



African Mineral Standards

MATRIX REFERENCE MATERIALS

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AMIS0373

Certified Reference Material

**Iron Ore, Hamersley Iron Ore province,
Western Australia**

Certificate of Analysis

**Recommended Concentrations and Limits¹
(at two Standard Deviations)**

Certified Concentrations²

Fe Fusion	55.70	±	1.12	%
Fe XRF	56.59	±	0.34	%

Provisional Concentrations

Fe M/ICP	51.57	±	8.98	%
Ba M/ICP	20	±	3	ppm
Mn M/ICP	1044	±	129	ppm
P M/ICP	357	±	63	ppm
Sn M/ICP	0.8	±	0.2	ppm
Zr M/ICP	39	±	9	ppm

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.

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

Certified Concentrations

Al ₂ O ₃	2.72	±	0.05	%
Fe ₂ O ₃	80.95	±	1.02	%
K ₂ O	0.03	±	0.002	%
MnO	0.15	±	0.01	%
P ₂ O ₅	0.09	±	0.006	%
SiO ₂	11.88	±	0.18	%
TiO ₂	0.19	±	0.01	%
LOI	3.71	±	0.34	%

Provisional Concentration

V ₂ O ₅	0.01	±	0.002	%
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Indicated Means

CaO	0.024	%
Cr ₂ O ₃	0.017	%
MgO	0.06	%
Na ₂ O	0.02	%
S Comb / LECO	0.020	%

1. **Intended Use:** AMIS0373 can be used to check analysis of samples of high-grade iron ore deposits hosted within banded iron formation (BIF) sequences 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:** AMIS0373 was supplied by SGS Australia.

3. **Mineral and Chemical Composition:** The precise mineralogy of the material was not detailed. Iron ore deposits of the Hamersley Province are mostly hosted within banded iron formation (BIF) sequences of the Brockman and Marra Mamba Iron Formations of the Hamersley Group and consist of two types: martite-microplaty hematite containing between 60 and 68 wt. % Fe, and martite-goethite containing between 56 and 63 wt. % Fe

4. **Appearance:** The material is a very fine strong brown powder (Corstor 5YR 4/6).

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 element scan to include Fe. Fusion, ICP-OES or ICP-MS.
2. Multi element scan. Multi-acid digest ICP-OES or ICP-MS.
3. Majors (Al₂O₃, CaO, Cr₂O₃, Fe₂O₃, K₂O, MgO, MnO, Na₂O, P₂O₅, SiO₂, TiO₂, V₂O₅.) XRF fusion.
4. LOI (TGA) – 105°C, 1000°C.
5. S – Combustion analysis.
6. 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.
4. Report all QC data, to include replicates, blanks and certified reference materials used.

9. **Method of Certification:** Twenty four laboratories were each given eight randomly selected packages of sample. Twenty one 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 21 out of 24 laboratories that provided results timeously were (not in same order as in the table of assays):

1. ACME Analytical Laboratories Ltd CA
2. Activation Laboratories Pty Ltd (ActLabs) CA

3. ALS Ammtec (Australia)
4. ALS Chemex Laboratory Group Brisbane Australia
5. ALS Chemex Laboratory Group Johannesburg SA
6. ALS Chemex Laboratory Group Perth WA
7. ALS OMAC (Ireland)
8. Anglo Research (Crown Campus)
9. BV Amdel (Australia)
10. Genalysis Laboratory Services (South Africa) Pty
11. Genalysis Laboratory Services (W Australia P)
12. Intertek Utama Services (Indonesia)
13. Set Point Laboratories (Isando) SA
14. SGS Australia Pty Ltd (Newburn) WA
15. SGS Geosol Laboratories Ltda (Brazil)
16. SGS Mineral Services Callao (Peru)
17. SGS Mineral Services Lakefield (Canada)
18. SGS South Africa (Pty) Ltd - Booyens JHB
19. SGS Townsville (Australia)
20. SGS Vancouver (Canada)
21. 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	Fe Fusion %	Fe M/ICP %	Fe XRF %	Ba M/ICP ppm	Mn M/ICP ppm	P M/ICP ppm	Sn M/ICP ppm	Zr M/ICP ppm
A		57.90	56.70	19.00	1100	450		43.00
A		57.30	56.83	17.00	1120	400		44.00
A		56.60	56.82	19.00	1120	400		45.00
A		57.50	56.88	20.00	1120	450		46.00
A		57.20	56.83	18.00	1100	400		44.00
A		56.70	56.71	19.00	1100	350		46.00
A		57.50	56.76	18.00	1100	400		46.00
A		57.80	56.80	18.00	1100	450		45.00
B		57.60			1100			
B		57.60			1100			
B		56.50			1100			
B		56.30			1200			
B		56.50			1100			
B		57.00			1100			
B		56.20			1100			
B		58.00			1100			
C		56.10	56.17		1200	400	0.80	40.00
C		56.40	55.76		1150	350	0.80	45.00
C		56.50	55.40		1200	450	0.90	45.00
C		55.70	56.60		1150	400	0.80	55.00
C		55.70	55.96		1100	400	0.80	45.00
C		56.10	56.29		1150	400	0.70	45.00
C		56.40	56.48		1150	400	0.80	50.00
C		56.20	55.71		1150	400	0.80	45.00
D			56.49	20.00	1080	380	0.90	38.10
D			56.45	20.00	1070	370	0.80	36.40
D			56.57	20.00	1060	360	0.90	36.40
D			56.51	20.00	1010	360	0.80	35.60
D			56.50	20.00	1080	380	0.90	37.30
D			56.49	20.00	1050	360	0.80	36.50
D			56.51	20.00	1060	370	0.90	38.20
D			56.51	20.00	1090	380	0.90	37.50

Assay data – Economic Elements (cont)

Lab Code	Fe Fusion %	Fe M/ICP %	Fe XRF %	Ba M/ICP ppm	Mn M/ICP ppm	P M/ICP ppm	Sn M/ICP ppm	Zr M/ICP ppm
E				17.9	936	371		37.93
E				19.1	949	382		38.94
E				21.9	981	363		40.18
E				17.6	959	353		41.61
E				18.8	968	363		41.72
E				44.5	987	368		42.63
E				18.6	974	351		41.86
E				17.5	965	361		39.14
G	48.60	45.70		23.0	1150	300	0.80	43.20
G	46.50	48.60		23.0	1240	320	0.90	43.80
G	48.20	46.70		24.0	1230	310	0.80	43.50
G	47.60	48.00		23.0	1220	320	0.80	42.90
G	48.60	48.20		23.0	1200	310	0.80	43.30
G	48.80	47.20		23.0	1220	310	0.80	44.70
G	49.10	47.40		24.0	1230	310	0.80	44.50
G	48.90	47.60		23.0	1220	310	0.80	43.50
I	55.10	49.60	56.80	21.0	1080	330	0.70	31.00
I	55.30	52.20	56.80	21.0	1080	330	0.80	30.00
I	54.90	50.90	56.80	32.0	1090	320	0.70	31.00
I	55.50	54.40	56.70	22.0	1140	350	0.70	33.00
I	55.40	53.80	56.70	22.0	1110	330	0.70	32.00
I	53.50	52.40	56.70	21.0	1090	355	0.70	31.00
I	55.60	52.70	56.80	23.0	1090	340	0.70	31.00
I	54.50	52.50	56.80	22.0	1120	335	0.70	32.00
J		44.70	56.77	20.0	1030	370	0.80	36.80
J		44.40	56.21	20.0	1000	360	0.80	36.50
J		45.40	56.08	20.0	1020	360	0.80	37.50
J		46.40	56.07	20.0	1050	370	0.90	37.80
J		46.50	56.26	20.0	1060	380	0.80	38.20
J		45.90	56.26	20.0	1150	360	0.90	43.40
J		45.40	56.49	20.0	1040	360	0.90	36.40
J		45.60	56.59	20.0	1030	370	0.90	37.50
K	56.89	45.60		19.0	1020		2.00	37.00
K	55.17	48.90		20.0	1110		2.00	39.00
K	56.06	46.00		19.0	1040		2.00	37.00
K	56.30	48.50		20.0	1080		1.00	37.00
K	56.90	45.30		18.0	1070		2.00	36.00
K	55.48	44.50		19.0	1060		2.00	36.00
K	55.20	47.70		18.0	1090		1.00	38.00
K	56.92	47.80		18.0	1080		2.00	37.00
L	55.90			40.0	913	320	0.80	37.10
L	56.10			40.0	914	310	0.80	36.80
L	56.50			40.0	911	320	0.80	36.10
L	56.00			43.0	927	320	0.70	36.90
L	56.20			38.0	896	300	0.80	37.00
L	55.90			37.0	920	300	0.80	36.60
L	56.80			39.0	922	250	0.80	29.40
L	56.00			37.0	916	300	0.80	35.40
M	55.26	47.44			1100	400		
M	55.01	47.27			1100	400		
M	55.73	47.39			1100	400		
M	55.62	49.98			1200	400		
M	50.08	50.29			1200	300		
M	55.86	51.33			1200	400		
M	58.09	49.84			1200	400		
M	55.91	50.98			1100	400		

Assay data –Economic Elements (cont)

Lab Code	Fe Fusion %	Fe M/ICP %	Fe XRF %	Ba M/ICP ppm	Mn M/ICP ppm	P M/ICP ppm	Sn M/ICP ppm	Zr M/ICP ppm
N		56.40	56.44	20.00	1030			
N		56.30	56.68	21.00	1040			
N		56.70	56.50	21.00	1060			
N		56.30	56.52	22.00	1050			
N		56.50	56.60	21.00	1040			
N		56.40	56.40	23.00	1020			
N		56.20	56.46	22.00	1040			
N		56.30	56.37	21.00	1010			
O			56.53	20.00	1030	350	0.80	35.20
O			56.45	20.00	974	350	0.80	33.80
O			56.22	20.00	995	350	0.80	35.30
O			56.22	20.00	1010	350	0.80	34.20
O			56.22	20.00	1020	360	0.80	34.00
O			56.41	20.00	992	350	0.70	34.20
O			56.50	20.00	984	350	0.70	32.40
O			56.45	20.00	980	360	0.80	34.20
Q				23.00	1035	326	0.70	
Q				24.00	1039	326	0.60	
Q				24.00	972	315	0.70	
Q				24.00	975	315	0.60	
Q				23.00	1007	317	0.60	
Q				23.00	1024	331	0.60	
Q				23.00	1058	322	0.60	
Q				24.00	1079	343	0.60	
R	55.70	51.72						
R	55.60	51.95						
R	55.10	51.33						
R	55.90	51.34						
R	55.40	50.85						
R	55.90	51.74						
R	55.70	51.89						
R	55.30	50.46						
S				27.00	1112	381	1.10	106.00
S				24.00	1131	338	0.90	117.00
S				27.00	1145	396	1.00	118.00
S				25.00	1118	320	1.00	106.10
S				27.00	1130	431	0.90	114.30
S				26.00	1146	372	0.80	116.70
S				27.00	1120	430	1.00	111.40
S				24.00	1113	328	1.20	112.90
T			56.79	19.00	1000	362		
T			56.64	21.00	990	369		
T			56.63	20.00	990	364		
T			56.64	20.00	1000	363		
T			56.73	20.00	1000	354		
T			56.75	19.00	1000	360		
T			56.89	20.00	1000	366		
T			56.62	20.00	980	354		
U			56.47					
U			56.35					
U			56.32					
U			56.54					
U			56.49					
U			56.37					
U			56.44					
U			56.51					

Assay data –Economic Elements (cont)

Lab Code	Fe Fusion %	Fe M/ICP %	Fe XRF %	Ba M/ICP ppm	Mn M/ICP ppm	P M/ICP ppm	Sn M/ICP ppm	Zr M/ICP ppm
V	55.40		56.67					
V	56.10		56.69					
V	56.00		56.67					
V	54.90		56.70					
V	55.40		56.74					
V	55.70		56.73					
V	55.90		56.68					
V	55.80		56.74					
W	57.60	45.39	56.59	18.00	954	357	0.70	38.90
W	55.96	48.09	56.65	17.00	1006	363	0.70	39.10
W	58.69	46.01	56.61	17.00	949	358	0.70	40.20
W	55.23	45.52	56.69	18.00	1007	392	0.70	39.50
W	54.48	48.97	56.57	18.00	996	375	0.70	40.70
W	55.39		56.68	18.00	985	383	0.80	41.00
W	56.34	47.95	56.63	17.00	991	401	0.70	39.90
W	55.54	47.77	56.60	18.00	989	366	0.70	39.90

Assay data – Major Oxides

Lab Code	Al ₂ O ₃ XRF %	CaO XRF %	Cr ₂ O ₃ XRF %	Fe ₂ O ₃ XRF %	K ₂ O XRF %	MgO XRF %	MnO XRF %	Na ₂ O XRF %	P ₂ O ₅ XRF %	SiO ₂ XRF %	TiO ₂ XRF %	V ₂ O ₅ XRF %	LOI %	S Comb/LECO %
A	2.70	0.02	0.02		0.03	0.06	0.14	0.01	0.09	11.82	0.19	0.01	3.58	0.02
A	2.74	0.02	0.02		0.03	0.07	0.14	0.01	0.09	11.93	0.19	0.01	3.57	0.02
A	2.71	0.02	0.02		0.03	0.06	0.15	0.01	0.09	11.84	0.19	0.01	3.56	0.02
A	2.71	0.02	0.02		0.03	0.06	0.15	0.01	0.09	11.86	0.19	0.01	3.59	0.03
A	2.74	0.02	0.02		0.03	0.06	0.15	0.02	0.09	11.88	0.19	0.01	3.60	0.03
A	2.74	0.02	0.02		0.03	0.06	0.14	0.01	0.09	11.92	0.19	0.01	3.64	0.03
A	2.75	0.02	0.02		0.03	0.06	0.14	0.01	0.09	11.91	0.19	0.01	3.59	0.02
A	2.74	0.02	0.02		0.03	0.06	0.14	0.01	0.09	11.87	0.19	0.01	3.59	0.02
B	2.72	0.03	0.02	80.90	0.03	0.07	0.14	0.01	0.09	11.80	0.19	0.01	3.74	
B	2.68	0.03	0.02	80.90	0.03	0.07	0.14	0.01	0.09	11.80	0.18	0.01	4.04	
B	2.75	0.03	0.02	80.60	0.03	0.07	0.14	0.01	0.09	11.90	0.19	0.01	3.81	
B	2.74	0.03	0.02	80.50	0.03	0.08	0.14		0.09	12.00	0.19	0.01	3.71	
B	2.72	0.03	0.01	80.80	0.03	0.07	0.14	0.01	0.10	12.00	0.19	0.01	3.75	
B	2.72	0.02	0.02	80.80	0.03	0.07	0.14	0.01	0.09	12.00	0.19	0.01	3.78	
B	2.77	0.03	0.02	80.60	0.03	0.07	0.15		0.09	12.10	0.19	0.01	3.95	
B	2.72	0.03	0.02	80.80	0.03	0.07	0.14	0.01	0.09	11.90	0.19	0.01	3.82	
C	2.69	0.04	0.02		0.03	0.09	0.15	0.03		11.91	0.18		3.76	0.02
C	2.68	0.04	0.02		0.03	0.09	0.14	0.03		11.83	0.17		3.76	0.02
C	2.67	0.03	0.02		0.03	0.09	0.14	0.03		11.81	0.18		3.71	0.02
C	2.74	0.04	0.02		0.03	0.10	0.15	0.03		12.01	0.18		3.74	0.02
C	2.73	0.04	0.02		0.03	0.09	0.14	0.03		11.96	0.18		3.75	0.02
C	2.71	0.04	0.02		0.03	0.10	0.15	0.03		11.98	0.18		3.76	0.02
C	2.72	0.04	0.02		0.03	0.09	0.15	0.03		11.93	0.18		3.71	0.02
C	2.68	0.04	0.02		0.03	0.09	0.14	0.03		11.88	0.18		3.74	0.02
D	2.74	0.02	0.01		0.03	0.07	0.15	0.03	0.09	12.00	0.18	0.01	3.79	0.02
D	2.74	0.02	0.01		0.03	0.08	0.15	0.04	0.09	12.20	0.18	0.01	3.68	0.02
D	2.74	0.02	0.02		0.03	0.06	0.15	0.03	0.09	12.00	0.18	0.01	3.70	0.02
D	2.74	0.02	0.02		0.03	0.07	0.15	0.02	0.09	12.05	0.18	0.01	3.72	0.02
D	2.74	0.02	0.01		0.03	0.09	0.15	0.03	0.09	12.05	0.18	0.01	3.74	0.02
D	2.74	0.02	0.01		0.03	0.09	0.15	0.04	0.09	12.00	0.18	0.01	3.79	0.02
D	2.73	0.02	0.01		0.03	0.07	0.15	0.03	0.09	11.95	0.18	0.01	3.82	0.02
D	2.74	0.02	0.02		0.03	0.07	0.15	0.03	0.09	12.00	0.18	0.01	3.75	0.02
E	2.74	0.03		81.57	0.03		0.16		0.10	12.10	0.21		3.81	0.02
E	2.73	0.03		81.70	0.03		0.16		0.09	12.04	0.22		3.77	0.02
E	2.70	0.03		80.53	0.03		0.16		0.10	11.63	0.20		3.78	0.02
E	2.75	0.02		81.17	0.03		0.17		0.09	12.02	0.20		3.80	0.02
E	2.69	0.03		80.72	0.03		0.16		0.09	11.96	0.21		3.82	0.02
E	2.71	0.03		81.44	0.03		0.17		0.10	11.93	0.20		3.83	0.02
E	2.73	0.03		81.50	0.04		0.16		0.09	11.93	0.21		3.94	0.02
E	2.80	0.03		81.19	0.05		0.17		0.09	12.03	0.20		3.91	0.02

Assay data - Major Oxides (cont.)

Lab Code	Al ₂ O ₃ XRF %	CaO XRF %	Cr ₂ O ₃ XRF %	Fe ₂ O ₃ XRF %	K ₂ O XRF %	MgO XRF %	MnO XRF %	Na ₂ O XRF %	P ₂ O ₅ XRF %	SiO ₂ XRF %	TiO ₂ XRF %	V ₂ O ₅ XRF %	LOI %	S Comb/LECO %
I	2.71	0.03			0.03	0.06		0.02	0.09	11.90	0.19		3.68	0.01
I	2.71	0.03			0.03	0.05		0.02	0.09	11.90	0.19		3.68	0.01
I	2.71	0.03			0.03	0.06		0.03	0.09	12.00	0.19		3.69	0.01
I	2.72	0.03			0.03	0.06		0.02	0.09	12.00	0.19		3.67	0.01
I	2.71	0.03			0.03	0.07		0.02	0.09	11.90	0.19		3.68	0.01
I	2.71	0.03			0.03	0.06		0.02	0.09	11.90	0.19		3.67	0.01
I	2.71	0.03			0.03	0.06		0.02	0.09	11.90	0.19		3.65	0.01
I	2.69	0.03			0.03	0.07		0.02	0.09	11.90	0.19		3.62	0.01
J	2.70	0.03	0.02		0.03	0.06	0.15	0.01	0.09	11.75	0.19	0.01	3.94	0.02
J	2.66	0.02	0.01		0.03	0.07	0.14	0.01	0.09	11.65	0.18	0.01	3.90	0.02
J	2.68	0.02	0.01		0.03	0.07	0.14	0.01	0.09	11.70	0.18	0.01	3.81	0.02
J	2.73	0.02	0.02		0.03	0.06	0.15	0.01	0.09	11.85	0.19	0.01	3.86	0.02
J	2.69	0.02	0.01		0.03	0.06	0.15	0.02	0.09	11.75	0.19	0.01	3.87	0.02
J	2.68	0.02	0.03		0.03	0.06	0.15	0.01	0.09	11.70	0.19	0.01	4.04	0.02
J	2.66	0.02	0.02		0.03	0.06	0.14	0.01	0.09	11.70	0.19	0.01	3.92	0.02
J	2.66	0.02	0.01		0.03	0.06	0.14	0.02	0.09	11.65	0.19	0.01	3.90	0.02
K	2.69	0.03	0.02	81.07	0.03	0.06	0.14		0.09	11.63	0.19	0.01	3.53	0.04
K	2.74	0.03	0.02	81.04	0.03	0.06	0.15		0.09	11.71	0.20	0.01	3.44	0.04
K	2.73	0.03	0.02	80.82	0.03	0.06	0.15		0.09	11.60	0.19	0.01	3.44	0.04
K	2.64	0.02	0.02	81.24	0.03	0.06	0.15		0.09	11.58	0.19	0.01	3.39	0.04
K	2.72	0.03	0.02	80.81	0.03	0.05	0.14		0.09	11.59	0.19	0.01	3.39	0.03
K	2.70	0.03	0.04	81.02	0.03	0.05	0.15		0.09	11.60	0.19	0.01	3.38	0.04
K	2.77	0.03	0.02	80.03	0.03	0.05	0.14		0.09	11.43	0.19	0.01	3.49	0.04
K	2.68	0.02	0.02	80.61	0.04	0.06	0.14		0.09	11.55	0.19	0.01	3.52	0.05
L													4.48	0.02
L													4.51	0.02
L													4.51	0.02
L													4.52	0.02
L													4.54	0.02
L													4.50	0.02
L													4.49	0.02
L													4.50	0.02
M	2.71	0.03	0.02	80.50	0.03	0.04	0.14		0.09	11.80	0.17	0.01	3.77	0.05
M	2.71	0.03	0.02	80.79	0.03	0.04	0.14		0.09	11.80	0.16	0.01	3.81	0.04
M	2.70	0.03	0.02	80.36	0.03	0.04	0.14		0.09	11.80	0.17	0.01	3.82	0.04
M	2.69	0.03	0.02	80.53	0.03	0.03	0.14		0.09	11.70	0.16	0.01	3.81	0.03
M	2.71	0.03	0.02	80.55	0.03	0.04	0.14		0.08	11.80	0.16	0.01	3.79	0.04
M	2.71	0.03	0.02	80.28	0.04	0.03	0.14		0.09	11.90	0.17	0.01	3.81	0.04
M	2.74	0.03	0.02	81.18	0.03	0.04	0.14		0.09	11.90	0.17	0.01	3.82	0.03
M	2.71	0.03	0.02	80.20	0.03	0.04	0.14		0.09	11.80	0.17	0.01	3.81	0.03
N	2.72	0.02	0.01	80.71	0.03	0.06	0.14	0.02	0.09	11.92	0.19	0.01		0.02
N	2.70	0.02	0.01	81.05	0.03	0.05	0.14	0.02	0.09	11.90	0.19	0.01		0.01
N	2.69	0.02	0.01	80.79	0.03	0.05	0.14	0.02	0.09	11.91	0.19	0.01		0.01
N	2.70	0.02	0.01	80.82	0.03	0.06	0.14	0.02	0.09	11.90	0.19	0.01		0.02
N	2.71	0.02	0.02	80.94	0.03	0.06	0.14	0.02	0.09	11.94	0.19	0.01		0.02
N	2.68	0.02	0.02	80.65	0.03	0.06	0.14	0.03	0.09	11.86	0.18	0.01		0.02
N	2.70	0.02	0.01	80.74	0.03	0.05	0.14	0.01	0.09	11.92	0.18	0.01		0.01
N	2.70	0.02	0.02	80.61	0.03	0.06	0.14	0.02	0.09	11.89	0.18	0.01		0.02
O	2.73	0.02	0.02		0.03	0.06	0.15		0.09	11.85	0.19	0.01	3.91	0.02
O	2.73	0.02	0.02		0.03	0.06	0.15		0.09	11.85	0.19	0.01	4.02	0.02
O	2.79	0.02	0.02		0.04	0.06	0.15		0.09	12.05	0.19	0.01	4.08	0.03
O	2.76	0.02	0.02		0.03	0.06	0.15		0.09	12.00	0.19	0.01	4.17	0.02
O	2.76	0.02	0.02		0.04	0.06	0.15		0.09	11.95	0.19	0.01	4.20	0.02
O	2.72	0.02	0.02		0.03	0.06	0.15		0.09	11.85	0.19	0.01	4.08	0.02
O	2.74	0.02	0.02		0.03	0.06	0.15		0.09	11.90	0.19	0.01	3.91	0.02
O	2.76	0.02	0.02		0.03	0.06	0.15		0.09	11.90	0.19	0.01	3.96	0.02
Q	2.78	0.02		80.40	0.03	0.09	0.15	0.03	0.09	11.80	0.23		3.69	0.01
Q	2.77	0.02		79.90	0.03	0.08	0.14	0.03	0.09	11.80	0.23		3.60	0.02
Q	2.82	0.02		80.40	0.03	0.09	0.15	0.03	0.09	11.90	0.23		4.02	0.02
Q	2.84	0.02		80.40	0.03	0.12	0.15	0.06	0.09	11.80	0.23		3.99	0.02
Q	2.79	0.02		80.60	0.03	0.08	0.15	0.02	0.09	11.80	0.23		3.99	0.02
Q	2.80	0.02		80.40	0.03	0.11	0.15	0.05	0.09	11.80	0.23		3.61	0.02
Q	2.80	0.02		80.40	0.03	0.08	0.15	0.03	0.09	11.80	0.23		4.10	0.02
Q	2.85	0.02		80.40	0.03	0.11	0.15	0.05	0.09	11.80	0.23		4.02	0.02
R	2.38		0.03	82.01			0.15		0.09	11.5	0.19	0.02	3.40	0.03
R	2.35		0.03	82.31			0.15		0.09	11.5	0.19	0.01	3.39	0.03
R	2.40		0.03	81.71			0.15		0.09	11.4	0.19	0.01	3.41	0.03
R	2.41		0.03	81.85			0.15		0.09	11.6	0.19	0.01	3.37	0.03
R	2.38		0.03	81.72			0.15		0.09	11.4	0.19	0.01	3.40	0.03
R	2.37		0.03	82.00			0.15		0.09	11.4	0.19	0.01	3.41	0.03
R	2.39		0.03	82.36			0.15		0.09	11.6	0.20	0.02	3.47	0.03
R	2.38		0.03	81.95			0.15		0.09	11.6	0.20	0.01	3.41	0.03

Assay data - Major Oxides (cont.)

Lab Code	Al ₂ O ₃ XRF %	CaO XRF %	Cr ₂ O ₃ XRF %	Fe ₂ O ₃ XRF %	K ₂ O XRF %	MgO XRF %	MnO XRF %	Na ₂ O XRF %	P ₂ O ₅ XRF %	SiO ₂ XRF %	TiO ₂ XRF %	V ₂ O ₅ XRF %	LOI %	S Comb/LECO %	
S													3.59	0.01	
S													3.60	0.02	
S													3.67	0.01	
S													3.59	0.01	
S													3.65	0.01	
S													3.59	0.01	
S													3.67	0.01	
S													3.65	0.01	
T	2.72		0.03		0.03	0.06	0.14			11.76	0.19	0.01		0.02	
T	2.70	0.02	0.02		0.03	0.06	0.14			11.81	0.19	0.01		0.03	
T	2.76	0.02	0.03		0.03	0.06	0.14			11.82	0.20	0.01		0.03	
T	2.71	0.02	0.03		0.03	0.05	0.14			11.79	0.20	0.01		0.03	
T	2.73	0.02	0.02		0.03	0.05	0.14			11.79	0.20	0.01		0.03	
T	2.75	0.02	0.03		0.03	0.06	0.14			11.77	0.20	0.01		0.03	
T	2.73	0.02	0.03		0.03	0.06	0.14			11.79	0.19	0.01		0.03	
T	2.71	0.02	0.02		0.03	0.06	0.14			11.73	0.19	0.01		0.03	
U	2.67	0.02	0.02		0.03	0.07	0.14		0.09	11.83	0.19	0.01		3.63	
U	2.66	0.02	0.02		0.03	0.08	0.14		0.09	11.70	0.19	0.01		3.61	
U	2.67	0.02	0.02		0.03	0.07	0.14		0.09	11.69	0.18	0.01		3.62	
U	2.65	0.02	0.02		0.03	0.08	0.15		0.09	11.76	0.18	0.01		3.66	
U	2.67	0.02	0.02		0.03	0.08	0.14		0.09	11.65	0.19	0.01		3.66	
U	2.68	0.02	0.02		0.03	0.08	0.14		0.09	11.73	0.19	0.01		3.66	
U	2.66	0.02	0.02		0.03	0.07	0.15		0.09	11.77	0.18	0.01		3.64	
U	2.65	0.02	0.02		0.03	0.07	0.15		0.09	11.71	0.19	0.01		3.63	
V	2.74	0.02	0.02		0.03	0.08	0.15	0.02	0.08	11.90	0.18	0.01		3.62	0.02
V	2.72	0.02	0.02		0.03	0.08	0.15	0.01	0.08	11.90	0.19	0.01		3.62	0.02
V	2.72	0.02	0.02		0.03	0.08	0.15	0.01	0.08	11.90	0.19	0.01		3.64	0.02
V	2.73	0.02	0.02		0.03	0.08	0.15	0.01	0.08	11.90	0.18	0.01		3.61	0.02
V	2.73	0.02	0.02		0.03	0.08	0.15	0.02	0.08	11.85	0.19	0.01		3.60	0.02
V	2.72	0.02	0.02		0.03	0.08	0.15	0.02	0.08	11.85	0.19	0.01		3.60	0.02
V	2.74	0.02	0.02		0.03	0.08	0.15	0.02	0.08	11.90	0.19	0.01		3.62	0.02
V	2.72	0.02	0.02		0.03	0.08	0.15	0.01	0.08	11.90	0.18	0.01		3.56	0.02
W	2.72	0.03	0.02		0.03	0.06	0.14	0.02	0.09	11.94	0.18	0.01		3.62	0.02
W	2.70	0.03	0.02		0.03	0.07	0.14	0.02	0.09	11.95	0.18	0.01		3.58	0.02
W	2.76	0.03	0.02		0.03	0.06	0.15	0.02	0.09	11.90	0.19	0.01		3.57	0.02
W	2.73	0.03	0.02		0.03	0.06	0.14	0.02	0.09	11.98	0.19	0.01		3.62	0.02
W	2.75	0.03	0.02		0.03	0.06	0.14	0.02	0.09	11.91	0.18	0.01		3.56	0.02
W	2.75	0.03	0.02		0.03	0.07	0.15	0.02	0.09	11.96	0.19	0.01		3.57	0.02
W	2.76	0.03	0.02		0.03	0.06	0.14	0.02	0.09	11.93	0.18	0.01		3.56	0.02
W	2.73	0.03	0.02		0.03	0.06	0.15	0.02	0.09	11.95	0.19	0.01		3.57	0.02
X	2.72	0.03	0.01	81.60	0.03	0.06	0.14		0.09	12.00	0.19			3.92	0.03
X	2.76	0.02	0.01	81.50	0.03	0.08	0.15		0.09	12.00	0.20			3.94	0.02
X	2.75	0.02	0.01	81.60	0.03	0.07	0.15		0.09	12.00	0.20			3.96	0.02
X	2.72	0.02	0.01	81.40	0.03	0.06	0.15		0.08	11.90	0.19			3.93	0.02
X	2.71	0.03	0.02	81.50	0.03	0.06	0.15		0.08	11.90	0.19			3.91	0.02
X	2.71	0.02	0.01	81.40	0.03	0.07	0.14		0.09	11.90	0.19			3.92	0.02
X	2.73	0.02	0.02	81.30	0.03	0.06	0.15		0.09	11.80	0.19			3.97	0.03
X	2.73	0.03	0.02	81.30	0.03	0.07	0.14		0.09	12.00	0.20			3.87	0.02

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

The samples used in this certification process have been 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	S _w ³	CSU ⁴
	Fusion	%	0.96	0.38	0.89	0.19
Fe	M/ICP	%	4.49	3.85	1.05	1.17
Fe	XRF	%	0.17	0.13	0.10	0.04
Ba	M/ICP	ppm	1.90	1.48	0.72	0.43
Mn	M/ICP	ppm	64.7	44.8	22.7	11.8
P	M/ICP	ppm	31.6	19.5	18.7	5.5
Sn	M/ICP	ppm	0.09	0.07	0.05	0.02
Zr	M/ICP	ppm	4.57	3.72	1.71	1.14
Al ₂ O ₃	XRF	%	0.026	0.013	0.019	0.004
CaO	XRF	%	0.005	0.003	0.002	0.001
Cr ₂ O ₃	XRF	%	0.003	0.001	0.002	0.0004
Fe ₂ O ₃	XRF	%	0.51	0.46	0.26	0.17
K ₂ O	XRF	%	0.001	0.001	0.001	0.0001
LOI		%	0.171	0.110	0.066	0.027
MgO	XRF	%	0.012	0.008	0.005	0.002
MnO	XRF	%	0.004	0.002	0.003	0.001
Na ₂ O	XRF	%	0.008	0.007	0.003	0.002
P ₂ O ₅	XRF	%	0.003	0.002	0.001	0.0004
SiO ₂	XRF	%	0.090	0.052	0.053	0.014
TiO ₂	XRF	%	0.007	0.004	0.004	0.001
V ₂ O ₅	XRF	%	0.001	0.001	0.001	0.0002
S	Comb/ LECO	%	0.005	0.003	0.003	0.001

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 S_w - 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. Uncertified 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 Dr Barry Smee.

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: AMIS0373 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 and a 30g sample size for the fire assay. These are the recommended minimum sample sizes 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, Dr Barry Smee and Smee and Associates Ltd; accept no liability for any decisions or actions taken following the use of the reference material.

24 May 2013

Certifying Officers:



African Mineral Standards: _____

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



Geochemist: _____

Barry W. Smee
BSc, PhD, P.Geo, (B.C.)

Appendix - uncertified trace element statistics

Analyte	Method	Unit	Mean	2SD	RSD%	n
Ag	M/ICP	ppm	0.16	0.14	42.4	74
Al	M/ICP	%	1.4	0.18	6.3	136
As	M/ICP	ppm	83.6	14.6	8.8	112
Be	M/ICP	ppm	1.3	0.38	14.1	91
Bi	M/ICP	ppm	0.51	0.10	10.2	93
Ca	M/ICP	%	0.02	0.01	27.7	111
Cd	M/ICP	ppm	0.09	0.14	79.9	52
Ce	M/ICP	ppm	12.6	1.3	5.3	80
Co	M/ICP	ppm	10.0	6.2	30.9	112
Cr	M/ICP	ppm	109	31.1	14.3	120
Cs	M/ICP	ppm	0.12	0.08	32.1	71
Cu	M/ICP	ppm	20.0	8.3	20.7	136
Dy	M/ICP	ppm	1.0	0.15	7.6	47
Er	M/ICP	ppm	0.72	0.09	5.9	45
Eu	M/ICP	ppm	0.23	0.04	8.0	47
Ga	M/ICP	ppm	5.1	0.69	6.7	96
Gd	M/ICP	ppm	0.92	0.15	8.2	47
Ge	M/ICP	ppm	1.5	2.5	84.6	52
Hf	M/ICP	ppm	1.0	0.33	16.4	78
Ho	M/ICP	ppm	0.23	0.04	9.1	47
In	M/ICP	ppm	0.04	0.02	19.0	68
K	M/ICP	%	0.03	0.01	24.9	118
La	M/ICP	ppm	4.8	1.1	11.6	90
Li	M/ICP	ppm	2.1	0.65	15.3	99
Lu	M/ICP	ppm	0.13	0.04	15.4	53
Mg	M/ICP	%	0.04	0.02	29.9	112
Mo	M/ICP	ppm	1.4	0.76	27.0	88
Na	M/ICP	%	0.09	0.52	282	97
Nb	M/ICP	ppm	3.1	1.1	17.2	94
Nd	M/ICP	ppm	4.1	0.80	9.8	48
Ni	M/ICP	ppm	16.4	5.2	15.9	123
Pb	M/ICP	ppm	20.9	4.0	9.6	104
Pr	M/ICP	ppm	1.0	0.15	7.1	45
Rb	M/ICP	ppm	1.21	0.39	16.1	93
S	M/ICP	%	0.02	0.01	23.2	92
Sb	M/ICP	ppm	5.0	3.5	34.8	104
Sc	M/ICP	ppm	3.8	1.4	17.8	91
Se	M/ICP	ppm	1.1	0.66	31.0	27
SG			4.2	0.21	2.5	95
Si	M/ICP	%	5.6	0.07	0.6	15
Sm	M/ICP	ppm	0.90	0.13	7.0	47
Sr	M/ICP	ppm	3.5	1.3	18.0	104
Ta	M/ICP	ppm	0.66	0.34	26.3	74
Tb	M/ICP	ppm	0.15	0.03	8.4	53
Te	M/ICP	ppm	0.12	0.16	66.3	53
Th	M/ICP	ppm	4.1	0.50	6.1	83
Ti	M/ICP	%	0.10	0.02	10.7	107
Tl	M/ICP	ppm	0.02	0.01	20.5	34
Tm	M/ICP	ppm	0.12	0.03	12.3	40
U	M/ICP	ppm	3.5	0.40	5.7	91
V	M/ICP	ppm	47.6	20.1	21.1	103
W	M/ICP	ppm	23.2	7.3	15.7	115
Y	M/ICP	ppm	6.7	0.85	6.4	103
Yb	M/ICP	ppm	0.87	0.13	7.6	61
Zn	M/ICP	ppm	21.4	20.2	47.3	114