



African Mineral Standards

MATRIX REFERENCE MATERIALS

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AMIS0357

Certified Reference Material

**Copper cobalt, Copperbelt
mixed Kakanda and Mukondo oxide ore, DRC**

Certificate of Analysis

**Recommended Concentrations and Limits¹
(at two Standard Deviations)**

Certified Concentrations²

Co F	8885	±	851	ppm
Co M/ICP	8627	±	634	ppm
Co P	8557	±	327	ppm
Cu F	2.249	±	0.066	%
Cu M/ICP	2.227	±	0.105	%
Cu P	2.209	±	0.094	%
Specific Gravity	2.77	±	0.14	

Provisional Concentrations

Cu Soluble ppm	2.102	±	0.298	%
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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	10.31	±	0.18	%
CaO	1.53	±	0.06	%
Fe ₂ O ₃	3.58	±	0.10	%
K ₂ O	2.25	±	0.06	%
MgO	7.81	±	0.16	%
MnO	0.120	±	0.002	%
Na ₂ O	0.13	±	0.01	%
SiO ₂	61.28	±	1.32	%
TiO ₂	0.68	±	0.02	%
LOI	7.80	±	0.78	%

Provisional Concentrations

Cr ₂ O ₃	0.034	%
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1. Intended Use: AMIS0357 can be used to check analysis of samples of copper cobalt ores with a similar grade and matrix.

It is a matrix matched Certified Reference Material (CRM) 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: AMIS0357 was made using Copper-Cobalt oxide ore blended from the Mukondo and Kakanda Est projects (located 6 km apart in the Kakanda area but with the same host rocks and mineralogy) operated by BOSS Mining. The latter is a Joint Venture between the Central African Mining and Exploration Company (CAMEC), owned by Eurasian Natural Resources Corporation (Africa) (ENRC), and the parastatal mining company GECAMINES. The Mukondo and Kakanda Est projects are in the Katanga Province, 50km north west of Likasi , 160km north west of the regional capital Lubumbashi and 95km east of Kolwezi, in the DRC. The Kakanda and Mukondo deposits are hosted by sedimentary rocks of the Neoproterozoic Katangan sequence developed within the Lufilian Arc in the Central African Copperbelt. Mineralisation is generally hosted within the dolomitic shales and argillites of the Mines Series.

3. Mineral and Chemical Composition: The main economic mineralogy comprises malachite and heterogenite with subordinate chrysocolla. Deeper holes at Kakanda have intersected chalcocite, and carrollite, with subordinate bornite and chalcopyrite.

4. Appearance: The material is a very fine powder. It is colored a Greyish Orange (Corstor 10YR 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 homogenized in a double cone blender, systematically divided and sealed into 1kg Laboratory Packs. Explorer Packs are subdivided from the Laboratory packs as required. Samples were randomly selected for homogeneity testing and third party analysis. Statistical analysis of both homogeneity and consensus test results were carried out by an independent statistician.

7. Methods of Analysis requested:

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

8. Information requested:

1. State and provide brief description of analytical techniques used.
2. State aliquots used for all determinations.
3. Results for individual analyses to be reported.
4. All results for base metals to be reported in ppm.
5. Report all QC data, to include replicates, blanks and certified reference materials used.

9. Method of Certification: Twenty five laboratories were each given eight packages, comprising eight samples scientifically selected from throughout the batch. Twenty one laboratories reported results in time for certification

Final limits were calculated after first determining if all data was compatible within a spread normally expected for similar analytical methods done by reputable laboratories. Data from any one laboratory was then removed from further calculations when the mean of all analyses from that laboratory failed a “t test” of the global means of the other laboratories. The means and standard deviations were then re-calculated using all remaining data. Any analysis that fell outside of the new two standard deviations was removed from the ensuing data base. The mean and standard deviations were again calculated using the remaining data.

The “between-laboratory” standard deviation is used in the calculation to eliminate technically and statistically invalid data. Upper and lower limits are based on the standard deviation of the remaining data, which reflect individual analyses and can be used to monitor accuracy in routine laboratory quality control. This is different to limits based on standard deviations derived from grouped set of analyses (see 12), which provide important measures for precision and trueness, but which are less useful for routine QC.

Standards with an RSD of near or less than 5 % are termed “Certified”, RSD’s of between near 5 % and 15 % are termed “Provisional”, and RSD’s over 15 % are termed “Informational”.

10. Participating Laboratories: The 21 out of 25 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 Chemex Laboratory Zambia
10. ALS OMAC (Ireland)
11. Genalysis Laboratory Services (W Australia P)
12. Intertek Utama Services (Indonesia)
13. Set Point Laboratories (Isando) SA
14. Set Point Laboratories Botswana
15. SGS Australia Pty Ltd (Newburn) WA
16. SGS Mineral Services Callao (Peru)
17. SGS Mineral Services Lakefield (Canada)
18. SGS South Africa (Pty) Ltd - Booyens JHB
19. SGS Townsville (Australia)
20. 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 is set out below.

Assay data

Lab Code	Co F ppm	Co M/ICP ppm	Co P ppm	Co Soluble 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 %	S Comb/LECO %	SG pyc
B 7380									20700												
B 8280					20800																
B 8170					20500																
B 8310					20800																
B 8190					20800																
B 7850					20600																
B 8330					20800																
B 8220					20700																
C 8740	8470				22800				10.25	1.50	0.03	3.56	2.28	8.56	0.12	0.09	60.10	0.68	8.54		2.73
C 8740	8540				22800				10.25	1.52	0.03	3.63	2.31	8.63	0.12	0.09	60.60	0.69	8.40		2.75
C 8620	8400				22500				10.35	1.68	0.03	3.64	2.63	8.84	0.12	0.10	59.00	0.67	8.50		2.81
C 8700	8310				22900				10.25	1.55	0.03	3.61	2.31	8.63	0.12	0.10	60.30	0.68	8.54		2.73
C 8770	8730				22900				10.20	1.53	0.03	3.60	2.29	8.56	0.12	0.09	60.10	0.67	8.52		2.76
C 8710	8680				22800				10.35	1.54	0.03	3.61	2.25	8.55	0.12	0.09	60.10	0.68	8.43		2.82
C 8740	8240				22800				10.20	1.57	0.03	3.59	2.31	8.62	0.12	0.10	60.70	0.68	8.61		2.76
C 8900	8450				23400				10.30	1.51	0.03	3.61	2.39	8.23	0.11	0.09	60.50	0.68	8.94		2.74
D 8580	8630		7180	22400	22000		21400		10.02	1.58	0.06	3.65	2.27	7.87	0.12	0.13	60.24	0.70	7.99		2.71
D 8880	8520		6970	20900	21500		21400		9.90	1.57	0.05	3.64	2.25	7.87	0.13	0.05	60.35	0.68	7.98		2.72
D 8760	8630		7710	21900	21300		21900		9.86	1.59	0.06	3.63	2.26	7.89	0.12	0.07	60.14	0.68	8.04		2.76
D 8930	8530		7860	21300	21800		21900		9.99	1.56	0.06	3.62	2.31	7.86	0.12	0.08	60.10	0.67	8.05		2.76
D 8630	8700		7630	22300	22200		21900		9.96	1.56	0.07	3.65	2.26	7.79	0.12	0.07	60.20	0.68	8.04		2.76
D 8820	8710		7570	22100	22100		21800		9.98	1.55	0.06	3.63	2.27	7.81	0.12	0.08	60.10	0.65	8.06		2.75
D 8610	8830		7840	23200	22400		21800		10.21	1.53	0.04	3.58	2.25	7.82	0.12	0.06	60.95	0.68	8.12		2.74
D 9090	8750		7960	22200	22400		21900		10.26	1.52	0.04	3.57	2.25	7.84	0.12	0.06	60.89	0.68	8.00		2.72
F 9170	8580	8630		22700	21640	21970	22110		10.21	1.50	0.04	3.54	2.23	7.86	0.12	0.13	61.00	0.66	8.05	0.18	2.69
F 9120	9000	8730		22560	23060	22120	22230		10.20	1.51	0.04	3.54	2.23	7.86	0.12	0.12	61.20	0.66	8.07	0.08	2.68
F 9220	8300	8600		22730	21250	21780	22420		10.20	1.50	0.04	3.52	2.26	7.81	0.12	0.12	60.80	0.67	8.05	0.08	2.67
F 9220	8990	8640		22800	23010	22090	22710		10.19	1.50	0.04	3.52	2.25	7.81	0.12	0.14	60.80	0.66	8.05	0.09	2.68
F 9130	8770	8690		22410	22320	22160	22410		10.14	1.49	0.04	3.48	2.22	7.78	0.12	0.14	60.60	0.69	8.06	0.03	2.67
F 9250	7770	8610		22710	19740	22000	22560		10.11	1.48	0.04	3.51	2.21	7.76	0.12	0.12	60.50	0.66	8.04	0.08	2.67
F 9170	8040	8750		22640	20560	22370	22340		10.21	1.51	0.04	3.54	2.21	7.85	0.12	0.13	61.20	0.67	8.05	0.03	2.67
F 9350	8210	8540		22960	21050	21910	22350		10.24	1.50	0.04	3.56	2.23	7.86	0.12	0.13	61.10	0.66	8.04	0.06	2.68
G 8910	8800	7500		22300	22200	19800					0.03					0.13					2.75
G 9000	8900	7500		22800	22100	21500					0.03					0.13					2.77
G 8570	8740	7700		22000	22100	19750					0.03					0.13					2.81
G 9230	8540	7700		23900	21200	20100					0.03					0.13					2.79
G 8690	8710	7700		22400	22300	21000					0.03					0.13					2.80
G 8840	8760	7500		22000	22200	20700					0.03					0.13					2.77
G 9070	8480	7700		22700	21400	20400					0.03					0.13					2.78
G 8960	8800	7600		22300	22100	20300					0.03					0.13					2.78
H 8953	8954			22226	22061		21967									0.13					2.80
H 9001	8884			22380	21936		22551									0.13					2.79
H 8986	8841			22789	21601		22433									0.13					2.88
H 9081	9067			22815	21583		22834									0.13					2.82
H 9095	9054			22471	21788		21977									0.13					2.87
H 9136	8770			22431	21989		22082									0.13					2.83
H 9035	8938			22708	21908		22560									0.13					2.81
H 9045	8871			22601	21935		23179									0.13					2.82

Assay data (cont)

Lab Code	Co F ppm	Co M/ICP ppm	Co P ppm	Co Soluble 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 %	S Comb/LECO %	SG pyc
I		9217	8490			22231	22050	21360													
I		8861	8430			21324	21940	21260													
I		9293	8620			22080	22450	21530													
I		9247	8400			22125	21620	21500													
I		9127	8490			21902	21970	18960													
I		9160	8470			21952	22260	21440													
I		9060	8510			21805	21630	19780													
I		9154	8280			22127	21160	21620													
J		10624	7341			21579	16880														
J		10740	7207			21174	16549														
J		10223	7364			20599	16794														
J		9576	7471			19238	17047														
J		10088	7157			20192	16462														
J		10462	7377			20971	16878														
J		10359	7398			20671	16748														
J		10568	7428			21421	16777														
K		8316	8157						10.20	1.49	0.03	3.52	2.23	7.67	0.12		61.80	0.69	7.91		2.77
K		8387	8241						10.30	1.50	0.03	3.55	2.26	7.76	0.12		61.70	0.69	7.94		2.76
K		8318	8147						10.30	1.50	0.03	3.53	2.27	7.78	0.12		61.70	0.69	7.94		2.77
K		8305	8223						10.10	1.48	0.06	3.53	2.23	7.65	0.12		61.60	0.68	7.96		2.77
K		8361	8130						10.10	1.48	0.04	3.49	2.22	7.62	0.12		61.50	0.68	7.87		2.76
K		8434	8176						10.00	1.41	0.03	3.36	2.04	7.88	0.11		62.00	0.65	7.95		2.77
K		8418	8337						9.64	1.45	0.03	3.34	2.17	7.31	0.11		58.40	0.65	7.91		2.77
K		8377	8435						10.20	1.48	0.03	3.50	2.21	7.73	0.11		61.60	0.68	7.89		2.77
L		8420				21900		20400	10.38	1.53	0.05	3.59	2.26	7.81	0.12	0.13	61.69	0.68	7.40		
L		8440				22200		20400	10.40	1.54	0.03	3.58	2.27	7.82	0.12	0.13	61.86	0.69	7.30		
L		8440				22200		20700	10.41	1.55	0.02	3.59	2.27	7.84	0.12	0.14	61.90	0.68	7.30		
L		8380				22300		20700	10.41	1.55	0.03	3.58	2.27	7.83	0.12	0.15	61.82	0.68	7.30		
L		8380				22200		20200	10.36	1.54	0.05	3.57	2.26	7.79	0.12	0.16	61.65	0.69	7.40		
L		8460				22000		20800	10.40	1.54	0.03	3.56	2.27	7.81	0.12	0.15	61.84	0.68	7.30		
L		8430				22400		20300	10.36	1.54	0.03	3.57	2.26	7.79	0.12	0.14	61.65	0.68	7.40		
L		8450				22000		20100	10.45	1.55	0.04	3.59	2.28	7.88	0.12	0.16	62.00	0.70	7.40		
M						23010		20000													
M						22940		19800													
M						23340		20700													
M						23250		20200													
M						22520		20600													
M						21610		20400													
M						22260		21200													
M						22860		19850													
N		8900		7300		22100		20000													
N		9100		7500		22700		20100													
N		8900		7300		22200		19700													
N		9000		7400		22400		19700													
N		9400		7300		22500		19800													
N		8900		7300		22100		19800													
N		9300		7300		23000		19700													
N		9400		7300		23300		19700													
P		8800	8440			22900	22200	21400	9.98	1.49	0.04	3.47	2.14	7.43	0.12	0.12	62.00	0.67	8.15		2.87
P		8850	8640			23200	22500	21500	10.25	1.53	0.04	3.53	2.21	7.62	0.12	0.12	63.80	0.69	8.14		2.87
P		9090	8650			23700	22900	21500	10.50	1.53	0.04	3.63	2.24	7.73	0.12	0.14	63.00	0.70	8.18		2.80
P		8680	8600			22900	22800	21300	10.10	1.49	0.04	3.47	2.18	7.47	0.12	0.12	62.80	0.68	8.16		2.93
P		8820	8500			23100	22400	21500	10.15	1.50	0.04	3.50	2.18	7.51	0.12	0.12	63.20	0.68	8.10		2.76
P		8670	8660			22200	22700	21600	10.00	1.49	0.04	3.46	2.15	7.45	0.12	0.12	62.20	0.68	8.10		2.79
P		8870	8500			23100	22500	21700	10.40	1.51	0.04	3.81	2.22	7.65	0.12	0.15	62.40	0.69	8.08		2.70
P		8850	8670			23000	22300	21400	10.35	1.53	0.04	3.60	2.22	7.64	0.12	0.12	64.40	0.69	8.03		2.79
Q		8657	8508			22900	22318														2.68
Q		8539	8503			22709	22478														2.68
Q		8574	8533			22638	22379														2.69
Q		8661	8537			22921	22424														2.66
Q		8506	8553			22694	22734														2.67
Q		8528	8582			22565	22376														2.67
Q		8588	8588			22728	22483														2.67
Q		8625	8612			22739	22703														2.68
R		8100	7700	5900		21600	21500	18400	10.40	1.55	0.05	3.66	2.26	7.77	0.12		61.11	0.70	7.95		2.78
R		8100	7700	5900		21800	21300	18300	10.27	1.54	0.05	3.62	2.24	7.63	0.12		60.40	0.69	7.91		2.79
R		8200	7700	6200		21700	21300	19300	10.39	1.56	0.04	3.66	2.25	7.77	0.12		60.95	0.70	7.95		2.79
R		8000	7800	6000		21500	21500	19200	10.36	1.56	0.04	3.68	2.26	7.75	0.12		61.22	0.69	8.00		2.78
R		8100	7600	6100		21800	21300	18800	10.36	1.55	0.04	3.66	2.26	7.71	0.12		60.94	0.69	8.26		2.78
R		8000	7700	6000		21500	21100	19000	10.32	1.54	0.04	3.64	2.25	7.69	0.12		60.51	0.69	7.91		2.78
R		8100	7800	6000		21600	21200	19000	10.36	1.55	0.04	3.66	2.25	7.71	0.12		60.86	0.69	7.97		2.79
R		8000	7900	6000		21400	21700	18700	10.43	1.56	0.04	3.67	2.26	7.77	0.12		61.25	0.69	7.97		2.78
S						23647		19129													
S						25079		18735													
S						24001		19533													
S						22457		18073													
S						22875		17574													
S						23027		18650													
S						22973		18842													
S						22639		18203													
T	8640	8690	8510	4210	22300	22300	21800	20900	10.41	1.55	0.04	3.57	2.27	7.92	0.12	0.13	61.76	0.70	7.41		2.90
T	8740	8740	8730	4210	22600	22400	22300	19600	10.39	1.54	0.03	3.56	2.26	7.92	0.12	0.13	61.74	0.69	7.42		2.92
T	8640	8790	8770	4220	21800	22600	22300	19500	10.34	1.54	0.03	3.54	2.25	7.89	0.12	0.13	61.64	0.69	7.41		2.91
T	8620	8770	8710	4350	21900	21700	22100	20700	10.36	1.54	0.03	3.55	2.27	7.89	0.12	0.13	61.66	0.69	7.42		2.89
T	8700	8640	8570	4260	22100	21500	21600	19400	10.38	1.54	0.03	3.56	2.26	7.90	0.12	0.13	61.72				

Assay data (cont)

Lab Code	Co F ppm	Co M/ICP ppm	Co P ppm	Co Soluble ppm	Cu F 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
V		8380	8410			22000	22100		10.35	1.52	0.03	3.49	2.26	7.68	0.12	0.13	61.20	0.67	7.36		2.74
V		8320	8370			21900	21900		10.35	1.52	0.03	3.51	2.26	7.70	0.12	0.14	61.30	0.67	7.35		2.73
V		8440	8100			22300	21300		10.35	1.53	0.03	3.53	2.28	7.74	0.12	0.13	61.70	0.67	7.38		2.71
V		8330	8570			22200	22200		10.40	1.53	0.03	3.55	2.28	7.76	0.12	0.13	61.90	0.68	7.36		2.73
V		8220	8300			21900	21900		10.30	1.52	0.03	3.50	2.26	7.69	0.12	0.13	61.50	0.67	7.33		2.71
V		8200	8020			21700	20800		10.40	1.52	0.03	3.51	2.26	7.75	0.12	0.13	61.60	0.67	7.36		2.74
V		8410	8430			22400	22100		10.35	1.54	0.03	3.55	2.28	7.76	0.12	0.13	61.70	0.67	7.40		2.75
V		8390	8340			22000	21800		10.35	1.53	0.03	3.52	2.26	7.73	0.12	0.13	61.50	0.66	7.34		2.72
W	9890	9960			22000			23600	10.30	1.53	0.04	3.60	2.29	7.89	0.12	0.15	62.20	0.70	7.36		
W	9740	9980			22100			22800	10.30	1.55	0.04	3.60	2.28	7.86	0.13	0.16	62.30	0.70	7.39		
W	10500	9330			22800			23400	10.40	1.53	0.04	3.60	2.28	7.91	0.12	0.15	62.20	0.69	7.38		
W	9670	8760			22500			23200	10.30	1.54	0.04	3.61	2.26	7.90	0.12	0.17	62.20	0.70	7.34		
W	9450	9630			21400			23200	10.40	1.55	0.04	3.64	2.28	7.85	0.12	0.15	62.10	0.71	7.36		
W	9970	9900			21900			23300	10.30	1.55	0.04	3.61	2.28	7.94	0.12	0.16	62.20	0.69	7.36		
W	10200	9210			22500			23700	10.30	1.55	0.04	3.62	2.29	7.88	0.12	0.16	62.20	0.70	7.36		
W	10100	9030			22400			23100	10.40	1.55	0.04	3.65	2.29	7.89	0.12	0.15	62.20	0.70	7.35		
X		8440	8530			22200	22500														2.65
X		8430	8760			22300	23600														2.70
X		8480	8400			22400	22700														2.68
X		8260	8660			21900	22900														2.68
X		8420	8800			22300	23300														2.69
X		8380	8490			22300	22700														2.67
X		8540	8470			22300	22800														2.64
X		8330	8810			22100	23000														2.71

12. Measurement of Uncertainty: (ref Dr Hugh Bartlett, Hugh Bartlett Consulting CC.)

The samples used in the certification process were 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	σ _W ³	CSU ⁴
Co	F	ppm	425.3	447.5	126.1	170.0
Co	M/ICP	ppm	317.0	209.1	146.1	55.65
Co	P	ppm	163.4	120.4	105.5	42.12
Cu	F	ppm	470.8	332.2	388.9	146.8
Cu	M/ICP	ppm	524.2	267.1	377.1	77.49
Cu	P	ppm	470.6	367.9	279.6	127.2
Cu	Soluble	ppm	1491	1097	461.6	296.5
Al ₂ O ₃	XRF	%	0.094	0.066	0.065	0.023
CaO	XRF	%	0.025	0.019	0.014	0.006
Cr ₂ O ₃	XRF	%	0.005	0.004	0.003	0.001
Fe ₂ O ₃	XRF	%	0.055	0.042	0.030	0.014
K ₂ O	XRF	%	0.033	0.025	0.020	0.008
LOI		%	0.387	0.356	0.039	0.113
MgO	XRF	%	0.080	0.071	0.044	0.026
MnO	XRF	%	0.001	0.0004	0.001	0.0001
Na ₂ O	XRF	%	0.007	0.004	0.006	0.002
SiO ₂	XRF	%	0.663	0.611	0.225	0.205
TiO ₂	XRF	%	0.011	0.008	0.007	0.003
SG	pycnometer		0.071	0.054	0.024	0.015

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

13. Certified values: The Certified, Provisional and Informational values listed on p1 and p2 of this certificate fulfill the AMIS statistical criteria regarding agreement for certification and have been independently validated by Dr Barry Smee.

14. Metrological Traceability: The values quoted herein are based on the consensus values derived from statistical analysis of the data from an inter laboratory measurement program. Traceability to SI units is via the standards used by the individual laboratories, the majority of which are accredited, who have maintained measurement traceability during the analytical process.

15. Certification: AMIS0357 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. This is the recommended minimum sample size for the use of this material.

18. Availability: This product is available in Laboratory Packs containing 1kg of material and Explorer Packs containing custom weights (from 50g to 250g) of material. The Laboratory Packs are sealed bottles delivered in sealed foil pouches. The Explorer Packs contain material in standard geochem envelopes, vacuum sealed in foil pouches.

19. Recommended use: The data used to characterize this CRM has been scrutinized using outlier treatment techniques. This, together with the number of participating laboratories, should overcome any "inter-laboratory issues" and should lead to a very accurate measure for the given methods, notwithstanding the underlying assumption that what the good inter-laboratory labs reported was accurate. However an amount of bad data might have had an effect, resulting in limits which in some situations might be too broad for the effective monitoring of a single analytical method, laboratory or production process. Users should set their own limits based on their own data quality objectives and control measurements, after determining the performance characteristics of their own particular method, using a minimum of 20 analyses using this CRM. User set limits should normally be within the limits recommended on p1 and 2 of this certificate.

20. Legal Notice: This certificate and the reference material described in it have been prepared with due care and attention. However AMIS, Set Point Technology (Pty) Ltd, Mike McWha, Dr Barry Smee and Smee and Associates Ltd; accept no liability for any decisions or actions taken following the use of the reference material.

7 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.)

Uncertified trace element statistics

Analyte	Method	Unit	Mean	2SD	RSD%	n
Ag	M/ICP	ppm	0.78	0.43	27.9	74
Al	M/ICP	%	5.37	0.38	3.51	110
As	M/ICP	ppm	16.8	9.47	28.2	92
Ba	M/ICP	ppm	174	19.6	5.65	87
Be	M/ICP	ppm	3.75	0.96	12.8	85
Bi	M/ICP	ppm	3.20	1.15	17.9	45
Ca	M/ICP	%	1.08	0.08	3.57	111
Cd	M/ICP	ppm	0.58	0.49	41.9	47
Ce	M/ICP	ppm	85.0	6.04	3.55	40
Co	Soluble	ppm	7138	1387	9.71	32
Cr	M/ICP	ppm	180	65.8	18.3	122
Cs	M/ICP	ppm	1.85	0.17	4.71	31
Dy	M/ICP	ppm	4.30	0.70	8.14	24
Er	M/ICP	ppm	2.53	0.52	10.3	24
Eu	M/ICP	ppm	1.08	0.17	7.89	24
Fe	M/ICP	%	2.43	0.21	4.25	120
Ga	M/ICP	ppm	14.7	7.75	26.3	65
Gd	M/ICP	ppm	5.13	0.68	6.61	23
Hf	M/ICP	ppm	2.89	1.39	24.1	37
Ho	M/ICP	ppm	0.88	0.13	7.65	24
In	M/ICP	ppm	0.57	0.10	8.61	38
K	M/ICP	%	1.81	0.24	6.74	108
La	M/ICP	ppm	46.6	5.92	6.36	70
Li	M/ICP	ppm	198	28.8	7.26	84
Lu	M/ICP	ppm	0.39	0.04	5.42	24
Mg	M/ICP	%	4.58	0.43	4.66	120
Mn	M/ICP	ppm	915	89.81	4.91	117
Mo	M/ICP	ppm	3.24	0.77	11.8	77
Na	M/ICP	%	0.11	0.06	26.7	99
Nb	M/ICP	ppm	11.71	8.29	35.4	52
Nd	M/ICP	ppm	32.2	1.86	2.89	23
Ni	M/ICP	ppm	49.2	10.6	10.8	117
P	M/ICP	ppm	1382	263	9.53	87
Pb	M/ICP	ppm	10.5	10.58	50.3	84
Pr	M/ICP	ppm	9.17	0.73	3.97	23
Rb	M/ICP	ppm	68.8	12.59	9.14	48
S	M/ICP	%	0.04	0.01	15.6	92
S	Comb/LECO	%	0.06	0.05	39.0	7
Sb	M/ICP	ppm	2.61	10.75	206	74
Sc	M/ICP	ppm	11.9	2.01	8.46	88
Se	M/ICP	ppm	1.42	2.42	85.5	26
Si	M/ICP	%	28.9	0.64	1.11	8
Sm	M/ICP	ppm	6.17	0.28	2.26	23
Sn	M/ICP	ppm	1.88	1.85	49.3	40
Sr	M/ICP	ppm	69.1	9.62	6.96	95
Ta	M/ICP	ppm	0.66	0.84	63.2	40
Tb	M/ICP	ppm	0.74	0.08	5.52	23
Te	M/ICP	ppm	0.31	0.77	124	40
Th	M/ICP	ppm	12.2	8.02	32.9	50
Ti	M/ICP	%	0.32	0.12	19.2	82
Tl	M/ICP	ppm	7.68	19.8	129	54
Tm	M/ICP	ppm	0.39	0.05	6.86	24
U	M/ICP	ppm	5.30	0.50	4.74	39
V	M/ICP	ppm	125	25.49	10.2	86
W	M/ICP	ppm	36.4	116	159	55
Y	M/ICP	ppm	22.4	3.73	8.33	78
Yb	M/ICP	ppm	2.44	0.35	7.22	23
Zn	M/ICP	ppm	73.3	14.9	10.2	102
Zr	M/ICP	ppm	112	45.8	20.4	76