



AMIS0243

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	1.344	±	0.054	%
Cu M/ICP	1.358	±	0.063	%
Cu P	1.346	±	0.050	%
Cu Soluble ppm	1.301	±	0.083	%
Co M/ICP	345	±	28	ppm
Co P	330	±	16	ppm
Specific Gravity	2.70	±	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	3.69	±	0.06	%
Fe ₂ O ₃	1.61	±	0.04	%
K ₂ O	0.29	±	0.02	%
MgO	2.73	±	0.06	%
SiO ₂	87.01	±	0.68	%
TiO ₂	0.24	±	0.01	%
LOI	2.14	±	0.12	%

Provisional Concentrations

CaO	0.10	±	0.02	%
MnO	0.06	±	0.01	%

Indicated Mean

Cr ₂ O ₃	0.05	%
S Comb/LECO	0.07	%

1. Intended Use: AMIS0243 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: AMIS0243 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 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 ($\text{Cu}_2\text{CO}_3(\text{OH})_2$), pseudomalachite ($\text{Cu}_5(\text{PO}_4)_2(\text{OH})_4$), chrysocolla (hydrated copper silicate) and heterogenite ($\text{Co}_3\text{O(OH)}$).

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 – 5YR 6/2).

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 <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 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 (Al_2O_3 , CaO , Cr_2O_3 , Fe_2O_3 , K_2O , MgO , MnO , Na_2O , SiO_2 , TiO_2 . 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 randomly 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	340	360		13250	13950	12300												2.70
A	340	360		13450	13250	12400												2.70
A	330	370		13050	13350	12100												2.69
A	330	360		13150	13450	11400												2.69
A	340	360		13300	13450	11850												2.64
A	340	370		13400	13450	12500												2.67
A	340	360		13450	13100	12650												2.67
A	330	360		13400	13150	12250												2.67
B	369	318	13713	14232		12755												2.78
B	351	330	13429	13000		12555												2.78
B	337	318	13563	13605		12673												2.74
B	353	332	13685	13860		12637												2.71
B	341	333	13675	14412		12905												2.79
B	356	327	13398	13582		12774												2.71
B	342	329	13598	12993		12757												2.73
B	356	323	13487	13851		12765												2.69
C						11300											0.06	
C						5450											0.08	
C						12200											0.09	
C						11500											0.08	
C						10200											0.08	
C						10900											0.07	
C						12100											0.10	
C						11200											0.09	

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	
D	360	324		14000	13700		3.49	0.11	0.05	1.66	0.28	2.68	0.05	85.6	0.23	2.33		2.71	
D	360	328		13400	13550		3.48	0.11	0.05	1.49	0.28	2.69	0.05	86.4	0.23	2.44		2.69	
D	340	328		13300	13300		3.46	0.12	0.05	1.46	0.28	2.67	0.05	84.7	0.22	2.30		2.74	
D	340	328		13500	13800		3.46	0.11	0.05	1.46	0.28	2.66	0.05	84.4	0.22	2.28		2.70	
D	340	325		13200	13400		3.51	0.12	0.05	1.51	0.28	2.72	0.05	86.6	0.23	2.30		2.69	
D	340	328		13500	13650		3.70	0.09	0.07	1.76	0.29	2.63	0.07	87.3	0.24	2.29		2.74	
D	340	322		13800	13550		3.64	0.08	0.05	1.56	0.28	2.58	0.06	86.0	0.23	2.42		2.70	
D	340	324		13300	13800		3.51	0.11	0.05	1.49	0.28	2.70	0.05	86.3	0.23	2.34		2.70	
F	330	330		13700	13350		3.68	0.10	0.06	1.61	0.30	2.75	0.06	86.6	0.24	2.15		2.64	
F	330	330		13750	13350		3.68	0.10	0.05	1.60	0.29	2.76	0.06	87.0	0.24	2.11		2.68	
F	310	310		12900	13300		3.64	0.10	0.06	1.60	0.29	2.75	0.06	86.6	0.23	2.14		2.67	
F	320	320		13250	12650		3.67	0.10	0.05	1.60	0.30	2.75	0.06	86.6	0.24	2.14		2.68	
F	330	330		13400	13550		3.70	0.10	0.06	1.60	0.30	2.76	0.06	87.0	0.23	2.13		2.65	
F	330	330		13450	13000		3.68	0.10	0.05	1.60	0.29	2.75	0.06	87.0	0.27	2.11		2.67	
F	320	320		13000	12900		3.68	0.10	0.05	1.60	0.30	2.75	0.06	87.1	0.24	2.19		2.68	
F	330	330		13700	13500		3.67	0.10	0.06	1.61	0.30	2.76	0.06	87.1	0.24	2.14		2.67	
G	340	330		13500	13450	12200	3.68	0.10	0.05	1.58	0.29	2.72	0.06	86.4	0.23	1.86			
G	340	320		13450	13300	12050	3.74	0.11	0.05	1.60	0.29	2.75	0.06	87.0	0.23	2.00			
G	350	330		13600	13400	12100	3.72	0.11	0.05	1.61	0.29	2.76	0.06	87.1	0.23	1.93			
G	340	320		13450	13350	11850	3.71	0.10	0.06	1.60	0.29	2.75	0.06	87.3	0.23	1.82			
G	340	320		13500	13150	12300	3.70	0.10	0.05	1.59	0.29	2.74	0.06	86.8	0.23	1.95			
G	340	320		13500	13300	12200	3.70	0.10	0.05	1.60	0.29	2.74	0.06	86.6	0.23	1.94			
G	340	320		13600	13250	12400	3.70	0.10	0.05	1.59	0.30	2.72	0.06	86.7	0.22	2.07			
G	340	330		13450	13400	12100	3.72	0.10	0.05	1.60	0.29	2.74	0.06	86.9	0.23	1.95			
H			13400			6400												0.07	
H			13500			9300												0.07	
H			13500			9200												0.07	
H			13500			7700												0.07	
H			13400			9200												0.07	
H			13400			7900												0.07	
H			13400			9700												0.07	
H			13600			9500												0.07	
I	340	340		13650	14000	12900												2.75	
I	340	340		13450	14350	12850												2.77	
I	340	340		13450	13950	12950												2.84	
I	340	340		13400	13750	12850												2.71	
I	340	330		13800	13500	13000												2.81	
I	340	320		13550	13150	12850												2.66	
I	340	330		13450	13350	13050												2.69	
I	340	330		13350	13800	12950												2.82	
J	357	333		12410		13070	3.63	0.10	0.06	1.59	0.30	2.77	0.06	86.8	0.21	2.28	0.07	2.61	
J	358	336		12590		12930	3.71	0.11	0.06	1.61	0.30	2.75	0.06	87.6	0.21	2.26	0.08	2.62	
J	354	336		12810		12980	3.65	0.09	0.06	1.61	0.30	2.79	0.07	87.2	0.21	2.24	0.08	2.62	
J	360	329		12860		13060	3.63	0.09	0.06	1.60	0.29	2.77	0.06	86.9	0.21	2.27	0.08	2.61	
J	351	319		12520		13070	3.63	0.09	0.06	1.59	0.28	2.75	0.06	86.8	0.21	2.26	0.08	2.61	
J	364	330		12770		13030	3.62	0.09	0.06	1.58	0.28	2.75	0.06	86.5	0.20	2.26	0.08	2.62	
J	359	325		13080		13080	3.60	0.09	0.06	1.60	0.29	2.76	0.06	86.6	0.21	2.24	0.08	2.61	
J	358	318		12770		13070	3.59	0.09	0.06	1.59	0.28	2.76	0.06	86.4	0.21	2.28	0.07	2.61	
K	337	342																0.08	2.76
K	333	339																0.08	2.70
K	332	340																0.09	2.77
K	332	345																0.09	2.74
K	330	355																0.09	2.73
K	332	351																0.09	2.72
K	307	349																0.08	2.72
K	331	347																0.09	2.74
L	350		13300	13000		13100	3.22	0.10	0.04	1.62	0.32	2.75	0.07	87.5	0.26	2.17		2.74	
L	360		13500	13800		13400	3.19	0.10	0.05	1.60	0.33	2.68	0.07	87.2	0.24	2.16		2.76	
L	380		13500	14100		13400	3.20	0.10	0.05	1.62	0.31	2.71	0.08	87.2	0.24	2.18		2.74	
L	360		13500	13500		13100	3.20	0.10	0.04	1.60	0.30	2.66	0.07	87.5	0.26	2.09		2.74	
L	340		13400	13000		13300	3.18	0.10	0.05	1.62	0.31	2.65	0.07	87.5	0.25	2.07		2.76	
L	360		13400	13500		13200	3.18	0.10	0.04	1.63	0.31	2.70	0.07	87.5	0.25	2.19		2.75	
L	370		13600	13800		13300	3.20	0.10	0.05	1.60	0.32	2.70	0.07	87.4	0.24	2.19		2.74	
L	360		13600	13300		13300	3.23	0.10	0.05	1.60	0.32	2.68	0.07	87.5	0.25	2.21		2.74	
M	300		13000	13900		11400													
M	400		13100	13900		11600													
M	300		13000	13800		11500													
M	300		13000	13800		11600													
M	300		13200	13900		11300													
M	300		13200	14000		11500													
M	300		13000	13600		11500													
M	300		12900	13900		11500													
N	300		13000	13000		13100												0.07	2.68
N	300		12700	13000		13000												0.07	2.68
N	300		12700	13200		13200												0.07	2.69
N	300		13000	13100		13100												0.07	2.70
N	300		13000	13200		13200												0.07	2.69
N	300		12900	13300		13300												0.07	2.69
N	300		12600	13200		13200												0.07	2.68
N	300		12600	13300		13300												0.07	2.70
O	300		13200																
O	300		13000																
O	300		13100																
O	300		13500																
O	300		13200																
O	300		13400																
O	300		13400																
O	300		13500																
P	360	321	13400	13500	13000	12900	3.66	0.10	0.06	1.62	0.30	2.78	0.06	87.2	0.24	2.09		2.74	
P	365	346	13400	13700	13700	13300	3.67	0.10	0.06	1.62	0.29	2.78	0.06	87.2	0.24	2.09		2.78	
P	360	331	13300	13500	13200	13300	3.68	0.10	0.06	1.63	0.29	2.76	0.06	87.2	0.24	2.06		2.74	
P	350	326	13100	13200	13700	13200	3.66	0.10	0.06</										

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		
R	330			14200														0.10		
R	330			14100														0.12		
R	330			14000														0.12		
R	330			14000														0.11		
R	320			13900														0.13		
R	330			13700														0.12		
R	330			14100														0.13		
R	330			14000														0.12		
S	337	308			13360	12800														
S	335	306			13300	12620														
S	356	306			13170	12870														
S	360	317			13090	12960														
S	344	308			13460	12680														
S	349	318			13310	12620														
S	349	305			13550	12710														
S	330	315			13280	12690														
T	321	283		13600	13300	13180												0.08	2.66	
T	335	284		13500	13300	13128												0.08	2.66	
T	331	295		13600	13500	13121												0.08	2.68	
T	317	296		13700	13500	13235												0.08	2.68	
T	326	296		13600	13500	13180												0.08	2.64	
T	324	280		13500	13300	13007												0.08	2.66	
T	325	295		13500	13400	13144												0.08	2.67	
T	345	287		13400	13300	13211												0.08	2.66	
U	341	325		12999	12753	12940													2.61	
U	362	323		13654	12638	12780													2.61	
U	382	328		14768	12775	12780													2.58	
U	363	330		14048	12815	12820													2.64	
U	353	329		13395	12795	12870													2.64	
U	372	326		14472	12660	12750													2.62	
U	374	315		14536	12277	12750													2.63	
U	358	333		13991	12817	12820													2.64	
V	366	343		14000		13100	3.69	0.10		1.60	0.29	2.70	0.07	86.5	0.24	2.20				
V	362	344		14000		13000	3.69	0.10		1.62	0.29	2.72	0.07	86.6	0.23	2.20				
V	367	343		14200		13100	3.70	0.11		1.62	0.29	2.73	0.07	86.8	0.24	2.20				
V	367	343		13900		13200	3.68	0.10		1.61	0.29	2.72	0.07	86.6	0.24	2.20				
V	362	343		13900		13200	3.66	0.10		1.58	0.29	2.68	0.07	86.3	0.23	2.10				
V	363	341		14100		13100	3.65	0.10		1.60	0.28	2.67	0.07	86.2	0.24	2.10				
V	365	339		13900		13000	3.68	0.10		1.58	0.29	2.68	0.07	86.3	0.23	2.10				
V	367	341		13800		13000	3.67	0.10		1.60	0.29	2.69	0.07	86.5	0.23	2.10				
W	471	442	13300	14700	14300	13900	3.40	0.14	0.04	1.76	0.27	2.56	0.06	86.7	0.24	2.14			2.71	
W	438	423	13300	14700	13800	13900	3.38	0.14	0.04	1.75	0.27	2.55	0.06	87.1	0.24	2.18			2.72	
W	462	445	13600	14400	14300	13900	3.35	0.14	0.04	1.74	0.26	2.53	0.06	86.8	0.24	2.14			2.72	
W	421	412	13300	14800	13900	13900	3.40	0.14	0.04	1.75	0.27	2.58	0.06	87.1	0.24	2.16			2.69	
W	416	434	13300	14100	13700	13800	3.36	0.14	0.05	1.74	0.26	2.53	0.06	86.5	0.23	2.10			2.72	
W	453	415	13800	14900	13800	13900	3.39	0.14	0.04	1.75	0.27	2.57	0.06	87.6	0.24	2.11			2.74	
W	465	398	13400	14800	13600	13900	3.44	0.15	0.04	1.76	0.27	2.63	0.06	87.9	0.24	2.11			2.69	
W	444	423	13500	14000	14000	13800	3.43	0.14	0.04	1.76	0.27	2.60	0.06	87.9	0.25	2.10			2.71	
X	346	330	13404				3.75	0.10	0.06	1.71	0.31	2.74	0.06	87.3	0.24	2.10			0.06	2.74
X	362	333	13910				3.75	0.10	0.07	1.65	0.34	2.74	0.06	87.1	0.24	2.20			0.06	2.72
X	358	331	13766				3.76	0.10	0.07	1.65	0.36	2.73	0.07	87.0	0.24	2.18			0.06	2.74
X	342	323	13971				3.75	0.11	0.06	1.65	0.35	2.75	0.06	87.1	0.24	2.18			0.06	2.72
X	364	314	13868				3.76	0.10	0.07	1.64	0.36	2.74	0.06	87.2	0.24	2.11			0.06	2.75
X	355	327	14244				3.73	0.12	0.07	1.66	0.32	2.73	0.06	86.7	0.24	2.14			0.05	2.72
X	337	323	14125				3.79	0.11	0.07	1.70	0.31	2.79	0.06	87.5	0.24	2.14			0.06	2.71
X	337	332	14001				3.74	0.12	0.06	1.65	0.31	2.74	0.06	87.4	0.24	2.17			0.06	2.74

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	13.8	8.4	7.2	2.19
Co	P	ppm	7.9	4.6	5.6	1.46
Cu	F	ppm	272	230	156	84
Cu	M/ICP	ppm	314	153	243	47
Cu	P	ppm	252	134	210	52
Cu	Soluble	ppm	413	299	135	81
Al ₂ O ₃	XRF	%	0.034	0.033	0.017	0.013
CaO	XRF	%	0.009	0.007	0.006	0.002
Cr ₂ O ₃	XRF	%	0.008	0.007	0.005	0.003
Fe ₂ O ₃	XRF	%	0.019	0.018	0.010	0.007
K ₂ O	XRF	%	0.008	0.007	0.004	0.003
LOI		%	0.058	0.046	0.038	0.017
MgO	XRF	%	0.032	0.027	0.017	0.009
MnO	XRF	%	0.006	0.005	0.003	0.002
SiO ₂	XRF	%	0.343	0.233	0.245	0.083
TiO ₂	XRF	%	0.007	0.005	0.004	0.002
S Comb	LECO	%	0.011	0.011	0.004	0.004
SG	pyc		0.047	0.032	0.021	0.009

1. S - Std Dev for use on control charts.
2. σ_L - Betw Lab Std Dev, for use to calculate a measure of accuracy.
3. Sw - Within Lab Stc Dev, for use to calculate a measure of precision.
4. CSU - Combined Standard Uncertainty, a component for use to calculate the total uncertainty in method validation.

13. Certified values: The Certified, Provisional and 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: AMIS0243 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.

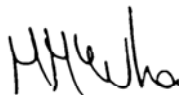
18. Availability: This product is available in Laboratory Packs containing 1kg of material and Explorer Packs containing custom weights (from 50g to 250g) of material. The Laboratory Packs are sealed bottles delivered in sealed foil pouches. The Explorer Packs contain material in standard geochem envelopes, 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	0.93	0.62	33.4	79
Al	M/ICP	%	1.9	0.21	5.5	112
As	M/ICP	ppm	5.8	4.8	41.0	70
Ba	M/ICP	ppm	47.6	6.1	6.4	75
Be	M/ICP	ppm	0.86	0.33	19.1	45
Bi	M/ICP	ppm	9.6	2.7	13.9	75
Ca	M/ICP	%	0.08	0.01	6.4	112
Cd	M/ICP	ppm	0.04	0.02	23.4	18
Ce	M/ICP	ppm	13.3	2.2	8.3	39
Co	Fus	ppm	319	34.0	5.3	24
Co	3 Acid	ppm	269	143	26.5	16
Co	Soluble	ppm	315	78.8	12.5	24
Cr	M/ICP	ppm	290	125	21.6	112
Cs	M/ICP	ppm	0.44	0.25	28.4	37
Cu	XRF	ppm	13581	1023	3.8	24
Cu	3 Acid	ppm	13776	228	0.8	8
Cu	QLT	ppm	13491	369	1.4	16
Dy	M/ICP	ppm	1.7	0.14	4.0	22
Er	M/ICP	ppm	0.90	0.16	8.6	23
Eu	M/ICP	ppm	0.44	0.08	8.5	24
Fe	M/ICP	%	1.1	0.09	4.0	115
Ga	M/ICP	ppm	4.6	1.6	17.1	47
Gd	M/ICP	ppm	2.2	0.21	4.8	24
Ge	M/ICP	ppm	0.38	0.51	66.2	13
Hf	M/ICP	ppm	1.4	0.41	14.3	39
Ho	M/ICP	ppm	0.30	0.07	12.0	23
In	M/ICP	ppm	0.08	0.03	16.3	39
K	M/ICP	%	0.24	0.04	8.7	120
La	M/ICP	ppm	7.7	0.56	3.7	47
Li	M/ICP	ppm	88.2	13.8	7.8	88
Lu	M/ICP	ppm	0.12	0.04	16.8	32
Mg	M/ICP	%	1.6	0.15	4.6	116
Mn	M/ICP	ppm	500	58.2	5.8	112
Mo	M/ICP	ppm	2.2	0.56	12.6	44
Na	M/ICP	ppm	0.06	0.02	12.6	104
Na2O	XRF	%	0.09	0.03	16.3	31
Nb	M/ICP	ppm	3.0	3.0	50.2	48
Nd	M/ICP	ppm	5.5	0.29	2.6	23
Ni	M/ICP	ppm	15.7	8.4	26.7	102
P	M/ICP	ppm	382	55.9	7.3	96
Pb	M/ICP	ppm	6.0	8.2	68.4	70
Pr	M/ICP	ppm	1.4	0.25	9.0	24
Rb	M/ICP	ppm	10.9	0.91	4.2	46
S	M/ICP	%	0.07	0.01	6.1	93
Sb	M/ICP	ppm	0.46	0.16	17.7	39
Sc	M/ICP	ppm	3.6	0.87	12.0	87
Se	M/ICP	ppm	0.59	0.08	6.5	7
Si	M/ICP	%	40.5	0.42	0.52	8
Sm	M/ICP	ppm	1.9	0.16	4.1	23
Sn	M/ICP	ppm	1.2	0.51	21.1	43
Sr	M/ICP	ppm	15.8	3.1	9.8	80
Ta	M/ICP	ppm	0.30	0.14	23.8	28
Tb	M/ICP	ppm	0.29	0.05	8.6	31
Th	M/ICP	ppm	3.5	0.69	9.8	48
Ti	M/ICP	%	0.10	0.08	39.5	88
Tl	M/ICP	ppm	0.11	0.03	12.2	24
Tm	M/ICP	ppm	0.12	0.06	26.6	23
U	M/ICP	ppm	2.9	0.5	8.6	48
V	M/ICP	ppm	135	42.5	15.7	112
W	M/ICP	ppm	2.6	1.0	18.7	45
Y	M/ICP	ppm	8.3	1.7	10.3	69
Yb	M/ICP	ppm	0.88	0.13	7.4	32
Zn	M/ICP	ppm	12.4	11.4	45.8	95
Zr	M/ICP	ppm	53.5	23.4	21.9	73