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AMIS0201

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	3059	±	120	ppm
Co M/ICP	3091	±	128	ppm
Co P	2999	±	210	ppm
Cu F	5.99	±	0.44	%
Cu M/ICP	6.07	±	0.29	%
Cu P	5.88	±	0.40	%
Specific Gravity	2.87	±	0.14	

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	14.11	±	0.70	%
Cr ₂ O ₃	0.030	±	0.002	%
Fe ₂ O ₃	2.40	±	0.08	%
K ₂ O	3.14	±	0.22	%
MgO	6.44	±	0.54	%
Na ₂ O	0.099	±	0.010	%
SiO ₂	56.51	±	1.00	%
TiO ₂	0.77	±	0.04	%
LOI	7.59	±	0.48	%

Provisional Concentrations

CaO	0.048	%
MnO	0.011	%

1. Intended Use: AMIS0201 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: AMIS0201 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 (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 Yellowish Gray 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 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 two 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 Laboratorios 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 (South Africa) Pty
10. Genalysis Laboratory Services WA
11. Intertek Utama Services (Indonesia)
12. Set Point Laboratories (Isando) SA
13. SGS Australia Pty Ltd (Newburn) WA
14. SGS Durango (Mexico)
15. SGS Geosol Laboratories Ltda (Brazil)
16. SGS Mineral Services Callao (Peru)
17. SGS Mineral Services Lakefield (Canada)
18. SGS South Africa (Pty) Ltd - Booysens
19. SGS Toronto (Canada)
20. Skyline Assayers and Labs
21. Tenke Exploration Fungurume Laboratory
22. 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 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
A	3180	3100	2960		57300	58700	56100		14.26	0.05	0.03	2.40	3.19	6.72		0.12	56.52	0.78	7.30	3.02
A	3040	3110	2970		56000	60300	54400		14.23	0.05	0.03	2.41	3.19	6.72	0.01	0.11	56.48	0.76	7.33	3.02
A	3120	3100	3030		58200	59800	55700		14.25	0.05	0.03	2.42	3.19	6.71	0.01	0.11	56.48	0.77	7.36	2.98
A	3120	3130	3000		58900	60800	55700		14.27	0.05	0.03	2.40	3.20	6.69	0.01	0.11	56.45	0.78	7.33	2.96
A	3060	3150	3000		56000	59600	55500		14.27	0.05	0.03	2.41	3.19	6.70	0.01	0.12	56.49	0.77	7.32	2.96
A	3060	3100	3090		59900	60100	56800		14.27	0.05	0.03	2.42	3.18	6.72	0.01	0.12	56.58	0.77	7.30	2.98
A	2960	3150	3030		55500	59500	57300		14.25	0.05	0.03	2.41	3.19	6.71	0.01	0.12	56.54	0.77	7.36	3.01
A	3080	3130	2980		57400	60000	55900		14.27	0.05	0.03	2.41	3.18	6.72	0.01	0.12	56.52	0.78	7.34	2.99
C		3100				61000				0.04				6.22	0.01					
C		3200				61600				0.03				6.35	0.01					
C		3200				60800				0.03				6.17	0.01					
C		3100				60600				0.04				6.05	0.01					
C		3200				61500				0.04				6.25	0.01					
C		3100				59600				0.03				5.92	0.01					
C		3100				59500				0.03				6.05	0.01					
C		3100				61100				0.03				6.05	0.01					

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
D	2750	3290	2940		59400	60900	56300			0.06				6.50	0.01					
D	2760	3290	2900		59800	61000	55600			0.04				6.50	0.01					
D	2750	3320	2970		59500	60700	56500			0.06				6.53	0.01					
D	2740	3320	2980		59700	61600	56700			0.08				6.65	0.01					
D	2800	3320	2950		60400	61500	56100			0.13				6.63	0.01					
D	2780	3320	3010		60400	60700	57000			0.06				6.53	0.01					
D	2740	3310	2980		59800	61300	55900			0.06				6.55	0.01					
D	2770	3290	3020		59800	61000	57000			0.04				6.50	0.01					
E	3040				65700					0.01				5.97	0.01					
E	3070				64180					0.02				6.02	0.01					
E	3065				64235					0.01				6.03	0.01					
E	3055				63120					0.02				5.94	0.01					
E	3050				62585					0.02				6.06	0.01					
E	3040				61975					0.02				5.97	0.01					
E	3080				63280					0.02				6.05	0.01					
E	3075				64305					0.02				6.00	0.01					
F	3150	3134	3129		61492	59981	60289		13.93	0.06	0.03	2.37	3.34	6.35	0.01	0.10	56.91	0.75	7.45	
F	2936	3120	3307		55945	59959	61859		12.89	0.04	0.03	2.26	2.92	5.97	0.01	0.10	56.91	0.70	7.49	
F	3128	3130	3189		58909	59398	61794		13.66	0.04	0.04	2.40	3.30	6.27	0.01	0.10	57.12	0.75	7.48	
F	2926	3018	3045		56337	58586	60256		12.81	0.06	0.03	2.24	3.07	5.87	0.01	0.10	53.49	0.70	7.46	
F	3104	3071	3180		60150	59269	61419		13.49	0.06	0.03	2.36	3.24	6.22	0.01	0.10	55.41	0.73	7.48	
F	3089	3039	3148		59184	58940	60175		13.47	0.06	0.03	2.36	3.22	6.18	0.01	0.10	55.84	0.73	7.48	
F	3116	3098	3214		59660	59072	61622		13.91	0.06	0.03	2.39	3.22	6.27	0.01		58.19	0.75	7.46	
F	3024	3063	3240		57634	58827	60482		13.42	0.06	0.03	2.33	3.14	6.15	0.01	0.10	56.27	0.73	7.44	
G	2997	3075			55049	59313														2.80
G	2963	3004			55985	60959														2.83
G	2998	2980			54957	59300														2.82
G	3004	3081			57828	59512														2.82
G	2937	2973			55388	59313														2.79
G	2976	3028			55919	59987														2.80
G	3026	2983			56907	60010														2.85
G	2969	3031			55291	59736														2.80
H	3100	3150	2860		60900	62800														
H	3100	3130	2830		60700	62500														
H	3070	3120	2810		60000	62500														
H	3070	3150	2850		60400	62300														
H	3080	3120	2830		60800	61900														
H	3070	3130	2840		60200	62000														
H	3050	3130	2820		60000	62900														
H	3090	3170	2830		60400	62900														
I		3090	3060		60300															
I		3200	3140		60200															
I		3060	2980		60200															
I		3220	2980		61500															
I		3100	2990		64200															
I		3200	3010		61500															
I		3060	2970		60600															
I		3260	3100		60200															
J	2915	3013	2905		59609				0.07			2.63	3.34	7.45	0.01	0.12			0.73	
J	2782	3066	2825		55907				0.11			2.63	3.35	7.22	0.01	0.11			0.71	
J	2947	2807	2830		61317				0.06			2.20	2.91	6.17	0.01	0.10			0.59	
J	3039	2640	2883		60194				0.05			2.26	2.95	6.24	0.01	0.10			0.58	
J	3221	2691	2901		64300				0.05			2.23	2.96	6.25	0.01	0.10			0.56	
J	3047	2661	2857		61007				0.05			2.20	2.87	6.04	0.01	0.09			0.56	
J	3053	2664	2911		61230				0.05			2.31	2.98	6.33	0.01	0.10			0.57	
J	2992	2977	2937		61407				0.07			2.73	3.68	7.73	0.02	0.13			0.69	
K		2990	3220			63200														
K		2990	2990			63500														
K		3060	3110			62800														
K		3030	3110			62400														
K		2830	3220			62300														
K		2870	3160			62900														
K		2970	3150			62300														
K		3060	3120			63000														
L		3020	2920		59100	58500	61900	14.35	0.05	0.03	2.42	3.16	6.64	0.01	0.10	56.30	0.76	7.40		
L		3030	2930		59500	58700	61900	14.45	0.05	0.03	2.43	3.17	6.66	0.01	0.10	56.50	0.76	7.41		
L		3060	2910		60000	58600	61800	14.35	0.05	0.04	2.44	3.16	6.66	0.01	0.10	56.20	0.76	7.39		
L		3000	2910		59300	58400	61800	14.35	0.05	0.03	2.41	3.17	6.66	0.01	0.10	56.20	0.76	7.43		
L		3020	2900		59300	58800	61600	14.35	0.05	0.04	2.42	3.17	6.67	0.01	0.10	56.30	0.75	7.41		
L		3040	2930		60100	59100	61800	14.45	0.05	0.02	2.42	3.21	6.67	0.01	0.10	56.40	0.76	7.40		
L		3020	2890		59200	58200	61600	14.35	0.05	0.03	2.42	3.21	6.64	0.01	0.10	56.40	0.75	7.46		
L		2970	2960		58600	59600	61800	14.40	0.05	0.03	2.42	3.21	6.64	0.01	0.10	56.20	0.76	7.41		
M		3110	2950		58900	57400	61100	13.26	0.06	0.03	2.49	2.89	6.17	0.01	0.09					
M		3070	2990		58700	57900	60900	12.74	0.06	0.03	2.34	3.06	5.95	0.01	0.09					
M		3050	2990		58100	58000	62500	13.23	0.06	0.03	2.37	3.06	6.15	0.01	0.09					
M		3070	3040		58100	59500	62500	13.60	0.06	0.03	2.46	3.05	6.32	0.01	0.11					
M		3110	3010		58900	58400	62100	13.26	0.06	0.03	2.40	3.08	6.20	0.01	0.11					
M		3040	3000		58400	58700	62400	13.40	0.06	0.03	2.42	3.12	6.23	0.01	0.11					
M		2940	3020		58100	59400	61400	13.15	0.06	0.03	2.39	2.96	6.10	0.01	0.11					
M		3150	2870		58900	57300	61400	13.66	0.06	0.03	2.46	2.92	6.33	0.01	0.11					
N	3140		3070		61100	60300	59600		13.50	0.02	0.03	2.33	2.92	6.34	0.01	0.10	54.70	0.73	8.08	3.06
N	3070		2960		60400	59200	59900		13.90	0.05	0.03	2.39	3.00	6.54	0.01	0.10	56.20	0.75	8.29	2.90
N	3110		2970		60500	60300	59400		13.50	0.02	0.03	2.31	2.92	6.31	0.01	0.10	54.60	0.72	8.35	3.05
N	3090		2960		59300	60200	59200		14.20	0.02	0.03	2.44	3.07	6.66	0.01	0.10	57.60	0.77	7.66	3.02
N	3070		3030		59500	59300	59300		14.15	0.02	0.03	2.43	3.06	6.60	0.01	0.10	57.40	0.76	7.58	2.89
N	3090		2920		60800	60300	59000		14.05	0.02	0.03	2.43	3.02	6.60	0.01	0.10	57.00	0.76	7.87	3.00
N	3080		3100		60600	59000	59700		14.10	0.05	0.03	2.43	3.05	6.59	0.01	0.10				

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 P ppm	Al2O3 XRF %	CaO XRF %	Cr2O3 XRF %	Fe2O3 XRF %	K2O XRF %	MgO XRF %	MnO XRF %	Na2O XRF %	SiO2 XRF %	TiO2 XRF %	LOI %	SG pyc
Q		2970	3130																	
Q		3040	3270																	
Q		2930	2990																	
Q		2950	3080																	
Q		3130	3280																	
Q		3110	3010																	
Q		3220	3270																	
Q		3070	3000																	
R		3101	3099			61200	61200													2.79
R		3122	3178			61100	61000													2.80
R		3169	3153			61100	60600													2.81
R		3127	3138			61300	61700													2.80
R		3115	3124			61400	60600													2.83
R		3105	3140			60400	60700													2.82
R		3127	3115			61500	62000													2.78
R		3148	3105			60800	60600													2.80
S		3100				61200			14.04	0.04	0.03	2.27		6.23	0.01					
S		3100				60800			14.36	0.05	0.03	2.26		6.30	0.01					
S		3100				61000			14.50	0.04	0.03	2.34		6.41	0.01					
S		3100				61800			14.36	0.04	0.03	2.32		6.30	0.01					
S		3100				61000			14.50	0.04	0.03	2.29		6.23	0.01					
S		3100				61200			14.48	0.04	0.03	2.23		6.60	0.01					
S		3100				60000			14.80	0.05	0.03	2.30		6.69	0.01					
S		3100				61100			14.66	0.04	0.03	2.34		6.53	0.01					
T	3050					60500				0.07				7.26	0.01					
T	3100					61500				0.07				7.28	0.01					
T	3070					61700				0.07				7.21	0.01					
T	3100					61300				0.08				7.35	0.01					
T	3080					61800								7.28	0.01					
T	3030					61100				0.07				7.26	0.01					
T	3090					61700				0.07				7.28	0.01					
T	3090					61200				0.06				7.23	0.01					
V		3100	3000	2568.38		63300	61000	65057	14.31		0.03	2.71	3.19	6.62	0.01	0.09	56.20	0.80	7.85	2.87
V		3100	3000	2555.93		63400	61100	64863	14.34		0.03	2.73	3.19	6.65	0.01	0.09	56.10	0.80	7.89	2.87
V		3200	3000	2544.97		63500	61100	64423	14.35		0.03	2.73	3.20	6.61	0.01	0.09	56.30	0.80	7.82	2.87
V		3300	3000	2586.34		63400	61200	65170	14.36		0.03	2.73	3.20	6.63	0.01	0.10	56.81	0.80	7.82	2.87
V		3200	3000	2567.36		63300	61100	64620	14.27		0.03	2.75	3.21	6.69	0.02	0.10	56.22	0.81	7.89	2.88
V		3200	3000	2552.51		63400	61200	65101	14.32		0.03	2.73	3.21	6.68	0.02	0.09	56.28	0.81	7.82	2.87
V		3100	3000	2526.20		63500	61100	65312	14.17		0.03	2.74	3.20	6.66	0.02	0.09	56.09	0.81	7.86	2.86
V		3300	2900	2557.18		63300	61000	64960	14.33		0.03	2.74	3.21	6.65	0.01	0.08	56.30	0.80	7.87	2.87
W		2550	2950	3244.00		54400	58600		14.10	0.07	0.03	2.40	3.17	6.58	0.01	0.14	57.20	0.77	7.85	2.90
W		2590	2800	3230.00		54300	55600		14.30	0.06	0.03	2.42	3.25	6.78	0.01	0.13	57.10	0.80	7.85	2.91
W		2600	3020	3237.00		53400	56400		14.40	0.06	0.03	2.41	3.17	6.71	0.01	0.15	56.90	0.78	7.85	2.86
W		2600	2840	3221.00		53100	58300		14.10	0.07	0.03	2.41	3.15	6.66	0.01	0.13	56.90	0.78	7.84	2.91
W		2580	2860	3249.00		55000	57500		14.10	0.06	0.03	2.38	3.19	6.58	0.02	0.16	56.90	0.77	7.86	2.91
W		2570	3080	3224.00		52800	55300		14.30	0.07	0.04	2.42	3.22	6.78	0.01	0.14	57.10	0.78	7.88	2.88
W		2650	2920	3233.00		54200	58400		14.40	0.07	0.03	2.44	3.22	6.81	0.01	0.14	57.40	0.79	7.89	2.91
W		2540	2850	3219.00		54300	56000		14.30	0.07	0.03	2.43	3.20	6.80	0.01	0.13	57.30	0.79	7.87	2.86

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:

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

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	F	ppm	59.846	36.195	46.156	13.336
Co	M/ICP	ppm	64.359	31.127	49.624	9.615
Co	P	ppm	105.179	65.706	54.478	17.722
Cu	F	ppm	2195.808	1624.157	1302.982	534.638
Cu	M/ICP	ppm	1465.901	1081.720	479.888	292.636
Cu	P	ppm	1991.088	1839.529	695.618	618.709
Al ₂ O ₃	XRF	%	0.352	0.302	0.161	0.102
CaO	XRF	%	0.016	0.011	0.007	0.003
Cr ₂ O ₃	XRF	%	0.001	0.001	0.001	0.000
Fe ₂ O ₃	XRF	%	0.051	0.041	0.032	0.015
K ₂ O	XRF	%	0.110	0.070	0.084	0.025
LOI		%	0.240	0.257	0.074	0.098
MgO	XRF	%	0.268	0.198	0.103	0.056
MnO	XRF	%	0.002	0.001	0.000	0.000
Na ₂ O	XRF	%	0.005	0.003	0.004	0.001
SiO ₂	XRF	%	0.499	0.431	0.310	0.169
TiO ₂	XRF	%	0.021	0.021	0.010	0.008
SG	pyc		0.070	0.064	0.041	0.025

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: AMIS0201 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.

20 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 economic element statistics

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 data has been compiled and iterated.

Analyte	Method	Unit	Mean	2SD	RSD%	n
Co	3 Acid	ppm	3104	247	3.98	40
Co	QLT	ppm	2988	373	6.24	14
Co	Soluble	ppm	2909	360	6.19	39
Cu	3 Acid	ppm	60962	2317	1.90	31
Cu	QLT	ppm	58917	2954	2.51	46
Cu	Soluble	ppm	59885	2594	2.17	39

Appendix 1 (cont) - Uncertified economic element statistics

Nineteen of the laboratories submitted significant total digestion / multi element scan trace element data and ten 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
Ag	M/ICP	ppm	0.25	0.15	30.24	23
Al	M/ICP	%	7.46	0.95	6.38	79
As	M/ICP	ppm	10.90	2.19	10.05	68
B	M/ICP	ppm	433	36.65	4.24	8
Ba	M/ICP	ppm	220	38.66	8.79	78
Be	M/ICP	ppm	2.19	0.36	8.15	64
Bi	M/ICP	ppm	44.28	37.84	42.73	83
Ca	M/ICP	%	0.04	0.02	20.45	121
Cd	M/ICP	ppm	0.40	0.88	110.75	21
Ce	M/ICP	ppm	58.73	8.15	6.94	32
Cr	M/ICP	ppm	176	80.04	22.77	93
Cs	M/ICP	ppm	3.04	0.23	3.82	24
Dy	M/ICP	ppm	3.56	0.15	2.10	23
Er	M/ICP	ppm	2.38	0.22	4.69	23
Eu	M/ICP	ppm	0.75	0.08	5.02	24
Fe	M/ICP	%	1.63	0.16	4.89	100
Ga	M/ICP	ppm	18.63	2.75	7.39	40
Gd	M/ICP	ppm	3.72	0.39	5.28	23
Hf	M/ICP	ppm	4.51	0.95	10.49	32
Ho	M/ICP	ppm	0.76	0.05	3.61	23
In	M/ICP	ppm	0.16	0.02	4.70	30
K	M/ICP	%	2.61	0.25	4.75	85
La	M/ICP	ppm	34.38	4.19	6.09	61
Li	M/ICP	ppm	306	22.91	3.74	80
Lu	M/ICP	ppm	0.37	0.03	3.73	30
Mg	M/ICP	%	3.71	0.39	5.23	121
Mn	M/ICP	ppm	103	8.86	4.30	126
Mo	M/ICP	ppm	2.27	1.53	33.83	56
Na	M/ICP	%	0.07	0.01	8.88	69
Nb	M/ICP	ppm	11.41	8.49	37.23	43
Nd	M/ICP	ppm	22.68	1.07	2.37	24
Ni	M/ICP	ppm	28.85	4.92	8.53	100
P	M/ICP	ppm	786	79.69	5.07	70
Pb	M/ICP	ppm	14.17	22.89	80.74	72
Pr	M/ICP	ppm	6.57	0.84	6.37	24
Rb	M/ICP	ppm	101	50.56	25.12	32
Re	M/ICP	ppm	0.01	0.005	45.50	8
S	M/ICP	%	0.02	0.01	17.43	79
Sb	M/ICP	ppm	0.79	0.14	8.68	31
Sc	M/ICP	ppm	14.34	1.79	6.25	86
Se	M/ICP	ppm	1.77	0.77	21.86	14
Si	M/ICP	%	26.49	1.04	1.95	15
Sm	M/ICP	ppm	3.90	0.23	2.91	24
Sn	M/ICP	ppm	3.92	0.51	6.50	30
Sr	M/ICP	ppm	67.93	5.67	4.17	69
Ta	M/ICP	ppm	4.31	10.75	124.69	40
Tb	M/ICP	ppm	0.54	0.11	10.43	31
Te	M/ICP	ppm	0.09	0.04	24.00	4
Th	M/ICP	ppm	12.56	1.14	4.54	32
Ti	M/ICP	%	0.29	0.27	46.34	88
Tl	M/ICP	ppm	0.39	0.05	6.91	30
Tm	M/ICP	ppm	0.36	0.03	4.38	22
U	M/ICP	ppm	6.13	0.55	4.50	32
V	M/ICP	ppm	134	36.19	13.50	93
W	M/ICP	ppm	2.43	1.52	31.19	30
Y	M/ICP	ppm	18.33	3.08	8.39	72
Yb	M/ICP	ppm	2.40	0.22	4.51	29
Zn	M/ICP	ppm	30.37	14.35	23.63	91
Zr	M/ICP	ppm	143	23.04	8.03	79