



African Mineral Standards

MATRIX REFERENCE MATERIALS

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AMIS0349

Certified Reference Material

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

Certificate of Analysis

Recommended Concentrations and Limits¹ (at two Standard Deviations)

Certified Concentrations²

Co P	176	±	15	ppm
Cu F	2.364	±	0.102	%
Cu M/ICP	2.354	±	0.074	%
Cu P	2.320	±	0.070	%
Cu Soluble	1.950	±	0.203	%
Specific Gravity	2.77	±	0.16	

Provisional Concentrations

Au Pb Collection	0.164	±	0.024	g/t
Co M/ICP	180	±	23	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	12.15	±	0.34	%
CaO	3.46	±	0.08	%
Cr ₂ O ₃	0.040	±	0.004	%
Fe ₂ O ₃	8.92	±	0.16	%
K ₂ O	1.55	±	0.02	%
MgO	1.13	±	0.06	%
Na ₂ O	2.15	±	0.10	%
SiO ₂	58.65	±	1.22	%
TiO ₂	1.05	±	0.03	%

Provisional Concentrations

MnO	0.075	±	0.010	%
LOI	7.13	±	1.52	%

1. **Intended Use:** AMIS0349 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 oxide ore sourced from the 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 subvertically, 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%202012-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 7/4).

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 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: Thirty laboratories were each given eight randomly selected packages of sample. Twenty two 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 22 out of 30 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 (Canada)
3. Activation Laboratories Pty Ltd (Canada)
4. Activation Laboratorios Ltda (Chile)
5. ALS Chemex Laboratory Group (Brisbane Australia)
6. ALS Chemex Laboratory Group (South Africa)
7. ALS Chemex Laboratory Group (Perth Australia)
8. ALS Chemex Laboratory Group (Canada)
9. ALS Chemex Laboratory (Zambia)
10. ALS OMAC (Ireland)
11. Genalysis Laboratory Services (Australia)
12. Intertek Utama Services (Indonesia)
13. Set Point Laboratories (South Africa)
14. Set Point Laboratories (Botswana)
15. SGS Australia Pty Ltd (Perth Australia)
16. SGS Geosol Laboratories Ltda (Brazil)
17. SGS Mineral Services Callao (Peru)
18. SGS South Africa (Pty) Ltd (South Africa)
19. SGS Toronto (Canada)
20. SGS Townsville (Australia)
21. Skyline Assayers and Labs (USA)
22. Ultra Trace (Pty) Ltd (Australia)

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 Col g/t	Co M/ICP ppm	Co P ppm	Cu F ppm	Cu M/ICP ppm	Cu P ppm	Cu Soluble ppm	Al2O3 XRF %	CaO XRF %	Cr2O3 XRF %	Fe2O3 XRF %	K2O XRF %	MgO XRF %	MnO XRF %	Na2O XRF %	SiO2 XRF %	TiO2 XRF %	LOI %	SG pyc	
A	0.14	213	200		24622	22880	19560													
A	0.15	190	200		23151	22960	19490													
A	0.15	193	180		23329	23120	18560													
A	0.16	193	180		23731	22900	19270													
A	0.14	191	180		23532	23070	19550													
A	0.15	193	180		23837	22860	19500													
A	0.15	193	180		23680	22920	17790													
A	0.14	191	180		23416	22870	19410													
B	0.20	200			23500		18200													
B	0.18	200			24000		17900													
B	0.16	200			24100		18100													
B	0.15	200			24000		18000													
B	0.15	200			23800		18100													
B	0.19	200			24300		18100													
B	0.17	200			23800		18200													
B	0.17	200			24000		18000													

Assay data (cont)

Lab Code	Au Pb Col g/t	Co M/ICP ppm	Co P ppm	Cu F ppm	Cu M/ICP ppm	Cu P ppm	Cu Soluble ppm	Al2O3 XRF %	CaO XRF %	Cr2O3 XRF %	Fe2O3 XRF %	K2O XRF %	MgO XRF %	MnO XRF %	Na2O XRF %	SiO2 XRF %	TiO2 XRF %	LOI %	SG pyc
C			170		23400	24600		12.30	3.46	0.04	8.96	1.56	1.14	0.07	2.15	58.70	1.04	6.39	2.65
C			180		23400	23800		12.35	3.47	0.04	8.99	1.56	1.14	0.07	2.15	58.80	1.04	6.33	2.67
C			170		23400	23900		12.30	3.48	0.04	8.99	1.56	1.13	0.07	2.15	58.80	1.04	6.37	2.65
C			180		23200	24600		12.25	3.47	0.04	9.02	1.56	1.13	0.07	2.15	58.70	1.05	6.40	2.69
C			170		23200	23600		12.30	3.49	0.04	9.00	1.56	1.14	0.07	2.16	58.70	1.05	6.35	2.68
C			180		23600	24100		12.35	3.49	0.03	8.98	1.56	1.13	0.07	2.15	58.80	1.03	6.36	2.68
C			180		23200	24400		12.30	3.48	0.04	8.97	1.56	1.14	0.07	2.15	58.80	1.04	6.32	2.71
C			180		23200	24100		12.30	3.47	0.04	8.99	1.56	1.14	0.07	2.15	58.70	1.05	6.35	2.73
D	0.17	185	186	24800			24600	12.20	3.48	0.04	9.06	1.57	1.15	0.08	2.22	59.40	1.07	6.22	
D	0.21	180	190	25100			24100	12.20	3.49	0.04	9.05	1.56	1.15	0.08	2.24	59.30	1.07	6.21	
D	0.22	195	191	24400			24500	12.20	3.49	0.04	9.04	1.55	1.17	0.08	2.21	59.50	1.08	6.14	
D	0.19	194	192	25000			24400	12.20	3.53	0.04	9.14	1.57	1.17	0.08	2.22	59.30	1.09	6.23	
D	0.16	179	188	23900			24200	12.20	3.49	0.04	9.04	1.55	1.15	0.08	2.20	59.40	1.07	6.20	
D	0.20	190	185	24500			24700	12.20	3.49	0.04	9.08	1.56	1.16	0.08	2.18	59.30	1.08	6.20	
D	0.18	180	187	23200			24800	12.20	3.48	0.05	9.04	1.55	1.16	0.08	2.22	59.50	1.08	6.22	
D	0.17	188	184	24300			24300	12.20	3.48	0.04	9.02	1.56	1.14	0.08	2.21	59.40	1.09	6.22	
F		221	156		21985	17585													
F		214	152		20903	17327													
F		228	160		22559	18464													
F		225	155		21974	17934													
F		224	164		22135	18971													
F		228	165		22537	18908													
F		224	163		22283	18455													
F		228	158		22889	18090													
G							19050												
G							23140												
G							23060												
G							23770												
G							23730												
G							23250												
G							23590												
G							23510												
H							25680												
H							24651												
H							25721												
H							25059												
H							24646												
H							25709												
H							25029												
H							25143												
J	0.16	185	182	22800	23000	22600	19000	12.24	3.49	0.04	8.88	1.54	1.16	0.07	2.14	58.94	1.06	6.39	2.89
J	0.17	190	179	23300	23200	22800	20100	12.24	3.47	0.04	8.90	1.54	1.16	0.07	2.14	58.83	1.06	6.40	2.92
J	0.16	190	183	23600	23100	23000	20200	12.24	3.48	0.04	8.87	1.54	1.16	0.07	2.14	58.84	1.07	6.44	2.90
J	0.17	190	179	23500	23800	23100	18200	12.27	3.49	0.04	8.90	1.55	1.16	0.08	2.13	58.94	1.07	6.42	2.89
J	0.16	190	188	23500	24000	22900	19800	12.24	3.48	0.04	8.86	1.54	1.16	0.08	2.14	58.86	1.07	6.44	2.89
J	0.17	190	185	23200	23700	22700	20100	12.30	3.49	0.04	8.89	1.54	1.16	0.07	2.14	58.95	1.07	6.40	2.89
J	0.16	185	180	23900	22900	22600	19900	12.29	3.48	0.04	8.88	1.54	1.17	0.07	2.14	58.98	1.07	6.41	2.90
J	0.17	190	186	23400	23800	23200	20000	12.27	3.49	0.04	8.88	1.54	1.16	0.08	2.13	58.90	1.07	6.40	2.88
K	0.19	189						12.05	3.44	0.04	8.86	1.55	1.27	0.08	2.09	57.70	1.04	8.44	2.77
K	0.15	187						11.90	3.44	0.04	8.93	1.56	1.24	0.08	2.13	57.60	1.05	8.26	2.77
K	0.17	186						12.15	3.45	0.04	8.87	1.55	1.25	0.07	2.10	57.60	1.06	8.24	2.88
K	0.15	186						12.05	3.41	0.04	8.90	1.57	1.24	0.08	2.14	57.60	1.05	8.37	2.77
K	0.18	194						12.10	3.51	0.04	8.90	1.57	1.28	0.07	2.16	57.50	1.05	8.38	2.73
K	0.15	187						12.25	3.62	0.03	9.06	1.56	1.27	0.07	2.20	58.00	1.05	8.79	2.75
K	0.18	192						11.95	3.45	0.04	9.02	1.59	1.24	0.07	2.17	57.50	1.06	8.41	2.81
K	0.14	186						12.60	3.57	0.03	9.18	1.52	1.17	0.08	2.24	58.70	1.07	8.40	2.76
L		164	167					12.10	3.39	0.04	8.78	1.51	1.13	0.07	2.10	58.20	1.05	7.85	2.79
L		162	163					12.10	3.40	0.03	8.79	1.50	1.14	0.07	2.11	58.30	1.05	7.79	2.79
L		164	167					11.90	3.35	0.04	8.77	1.48	1.08	0.07	2.09	57.60	1.05	7.86	2.79
L		164	165					12.00	3.38	0.03	8.82	1.49	1.08	0.07	2.10	57.60	1.05	7.88	2.79
L		162	172					11.30	3.03	0.04	8.75	1.48	1.08	0.07	2.06	57.00	1.04	7.87	2.78
L		163	163					12.00	3.39	0.04	8.86	1.50	1.09	0.07	2.13	58.30	1.06	7.72	2.78
L		164	170					11.90	3.35	0.03	8.77	1.47	1.07	0.08	2.11	57.50	1.05	7.70	2.79
L		166	170					12.10	3.40	0.04	8.81	1.52	1.10	0.08	2.08	58.30	1.05	7.86	2.78
N	0.17	164	186	20700				12.24	3.52	0.04	9.06	1.55	1.13	0.08	2.25	59.42	1.09	6.62	
N	0.17	164	182	20000				12.20	3.52	0.05	9.08	1.57	1.14	0.08	2.30	59.24	1.08	6.70	
N	0.17	164	185	21700				12.21	3.49	0.04	9.04	1.56	1.12	0.08	2.28	59.33	1.07	6.65	
N	0.17	169	188	22400				12.05	3.49	0.04	8.94	1.51	1.13	0.07	2.24	58.92	1.07	6.47	
N	0.16	166	181	21600				12.06	3.49	0.04	8.96	1.51	1.12	0.08	2.23	59.04	1.08	6.28	
N	0.17	162	176	23000				12.16	3.45	0.04	8.97	1.56	1.13	0.07	2.22	58.88	1.07	6.25	
N	0.17	168	181	21300				12.15	3.59	0.04	8.98	1.55	1.10	0.08	2.35	58.93	1.06	6.44	
N	0.17	158	178	20900				12.05	3.51	0.04	8.95	1.52	1.11	0.07	2.20	58.88	1.05	6.42	
Q	0.16	192	175	24030	22410	23560	19430	12.06	3.39	0.04	8.90	1.54	1.16	0.08	2.15	58.20	1.02	7.86	2.65
Q	0.17	184	172	22820	22040	22860	19860	12.01	3.40	0.04	8.90	1.55	1.17	0.08	2.16	58.20	1.02	7.86	2.64
Q	0.18	184	176	24370	22130	22980	19900	12.06	3.40	0.04	8.91	1.53	1.15	0.07	2.15	58.30	1.03	7.88	2.63
Q	0.16	191	173	24650	24100	23460	19860	12.09	3.43	0.04	8.94	1.50	1.16	0.08	2.13	58.50	1.03	7.86	2.65
Q	0.16	189	176	23480	23880	23530	19810	12.07	3.39	0.05	8.91	1.55	1.16	0.07	2.15	58.20	1.03	7.88	2.65
Q	0.19	185	181	22560	24210	23280	19840	12.03	3.40	0.04	8.85	1.55	1.16	0.08	2.16	58.10	1.04	7.85	2.63
Q	0.15	187	178	22880	23970	23320	19900	12.02	3.41	0.04	8.91	1.54	1.17	0.08	2.15	58.20	1.03	7.84	2.59
Q	0.18	189	180	22490	23690	23590	19850	12.09	3.41	0.04	8.91	1.51	1.15	0.07	2.15	58.50	1.04	7.82	2.65
R	0.17	187			23500		19700	12.32	3.47	0.03	8.94	1.54	1.10	0.07	2.22	58.96	1.05	6.60	
R	0.17	184			23500		19200	12.33	3.48	0.03	8.94	1.55	1.10	0.07	2.19	58.97	1.05	6.60	

Assay data. (cont)

Lab Code	Au Pb Col g/t	Co M/ICP ppm	Co P ppm	Cu F ppm	Cu M/ICP ppm	Cu P ppm	Cu Soluble ppm	Al2O3 XRF %	CaO XRF %	Cr2O3 XRF %	Fe2O3 XRF %	K2O XRF %	MgO XRF %	MnO XRF %	Na2O XRF %	SiO2 XRF %	TiO2 XRF %	LOI %	SG pyc
T					23700	23400	19650	11.85	3.41	0.04	8.79	1.48	1.09	0.08	2.16	59.00	1.06	7.81	2.72
T					23700	23200	19650	11.95	3.46	0.04	8.88	1.49	1.10	0.07	2.18	59.80	1.05	7.92	2.86
T					23600	24000	19700	11.85	3.41	0.04	8.80	1.48	1.08	0.07	2.15	58.90	1.06	7.90	2.80
T					23400	23600	19550	11.80	3.39	0.04	8.75	1.47	1.08	0.07	2.15	58.70	1.06	7.84	2.79
T					24200	23500	19550	11.60	3.36	0.04	8.70	1.45	1.08	0.08	2.11	58.00	1.04	7.84	2.79
T					24600	23500	19500	11.80	3.40	0.04	8.78	1.47	1.08	0.08	2.15	58.90	1.06	7.89	2.89
T					23900	23300	19650	11.75	3.38	0.04	8.74	1.47	1.08	0.07	2.15	58.70	1.05	7.79	2.77
T					23900	24200	19800	12.05	3.43	0.04	8.88	1.51	1.10	0.07	2.20	59.90	1.07	7.79	2.79
U	0.18	179	170		23400	23500	18850												2.84
U	0.20	177	171		23500	22300	18450												2.86
U	0.16	179	171		21100	22800	18150												2.84
U	0.17	181	166		23500	23200	17850												2.83
U	0.17	181	171		22900	23100	18050												2.84
U	0.15	177	168		23300	22600	19650												2.82
U	0.18	179	172		23000	22600	18050												2.86
U	0.16	180	173		22700	22200	18800												2.84
V	0.16	181	191	23648	22784		20304												2.77
V	0.16	186	184	23873	23132		21393												2.85
V	0.15	183	188	23197	23037		21458												2.80
V	0.15	184	182	23429	22389		21670												2.86
V	0.15	187	184	23592	23563		22124												2.80
V	0.16	186	190	22985	23262		21358												2.82
V	0.16	197	179	23534	23254		21831												2.86
V	0.16	184	183	23703	22569		20328												2.86
W	0.17	171	167	22900			24000												2.87
W	0.17	177	170	23800			24700												2.87
W	0.18	176	165	24300			24500												2.87
W	0.16	186	165	23700			24500												2.88
W	0.17	178	175	23400			24500												2.87
W	0.18	170	168	24000			24600												2.86
W	0.16	176	163	24000			24700												2.86
W	0.17	182	164	24800			24300												2.87
X		171	175		23674	23040													2.69
X		169	176		23728	23292													2.69
X		173	177		23683	22965													2.69
X		175	172		23599	23380													2.68
X		166	173		23780	22944													2.64
X		174	177		23638	23034													2.66
X		171	171		23835	23320													2.70
X		173	172		23736	23211													2.70
Y	0.18	170	180		23800	23600		12.25	3.47	0.04	8.86	1.54	1.15	0.08		59.00	1.04	6.44	2.77
Y	0.17	170	170		24000	22700		12.40	3.51	0.04	8.99	1.56	1.16	0.08		59.60	1.06	6.44	2.73
Y	0.15	170	180		23400	23000		12.20	3.49	0.04	8.93	1.56	1.14	0.08		59.20	1.04	6.55	2.74
Y	0.21	170	170		24000	23200		12.20	3.46	0.04	8.84	1.54	1.14	0.08		58.90	1.04	6.79	2.73
Y	0.18	160	180		22900	22900		12.25	3.47	0.04	8.86	1.54	1.15	0.08		59.00	1.04	6.50	2.74
Y	0.17	160	170		23700	23200		12.20	3.48	0.04	8.87	1.56	1.12	0.07		59.00	1.03	6.43	2.76
Y	0.15	160	180		23900	23700		12.25	3.47	0.04	8.88	1.55	1.16	0.08		59.10	1.04	6.44	2.75
Y	0.19	160	180		23600	23100		12.35	3.49	0.04	8.98	1.55	1.17	0.08		59.60	1.06	6.43	2.74
ZB	0.15	160	141	23500	23900	23100		12.30	3.49	0.04	8.89	1.56	1.04	0.08	2.07	58.45	1.06	7.53	2.79
ZB	0.14	162	142	23300	23900	23400		12.33	3.50	0.04	8.94	1.56	1.06	0.08	2.05	58.71	1.07	7.53	2.80
ZB	0.16	164	142	23000	23900	23500		12.34	3.49	0.03	8.92	1.57	1.05	0.08	2.08	58.78	1.06	7.54	2.80
ZB	0.16	160	144	24000	23500	23500		12.33	3.47	0.04	8.90	1.56	1.05	0.08	2.06	58.41	1.06	7.51	2.79
ZB	0.16	160	141	23800	23300	23200		12.26	3.49	0.04	8.88	1.57	1.06	0.08	2.09	58.36	1.06	7.51	2.79
ZB	0.16	162	143	24000	23700	23500		12.34	3.51	0.03	8.91	1.57	1.05	0.08	2.07	58.84	1.06	7.51	2.79
ZB	0.16	164	140	23900	23100	23100		12.36	3.53	0.03	8.93	1.57	1.12	0.08	2.08	59.00	1.06	7.52	2.79
ZB	0.15	162	144	23500	23100	23400		12.28	3.51	0.04	8.96	1.57	1.07	0.08	2.06	58.72	1.07	7.55	2.80
ZD	0.17	178	171		23100	25800													
ZD	0.17	182	173		23900	25200													
ZD	0.16	186	174		24200	25300													
ZD	0.15	180	171		23800	25100													
ZD	0.15	184	170		23600	25400													
ZD	0.17	183	169		24000	23900													
ZD	0.17	183	175		24900	24700													
ZD	0.16	183	168		23200	24200													

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
Co	M/ICP	ppm	11.5	7.92	3.69	2.07
Co	P	ppm	7.35	5.30	3.58	1.51
Cu	F	ppm	512	241	499	120
Cu	M/ICP	ppm	371	201	278	64.1
Cu	P	ppm	348	251	246	88.5
Cu	Soluble	ppm	1015	839	456	270
Au	Pb Col	g/t	0.012	0.005	0.011	0.002
Al ₂ O ₃	XRF	%	0.17	0.13	0.07	0.040
CaO	XRF	%	0.04	0.03	0.02	0.01
Cr ₂ O ₃	XRF	%	0.002	0.001	0.002	0.000
Fe ₂ O ₃	XRF	%	0.08	0.06	0.05	0.019
K ₂ O	XRF	%	0.012	0.006	0.010	0.002
MgO	XRF	%	0.03	0.02	0.01	0.008
MnO	XRF	%	0.0046	0.0022	0.0039	0.0008
Na ₂ O	XRF	%	0.050	0.036	0.024	0.012
SiO ₂	XRF	%	0.611	0.495	0.290	0.152
TiO ₂	XRF	%	0.013	0.010	0.008	0.003
LOI		%	0.765	0.694	0.095	0.209
SG	pyc		0.079	0.066	0.026	0.019

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 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: AMIS0349 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.

6 November 2012

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	0.61	0.53	43.1	59
Al	M/ICP	%	6.17	0.60	4.88	124
As	M/ICP	ppm	6.55	6.71	51.2	71
Ba	M/ICP	ppm	255	26.1	5.11	98
Be	M/ICP	ppm	3.03	0.78	12.9	94
Bi	M/ICP	ppm	0.69	2.10	151	42
Ca	M/ICP	%	2.42	0.14	2.97	122
Cd	M/ICP	ppm	0.88	2.46	140	28
Ce	M/ICP	ppm	234	31.7	6.78	53
Co	F	ppm	184	46.2	12.5	16
Cr	M/ICP	ppm	235	66.5	14.1	121
Cs	M/ICP	ppm	1.67	0.11	3.41	29
Dy	M/ICP	ppm	12.2	1.74	7.11	24
Er	M/ICP	ppm	8.91	1.21	6.81	24
Eu	M/ICP	ppm	3.11	0.34	5.54	23
Fe	M/ICP	%	6.13	0.44	3.57	130
Ga	M/ICP	ppm	18.5	4.38	11.8	71
Gd	M/ICP	ppm	13.61	1.31	4.80	22
Ge	M/ICP	ppm	0.94	0.84	44.7	16
Hf	M/ICP	ppm	3.39	0.69	10.1	45
Ho	M/ICP	ppm	2.73	0.29	5.24	24
In	M/ICP	ppm	0.44	0.16	18.5	44
K	M/ICP	%	1.25	0.13	5.14	122
La	M/ICP	ppm	130	20.5	7.87	83
Li	M/ICP	ppm	14.0	2.65	9.47	92
Lu	M/ICP	ppm	1.75	0.28	7.93	32
Mg	M/ICP	%	0.65	0.07	5.70	134
Mn	M/ICP	ppm	563	64.8	5.75	139
Mo	M/ICP	ppm	6.15	1.60	13.0	88
Na	M/ICP	%	1.57	0.17	5.37	108
Nb	M/ICP	ppm	17.7	8.72	24.6	56
Nd	M/ICP	ppm	89.1	6.36	3.57	23
Ni	M/ICP	ppm	178	26.8	7.52	118
P	M/ICP	ppm	933	137	7.36	88
Pb	M/ICP	ppm	7.73	10.8	70.0	88
Pr	M/ICP	ppm	25.3	1.31	2.60	22
Rb	M/ICP	ppm	64.4	7.67	5.96	55
S	M/ICP	%	0.26	0.03	4.84	108
S	Comb/LECO	%	0.25	0.01	2.80	8
Sb	M/ICP	ppm	3.72	8.73	117	50
Sc	M/ICP	ppm	21.3	2.84	6.66	88
Se	M/ICP	ppm	28.7	5.45	9.49	55
Si	M/ICP	%	27.7	0.88	1.59	8
Sm	M/ICP	ppm	15.1	1.28	4.26	23
Sn	M/ICP	ppm	6.47	0.86	6.64	47
Sr	M/ICP	ppm	256	25.7	5.01	105
Ta	M/ICP	ppm	0.93	0.69	36.8	39
Tb	M/ICP	ppm	1.92	0.55	14.4	32
Te	M/ICP	ppm	5.98	5.13	43.0	59
Th	M/ICP	ppm	11.7	2.04	8.70	53
Ti	M/ICP	%	0.40	0.08	9.79	94
Tl	M/ICP	ppm	0.68	2.22	162	36
Tm	M/ICP	ppm	1.51	0.15	5.08	23
U	M/ICP	ppm	19.2	2.97	7.72	64
V	M/ICP	ppm	125	22.1	8.84	96
W	M/ICP	ppm	1.56	1.07	34.4	40
Y	M/ICP	ppm	60.0	8.24	6.87	93
Yb	M/ICP	ppm	10.8	1.41	6.50	32
Zn	M/ICP	ppm	22.4	7.82	17.5	95
Zr	M/ICP	ppm	124	29.5	11.9	91