



AMIS0163

Certified Reference Material

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

Certificate of Analysis

Recommended Concentrations and Limits¹ (at two Standard Deviations)

Certified Concentrations²

Co F	2733	±	197	ppm
Co M/ICP	2791	±	180	ppm
Co P	2725	±	214	ppm
Co XRF	2701	±	249	ppm
Cu F	2.730	±	0.266	%
Cu M/ICP	2.754	±	0.167	%
Cu P	2.697	±	0.169	%
Cu XRF	2.665	±	0.151	%
Specific Gravity	2.78	±	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.

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

Certified Concentrations

Al ₂ O ₃	1.73	±	0.04	%
Fe ₂ O ₃	3.81	±	0.10	%
K ₂ O	0.35	±	0.01	%
MgO	0.67	±	0.03	%
MnO	0.030	±	0.002	%
SiO ₂	87.03	±	1.14	%
LOI	2.33	±	0.22	%

Provisional Concentrations

CaO	0.065	±	0.018	%
Cr ₂ O ₃	0.065	±	0.016	%
P ₂ O ₅	0.101	±	0.014	%
TiO ₂	0.102	±	0.012	%

Informational Mean

Na ₂ O	0.034	%
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1. Intended Use: AMIS0163 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: AMIS0163 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 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 (Co₃O(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 Greyish Orange powder (Corstor colour chart – 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 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.
2. Multi-acid digest multi-element scan - (to include Co, Cu). ICP-OES or ICP-MS.
3. Aqua regia digest – Co, Cu. ICP-OES or ICP-MS.
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 additionally requested to complete the additional analyses. This was too few laboratories for a formal certification, so this uncertified data is presented in the appendix.

- 1 SOP 06. Quick Leach Test
- 2 Acid soluble Cu & Co.
- 3 Total Cu, Co, Ca, Mg & Mn.

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 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. Alex Stewart International Corporation Zambia
2. ALS Chemex Laboratory Group Brisbane Australia
3. ALS Chemex Laboratory Group Johannesburg SA
4. ALS Chemex Laboratory Group Lima (Peru)
5. ALS Chemex Laboratory Group Perth WA
6. ALS Chemex Laboratory Group Vancouver CA
7. Anglo Research (Crown Campus)
8. FMI Technology Center
9. Genalysis Laboratory Services (South Africa) Pty
10. Genalysis Laboratory Services WA
11. Intertek Utama Services (Indonesia)
12. OMAC Laboratories Limited (Ireland)
13. Set Point Laboratories (Isando) SA
14. SGS Australia Pty Ltd (Newburn) WA
15. SGS Mineral Services Callao (Peru)
16. SGS Mineral Services Lakefield (Canada)
17. SGS South Africa (Pty) Ltd - Booyens
18. SGS Toronto (Canada)
19. Skyline Assayers and Labs
20. 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 ppm	Co M/ICP ppm	Co P ppm	Co XRF ppm	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 %	P2O5 XRF %	SiO2 XRF %	TiO2 XRF %	LOI %	SG pyc
A	2662		2728		26775		24358		1.71	0.06	0.06	3.84	0.36	0.66	0.03	0.02	0.11	86.40	0.10	2.34	2.74
A	2738		2714		26603		24511		1.71	0.06	0.07	3.86	0.36	0.65	0.03	0.01	0.10	86.59	0.11	2.32	2.73
A	2694		2854		26460		25604		1.69	0.07	0.06	3.85	0.35	0.65	0.03	0.02	0.09	85.99	0.11	2.29	2.83
A	2745		2818		27207		25517		1.75	0.06	0.07	3.85	0.35	0.66	0.03	0.02	0.11	86.39	0.10	2.32	2.80
A	2685		2780		27183		24905		1.70	0.07	0.07	3.88	0.36	0.66	0.03	0.03	0.09	86.86	0.11	2.33	2.77
A	2771		2926		27230		26170		1.70	0.06	0.06	3.86	0.36	0.64	0.03	0.00	0.10	86.42	0.11	2.31	2.77
A	2659		2835		27053		25711		1.75	0.06	0.07	3.86	0.35	0.65	0.03	0.01	0.10	86.84	0.10	2.34	2.78
A	2742		2820		26968		25905		1.69	0.06	0.06	3.83	0.35	0.65	0.03	0.02	0.10	86.16	0.10	2.31	2.77

Assay data (cont)

Lab Code	Co F ppm	Co M/ICP ppm	Co P ppm	Co XRF ppm	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 %	P2O5 XRF %	SiO2 XRF %	TiO2 XRF %	LOI %	SG pyc	
B																					2.74	
B																					2.68	
B																					2.74	
B																					2.67	
B																					2.64	
B																					2.73	
B																					2.72	
B																					2.72	
C		2670	2660			28200	27900		1.74	0.07	0.06	3.79	0.35	0.67	0.03	0.03	0.11	86.84	0.09	2.20		
C		2880	2860			28400	27500		1.74	0.07	0.06	3.80	0.35	0.67	0.03	0.04	0.11	87.05	0.10	2.30		
C		2860	2670			28300	27100		1.74	0.07	0.06	3.80	0.35	0.67	0.03	0.04	0.11	86.80	0.10	2.30		
C		2840	2650			28200	27800		1.73	0.07	0.06	3.80	0.35	0.66	0.03	0.03	0.11	86.77	0.10	2.20		
C		2830	2690			27800	27700		1.75	0.07	0.09	3.83	0.35	0.69	0.03	0.04	0.11	87.00	0.10	2.20		
C		2820	2680			28100	27200		1.74	0.07	0.07	3.80	0.35	0.68	0.03	0.04	0.11	86.98	0.10	2.30		
C		2830	2640			28500	27100		1.75	0.07	0.09	3.82	0.35	0.68	0.03	0.04	0.11	87.17	0.10	2.30		
C		2830	2680			27700	27800		1.74	0.07	0.06	3.82	0.35	0.68	0.03	0.03	0.11	87.11	0.10	2.30		
D	2644		2703	2803	25762		25362	28276	1.71	0.06	0.07	3.91	0.35	0.70	0.04		0.10	87.65	0.11	2.76	2.75	
D	2721		2733	2774	26214		25849	27286	1.81	0.06	0.07	3.81	0.34	0.65	0.04		0.10	85.72	0.10	2.82	2.71	
D	2575		2805	2842	24740		26655	27820	1.77	0.06	0.07	3.89	0.35	0.66	0.03		0.11	87.68	0.10	2.76	2.69	
D	2719		2719	2638	26374		25607	27073	1.72	0.06	0.07	3.82	0.34	0.67	0.03		0.10	85.93	0.10	2.73	2.77	
D	2721		2736	2716	26270		26151	27179	1.79	0.06	0.07	3.82	0.35	0.67	0.03		0.10	86.30	0.10	2.79	2.75	
D	2610		2721	2765	25334		26122	27878	1.73	0.07	0.07	3.88	0.35	0.68	0.03		0.10	87.26	0.11	2.82	2.70	
D	2569		2756	2677	25534		25605	27829	1.72	0.06	0.07	3.88	0.35	0.67	0.04	0.05	0.10	87.30	0.10	2.96	2.69	
D	2637		2738	2765	26621		25839	27626	1.76	0.06	0.07	3.86	0.35	0.66	0.03	0.06	0.10	87.01	0.11	2.96	2.77	
F	2900	2900	2800	2400	29500	28000	26800	26700	1.69	0.05	0.08	3.81	0.34	0.67	0.03	0.06	0.11	87.50	0.09	2.54	2.77	
F	2900	2700	2900	2300	29600	28200	27600	26600	1.75	0.05	0.08	3.82	0.36	0.66	0.03	0.06	0.11	87.50	0.09	2.55	2.78	
F	2800	2900	2900	2400	29300	28500	27200	26600	1.71	0.05	0.07	3.82	0.35	0.68	0.03	0.06	0.11	87.70	0.09	2.53	2.76	
F	2900	2800	2800	2300	29500	28300	27200	26500	1.70	0.05	0.08	3.81	0.36	0.67	0.03	0.06	0.10	87.60	0.09	2.53	2.77	
F	2800	2900	2800	2400	29500	28600	26600	26400	1.70	0.05	0.08	3.82	0.36	0.66	0.03	0.06	0.11	87.60	0.09	2.53	2.78	
F	2900	2700	2700	2400	29400	28100	27700	26600	1.76	0.04	0.09	3.82	0.35	0.68	0.03	0.06	0.11	87.50	0.09	2.53	2.76	
F	2800	2900	2900	2400	29100	28300	27200	26000	1.71	0.05	0.07	3.82	0.35	0.67	0.03	0.06	0.11	87.60	0.09	2.52	2.77	
F	2900	2900	2900	2300	28400	28100	26800	26600	1.70	0.05	0.08	3.82	0.36	0.68	0.03	0.06	0.11	87.50	0.09	2.52	2.77	
G	2650	2890			26800	25700			1.72	0.08	0.07	3.90	0.36	0.67	0.03	0.05		87.30	0.10	2.28		
G	2710	2890			26900	27500			1.72	0.08	0.07	3.89	0.36	0.66	0.04	0.04		87.30	0.10	2.27		
G	2770	2890			28000	25300			1.71	0.08	0.07	3.88	0.36	0.66	0.03	0.06		87.30	0.11	2.27		
G	2620	2860			25700	26200			1.71	0.08	0.07	3.90	0.36	0.67	0.03	0.05		87.20	0.11	2.29		
G	2810	2880			28300	26600			1.71	0.08	0.07	3.89	0.36	0.67	0.03	0.05		87.20	0.10	2.32		
G	2820	2850			28700	26400			1.73	0.08	0.07	3.91	0.35	0.67	0.03	0.05		87.30	0.10	2.28		
G	2670	2890			27800	26900			1.70	0.08	0.07	3.90	0.35	0.66	0.03	0.04		87.30	0.10	2.26		
G	2570	2840			27200	25200			1.70	0.08	0.07	3.89	0.35	0.65	0.03	0.06		87.30	0.10	2.27		
H		2720	2950					25300														
H		2910	2880					25800														
H		2810	2910					26100														
H		2900	2940					25800														
H		2860	3360					25900														
H		2890	2910					25400														
H		2880	3040					25900														
H		2610	2920					25900														
I		2800		2700				26100														
I		2900		2700				26100														
I		2900		2700				26200														
I		2800		2700				26000														
I		2800		2700				26300														
I		2800		2700				26100														
I		2900		2700				26100														
I		3000		2700				26400														
J		2764	2683			27504	27604															
J		2744	2691			27592	27757															
J		2742	2685			27508	27610															
J		2736	2704			27574	27766															
J		2715	2691			27418	27622															
J		2714	2696			27572	27415															
J		2754	2707			27515	27605															
J		2746	2698			27737	27500															
K																						
K		2800	2660	2700		26200	28100	23900	1.72	0.08	0.07	3.73	0.39	0.71	0.03	0.07	0.09	84.70	0.10	2.38	2.75	
K		2840	2600	2600		25800	28200	24200	1.71	0.09	0.07	3.76	0.37	0.69	0.03	0.06	0.10	85.20	0.10	2.33	2.77	
K		2790	2670	2600		25700	28100	24100	1.71	0.10	0.10	3.94	0.40	0.69	0.04	0.06	0.10	84.80	0.10	2.27	2.79	
K		2830	2610	2600		26900	28700	24200	1.73	0.09	0.08	3.79	0.37	0.70	0.03	0.06	0.09	86.10	0.10	2.22	2.74	
K		2800	2630	2600		25900	28000	24300	1.75	0.09	0.07	3.83	0.38	0.70	0.03	0.06	0.10	87.00	0.11	2.45	2.75	
K		2820	2640	2700		26600	28700	24200	1.75	0.09	0.08	3.77	0.38	0.72	0.09	0.07	0.09	86.20	0.12	2.27	2.74	
K		2840	2630	2600		26400	28200	23900	1.73	0.09	0.08	3.82	0.37	0.71	0.04	0.06	0.09	86.60	0.11	2.40	2.80	
L	2800	2820		2880	28500	28500		27500	1.72	0.07	0.06	3.82	0.35	0.68	0.03	0.04		87.11	0.11	2.32	2.82	
L	2900	2820		2830	28500	28600		27500	1.73	0.07	0.07	3.83	0.36	0.69	0.03	0.04		87.03	0.10	2.32	2.82	
L	2840	2850		2850	28400	28100		27300	1.73	0.07	0.07	3.82	0.35	0.68	0.03	0.04		87.10	0.10	2.31	2.77	
L	2840	2860		2880	28300	28200		28100	1.73	0.07	0.07	3.81	0.35	0.68	0.03	0.03		87.00	0.11	2.34	2.75	
L	2860	2890		2860	28400	28500		27500	1.73	0.07	0.07	3.81	0.35	0.68	0.03	0.03		86.88	0.10	2.29	2.82	
L	2840	2870		2870	28400	28500		28000	1.74	0.07	0.07	3.84	0.36	0.69	0.03	0.03						

Assay data (cont)

Lab Code	Co F ppm	Co M/ICP ppm	Co P ppm	Co XRF ppm	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 %	P2O5 XRF %	SiO2 XRF %	TiO2 XRF %	LOI %	SG pyc	
P	2660	2730	2680		26500	26500	26400		1.72	0.06	0.06	3.76	0.36	0.72	0.03	0.01		87.07	0.14	2.45	2.82	
P	2620	2480	2700		26300	28000	24600		1.74	0.06	0.06	3.75	0.36	0.72	0.03	0.01		87.12	0.14	2.43	2.85	
P	2600	2550	2710		26200	28200	25700		1.74	0.06	0.06	3.79	0.36	0.72	0.03	0.01		87.39	0.13	2.43	2.83	
P	2660	2570	2620		26600	27100	25500		1.74	0.06	0.06	3.81	0.36	0.72	0.03	0.02		87.45	0.13	2.45	2.77	
P	2630	2720	2730		26200	27800	26900		1.74	0.06	0.06	3.74	0.35	0.72	0.03	0.02		87.05	0.16	2.46	2.86	
P	2440	2710	2690		24900	27300	26900		1.73	0.06	0.06	3.73	0.36	0.71	0.03	0.02		87.10	0.16	2.49	2.83	
P	2620	2650	2970		26200	30200	28500		1.72	0.06	0.06	3.73	0.36	0.72	0.03	0.01		86.94	0.17	2.46	2.77	
P	2650	2710	2720		26200	27500	27100		1.73	0.06	0.06	3.72	0.35	0.71	0.03	0.01		86.89	0.16	2.45	2.78	
Q	2600	2710	2630	2700	25400	27300	28300	26900	1.71	0.06	0.07	3.78	0.35	0.64	0.03	0.01	0.10	87.90	0.13	2.23		
Q	2700	2590	2700	2710	26200	25900	29600	27400	1.74	0.06	0.06	3.80	0.35	0.64	0.03	0.01	0.10	88.20	0.13	2.23		
Q	2740	2740	2650	2700	26100	28800	28300	27400	1.71	0.06	0.06	3.79	0.35	0.64	0.03	0.00	0.10	88.10	0.12	2.28		
Q	2760	2640	2660	2720	26800	27800	28200	27400	1.72	0.06	0.06	3.81	0.35	0.64	0.03	0.00	0.10	88.30	0.12	2.22		
Q	2760	2670	2640	2690	26600	27500	26900	27100	1.71	0.06	0.06	3.78	0.35	0.64	0.03	0.01	0.10	87.90	0.12	2.17		
Q	2700	2680	2620	2680	25400	26200	27600	26900	1.71	0.06	0.06	3.75	0.35	0.64	0.03	0.01	0.10	87.50	0.14	2.24		
Q	2680	2640	2610	2670	26000	26500	27900	26500	1.71	0.06	0.06	3.74	0.35	0.64	0.03	0.01	0.10	87.50	0.15	2.26		
Q	2720	2700	2660	2710	26100	27100	27700	27000	1.72	0.06	0.06	3.79	0.35	0.64	0.03	0.00	0.10	88.10	0.13	2.25		
R	2580	2640	2800		26000	26800	26100		1.61	0.15		3.83		0.65	0.03			86.10	0.11		2.81	
R	2590	2700	2620		27500	27800	25600		1.72	0.17		3.91		0.67	0.03			89.30	0.11		2.79	
R	3000	2610	2770		29100	26400	27500		1.79	0.16		3.85		0.71	0.03			93.80	0.11		2.78	
R	2980	2730	2730		28800	27800	27100		1.78	0.16		3.81		0.70	0.03			92.90	0.11		2.78	
R	2990	2640	2730		28800	26800	27200		1.78	0.16		3.81		0.70	0.03			92.90	0.11		2.77	
R	2970	2610	2750		28400	26800	26900		1.78	0.15		3.79		0.69	0.03			90.90	0.11		2.84	
R	3000	2610	2720		29000	26300	26900		1.80	0.15		3.82		0.71	0.03			93.80	0.11		2.83	
R	2930	2670	2800		28200	27000	28100		1.74	0.14		3.66		0.69	0.03			89.70	0.11		2.82	
S				3600				25800														2.79
S				3700				26000														2.78
S				3700				26000														2.79
S				3800				26000														2.78
S				3700				26100														2.78
S				3700				26300														2.77
S				3700				25800														2.78
S				3800				25800														2.79
W		2788					27456															
W		2800					27741															
W		2784					27613															
W		2812					27606															
W		2827					27489															
W		2835					27667															
W		2753					27565															
W		2796					27503															

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:

$$\text{Combined standard uncertainty} = \sqrt{(\text{between lab. var}/\text{no of labs}) + (\text{mean square within lab. var}/\text{no of assays})}$$

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	98.78	92.68	55.47	35.82
Co	M/ICP	ppm	89.85	59.14	50.05	17.16
Co	P	ppm	107.21	73.66	53.47	21.12
Co	XRF	ppm	124.43	131.92	33.94	50.08
Cu	F	%	1330.3	1242.7	630.1	446.4
Cu	M/ICP	%	836.3	547.8	475.9	159.2
Cu	P	%	884.3	638.0	485.8	199.6
Cu	XRF	%	752.5	792.7	278.5	302.0
Al2O3	XRF	%	0.021	0.010	0.017	0.003
CaO	XRF	%	0.009	0.007	0.002	0.002
Cr2O3	XRF	%	0.008	0.006	0.004	0.002
Fe2O3	XRF	%	0.050	0.034	0.026	0.010
K2O	XRF	%	0.005	0.003	0.004	0.001
MgO	XRF	%	0.016	0.012	0.009	0.004
MnO	XRF	%	0.0011	0.0008	0.0005	0.0002
Na2O	XRF	%	0.019	0.016	0.006	0.005
P2O5	XRF	%	0.007	0.006	0.004	0.002
SiO2	XRF	%	0.566	0.388	0.308	0.117
TiO2	XRF	%	0.006	0.005	0.004	0.001
LOI		%	0.109	0.081	0.063	0.027
SG	pyc		0.029	0.015	0.024	0.006

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: AMIS0163 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.

14 July 2010

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 trace element statistics

Eight 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.

Analyte	Method	Unit	Mean	2SD	RSD%	n
Al	M/ICP	ppm	0.90	0.03	1.5	37
As	M/ICP	ppm	16.8	2.3	6.8	38
Ba	M/ICP	ppm	41.4	4.8	5.8	61
Be	M/ICP	ppm	1.1	0.15	6.7	32
Bi	M/ICP	ppm	4.8	0.28	2.9	16
Ca	M/ICP	ppm	0.05	0.01	8.2	52
Cd	M/ICP	ppm	0.10			7
Ce	M/ICP	ppm	9.9	1.3	6.5	22
Co	Sol	%	0.23	0.04	8.0	24
Co	3 Acid	%	0.29	0.03	5.0	39
Cr	M/ICP	ppm	414	90.0	10.9	46
Cs	M/ICP	ppm	0.25	0.10	19.6	16
Cu	QLT	%	2.6	0.13	2.5	30
Cu	Sol	%	2.6	0.23	4.4	32
Cu	3 Acid	%	2.7	0.12	2.1	44
Dy	M/ICP	ppm	1.9	0.13	3.4	16
Er	M/ICP	ppm	0.96	0.07	3.9	15
Eu	M/ICP	ppm	0.46	0.02	2.5	16
Fe	M/ICP	ppm	2.7	0.20	3.6	62
Ga	M/ICP	ppm	2.6	0.10	2.0	15
Gd	M/ICP	ppm	2.5	0.28	5.6	16
Hf	M/ICP	ppm	0.63	0.03	2.1	7
Ho	M/ICP	ppm	0.35	0.03	4.6	15
In	M/ICP	ppm	0.08	0.02	11.4	16
K	M/ICP	ppm	0.29	0.02	3.7	62
La	M/ICP	ppm	5.1	0.78	7.7	37
Li	M/ICP	ppm	36.0	4.2	5.8	55
Lu	M/ICP	ppm	0.12	0.01	3.4	15
Mg	M/ICP	ppm	0.42	0.04	4.8	62
Mn	M/ICP	ppm	267	23.3	4.4	69
Mo	M/ICP	ppm	4.1	1.1	13.2	38
Na	M/ICP	ppm	0.02	0.01	12.6	47
Nd	M/ICP	ppm	6.2	0.32	2.6	16
Ni	M/ICP	ppm	20.9	3.5	8.5	71
P	M/ICP	%	0.04	0.004	4.9	47
Pb	M/ICP	ppm	7.6	5.8	38.7	61
Pr	M/ICP	ppm	1.4	0.02	0.8	15
Rb	M/ICP	ppm	11.4	0.85	3.7	16
S	M/ICP	ppm	0.01	0.01	29.5	39
Sb	M/ICP	ppm	2.4	1.7	36.7	17
Sc	M/ICP	ppm	4.0	0.28	3.5	44
Se	M/ICP	ppm	18.4	3.4	9.3	7
Si	M/ICP	%	40.8	0.19	0.2	8
Sm	M/ICP	ppm	2.2	0.14	3.1	16
Sn	M/ICP	ppm	1.6	0.72	21.9	16
Sr	M/ICP	ppm	8.8	1.6	9.1	40
Tb	M/ICP	ppm	0.35	0.02	2.6	16
Th	M/ICP	ppm	1.3	0.66	24.9	16
Ti	M/ICP	%	0.04	0.02	24.1	45
Tm	M/ICP	ppm	0.14	0.01	3.4	14
U	M/ICP	ppm	5.2	0.38	3.6	14
V	M/ICP	ppm	56.8	3.9	3.4	60
Y	M/ICP	ppm	10.8	1.5	7.0	38
Yb	M/ICP	ppm	0.84	0.07	4.1	16
Zn	M/ICP	ppm	67.3	17.4	13.0	95
Zr	M/ICP	ppm	24.9	5.9	11.9	48