African Mineral Standards
REFERENCE MATERIALS FOR AFRICAN ORES

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AMIS0301

Certified Reference Material

Copper cobalt oxide ore
Tenke Fungurume, DRC

Certificate of Analysis

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

Certified Concentrations[2.]

Co F[3.]	2126	±	136	ppm
Co M/ICP	2132	±	132	ppm
Co P	2095	±	140	ppm
Cu F	1.151	±	0.072	%
Cu M/ICP	1.151	±	0.049	%
Cu P	1.141	±	0.032	%
Specific Gravity	2.73	±	0.06	

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.*
3. *Method codes, see Section 7.*

Major Element
Recommended Concentrations and Limits
(at two Standard Deviations)

Certified Concentrations

Al_2O_3	2.86	±	0.06	%
Cr_2O_3	0.08	±	0.01	%
Fe_2O_3	1.28	±	0.04	%
K2O	0.64	±	0.01	%
MgO	1.31	±	0.08	%
MnO	0.073	±	0.008	%
SiO_2	90.03	±	0.46	%
TiO_2	0.17	±	0.014	%

Provisional Concentrations

LOI	1.65	±	0.28	%

IndicatedMean

CaO	0.054	%

1. Intended Use: AMIS0301 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, 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: AMIS0301 is a commissioned CRM made from run-of-mine oxide Cobalt-Copper ore from the Tenke Fungurume (Tenke) mine operated by Freeport- McMoRan Copper & Gold Inc. The mine is situated in Katanga Province of the Democratic Republic of Congo 175km northwest of the regional capital Lubumbashi.

3. Mineral and Chemical Composition: The Tenke-Fungurume deposits are sedimentary copper deposits located in the Lufilian arc, an 800 km fold belt formed between the Angolan Plate to the southeast and Congo Plate to the northwest during the late Neoproterozic approximately 650 to 600 million years before present (Ma). Copper mineralization at Tenke-Fungurume is stratabound and generally restricted to two dolomitic shale horizons (RSF and SDB respectively) each ranging in thickness from 5 to 15 m, separated by 20 m of cellular silicified dolomite (RSC).

The main economic minerals present at Tenke and Fungurume are malachite, chrysocolla, bornite, and hetrogenite; the primary copper and cobalt mineralogy is predominately chalcocite (Cu2S), digenite (Cu_9S_5) bornite (Cu_5FeS_4), and carrollite ($CuCo_2S_4$); however oxidation has resulted in

widespread alteration producing malachite ($Cu_2CO_3(OH)_2$), pseudomalachite ($Cu_5(PO_4)_2(OH)_4$), chrysocolla (hydrated copper silicate) and heterogenite (Co_3+O(OH)).

The primary copper-cobalt mineral associations are homogeneous in both mineralized zones and anyvariations are due to the effect of oxidation and supergene enrichment. Consequently the mineral assemblages can be grouped into three main categories dependent upon the degree of alteration – oxide, mixed and sulfide zone. Dolomite and quartz are the main gangue minerals present. Dolomite or dolomitic rocks make up the bulk of the host strata. Weathering of the host rocks is normally depth related, intensity decreasing with increasing depth, producing hydrated iron oxides and silica at the expense of dolomite, which is leached and removed.

For a detailed description please refer to the Technical Report prepared for Tenke Mining Corp by GRD Minproc Limited available at:

http://www.lundinmining.com/i/pdf/TenkeFungurumeFeasibilityStudy.pdf

4. Appearance: The material is a very fine Yellowish Grey (Corstor colour chart – 5Y 8/2).

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 consensus test results were carried out by an independent statistician.

7. Methods of Analysis requested:

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

Six laboratories with the capability were requested to complete the additional specialized analyses listed below. There are too few results for a formal certification however the results are of interest. This uncertified data is presented in the appendix.

1 SOP 06. Quick Leach Test (QLT).
2 Acid soluble Cu & Co (Soluble).
3 Total Cu, Co, Ca, Mg & Mn (3 acid).

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 three laboratories were each given eight packages, comprising eight samples scientifically selected from throughout the batch. Twenty one

laboratories reported results in time for certification of the economic elements. Fifteen of these laboratories reported results for the major elements.

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: (Not in same order as in the table of assays):

1. Activation Laboratories Pty Ltd (ActLabs) CA
2. Activation Labortorios Ltda (Chile)
3. Alex Stewart International Corporation Zambia
4. ALS Chemex Laboratory Group Brisbane Australia
5. ALS Chemex Laboratory Group Johannesburg SA
6. ALS Chemex Laboratory Group Perth WA
7. ALS Chemex Laboratory Group Vancouver CA
8. FMI Technology Center
9. Genalysis Laboratory Services WA
10. Intertek Utama Services (Indonesia)
11. Set Point Laboratories (Isando) SA
12. SGS Australia Pty Ltd (Newburn) WA
13. SGS Durango (Mexico)
14. SGS Geosol Laboratories Ltda (Brazil)
15. SGS Mineral Services Callao (Peru)
16. SGS Mineral Services Lakefield (Canada)
17. SGS South Africa (Pty) Ltd - Booysens
18. SGS Toronto (Canada)
19. Skyline Assayers and Labs
20. Tenke Exploration Fungurume Laboratory
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. A proficiency report has been sent to the managers of the participating laboratories. Additional digital data from this round robin is available on request.

Lab Code	Co F	Co M/ICP	Co P	Co XRF	Cu F	Cu M/ICP	Cu P	Cu XRF	Al2O3 XRF	CaO XRF	Cr2O3 XRF	Fe2O3 XRF	K2O XRF	MgO XRF	MnO XRF	Na2O XRF	SiO2 XRF	TiO2 XRF	LOI	SG pyc
	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%	%	%	%	%	%	%	%	%	%	%	
A		1920	2000	2039		10900	11200	11077	2.87	0.07	0.08	1.28	0.67	1.37	0.08	0.05	89.80	0.18	1.89	2.75
A		1970	2010	2046		11400	11000	11098	2.88	0.07	0.08	1.28	0.67	1.34	0.07	0.06	89.40	0.18	1.91	2.69
A		1990	2030	2047		11600	10800	11140	2.89	0.07	0.08	1.28	0.67	1.37	0.07	0.06	89.70	0.18	1.91	2.73
A		1980	2080	2037		11200	11400	11105	3.04	0.07	0.07	1.29	0.68	1.41	0.07	0.09	90.30	0.18	1.89	2.72
A		2000	2020	2047		11500	10600	11065	2.88	0.07	0.08	1.27	0.67	1.36	0.07	0.06	89.80	0.19	1.86	2.74
A		2020	2000	2041		11500	10900	11074	2.93	0.07	0.08	1.29	0.67	1.39	0.07	0.06	90.40	0.19	1.86	2.71
A		2020	2050	2031		11400	11200	11043	2.87	0.07	0.07	1.27	0.67	1.36	0.08	0.06	89.70	0.18	1.89	2.73
A		2070	2030	2042		11900	11400	11127	2.96	0.07	0.08	1.29	0.67	1.36	0.07	0.05	89.90	0.18	1.89	2.73
B		2030	2170		10600															
B		2000	2180		12100															
B		2090	2180		11500															
B		2080	2150		12300															
B		2160	2190		12000															
B		2090	2200		12200															
B		2100	2190		12400															
B		2010	2140		12100															

Assay data (cont)

Lab Code	Co F ppm	Co M/ICP ppm	Co P ppm	Co XRF ppm	Cu F ppm	Cu M/ICP ppm	Cu P ppm	Cu XRF 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	2226	2144	2028		11933				2.79	0.06	0.08	1.31	0.66	1.31	0.06		89.70	0.18	1.67	
C	2077	2174	2013		11117				2.85	0.05	0.08	1.32	0.67	1.30	0.06		90.70	0.18	1.59	
C	2208	2237	2020		11929				2.82	0.06	0.08	1.32	0.65	1.29	0.06		90.20	0.17	1.63	
C	2258	2184	2044		12155				2.84	0.06	0.07	1.32	0.65	1.28	0.06		90.30	0.17	1.57	
C	2262	2248	1986		12358				2.78	0.05	0.08	1.32	0.64	1.30	0.06		90.20	0.18	1.59	
C	2309	2292	1987		12348				2.85	0.06	0.08	1.33	0.65	1.31	0.06		91.80	0.18	1.59	
C	2305	2256	1973		12207				2.79	0.05	0.08	1.31	0.64	1.28	0.06		90.00	0.17	1.62	
C	2293	2192	2026		11967				2.76	0.06	0.08	1.31	0.64	1.30	0.06		90.10	0.16	1.62	
D		2120	2230			11700	11800													
D		2070	2190			11800	11800													
D		2120	2320			11700	11700													
D		2110	2150			11800	11500													
D		2040	2190			12000	11700													
D		2050	2240			11700	11700													
D		1930	2210			11500	11900													
D		2060	2240			11800	11700													
E	2100	2320	2100		11500	12000	10500			0.04				1.33	0.08					
E	2110	2240	2120		11400	11700	10600			0.04				1.29	0.08					
E	2110	2290	2140		11500	11900	10600			0.11				1.33	0.08					
E	2140	2280	2140		11700	11700	10600			0.06				1.31	0.08					
E	2110	2310	2140		11400	11500	10600			0.04				1.31	0.08					
E	2100	2300	2110		11500	11500	10400			0.07				1.29	0.08					
E	2110	2290	2100		11500	11200	10400			0.06				1.28	0.08					
E	2110	2310	2180		11500	11500	10800			0.06				1.28	0.08					
F	2145				11400					0.05				1.23	0.08					
F	2155				11580					0.04				1.17	0.07					
F	2125				11585					0.04				1.22	0.07					
F	2165				11835					0.02				1.22	0.08					
F	2165				11890					0.09				1.25	0.08					
F	2140				11655					0.03				1.19	0.07					
F	2065				11375					0.03				1.18	0.08					
F	2060				11195					0.02				1.21	0.08					
G	2200	2170	2060		11000	11200	10600		2.83	0.05	0.08	1.27	0.64	1.29	0.07	0.04	90.00	0.16	1.59	2.78
G	2200	2170	2100		11100	11300	11700		2.85	0.05	0.08	1.26	0.64	1.29	0.07	0.04	90.07	0.17	1.59	2.81
G	2200	2190	2000		11100	11200	10600		2.85	0.05	0.08	1.26	0.64	1.29	0.07	0.04	89.97	0.16	1.60	2.77
G	2200	2180	2040		11100	11300	11000		2.84	0.05	0.08	1.26	0.64	1.29	0.07	0.04	89.95	0.16	1.61	2.79
G	2300	2170	2070		11200	11100	11100		2.86	0.05	0.08	1.27	0.64	1.30	0.07	0.04	90.08	0.17	1.60	2.77
G	2250	2180	2110		11200	11300	11200		2.85	0.05	0.08	1.26	0.64	1.29	0.07	0.04	90.01	0.16	1.61	2.78
G	2200	2170	2000		10700	11300	11100		2.85	0.05	0.08	1.27	0.64	1.30	0.07	0.05	90.06	0.17	1.60	2.80
G	2200	2150	2090		10900	11100	10900		2.86	0.05	0.08	1.26	0.64	1.29	0.07	0.04	90.03	0.16	1.59	2.77
H										0.04				1.13						2.77
H										0.04				1.13						2.76
H										0.04				1.16						2.75
H										0.04				1.16						2.75
H										0.04				1.14						2.70
H										0.04				1.14						2.75
H										0.04				1.14						2.74
H										0.04				1.14						2.75
J		2200				12000				0.06				1.28	0.08					
J		2100				11800				0.06				1.26	0.08					
J		2100				11800				0.06				1.26	0.08					
J		2200				11700				0.04				1.24	0.08					
J		2200				12200				0.06				1.29	0.08					
J		2200				11800				0.06				1.26	0.08					
J		2200				11900				0.06				1.26	0.08					
J		2100				11700				0.04				1.24	0.08					
K	2166	2199	2204		11139	11126	11525												1.46	
K	2206	2192	2163		11235	11099	11250												1.49	
K	2334	2187	2147		11783	10995	11266												1.49	
K	2189	2164	2185		11250	10950	11352												1.47	
K	2211	2183	2122		11101	11078	11073												1.44	
K	2153	2167	2152		11276	10791	11244												1.47	
K	2125	2165	2154		11226	10840	11240												1.43	
K	2018	2171	2155		10623	11084	11266												1.44	
L	2040				11500					0.06				1.41	0.09					
L	2080				11400					0.07				1.44	0.09					
L	2040				11300					0.06				1.44	0.09					
L	2090				11600					0.06				1.44	0.09					
L	2080				11600					0.06				1.43	0.09					
L	2090				11600					0.06				1.46	0.09					
L	2090				11500					0.06				1.44	0.09					
L	2090				11500					0.06				1.44	0.09					
N		2100				10500			2.84	0.06	0.07	1.16		1.36	0.07					
N		2100				10500			2.87	0.07	0.07	1.21		1.38	0.07					
N		2100				10600			2.84	0.07	0.07	1.20		1.41	0.07					
N		2100				10600			2.91	0.07	0.07	1.20		1.39	0.07					
N		2100				10600			3.06	0.06	0.07	1.19		1.38	0.07					
N		2100				10500			2.87	0.06	0.07	1.19		1.34	0.07					
N		2100				10400			2.99	0.06	0.07	1.17		1.33	0.07					
N		2100				10300			2.87	0.06	0.07	1.20		1.34	0.07					
O	2030	2120	2110		11250	11550	11100		2.89	0.04	0.07	1.28	0.64	1.34	0.07	0.01	90.23	0.17	1.81	2.74
O	2040	2090	2130		11300	11450	11250		2.89	0.04	0.08	1.25	0.65	1.33	0.07	0.01	90.21	0.16	1.81	2.74
O	2030	2080	2130		11200	11350	11300		2.88	0.04	0.08	1.26	0.64	1.33	0.07	0.01	90.17	0.18	1.80	2.73
O	2040	2100	2090		11200	11400	11000		2.87	0.04	0.07	1.26	0.63	1.32	0.07	0.01	90.32	0.18	1.77	2.83
O	2040	2130	2060		11300	11600	10950		2.90	0.04	0.08	1.25	0.64	1.34	0.07	0.02	90.27	0.18	1.80	2.64
O	2060	2050	2140		11300	11300	11300		2.85	0.05	0.08	1.26	0.64	1.32	0.07	0.02	90.45	0.18	1.79	2.74
O	1990	2120	2120		11050	11500	11150		2.89	0.04	0.07	1.28	0.63	1.31	0.07	0.01	90.23	0.18	1.82	2.86
O	2010	2160	2090		11100	11550	11100		2.87	0.05	0.08	1.25	0.63	1.34	0.07	0.02	90.17	0.16	1.82	2.74
P	2080	2280	1970		11800				2.82	0.06	0.08	1.30	0.65	1.32	0.08	0.08	90.10	0.18	1.57	
P	2030	2060	2050		12300				2.82	0.06	0.08	1.30	0.65	1.31	0.08	0.07	90.30	0.18	1.58	
P	2060	2270	2110		12200				2.81	0.06	0.08	1.30	0.65	1.32	0.08	0.07	90.30	0.17	1.58	
P	2130	2100	2080		11900				2.81	0.06	0.08	1.29	0.65	1.31	0.08	0.07	90.30	0.18	1.57	
P	2090	2150	2040		11800				2.81	0.06	0.08	1.30	0.66	1.30	0.08	0.07	90.30	0.18	1.58	
P	2130	2070	1900		11900				2.78	0.06	0.08	1.29	0.65	1.31	0.08	0.08	90.20	0.18	1.58	
P	2180	2130	1960		11800				2.80	0.05	0.08	1.31	0.65	1.31	0.08	0.07	90.10	0.18	1.57	
P	2070	2160	2010		11600				2.79	0.06	0.08	1.29	0.65	1.31	0.08	0.07	90.20	0.17	1.57	
Q		2160	2050			11250	11700		2.87	0.05	0.07	1.24	0.64	1.38	0.07	0.17	89.70	0.16	1.58	
Q		2080	2020			11000	11900		2.89	0.05	0.07	1.23	0.64	1.39	0.07	0.16	89.70	0.17	1.57	
Q		2110	2030			10950	11700		2.87	0.05	0.08	1.24	0.64	1.38	0.07	0.17	89.60	0.17	1.55	
Q		1960	2000			10250	11600		2.87	0.05	0.07	1.24	0.64	1.39	0.07	0.16	89.60	0.16	1.55	
Q		2060	2090			10700	11850		2.88	0.05	0.07	1.24	0.64	1.40	0.07	0.16	89.60	0.17	1.55	
Q		2050	2180			10500	11650		2.88	0.05	0.07	1.24	0.64	1.38	0.07	0.17	89.60	0.17	1.56	
Q		2040	2080			11400	11800		2.88	0.05	0.08	1.24	0.64	1.39	0.07	0.16	89.60	0.17	1.56	
Q		2060	2000			10700	11500		2.88	0.05	0.07	1.24	0.64	1.39	0.07	0.16	89.70	0.19	1.55	
R		2070	2150																	
R		2080	2240																	
R		2170	2230																	
R		2090	2080																	
R		2050	2080																	
R		2130	2240																	
R		2080	2160																	
R		2040	2040																	

Assay data (cont)

Lab Code	Co F ppm	Co M/ICP ppm	Co P ppm	Co XRF ppm	Cu F ppm	Cu M/ICP ppm	Cu P ppm	Cu XRF ppm	Al2O3 XRF %	CaO XRF %	Cr2O3 XRF %	Fe2O3 XRF %	K2O XRF %	MgO XRF %	MnO XRF %	Na2O XRF %	SiO2 XRF %	TiO2 XRF %	LOI %	SG pyc
S		2100	2050			11550	11600	11600	2.88	0.06	0.06	1.29	0.64	1.31	0.07	0.04	90.10	0.17	1.56	
S		2060	2020			11450	11500	11600	2.87	0.06	0.06	1.28	0.63	1.30	0.07	0.03	89.90	0.17	1.53	
S		2100	2030			11650	11550	11650	2.86	0.05	0.06	1.28	0.64	1.31	0.07	0.04	90.00	0.17	1.53	
S		2100	2060			11500	11650	11600	2.87	0.05	0.06	1.28	0.64	1.31	0.07	0.04	90.10	0.17	1.55	
S		2100	2000			11500	11350	11550	2.88	0.06	0.06	1.27	0.63	1.30	0.07	0.04	89.80	0.17	1.57	
S		2100	2030			11450	11550	11650	2.87	0.06	0.06	1.27	0.64	1.30	0.07	0.04	90.10	0.17	1.58	
S		2070	2010			11400	11450	11650	2.86	0.05	0.06	1.27	0.63	1.31	0.07	0.04	89.80	0.17	1.60	
S		2060	1990			11400	11300	11650	2.85	0.06	0.06	1.27	0.64	1.30	0.07	0.04	89.80	0.17	1.58	
U		2184	2169			11700	11500													2.69
U		2185	2138			11600	11500													2.68
U		2169	2139			11700	11500													2.70
U		2193	2135			11600	11400													2.71
U		2184	2138			11600	11300													2.69
U		2177	2154			11600	11600													2.68
U		2144	2141			11600	11500													2.70
U		2155	2130			11500	11400													2.68
V	2190	2220	2030		11400	11500			2.86	0.06	0.09	1.29	0.65	1.25	0.08		90.26	0.17		
V	2120	2210	2050		11200	11400			2.85	0.06	0.08	1.28	0.64	1.25	0.08		90.32	0.17		
V	2150	2220	2070		11200	11600			2.85	0.06	0.07	1.29	0.64	1.24	0.08		90.31	0.16		
V	2140	2240	2080		11400	11500			2.83	0.06	0.08	1.29	0.64	1.24	0.08		90.04	0.16		
V	2140	2210	2080		11300	11500			2.85	0.06	0.08	1.28	0.64	1.25	0.08		89.98	0.16		
V	2160	2220	2090		11400	11400			2.85	0.06	0.08	1.27	0.64	1.25	0.08		89.71	0.17		
V	2160	2220	2100		11400	11500			2.86	0.06	0.09	1.29	0.64	1.25	0.08		90.16	0.16		
V	2160	2230	2030		11500	11500			2.85	0.06	0.08	1.28	0.65	1.25	0.08		90.13	0.16		
W		2200	2000	2113		13300	11400	11800	2.88	0.05	0.08	1.27	0.64	1.31	0.07		90.05	0.16	1.78	2.73
W		2200	2100	2100		13600	11500	11600	2.86	0.04	0.08	1.26	0.64	1.31	0.07		90.11	0.17	1.77	2.72
W		2300	2100	2115		13500	11400	11800	2.90	0.05	0.08	1.27	0.64	1.38	0.07		90.02	0.17	1.80	2.73
W		2300	2100	2115		13700	11500	11600	2.88	0.05	0.08	1.27	0.64	1.32	0.07		90.08	0.17	1.76	2.72
W		2200	2100	2108		13500	11400	11700	2.91	0.05	0.08	1.28	0.64	1.33	0.07		90.02	0.16	1.76	2.72
W		2200	2100	2128		13500	11500	11700	2.90	0.05	0.08	1.27	0.64	1.32	0.07		90.00	0.17	1.80	2.72
W		2200	2100	2109		13400	11400	11600	2.88	0.05	0.08	1.29	0.64	1.34	0.07		89.96	0.17	1.84	2.72
W		2200	2100	2122		13400	11400	11600	2.89	0.05	0.08	1.27	0.64	1.33	0.07		90.05	0.17	1.77	2.71

12. Measurement of Uncertainty: 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:

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]	σL [2]	Sw [3]	CSU [4]
Co	F	ppm	68.116	52.787	40.563	18.270
Co	M/ICP	ppm	66.491	38.729	37.700	10.271
Co	P	ppm	70.120	43.709	38.570	11.831
Cu	F	ppm	359.674	268.258	204.558	88.058
Cu	M/ICP	ppm	242.825	184.126	135.207	60.256
Cu	P	ppm	259.716	205.648	150.578	70.906
Al2O3	XRF	%	0.032	0.025	0.017	0.008
CaO	XRF	%	0.009	0.006	0.005	0.002
Cr2O3	XRF	%	0.004	0.003	0.003	0.001
Fe2O3	XRF	%	0.021	0.019	0.008	0.007
K2O	XRF	%	0.006	0.004	0.004	0.002
LOI		%	0.135	0.133	0.020	0.044
MgO	XRF	%	0.041	0.033	0.014	0.010
MnO	XRF	%	0.004	0.003	0.001	0.001
SiO2	XRF	%	0.225	0.165	0.148	0.058
TiO2	XRF	%	0.007	0.005	0.005	0.002
SG	pyc		0.032	0.035	0.015	0.014

1. *S - Std Dev for use on control charts.*
2. *σL - 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 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: AMIS0301 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.

26 March 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 1. – Uncertified element statistics

Five of the laboratories submitted significant total digestion / multi element scan trace element data and four laboratories submitted additional Co and Cu methods. This data has been compiled and iterated but not certified. It is presented below for informational use.

	ppm	2SD	RSD%	n
Co XRF	2078	76	1.83	16
Co 3 Acid ppm	2064	259	6.28	40
Co QLT ppm	2149	197	4.58	16
Co Soluble ppm	2027	256	6.30	39
Cu XRF	11462	549	2.39	24
Cu 3 Acid ppm	11615	597	2.57	40
Cu QLT ppm	11038	589	2.67	38
Cu Soluble ppm	10882	1237	5.68	39

Appendix 1 (Cont) – Uncertified trace element statistics

Analyte	Method	Unit	Mean	2SD	RSD%	n
Ag	M/ICP	ppm	0.15	0.18	60.77	22
Al	M/ICP	%	1.46	0.16	5.31	91
As	M/ICP	ppm	6.05	7.24	59.87	56
B	M/ICP	ppm	113	20.70	9.20	8
Ba	M/ICP	ppm	54.20	7.16	6.61	78
Be	M/ICP	ppm	0.73	0.17	11.99	60
Bi	M/ICP	ppm	6.25	1.21	9.65	38
Ca	M/ICP	%	0.04	0.01	11.39	119
Cd	M/ICP	ppm	0.40	0.81	101	23
Ce	M/ICP	ppm	19.23	2.87	7.46	31
Cr	M/ICP	ppm	435	162	18.66	79
Cs	M/ICP	ppm	0.67	0.11	8.53	24
Dy	M/ICP	ppm	1.23	0.11	4.35	24
Er	M/ICP	ppm	0.75	0.07	4.96	23
Eu	M/ICP	ppm	0.24	0.05	9.67	24
Fe	M/ICP	%	0.91	0.09	5.12	100
Ga	M/ICP	ppm	3.45	2.71	39.36	40
Gd	M/ICP	ppm	1.37	0.25	9.07	24
Hf	M/ICP	ppm	1.29	0.76	29.42	24
Ho	M/ICP	ppm	0.25	0.02	4.80	23
In	M/ICP	ppm	0.04	0.01	9.67	30
K	M/ICP	%	0.52	0.04	4.24	85
La	M/ICP	ppm	9.69	1.83	9.42	78
Li	M/ICP	ppm	57.47	6.12	5.32	86
Lu	M/ICP	ppm	0.11	0.02	7.65	31
Mg	M/ICP	%	0.77	0.08	4.93	131
Mn	M/ICP	ppm	583	46.72	4.01	118
Mo	M/ICP	ppm	2.34	0.77	16.45	58
Na	M/ICP	%	0.03	0.01	17.30	77
Nb	M/ICP	ppm	2.52	1.33	26.27	39
Nd	M/ICP	ppm	7.78	0.72	4.66	24
Ni	M/ICP	ppm	27.08	6.78	12.51	106
P	M/ICP	ppm	190	39.07	10.31	85
Pb	M/ICP	ppm	6.16	5.59	45.37	73
Pr	M/ICP	ppm	2.16	0.19	4.31	22
Rb	M/ICP	ppm	27.34	16.13	29.50	31
Re	M/ICP	ppm	0.003	0.002	33.53	5
S	M/ICP	%	0.04	0.01	9.73	75
Sb	M/ICP	ppm	0.45	0.14	16.12	32
Sc	M/ICP	ppm	3.12	0.34	5.43	89
Se	M/ICP	ppm	0.57	0.23	20.38	3
Si	M/ICP	%	42.64	1.47	1.73	23
Sm	M/ICP	ppm	1.38	0.12	4.18	22
Sn	M/ICP	ppm	1.54	0.73	23.79	31
Sr	M/ICP	ppm	14.37	1.59	5.55	77
Ta	M/ICP	ppm	0.23	0.13	27.88	29
Tb	M/ICP	ppm	0.20	0.04	10.11	31
Te	M/ICP	ppm	0.72	0.91	63.10	5
Th	M/ICP	ppm	3.47	0.72	10.38	31
Ti	M/ICP	%	0.07	0.05	37.21	88
Tl	M/ICP	ppm	0.10	0.02	10.56	16
Tm	M/ICP	ppm	0.11	0.02	7.88	24
U	M/ICP	ppm	2.95	0.26	4.47	32
V	M/ICP	ppm	31.80	4.28	6.73	87
W	M/ICP	ppm	1.90	0.25	6.65	23
Y	M/ICP	ppm	6.39	0.55	4.34	69
Yb	M/ICP	ppm	0.73	0.09	6.21	31
Zn	M/ICP	ppm	32.01	11.63	18.16	86
Zr	M/ICP	ppm	42.60	13.59	15.95	70