



African Mineral Standards

MATRIX REFERENCE MATERIALS

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AMIS0371

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	53.00	±	3.98	%
Fe XRF	54.84	±	0.32	%
Mn M/ICP	1113	±	133	ppm
Specific Gravity	4.09	±	0.28	

Provisional Concentrations

Fe M/ICP	50.40	±	8.44	%
Ba M/ICP	19	±	4	ppm
P M/ICP ppm	375	±	57	ppm
S Comb / LECO	0.06	±	0.01	%
Sn M/ICP	0.8	±	0.1	ppm
Zr M/ICP	43	±	6	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	3.15	±	0.06	%
Fe ₂ O ₃	78.50	±	0.70	%
K ₂ O	0.04	±	0.002	%
MnO	0.15	±	0.01	%
P ₂ O ₅	0.10	±	0.01	%
SiO ₂	13.39	±	0.22	%
TiO ₂	0.21	±	0.01	%
LOI	4.16	±	0.22	%

Provisional Concentration

V ₂ O ₅	0.01	±	0.02	%
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Indicated Mean

CaO	0.025	%
Cr ₂ O ₃	0.018	%
MgO	0.07	%
Na ₂ O	0.015	%

1. **Intended Use:** AMIS0371 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:** AMIS0371 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	SG pyc
A		54.40	54.8		1200	400	0.80	60.00	3.90
A		55.30	54.9		1150	450	0.70	55.00	3.84
A		54.10	54.8		1100	450	0.70	60.00	3.83
A		55.10	54.5		1150	400	0.70	60.00	3.82
A		55.50	54.8		1150	450	0.70	60.00	3.84
A		54.60	54.8		1150	450	0.80	60.00	3.84
A		54.30	54.9		1200	400	0.70	65.00	3.85
A		55.50	54.8		1150	400	0.80	60.00	3.85
B	54.55	50.27	55.0	18.00	1009	369	0.90	46.40	4.27
B	53.80	49.21	54.9	18.00	1004	361	0.80	47.00	4.23
B	53.11	48.63	54.9	17.00	1010	355	0.80	46.20	4.26
B	57.37	48.64	54.9	18.00	998	366	0.70	46.50	4.30
B	58.35	48.26	54.9	17.00	1005	356	0.80	47.20	4.31
B	53.19	48.90	55.0	17.00	991	359	0.80	47.40	4.22
B	55.09	48.17	54.9	18.00	1013	360	0.90	46.50	4.28
B	51.86	47.58	54.9	17.00	1024	373	0.80	46.90	4.23
C		48.70	54.9	20.00	1020	390	3.60	38.40	
C		48.60	54.8	20.00	1010	380	0.90	37.60	
C		49.20	54.7	20.00	998	380	0.80	38.10	
C		48.50	54.8	20.00	993	370	0.80	40.40	
C		49.00	54.8	20.00	994	380	0.90	40.00	
C		48.20	54.8	20.00	976	380	0.80	40.10	
C		48.30	54.9	20.00	1010	380	0.80	38.70	
C		48.70	54.8	20.00	982	380	0.80	38.00	
D		36.40	54.6	21.00	1198	380			3.59
D		37.12	54.7	21.00	1219	387			3.72
D		37.66	54.9	20.00	1223	374			3.61
D		36.71	54.8	20.00	1201	386			3.60
D		37.98	54.6	20.00	1203	363			3.64
D		37.62	55.0	21.00	1206	362			3.64
D		35.32	54.9	20.00	1198	377			3.65
D		36.09	54.5	20.0	1190	364			3.64

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	SG pyc
E		55.00			1100				3.99
E		54.90			1100				4.00
E		56.30			1100				4.00
E		55.30			1100				4.00
E		55.50			1100				4.00
E		55.50			1100				4.00
E		55.50			1100				4.00
E		55.40			1100				3.99
F		54.70	54.67	22.00	1060				
F		54.30	54.70	21.00	1070				
F		54.30	54.74	20.00	1070				
F		54.40	54.74	21.00	1070				
F		53.90	54.83	22.00	1080				
F		54.30	54.74	21.00	1100				
F		53.80	54.62	21.00	1070				
F		54.30	55.06	21.00	1100				
G	49.80	46.50		22.00	1230	330	0.80	48.60	4.22
G	49.40	46.00		22.00	1240	320	0.80	46.50	4.25
G	50.00	45.50		22.00	1180	310	0.80	47.80	4.24
G	49.70	47.40		21.00	1230	320	0.80	48.10	4.24
G	48.40	46.60		22.00	1230	330	0.80	49.30	4.24
G	50.20	45.50		22.00	1240	330	0.80	49.50	4.22
G	50.10	47.70		22.00	1240	330	0.70	48.80	4.25
G	51.50	46.80		21.00	1190	320	0.70	47.30	4.24
H		41.00		18.00	953		1.00	43.00	4.22
H		43.10		19.00	997		2.00	43.00	4.17
H		43.40		19.00	983		1.00	43.00	4.18
H		42.80		19.00	982		2.00	44.00	4.18
H		42.00		18.00	967		1.00	41.00	4.21
H		40.60		18.00	926		1.00	42.00	4.20
H		43.70		19.00	977		1.00	41.00	4.19
H		42.30		19.00	939		1.00	42.00	4.18
I				14.05	776	342		35.67	3.77
I				15.19	823	330		37.08	3.80
I				17.20	815	329		38.93	3.76
I				14.81	802	332		36.33	3.70
I				16.67	841	341		41.50	3.71
I				15.09	867	348		40.36	3.72
I				15.74	823	336		38.68	3.76
I				15.12	816	321		38.14	3.77
J	50.59	36.06			1100	400			3.58
J	54.48	35.96			1100	400			3.71
J	51.21	37.98			1100	400			3.75
J	53.97	42.43			1100	400			3.72
J	56.81	41.23			1100	400			3.56
J	53.96	40.31			1100	400			3.53
J	55.10	38.60			1100	400			3.69
J	52.53	39.25			1100	400			3.63
N				26.00	1091	397	0.70		4.14
N				24.00	1128	380	0.60		4.09
N				24.00	1059	383	0.70		4.07
N				24.00	1067	379	0.70		4.15
N				25.00	1066	384	0.70		4.10
N				25.00	1058	382	0.60		4.07
N				24.00	1040	384	0.70		4.13
N				25.00	1063	386	0.70		4.10
O		44.80	54.84	20.00	1060	410	0.80	43.50	4.28
O		44.20	54.64	20.00	1050	400	0.80	41.00	4.26
O		45.70	54.66	20.00	1080	420	0.80	43.90	4.25
O		45.60	54.58	20.00	1080	390	0.90	44.40	4.22
O		45.60	55.12	20.00	1080	400	0.80	44.10	4.26
O		44.90	54.22	20.00	1070	410	0.80	43.00	4.22
O		44.80	54.15	20.00	1070	420	0.80	41.70	4.18
O		44.90	54.19	20.00	1070	390	0.80	43.40	4.20

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	SG pyc
P			54.71						4.07
P			54.90						4.05
P			54.87						4.05
P			54.94						4.06
P			54.74						4.05
P			54.58						4.07
P			54.80						4.05
P			54.55						4.06
Q			54.75	20.00	1100	410	0.90	42.40	3.97
Q			54.76	20.00	1100	410	0.90	42.00	3.97
Q			54.71	20.00	1100	410	0.80	43.10	3.94
Q			54.68	20.00	1130	420	0.90	42.20	3.95
Q			54.66	20.00	1120	420	0.80	40.10	4.00
Q			54.59	20.00	1080	410	0.80	41.80	3.90
Q			54.72	20.00	1080	410	0.90	42.70	3.97
Q			54.73	20.00	1120	420	0.90	41.4	3.99
S	53.90				908	360	0.80	40.70	4.01
S	54.40				914	350	0.70	41.20	4.01
S	54.20				914	350	0.80	40.90	4.01
S	54.60				930	350	0.80	40.70	4.04
S	54.40				919	330	0.70	41.00	4.04
S	54.40				923	320	0.80	41.20	4.01
S	54.90				927	360	0.80	41.50	4.04
S	54.30				917	340	0.80	41.40	4.02
T	53.90		54.85						
T	54.20		54.89						
T	54.60		54.78						
T	54.70		54.69						
T	53.40		54.79						
T	53.50		54.70						
T	53.40		54.68						
T	54.00		54.67						
U		55.30	55.09	17.00	1140	500		44.00	4.21
U		55.40	54.99	17.00	1130	400		43.00	4.25
U		54.80	54.87	17.00	1140	550		45.00	4.25
U		55.80	54.86	17.00	1140	500		45.00	4.21
U		55.00	55.07	16.00	1130	550		44.00	4.23
U		55.80	55.01	16.00	1140	500		43.00	4.21
U		55.80	55.03	17.00	1120	550		46.00	4.24
U		55.80	54.93	17.00	1120	550		45.00	4.19
V	51.70	49.30	55.10	16.00	1170	350		41.00	
V	52.00	49.10	55.10	16.00	1200	390		42.00	
V	50.00	48.60	55.10	16.00	1230	375		41.00	
V	53.40	50.20	55.20	20.00	1190	380		42.00	
V	51.60	48.80	55.10	21.00	1170	405		48.00	
V	53.20	48.10	55.10	15.00	1170	350		42.00	
V	52.00	45.20	55.00	15.00	1190	360		42.00	
V	49.00	49.00	55.20	15.00	1220	350		43.00	
W		52.00							4.08
W		51.42							4.07
W		53.00							4.09
W		52.32							4.11
W		52.46							4.08
W		52.00							4.10
W		51.53							4.07
W		53.11							4.09
X				27.00	1134	393	1.10	120	3.87
X				27.00	1163	373	1.30	113	3.87
X				28.00	1101	387	1.00	112	3.91
X				25.00	1122	401	0.90	101	3.88
X				28.00	1118	340	1.00	128	3.88
X				27.00	1147	435	1.00	120	3.87
X				25.00	1138	367	1.10	128	3.88
X				27.00	1136	397	0.90	115	3.91

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	3.15	0.02	0.02		0.04	0.05	0.15	0.02		13.3	0.21	0.01	4.28	0.07
A	3.12	0.02	0.02		0.04	0.05	0.15	0.02		13.3	0.20	0.01	4.26	0.07
A	3.11	0.02	0.02		0.03	0.05	0.15	0.02		13.3	0.21	0.01	4.27	0.06
A	3.49	0.02	0.02		0.03	0.05	0.15	0.02		13.3	0.21	0.01	4.32	0.07
A	3.11	0.02	0.02		0.04	0.05	0.15	0.02		13.3	0.20	0.01	4.36	0.06
A	3.13	0.02	0.02		0.04	0.05	0.15	0.02		13.4	0.21	0.01	4.30	0.08
A	3.10	0.02	0.02		0.04	0.05	0.15	0.02		13.3	0.20	0.01	4.28	0.08
A	3.11	0.02	0.02		0.03	0.05	0.15	0.02		13.3	0.21	0.01	4.33	0.08
B	3.15	0.03	0.02		0.04	0.08	0.14	0.03	0.10	13.5	0.21	0.01	4.04	0.07
B	3.19	0.03	0.02		0.04	0.07	0.14	0.03	0.11	13.5	0.21	0.01	4.05	0.07
B	3.18	0.03	0.02		0.04	0.07	0.14	0.02	0.10	13.5	0.21	0.01	4.05	0.07
B	3.13	0.02	0.02		0.04	0.07	0.14	0.02	0.11	13.5	0.20	0.01	4.05	0.07
B	3.13	0.02	0.02		0.04	0.08	0.14	0.02	0.10	13.6	0.21	0.01	4.08	0.07
B	3.16	0.02	0.02		0.04	0.07	0.14	0.02	0.10	13.5	0.20	0.01	4.05	0.07
B	3.16	0.03	0.02		0.04	0.07	0.14	0.02	0.11	13.5	0.20	0.01	4.05	0.07
B	3.14	0.03	0.02		0.04	0.07	0.14	0.03	0.10	13.4	0.20	0.01	4.06	0.07
C	3.22	0.02	0.02		0.04	0.07	0.15	0.01	0.10	13.5	0.21	0.01	4.02	0.07
C	3.18	0.02	0.01		0.04	0.06	0.15	0.01	0.10	13.4	0.21	0.01	4.25	0.06
C	3.21	0.03	0.01		0.04	0.06	0.15	0.01	0.10	13.4	0.21	0.01	4.29	0.07
C	3.18	0.02	0.02		0.04	0.06	0.15	0.01	0.10	13.5	0.21	0.01	4.15	0.06
C	3.20	0.02	0.02		0.04	0.06	0.15	0.01	0.10	13.5	0.21	0.01	4.13	0.06
C	3.18	0.02	0.02		0.04	0.06	0.15	0.01	0.10	13.4	0.21	0.01	4.23	0.07
C	3.17	0.02	0.02		0.04	0.06	0.15	0.01	0.10	13.4	0.21	0.01	4.20	0.06
C	3.18	0.02	0.02		0.04	0.06	0.15	0.01	0.10	13.4	0.21	0.01	4.27	0.06
D	3.13				0.04	0.06	0.14		0.09	13.1	0.21	0.01		0.06
D	3.16				0.04	0.07	0.14		0.10	13.2	0.21	0.01		0.06
D	3.15	0.02			0.04	0.06	0.14		0.09	13.2	0.21	0.01		0.07
D	3.17	0.02			0.04	0.06	0.14		0.10	13.3	0.21	0.02		0.07
D	3.13	0.02			0.04	0.06	0.14		0.09	13.2	0.21	0.01		0.06
D	3.17	0.02			0.04	0.06	0.14		0.10	13.3	0.22	0.01		0.07
D	3.19	0.02			0.04	0.07	0.14		0.10	13.3	0.21	0.01		0.07
D	3.16				0.04	0.06	0.14		0.10	13.2	0.22	0.01		0.06
E	3.15	0.03	0.02	78.5	0.04	0.09	0.14			13.4	0.21		4.08	
E	3.16	0.03	0.02	78.7	0.04	0.06	0.15	0.01		13.4	0.21		4.27	
E	3.13	0.03	0.02	78.4	0.04	0.05	0.15	0.02		13.4	0.21		4.35	
E	3.18	0.03	0.01	78.3	0.04	0.08	0.14	0.01		13.5	0.20		4.14	
E	3.13	0.03	0.02	78.6	0.04	0.06	0.15	0.01		13.4	0.21		4.13	
E	3.17	0.03	0.02	78.5	0.04	0.06	0.15			13.4	0.21		4.20	
E	3.16	0.03	0.02	78.5	0.04	0.07	0.14	0.01		13.4	0.21		4.14	
E	3.16	0.03	0.02	78.5	0.04	0.08	0.14			13.5	0.21		4.20	
F	3.14	0.03		78.2	0.04	0.06	0.14		0.10	13.5	0.20	0.01	4.00	0.06
F	3.10	0.03		78.2	0.04	0.06	0.14		0.10	13.5	0.21	0.01	4.10	0.05
F	3.12	0.03		78.3	0.04	0.06	0.14		0.10	13.5	0.20	0.01	4.10	0.06
F	3.08	0.03		78.3	0.04	0.05	0.14		0.10	13.5	0.20	0.01	4.00	0.06
F	3.13	0.03		78.4	0.04	0.07	0.14		0.10	13.5	0.20	0.01	4.00	0.06
F	3.13	0.03		78.3	0.04	0.06	0.14		0.10	13.5	0.20	0.01	4.10	0.06
F	3.09	0.03		78.1	0.04	0.07	0.14		0.10	13.3	0.20	0.01	4.10	0.06
F	3.13	0.03		78.7	0.04	0.06	0.14		0.10	13.5	0.21	0.01	4.10	0.06
G														0.05
G														0.05
G														0.05
G														0.04
G														0.05
G														0.05
G														0.05
G														0.05
H	3.09	0.03	0.02	78.4	0.04	0.07	0.14	0.01	0.10	13.1	0.21	0.01	4.01	0.09
H	2.99	0.02	0.02	78.3	0.04	0.06	0.14	0.01	0.09	13.1	0.22	0.01	4.02	0.07
H	3.05	0.03	0.02	78.7	0.05	0.07	0.14	0.01	0.10	13.2	0.21	0.01	3.97	0.07
H	3.02	0.03	0.02	78.0	0.04	0.07	0.14	0.01	0.10	13.1	0.21	0.01	3.97	0.09
H	3.04	0.03	0.04	78.7	0.04	0.07	0.14	0.01	0.10	13.2	0.21	0.01	3.97	0.07
H	3.09	0.03	0.02	78.0	0.04	0.07	0.14	0.01	0.10	13.0	0.21	0.01	3.97	0.07
H	3.02	0.03	0.05	78.5	0.05	0.07	0.14	0.01	0.10	13.2	0.21	0.01	3.97	0.07
H	3.02	0.03	0.03	78.0	0.04	0.06	0.14	0.01	0.10	13.1	0.21	0.01	3.96	0.07
I	3.23	0.03		79.2	0.05		0.16		0.11	13.4	0.22		4.12	0.06
I	3.26	0.03		79.5	0.04		0.17		0.10	13.6	0.22		4.17	0.06
I	3.16	0.03		78.9	0.04		0.17		0.11	13.5	0.22		4.20	0.05
I	3.22	0.03		79.1	0.04		0.16		0.10	13.6	0.23		4.18	0.06
I	3.17	0.03		79.2	0.05		0.17		0.11	13.5	0.23		4.28	0.06
I	3.19	0.03		78.6	0.04		0.16		0.11	13.5	0.22		4.12	0.06
I	3.23	0.03		78.7	0.05		0.16		0.10	13.4	0.23		4.20	0.06
I	3.21	0.03		78.6	0.04		0.16		0.10	13.5	0.22		4.19	0.05

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 %
J	3.17	0.03	0.02	78.3	0.04	0.04	0.14		0.09	13.4	0.19	0.01	4.10	0.07
J	3.16	0.03	0.02	78.4	0.05	0.05	0.14		0.10	13.4	0.19	0.01	4.10	0.06
J	3.17	0.03	0.02	78.9	0.05	0.04	0.14		0.09	13.4	0.18	0.01	4.10	0.06
J	3.13	0.03	0.02	78.5	0.05	0.04	0.15		0.09	13.3	0.18	0.01	4.07	0.06
J	3.18	0.03	0.02	78.3	0.04	0.04	0.15		0.10	13.4	0.19	0.01	4.10	0.06
J	3.16	0.03	0.02	78.4	0.04	0.05	0.14		0.09	13.3	0.19	0.01	4.09	0.06
J	3.16	0.03	0.02	78.2	0.04	0.05	0.14		0.09	13.3	0.19	0.01	4.08	0.06
J	3.14	0.02	0.02	78.4	0.04	0.05	0.14		0.09	13.3	0.19	0.01	4.16	0.06
K	3.17	0.02	0.02	78.9	0.04	0.07	0.14		0.10	13.3	0.21		4.30	0.06
K	3.19	0.02	0.01	78.9	0.04	0.07	0.15	0.01	0.09	13.6	0.22		4.34	0.06
K	3.17	0.02	0.01	79.1	0.04	0.06	0.14	0.02	0.10	13.4	0.22		4.32	0.06
K	3.18	0.02	0.01	79.0	0.04	0.06	0.14	0.01	0.10	13.4	0.21		4.35	0.06
K	3.2	0.02	0.02	79.2	0.04	0.08	0.14	0.02	0.10	13.6	0.22		4.34	0.06
K	3.16	0.02	0.01	78.7	0.04	0.08	0.15		0.10	13.4	0.21		4.35	0.06
K	3.16	0.02	0.02	78.9	0.04	0.07	0.15	0.01	0.09	13.5	0.22		4.33	0.06
K	3.17	0.02	0.02	78.9	0.04	0.06	0.14		0.09	13.4	0.21		4.35	0.06
N	3.12	0.01		77.5	0.04	0.11	0.14	0.05	0.09	13.2	0.25		4.23	0.05
N	3.14	0.02		78.1	0.04	0.1	0.15	0.05	0.10	13.4	0.25		4.29	0.04
N	3.14	0.03		78.1	0.04	0.12	0.15	0.06	0.10	13.5	0.25		4.26	0.05
N	3.14	0.02		77.8	0.04	0.11	0.15	0.06	0.10	13.3	0.25		4.25	0.05
N	3.12	0.01		78.2	0.04	0.09	0.15	0.03	0.09	13.3	0.25		4.22	0.06
N	3.14	0.03		78.1	0.04	0.11	0.15	0.06	0.10	13.5	0.25		4.30	0.05
N	3.16	0.02		77.6	0.04	0.09	0.14	0.03	0.09	13.2	0.25		4.21	0.04
N	3.11	0.02		78.1	0.04	0.08	0.15	0.03	0.09	13.3	0.25		4.19	0.05
O	3.18	0.03	0.04		0.04	0.07	0.150	0.02	0.10	13.4	0.21	0.01	4.18	0.06
O	3.17	0.02	0.02		0.04	0.07	0.147	0.01	0.10	13.3	0.21	0.01	4.30	0.06
O	3.11	0.02	0.02		0.04	0.07	0.146	0.01	0.10	13.2	0.21	0.01	4.26	0.06
O	3.15	0.03	0.02		0.04	0.07	0.147	0.02	0.10	13.3	0.21	0.01	4.33	0.06
O	3.17	0.03	0.04		0.04	0.07	0.152	0.02	0.10	13.4	0.21	0.01	4.25	0.06
O	3.15	0.03	0.05		0.04	0.07	0.147	0.01	0.09	13.2	0.20	0.01	4.27	0.06
O	3.15	0.02	0.05		0.04	0.06	0.147	0.01	0.09	13.3	0.20	0.01	4.32	0.06
O	3.13	0.03	0.05		0.04	0.07	0.147	0.01	0.10	13.2	0.21	0.01	4.34	0.06
P	3.11	0.02	0.03		0.04	0.087	0.147		0.10	13.2	0.21	0.01	4.07	
P	3.11	0.02	0.03		0.04	0.087	0.146		0.10	13.3	0.20	0.01	4.11	
P	3.10	0.02	0.03		0.04	0.086	0.146		0.10	13.3	0.21	0.01	4.07	
P	3.10	0.02	0.03		0.04	0.082	0.145		0.10	13.2	0.21	0.01	4.09	
P	3.11	0.02	0.03		0.04	0.085	0.147		0.10	13.2	0.21	0.01	4.09	
P	3.13	0.02	0.03		0.04	0.085	0.146		0.10	13.3	0.20	0.01	4.07	
P	3.13	0.02	0.03		0.04	0.084	0.145		0.10	13.2	0.21	0.01	4.06	
P	3.08	0.02	0.03		0.04	0.085	0.146		0.10	13.3	0.20	0.01	4.08	
Q	3.15	0.02	0.01		0.04	0.09	0.146	0.03	0.10	13.5	0.20	0.01	4.19	0.06
Q	3.14	0.02	0.01		0.04	0.09	0.146	0.03	0.10	13.5	0.20	0.01	4.19	0.06
Q	3.16	0.03	0.01		0.04	0.1	0.146	0.04	0.10	13.5	0.20	0.01	4.29	0.06
Q	3.18	0.02	0.01		0.04	0.09	0.146	0.02	0.10	13.6	0.20	0.01	4.18	0.06
Q	3.16	0.02	0.02		0.04	0.08	0.145	0.02	0.10	13.6	0.20	0.01	4.26	0.06
Q	3.18	0.02	0.02		0.04	0.09	0.142	0.03	0.10	13.7	0.20	0.01	4.28	0.06
Q	3.14	0.02	0.01		0.04	0.09	0.150	0.03	0.10	13.5	0.20	0.01	4.24	0.06
Q	3.17	0.02	0.01		0.04	0.11	0.146	0.03	0.10	13.5	0.20	0.01	4.21	0.06
S													5.01	0.07
S													5.02	0.06
S													5.02	0.06
S													4.92	0.06
S													4.96	0.06
S													4.94	0.06
S													4.99	0.06
S													4.99	0.06
T	3.15	0.01	0.01		0.04	0.09	0.15	0.01	0.09	13.5	0.20	0.01	4.18	0.06
T	3.15	0.02	0.01		0.04	0.09	0.15	0.01	0.09	13.4	0.20	0.01	4.20	0.06
T	3.17	0.02	0.01		0.04	0.09	0.15	0.02	0.09	13.5	0.20	0.01	4.16	0.06
T	3.17	0.02	0.01		0.04	0.10	0.15	0.02	0.09	13.5	0.21	0.01	4.18	0.06
T	3.15	0.02	0.02		0.04	0.10	0.15	0.02	0.09	13.5	0.21	0.01	4.17	0.06
T	3.19	0.02	0.02		0.04	0.09	0.15	0.02	0.09	13.5	0.21	0.01	4.20	0.06
T	3.19	0.03	0.01		0.04	0.10	0.15	0.02	0.09	13.5	0.21	0.01	4.19	0.06
T	3.19	0.03	0.02		0.04	0.10	0.15	0.02	0.09	13.5	0.21	0.01	4.16	0.06
U	3.15	0.01	0.01		0.04	0.07	0.15	0.02	0.10	13.4	0.21	0.01	4.07	0.06
U	3.17	0.01	0.01		0.04	0.07	0.14	0.02	0.10	13.4	0.21	0.01	4.04	0.06
U	3.17	0.01	0.01		0.04	0.06	0.14	0.02	0.10	13.3	0.21	0.01	4.05	0.06
U	3.19	0.01	0.01		0.04	0.06	0.14	0.01	0.10	13.4	0.21	0.01	4.04	0.06
U	3.18	0.01	0.01		0.04	0.07	0.15	0.02	0.10	13.4	0.21	0.01	4.02	0.07
U	3.18	0.01	0.01		0.04	0.07	0.15	0.02	0.10	13.4	0.21	0.01	4.06	0.06
U	3.19		0.01		0.04	0.07	0.15	0.02	0.10	13.4	0.21	0.01	4.04	0.07
U	3.16	0.01	0.01		0.04	0.07	0.14	0.02	0.10	13.3	0.21	0.01	4.03	0.06

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 %
V	3.14	0.03			0.04	0.07		0.02	0.10	13.5	0.21		4.12	0.05
V	3.15	0.03			0.04	0.06		0.01	0.10	13.4	0.21		4.12	0.05
V	3.16	0.03			0.04	0.06		0.02	0.10	13.5	0.21		4.12	0.04
V	3.16	0.03			0.04	0.07		0.01	0.10	13.5	0.21		4.07	0.05
V	3.16	0.03			0.04	0.07		0.02	0.10	13.5	0.21		4.08	0.05
V	3.14	0.03			0.04	0.07		0.02	0.10	13.4	0.21		4.11	0.05
V	3.18	0.03			0.04	0.07		0.01	0.10	13.5	0.21		4.10	0.05
V	3.14	0.03			0.04	0.07		0.02	0.10	13.4	0.21		4.12	0.05
W	2.71		0.03	79.9	0.03		0.15		0.09	11.8	0.21	0.01	3.81	
W	2.67		0.03	80.5	0.03		0.15		0.09	11.8	0.21	0.01	3.78	
W	2.75		0.03	79.9	0.03		0.15		0.09	11.9	0.21	0.01	3.75	
W	2.80		0.03	79.2	0.03		0.15		0.09	11.8	0.21	0.01	3.81	
W	2.76		0.07	79.2	0.04		0.15		0.09	11.7	0.21	0.01	3.79	
W	2.74		0.03	79.6	0.03		0.15		0.09	11.9	0.21	0.01	3.81	
W	2.72		0.03	79.8	0.03		0.15		0.09	11.8	0.21	0.02	3.84	
W	2.85		0.03	79.1	0.03		0.15		0.09	11.7	0.21	0.01	3.88	
X													4.06	0.04
X													4.25	0.04
X													4.26	0.03
X													4.05	0.04
X													4.20	0.03
X													4.05	0.04
X													4.24	0.04
X													4.11	0.04

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.

Analyte	Method	Unit	S ¹	σ _L ²	S _w ³	CSU ⁴
Fe	Fusion	%	1.99	1.83	1.31	0.77
Fe	M/ICP	%	4.22	3.66	0.70	1.10
Fe	XRF	%	0.16	0.11	0.10	0.04
Ba	M/ICP	ppm	2.07	1.67	0.86	0.51
Mn	M/ICP	ppm	66.4	49.8	17.7	13.4
P	M/ICP	ppm	28.6	20.5	12.4	5.8
Sn	M/ICP	ppm	0.1	0.05	0.05	0.02
Zr	M/ICP	ppm	2.9	2.40	1.19	0.77
Al ₂ O ₃	XRF	%	0.026	0.014	0.018	0.004
CaO	XRF	%	0.005	0.003	0.003	0.001
Cr ₂ O ₃	XRF	%	0.005	0.004	0.002	0.001
Fe ₂ O ₃	XRF	%	0.35	0.31	0.21	0.12
K ₂ O	XRF	%	0.001	0.000	0.001	0.000
LOI		%	0.107	0.067	0.048	0.017
MgO	XRF	%	0.010	0.007	0.006	0.002
MnO	XRF	%	0.005	0.003	0.003	0.001
Na ₂ O	XRF	%	0.004	0.001	0.003	0.001
P ₂ O ₅	XRF	%	0.004	0.002	0.002	0.001
SiO ₂	XRF	%	0.112	0.065	0.060	0.017
TiO ₂	XRF	%	0.005	0.003	0.003	0.001
V ₂ O ₅	XRF	%	0.001	0.001	0.001	0.000
S	Comb/ LECO	%	0.007	0.004	0.003	0.001
SG	pyc		0.136	0.109	0.022	0.030

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.

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.

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: AMIS0371 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.

23 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	0.22	0.12	28.2	73
Al	M/ICP	%	1.6	0.19	5.9	131
As	M/ICP	ppm	98.3	15.4	7.8	109
Be	M/ICP	ppm	1.4	0.42	15.3	90
Bi	M/ICP	ppm	0.42	0.08	9.4	94
Ca	M/ICP	%	0.02	0.01	24.0	109
Cd	M/ICP	ppm	2.2	8.7	195	59
Ce	M/ICP	ppm	14.4	2.4	8.3	88
Co	M/ICP	ppm	10.0	6.3	31.4	104
Cr	M/ICP	ppm	105	27.3	13.0	120
Cs	M/ICP	ppm	0.12	0.07	29.6	73
Cu	M/ICP	ppm	14.7	5.4	18.5	118
Dy	M/ICP	ppm	1.3	0.24	9.3	47
Er	M/ICP	ppm	0.91	0.12	6.4	44
Eu	M/ICP	ppm	0.26	0.03	5.9	45
Ga	M/ICP	ppm	6.0	2.2	18.6	102
Gd	M/ICP	ppm	1.2	0.22	9.5	47
Ge	M/ICP	ppm	1.8	2.5	70.1	52
Hf	M/ICP	ppm	1.1	0.23	10.2	72
Ho	M/ICP	ppm	0.30	0.04	5.9	50
In	M/ICP	ppm	0.04	0.01	12.7	68
K	M/ICP	%	0.03	0.01	21.0	124
La	M/ICP	ppm	5.7	1.4	12.2	89
Li	M/ICP	ppm	2.1	0.40	9.8	96
Lu	M/ICP	ppm	0.16	0.04	12.5	53
Mg	M/ICP	%	0.04	0.03	36.8	119
Mo	M/ICP	ppm	1.4	0.69	25.0	93
Na	M/ICP	%	0.01	0.01	54.4	95
Nb	M/ICP	ppm	3.0	0.81	13.4	88
Nd	M/ICP	ppm	4.4	1.0	11.0	47
Ni	M/ICP	ppm	15.1	5.3	17.6	128
Pb	M/ICP	ppm	29.8	7.7	12.9	120
Pr	M/ICP	ppm	1.2	0.29	11.8	47
Rb	M/ICP	ppm	1.7	0.74	22.3	90
S	M/ICP	%	0.06	0.01	9.9	100
Sb	M/ICP	ppm	4.3	4.0	45.9	104
Sc	M/ICP	ppm	4.2	1.0	12.3	95
Se	M/ICP	ppm	1.0	0.56	27.5	30
Si	M/ICP	%	6.3	0.19	1.5	16
Sm	M/ICP	ppm	1.0	0.19	9.0	46
Sr	M/ICP	ppm	3.5	1.3	18.2	104
Ta	M/ICP	ppm	0.29	0.14	23.4	74
Tb	M/ICP	ppm	0.21	0.03	6.4	58
Te	M/ICP	ppm	0.14	0.25	90.8	59
Th	M/ICP	ppm	6.7	1.0	7.6	88
Ti	M/ICP	%	0.11	0.04	17.7	104
Tl	M/ICP	ppm	0.02	0.01	19.7	42
Tm	M/ICP	ppm	0.13	0.04	15.7	40
U	M/ICP	ppm	24.7	2.6	5.3	92
V	M/ICP	ppm	47.2	24.2	25.6	112
W	M/ICP	ppm	17.4	4.6	13.2	109
Y	M/ICP	ppm	8.2	1.2	7.2	105
Yb	M/ICP	ppm	1.0	0.19	9.0	63
Zn	M/ICP	ppm	23.1	13.8	30.0	110