certificate of Analysis

Recommended Concentrations and Limits^{1, 2} (at two Standard Deviations)

Certified Concentrations

Ce FUS	215	±	17	ppm
Dy FUS	8.4	±	0.7	ppm
Er FUS	5.4	±	0.4	ppm
Gd FUS	8.4	±	1.2	ppm
Ho FUS	1.8	±	0.1	ppm
La FUS	75.4	±	5.9	ppm
La M/ICP	76.6	±	8.1	ppm
Nb Fus	107	±	11	ppm
Nb M/ICP	108	±	7	ppm
Nd FUS	53.8	±	4.3	ppm
Pr FUS	15.3	±	1.1	ppm
Sm FUS	9.7	±	0.9	ppm
Sr M/ICP	16.6	±	1.7	ppm
U Fus	6.9	±	0.5	ppm
Yb FUS	5.4	±	0.5	ppm
Yb M/ICP	3.4	±	0.3	ppm
Specific Gravity	2.58	±	1.2	

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. TREO = 539 ppm (see Appendix 2)

Provisional Concentrations

Ce M/ICP	208	±	42	ppm
Eu FUS	1.37	±	0.16	ppm
Lu FUS	8.3	±	0.1	ppm
Lu M/ICP	0.5	±	0.1	ppm
Sc M/ICP	13.1	±	1.6	ppm
Sr FUS	17.9	±	4.2	ppm
Tb FUS	1.4	±	0.2	ppm
Tb M/ICP	1.2	±	0.1	ppm
Th Fus	34.7	±	5.3	ppm
Th M/ICP	27.9	±	4.7	ppm
Tm FUS	0.81	±	0.08	ppm
U M/ICP	4.90	±	1.10	ppm
Y FUS	46.6	±	6.0	ppm

Indicated Means

Y M/ICP	33.2	ppm
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Major Element Recommended Concentrations and Limits (at two Standard Deviations)

Certified Concentrations

Al ₂ O ₃	23.9	±	0.4	%
CaO	0.3	±	0.01	%
Fe ₂ O ₃	9.7	±	0.2	%
K ₂ O	1.7	±	0.04	%
MgO	0.6	±	0.02	%
MnO	0.1	±	0.01	%
P ₂ O ₅	0.090	±	0.002	%
SiO ₂	51.4	±	0.8	%
TiO ₂	1.0	±	0.04	%
LOI	10.2	±	0.3	%

Provisional Concentrations

Cr ₂ O ₃	0.03	±	0.01	%
Na ₂ O	0.3	±	0.06	%

1. **Intended Use:** AMIS0276 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: AMIS0276 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 Dark Yellowish Brown powder (Corstor colour chart – 10YR 6/6).

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 <54µm. Wet sieve particle size analysis of random samples confirmed the material was 98.5% <54µm. 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_2O_3 , CaO , Cr_2O_3 , Fe_2O_3 , K_2O , MgO , MnO , Na_2O , P_2O_5 , SiO_2 , TiO_2 . 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: Eighteen laboratories were each given eight randomly selected packages of sample. Sixteen 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 16 out of 18 laboratories that provided results timeously were (not in same order as in the table of assays):

- 1 ACME Vancouver
- 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 SGS Geosol Laboratories Ltda (Brazil)
- 12 SGS Mineral Services Callao (Peru)
- 13 SGS Mineral Services Lakefield (Canada)
- 14 SGS South Africa (Pty) Ltd - Booyens JHB
- 15 SGS Vancouver (Canada)
- 16 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.

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
B	221	228	8.40	5.17	1.42	8.61	1.64	74.70	74.70	0.83	0.51	105	112	54.70	
B	231	226	8.90	5.70	1.46	9.29	1.75	78.30	73.90	0.87	0.51	107	111	57.50	
B	229	217	9.61	5.77	1.48	9.52	1.86	78.00	71.00	0.93	0.49	106	107	57.40	
B	224	230	8.67	5.35	1.45	8.67	1.71	76.20	75.10	0.84	0.51	106	113	56.20	
B	229	224	8.92	5.61	1.46	8.92	1.75	77.50	73.80	0.90	0.52	107	114	56.70	
B	222	225	8.48	5.46	1.46	8.87	1.70	76.10	73.10	0.86	0.51	108	110	55.60	
B	224	221	8.52	5.35	1.46	8.94	1.69	76.20	71.70	0.86	0.49	107	107	55.70	
B	226	219	8.82	5.46	1.44	8.92	1.75	77.30	71.30	0.87	0.50	108	111	56.30	
C	206	219	8.40	5.20	1.40	8.00	1.70	74.10	81.90	0.80	0.52	131	108	53.80	15.80
C	212	223	8.50	5.00	1.40	8.40	1.70	74.30	80.40	0.90	0.53	128	111	54.70	16.20
C	204	218	8.50	5.10	1.40	8.00	1.80	73.20	79.50	0.80	0.53	129	108	55.30	15.70
C	217	221	8.30	5.20	1.50	8.40	1.70	80.30	79.70	0.90	0.54	131	107	59.00	17.40
C	209	222	8.60	5.30	1.40	8.30	1.80	75.20	80.40	0.90	0.54	130	110	57.20	16.20
C	207	224	8.60	5.30	1.50	8.20	1.80	74.30	80.10	0.90	0.54	129	111	55.30	16.20
C	203	221	8.30	5.40	1.30	8.30	1.80	75.00	82.50	0.80	0.55	132	112	56.10	16.10
C	202	217	8.60	5.20	1.40	8.40	1.70	73.60	82.00	0.80	0.55	131	111	55.20	15.70
D	216	200	8.71	5.44	1.41	9.37	1.76	78.90	65.00	0.86		108	111	56.10	15.65
D	221	176	8.61	5.57	1.50	8.92	1.75	80.20	54.50	0.80		113	104	57.40	15.95
D	207	189	8.53	5.63	1.50	8.85	1.63	76.50	59.40	0.84		108	111	53.10	15.50
D	219	169	8.80	5.62	1.30	8.09	1.85	78.10	53.30	0.89		112	103	56.90	15.45
D	213	178	9.32	5.62	1.37	8.55	1.74	77.60	52.30	0.82		110	111	54.90	15.85
D	236	175	9.38	5.78	1.36	9.40	1.90	81.50	55.90	0.89		120	107	59.60	16.95
D	221	167	9.24	5.39	1.38	8.16	1.79	76.40	50.80	0.83		112	111	55.00	15.50
D	219	179	8.49	5.36	1.38	8.33	1.65	79.00	56.50	0.80		113	108	56.60	16.00

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
E		219							81.90		0.52		110		
E		223							80.40		0.53		111		
E		218							79.50		0.53		109		
E		221							79.70		0.54		109		
E		222							80.40		0.54		111		
E		224							80.10		0.54		109		
E		221							82.50		0.55		111		
E		217							82.00		0.55		112		
F	211	131	8.21	5.24	1.29	8.35	1.70	77.50	42.35	0.77	0.42	100.92	108	53.20	14.85
F	208	137	8.26	5.23	1.36	8.44	1.74	79.20	44.17	0.78	0.44	100.66	116	53.30	14.66
F	206	129	8.26	5.25	1.33	8.37	1.73	72.90	40.44	0.78	0.46	98.70	112	54.00	14.59
F	211	145	8.46	5.25	1.27	8.28	1.72	77.90	47.88	0.78	0.48	99.76	110	54.10	14.80
F	205	137	8.10	5.25	1.31	8.22	1.68	72.40	44.40	0.76	0.42	97.20	106	52.40	14.42
F	207	143	8.24	5.20	1.31	8.27	1.71	84.20	45.00	0.77	0.47	98.88	112	53.00	14.59
F	203	134	8.15	5.09	1.26	8.07	1.72	72.90	44.03	0.75	0.41	97.78	99	52.60	14.47
F	203	140	8.26	5.08	1.32	8.16	1.68	75.20	45.06	0.74	0.41	97.17	105	51.50	14.31
H	205	212	7.77	5.07	1.24	7.62	1.68	71.70	74.40	0.78		99.40	108	51.30	14.80
H	207	213	7.94	5.13	1.29	7.55	1.68	72.30	70.70	0.78		99.50	108	52.00	14.95
H	204	208	7.88	5.05	1.28	7.18	1.64	71.40	69.30	0.77		97.60	108	50.30	14.90
H	206	213	8.08	5.18	1.28	7.33	1.69	72.40	70.90	0.78		100.50	111	52.30	15.05
H	212	219	8.13	5.31	1.31	7.69	1.67	73.20	71.30	0.83		103.50	120	52.70	15.40
H	203	223	7.80	4.91	1.29	7.38	1.65	70.20	74.00	0.77		97.30	116	50.50	14.70
H	206	241	7.91	5.11	1.28	7.40	1.66	71.50	80.30	0.80		100.00	121	51.60	15.10
H	215	215	8.32	5.35	1.38	7.52	1.76	75.70	71.40	0.84		101.50	110	52.80	15.00
I	225	185	8.08	5.62	1.27	8.28	1.77	74.40	56.30	0.86		107		54.00	14.84
I	222	193	8.34	5.48	1.30	8.27	1.82	75.40	60.90	0.85		106		52.60	15.21
I	220	190	8.22	5.30	1.33	8.08	1.81	72.20	58.20	0.88		108		50.90	15.16
I	224	177	8.52	5.62	1.30	8.32	1.84	74.90	54.20	0.84		106		54.40	15.37
I	217	175	7.93	5.44	1.23	7.87	1.80	71.70	53.90	0.84		110		50.40	14.73
I	225	184	8.12	5.35	1.28	7.95	1.92	74.00	58.00	0.82		106		53.70	15.26
I	223	165	7.95	5.57	1.29	8.01	1.83	73.70	49.80	0.85		108		51.20	15.08
I	220	195	7.99	5.17	1.22	7.86	1.79	72.60	61.10	0.83		109		49.80	14.65
J	225	108	8.57	5.43	1.38	8.22	1.76	77.00	29.20	0.76		114		54.80	15.75
J	232	116	8.35	5.28	1.36	8.30	1.74	79.00	31.50	0.79		117		55.10	16.35
J	216	94	8.16	5.10	1.23	8.13	1.68	75.40	24.80	0.75		111		52.80	15.25
J	223	94	8.14	5.31	1.34	8.13	1.66	76.50	25.00	0.76		113		54.30	15.60
J	227	93	8.44	5.38	1.42	8.51	1.80	78.60	24.50	0.76		117		54.80	15.90
J	229	98	8.33	5.23	1.39	8.28	1.78	79.60	26.00	0.77		116		54.90	15.95
J	227	104	8.38	5.41	1.37	8.29	1.77	78.90	27.90	0.76		117		55.40	16.00
J	229	87	8.70	5.37	1.40	8.29	1.74	78.70	22.70	0.79		115.50		54.80	15.95
K		185							62.00				98.00		
K		175							58.70				96.20		
K		180							60.20				97.30		
K		183							62.40				94.80		
K		184							60.90				99.90		
K		208							64.40				107.50		
K		163							46.40				107.50		
K		175							57.90				97.30		
L		211							77.70		0.64		110		
L		212							77.90		0.66		107		
L		215							80.60		0.64		104		
L		212							79.10		0.64		109		
L		205							78.60		0.64		105		
L		210							78.30		0.64		103		
L		210							78.80		0.66		102		
L		219							81.30		0.62		108		
M	210	228	9.03	5.26	1.35	8.86	1.60	72.30	75.00	0.89	0.44	103	105	52.20	14.90
M	233	235	9.42	5.96	1.52	9.23	1.79	83.50	76.70	0.96	0.41	107	104	55.80	17.30
M	221	251	8.63	5.31	1.30	8.54	1.69	76.60	83.70	0.81	0.43	103	104	54.60	15.80
M	205	247	8.51	5.14	1.26	8.52	1.56	75.20	80.50	0.82	0.45	111	104	51.00	14.50
M	230	250	8.96	5.83	1.46	8.73	1.77	79.20	83.40	0.90	0.47	105	102	56.80	16.40
M	242	244	10.50	6.59	1.70	9.83	1.85	75.20	81.70	0.81	0.44	122	102	56.20	19.60
M	220	264	8.82	5.81	1.24	9.02	1.46	72.10	81.80	0.91	0.46	112		52.00	14.40
M	208	228	8.25	5.13	1.28	9.50	1.60	73.50	75.60	0.83	0.42	105		50.70	14.70
N	211	209	8.67	5.39	1.45	9.15	1.79	72.70	72.00	0.82	0.44	124	113	52.00	15.10
N	214	215	8.64	5.55	1.45	9.08	1.75	74.70	71.20	0.82	0.43	125	115	51.60	15.10
N	211	208	8.38	5.47	1.44	9.15	1.79	75.10	71.40	0.82	0.43	127	110	51.30	15.20
N	209	205	8.62	5.47	1.42	8.93	1.77	74.40	71.60	0.79	0.42	126	109	51.10	15.20
N	210	214	8.58	5.44	1.40	9.08	1.80	72.80	72.40	0.80	0.46	125	111	51.50	15.00
N	216	213	8.70	5.48	1.42	9.27	1.82	75.80	71.30	0.81	0.45	126	111	51.80	15.10
N	209	214	8.61	5.57	1.43	9.14	1.77	73.00	71.60	0.83	0.44	125	111	51.40	15.20
N	209	206	8.67	5.42	1.42	9.10	1.75	72.50	71.30	0.82	0.45	124	110	51.90	15.00
O	211	206	8.05	5.17	1.35	7.95	1.72	76.50	76.20	0.84	0.41	105	105	51.40	15.10
O	215	210	8.16	5.24	1.38	7.87	1.75	78.10	77.40	0.86	0.43	105	107	52.80	15.30
O	209	207	8.10	4.93	1.33	7.53	1.68	75.40	77.40	0.85	0.41	102	106	51.50	14.80
O	208	208	7.88	5.22	1.36	7.57	1.71	76.60	78.00	0.82	0.45	103	106	51.20	14.90
O	212	209	8.15	5.19	1.34	7.78	1.75	76.00	77.20	0.87	0.39	104	103	52.00	15.10
O	213	204	8.29	5.00	1.33	7.85	1.77	76.70	75.70	0.82	0.41	104	106	52.60	15.30
O	213	207	8.15	5.18	1.31	7.78	1.75	76.90	76.30	0.80	0.47	104	104	52.90	15.40
O	211	208	8.16	5.19	1.38	7.85	1.72	77.00	77.40	0.83	0.41	103	107	51.90	15.20
P	213		8.00	7.00	1.50		2.00	72.00		1.00		130		57.50	15.00
P	215		8.50	7.00	1.00		2.00	71.00		1.00		125		57.00	15.00
P	207		8.50	7.00	1.50		2.00	73.00		1.00		130		56.00	15.00
P	213		8.00	7.00	1.50		2.00	73.00		1.00		130		56.00	15.00
P	208		8.00	6.00	1.00		2.00	70.00		1.00		125		55.50	15.00
P	207		8.50	7.00	1.00		2.00	70.00		1.00		125		56.50	15.00
P	210		8.50	7.00	1.00		2.00	70.00		1.00		125		55.50	15.00
P	205		8.50	7.00	1.00		2.00	71.00		1.00		125		56.50	15.00

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
Q	258	148	9.69	6.26	1.57	9.44	2.11	88.40	44.60	0.96		122	107	59.60	17.75
Q	235	133	8.54	5.45	1.41	8.05	1.84	81.30	39.70	0.88		112	109	53.30	15.80
Q	224	158	8.13	5.26	1.43	7.83	1.74	77.40	47.90	0.82		107	110	51.20	15.20
Q	248	179	9.19	6.13	1.53	9.29	1.99	85.80	55.50	0.92		117	111	57.10	17.25
Q	258	125	10.10	6.31	1.56	9.46	2.04	89.50	36.90	0.95		123	113	60.10	18.00
Q	241	163	9.13	5.90	1.52	8.82	1.85	83.30	49.40	0.87		115	113	54.90	16.30
Q	229	129	8.49	5.57	1.34	8.34	1.83	79.40	38.10	0.81		109	110	52.70	15.40
Q	228	146	8.49	5.64	1.37	8.47	1.77	78.80	43.90	0.82		107	106	51.60	15.30
R	400	214						100	72.80		0.78		111		
R	300	210						100	71.90		0.79		108		
R	200	218						100	74.90		0.79		111		
R	300	213						100	72.70		0.76		107		
R	300	218						200	74.20		0.75		106		
R	300	227						100	78.00		0.79		107		
R	200	210						100	72.50		0.76		102		
R	300	240						100	82.00		0.80		113		

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
B	14.10	9.10	20.00	16.50	1.36	1.21	33.40	30.20	0.87	6.62	5.00	43.80	33.40	5.00	3.60
B	13.80	9.70	20.00	16.70	1.49	1.22	34.90	30.20	0.85	6.72	4.94	45.90	33.30	5.20	3.60
B	13.60	9.90	40.00	15.60	1.51	1.16	34.40	25.40	0.96	6.73	4.84	49.50	32.30	5.70	3.50
B	14.10	9.60	20.00	16.50	1.40	1.21	34.50	30.50	0.86	6.65	4.99	45.70	34.00	5.20	3.60
B	13.80	9.40	20.00	16.90	1.42	1.22	34.80	28.70	0.87	6.91	4.96	45.90	34.10	5.40	3.70
B	13.60	9.40	20.00	16.40	1.40	1.22	34.40	26.90	0.85	6.79	4.95	46.40	33.50	5.10	3.80
B	13.50	9.50	20.00	16.00	1.40	1.20	33.90	26.00	0.86	6.72	4.84	45.70	32.60	5.20	3.60
B	13.50	9.90	20.00	16.40	1.41	1.19	34.60	30.10	0.88	6.70	4.83	46.70	33.80	5.20	3.50
C	13.00	10.30	20.00	16.50	1.40	1.11	34.10	28.74	0.80	7.10	5.63	48.90	36.50	5.00	3.30
C	13.00	10.40		16.60	1.40	1.11	33.20	29.82	0.80	6.60	5.52	55.90	37.00	5.20	3.30
C	13.00	9.50		17.80	1.40	1.08	33.50	28.29	0.80	6.80	5.11	46.80	34.30	5.30	3.30
C	13.00	10.40	20.00	15.90	1.40	1.12	34.40	26.86	0.80	6.80	5.34	50.10	34.40	5.40	3.40
C	13.00	10.40	20.00	15.60	1.40	1.11	33.70	28.02	0.80	7.10	5.55	48.20	34.50	5.50	3.30
C	13.00	9.70		16.40	1.50	1.12	33.20	28.88	0.70	6.70	5.37	46.70	35.80	5.30	3.30
C	13.00	9.80	21.00	16.70	1.30	1.13	32.60	29.37	0.90	6.90	5.46	48.70	37.00	5.20	3.40
C	13.00	9.40		16.60	1.30	1.09	34.00	28.72	0.80	6.70	5.30	47.30	36.00	5.20	3.20
D	13.80	10.00	16.80	16.30	1.47		37.50	27.60	0.87	7.22	4.90	47.00	32.30	5.09	
D	13.50	9.83	16.90	16.00	1.56		37.30	26.60	0.83	7.40	4.80	49.80	29.80	5.28	
D	13.90	9.76	16.40	16.10	1.53		36.50	26.50	0.83	6.94	4.70	46.00	30.50	5.52	
D	13.20	9.35	16.10	15.90	1.43		36.40	24.90	0.86	6.89	4.50	49.30	28.70	5.35	
D	13.50	9.88	16.30	16.20	1.45		36.50	26.00	0.83	7.17	4.70	47.40	29.20	5.69	
D	13.70	10.10	17.30	16.50	1.62		38.70	25.50	0.96	7.45	4.70	52.80	30.00	5.85	
D	13.50	9.21	18.60	16.30	1.49		36.10	24.50	0.88	6.79	4.70	49.70	28.10	5.64	
D	13.30	10.05	16.90	15.90	1.46		35.70	26.30	0.76	7.04	4.70	46.80	29.30	5.42	
E	13.00		15.60			1.11		29.80			5.13		42.20		3.30
E	13.00		15.40			1.11		30.10			5.17		41.70		3.30
E	13.00		15.30			1.08		29.50			5.37		41.50		3.30
E	13.00		15.60			1.12		29.10			5.16		40.10		3.40
E	13.00		15.50			1.11		30.10			5.30		41.90		3.30
E	13.00		15.40			1.12		29.30			5.00		40.20		3.30
E	13.00		15.60			1.13		29.50			5.06		40.20		3.40
E	13.00		15.60			1.09		30.20			5.13		42.10		3.20
F	9.52	9.20	11.00	13.80		1.15	34.00	28.11	0.79	6.06	3.81	41.34	24.35	5.00	3.37
F	15.98	9.30	11.00	16.61		1.20	33.30	26.26	0.74	5.98	3.88	41.93	26.09	5.20	3.45
F	11.10	9.40	11.00	14.86		1.22	32.80	23.57	0.83	5.94	3.86	41.33	24.66	5.30	3.40
F	12.65	9.70	11.00	15.24		1.25	32.50	28.74	0.78	6.00	3.97	41.52	28.85	5.20	3.81
F	10.28	9.60		14.97		1.20	31.50	28.47	0.76	5.87	3.89	40.32	26.39	5.10	3.35
F	14.58	9.40	11.00	15.70		1.29	34.60	27.30	0.84	6.39	3.91	41.12	28.03	5.10	3.71
F	9.18	9.40	10.00	14.26		1.16	30.90	28.47	0.81	5.74	3.79	40.56	25.43	5.10	3.26
F	9.04	9.10		14.89		1.15	30.80	29.91	0.79	5.83	3.92	40.84	24.94	5.10	3.22
H	13.00	9.42	16.20	15.50	1.24		29.30	28.30	0.73	6.52	4.90	44.70	33.70	5.03	
H	13.20	9.28	16.50	15.70	1.29		29.50	28.30	0.72	6.64	5.10	45.10	32.70	5.12	
H	13.50	9.05	16.10	15.80	1.24		29.20	28.30	0.71	6.56	5.00	44.60	32.70	5.02	
H	13.90	9.14	16.40	15.90	1.26		29.40	29.20	0.75	6.66	5.10	45.50	33.60	5.05	
H	15.00	9.51	16.80	17.10	1.30		30.40	28.50	0.75	6.73	5.10	45.90	35.10	5.23	
H	14.70	9.24	16.00	17.00	1.21		28.80	30.10	0.73	6.55	5.30	43.90	35.80	4.90	
H	15.30	9.20	16.30	17.70	1.25		29.30	29.60	0.74	6.69	5.10	45.10	37.30	5.11	
H	14.10	9.22	16.50	16.10	1.27		31.20	29.00	0.77	6.68	5.00	46.90	34.30	5.48	
I	13.00	9.53	18.10	18.00	1.42		33.70	25.80	0.82	6.60	4.90	46.90	27.80	5.67	
I	12.00	9.08	17.60	17.00	1.36		34.60	26.50	0.85	6.80	4.90	46.30	29.70	5.69	
I	13.00	9.64	16.20	18.00	1.39		32.90	26.90	0.80	6.70	5.00	44.40	29.30	5.65	
I	12.00	9.68	17.80	17.00	1.44		34.80	25.30	0.83	6.90	4.80	45.60	26.80	5.74	
I	12.00	8.97	17.60	18.00	1.36		35.40	25.60	0.81	6.90	4.80	42.50	27.40	5.41	
I	13.00	8.96	18.30	18.00	1.37		34.20	26.20	0.83	7.20	4.90	44.00	29.40	5.63	
I	12.00	9.46	19.30	18.00	1.44		33.10	24.80	0.85	6.60	4.80	45.30	26.90	5.74	
I	13.00	8.93	18.40	18.00	1.41		33.50	27.10	0.87	6.90	4.90	43.90	29.70	5.46	

Assay data – Economic Elements (cont)

Lab Code	Sc M/ICP ppm	Sm Fusion ppm	Sr Fusion	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	12.50	10.30	16.70	16.60	1.41		32.20	20.40	0.84	6.88	4.50	47.60	20.70	5.47	
J	12.70	10.25	17.10	16.70	1.34		31.80	21.40	0.81	6.84	4.60	48.20	21.50	5.39	
J	12.50	9.57	15.70	17.00	1.38		30.50	19.70	0.81	6.50	4.70	45.30	19.10	5.22	
J	12.40	10.10	17.10	16.80	1.34		31.30	19.60	0.81	6.82	4.70	46.60	18.90	5.40	
J	12.20	10.25	16.80	16.50	1.41		32.30	19.10	0.81	6.97	4.50	48.00	18.60	5.68	
J	12.80	10.40	17.70	17.20	1.43		32.00	20.00	0.86	6.96	4.70	47.90	19.50	5.54	
J	12.50	10.20	16.40	16.80	1.40		32.30	20.70	0.84	6.97	4.70	47.70	20.20	5.64	
J	12.00	9.95	17.50	16.30	1.36		32.20	18.40	0.85	6.94	4.50	48.00	17.80	5.60	
K	12.90			16.40				25.90			4.40		29.70		
K	12.40			15.70				25.70			4.30		28.40		
K	12.70			16.30				26.60			4.40		29.30		
K	12.10			15.70				25.90			4.30		29.60		
K	12.70			16.50				26.80			4.50		29.70		
K	13.50			16.10				29.40			4.80		31.40		
K	13.30			15.60				25.60			4.70		25.00		
K	12.20			16.00				25.50			4.30		28.60		
L	12.00			16.50		1.24		31.80			5.80		40.90		4.65
L	13.00			16.50		1.24		33.00			5.90		40.50		4.70
L	12.00			17.50		1.24		33.40			5.70		40.90		4.70
L	13.00			17.50		1.20		30.80			5.70		41.40		4.65
L	13.00			17.00		1.26		31.90			5.70		40.40		4.70
L	12.00			17.00		1.26		30.40			5.80		40.20		4.55
L	13.00			16.50		1.26		33.20			5.90		40.90		4.60
L	13.00			17.00		1.24		32.70			5.50		40.30		4.60
M	11.90	9.50	19.00	17.60	1.23	1.07	40.80	24.50	0.75	6.36	3.96	52.30	27.60	5.20	3.30
M	11.30	10.80	21.00	17.40	1.45	1.15	40.40	23.60	0.96	6.45	4.01	52.50	27.40	5.90	3.20
M	11.10	10.10	20.00	17.60	1.33	1.25	39.20	24.20	0.81	6.09	3.90	47.60	31.00	5.40	3.30
M	11.40	9.40	17.00	17.40	1.19	1.25	36.60	24.10	0.73	5.70	3.93	45.10	31.10	5.10	3.40
M	11.30	10.30	20.00	17.90	1.38	1.28	40.90	24.30	0.81	6.37	3.88	50.40	31.90	5.60	3.50
M	11.30	12.20	22.00	17.90	1.64	1.30	36.80	23.70	0.90	7.32	3.86	49.60	30.70	6.50	3.40
M	12.10	10.40	23.00	17.30	1.17	1.36	41.10	25.40	0.76	6.87	3.68	49.90	30.10	5.50	3.70
M	10.20	9.40	21.00	16.80	1.25	1.11	36.50	24.80	0.79	5.69	3.20	51.90	27.70	6.20	3.20
N	12.30	9.60		17.80	1.29	1.08	34.60	29.40	0.79	6.72	4.40	49.40	30.10	5.50	3.20
N	12.20	9.80		17.60	1.27	1.10	35.20	29.70	0.83	6.76	4.60	49.30	29.90	5.60	3.10
N	12.30	9.50		17.20	1.28	1.11	33.80	29.70	0.83	6.77	4.50	48.60	29.90	5.50	3.10
N	12.10	9.50		17.90	1.30	1.12	35.00	29.30	0.82	6.74	4.40	48.70	31.00	5.60	3.20
N	12.60	9.70		18.10	1.32	1.09	34.30	29.40	0.82	6.74	4.50	49.90	31.30	5.50	3.20
N	12.50	9.60		17.50	1.32	1.10	34.40	29.60	0.82	6.78	4.40	49.60	31.40	5.60	3.20
N	12.40	9.50		17.80	1.30	1.10	34.70	29.50	0.81	6.78	4.40	49.70	31.30	5.50	3.20
N	12.30	9.50		18.10	1.29	1.11	34.30	29.50	0.82	6.76	4.50	49.10	30.30	5.50	3.20
O	14.00	9.30	30.00	16.00	1.33	1.26	35.50	32.20	0.78	7.09	5.74	44.70	40.10	5.00	4.20
O	14.40	9.30	30.00	16.20	1.35	1.24	36.00	34.50	0.81	7.28	5.56	45.70	39.70	5.30	4.30
O	14.30	9.20	20.00	15.40	1.28	1.24	35.30	34.60	0.76	7.10	6.09	44.50	39.10	5.10	4.20
O	14.50	9.20	30.00	16.30	1.27	1.21	35.10	35.70	0.78	7.04	5.56	45.30	38.60	5.10	3.80
O	15.00	9.40	30.00	16.10	1.35	1.26	35.50	36.90	0.81	7.15	5.46	45.50	39.80	5.20	4.00
O	14.70	9.50	30.00	16.00	1.31	1.23	35.20	35.10	0.79	7.04	5.56	45.30	39.90	5.20	3.90
O	14.70	9.40	30.00	16.20	1.31	1.24	35.70	35.10	0.76	7.13	5.77	45.30	37.80	5.20	4.10
O	15.70	9.60	30.00	16.10	1.33	1.23	35.40	32.90	0.81	7.05	5.66	45.70	38.90	5.30	4.20
P		10.00	20.00		1.50		38.50		1.00	7.50		45.00		7.00	
P		10.50	15.00		1.50		39.50		1.00	7.50		43.00		7.00	
P		10.50	20.00		1.50		37.00			7.00		45.00		7.00	
P		10.00	20.00		1.50		39.50		1.00	7.00		45.00		7.00	
P		10.50	15.00		1.50		37.00			7.50		42.00		7.00	
P		10.50	15.00		1.50		39.00		1.00	7.50		43.00		7.00	
P		10.00	15.00		1.50		37.50		1.00	7.50		44.00		7.00	
P		10.00	15.00		1.50		37.00		1.00	7.00		42.00		7.00	
Q	13.30	10.80	23.10	14.30	1.54		40.30	25.50	0.90	7.70	5.20	57.10	23.40	6.04	
Q	13.00	9.61	18.50	14.40	1.36		36.30	23.30	0.78	6.85	5.00	51.90	22.80	5.43	
Q	13.50	8.96	17.60	15.10	1.29		35.50	26.20	0.74	6.78	5.10	48.60	26.50	5.51	
Q	14.20	10.55	21.40	15.50	1.45		41.00	29.10	0.87	7.53	5.30	55.40	28.70	5.84	
Q	13.10	11.30	21.20	14.80	1.52		42.40	22.30	0.93	7.98	5.00	56.40	22.10	6.33	
Q	14.20	10.05	20.00	15.30	1.46		39.50	27.50	0.85	7.34	5.30	53.20	26.00	5.67	
Q	12.50	9.41	18.60	14.20	1.39		36.60	22.00	0.78	6.83	4.90	50.70	21.80	5.40	
Q	13.50	9.50	18.00	14.30	1.35		36.40	25.50	0.77	6.76	5.10	49.80	23.80	5.47	
R	14.70			15.70		1.53		33.30			6.42		41.20		4.98
R	14.10			15.60		1.49		33.70			6.39		40.30		4.96
R	14.10			16.10		1.51		33.80			6.47		40.80		5.06
R	13.30			15.40		1.45		32.70			6.27		39.40		4.81
R	12.80			15.50		1.44		32.20			6.28		39.40		4.77
R	14.50			16.40		1.51		33.30			6.45		42.00		5.04
R	14.70			15.30		1.40		32.40			6.23		39.10		4.87
R	13.50			16.50		1.50		34.10			6.60		41.40		5.08

Assay data Major Oxides

Lab Code	Al2O3 XRF %	CaO XRF %	Cr2O3 XRF %	Fe2O3 XRF %	K2O XRF %	LOI %	MgO XRF %	MnO XRF %	Na2O XRF %	P2O5 XRF %	SiO2 XRF %	TiO2 XRF %	SG pyc
B	24.20	0.25	0.03	9.94	1.70	10.10	0.68	0.09	0.33	0.09	52.10	1.04	2.53
B	24.20	0.26	0.03	9.95	1.70	10.10	0.70	0.09	0.29	0.10	52.00	1.04	2.52
B	24.20	0.26	0.03	9.97	1.71	10.00	0.68	0.09	0.31	0.10	52.20	1.05	2.52
B	24.20	0.25	0.03	9.96	1.71	10.00	0.68	0.09	0.31	0.10	51.70	1.04	2.53
B	24.20	0.25	0.03	9.96	1.69	10.00	0.67	0.09	0.32	0.09	52.20	1.04	2.52
B	24.20	0.25	0.03	9.97	1.72	10.10	0.68	0.09	0.37	0.10	52.20	1.04	2.52
B	24.20	0.26	0.03	9.96	1.71	10.20	0.66	0.09	0.31	0.10	52.00	1.05	2.53
B	24.20	0.25	0.03	9.93	1.70	10.10	0.65	0.09	0.33	0.09	52.20	1.04	2.54
C	24.18	0.26		9.75	1.67	10.14	0.65	0.09	0.24	0.09	51.50	1.02	2.81
C	23.99	0.26		9.90	1.65	10.13	0.63	0.09	0.25	0.10	51.33	1.01	2.72
C	24.07	0.26		9.74	1.67	10.15	0.64	0.09	0.24	0.10	51.35	1.01	2.73
C	24.04	0.26		9.72	1.66	10.15	0.64	0.09	0.25	0.10	51.38	1.01	2.76
C	24.03	0.26		9.71	1.66	10.17	0.65	0.09	0.25	0.10	51.46	1.01	2.80
C	23.99	0.26		9.71	1.67	10.16	0.63	0.09	0.23	0.10	51.42	1.01	2.77
C	24.13	0.26		9.88	1.67	10.16	0.64	0.09	0.24	0.10	51.62	1.01	2.77
C	24.19	0.25		9.93	1.67	10.14	0.64	0.09	0.25	0.10	51.67	1.01	2.73
D	23.90	0.25	0.03	9.75	1.68	11.31	0.64	0.09	0.30	0.09	51.20	1.00	
D	24.10	0.27	0.03	9.81	1.68	11.25	0.64	0.09	0.31	0.09	51.40	1.00	
D	24.00	0.25	0.03	9.80	1.68	11.14	0.64	0.09	0.30	0.09	51.40	1.00	
D	24.00	0.25	0.03	9.72	1.68	11.30	0.64	0.09	0.31	0.09	51.30	1.00	
D	23.90	0.25	0.03	9.72	1.66	11.07	0.64	0.09	0.30	0.09	51.10	0.99	
D	24.00	0.25	0.03	9.78	1.66	11.15	0.64	0.09	0.31	0.09	51.30	1.01	
D	23.80	0.25	0.03	9.72	1.65	11.33	0.64	0.09	0.31	0.09	51.00	0.99	
D	23.80	0.25	0.03	9.69	1.66	11.22	0.63	0.09	0.30	0.09	50.90	0.99	
E	23.85	0.26	0.04	9.70	1.70	10.00	0.66	0.09	0.36	0.09	51.54	0.99	
E	24.00	0.26	0.05	9.79	1.69	10.00	0.67	0.09	0.36	0.09	51.65	1.00	
E	23.95	0.26	0.05	9.71	1.68	10.10	0.66	0.09	0.36	0.10	51.72	1.00	
E	24.00	0.26	0.04	9.82	1.69	10.00	0.66	0.09	0.36	0.10	51.66	0.99	
E	23.90	0.26	0.04	9.66	1.67	10.00	0.66	0.09	0.34	0.10	51.49	0.99	
E	24.08	0.25	0.04	9.77	1.69	10.00	0.67	0.09	0.36	0.09	51.93	1.00	
E	23.96	0.25	0.04	9.75	1.67	10.10	0.66	0.09	0.35	0.10	51.46	0.99	
E	23.93	0.25	0.05	9.74	1.69	10.10	0.66	0.09	0.35	0.10	51.76	1.01	
F	24.10	0.27	0.04	9.69	1.68	11.15	0.63	0.09	0.40		50.79	1.02	2.52
F	24.03	0.26	0.03	9.66	1.67	11.16	0.62	0.09	0.37		50.64	1.00	2.47
F	24.08	0.25	0.03	9.84	1.69	11.27	0.64	0.09	0.41		51.50	1.01	2.55
F	24.06	0.27	0.02	9.75	1.66	11.19	0.65	0.09	0.36		51.55	1.02	2.52
F	23.94	0.26	0.03	9.81	1.70	11.36	0.65	0.09	0.38		50.97	1.03	2.50
F	23.97	0.26	0.03	9.69	1.67	11.11	0.64	0.09	0.41		51.20	1.02	2.54
F	24.04	0.27	0.02	9.79	1.66	11.07	0.65	0.09	0.37		51.51	1.00	2.51
F	24.01	0.27	0.02	9.71	1.69	11.51	0.65	0.09	0.39		51.39	1.03	2.57
I	24.03	0.26	0.03	9.77	1.71	10.07	0.64	0.09	0.28	0.09	51.61	1.02	2.51
I	24.11	0.25	0.03	9.76	1.71	10.05	0.64	0.09	0.27	0.09	51.90	1.02	2.50
I	24.01	0.26	0.03	9.85	1.72	10.07	0.64	0.09	0.27	0.09	51.75	1.02	2.49
I	24.01	0.26	0.03	9.82	1.71	10.05	0.64	0.09	0.27	0.09	51.76	1.03	2.50
I	24.05	0.26	0.03	9.82	1.71	10.09	0.64	0.09	0.27	0.09	51.73	1.02	2.52
I	24.00	0.25	0.03	9.94	1.71	10.04	0.64	0.09	0.27	0.09	51.82	1.02	2.50
I	23.90	0.26	0.03	10.02	1.69	10.15	0.64	0.09	0.28	0.09	51.58	1.02	2.50
I	24.01	0.26	0.03	9.98	1.71	10.16	0.63	0.09	0.28	0.09	51.62	1.01	2.49
J	24.00	0.26	0.03	9.79	1.68	10.39	0.64	0.09	0.31	0.09	51.40	1.00	2.61
J	23.80	0.25	0.03	9.70	1.67	10.45	0.64	0.09	0.31	0.09	51.10	0.99	2.66
J	23.90	0.26	0.03	9.76	1.66	10.43	0.64	0.09	0.32	0.09	51.20	0.99	2.64
J	23.80	0.25	0.03	9.68	1.67	10.55	0.63	0.09	0.31	0.09	51.10	0.98	2.64
J	24.00	0.26	0.03	9.73	1.68	10.38	0.63	0.09	0.31	0.09	51.40	0.99	2.67
J	23.80	0.25	0.03	9.68	1.66	10.40	0.63	0.09	0.32	0.09	51.10	0.99	2.63
J	23.80	0.26	0.03	9.72	1.66	10.57	0.64	0.09	0.31	0.09	51.10	0.99	2.69
J	23.90	0.26	0.03	9.73	1.66	10.39	0.64	0.09	0.32	0.09	51.30	0.99	2.63
K	23.90	0.25	0.03	9.67	1.66	10.42	0.64	0.09	0.31	0.09	51.20	0.98	
K	24.10	0.25	0.03	9.78	1.68	10.44	0.65	0.09	0.32	0.09	51.80	0.99	
K	24.10	0.25	0.03	9.77	1.68	10.42	0.64	0.09	0.31	0.09	51.70	0.99	
K	23.90	0.25	0.03	9.67	1.67	10.50	0.64	0.09	0.31	0.09	51.30	0.98	
K	24.00	0.25	0.03	9.72	1.67	10.47	0.64	0.09	0.31	0.09	51.50	0.99	
K	24.10	0.25	0.03	9.78	1.68	10.46	0.65	0.09	0.32	0.09	51.70	0.99	
K	24.00	0.26	0.03	9.76	1.68	10.45	0.65	0.09	0.32	0.09	51.70	1.00	
K	24.00	0.25	0.04	9.71	1.66	10.47	0.64	0.09	0.31	0.09	51.40	0.99	
L	23.80	0.27		9.70		10.20	0.64	0.09		0.09	51.10	0.98	2.83
L	23.60	0.25		9.64		10.30	0.63	0.09		0.09	51.10	0.97	2.80
L	23.70	0.25		9.70		10.30	0.64	0.09		0.09	51.10	0.97	2.82
L	23.80	0.25		9.66		10.20	0.63	0.09		0.09	51.10	0.98	2.86
L	23.70	0.26		9.68		10.20	0.63	0.09		0.09	51.10	0.97	2.84
L	23.80	0.26		9.72		10.10	0.65	0.10		0.09	51.10	0.98	2.80
L	23.60	0.26		9.72		10.20	0.65	0.10		0.09	51.00	0.97	2.84
L	23.70	0.26		9.64		10.20	0.64	0.09		0.09	51.00	0.97	2.81
M	23.60	0.35	0.03	9.53	1.53	10.31	0.62	0.09	0.34		50.20	0.99	2.66
M	23.70	0.23	0.03	9.45	1.59	10.28	0.63	0.09	0.34		50.30	0.99	2.66
M	23.20	0.22	0.02	9.21	1.51	10.28	0.70	0.09	0.38		48.90	0.96	2.66
M	23.30	0.23	0.02	9.33	1.53	10.20	0.70	0.09	0.34		49.40	0.96	2.66
M	23.20	0.22	0.03	9.28	1.51	10.22	0.70	0.09	0.34		49.40	0.95	2.66
M	23.60	0.23	0.03	9.55	1.53	10.19	0.63	0.09	0.35		50.10	0.99	2.67
M	23.30	0.23	0.03	9.26	1.54	10.22	0.72	0.09	0.42		49.20	0.96	2.66
M	23.70	0.23	0.03	9.47	1.59	10.25	0.64	0.09	0.36		50.40	0.99	2.67

Assay data Major Oxides (cont)

Lab Code	Al2O3 XRF %	CaO XRF %	Cr2O3 XRF %	Fe2O3 XRF %	K2O XRF %	LOI %	MgO XRF %	MnO XRF %	Na2O XRF %	P2O5 XRF %	SiO2 XRF %	TiO2 XRF %	SG pyc
O	23.70	0.26	0.03	9.74	1.67	11.80	0.62	0.08	0.29	0.09	51.00	1.01	
O	23.70	0.25	0.03	9.67	1.69	11.80	0.64	0.09	0.30	0.09	50.50	1.00	
O	23.60	0.26	0.04	9.66	1.68	11.70	0.65	0.09	0.30	0.09	50.60	0.99	
O	23.70	0.25	0.03	9.72	1.67	11.70	0.63	0.08	0.30	0.09	50.90	1.01	
O	23.60	0.26	0.04	9.70	1.68	11.70	0.62	0.08	0.30	0.09	50.70	1.01	
O	23.70	0.25	0.02	9.70	1.67	11.70	0.62	0.08	0.30	0.09	50.90	1.02	
O	23.60	0.26	0.03	9.65	1.67	11.80	0.65	0.10	0.30	0.09	50.40	1.01	
O	23.70	0.26	0.04	9.74	1.68	11.80	0.62	0.08	0.29	0.09	50.80	1.01	
P	23.50	0.25	0.03	9.61	1.69	10.29	0.65	0.09	0.31	0.09	51.66	0.98	2.60
P	23.50	0.25	0.03	9.61	1.70	10.21	0.66	0.09	0.30	0.09	51.70	0.98	2.59
P	23.40	0.25	0.03	9.56	1.69	10.29	0.66	0.09	0.30	0.09	51.68	0.98	2.61
P	23.50	0.25	0.03	9.59	1.69	10.24	0.66	0.09	0.30	0.09	51.78	0.97	2.64
P	23.40	0.25	0.03	9.56	1.69	10.26	0.65	0.09	0.31	0.09	51.64	0.97	2.60
P	23.50	0.25	0.03	9.56	1.70	10.31	0.66	0.09	0.31	0.09	51.56	0.98	2.59
P	23.50	0.25	0.03	9.58	1.69	10.35	0.66	0.09	0.30	0.09	51.66	0.98	2.59
P	23.50	0.25	0.03	9.59	1.69	10.31	0.66	0.09	0.31	0.09	51.67	0.98	2.59
Q	23.80	0.25	0.03	9.78	1.68	10.34	0.63	0.09	0.32	0.09	51.10	0.99	
Q	23.80	0.25	0.02	9.73	1.68	10.38	0.64	0.09	0.32	0.09	51.20	0.99	
Q	23.80	0.25	0.03	9.68	1.67	10.49	0.63	0.09	0.32	0.09	51.00	0.98	
Q	23.80	0.25	0.02	9.71	1.68	10.30	0.63	0.09	0.32	0.09	51.10	0.99	
Q	23.90	0.25	0.03	9.73	1.68	10.35	0.64	0.09	0.33	0.09	51.20	0.99	
Q	23.80	0.25	0.02	9.68	1.68	10.43	0.64	0.09	0.32	0.09	51.10	0.99	
Q	23.90	0.25	0.03	9.77	1.68	10.33	0.64	0.09	0.32	0.09	51.30	0.99	
Q	23.90	0.25	0.02	9.74	1.68	10.31	0.64	0.09	0.33	0.09	51.30	0.99	
R	22.90	0.24	0.03	9.49	1.59	13.20	0.62	0.09	0.29	0.08	49.00	0.98	2.63
R	23.10	0.24	0.03	9.54	1.63	13.10	0.63	0.09	0.30	0.08	49.30	0.99	2.64
R	22.90	0.24	0.03	9.47	1.61	13.20	0.63	0.09	0.28	0.08	49.10	0.98	2.61
R	22.70	0.24	0.03	9.40	1.55	13.20	0.61	0.09	0.28	0.08	48.90	0.97	2.61
R	23.20	0.24	0.03	9.56	1.62	13.30	0.63	0.09	0.28	0.09	49.40	0.98	2.65
R	23.00	0.24	0.03	9.48	1.61	13.30	0.64	0.09	0.29	0.08	49.20	1.00	2.64
R	23.00	0.24	0.02	9.51	1.60	13.20	0.62	0.09	0.29	0.09	49.10	0.99	2.63
R	23.00	0.24	0.02	9.49	1.63	13.20	0.63	0.09	0.30	0.08	49.10	0.99	2.60

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 ¹	σ_L ²	Sw ³	CSU ⁴
Ce	Fusion	ppm	27.52	6.04	4.80	1.89
Ce	M/ICP	ppm	39.13	15.10	8.04	4.27
Dy	Fusion	ppm	0.47	0.22	0.24	0.07
Er	Fusion	ppm	0.51	0.13	0.17	0.04
Eu	Fusion	ppm	0.09	0.08	0.05	0.04
Gd	Fusion	ppm	0.59	0.42	0.31	0.13
Ho	Fusion	ppm	0.11	0.03	0.06	0.01
La	Fusion	ppm	13.9	1.9	1.76	0.59
La	M/ICP	ppm	16.4	3.4	2.21	1.15
Lu	Fusion	ppm	0.07	0.03	0.04	0.01
Lu	M/ICP	ppm	0.11	0.05	0.02	0.02
Nb	Fusion	ppm	10.42	4.85	2.52	1.65
Nb	M/ICP	ppm	4.53	1.53	2.83	0.51
Nd	Fusion	ppm	2.39	1.39	1.31	0.43
Pr	Fusion	ppm	0.87	0.36	0.34	0.11
Sc	M/ICP	ppm	1.18	0.51	0.42	0.14
Sm	Fusion	ppm	0.55	0.26	0.34	0.08
Sr	Fusion	ppm	4.85	1.51	1.31	0.50
Sr	M/ICP	ppm	0.99	0.55	0.46	0.16
Tb	Fusion	ppm	0.10	0.06	0.05	0.02
Tb	M/ICP	ppm	0.12	0.06	0.04	0.02
Th	Fusion	ppm	2.99	2.02	1.05	0.59
Th	M/ICP	ppm	3.79	1.71	1.22	0.51
Tm	Fusion	ppm	0.07	0.03	0.03	0.01
U	Fusion	ppm	0.07	0.03	0.03	0.01
U	M/ICP	ppm	0.68	0.41	0.12	0.11
Y	Fusion	ppm	3.52	2.19	1.43	0.65
Y	M/ICP	ppm	6.42	4.19	1.34	1.13
Yb	Fusion	ppm	0.53	0.15	0.16	0.05
Yb	M/ICP	ppm	0.62	0.14	0.11	0.06
Al ₂ O ₃	XRF	%	0.326	0.155	0.069	0.044
CaO	XRF	%	0.013	0.002	0.004	0.001
Cr ₂ O ₃	XRF	%	0.006	0.002	0.004	0.001
Fe ₂ O ₃	XRF	%	0.151	0.076	0.049	0.022
K ₂ O	XRF	%	0.045	0.011	0.009	0.004
LOI		%	0.865	0.127	0.049	0.040
MgO	XRF	%	0.019	0.009	0.008	0.003
MnO	XRF	%	0.003	0.001	0.001	0.000
Na ₂ O	XRF	%	0.038	0.021	0.010	0.006
P ₂ O ₅	XRF	%	0.004	0.002	0.001	0.000
SiO ₂	XRF	%	0.797	0.292	0.176	0.086
TiO ₂	XRF	%	2.048	0.012	0.008	0.003
SG	pyc		0.106	0.070	0.019	0.027

1. S - Std Dev for use on control charts.
2. σ_L - Betw Lab Std Dev, for use to calculate a measure of accuracy.
3. Sw - Within Lab Std 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 Margaret M. 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:** AMIS0276 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 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.

Date of Version v0.01: 16 January 2020

Version: v0.01

Reason for Version v0.01: Correction of element of TREE calculations i.e. Ef to Er

Version v0.01 replaces the original report of AMIS0276 Certification

Date of Version 000: 07 November 2014

Version: 000

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	0.39	0.47	60.7	101
Al	M/ICP	%	11.6	1.3	5.4	113
As	M/ICP	ppm	14.0	2.9	10.3	118
Ba	M/ICP	ppm	188	21.3	5.7	122
Be	M/ICP	ppm	3.4	0.88	12.9	120
Bi	M/ICP	ppm	0.50	0.09	8.7	120
Ca	M/ICP	%	0.18	0.02	5.0	112
Cd	M/ICP	ppm	0.14	0.14	50.3	108
Co	M/ICP	ppm	11.4	1.4	6.3	123
Cr	M/ICP	ppm	162	75.7	23.4	127
Cs	M/ICP	ppm	5.9	1.1	9.5	116
Cu	M/ICP	ppm	103	8.5	4.1	117
Fe	M/ICP	%	6.5	0.58	4.5	114
Ga	M/ICP	ppm	37.1	3.2	4.3	104
Ge	M/ICP	ppm	0.66	1.1	83.9	80
Hf	M/ICP	ppm	5.4	2.5	22.8	120
In	M/ICP	ppm	0.13	0.03	11.7	106
K	M/ICP	%	1.3	0.11	4.2	111
La	M/ICP	ppm	68.1	25.4	18.7	120
Li	M/ICP	ppm	21.9	3.3	7.6	120
Mg	M/ICP	%	0.35	0.06	9.1	109
Mn	M/ICP	ppm	667	68.9	5.2	105
Mo	M/ICP	ppm	6.3	0.81	6.4	123
Na	M/ICP	%	0.23	0.03	7.0	110
Ni	M/ICP	ppm	38.6	4.9	6.3	122
P	M/ICP	ppm	374	52.5	7.0	112
Pb	M/ICP	ppm	43.3	4.8	5.5	120
Rb	M/ICP	ppm	93.7	16.2	8.6	110
Re	M/ICP	ppm	0.0	0.0	38.9	16
S	M/ICP	%	0.03	0.01	16.1	104
Sb	M/ICP	ppm	1.4	0.23	8.3	121
Se	M/ICP	ppm	1.7	1.3	39.5	68
Si	M/ICP	ppm	15.8	22.8	72.1	24
Sn	M/ICP	ppm	7.1	1.7	11.6	123
Ta	M/ICP	ppm	7.4	3.1	21.2	116
Te	M/ICP	ppm	0.11	0.07	32.6	74
Th	M/ICP	ppm	28.0	9.2	16.4	122
Ti	M/ICP	%	0.53	0.09	8.1	112
Tl	M/ICP	ppm	0.69	0.12	8.6	125
U	M/ICP	ppm	4.9	1.3	13.6	120
V	M/ICP	ppm	74.1	9.6	6.5	122
W	M/ICP	ppm	5.7	0.7	6.4	122
Zn	M/ICP	ppm	85.7	12.0	7.0	127
Zr	M/ICP	ppm	211	142	33.6	112

Appendix 2. – Rare Earth Oxide Content

AMIS0276 Rare Earth Element content by different reporting conventions (Total, Critical, Light, Medium, Heavy).

TREE	450	La+Ce+Pr+Nd+Sm+Eu+Gd+Tb+Dy+Ho+Er+Tm+Yb+Lu+Y
CREE	112	Nd+Eu+Tb+Dy+Y
LREE	360	La+Ce+Pr+Nd
MREE	19	Sm+Eu+Gd
HREE	71	Tb+Dy+Ho+Er+Tm+Yb+Lu+Y

AMIS0276 Rare Earth Oxide content by different reporting conventions.

TREO	530	(La+Ce+Pr+Nd+Sm+Eu+Gd+Tb+Dy+Ho+Er+Tm+Yb+Lu+Y) ₂ O ₃
CREO	135	(Nd+Eu+Tb+Dy+Y) ₂ O ₃
LREO	421	(La+Ce+Pr+Nd) ₂ O ₃
MREO	23	(Sm+Eu+Gd) ₂ O ₃
HREO	87	(Tb+Dy+Ho+Er+Tm+Yb+Lu+Y) ₂ O ₃

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/>