African Mineral Standards
REFERENCE MATERIALS FOR AFRICAN ORES

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AMIS0417

Certified Reference Material

Copper cobalt oxide ore
Tenke Fungurume Mine, DRC

Certificate of Analysis

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

Certified Concentrations[2.]

Co Fus	5344	±	275	ppm
Co M/ICP	5242	±	416	ppm
Co P	5203	±	321	ppm
Cu Fus	3.845	±	0.204	%
Cu M/ICP	3.820	±	0.178	%
Cu P	3.770	±	0.186	%
Cu 3 Acid ppm	3.711	±	0.240	%
Specific Gravity	2.83	±	0.08	

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_2O_3	14.86	±	0.26	%
Fe_2O_3	2.61	±	0.08	%
K_2O	3.21	±	0.06	%
MgO	6.03	±	0.16	%
MnO	0.020	±	0.002	%
SiO_2	60.37	±	0.90	%
TiO_2	0.86	±	0.04	%
LOI	6.11	±	0.26	%

Provisional Concentrations

CaO	0.048	±	0.008	%
Na_2O	0.14	±	0.03	%

Indicated Means

Cr_2O_3	0.02	%

1. Intended Use: AMIS0417 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: AMIS0417 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 Neoproterozic approximately 650 to 600 million years before present (Ma). Copper mineralization at Tenke-Fungurume is stratabound and generally restricted to two dolomitic shale horizons (RSF and SDB respectively) each ranging in thickness from 5 to 15 m, separated by 20 m of cellular silicified dolomite (RSC).

The main economic minerals present at Tenke and Fungurume are malachite, chrysocolla, bornite, and hetrogenite; the primary copper and cobalt mineralogy is predominately chalcocite (Cu_2S), digenite (Cu_9S_5) bornite (Cu_5FeS_4), and carrollite ($CuCo_2S_4$); however oxidation has resulted in widespread alteration producing malachite ($Cu_2CO_3(OH)_2$), pseudomalachite ($Cu_5(PO_4)_2(OH)_4$), chrysocolla (hydrated copper silicate) and heterogenite (Co_3+O(OH)).

The primary copper-cobalt mineral associations are homogeneous in both mineralized zones and 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 Brown powder (Corstor 5YR 6/4).

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 <54um. Wet sieve parti**c**le size analysis of random samples confirmed the material was 98.5% <54um. It was then blended in a bi-conical mixer, systematically divided and then sealed into 1kg Laboratory Packs. Explorer Packs are subdivided from the Laboratory packs as required. Samples were 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 (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: Eighteen laboratories were each given eight selected packages of sample. Seventeen 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 17 out of 18 laboratories that provided results timeously were (not in same order as in the table of assays):

1. ACME Analytical Laboratories Ltd CA
2. ALS Chemex Laboratory Group Johannesburg SA
3. ALS Chemex Laboratory Group Vancouver CA
4. BV Amdel (Australia)
5. BV Rustenburg (South Africa)
6. Genalysis Laboratory Services (W Australia P)
7. Genalysis Zambia
8. Intertek Testing Services (Philippines)
9. Intertek Testing Services Ltd Shanghai (Beijing)
10. Met-Solve Analytical Services
11. Set Point Laboratories (Isando) SA
12. SGS Australia Pty Ltd (Newburn) WA
13. SGS Mineral Services Callao (Peru)
14. SGS Mineral Services Lakefield (Canada)
15. SGS South Africa (Pty) Ltd - Booysens JHB
16. SGS Vancouver (Canada)
17. 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 F ppm	Co M/ICP ppm	Co P ppm	Cu F ppm	Cu M/ICP ppm	Cu P ppm	Cu 3 Acid ppm	Al_2O_3 XRF %	CaO XRF %	Cr_2O_3 XRF %	Fe_2O_3 XRF %	K_2O XRF %	MgO XRF %	MnO XRF %	Na_2O XRF %	SiO_2 XRF %	TiO_2 XRF %	LOI %	SG pyc
A	5095	5093	4980	33570	36480	34200		14.4			2.70	3.18	5.80	0.03		58.5	0.86	6.30	2.86
A	5102	5063	4950	33980	36630	33770		14.3			2.68	3.17	5.70	0.03		58.1	0.85	6.32	2.84
A	5270	5149	5062	35070	37520	34600		14.3			2.72	3.17	5.70	0.03		58.1	0.85	6.30	2.87
A	5285	5025	4972	34410	36740	33850		14.3			2.68	3.18	5.80	0.03		58.5	0.85	6.32	2.83
A	5029	5077	5015	33480	36020	33050		14.5			2.68	3.17	5.80	0.03		58.4	0.85	6.32	2.87
A	5156	5116	5013	34000	38200	34220		14.4			2.68	3.17	5.80	0.03		58.3	0.86	6.33	2.86
A	5237	5068	4996	33700	36970	34350		14.5			2.69	3.17	5.70	0.03		58.3	0.85	6.31	2.87
A	5000	5019	5028	32790	36710	34350		14.3			2.68	3.16	5.70	0.03		58.6	0.85	6.33	2.84
B		5358	5358		39300	38400	39000												2.77
B		5318	5318		39300	38400	39800												2.77
B		5345	5345		39400	38600	39300												2.78
B		5325	5325		39200	38700	39000												2.78
B		5286	5286		39000	39000	39000												2.79
B		5258	5258		38900	38500	39000												2.76
B		5273	5273		39300	38700	39200												2.77
B		5362	5362		39400	39400	39000												2.76
C	5400	5200	4910	38600	38000	37300		15.0	0.05	0.02	2.62	3.20	6.04	0.02	0.15	60.1	0.87	6.10	2.87
C	5140	5240	4940	38300	38300	37300		14.9	0.05	0.02	2.62	3.20	6.04	0.02	0.15	60.1	0.86	6.11	2.89
C	5400	5300	5090	39100	39100	38400		15.0	0.05	0.02	2.61	3.19	6.03	0.02	0.15	60.2	0.86	6.09	2.88
C	5280	5200	4970	38200	38100	38000		14.9	0.05	0.02	2.61	3.19	6.01	0.02	0.15	60.1	0.86	6.14	2.85
C	5180	5180	5090	38100	38300	38200		14.9	0.05	0.02	2.62	3.20	6.02	0.02	0.15	60.1	0.86	6.12	2.85
C	5480	5330	4980	38200	38800	37700		15.0	0.05	0.02	2.62	3.20	6.03	0.02	0.15	60.1	0.86	6.11	2.87
C	5420	5230	4970	38800	39100	37700		15.0	0.05	0.02	2.62	3.19	6.04	0.02	0.15	60.1	0.87	6.08	2.88
C	5440	5190	4860	39000	38100	37100		15.0	0.05	0.02	2.61	3.20	6.04	0.02	0.15	60.2	0.86	6.08	2.90
D							38300												
D							38300												
D							38100												
D							37100												
D							37900												
D							37500												
D							37600												
D							37900												
E	4890	4854		36950	36580	33824													
E	5010	4985		37200	37332	35848													
E	5100	4966		38470	36953	33315													
E	4950	4957		37810	36817	33507													
E	4990	4941		38040	36522	35071													
E	4910	5110		37460	38548	34956													
E	5030	5002		38210	37502	32919													
E	5000	5257		37930	38600	33542													
F	5340	5599	5330	37770	38795	35600		14.9	0.04	0.03	2.63	3.26	6.10	0.02	0.12	60.4	0.85	5.83	2.66
F	5520	5622	5380	39050	39020	36020		14.9	0.04	0.03	2.64	3.24	6.09	0.02	0.11	60.3	0.85	5.85	2.65
F	5400	5560	5370	38990	38714	36480		14.9	0.04	0.03	2.62	3.25	6.06	0.02	0.12	60.3	0.85	5.88	2.66
F	5380	5543	5300	40050	38980	36740		14.9	0.04	0.03	2.63	3.25	6.08	0.02	0.12	60.5	0.85	5.86	2.64
F	5230	5558	5360	40030	38754	36810		14.9	0.04	0.03	2.63	3.24	6.12	0.02	0.10	60.3	0.85	5.85	2.64
F	5340	5512	5310	39980	38326	36160		14.9	0.04	0.02	2.63	3.24	6.09	0.02	0.11	60.3	0.85	5.89	2.64
F	5430	5422	5390	40330	38617	36370		14.9	0.04	0.03	2.61	3.26	6.09	0.02	0.11	60.3	0.85	5.88	2.65
F	5460	5502	5400	39980	39149	36270		14.8	0.04	0.03	2.61	3.24	6.08	0.02	0.10	60.2	0.85	5.87	2.65

Assay data (cont)

Lab Code	Co F ppm	Co M/ICP ppm	Co P ppm	Cu F ppm	Cu M/ICP ppm	Cu P ppm	Cu 3 Acid ppm	Al_2O_3 XRF %	CaO XRF %	Cr_2O_3 XRF %	Fe_2O_3 XRF %	K_2O XRF %	MgO XRF %	MnO XRF %	Na_2O XRF %	SiO_2 XRF %	TiO_2 XRF %	LOI %	SG pyc
G		4980			29400			14.8	0.18	0.03	2.55	3.16	6.05	0.03	0.11	60.0	0.88		
G		4980			34000			14.9	0.15	0.02	2.58	3.24	6.09	0.02	0.11	60.4	0.89		
G		4900			30300			14.7	0.16	0.03	2.56	3.23	6.05	0.03	0.10	59.7	0.88		
G		4920			29800			14.8	0.13	0.02	2.57	3.22	5.98	0.02	0.08	59.9	0.88		
G		4920			30000			14.6	0.10	0.02	2.55	3.19	6.03	0.02	0.07	59.3	0.86		
G		4880			29800			14.9	0.08	0.02	2.59	3.22	6.05	0.02	0.07	60.2	0.87		
G		4940			33100			14.7	0.11	0.02	2.55	3.18	6.00	0.03	0.08	59.6	0.88		
G		4880			31100			14.8	0.12	0.03	2.57	3.20	6.04	0.03	0.10	60.0	0.87		
H	4990	4030	5100	38700		39100													2.78
H	5450	4080	5100	41800		39200													2.79
H	5200	4190	5100	40000		39200													2.78
H	5180	4080	5100	40300		38800													2.79
H	5200	4160	5200	40100		39200													2.78
H	5240	4180	5100	40500		39500													2.77
H	4930	4220	5100	40300		39000													2.80
H	4910	4250	5100	40500		38600													2.80
I	5492	5329	5051	35030	34870	35030													2.77
I	5459	5391	5032	36460	35600	34860													2.75
I	5372	5462	5104	34950	36010	35270													2.79
I	5355	5354	5282	34970	35310	36450													2.78
I	5383	5439	5199	35290	36040	35900													2.77
I	5313	5268	5301	36550	35940	36550													2.76
I	5230	5441	5270	35720	34740	35720													2.77
I	5429	5398	5227	35760	36150	35760													2.79
J		5050	5210		37700	37100	36100												
J		5320	5260		39800	37500	35800												
J		4970	5200		37300	37000	36300												
J		5090	5220		38100	37500	36400												
J		5240	5260		39200	37500	34500												
J		5220	5100		39100	36500	36200												
J		5220	5080		39100	36200	35700												
J		4870	5200		36300	37200	36200												
K	5398	5153	4899	40644				14.8	0.07	0.03	2.58	3.13	5.87	0.02	0.20	59.5	0.87	6.13	2.84
K	5485	5037	4903	39248				14.9	0.07	0.03	2.60	3.24	5.89	0.02	0.20	60.7	0.89	6.15	2.86
K	5285	5107	4837	41756				15.4	0.07	0.03	2.63	3.06	6.10	0.02	0.22	61.0	0.88	6.13	2.84
K	5360	5274	4862	40668				14.8	0.07	0.02	2.60	3.15	5.89	0.02	0.22	60.2	0.88	6.13	2.84
K	5500	5293	4979	39957				14.8	0.07	0.03	2.58	3.18	5.84	0.02	0.18	59.9	0.88	6.12	2.85
K	5425	5093	4990	41262				14.7	0.07	0.02	2.56	3.17	5.78	0.02	0.19	59.6	0.87	6.14	2.86
K	5436	5286	4990	39547				15.0	0.07	0.03	2.64	3.16	5.94	0.02	0.22	60.6	0.90	6.12	2.85
K	5574	5224	4959	41560				14.8	0.07	0.02	2.60	3.20	5.85	0.02	0.20	60.4	0.89	6.13	2.85
L	5180	5550		37100	38400		37600	15.0	0.05	0.02	2.62	3.26	6.16	0.02	0.15	60.7	0.88	6.08	
L	5140	5300		36500	38700		37400	15.1	0.05	0.02	2.61	3.26	6.14	0.02	0.15	60.7	0.88	6.09	
L	5570	5390		37500	38800		37700	15.1	0.05	0.03	2.62	3.26	6.17	0.02	0.15	60.7	0.88	6.09	
L	5380	5330		37100	38900		38100	15.1	0.05	0.02	2.62	3.26	6.14	0.02	0.14	60.7	0.88	6.06	
L	5800	5290		37400	37400		37600	15.1	0.05	0.03	2.61	3.25	6.17	0.02	0.14	60.7	0.88	6.05	
L	5360	5230		37100	37000		36800	15.1	0.05	0.02	2.61	3.25	6.17	0.02	0.15	60.7	0.88	6.09	
L	5110	5290		36900	35900		38500	15.1	0.06	0.02	2.61	3.25	6.17	0.02	0.15	60.6	0.88	6.10	
L	5460	5260		36900	36500		37700	15.1	0.05	0.03	2.61	3.25	6.14	0.02	0.15	60.6	0.88	6.09	
M	5406	5394	5326	39281	38731	38337	36549												2.80
M	5353	5507	5469	38681	38272	38684	36073												2.83
M	5576	5337	5316	39653	37540	37974	35308												2.79
M	5421	5444	5425	39074	38231	38909	35442												2.82
M	5481	5334	5350	39333	37207	38411	35779												2.87
M	5425	5385	5401	39107	37488	38333	36052												2.89
M	5439	5218	5365	38629	38721	37537	35491												2.88
M	5416	5350	5330	38618	37327	38389	36170												2.83
N	5200	5490	5230	37400	39100	38000		14.6	0.05	0.02	2.55	3.09	5.92	0.02	0.14	61.1	0.82	6.63	2.92
N	5160	5420	5300	37400	37500	37700		14.6	0.05	0.02	2.54	3.08	5.91	0.02	0.14	61.1	0.83	6.60	2.94
N	5140	5310	5200	38000	36800	37500		14.7	0.05	0.02	2.55	3.09	5.94	0.02	0.14	61.4	0.84	6.64	2.83
N	5180	5290	5230	36800	38000	37300		14.6	0.05	0.02	2.54	3.09	5.93	0.02	0.13	61.1	0.83	6.62	2.94
N	5240	5370	5320	37700	38600	38300		14.7	0.05	0.02	2.54	3.09	5.95	0.02	0.13	61.2	0.83	6.57	2.94
N	5080	5450	5240	37000	38200	38100		14.9	0.05	0.02	2.58	3.14	6.02	0.02	0.13	62.0	0.84	6.57	2.89
N	5150	5280	5270	37300	37500	37400		14.5	0.05	0.02	2.51	3.06	5.87	0.02	0.12	60.6	0.82	6.49	2.82
N	5240	5350	5440	37500	38300	38400		14.8	0.05	0.02	2.57	3.13	6.01	0.02	0.12	61.7	0.84	6.51	2.90
O	5300	4740		37500															
O	5300	4830		37900															
O	5300	4850		38700															
O	5300	4860		38400															
O	5300	4830		38100															
O	5300	4910		38100															
O	5300	4770		38200															
O	5300	4900		38100															
P	5316	5308	5379	38059	38114	37351	36205	14.9	0.05	0.02	2.62	3.22	6.08	0.02	0.15	61.0	0.86	6.19	2.86
P	5375	5380	5378	37995	38030	37258	36414	14.8	0.05	0.03	2.61	3.21	6.06	0.02	0.14	60.9	0.86	6.19	2.82
P	5310	5382	5300	38018	38030	37395	36318	14.8	0.05	0.03	2.62	3.21	6.09	0.02	0.15	60.9	0.87	6.21	2.84
P	5333	5341	5357	38247	37797	37613	36663	14.8	0.05	0.02	2.61	3.20	6.05	0.02	0.15	60.7	0.86	6.69	2.84
P	5382	5376	5372	38239	37895	37846	36164	14.7	0.05	0.03	2.61	3.20	6.02	0.02	0.14	60.8	0.86	6.25	2.82
P	5325	5328	5338	38009	38151	37598	36105	14.7	0.05	0.02	2.60	3.20	6.00	0.02	0.15	60.6	0.85	6.22	2.80
P	5363	5314	5343	38149	38048	37356	36095	14.8	0.05	0.03	2.62	3.21	6.05	0.02	0.14	60.9	0.86	6.26	2.81
P	5360	5359	5352	38140	38236	37305	35785	14.9	0.05	0.02	2.62	3.21	6.09	0.02	0.15	60.8	0.86	6.21	2.82
Q	5630	5750	5230	38800	40500	36200		14.9	0.05	0.00	2.80	3.17	5.98	0.02	0.12	59.8	0.83	6.09	
Q	5330	5550	5500	38400	38700	37700		14.9	0.05	0.00	2.80	3.19	5.98	0.02	0.12	59.9	0.83	6.07	
Q	5790	5600	5160	40400	38300	37900		14.9	0.05	0.00	2.80	3.17	5.94	0.02	0.12	59.8	0.83	6.08	
Q	5630	5540	5540	38900	39900	39200		14.9	0.06	0.00	2.80	3.19	5.94	0.02	0.12	59.9	0.83	6.02	
Q	5610	5810	5170	38200	38600	36300		14.8	0.05	0.00	2.82	3.18	5.96	0.02	0.12	60.0	0.83	6.06	
Q	5560	5530	5170	39000	38900	35900		14.8	0.05	0.00	2.82	3.18	5.98	0.02	0.12	60.0	0.83	6.01	
Q	5620	5510	5420	39600	38900	36600		14.9	0.05	0.00	2.82	3.19	5.96	0.02	0.12	59.8	0.83	6.04	
Q	5530	5520	5400	39600	39700	37600		14.9	0.05	0.00	2.82	3.18	5.95	0.02	0.12	59.8	0.83	6.12	

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:

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

These uncertainty measurements may be used, by laboratories, as a component for calculating the total uncertainty for method validation according to the relevant ISO guidelines.

Analyte	Method	Unit	S [1]	σ_L [2]	Sw [3]	CSU [4]
Co	F	ppm	137.5	82.5	93.9	25.8
Co	M/ICP	ppm	207.8	142.2	79.2	37.4
Co	P	ppm	160.4	120.9	68.8	35.6
Cu	F	ppm	1022	826	507	267
Cu	M/ICP	ppm	888	510	669	170
Cu	P	ppm	928	761	516	261
Cu	3 Acid	ppm	1201	1404	359	575
Al_2O_3	XRF	%	0.133	0.118	0.069	0.043
CaO	XRF	%	0.004	0.005	0.001	0.002
Cr_2O_3	XRF	%	0.004	0.003	0.004	0.001
Fe_2O_3	XRF	%	0.037	0.036	0.013	0.013
K_2O	XRF	%	0.032	0.030	0.015	0.011
MgO	XRF	%	0.082	0.075	0.039	0.027
MnO	XRF	%	0.001	0.001	0.000	0.000
Na_2O	XRF	%	0.014	0.016	0.005	0.007
SiO_2	XRF	%	0.454	0.400	0.240	0.145
TiO_2	XRF	%	0.019	0.018	0.006	0.006
LOI		%	0.129	0.143	0.022	0.054
SG	pyc		0.043	0.037	0.021	0.012

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: AMIS0417 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.

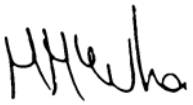
18. Availability: This product is available in Laboratory Packs containing 1kg of material and Explorer Packs containing custom weights (from 50g to 250g) of material. The Laboratory Packs are sealed bottles delivered in sealed foil pouches. The Explorer Packs contain material in standard geochem envelopes,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

06 October 2014

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 element statistics

Analyte	Method	Unit	Mean	2SD	RSD%	n
Ag	M/ICP	ppm	0.54	0.76	71.0	51
Al	M/ICP	ppm	7.56	0.89	5.87	91
As	M/ICP	ppm	12.7	2.02	7.96	64
Ba	M/ICP	ppm	220	30.1	6.83	99
Be	M/ICP	ppm	2.85	0.54	9.50	67
Bi	M/ICP	ppm	12.1	4.58	18.9	64
Ca	M/ICP	ppm	0.04	0.01	14.0	79
Ce	M/ICP	ppm	83.4	7.56	4.53	46
Cr	M/ICP	ppm	130	43.9	16.9	95
Cs	M/ICP	ppm	2.55	0.81	15.9	48
Dy	M/ICP	ppm	4.10	0.13	1.62	15
Er	M/ICP	ppm	3.01	0.17	2.83	15
Eu	M/ICP	ppm	0.63	0.05	3.96	16
Fe	M/ICP	ppm	1.78	0.17	4.64	101
Ga	M/ICP	ppm	20.2	3.83	9.46	51
Gd	M/ICP	ppm	3.18	0.26	4.16	16
Ge	M/ICP	ppm	1.67	0.30	9.14	15
Hf	M/ICP	ppm	4.99	0.62	6.17	55
Ho	M/ICP	ppm	0.95	0.07	3.89	16
In	M/ICP	ppm	0.25	0.04	8.26	48
K	M/ICP	ppm	2.53	0.25	4.95	100
La	M/ICP	ppm	50.6	5.05	4.99	62
Li	M/ICP	ppm	235	41.0	8.71	80
Lu	M/ICP	ppm	0.49	0.04	3.74	32
Mg	M/ICP	ppm	3.57	0.42	5.94	100
Mn	M/ICP	ppm	156	21.1	6.74	101
Mo	M/ICP	ppm	2.13	0.55	13.0	66
Na	M/ICP	ppm	0.10	0.02	7.84	88
Nb	M/ICP	ppm	14.41	5.44	18.9	56
Nd	M/ICP	ppm	24.7	4.14	8.36	16
Ni	M/ICP	ppm	28.7	3.86	6.71	93
P	M/ICP	ppm	1043	209	10.0	88
Pb	M/ICP	ppm	7.22	15.0	104	70
Pr	M/ICP	ppm	8.20	0.87	5.27	16
Rb	M/ICP	ppm	106	12.1	5.68	50
S	M/ICP	ppm	0.02	0.01	22.4	66
Sb	M/ICP	ppm	1.40	0.57	20.4	53
Sc	M/ICP	ppm	13.8	3.94	14.3	96
Se	M/ICP	ppm	1.46	1.21	41.4	16
Sm	M/ICP	ppm	3.13	0.35	5.52	16
Sn	M/ICP	ppm	4.86	2.28	23.5	57
Sr	M/ICP	ppm	21.1	4.02	9.54	89
Ta	M/ICP	ppm	2.47	0.65	13.1	54
Tb	M/ICP	ppm	0.58	0.06	4.80	32
Th	M/ICP	ppm	14.7	1.19	4.04	53
Ti	M/ICP	ppm	0.32	0.22	33.5	96
Tl	M/ICP	ppm	0.29	0.04	6.53	47
Tm	M/ICP	ppm	0.47	0.02	2.65	15
U	M/ICP	ppm	7.50	0.64	4.26	55
V	M/ICP	ppm	156	25.4	8.12	103
W	M/ICP	ppm	1.35	0.42	15.6	52
Y	M/ICP	ppm	24.5	4.63	9.45	77
Yb	M/ICP	ppm	3.07	0.22	3.66	31
Zn	M/ICP	ppm	18.7	4.12	11.0	75
Zr	M/ICP	ppm	180	16.8	4.67	82