



African Mineral Standards

MATRIX REFERENCE MATERIALS

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AMIS0370

Certified Reference Material

**Copper ore, oxide,
Kansanshi Mine, Zambia**

Certificate of Analysis

Recommended Concentrations and Limits¹ (at two Standard Deviations)

Certified Concentrations²

Cu M/ICP	7129	±	474	ppm
Cu P	7075	±	220	ppm
Co P	55	±	6	ppm
Specific Gravity	2.70	±	0.06	

Provisional Concentrations

Au Pb Collection	0.087	±	0.016	g/t
Cu Soluble ppm	5618	±	842	ppm
Co M/ICP	58	±	8	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	3.82	±	0.06	%
CaO	1.11	±	0.04	%
Fe ₂ O ₃	3.59	±	0.06	%
K ₂ O	0.51	±	0.02	%
MgO	0.38	±	0.04	%
Na ₂ O	0.67	±	0.04	%
SiO ₂	86.00	±	1.06	%
TiO ₂	0.34	±	0.02	%

Provisional Concentrations

Cr ₂ O ₃	0.07	±	0.01	%
MnO	0.06	±	0.01	%
LOI	2.11	±	0.36	%

1. Intended Use: AMIS0370 is a certified reference material which may be used to demonstrate the validity of measurement results of a single analysis of oxide copper ores 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: This standard was made using an oxide ore sourced from Kansanshi Mine, located in the North Western Province of Zambia. The mine is located approximately 10 kilometres north of the town of Solwezi, 180 kilometres to the northwest of the Copperbelt town of Chingola and 16 kilometres south of the Democratic Republic of Congo border. Kansanshi, Africa's largest copper mine, is 80% owned by Kansanshi Mining PLC, a First Quantum subsidiary. The remaining 20% is owned by a subsidiary of ZCCM.

The Kansanshi deposit occurs within the Lufilian arc, a major tectonic province characterized by broadly north directed fold and thrust structures, which hosts the world class Central African Copperbelt. The deposit at Kansanshi occurs within a broad, northwest trending, north-west closing antiform, which can be traced for approximately 12 kilometres. Kansanshi is a vein deposit developed within a tectonised rock sequence and, as such, constitutes a major mineralization control. The main

veins and vein swarms dip sub vertically, perpendicular to the fold axes, in the plane of maximum extension.

(for more information, refer to the following: http://www.first-quantum.com/files/doc_downloads/Kansanshi_April%20_2012-FINAL.pdf, www.first-quantum.com.)

3. Mineral and Chemical Composition: Deep tropical weathering has resulted in supergene enrichment and subsequent partial oxidation of the deposit. Primary copper sulphide mineralization is dominated by chalcopyrite, with very minor bornite, accompanied by relatively minor pyrite and pyrrhotite. Oxide mineralization is dominated by chrysocolla with malachite, limonite and cupriferous goethite. The mixed zone includes both oxide and primary mineralization but also carries significant chalcocite, minor native copper and tenorite. Some copper appears to be carried in clay and mica minerals, where it is essentially refractory.

4. Appearance: The material is a very fine powder. It is colored Pale Yellow (Corstor 5Y 8/3).

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

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

7. Methods of Analysis requested:

1. Au – Pb collection, ICP-OES/ICP-MS.
2. Cu. Acid Soluble AAS or ICP-OES.
3. Cu. Fusion AAS or ICP-OES.
4. Multi-acid digest multi-element scan - (to include Co, Cu). ICP-OES or ICP-MS.
5. Aqua regia digest – Co, Cu. ICP-OES or ICP-MS.
6. Majors (Al₂O₃, CaO, Cr₂O₃, Fe₂O₃, K₂O, MgO, MnO, Na₂O, SiO₂, TiO₂. LOI.) XRF fusion.
7. SG, gas pycnometer.

8. Information requested:

1. Aliquots used for all determinations.
2. Results for individual PGM's reported in ppb.
3. Results for base metals reported in ppm.
4. QC data, to include replicates, blanks and certified reference materials used.
5. Analytical techniques used.

9. Method of Certification: Twenty seven laboratories were each given eight randomly selected packages of sample. Twenty of the laboratories submitted results.

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 20 out of 27 laboratories that provided results timeously were (not in same order as in the table of assays):

1. Acme Analytical Laboratories Chile
2. ACME Analytical Laboratories Ltd CA
3. Activation Laboratories Pty Ltd (ActLabs) CA
4. ALS Chemex Laboratory Group Brisbane Australia
5. ALS Chemex Laboratory Group Johannesburg SA
6. ALS Chemex Laboratory Group Perth WA
7. ALS Chemex Laboratory Group Vancouver CA
8. ALS OMAC (Ireland)
9. Genalysis Laboratory Services (South Africa) Pty
10. Genalysis Laboratory Services (W Australia P)
11. Intertek Minerals Zambia
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. Skyline Assayers and Labs (USA)
20. Ultra Trace (Pty) Ltd WA

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

Lab Code	Au Pb Coll g/t	Co M/ICP ppm	Co P ppm	Cu M/ICP ppm	Cu P ppm	Cu Soluble ppm	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 %	SiO ₂ XRF %	TiO ₂ XRF %	LOI %	SG pyc
C		53.6	53.0	7162	7184	6367												2.64
C		52.8	53.0	7073	7192	6238												2.68
C		54.5	53.0	7143	7186	6365												2.67
C		54.1	53.0	7048	7127	6217												2.68
C		54.2	53.0	7145	7219	6401												2.64
C		54.1	53.0	7098	7109	6235												2.68
C		54.0	53.0	7131	7100	6448												2.67
C		54.5	54.0	7132	7218	6357												2.67
D		60.0	50.0	7070	7130		3.79	1.10	0.07	3.56	0.51	0.39	0.06	0.68	85.7	0.33	1.91	2.68
D		50.0	50.0	6760	7120		3.81	1.10	0.07	3.57	0.51	0.40	0.06	0.69	86.0	0.34	1.94	2.68
D		60.0	60.0	7020	7110		3.80	1.10	0.07	3.56	0.51	0.38	0.06	0.67	85.9	0.33	1.95	2.68
D		60.0	50.0	7200	7010		3.79	1.10	0.07	3.56	0.51	0.39	0.06	0.69	85.7	0.33	1.94	2.68
D		60.0	50.0	6950	7110		3.80	1.10	0.07	3.56	0.51	0.38	0.05	0.67	85.8	0.33	1.93	2.69
D		60.0	60.0	7000	7280		3.80	1.10	0.07	3.55	0.51	0.39	0.06	0.67	85.6	0.33	1.95	2.68
D		60.0	50.0	6970	7170		3.78	1.09	0.07	3.55	0.51	0.39	0.06	0.67	85.8	0.33	1.93	2.67
D		60.0	50.0	7210	7120		3.79	1.09	0.07	3.55	0.51	0.39	0.06	0.68	85.7	0.33	1.92	2.68

Assay data. (cont)

Lab Code	Au Pb Coll g/t	Co M/ICP ppm	Co P ppm	Cu M/ICP ppm	Cu P ppm	Cu Soluble ppm	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 %	SiO ₂ XRF %	TiO ₂ XRF %	LOI %	SG pyc
E	0.08	75.0	62.0				3.84	1.12	0.07	3.62	0.52	0.38	0.06	0.67	86.0	0.36	2.08	
E	0.08	76.0	64.0				3.82	1.12	0.07	3.62	0.51	0.38	0.06	0.67	86.1	0.35	2.17	
E	0.09	73.0	61.0				3.82	1.11	0.07	3.61	0.51	0.38	0.06	0.68	86.2	0.34	2.04	
E	0.09	72.0	64.0				3.81	1.12	0.07	3.60	0.52	0.39	0.06	0.66	86.2	0.34	1.99	
E	0.08	70.0	65.0				3.80	1.12	0.07	3.62	0.51	0.38	0.06	0.67	86.1	0.34	2.17	
E	0.09	75.0	66.0				3.81	1.12	0.07	3.60	0.51	0.38	0.06	0.68	86.1	0.34	2.16	
E	0.08	73.0	60.0				3.80	1.12	0.07	3.62	0.52	0.38	0.06	0.67	86.0	0.35	2.23	
E	0.09	75.0	65.0				3.80	1.12	0.07	3.62	0.51	0.38	0.06	0.67	86.2	0.35	2.07	
G	0.09	53.7	53.6	7087	7107		3.82	1.09	0.07	3.60	0.52	0.36	0.06	0.41	85.0	0.34	1.968	
G	0.09	55.0	52.9	7389	7143		3.81	1.10	0.07	3.56	0.49	0.38	0.06	0.40	84.7	0.35	1.987	
G	0.09	55.3	53.0	7512	7089		3.79	1.08	0.06	3.57	0.50	0.38	0.05	0.41	84.8	0.35	1.994	
G	0.09	53.5	52.8	6941	7070		3.81	1.10	0.06	3.56	0.50	0.39	0.05	0.40	85.0	0.36	1.986	
G	0.09	56.1	54.4	7178	7271		3.83	1.11	0.07	3.63	0.51	0.37	0.06	0.44	85.1	0.33	1.998	
G	0.09	55.1	54.4	7393	7114		3.81	1.10	0.06	3.58	0.51	0.38	0.06	0.43	84.7	0.35	1.978	
G	0.09	55.8	53.6	7454	7110		3.85	1.10	0.07	3.57	0.51	0.37	0.05	0.41	85.3	0.37	2.014	
G	0.09	55.3	54.3	7184	7152		3.85	1.10	0.06	3.56	0.52	0.39	0.06	0.39	85.4	0.37	2.009	
H	0.09	61.9	56.6	7401	6672	5760	3.80	1.09	0.07	3.57	0.51	0.38	0.06	0.64	86.1	0.31	2.37	2.68
H	0.09	61.2	56.2	7432	6550	5800	3.81	1.10	0.07	3.58	0.52	0.37	0.06	0.65	86.3	0.32	2.39	2.68
H	0.10	63.3	56.4	7481	6683	5820	3.81	1.11	0.07	3.60	0.53	0.37	0.06	0.63	86.7	0.32	2.38	2.67
H	0.08	63.5	56.6	7541	6616	5930	3.83	1.11	0.07	3.60	0.51	0.37	0.06	0.65	86.8	0.33	2.37	2.68
H	0.08	64.6	54.5	7664	6725	5910	3.83	1.10	0.07	3.56	0.52	0.38	0.05	0.64	86.3	0.32	2.39	2.68
H	0.07	60.8	56.4	7441	6648	5880	3.79	1.10	0.07	3.58	0.52	0.38	0.06	0.64	86.4	0.31	2.4	2.68
H	0.09	62.8	55.9	7475	6698	5830	3.79	1.10	0.07	3.57	0.51	0.37	0.06	0.64	86.2	0.32	2.37	2.67
H	0.09	60.4	56.8	7410	6795	5860	3.79	1.10	0.08	3.57	0.51	0.36	0.06	0.62	86.2	0.32	2.36	2.67
I	0.08	57.0	56.0	6930			3.88	1.14	0.07	3.66	0.52	0.41	0.06	0.69	87.2	0.35	2.54	2.67
I	0.09	57.0	56.0	6940			3.90	1.14	0.07	3.67	0.52	0.41	0.06	0.69	87.3	0.34	2.5	2.70
I	0.07	57.0	56.0	6970			3.86	1.09	0.07	3.57	0.51	0.40	0.06	0.70	87.4	0.34	2.5	2.72
I	0.09	57.0	56.0	6840			3.87	1.12	0.06	3.68	0.52	0.40	0.06	0.69	86.5	0.34	2.48	2.68
I	0.08	57.0	56.0	6960			3.79	1.10	0.06	3.56	0.51	0.39	0.06	0.67	84.8	0.33	2.42	2.70
I	0.10	57.0	56.0	6920			3.75	1.08	0.06	3.52	0.50	0.39	0.05	0.66	84.1	0.33	2.53	2.72
I	0.09	61.0	55.0	6910			3.86	1.12	0.08	3.64	0.52	0.40	0.06	0.69	86.5	0.34	2.42	2.70
I	0.08	57.0	54.0	6790			3.83	1.11	0.07	3.59	0.51	0.39	0.06	0.68	85.7	0.34	2.4	2.68
J	0.09	57.0	54.0	7048	6998	5200												2.65
J	0.09	58.0	56.0	7122	7103	5310												2.61
J	0.08	58.0	56.0	7150	7029	5360												2.60
J	0.09	58.0	56.0	7177	7223	5380												2.62
J	0.08	57.0	56.0	6954	6992	5350												2.65
J	0.09	58.0	55.0	7089	7078	5600												2.63
J	0.09	59.0	57.0	7103	7104	5300												2.61
J	0.08	58.0	57.0	6990	7239	5090												2.63
K	0.10	60.0	60.0	7060	7130	5100	3.79	1.12	0.07	3.54	0.50	0.35	0.06	0.66	85.3	0.34	2.33	2.80
K	0.09	60.0	50.0	7180	7120	4980	3.80	1.11	0.07	3.54	0.49	0.34	0.06	0.66	85.4	0.34	2.32	2.79
K	0.09	60.0	50.0	7080	7170	5080	3.82	1.12	0.07	3.56	0.50	0.35	0.06	0.67	85.6	0.35	2.31	2.79
K	0.08	50.0	50.0	6920	7100	5130	3.84	1.12	0.07	3.57	0.51	0.35	0.06	0.67	86.0	0.34	2.29	2.81
K	0.08	50.0	50.0	7100	7110	5040	3.79	1.11	0.07	3.52	0.50	0.36	0.06	0.66	85.3	0.35	2.29	2.78
K	0.09	50.0	50.0	6870	6980	4970	3.78	1.10	0.07	3.51	0.50	0.35	0.06	0.66	85.2	0.36	2.3	2.78
K	0.08	50.0	50.0	7130	7010	5080	3.83	1.12	0.07	3.57	0.50	0.35	0.06	0.67	86.0	0.35	2.29	2.73
K	0.09	60.0	50.0	6990	7030	4990	3.81	1.12	0.07	3.55	0.50	0.35	0.06	0.67	85.5	0.35	2.28	2.79
L	0.10	63.3		7270		5810	3.85	1.10	0.06	3.61	0.52	0.40	0.05	0.59	87.0	0.35	2.01	2.74
L	0.07	61.0		6990		5740	3.77	1.12	0.07	3.62	0.52	0.40	0.05	0.58	86.9	0.35	2.02	2.73
L	0.09	63.3		7210		5770	3.79	1.10	0.07	3.61	0.52	0.39	0.05	0.56	86.6	0.35	2.02	2.73
L	0.09	62.1		6980		5770	3.78	1.11	0.07	3.62	0.52	0.39	0.05	0.58	86.8	0.35	2.01	2.73
L	0.10	63.2		7030		5760	3.80	1.12	0.07	3.64	0.52	0.41	0.05	0.56	87.1	0.35	2.06	2.75
L	0.09	64.5		7030		5890	3.74	1.10	0.08	3.60	0.51	0.39	0.05	0.57	86.2	0.35	2.06	2.75
L	0.09	63.1		6990		5850	3.83	1.10	0.07	3.62	0.52	0.40	0.05	0.58	86.8	0.35	2.01	2.72
L	0.09	62.4		7000		5730	3.70	1.10	0.07	3.60	0.52	0.38	0.05	0.58	86.4	0.35	2.35	2.70
M	0.09	60.0	60.0	7050	6870	5080												2.72
M	0.09	60.0	60.0	7140	7030	5110												2.72
M	0.09	60.0	60.0	6990	7010	5330												2.72
M	0.09	50.0	60.0	6830	6990	5310												2.72
M	0.09	60.0	60.0	7120	7020	5030												2.69
M	0.09	50.0	60.0	6800	7080	5070												2.71
M	0.09	60.0	50.0	6930	7100	5230												2.72
M	0.08	60.0	50.0	6890	6460	5130												2.67
N	0.10			7400		5900												
N	0.09			7400		5800												
N	0.09			7400		5700												
N	0.08			7500		5800												
N	0.07			7400		5800												
N	0.09			7500		5800												
N	0.07			7400		5700												
N	0.10			7500		5700												

Assay data. (cont)

Lab Code	Au Pb Coll g/t	Co M/ICP ppm	Co P ppm	Cu M/ICP ppm	Cu P ppm	Cu Soluble ppm	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 %	SiO ₂ XRF %	TiO ₂ XRF %	LOI %	SG pyc
P	0.08	55.0	55.0	6960	6840	5850	3.81	1.12	0.07	3.61	0.51	0.40	0.06		86.2	0.34	1.89	2.77
P	0.09	50.0	54.0	6950	6940	6000	3.83	1.12	0.07	3.61	0.51	0.40	0.06		86.3	0.34	1.89	2.77
P	0.11	55.0	55.0	6980	6870	6030	3.82	1.12	0.07	3.61	0.51	0.40	0.06		86.2	0.34	1.9	2.76
P	0.09	50.0	54.0	6900	6870	6050	3.83	1.12	0.07	3.62	0.51	0.40	0.06		86.2	0.34	1.9	2.74
P	0.12	50.0	55.0	6910	6850	6050	3.81	1.12	0.07	3.60	0.51	0.40	0.06		86.2	0.34	1.92	2.74
P	0.11	50.0	53.0	6960	6900	6050	3.82	1.12	0.07	3.61	0.51	0.40	0.06		86.2	0.34	1.89	2.77
P	0.09	55.0	55.0	6960	6900	6020	3.83	1.12	0.07	3.61	0.51	0.40	0.06		86.2	0.34	1.91	2.77
P	0.08	55.0	55.0	6950	6930	6140	3.82	1.12	0.07	3.60	0.51	0.40	0.06		86.2	0.34	1.9	2.76
Q	0.10	26.6	61.0	6943	7349	5960												2.74
Q	0.11	29.1	57.0	6866	7163	5842												2.71
Q	0.09	29.7	58.0	6974	7260	5876												2.69
Q	0.09	28.9	57.0	6965	7040	5927												2.74
Q	0.10	30.5	59.0	6922	7237	5871												2.71
Q	0.08	26.7	57.0	6883	6986	5861												2.74
Q	0.09	26.5	56.0	7030	7011	5974												2.68
Q	0.09	29.5	56.0	7054	7022	5947												2.73
R	0.09	61.0	57.0	7450	7010		3.81	1.13	0.06	3.48	0.51	0.35	0.06	0.67	86.4	0.34	2	
R	0.10	60.0	55.0	7480	7080		3.82	1.13	0.06	3.47	0.51	0.35	0.06	0.69	86.7	0.34	2	
R	0.10	60.0	57.0	7460	7080		3.79	1.12	0.06	3.45	0.51	0.34	0.06	0.68	86.4	0.35	2	
R	0.11	60.0	57.0	7420	7090		3.81	1.12	0.07	3.46	0.51	0.35	0.06	0.68	86.4	0.35	2	
R	0.09	60.0	57.0	7480	7070		3.81	1.13	0.06	3.48	0.51	0.35	0.06	0.67	86.3	0.34	2	
R	0.10	60.0	57.0	7490	7040		3.83	1.13	0.05	3.47	0.51	0.36	0.06	0.68	86.5	0.34	2.1	
R	0.10	60.0	56.0	7480	7020		3.83	1.13	0.06	3.50	0.51	0.35	0.06	0.68	86.6	0.34	2.1	
R	0.09	60.0	56.0	7430	7020		3.82	1.13	0.05	3.47	0.51	0.35	0.06	0.67	86.5	0.34	2	
S	0.08	57.0		6800		5100												2.65
S	0.09	55.0		6900		5100												2.70
S	0.07	56.0		7000		5100												2.66
S	0.07	58.0		6900		4900												2.69
S	0.08	57.0		6800		4800												2.66
S	0.08	56.0		6800		5000												2.69
S	0.07	55.0		6800		4900												2.68
S	0.07	58.0		6800		5200												2.65
T	0.09					3700	3.82	1.15	0.07	3.59	0.52	0.41	0.05	0.62	85.7	0.34	2.15	
T	0.08					3800	3.82	1.14	0.08	3.64	0.52	0.39	0.05	0.63	86.8	0.34	2.21	
T	0.10					3800	3.84	1.14	0.08	3.59	0.51	0.42	0.06	0.62	86.2	0.35	2.05	
T	0.09					3700	3.83	1.14	0.08	3.62	0.53	0.40	0.05	0.65	86.5	0.35	2.02	
T	0.11					3700	3.83	1.13	0.07	3.62	0.53	0.40	0.05	0.63	85.7	0.33	2.01	
T	0.09					3800	3.85	1.13	0.08	3.63	0.50	0.41	0.06	0.63	85.4	0.35	2.03	
T	0.09					3800	3.85	1.14	0.08	3.59	0.51	0.41	0.05	0.63	86.1	0.34	2.12	
T	0.09					3600	3.83	1.15	0.08	3.62	0.50	0.41	0.06	0.62	86.5	0.35	2.09	
W	0.08	64.7	64.8	7560	7040	7100	3.61	1.06	0.05	3.84	0.52	0.23	0.05		86.2	0.37	2.3	2.71
W	0.09	69.9	65.0	7520	7300	7100	3.59	1.08	0.05	3.83	0.52	0.22	0.05		85.7	0.37	2.31	2.71
W	0.09	64.0	65.8	7620	7450	7600	3.55	1.09	0.05	3.84	0.53	0.21	0.05		85.5	0.37	2.3	2.71
W	0.08	64.5	63.9	7560	7440	7600	3.66	1.10	0.06	3.83	0.51	0.24	0.05		85.5	0.36	2.31	2.72
W	0.07	69.7	65.3	7530	7190	7400	3.64	1.10	0.05	3.83	0.52	0.22	0.05		85.8	0.36	2.34	2.71
W	0.07	65.8	66.0	7560	7290	7100	3.58	1.11	0.05	3.81	0.52	0.22	0.05		85.9	0.36	2.32	2.71
W	0.08	66.5	63.9	7620	7140	7000	3.62	1.12	0.04	3.86	0.54	0.21	0.05		86.1	0.37	2.33	2.71
W	0.08	69.0	66.1	7640	7280	7300	3.63	1.14	0.04	3.86	0.52	0.23	0.05		87.0	0.37	2.32	2.71
Y	0.09	60.0	60.0	7150	7000		3.87	1.08	0.07	3.60	0.51	0.35	0.06	0.65	85.9	0.33	2	
Y	0.09	60.0	60.0	7060	7150		3.86	1.09	0.07	3.59	0.51	0.35	0.06	0.66	85.9	0.33	1.99	
Y	0.08	60.0	60.0	7120	7140		3.87	1.08	0.07	3.61	0.52	0.37	0.06	0.66	85.9	0.33	1.99	
Y	0.08	50.0	50.0	7030	6930		3.86	1.08	0.07	3.57	0.51	0.35	0.06	0.66	85.7	0.33	1.98	
Y	0.09	60.0	60.0	7130	7160		3.87	1.09	0.07	3.59	0.51	0.37	0.06	0.68	86.0	0.34	1.97	
Y	0.03	60.0	60.0	7180	7150		3.85	1.08	0.06	3.57	0.51	0.35	0.06	0.66	86.0	0.33	1.98	
Y	0.10	50.0	60.0	6680	7160		3.87	1.09	0.07	3.57	0.51	0.36	0.06	0.66	86.0	0.33	1.97	
Y	0.08	60.0	60.0	6850	7080		3.86	1.08	0.06	3.61	0.51	0.36	0.06	0.67	85.7	0.33	1.98	
Z						5552	3.86	1.14	0.08	3.53	0.52	0.43	0.06	0.73	85.3	0.34	1.77	2.74
Z						5585	3.88	1.15	0.07	3.55	0.52	0.42	0.07	0.74	85.4	0.33	1.84	2.73
Z						5581	3.81	1.16	0.10	3.63	0.52	0.39	0.06	0.73	85.5	0.34	1.81	2.74
Z						5640	3.84	1.13	0.08	3.51	0.52	0.41	0.06	0.72	85.2	0.34	2.3	2.73
Z						5565	3.88	1.14	0.08	3.54	0.52	0.41	0.06	0.72	85.3	0.34	2	2.73
Z						5575	3.89	1.15	0.08	3.53	0.52	0.42	0.06	0.73	85.3	0.33	1.98	2.74
Z						5541	3.86	1.14	0.08	3.55	0.53	0.38	0.06	0.73	85.5	0.34	2.24	2.72
Z						5569	3.82	1.14	0.08	3.50	0.53	0.40	0.06	0.74	84.7	0.34	2.24	2.73
ZA					7000													
ZA					7100													
ZA					6900													
ZA					6900													
ZA					7000													
ZA					7000													
ZA					6900													
ZA					6900													

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	SW ³	CSU ⁴
Au	Pb Coll	g/t	0.008	0.003	0.007	0.001
Co	M/ICP	ppm	4.16	2.43	2.71	0.70
Co	P	ppm	3.21	1.72	2.49	0.56
Cu	M/ICP	ppm	237	155	101	40
Cu	P	ppm	110	66.8	75.0	21.6
Cu	Soluble	ppm	421	366	88.3	111
Al ₂ O ₃	XRF	%	0.027	0.016	0.019	0.005
CaO	XRF	%	0.019	0.013	0.010	0.004
Cr ₂ O ₃	XRF	%	0.006	0.003	0.004	0.001
Fe ₂ O ₃	XRF	%	0.030	0.019	0.020	0.006
K ₂ O	XRF	%	0.008	0.004	0.006	0.001
LOI		%	0.184	0.135	0.077	0.038
MgO	XRF	%	0.021	0.017	0.008	0.005
MnO	XRF	%	0.004	0.003	0.002	0.001
Na ₂ O	XRF	%	0.017	0.016	0.008	0.006
SiO ₂	XRF	%	0.533	0.330	0.330	0.097
TiO ₂	XRF	%	0.010	0.007	0.006	0.002
SG	pyc		0.028	0.020	0.014	0.006

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 Stc Dev, for use to calculate a measure of precision.
4. CSU - Combined Standard Uncertainty, a component for use to calculate the total uncertainty in method validation.

13. Certified values: The Certified, Provisional and Indicated 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 and who have maintained measurement traceability during the analytical process.

15. Certification: AMIS0370 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 50 to 250g) of material. The Laboratory Packs are sealed bottles delivered in sealed foil pouches. The Explorer Packs contain material in standard geochem envelopes, nitrogen flushed and 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.

2 July 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	0.24	0.08	17.3	32
Al	M/ICP	%	2.0	0.17	4.3	104
As	M/ICP	ppm	4.6	4.0	43.3	46
Ba	M/ICP	ppm	129	18.6	7.2	88
Be	M/ICP	ppm	1.0	0.17	8.8	37
Bi	M/ICP	ppm	0.64	1.6	126	36
Ca	M/ICP	%	0.80	0.06	3.7	103
Cd	M/ICP	ppm	0.07	0.10	77.6	12
Ce	M/ICP	ppm	99.8	20.6	10.3	39
Cr	M/ICP	ppm	400	116	14.5	104
Cs	M/ICP	ppm	0.67	0.31	23.5	30
Cu	Fusion	ppm	7269	398	2.7	38
Dy	M/ICP	ppm	4.0	0.59	7.4	16
Er	M/ICP	ppm	2.8	0.67	12.0	16
Eu	M/ICP	ppm	1.0	0.09	4.6	15
Fe	M/ICP	%	2.5	0.25	5.0	105
Ga	M/ICP	ppm	6.8	4.0	29.5	40
Gd	M/ICP	ppm	4.4	0.77	8.8	16
Ge	M/ICP	ppm	0.46	0.68	73.8	24
Hf	M/ICP	ppm	1.6	1.1	32.8	34
Ho	M/ICP	ppm	0.89	0.04	2.0	14
In	M/ICP	ppm	0.12	0.04	15.4	38
K	M/ICP	%	0.4	0.04	4.6	104
La	M/ICP	ppm	61.7	9.4	7.6	61
Li	M/ICP	ppm	5.3	1.1	10.4	65
Lu	M/ICP	ppm	0.54	0.07	6.4	24
Mg	M/ICP	%	0.22	0.05	10.2	107
Mn	M/ICP	ppm	445	75.2	8.4	117
Mo	M/ICP	ppm	3.8	1.7	22.2	58
Na	M/ICP	%	0.48	0.04	4.6	102
Nb	M/ICP	ppm	6.4	1.9	15.2	48
Nd	M/ICP	ppm	31.5	2.9	4.5	15
Ni	M/ICP	ppm	68.4	10.0	7.3	116
P	M/ICP	ppm	327	42.2	6.5	88
Pb	M/ICP	ppm	9.2	27.9	150.7	74
Pr	M/ICP	ppm	9.8	0.9	4.7	16
Rb	M/ICP	ppm	22.3	8.7	19.5	37
S	M/ICP	%	0.10	0.01	4.4	78
Sb	M/ICP	ppm	0.34	0.27	40.0	28
Sc	M/ICP	ppm	6.8	1.3	9.3	97
Se	M/ICP	ppm	8.5	4.2	24.6	39
Sm	M/ICP	ppm	4.6	0.32	3.4	16
Sn	M/ICP	ppm	2.4	1.1	22.1	45
Sr	M/ICP	ppm	123	30.1	12.3	109
Ta	M/ICP	ppm	0.45	0.28	31.5	32
Tb	M/ICP	ppm	0.64	0.10	7.5	24
Te	M/ICP	ppm	1.7	1.3	39.2	39
Th	M/ICP	ppm	5.2	1.9	17.9	46
Ti	M/ICP	%	0.14	0.03	11.1	64
Tl	M/ICP	ppm	0.11	0.04	17.2	24
Tm	M/ICP	ppm	0.51	0.03	2.9	15
U	M/ICP	ppm	6.0	1.5	12.7	39
V	M/ICP	ppm	45.3	3.9	4.3	73
W	M/ICP	ppm	1.7	3.2	93.2	37
Y	M/ICP	ppm	20.2	3.8	9.3	60
Yb	M/ICP	ppm	3.4	0.43	6.2	24
Zn	M/ICP	ppm	14.6	15.3	52.5	106
Zr	M/ICP	ppm	55.3	12.0	10.9	67