African Mineral Standards
MATRIX REFERENCE MATERIALS

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AMIS0420

Certified Reference Material

Copper ore, carbonatite, Palabora Mine, South Africa

Certificate of Analysis

Recommended Concentrations and Limits[1.]
(at two Standard Deviations)

Certified Concentrations[2.]

Au Pb Collection	0.41	±	0.04	g/t
Cu Fus	5829	±	293	ppm
Cu M/ICP	5780	±	459	ppm
Cu P	5717	±	246	ppm
Specific Gravity	3.24	±	0.10	

Provisional Concentrations

Co M/ICP	88	±	13	ppm
Co P	82	±	14	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_2O_3	0.52	±	0.02	%
CaO	29.19	±	0.42	%
Fe_2O_3	26.38	±	0.28	%
K_2O	0.24	±	0.01	%
MgO	8.60	±	0.08	%
MnO	0.16	±	0.01	%
SiO_2	6.98	±	0.14	%
TiO_2	0.67	±	0.02	%
LOI	18.53	±	0.14	%
S Comb/LECO	0.74	±	0.06	%

Provisional Concentration

Na_2O	0.05	±	0.01	%

Indicated Mean

Cr_2O_3	0.015	%

1. Intended Use: AMIS0420 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 bicentered alkaline ring complex with a carbonatite core which was 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 pyrhotite (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 parti**c**le 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 (Al_2O_3, CaO, Cr_2O_3, Fe_2O_3, K_2O, MgO, MnO, Na_2O, SiO_2, TiO_2. 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 - Booysens 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	Al_2O_3 XRF %	CaO XRF %	Cr_2O_3 XRF %	Fe_2O_3 XRF %	K_2O XRF %	MgO XRF %	MnO XRF %	Na_2O XRF %	SiO_2 XRF %	TiO_2 XRF %	LOI %	S Comb/LECO %	SG pyc
A	0.40	90.4	89.7		5920	5800	0.53	29.8	0.01	26.1	0.24	8.90	0.16	0.05	6.93	0.67	18.2		3.24
A	0.39	92.1	90.4		5830	5760	0.55	29.8	0.01	26.3	0.24	8.89	0.16	0.06	7.06	0.68	17.6		3.22
A	0.39	90.1	92.1		5730	5810	0.52	29.2	0.01	25.7	0.24	8.77	0.15	0.04	6.77	0.65	17.9		3.26
A	0.39	89.0	91.4		5890	5700	0.54	29.6	0.01	26.6	0.25	8.83	0.16	0.06	6.94	0.68	17.9		3.24
A	0.41	92.7	91.2		5900	5790	0.54	29.6	0.02	26.6	0.25	8.83	0.16	0.06	6.94	0.68	18.2		3.20
A	0.39	91.1	93.0		5950	5790	0.54	29.3		26.5	0.24	8.93	0.16	0.06	6.96	0.65	18.0		3.24
A	0.39	89.2	92.4		5910	5840	0.54	29.7	0.01	26.4	0.25	8.84	0.16	0.06	6.97	0.68	18.3		3.26
A	0.39	90.6	89.9		5890	5880	0.54	29.5	0.01	26.3	0.25	8.82	0.16	0.06	6.96	0.68	18.3		3.24
B		82.0			5730														3.28
B		82.0			5660														3.28
B		82.0			5750														3.27
B		84.0			5700														3.28
B		84.0			5600														3.27
B		86.0			5790														3.29
B		82.0			5810														3.27
B		86.0			5760														3.29
C	0.41	85.0	81.0	5737	6612	5789													3.20
C	0.37	85.5	80.0	5786	5735	5816													3.24
C	0.42	84.9	79.0	5728	6448	5801													3.38
C	0.38	87.0	80.0	5820	5781	5908													3.29
C	0.34	88.2	80.0	5846	6042	5753													3.28
C	0.35	86.2	78.0	5696	5745	5713													3.36
C	0.40	86.5	80.0	5721	6073	5811													3.21
C	0.38	85.5	79.0	5826	6438	5943													3.31
F	0.42	87.0			5660		0.50	28.8		26.1	0.24	8.62	0.16	0.07	7.15	0.68	18.5	0.75	
F	0.41	87.0			5620		0.50	29.0		25.9	0.24	8.65	0.16	0.09	7.21	0.68	18.4	0.75	
F	0.43	85.0			5570		0.50	29.0		26.0	0.24	8.60	0.16	0.09	7.17	0.68	18.5	0.76	
F	0.43	84.0			5600		0.54	29.0		26.0	0.24	8.58	0.16	0.09	7.17	0.68	18.5	0.78	
F	0.41	87.0			5660		0.51	29.0		25.8	0.24	8.63	0.16	0.09	7.19	0.68	18.5	0.77	
F	0.43	86.0			5710		0.50	29.0		25.9	0.24	8.64	0.16	0.09	7.18	0.69	18.5	0.75	
F	0.42	86.0			5670		0.51	29.0		26.0	0.24	8.64	0.16	0.08	7.18	0.68	18.4	0.78	
F	0.42	86.0			5690		0.52	29.0		26.0	0.24	8.59	0.16	0.08	7.16	0.69	18.5	0.78	

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	Al_2O_3 XRF %	CaO XRF %	Cr_2O_3 XRF %	Fe_2O_3 XRF %	K_2O XRF %	MgO XRF %	MnO XRF %	Na_2O XRF %	SiO_2 XRF %	TiO_2 XRF %	LOI %	S Comb/LECO %	SG pyc
G	0.42	93.0	83.9	5614	5151	5026	0.43	29.5		26.6	0.18	8.60	0.15		6.90	0.67	18.5		3.24
G	0.40	89.0	85.1	5575	5490	5153	0.45	29.3		26.4	0.16	8.60	0.14		6.90	0.67	18.4		3.22
G	0.41	87.0	82.3	5563	5260	5172	0.42	29.3		26.4	0.17	8.60	0.14		6.90	0.67	18.4		3.26
G	0.41	96.0	85.5	5600	5367	5107	0.42	29.3		26.4	0.17	8.50	0.14		6.90	0.67	18.4		3.24
G	0.39	100.0	81.5	5698	5836	5119	0.44	29.4		26.7	0.18	8.60	0.15		6.90	0.66	18.5		3.22
G	0.39	88.0	80.3	5537	5297	5023	0.48	29.5		26.5	0.18	8.50	0.15		6.90	0.66	18.5		3.27
G	0.40	94.0	86.5	5455	5700	5242	0.42	29.4		26.5	0.17	8.60	0.15		6.90	0.66	18.4		3.24
G	0.41	92.0	84.7	5811	5495	5106	0.43	29.4		26.5	0.18	8.60	0.14		6.90	0.67	18.4		3.24
H		89.9	91.0		5486	5553												0.71	3.18
H		91.4	90.0		5611	5611												0.71	3.20
H		91.2	92.0		5430	5643												0.73	3.21
H		88.9	89.0		5525	5612												0.73	3.21
H		89.3	87.0		5449	5574												0.72	3.19
H		90.5	86.0		5481	5549												0.72	3.19
H		89.1	89.0		5606	5501												0.71	3.19
H		88.2	88.0		5541	5558												0.73	3.18
I	0.43	78.9	71.0	6149	6199	5664	0.64	28.9		25.6	0.25	8.63	0.15		6.80	0.65	17.7	0.68	3.24
I	0.47	77.0	71.0	5985	6048	5751	0.71	29.3		26.0	0.25	8.74	0.16		6.95	0.67	17.9	0.68	3.24
I	0.39	77.4	72.0	5991	6046	5727	0.58	29.5		26.6	0.25	8.87	0.16		7.06	0.68	18.4	0.68	3.25
I	0.53		69.0	6290	6166	5677	0.58	29.8		26.4	0.25	8.86	0.16		7.03	0.68	18.4	0.69	3.26
I	0.38	76.9	73.0	6111	6071	5845	0.60	29.6		26.2	0.25	8.80	0.16		6.98	0.67	17.5	0.64	3.25
I	0.41	76.4	74.0	6003	6057	5803	0.64	29.3		25.9	0.25	8.75	0.16		6.88	0.66	18.3	0.70	3.25
I	0.39	76.0	71.0	5881	5854	5812	0.64	28.8		25.5	0.25	8.61	0.15		6.82	0.65	18.4	0.68	3.25
I	0.39	76.1	75.0	5992	6152	5870	0.65	29.5		26.3	0.25	8.80	0.16		6.80	0.66	18.5	0.68	3.25
J	0.43		69.4				0.56				0.24	8.59	0.17			0.69	18.5	0.75	
J	0.44		69.2				0.55				0.24	8.55	0.17			0.67	18.5	0.75	
J	0.43		70.4				0.55				0.24	8.53	0.17			0.69	18.5	0.75	
J	0.42		69.4				0.53				0.24	8.51	0.15			0.68	18.5	0.75	
J	0.43		70.5				0.53				0.24	8.60	0.15			0.68	18.5	0.76	
J	0.42		69.9				0.56				0.25	8.58	0.15			0.69	18.5	0.76	
J	0.42		69.8				0.55				0.24	8.55	0.17			0.68	18.6	0.75	
J	0.42		68.4				0.52				0.24	8.63	0.17			0.67	18.5	0.76	
K	0.41			5970			0.51	28.6		26.4	0.24	8.42	0.16	0.03	7.04	0.65	18.1	0.71	
K	0.40			5960			0.52	28.5		26.5	0.25	8.39	0.15	0.03	6.98	0.66	18.1	0.73	
K	0.43			5870			0.50	28.5		25.9	0.24	8.41	0.15	0.05	6.96	0.64	18.2	0.72	
K	0.37			6060			0.52	28.4		26.5	0.25	8.38	0.16	0.04	7.02	0.65	18.2	0.71	
K	0.40			5890			0.51	28.4		26.5	0.24	8.37	0.17	0.05	6.98	0.66	18.2	0.73	
K	0.38			5910			0.53	28.5		26.4	0.24	8.41	0.16	0.05	7.00	0.65	18.1	0.72	
K	0.41			5850			0.50	28.5		26.4	0.24	8.38	0.16	0.05	7.00	0.65	18.1	0.72	
K	0.39			5890			0.53	28.4		26.5	0.25	8.32	0.15	0.04	7.04	0.64	18.2	0.73	
L							0.51	29.1	0.01	26.3	0.25	8.60	0.16	0.06	7.02	0.67	18.5	0.24	
L							0.51	29.1	0.01	26.4	0.24	8.60	0.16	0.05	7.03	0.67	18.5	0.23	
L							0.51	29.1	0.01	26.4	0.25	8.62	0.16	0.05	7.02	0.67	18.5	0.23	
L							0.51	29.1	0.01	26.4	0.25	8.63	0.16	0.05	7.05	0.67	18.5	0.24	
L							0.51	29.1	0.02	26.4	0.25	8.58	0.16	0.05	7.03	0.67	18.4	0.23	
L							0.51	29.1	0.02	26.3	0.25	8.61	0.16	0.05	7.04	0.67	18.5	0.23	
L							0.51	29.1	0.01	26.3	0.25	8.60	0.16	0.06	7.04	0.67	18.5	0.23	
L							0.50	29.1	0.01	26.4	0.25	8.63	0.16	0.05	7.03	0.68	18.5	0.22	
M	0.39	76.3	81.0	5900	5900	6130												0.73	
M	0.40	77.5	83.0	5900	5950	6120												0.75	
M	0.41	77.4	83.0	5900	5960	6070												0.74	
M	0.43	77.2	83.0	5900	6300	6120												0.76	
M	0.40	75.6	80.0	5900	6130	6060												0.75	
M	0.41	75.3	82.0	5800	5940	6330												0.75	
M	0.41	75.8	82.0	5800	6070	6060												0.75	
M	0.43	80.9	81.0	5800	6160	6160												0.74	
N	0.41	100.0			5800														
N	0.44	100.0			5800														
N	0.43				5800														
N	0.44				5800														
N	0.45	100.0			5800														
N	0.44	100.0			5900														
N	0.42	100.0			5800														
N	0.47	100.0			5900														
O	0.38	85.0	76.0	5650	5600	5560	0.50	29.0	0.01	26.3	0.24	8.60	0.16		7.00	0.67	18.7		3.31
O	0.40	85.0	76.0	5750	5620	5610	0.52	29.0	0.01	26.3	0.24	8.58	0.16		7.02	0.67	18.7		3.30
O	0.39	85.0	78.0	5650	5620	5730	0.51	28.9	0.01	26.3	0.24	8.58	0.16		7.01	0.67	18.7		3.31
O	0.39	90.0	78.0	5700	5730	5640	0.51	28.9	0.01	26.4	0.24	8.56	0.16		7.02	0.67	18.7		3.30
O	0.40	85.0	79.0	5700	5690	5680	0.53	29.0	0.01	26.3	0.24	8.55	0.16		7.01	0.67	18.6		3.30
O	0.39	85.0	75.0	5650	5740	5580	0.52	28.9	0.01	26.3	0.24	8.57	0.16		7.03	0.67	18.6		3.30
O	0.41	85.0	76.0	5650	5740	5710	0.51	29.0	0.01	26.4	0.24	8.56	0.16		7.01	0.67	18.7		3.30
O	0.41	85.0	76.0	5700	5700	5720	0.52	28.9	0.01	26.3	0.24	8.59	0.16		7.04	0.67	18.7		3.29
P	0.41	84.1	87.5		5740	5943	0.51	29.3	0.02	25.6	0.08	8.51	0.16	0.13	6.82	0.68	18.6	0.76	3.14
P	0.42	84.1	88.0		5677	6087	0.52	29.4	0.02	25.7	0.06	8.55	0.15	0.11	6.83	0.69	18.6	0.80	3.15
P	0.41	83.3	89.3		5640	6162	0.52	29.4	0.01	25.6	0.12	8.52	0.16	0.11	6.80	0.69	18.7	0.79	3.15
P	0.42	83.6	87.2		5756	5981	0.52	29.4	0.01	25.7	0.09	8.50	0.15	0.11	6.78	0.67	18.7	0.79	3.15
P	0.42	85.3	88.8		5689	5939	0.52	29.4	0.02	25.7	0.08	8.52	0.15	0.11	6.82	0.67	18.6	0.79	3.14
P	0.43	83.8	84.7		5927	5856	0.52	29.9	0.02	26.4	0.08	8.67	0.15	0.14	6.99	0.67	18.7	0.81	3.14
P	0.41	84.9	88.3		5817	5891	0.52	29.5	0.01	25.9	0.10	8.58	0.15	0.14	6.88	0.67	18.6	0.79	3.15
P	0.44	82.9	82.6		5864	5753	0.52	29.9	0.02	26.2	0.06	8.68	0.16	0.11	6.94	0.70	18.6	0.76	3.15
Q	0.44	90.0	79.0		6071	5603													3.20
Q	0.41	89.0	78.0		6305	5946													3.28
Q	0.40	91.0	79.0		6225	5865													3.08
Q	0.41	90.0	77.0		6257	5876													3.08
Q	0.43	94.0	79.0		6261	5734													3.15
Q	0.40	101.0	79.0		6462	5901													3.21
Q	0.41	91.0	79.0		6176	5904													3.23
Q	0.42	91.0	79.0		5872	5821													3.26

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	Al_2O_3 XRF %	CaO XRF %	Cr_2O_3 XRF %	Fe_2O_3 XRF %	K_2O XRF %	MgO XRF %	MnO XRF %	Na_2O XRF %	SiO_2 XRF %	TiO_2 XRF %	LOI %	S Comb/LECO %	SG pyc
R	0.39	83.2	61.0	6000	5020	5280	0.69	29.4	0.01	26.6	0.05	8.61	0.15	0.02	7.10	0.67	18.5		3.31
R	0.43	81.1	53.0	6060	4960	4680	0.74	29.2	0.02	26.6	0.05	8.60	0.15	0.02	7.12	0.67	18.5		3.30
R	0.43	83.2	55.0	5890	4920	4840	0.69	29.5	0.01	26.6	0.08	8.61	0.15		7.09	0.68	18.5		3.30
R	0.39	82.2	54.0	5830	5060	4710	0.69	29.4	0.01	26.6	0.06	8.61	0.15	0.02	7.06	0.67	18.5		3.30
R	0.39	84.6	54.0	5950	5030	4790	0.73	29.5	0.01	26.8	0.09	8.64	0.15	0.02	7.08	0.67	18.5		3.31
R	0.37	83.3	54.0	5790	4990	4940	0.72	29.4	0.01	26.6	0.06	8.60	0.15	0.03	7.11	0.68	18.5		3.32
R	0.45	84.7	56.0	5800	5050	4950	0.71	29.3	0.03	26.5	0.07	8.59	0.15	0.02	7.06	0.67	18.5		3.30
R	0.39	85.6	57.0	6010	5010	4810	0.71	29.4	0.02	26.6	0.07	8.59	0.15	0.02	7.10	0.67	18.5		3.30
S					5340	5290													
S					5320	5270													
S					5310	5300													
S					5330	5240													
S					5400	5220													
S					5380	5250													
S					5310	5070													
S					5370	5130													
T		100.0			5750	5670	0.53	29.0	0.02	26.3	0.25	8.58	0.16	0.05	6.98	0.68	18.5	0.74	3.17
T		100.0			5910	5650	0.51	29.0	0.02	26.3	0.25	8.56	0.16	0.05	7.00	0.67	18.5	0.73	3.20
T		90.0			5850	5510	0.53	29.0	0.02	26.3	0.25	8.58	0.16	0.05	6.96	0.67	18.5	0.73	3.14
T		100.0			5930	5700	0.51	29.0	0.02	26.3	0.26	8.56	0.16	0.05	6.97	0.67	18.5	0.73	3.16
T		100.0			5880	5670	0.52	28.9	0.02	26.2	0.25	8.54	0.16	0.06	6.96	0.67	18.5	0.73	3.17
T		90.0			5870	5690	0.51	29.1	0.02	26.3	0.25	8.59	0.16	0.05	7.01	0.68	18.5	0.74	3.19
T		100.0			5900	5560	0.52	29.0	0.02	26.3	0.25	8.58	0.16	0.04	7.03	0.68	18.5	0.74	3.18
T		90.0			5770	5650	0.53	29.1	0.02	26.4	0.25	8.59	0.16	0.05	7.02	0.67	18.5	0.74	3.19
U	0.41	90.0	90.0		5840	5740	0.52	29.2	0.01	26.3	0.25	8.64	0.16	0.06	6.91	0.68	18.6		
U	0.41	90.0	80.0		6090	5760	0.51	29.1	0.01	26.3	0.25	8.64	0.16	0.06	6.94	0.68	18.5		
U	0.38	90.0	90.0		5950	5740	0.51	29.1	0.01	26.3	0.25	8.67	0.16	0.05	6.95	0.69	18.5		
U	0.41	80.0	90.0		5810	5660	0.53	29.1	0.01	26.3	0.25	8.68	0.16	0.05	6.99	0.68	18.5		
U	0.42	80.0	80.0		6060	5720	0.52	29.1	0.01	26.4	0.25	8.64	0.16	0.06	6.92	0.69	18.5		
U	0.42	90.0	80.0		6030	5720	0.52	29.2	0.01	26.3	0.25	8.67	0.16	0.05	6.93	0.68	18.5		
U	0.40	90.0	90.0		5950	5730	0.52	29.1	0.02	26.4	0.25	8.66	0.16	0.05	6.97	0.68	18.4		
U	0.40	90.0	90.0		5920	5710	0.52	29.1	0.02	26.3	0.25	8.68	0.16	0.05	6.95	0.68	18.5		
V	0.40	80.0	90.0		5710	5690	0.53	29.2	0.02	26.2	0.24	8.64	0.16	0.05	7.00	0.67	18.6		3.32
V	0.40	90.0	80.0		5690	5590	0.53	29.2	0.02	26.3	0.24	8.66	0.16	0.06	7.00	0.67	18.6		3.27
V	0.40	90.0	80.0		5630	5550	0.52	29.2	0.02	26.2	0.25	8.62	0.16	0.05	6.98	0.67	18.6		3.30
V	0.40	90.0	80.0		5670	5530	0.53	29.2	0.02	26.2	0.24	8.65	0.16	0.06	7.02	0.67	18.7		3.27
V	0.42	90.0	90.0		5580	5540	0.52	29.2	0.02	26.3	0.24	8.67	0.16	0.06	6.99	0.67	18.6		3.16
V	0.41	90.0	80.0		5630	5550	0.52	29.1	0.02	26.2	0.24	8.63	0.16	0.06	6.98	0.68	18.6		3.32
V	0.41	90.0	80.0		5590	5540	0.53	29.1	0.02	26.3	0.23	8.65	0.16	0.05	6.98	0.67	18.6		3.16
V	0.42	90.0	80.0		5550	5500	0.52	29.2	0.02	26.3	0.23	8.64	0.16	0.05	7.00	0.66	18.6		3.22
W	0.40	90.0	90.0		5840	5770													3.22
W	0.40	90.0	100.0		5760	5770													3.29
W	0.41	90.0	80.0		5850	5730													3.24
W	0.41	100.0	90.0		5880	5750													3.24
W	0.41	100.0	90.0		5810	5660													3.23
W	0.40	90.0	90.0		5630	5650													3.29
W	0.40	100.0	90.0		5850	5580													3.24
W	0.39	90.0	90.0		5460	5510													3.25

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:

Combined standard uncertainty=sqrt((between lab.var/no of labs) + (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	0.017	0.007	0.013	0.002
Co	M/ICP	ppm	6.32	3.94	2.78	0.98
Co	P	ppm	6.81	5.10	2.56	1.44
Cu	Fus	ppm	146.3	141.4	74.5	54.4
Cu	M/ICP	ppm	229.6	141.8	101.6	35.5
Cu	P	ppm	122.9	87.5	72.2	27.5
Al_2O_3	XRF	%	0.014	0.010	0.009	0.003
CaO	XRF	%	0.210	0.152	0.116	0.047
Cr_2O_3	XRF	%	0.004	0.003	0.003	0.001
Fe_2O_3	XRF	%	0.139	0.090	0.097	0.031
K_2O	XRF	%	0.005	0.003	0.003	0.001
LOI		%	0.074	0.064	0.028	0.021
MgO	XRF	%	0.040	0.026	0.029	0.009
MnO	XRF	%	0.005	0.003	0.004	0.001
Na_2O	XRF	%	0.006	0.003	0.005	0.001
SiO_2	XRF	%	0.067	0.048	0.037	0.015
TiO_2	XRF	%	0.010	0.006	0.007	0.002
S Comb	LECO	%	0.030	0.029	0.010	0.010
SG	pyc		0.052	0.035	0.028	0.010

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: AMIS0420 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.

18 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	1.4	0.56	19.8	81
Al	M/ICP	%	0.27	0.04	6.8	103
As	M/ICP	ppm	603	177	14.7	101
Ba	M/ICP	ppm	478	39.1	4.1	86
Be	M/ICP	ppm	0.30	0.17	28.0	47
Bi	M/ICP	ppm	8.6	1.8	10.3	68
Ca	M/ICP	%	20.3	2.0	4.8	82
Cd	M/ICP	ppm	0.86	0.37	21.3	70
Ce	M/ICP	ppm	535	117	11.0	50
Co	Fusion	ppm	80.3	4.7	2.9	8
Cr	M/ICP	ppm	68.7	29.7	21.6	110
Cs	M/ICP	ppm	0.26	0.11	20.6	45
Cu	Soluble	ppm	1368	306	11.2	85
Dy	M/ICP	ppm	15.0	3.6	11.9	24
Er	M/ICP	ppm	3.7	0.84	11.3	24
Eu	M/ICP	ppm	11.9	2.5	10.6	24
Fe	M/ICP	%	18.1	1.4	3.9	85
Ga	M/ICP	ppm	9.0	2.9	16.1	55
Gd	M/ICP	ppm	36.9	5.0	6.8	24
Ge	M/ICP	ppm	1.0	1.1	55.6	32
Hf	M/ICP	ppm	5.8	12.0	103	50
Ho	M/ICP	ppm	2.0	0.39	9.7	24
In	M/ICP	ppm	0.17	0.05	13.1	60
K	M/ICP	%	0.20	0.03	6.9	109
La	M/ICP	ppm	231	47.0	10.2	69
Li	M/ICP	ppm	3.8	1.2	15.9	69
Lu	M/ICP	ppm	0.20	0.04	9.8	38
Mg	M/ICP	%	5.0	0.38	3.9	104
Mn	M/ICP	ppm	1161	123	5.3	106
Mo	M/ICP	ppm	1.2	0.40	16.4	42
Na	M/ICP	%	0.03	0.02	28.9	96
Nb	M/ICP	ppm	6.8	7.3	53.7	64
Nd	M/ICP	ppm	290	62.3	10.8	24
Ni	M/ICP	ppm	126	19.5	7.7	107
P	M/ICP	ppm	24124	2281	4.7	75
Pb	M/ICP	ppm	92.8	18.8	10.1	107
Pr	M/ICP	ppm	67.7	14.8	10.9	24
Rb	M/ICP	ppm	14.2	1.3	4.7	62
S	M/ICP	%	0.71	0.10	7.0	90
Sb	M/ICP	ppm	33.8	18.1	26.8	104
Sc	M/ICP	ppm	15.7	1.7	5.5	88
Se	M/ICP	ppm	5.3	2.8	26.6	54
Si	M/ICP	%	3.3	0.02	0.24	7
Sm	M/ICP	ppm	50.9	9.0	8.8	24
Sn	M/ICP	ppm	16.7	5.3	15.8	78
Sr	M/ICP	ppm	3085	311	5.0	94
Ta	M/ICP	ppm	1.3	2.4	96.3	55
Tb	M/ICP	ppm	4.0	0.32	4.0	39
Te	M/ICP	ppm	8.4	1.9	11.2	61
Th	M/ICP	ppm	67.7	8.5	6.3	70
Ti	M/ICP	%	0.38	0.05	6.9	76
Tl	M/ICP	ppm	0.29	0.07	12.0	56
Tm	M/ICP	ppm	0.36	0.08	10.8	24
U	M/ICP	ppm	17.0	1.7	5.1	63
V	M/ICP	ppm	188	27.5	7.3	111
W	M/ICP	ppm	0.73	0.34	23.5	59
Y	M/ICP	ppm	50.7	5.8	5.7	76
Yb	M/ICP	ppm	1.6	0.28	8.5	40
Zn	M/ICP	ppm	199	34.2	8.6	111
Zr	M/ICP	ppm	175	467	133	75