



African Mineral Standards

MATRIX REFERENCE MATERIALS

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AMIS0423

Certified Reference Material

**Copper ore, carbonatite,
Palabora Mine, South Africa**

Certificate of Analysis

Recommended Concentrations and Limits¹ (at two Standard Deviations)

Certified Concentrations²

Au Pb Collection	0.122	±	0.012	g/t
Co M/ICP	79	±	8	ppm
Cu Fus	8207	±	282	ppm
Cu M/ICP	8058	±	504	ppm
Cu P	7897	±	300	ppm
Specific Gravity	3.21	±	0.08	

Provisional Concentration

Co P 76 ± 14 ppm

Indicated Mean

Cu Soluble 1171 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	0.46	±	0.03	%
CaO	31.02	±	0.36	%
Fe ₂ O ₃	23.65	±	0.46	%
K ₂ O	0.22	±	0.01	%
MgO	8.23	±	0.10	%
MnO	0.15	±	0.01	%
SiO ₂	6.04	±	0.08	%
TiO ₂	0.60	±	0.02	%
LOI	20.79	±	0.12	%
S Comb/LECO	0.68	±	0.06	%

Indicated Means

Cr ₂ O ₃	0.013	%
Na ₂ O	0.05	%

1. Intended Use: AMIS0423 is a certified reference material which may be used to demonstrate the validity of measurement results of a single analysis of carbonatite hosted 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 ore sourced from Palabora Mining Company Limited. Palabora Mine is located next to the town of Phalaborwa in Mpumalanga Province, 380 kilometres north east of Johannesburg, South Africa. The Palabora alkali carbonatitic massif is an ovoid bicertered alkaline ring complex with a carbonatite core intruded as a vertical pipe into Archean granite prior to 2.06Ga. The Palabora complex is unique in that it hosts the only economic copper sulphide carbonatite orebody in the world.

3. Mineral and Chemical Composition: The host rocks are carbonatite and foskorite. Chalcopyrite is the most abundant ore mineral followed by bornite. Chalcocite is a subsidiary sulphide in the foskorite. Other sulphides are valleriite, cubanite and pyrrhotite (minor). Other important mineral by-products are titaniferous magnetite and apatite. Uranothorite is also recovered.

4. **Appearance:** The material is a very fine powder. It is colored Medium Dark Grey.
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 three laboratories were each given eight randomly selected packages of sample. Twenty one 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 21 out of 23 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. Activation Labortorios Ltda (Chile)
5. ALS Chemex Laboratory Group Brisbane Australia
6. ALS Chemex Laboratory Group Johannesburg SA
7. ALS Chemex Laboratory Group Perth WA
8. ALS Chemex Laboratory Group Vancouver CA
9. ALS OMAC (Ireland)
10. Bureau Veritas (Namibia)
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 Vancouver (Canada)
20. Skyline Assayers and Labs (USA)
21. 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 Fus 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 %	S Comb LECO %	SG pyc
A		90.0			8170	8100	5570	0.45	30.9	0.02	23.7	0.23	8.19	0.16	0.05	6.06	0.60	20.8	0.68	3.16
A		90.0			8070	7940	5560	0.46	30.8	0.01	23.6	0.23	8.16	0.16	0.05	5.99	0.59	20.8	0.68	3.15
A		90.0			8030	7840	5620	0.45	31.0	0.01	23.8	0.23	8.23	0.16	0.05	6.02	0.60	20.8	0.69	3.11
A		90.0			7990	7800	5570	0.45	30.9	0.01	23.8	0.23	8.21	0.16	0.05	6.09	0.60	20.8	0.69	3.14
A		90.0			8120	7960	5580	0.45	30.9	0.01	23.8	0.23	8.15	0.16	0.05	6.04	0.60	20.8	0.68	3.16
A		90.0			7950	7880	5570	0.46	30.9	0.02	23.8	0.23	8.19	0.16	0.05	6.05	0.59	20.8	0.68	3.15
A		90.0			8160	8250	5580	0.45	30.9	0.01	23.6	0.23	8.18	0.16	0.06	6.02	0.59	20.8	0.68	3.15
A		90.0			8120	7820	5600	0.45	30.9	0.01	23.7	0.23	8.19	0.16	0.05	6.03	0.60	20.8	0.68	3.16
B	0.13	80.0	80.0		8270	8200		0.45	31.0	0.01	23.8	0.23	8.28	0.15	0.06	6.01	0.61	20.8		
B	0.12	80.0	80.0		8140	8150		0.45	31.0	0.01	23.8	0.23	8.27	0.16	0.06	5.99	0.60	20.8		
B	0.12	80.0	80.0		8320	8120		0.43	31.1	0.01	23.8	0.23	8.26	0.16	0.04	6.01	0.60	20.8		
B	0.12	80.0	80.0		8320	7990		0.45	31.0	0.01	23.9	0.23	8.28	0.16	0.05	6.01	0.61	20.7		
B	0.12	80.0	80.0		8360	8100		0.45	30.9	0.01	23.9	0.23	8.27	0.16	0.05	5.98	0.61	20.8		
B	0.11	80.0	80.0		8340	8100		0.46	31.0	0.01	23.8	0.23	8.29	0.15	0.05	6.02	0.61	20.8		
B	0.11	80.0	80.0		8390	7920		0.46	31.1	0.01	23.8	0.23	8.28	0.15	0.05	6.02	0.60	20.8		
B	0.11	80.0	80.0		8200	7980		0.45	31.1	0.01	23.7	0.23	8.29	0.15	0.05	6.00	0.61	20.8		
C	0.11	75.8	58.0	8280	8235	7025	1372													3.24
C	0.12	76.0	57.0	8133	8210	7038	1360													3.23
C	0.11	75.2	58.0	8040	8295	7068	1379													3.28
C	0.12	76.4	57.0	8184	8147	7183	1378													3.28
C	0.11	75.9	59.0	8100	8241	7342	1376													3.22
C	0.12	75.8	58.0	8165	8230	7074	1369													3.23
C	0.11	76.0	58.0	8003	8260	7087	1371													3.21
C	0.12	75.6	58.0	8092	8293	7331	1396													3.28
D	0.11	72.9	49.0	8180	6640	6700	1310	0.69	31.2	0.03	24.0	0.04	8.22	0.15		6.13	0.60	20.8		3.26
D	0.12	75.9	51.0	8200	6940	6810	1280	0.72	31.2	0.01	23.9	0.04	8.26	0.15		6.11	0.60	20.8		3.26
D	0.12	72.6	51.0	8430	6760	6660	1360	0.68	31.4	0.01	24.1	0.03	8.26	0.15		6.11	0.60	20.8		3.26
D	0.12	77.6	51.0	8180	7040	6680	1230	0.68	31.1	0.01	23.8	0.04	8.19	0.15		6.09	0.59	20.8		3.26
D	0.12	74.6	52.0	8320	6940	6770	1240	0.73	31.2	0.01	23.6	0.02	8.18	0.14		6.08	0.59	20.8		3.26
D	0.12	76.0	51.0	8350	7410	6770	1220	0.74	31.0	0.01	23.7	0.03	8.18	0.15		6.10	0.59	20.8		3.25
D	0.12	76.2	50.0	8480	7030	6750	1280	0.74	31.1	0.01	23.8	0.02	8.19	0.14		6.06	0.60	20.7		3.25
D	0.12	72.9	50.0	8730	6690	6690	1290	0.72	31.3	0.02	23.9		8.21	0.15		6.11	0.60	20.8		3.24
F	0.15	81.0			8050		1770	0.44	30.8		23.3	0.22	8.27	0.16	0.07	6.20	0.61	20.7	0.71	
F	0.14	82.0			7890		1740	0.44	30.9		23.4	0.22	8.31	0.16	0.07	6.25	0.60	20.7	0.71	
F	0.16	84.0			7880		1730	0.45	30.9		23.3	0.22	8.27	0.16	0.09	6.23	0.60	20.7	0.71	
F	0.16	80.0			7990		1740	0.44	30.9		23.3	0.22	8.30	0.16	0.08	6.25	0.61	20.7	0.71	
F	0.15	83.0			7980		1740	0.45	30.9		23.3	0.22	8.24	0.16	0.07	6.22	0.59	20.7	0.71	
F	0.15	81.0			7810		1750	0.44	30.9		23.4	0.23	8.27	0.16	0.07	6.28	0.60	20.9	0.75	
F	0.15	78.0			8080		1740	0.44	30.9		23.4	0.22	8.31	0.16	0.07	6.23	0.60	20.7	0.70	
F	0.14	82.0			8010		1770	0.45	30.8		23.3	0.22	8.21	0.16	0.08	6.21	0.62	20.7	0.72	

Assay data (cont)

Lab Code	Au Pb Coll g/t	Co M/ICP ppm	Co P ppm	Cu Fus 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 %	S Comb LECO %	SG pyc	
G	0.14	98.8	86.0	7489	7400	7392	627	0.36	30.8		23.6		8.00	0.14	0.15	5.89	0.58	20.2		3.21	
G	0.14	93.2	82.0	7542	7400	7703	647	0.37	31.0		23.7		8.02	0.14	0.14	5.92	0.58	20.4		3.20	
G	0.13	105.5	93.0	7770	7400	7862	648	0.37	30.9		23.6		8.00	0.14	0.15	5.91	0.58	20.4		3.17	
G	0.14	90.0	87.0	7669	7600	7886	667	0.41	30.9		23.7		8.05	0.14	0.13	5.94	0.57	20.4		3.21	
G	0.12	97.3	86.0	7584	7300	7790	639	0.40	31.0		23.7		8.05	0.14	0.14	5.97	0.58	20.5		3.20	
G	0.12	105.3	87.0	7711	7500	7758	648	0.37	31.0		23.6		8.04	0.14	0.14	5.91	0.57	20.6		3.17	
G	0.12	105.8	85.0	7539	7500	7658	629	0.35	30.9		23.5		8.08	0.14	0.13	5.89	0.57	20.6		3.20	
G	0.12	108.5	92.0	7565	7200	7977	623	0.40	31.3		23.9		8.12	0.14	0.15	6.04	0.59	20.6		3.21	
H	0.14	72.6	73.0	8100	8370	8390													0.69		
H	0.12	73.0	79.0	8100	8300	8690													0.69		
H	0.12	75.4	77.0	8300	8440	8600													0.69		
H	0.14	73.2	76.0	8200	8470	8380													0.68		
H	0.14	74.2	76.0	8200	8420	8520													0.70		
H	0.14	72.3	76.0	8100	8300	8290													0.68		
H	0.12	69.2	77.0	8200	8360	8430													0.68		
H	0.12	73.8	76.0	8200	8370	8560													0.70		
I	0.12	79.0	70.0		8200	7969	580													3.02	
I	0.12	81.0	70.0		8591	7961	610													3.04	
I	0.13	80.0	70.0		8113	8032	620													3.13	
I	0.12	81.0	70.0		8500	7948	590													3.15	
I	0.13	78.0	69.0		8365	8108	620													3.04	
I	0.12	78.0	69.0		8129	8016	600													3.04	
I	0.12	81.0	69.0		8403	7945	620													3.04	
I	0.12	85.0	67.0		8538	7904	600													3.06	
J	0.14	90.0	80.0		8110	7940	1390													3.21	
J	0.12	80.0	80.0		7920	7810	1380													3.24	
J	0.13	80.0	80.0		8110	7940	1390													3.24	
J	0.12	80.0	80.0		8150	7990	1540													3.26	
J	0.13	80.0	80.0		7950	7920	1660													3.24	
J	0.13	80.0	80.0		8200	8060	2090													3.24	
J	0.12	80.0	80.0		8090	7890	1390													3.24	
J	0.11	80.0	80.0		7760	8020	1380													3.21	
K	0.13			8250			940	0.51	31.4		24.0	0.21	8.21	0.15	0.03	6.08	0.60	20.8	0.66		
K	0.12			8270			960	0.48	31.1	0.02	23.8	0.23	8.23	0.15	0.02	6.02	0.58	21.0	0.65		
K	0.12			8230			980	0.48	31.2	0.02	23.8	0.22	8.19	0.14	0.01	6.04	0.58	20.8	0.67		
K	0.13			8310			930	0.53	31.3	0.03	24.1	0.23	8.26	0.14	0.04	6.11	0.58	20.9	0.64		
K	0.12			8430			960	0.50	31.4	0.02	24.1	0.21	8.22	0.15	0.04	6.09	0.58	20.9	0.65		
K	0.12			8390			960	0.48	31.3	0.02	24.0	0.22	8.17	0.15	0.02	6.00	0.59	20.9	0.65		
K	0.13			8510			960	0.49	31.8	0.02	24.2	0.23	8.20	0.14	0.03	6.06	0.60	20.9	0.67		
K	0.12			8200			930	0.48	31.4		24.1	0.22	8.23	0.14	0.03	6.10	0.58	20.8	0.67		
L		72.0			7820															3.22	
L		76.0			7870															3.22	
L		76.0			8120															3.23	
L		74.0			7870															3.23	
L		74.0			7980															3.24	
L		76.0			7830															3.24	
L		76.0			7980															3.23	
L		74.0			8180															3.23	
M							7630	0.45	31.2	0.01	23.8	0.22	8.31	0.15	0.04	6.10	0.61	20.7	0.02		
M							7680	0.45	31.0	0.01	23.6	0.23	8.34	0.16	0.04	6.09	0.62	20.7	0.02		
M							7780	0.44	31.1	0.01	23.7	0.23	8.31	0.16	0.04	6.07	0.61	20.7	0.02		
M							7780	0.45	31.0	0.01	23.7	0.23	8.31	0.15	0.03	6.08	0.60	20.7	0.02		
M							7760	0.44	31.0	0.02	23.7	0.22	8.30	0.16	0.04	6.06	0.60	20.7	0.02		
M							7890	0.45	31.1	0.01	23.7	0.23	8.34	0.15	0.03	6.09	0.62	20.7	0.02		
M							7850	0.44	31.0	0.01	23.7	0.23	8.32	0.16	0.05	6.06	0.60	20.8	0.02		
M							7800	0.45	31.1	0.01	23.7	0.22	8.28	0.16	0.04	6.06	0.61	20.7	0.02		
N	0.13				7600		2200														
N	0.13				7600		2200														
N	0.14				7700		2200														
N	0.12				7700		2100														
N	0.13				7700		2200														
N	0.16				7700		2100														
N	0.12				7600		2100														
N	0.12				7600		2100														
O	0.12	85.0	66.0	8350	8320	7740	730	0.43	30.8	0.01	23.8	0.22	8.22	0.15		6.05	0.60	20.8		3.24	
O	0.12	80.0	65.0	8300	8240	7640	770	0.44	30.9	0.01	23.8	0.22	8.24	0.16		6.07	0.60	20.9		3.24	
O	0.12	80.0	63.0	8250	8240	7930	760	0.44	30.8	0.01	23.9	0.22	8.24	0.16		6.05	0.59	20.8		3.24	
O	0.12	80.0	64.0	8300	8220	7700	740	0.43	30.8	0.01	23.8	0.22	8.23	0.15		6.05	0.59	20.8		3.24	
O	0.11	80.0	67.0	8300	8320	7530	770	0.44	30.8	0.01	23.8	0.22	8.23	0.16		6.04	0.59	20.8		3.25	
O	0.12	80.0	63.0	8350	8290	7650	760	0.45	30.9	0.01	23.8	0.22	8.23	0.15		6.04	0.60	20.8		3.26	
O	0.12	80.0	65.0	8350	8310	7600	750	0.44	30.8	0.01	23.9	0.22	8.23	0.16		6.06	0.60	20.8		3.24	
O	0.12	85.0	64.0	8300	8270	7970	740	0.44	30.8	0.01	23.8	0.22	8.25	0.15		6.05	0.59	20.8		3.24	
P	0.12	76.0	77.2		7953	7882	1180	0.47	31.2	0.01	23.3	0.06	8.18	0.15	0.01	5.98	0.60	20.9	0.74	3.14	
P	0.13	77.6	78.8		8378	8058	1130	0.45	31.1	0.02	23.4	0.06	8.21	0.15	0.03	5.99	0.60	20.9	0.74	3.14	
P	0.12	78.2	81.6		8090	8096	1170	0.46	31.2	0.01	23.4	0.05	8.21	0.15	0.02	6.01	0.61	20.9	0.75	3.14	
P	0.12	75.8	79.4		8209	7900	1190	0.46	31.1	0.02	23.2	0.06	8.18	0.14	0.04	5.99	0.62	20.9	0.74	3.14	
P	0.12	77.1	79.2		8226	7963	1240	0.46	31.3	0.01	23.6	0.06	8.23	0.15	0.02	5.99	0.58	20.9	0.73	3.14	
P	0.12	82.5	79.0		8485	7967	1180	0.47	31.2	0.02	23.3	0.05	8.20	0.15	0.02	6.00	0.62	20.8	0.74	3.15	
P	0.14	80.6	78.4		8468	7941	1220	0.46	31.1	0.02	23.3	0.09	8.19	0.15	0.02	5.97	0.61	20.9	0.73	3.15	
P	0.14	78.9	74.2		8426	7653	1190	0.46	31.4	0.02	23.5	0.04	8.25	0.15	0.03	6.04	0.59	20.8	0.74	3.14	
Q	0.12	81.9	79.5		8250	7790		0.46	30.9	0.01	23.3	0.22	8.30	0.15	0.05	5.84	0.59	20.4		3.15	
Q	0.12	80.8	83.2		8120	8070		0.46	30.9	0.01	23.3	0.22	8.27	0.15	0.05	5.83	0.59	20.4		3.19	
Q	0.11	83.9	82.8		8170	8030		0.49	31.0	0.02	23.1	0									

Assay data (cont)

Lab Code	Au Pb Coll g/t	Co M/ICP ppm	Co P ppm	Cu Fus 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 %	S Comb LECO %	SG pyc		
R	0.16	72.6	67.0	7955	7855	7684	1268	0.64	31.0		23.7	0.19	8.18	0.16	0.07	5.97	0.60	20.8	0.64	3.23		
R	0.17	72.7	65.0	8076	7813	7883	1321	0.58	31.1		23.7	0.14	8.17	0.17	0.07	6.02	0.60	20.8	0.62	3.21		
R	0.15	74.8	67.0	7972	7856	7779	1316	0.64	31.1		23.7	0.19	8.20	0.16	0.06	6.01	0.61	20.8	0.63	3.21		
R	0.17	71.4	65.0	7983	7780	7646	1317	0.62	31.0		23.7	0.17	8.20	0.16	0.06	5.97	0.60	20.8	0.63	3.23		
R	0.15	74.6	66.0	8068	7851	7722	1377	0.62	30.5		23.3	0.14	8.07	0.16	0.09	5.90	0.59	20.8	0.63	3.21		
R	0.15	70.9	64.0	8051	7860	7682	1334	0.55	31.1		23.7	0.17	8.13	0.16	0.05	5.99	0.60	20.8	0.65	3.21		
R	0.15	71.8	65.0	7996	7880	7702	1352	0.70	30.6		23.4	0.20	8.13	0.16	0.06	5.92	0.60	20.8	0.62	3.23		
R	0.15	71.3	67.0	7974	7891	7703	1273	0.51	31.4		24.0	0.17	8.18	0.17	0.06	6.08	0.61	20.8	0.64	3.23		
S					7600	7320	1100															
S					7580	7340	1130															
S					7700	7340	1140															
S					7650	7250	1150															
S					7600	7210	1150															
S					7700	7370	1130															
S					7600	7260	1150															
S					7600	7410	1140															
U		84.4	84.0		7937	8021	1506													0.65	3.23	
U		82.7	84.0		7951	8082	1286														0.67	3.18
U		82.9	84.0		7987	7920	1495														0.66	3.17
U		81.8	82.0		7883	7914	1551														0.67	3.14
U		85.5	83.0		7898	7954	1466														0.67	3.14
U		84.7	83.0		7931	8075	1518														0.67	3.14
U		85.1	84.0		7853	7881	1258														0.69	3.17
U		84.6	83.0		7918	8069	1241														0.66	3.10
V	0.12	80.0	70.0		7840	7610	1300	0.46	31.1	0.02	23.7	0.22	8.27	0.15	0.05	6.03	0.59	20.9		3.22		
V	0.12	80.0	70.0		7810	7830	1490	0.46	31.1	0.02	23.7	0.23	8.28	0.16	0.05	6.03	0.59	20.8		3.22		
V	0.13	80.0	80.0		7960	7770	1500	0.46	31.1	0.02	23.7	0.23	8.28	0.15	0.05	6.03	0.60	20.8		3.28		
V	0.12	80.0	80.0		7730	7650	1480	0.46	31.1	0.02	23.7	0.23	8.27	0.15	0.05	6.00	0.60	20.9		3.29		
V	0.12	80.0	70.0		7770	7830	1310	0.46	31.2	0.02	23.7	0.23	8.29	0.15	0.05	6.03	0.60	20.8		3.22		
V	0.12	80.0	70.0		7820	7720	1340	0.46	30.9	0.01	23.6	0.22	8.19	0.15	0.05	5.99	0.59	20.9		3.13		
V	0.14	80.0	70.0		8000	7770	1420	0.47	31.1	0.02	23.7	0.22	8.26	0.15	0.05	6.04	0.60	20.8		3.21		
V	0.12	80.0	70.0		7820	7680	1410	0.47	31.1	0.02	23.7	0.22	8.26	0.16	0.05	6.05	0.59	20.9		3.13		
W	0.13						7900	0.47			23.5	0.23	8.23	0.16			0.60	20.7	0.68			
W	0.13						8000	0.49			23.6	0.23	8.25	0.16			0.62	20.7	0.69			
W	0.12						8000	0.47			23.7	0.22	8.22	0.16			0.61	20.8	0.71			
W	0.13						7900	0.49			23.5	0.23	8.15	0.16			0.61	20.7	0.69			
W	0.13						8000	0.48			23.6	0.24	8.16	0.16			0.62	20.8	0.70			
W	0.12						8000	0.46			23.6	0.23	8.18	0.16			0.60	20.7	0.70			
W	0.13						7800	0.47			23.5	0.23	8.18	0.16			0.60	20.8	0.70			
W	0.13						7900	0.48			23.6	0.22	8.15	0.16			0.58	20.9	0.69			

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	0.006	0.002	0.005	0.001
Co	M/ICP	ppm	3.75	2.66	1.50	0.72
Co	P	ppm	7.06	5.98	1.89	1.81
Cu	Fus	ppm	141	141	83.2	58.8
Cu	M/ICP	ppm	252	168	99.2	42.9
Cu	P	ppm	159	102	109	32.8
Cu	Soluble	ppm	337	269	55.8	74.8
Al ₂ O ₃	XRF	%	0.014	0.011	0.007	0.004
CaO	XRF	%	0.183	0.118	0.115	0.036
Cr ₂ O ₃	XRF	%	0.004	0.003	0.003	0.001
Fe ₂ O ₃	XRF	%	0.226	0.160	0.107	0.046
K ₂ O	XRF	%	0.005	0.003	0.004	0.001
LOI		%	0.063	0.041	0.042	0.013
MgO	XRF	%	0.050	0.035	0.029	0.010
MnO	XRF	%	0.007	0.005	0.003	0.001
Na ₂ O	XRF	%	0.015	0.013	0.006	0.004
SiO ₂	XRF	%	0.040	0.030	0.025	0.010
TiO ₂	XRF	%	0.012	0.007	0.008	0.002
S Comb	LECO	%	0.031	0.031	0.009	0.011
SG	pyc		0.043	0.030	0.024	0.009

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 Smees.

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: AMIS0423 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.

21 October 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	3.3	1.2	18.0	98
Al	M/ICP	%	0.24	0.04	8.2	104
As	M/ICP	ppm	499	155	15.6	100
Ba	M/ICP	ppm	487	53.2	5.5	86
Be	M/ICP	ppm	0.29	0.12	21.6	48
Bi	M/ICP	ppm	6.7	2.1	15.3	67
Ca	M/ICP	%	21.7	2.3	5.3	84
Cd	M/ICP	ppm	0.53	0.18	16.9	66
Ce	M/ICP	ppm	561	92.1	8.2	48
Co	Fusion	ppm	72.8	4.8	3.3	8
Cr	M/ICP	ppm	57.2	21.3	18.6	104
Cs	M/ICP	ppm	0.25	0.10	19.0	46
Dy	M/ICP	ppm	15.8	4.7	14.9	24
Er	M/ICP	ppm	4.0	1.1	13.8	24
Eu	M/ICP	ppm	12.4	3.4	13.6	24
Fe	M/ICP	%	16.3	1.5	4.7	89
Ga	M/ICP	ppm	9.0	4.1	22.4	55
Gd	M/ICP	ppm	39.0	7.4	9.5	24
Ge	M/ICP	ppm	0.89	0.80	45.1	32
Hf	M/ICP	ppm	5.5	11.2	101	46
Ho	M/ICP	ppm	2.1	0.54	12.5	24
In	M/ICP	ppm	0.27	0.06	11.2	62
K	M/ICP	%	0.19	0.03	8.8	110
La	M/ICP	ppm	236	43.6	9.2	71
Li	M/ICP	ppm	2.7	0.93	17.2	68
Lu	M/ICP	ppm	0.21	0.04	8.9	40
Mg	M/ICP	%	4.7	0.42	4.4	106
Mn	M/ICP	ppm	1147	154	6.7	110
Mo	M/ICP	ppm	0.64	0.43	33.8	46
Na	M/ICP	%	0.03	0.02	28.2	102
Nb	M/ICP	ppm	6.9	5.6	40.7	64
Nd	M/ICP	ppm	305	89.3	14.6	24
Ni	M/ICP	ppm	128	14.7	5.7	105
P	M/ICP	ppm	22291	2321	5.2	80
Pb	M/ICP	ppm	80.4	20.4	12.7	109
Pr	M/ICP	ppm	72.2	21.2	14.7	24
Rb	M/ICP	ppm	13.4	1.5	5.8	62
S	M/ICP	%	0.66	0.11	8.4	94
Sb	M/ICP	ppm	36.2	11.0	15.1	88
Sc	M/ICP	ppm	14.8	1.8	6.0	96
Se	M/ICP	ppm	5.5	8.5	76.7	29
Sm	M/ICP	ppm	54.3	14.3	13.1	24
Sn	M/ICP	ppm	34.8	10.7	15.4	80
Sr	M/ICP	ppm	3369	320	4.7	88
Ta	M/ICP	ppm	1.0	1.7	81.8	48
Tb	M/ICP	ppm	4.3	0.60	6.9	39
Te	M/ICP	ppm	3.0	1.2	20.1	61
Th	M/ICP	ppm	98.7	11.2	5.7	66
Ti	M/ICP	%	0.34	0.03	4.7	79
Tl	M/ICP	ppm	0.12	0.03	11.0	53
Tm	M/ICP	ppm	0.38	0.09	11.5	23
U	M/ICP	ppm	28.8	3.1	5.3	61
V	M/ICP	ppm	172	36.5	10.6	112
W	M/ICP	ppm	0.81	0.47	29.0	58
Y	M/ICP	ppm	52.0	3.6	3.4	75
Yb	M/ICP	ppm	1.8	0.30	8.5	40
Zn	M/ICP	ppm	189	32.5	8.6	110
Zr	M/ICP	ppm	267	595	112	80