



African Mineral Standards

REFERENCE MATERIALS FOR AFRICAN ORES

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AMIS0202

Certified Reference Material

**Copper cobalt oxide ore
Tenke Fungurume Mine, DRC**

Certificate of Analysis

Recommended Concentrations and Limits¹ (at two Standard Deviations)

Certified Concentrations²

Cu Fus	6.064	±	0.236	%
Cu M/ICP	6.077	±	0.210	%
Cu P	6.003	±	0.170	%
Cu Soluble	5.758	±	0.605	%
Co M/ICP	1053	±	117	ppm
Co P	1016	±	67	ppm
Specific Gravity	2.81	±	0.10	

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	5.15	±	0.10	%
CaO	0.18	±	0.01	%
Fe ₂ O ₃	1.92	±	0.08	%
MgO	2.90	±	0.06	%
SiO ₂	75.68	±	1.12	%
TiO ₂	0.31	±	0.02	%
LOI	4.64	±	0.18	%

Provisional Concentrations

Cr ₂ O ₃	0.05	±	0.01	%
K ₂ O	0.21	±	0.04	%
MnO	0.06	±	0.01	%
S Combustion / LECO	0.08	±	0.02	%

1. Intended Use: AMIS0202 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: AMIS0202 is a commissioned CRM made out of Cobalt-Copper oxide 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 Neoproterozoic 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 heterogenite; the primary copper and cobalt mineralogy is predominately chalcocite (Cu₂S), digenite (Cu₉S₅), bornite (Cu₅FeS₄), and carrollite (CuCo₂S₄); however oxidation has resulted in widespread alteration producing malachite (Cu₂CO₃(OH)₂), pseudomalachite (Cu₅(PO₄)₂(OH)₄), chrysocolla (hydrated copper silicate) and heterogenite (Co₃+O(OH)).

The primary copper-cobalt mineral associations are homogeneous in both mineralized zones and any variations 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 Light Brownish Grey powder (Corstor Colour chart – 5Y 8/1).

5. Handling instructions: The material is packaged in Laboratory Packs and Explorer Packs that must be shaken or otherwise agitated before use. Normal safety precautions for handling fine particulate matter are suggested, such as the use of safety glasses, breathing protection, gloves and a laboratory coat.

6. Method of Preparation: The material was crushed, dry-milled and air-classified to <54µm. Wet sieve particle size analysis of random samples confirmed the material was 98.5% <54µm. It was then blended in a bi-conical mixer, systematically divided and then sealed into 1kg Laboratory Packs. Explorer Packs are subdivided from the Laboratory packs as required. Samples were scientifically selected from throughout the batch 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.

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 four laboratories were each given eight selected packages of sample. Twenty three of the laboratories submitted 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 23 out of 24 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 Laboratorios 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. Genalysis Laboratory Services (South Africa) Pty
11. Genalysis Laboratory Services (W Australia P)
12. Intertek Minerals Zambia
13. Intertek Utama Services (Indonesia)
14. Set Point Laboratories (Isando) SA
15. Set Point Laboratories Botswana
16. SGS Australia Pty Ltd (Newburn) WA
17. SGS Geosol Laboratories Ltda (Brazil)
18. SGS Mineral Services Callao (Peru)
19. SGS Mineral Services Lakefield (Canada)
20. SGS Prominent Hill Australia (AU)
21. SGS South Africa (Pty) Ltd - Booyens JHB
22. Skyline Assayers and Labs (USA)
23. 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.

Lab Code	Co M/ICP ppm	Co P 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 %	SiO ₂ XRF %	TiO ₂ XRF %	LOI %	S Comb LECO %	SG pyc
A	1000			59200														2.85
A	1000			60300														2.86
A	1000			59600														2.89
A	1000			59600														2.88
A	1100			60300														2.86
A	1000			59700														2.86
A	1100			61900														2.87
A	1100			60000														2.88
B	1100			62700														
B	1100			61900														
B	1000			61800														
B	1100			62100														
B	1100			61200														
B	1100			62100														
B	1100			62400														
B	1100			62100														
C	1060	1010	61800	61800	59500		5.16	0.18	0.05	1.90	0.20	2.90	0.06	76.2	0.31	4.60		
C	1070	1040	61600	60700	61100		5.16	0.18	0.05	1.89	0.20	2.89	0.05	76.2	0.31	4.60		
C	1080	1060	61900	60800	61600		5.18	0.18	0.05	1.90	0.20	2.90	0.06	76.2	0.32	4.58		
C	1090	1000	62300	61700	60300		5.18	0.18	0.05	1.90	0.20	2.90	0.05	76.2	0.31	4.59		
C	1100	1060	61200	61400	61200		5.18	0.18	0.05	1.90	0.20	2.91	0.05	76.2	0.31	4.58		
C	1090	1010	61900	62000	59900		5.16	0.18	0.05	1.90	0.20	2.92	0.05	76.2	0.31	4.56		
C	1120	1030	61900	61900	62200		5.17	0.18	0.05	1.90	0.20	2.90	0.05	76.2	0.32	4.58		
C	1080	1030	60500	61300	59600		5.18	0.18	0.05	1.91	0.20	2.89	0.06	76.2	0.32	4.60		
D	1090	1180	59800	59600			5.07	0.19		0.20	2.88			74.8	0.32	4.59	0.05	
D	1090	1150	60100	58500			5.07	0.19		0.20	2.89			74.8	0.32	4.56	0.05	
D	1190	1160	60000	60600			5.07	0.19		0.20	2.87			74.8	0.32	4.55	0.06	
D	1240	1170	59400	60000			5.08	0.19		0.20	2.89			74.8	0.31	4.59	0.06	
D	1160	1240	59400	60800			5.15	0.21		0.21	2.89			74.7	0.32	4.59	0.06	
D	1110	1160	60800	60400			5.09	0.19		0.20	2.86			74.8	0.32	4.55	0.06	
D	1090	1160	60200	60200			5.08	0.19		0.20	2.89			74.8	0.32	4.47	0.06	
D	1110	1210	60600	60200			5.06	0.19		0.20	2.88			74.8	0.33	4.50	0.05	

Assay data (cont)

Lab Code	Co M/ICP ppm	Co P 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 %	SiO ₂ XRF %	TiO ₂ XRF %	LOI %	S Comb LECO %	SG pyc
E	1020			63100														0.09
E	1040			63900														0.09
E	1060			65100														0.09
E	1050			65200														0.09
E	1060			64800														0.09
E	1010			63000														0.11
E	1020			64300														0.12
E	1020			64300														0.12
F	1171	1016			61270	58700												
F	1135	1015			61310	59520												
F	1160	1046			60730	59690												
F	1164	1023			60410	59000												
F	1126	1024			60040	59530												
F	1117	1011			61280	59060												
F	1149	1015			61020	59070												
F	1162	1016			61110	59310												
G	975	975		59600	59500	59230											0.09	2.78
G	976	980		59700	59800	59594											0.09	2.77
G	973	979		60400	59200	59109											0.09	2.79
G	974	978		60000	59000	59001											0.09	2.78
G	974	972		60600	59700	59523											0.09	2.74
G	971	975		60200	59500	59312											0.09	2.75
G	973	974		60700	60100	59104											0.09	2.77
G	972	978		60200	60500	59283											0.09	2.77
H	1104	1033		61253	60550	62120												2.68
H	1044	1032		60464	60527	61580												2.70
H	1116	1037		62890	60993	62410												2.70
H	1129	1032		62084	60452	61800												2.79
H	1105	1022		61811	60094	61620												2.68
H	1122	1035		63380	60599	60120												2.70
H	1091	1063		61136	62430	62480												2.71
H	1078	1020		61291	59035	62290												2.70
I	1030	1010		63200		59000												
I	1020	1010		62300		58900												
I	1040	1010		62600		59200												
I	1020	1000		62800		59300												
I	1040	1000		62000		59200												
I	1030	1010		62300		59500												
I	1040	1010		63100		59600												
I	1020	1000		62900		59500												
J		1090	60910	58890	60540	60500	4.83	0.22	0.05	2.15	0.19	2.68	0.07	73.7	0.33	4.58		2.84
J		1080	61110	60010	59890	58800	4.84	0.21	0.05	2.13	0.19	2.66	0.07	73.7	0.33	4.59		2.82
J		1080	62110	59300	59790	61800	4.91	0.22	0.05	2.14	0.19	2.69	0.07	74.5	0.33	4.58		2.84
J		1070	61050	58770	59610	60400	4.88	0.22	0.05	2.15	0.19	2.73	0.07	75.0	0.33	4.58		2.83
J		1110	62210	59880	61840	61500	4.92	0.22	0.04	2.15	0.20	2.71	0.07	74.6	0.32	4.58		2.84
J		1060	63580	59580	54910	58300	4.89	0.22	0.04	2.15	0.19	2.73	0.07	74.7	0.33	4.60		2.83
J		1000	60910	60110	55730	60638	4.78	0.22	0.04	2.12	0.19	2.63	0.06	73.8	0.32	4.58		2.84
J		1060	61270	60130	58560	61500	4.94	0.22	0.04	2.14	0.19	2.69	0.06	74.0	0.32	4.59		2.84
K	1139	990	57088				5.18	0.18	0.07	2.02	0.28	2.89	0.06	75.4	0.31	4.66	0.66	2.82
K	1124	996	57417				5.27	0.19	0.08	2.02	0.29	2.89	0.06	75.4	0.32	4.72	0.07	2.84
K	1129	996	58160				5.22	0.19	0.08	2.02	0.29	2.89	0.06	75.3	0.31	4.74	0.07	2.82
K	1139	994	56106				5.19	0.17	0.06	2.06	0.27	2.90	0.06	75.5	0.32	4.69	0.07	2.82
K	1112	1002	56387				5.17	0.17	0.07	2.05	0.27	2.88	0.06	75.3	0.31	4.75	0.07	2.82
K	1145	983	56863				5.17	0.17	0.07	2.04	0.26	2.85	0.06	75.2	0.32	4.71	0.07	2.84
K	1140	990	56442				5.17	0.17	0.06	2.07	0.27	2.88	0.06	75.5	0.31	4.73	0.07	2.82
K	1169	981	56587				5.16	0.17	0.05	2.05	0.26	2.85	0.06	75.0	0.31	4.66	0.06	2.85
L	1020	1020		59900	60500	59600												2.92
L	1020	1010		60000	59900	58600												2.86
L	1010	1030		59000	60700	59100												2.88
L	1020	1030		59400	63100	59000												2.95
L	1020	1030		60800	61400	58900												2.81
L	1020	1030		59600	61100	59000												2.89
L	1020	1010		59800	59200	58100												2.91
L	1010	1000		58200	59600	58000												2.92
M	1010	1090		61700	60700	53900												2.80
M	1010	1110		61100	61000	53100												2.82
M	1000	1100		60100	60300	54100												2.81
M	1010	1090		60600	60100	54000												2.82
M	1020	1090		61100	60400	54100												2.82
M	1020	1110		61500	60600	51800												2.79
M	990	1090		59900	59800	52800												2.76
M	1000	1090		60300	60000	52700												2.79
N	1055	977	61009															2.82
N	1013	1000	59717															2.86
N	1016	994	61009															2.87
N	1016	997	60742															2.85
N	1040	970	60346															2.86
N	1033	977	61050															2.84
N	1011	984	61167															2.79
N	1069	993	60492															2.83
O						53300												0.10
O						55000												0.10
O						57100												0.10
O						54100												0.10
O						55000												0.09
O						54900												0.10
O						56100												0.10
O						51600												0.10
P		991	58500				5.29	0.18	0.05	1.96	0.21	2.98	0.06	76.9	0.31	4.68		2.80
P		998	58800				5.21	0.18	0.04	1.92	0.21	2.93	0.05	76.0	0.30	4.75		2.76
P		1000	59000				5.02	0.20	0.06	1.81	0.20	2.88	0.04	74.9	0.31	4.66		2.85
P		993	60400				5.16	0.16	0.04	1.88	0.20	2.79	0.06	75.8	0.31	4.91		2.80
P		1005	59200				4.95	0.19	0.05	1.78	0.19	2.84	0.04	74.2	0.30	4.76		2.79
P		1000	58900				5.02	0.19	0.06	1.84	0.19	2.88	0.04	75.2	0.31	4.58		2.77
P		992	59200				5.04	0.20	0.05	1.84	0.20	2.89	0.05	75.4	0.31	4.64		2.85
P		986	58400				4.98	0.19	0.05	1.79	0.19	2.86	0.04	75.0	0.30	4.85		2.80
R	1000	1010		60600	59500		5.15	0.18	0.05	1.92	0.21	2.92	0.06	76.1	0.31	4.75		2.78
R	890	940		54200	55600		5.15	0.18	0.05	1.92	0.21	2.94	0.06	76.1	0.31	5.15		2.78
R	1000	1010		60600	59700		5.17	0.18	0.05	1.92	0.21	2.93	0.06	75.8	0.31	4.81		2.79
R	1010	990		61200	58600		5.18	0.18	0.05	1.								

Assay data (cont)

Lab Code	Co M/ICP ppm	Co P 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 %	SiO ₂ XRF %	TiO ₂ XRF %	LOI %	S Comb LECO %	SG pyc	
S	1040	980		60500	58800	55800	5.21	0.18	0.05	1.93	0.20	2.93	0.06	75.7	0.31	4.51			
S	1040	990		59500	58700	55400	5.16	0.18	0.05	1.92	0.20	2.90	0.06	75.7	0.31	4.58			
S	1030	990		59700	59300	54100	5.21	0.18	0.05	1.93	0.21	2.94	0.06	75.9	0.31	4.58			
S	1050	980		60500	58600	55400	5.19	0.18	0.05	1.92	0.20	2.92	0.06	75.5	0.31	4.54			
S	1050	1000		61000	59300	55900	5.22	0.18	0.05	1.92	0.21	2.93	0.06	75.8	0.31	4.68			
S	1030	980		59600	59000	56800	5.19	0.18	0.05	1.92	0.20	2.92	0.06	75.7	0.31	4.56			
S	1030	990		60900	58800	55900	5.21	0.18	0.05	1.93	0.20	2.92	0.06	75.6	0.31	4.51			
S	1020	980		59400	58800	55700	5.16	0.18	0.05	1.91	0.20	2.91	0.06	75.5	0.30	4.61			
T			60600			45500												0.08	
T			61900			46200												0.08	
T			62600			46900												0.08	
T			61800			47000												0.08	
T			62900			47600												0.08	
T			62100			46500												0.08	
T			63000			47200												0.08	
T			62200			45800												0.08	
U	975	1115		56730		54770	5.13	0.18	0.06	1.91	0.21	2.93	0.06	75.9	0.29	4.65	0.08	2.72	
U	973	1141		56210		54730	5.09	0.17	0.06	1.88	0.22	2.94	0.06	75.4	0.29	4.73	0.09	2.72	
U	979	1128		57560		54400	5.10	0.17	0.06	1.88	0.21	2.92	0.06	75.2	0.29	4.66	0.08	2.72	
U	988	1189		57120		54680	5.13	0.18	0.06	1.90	0.20	2.94	0.05	75.7	0.28	4.71	0.08	2.71	
U	973	1145		56990		54360	5.12	0.17	0.05	1.90	0.21	2.96	0.06	75.9	0.28	4.67	0.08	2.71	
U	972	1191		57370		54400	5.14	0.17	0.06	1.91	0.21	2.95	0.06	75.6	0.29	4.72	0.08	2.72	
U	961	1185		57010		54860	5.10	0.18	0.06	1.87	0.22	2.94	0.06	74.8	0.28	4.72	0.09	2.71	
U	990	1152		55850		55440	5.09	0.17	0.06	1.87	0.20	2.93	0.06	75.2	0.29	4.70	0.09	2.71	
V	979	1055																0.07	2.87
V	1010	1051																0.07	2.85
V	987	1055																0.07	2.86
V	980	1001																0.07	2.89
V	994	1092																0.08	2.84
V	973	1082																0.08	2.84
V	989	1076																0.08	2.84
V	1008	1037																0.08	2.87
W	1140	1160	61000	62300		60400	4.42	0.20	0.04	1.93	0.26	2.79	0.07	76.5	0.32	4.63		2.86	
W	1120	1130	59500	61000		60600	4.28	0.18	0.05	1.95	0.26	2.75	0.07	76.6	0.33	4.68		2.85	
W	1140	1150	59300	62300		60200	4.37	0.19	0.04	1.95	0.27	2.78	0.07	76.6	0.33	4.81		2.85	
W	1140	1160	62100	61400		59700	4.33	0.19	0.04	1.97	0.26	2.81	0.07	76.7	0.34	4.70		2.86	
W	1140	1110	61600	61900		60000	4.31	0.19	0.05	1.96	0.25	2.78	0.07	76.4	0.34	4.64		2.86	
W	1130	1140	61100	61300		61200	4.37	0.18	0.04	1.93	0.27	2.82	0.07	76.3	0.34	4.55		2.86	
W	1110	1130	60400	59700		60700	4.40	0.19	0.04	1.94	0.26	2.79	0.07	76.5	0.32	4.61		2.85	
W	1080	1100	60700	58300		61500	4.35	0.19	0.05	1.94	0.25	2.83	0.07	76.4	0.34	4.68		2.85	
X	1100		59900	61100		53300													
X	1100		58700	61600		54700													
X	1100		59600	61500		53600													
X	1100		60100	61200		51800													
X	1100		57400	61500		52200													
X	1100		58900	61400		54800													
X	1100		59300	61400		54100													
X	1100		59600	61600		52600													

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	SW ³	CSU ⁴
Co	M/ICP	ppm	58.3	35.6	21.6	8.36
Co	P	ppm	33.6	23.0	15.0	6.31
Cu	F	ppm	1181	1035	643	375
Cu	M/ICP	ppm	1049	643	620	182
Cu	P	ppm	851	538	631	196
Cu	Soluble	ppm	3025	2464	846	716
Al ₂ O ₃	XRF	%	0.054	0.046	0.035	0.018
CaO	XRF	%	0.007	0.005	0.005	0.002
Cr ₂ O ₃	XRF	%	0.006	0.004	0.004	0.002
Fe ₂ O ₃	XRF	%	0.061	0.063	0.027	0.024
K ₂ O	XRF	%	0.025	0.024	0.005	0.008
LOI		%	0.085	0.070	0.045	0.024
MgO	XRF	%	0.049	0.045	0.025	0.016
MnO	XRF	%	0.006	0.005	0.003	0.002
SiO ₂	XRF	%	0.602	0.529	0.337	0.192
TiO ₂	XRF	%	0.010	0.009	0.006	0.003
S Comb	LECO	%	0.012	0.011	0.003	0.004
SG	pyc		0.055	0.040	0.021	0.011

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 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: AMIS0202 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.

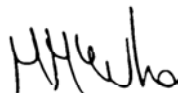
18. Availability: This product is available in Laboratory Packs containing 1kg of material and Explorer Packs containing custom weights (from 50g to 250g) of material. The Laboratory Packs are sealed bottles delivered in sealed foil pouches. The Explorer Packs contain material in standard geochem envelopes,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

16 August 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	1.9	0.76	19.8	96
Al	M/ICP	%	2.6	0.33	6.4	112
As	M/ICP	ppm	4.8	4.7	48.7	60
Ba	M/ICP	ppm	63.1	16.9	13.4	77
Be	M/ICP	ppm	1.0	0.27	14.0	50
Bi	M/ICP	ppm	27.0	21.2	39.2	68
Ca	M/ICP	%	0.14	0.01	5.2	116
Cd	M/ICP	ppm	0.07	0.08	55.1	23
Ce	M/ICP	ppm	8.3	1.5	9.2	31
Co	Fusion	ppm	1032	55.1	2.7	29
Co	3 Acid	ppm	1012	327	16.1	24
Co	Soluble	ppm	925	92.6	5.0	8
Cr	M/ICP	ppm	274	75.1	13.7	106
Cs	M/ICP	ppm	0.32	0.08	13.2	32
Cu	XRF	ppm	61535	2357	1.9	23
Cu	3 Acid	ppm	60315	5198	4.3	24
Cu	QLT	ppm	60944	1714	1.4	16
Dy	M/ICP	ppm	2.4	0.31	6.5	16
Er	M/ICP	ppm	1.4	0.08	2.9	15
Eu	M/ICP	ppm	0.45	0.14	15.4	16
Fe	M/ICP	%	1.4	0.09	3.5	121
Ga	M/ICP	ppm	6.8	3.2	23.3	48
Gd	M/ICP	ppm	2.5	0.37	7.5	16
Ge	M/ICP	ppm	0.48	0.50	51.6	16
Hf	M/ICP	ppm	2.5	0.56	11.4	39
Ho	M/ICP	ppm	0.47	0.18	19.4	16
In	M/ICP	ppm	0.06	0.03	25.7	35
K	M/ICP	%	0.17	0.03	9.6	120
La	M/ICP	ppm	3.8	0.43	5.6	39
Li	M/ICP	ppm	54.1	10.3	9.5	80
Lu	M/ICP	ppm	0.21	0.03	6.9	24
Mg	M/ICP	%	1.7	0.2	5.3	112
Mn	M/ICP	ppm	460.1	79.3	8.6	120
Mo	M/ICP	ppm	3.4	1.4	20.3	47
Na	M/ICP	%	0.23	0.02	4.4	96
Na ₂ O	XRF	%	0.37	0.15	20.7	32
Nb	M/ICP	ppm	11.9	29.2	123	39
Nd	M/ICP	ppm	116	323	138	24
Ni	M/ICP	ppm	18.7	9.4	25.1	101
P	M/ICP	ppm	300	316	52.7	96
Pb	M/ICP	ppm	9.8	26.6	136	73
Pr	M/ICP	ppm	5.9	14.0	118	24
Rb	M/ICP	ppm	6.6	1.2	9.1	40
Re	M/ICP	ppm	3.6	6.4	89.7	14
S	M/ICP	%	0.08	0.01	4.8	105
Sb	M/ICP	ppm	0.68	0.16	12.0	31
Sc	M/ICP	ppm	5.3	1.4	13.2	101
Si	M/ICP	%	35.8	0.62	0.9	8
Sm	M/ICP	ppm	1.9	0.26	7.1	16
Sn	M/ICP	ppm	1.5	0.83	27.6	40
Sr	M/ICP	ppm	50.8	9.1	9.0	75
Ta	M/ICP	ppm	0.44	0.19	21.9	32
Tb	M/ICP	ppm	0.37	0.07	10.2	24
Te	M/ICP	ppm	5.3	7.7	71.8	6
Th	M/ICP	ppm	5.4	0.77	7.2	39
Ti	M/ICP	%	0.14	0.10	37.0	88
Tl	M/ICP	ppm	0.71	3.9	273	18
Tm	M/ICP	ppm	0.22	0.10	22.5	16
U	M/ICP	ppm	5.6	0.39	3.5	39
V	M/ICP	ppm	78.4	28.7	18.3	107
W	M/ICP	ppm	1.5	1.3	42.3	40
Y	M/ICP	ppm	12.6	1.7	6.8	65
Yb	M/ICP	ppm	1.5	0.24	7.7	24
Zn	M/ICP	ppm	16.3	13.2	40.5	95
Zr	M/ICP	ppm	86.1	12.5	7.3	77