



AMIS0160

Certified Reference Material

**Copper cobalt oxide ore
Mukondo, DRC**

Certificate of Analysis

**Recommended Concentrations and Limits¹
(at two Standard Deviations)**

Certified Concentrations²

Co F	3.16	±	0.31	%
Co M/ICP	3.10	±	0.18	%
Co P	3.03	±	0.21	%
Co XRF	3.16	±	0.17	%
Cu F	2.06	±	0.23	%
Cu M/ICP	2.04	±	0.08	%
Cu P	2.03	±	0.08	%
Cu XRF	2.04	±	0.16	%
Specific Gravity	2.83	±	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	9.88	±	0.22	%
CaO	0.41	±	0.04	%
Fe ₂ O ₃	2.49	±	0.14	%
K ₂ O	1.90	±	0.04	%
MgO	5.38	±	0.16	%
MnO	0.18	±	0.01	%
P ₂ O ₅	0.49	±	0.02	%
SiO ₂	65.53	±	1.58	%
TiO ₂	0.80	±	0.03	%

Provisional Concentrations

Cr ₂ O ₃	0.05	±	0.01	%
LOI	6.22	±	0.98	%

Informational Mean

Na ₂ O	0.10	%
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1. Intended Use: AMIS0160 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: AMIS0160 was made using run-of-mine oxide Cobalt-Copper ore from the Mukondo mine, owned and operated by BOSS Mining. The latter is a Joint Venture between the Central African Mining and Exploration Company (CAMEC), owned by Eurasian Natural Resources Corporation (Africa) (ENRC), and the parastatal mining company GECAMINES. The mine is situated in Katanga Province of the Democratic Republic of Congo 50km northwest of Likasi, 160km northwest of the regional capital Lubumbashi and 95km east of Kolwezi. The Mukondo deposit is located in the Katangan part of the Neoproterozoic Central African Copperbelt, a world-class metallogenic province of sediment hosted Cu-Co deposits. Mineralisation is hosted within the Mines Series, a package of sediments comprising largely altered dolomite and dolomitic shale units. Two ore horizons are commonly present although the high grade cobalt ore at Mukondo is largely concentrated in the "Upper Orezone" hosted by the SDB, a strongly dolomitic sandy shale at the base of a largely dolomitic shale sequence. The Mukondo deposit comprises two fragments of the Mines Series that strike approximately east-west and dip to the north. These

two rafts exhibit reversed stratigraphic sequences which may indicate they represent the limbs of an isoclinal, recumbent anticlinal fold the crest of which has been eroded.

3. Mineral and Chemical Composition: The main economic mineralogy comprises heterogenite and malachite with lesser amounts of pseudomalachite. Low levels of hematite and traces of goethite, rutile and dolomite have been observed in selected core samples. Co carbonate (sphaerocobaltite) mineralisation has been intersected in boreholes at depth.

4. Appearance: The material is a very fine Pale Red powder (Corstor colour chart – 10R 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.
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.

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 (not averages)
4. All results for Zn and major elements to be reported in %.
5. All results for multi-element scans to be reported in ppm.
6. Report all QC data, to include replicates, blanks and certified reference materials used.

9. Method of Certification: Nineteen laboratories were each given eight packages, comprising eight samples scientifically selected from throughout the batch. Eighteen laboratories reported results in time for certification of the economic elements. Eight 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. Genalysis Laboratory Services (South Africa) Pty
9. Genalysis Laboratory Services WA
10. Intertek Utama Services (Indonesia)
11. OMAC Laboratories Limited (Ireland)
12. Set Point Laboratories (Isando) SA
13. SGS Australia Pty Ltd (Newburn) WA
14. SGS Mineral Services Callao (Peru)
15. SGS Mineral Services Lakefield (Canada)
16. SGS South Africa (Pty) Ltd - Booyens
17. SGS Toronto (Canada)
18. 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	Co M/ICP	Co P	Co XRF	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 XRF	SG
	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%	%	%	%	%	%	%	%	%	%	%	%	
A	31800	32100		32300	20100	20200		19900	9.88	0.41	0.05	2.45	1.90	5.32	0.17	0.10		65.42	0.80	5.88	2.85
A	32000	31800		32900	20300	20400		20000	9.87	0.41	0.05	2.44	1.90	5.31	0.17	0.11		65.41	0.80	5.86	2.85
A	31500	32000		32700	20500	20300		19800	9.90	0.41	0.05	2.44	1.91	5.33	0.17	0.10		65.56	0.79	5.86	2.80
A	32000	31900		32700	20400	20000		20000	9.91	0.41	0.05	2.45	1.91	5.33	0.17	0.10		65.57	0.79	5.86	2.80
A	32200	31800		33200	20200	20200		20300	9.89	0.41	0.05	2.44	1.90	5.31	0.17	0.11		65.39	0.79	5.84	2.79
A	32000	32100		33100	20100	20200		20000	9.91	0.41	0.05	2.45	1.91	5.33	0.17	0.10		65.53	0.79	5.82	2.84
A	31800	31800		32700	20100	20400		19800	9.95	0.42	0.05	2.47	1.91	5.35	0.18	0.11		65.44	0.80	5.86	2.79
A	32100	32000		32800	20500	20200		20100	9.92	0.42	0.05	2.46	1.91	5.35	0.18	0.11		65.47	0.80	5.81	2.80
B	28800	31400			21700	20200			9.94	0.43	0.05	2.51	1.91	5.38	0.18	0.10		66.00	0.78	5.89	
B	30500	32700			19500	19400			9.97	0.42	0.05	2.51	1.93	5.37	0.18	0.10		66.10	0.79	5.90	
B	31200	31800			19800	20600			9.92	0.42	0.06	2.52	1.93	5.35	0.18	0.09		66.00	0.78	5.89	
B	31600	30800			20600	19000			9.98	0.43	0.05	2.51	1.93	5.38	0.18	0.09		66.00	0.78	5.89	
B	31300	31000			20100	20300			9.97	0.42	0.05	2.52	1.92	5.36	0.18	0.09		66.00	0.78	5.90	
B	32400	32400			20700	20000			9.97	0.42	0.05	2.51	1.92	5.35	0.18	0.09		66.00	0.79	5.89	
B	32400	31100			20900	19700			9.95	0.43	0.05	2.51	1.93	5.36	0.18	0.10		66.00	0.78	5.89	
B	30700	31800			22300	20100			9.95	0.42	0.06	2.52	1.92	5.37	0.18	0.10		66.10	0.79	5.89	
C				34500				19900													
C				32900				21000													
C				31600				20000													
C				31300				20000													
C				33300				20000													
C				34300				20000													
C				33200				20000													
C				31400				19800													
D				31000				20200													
D				31400				20500													
D				31200				20300													
D				31400				20300													
D				31400				20400													
D				31100				20200													
D				31400				20300													
D				31500				20400													
E		31547	31225			20659	20553														
E		31435	31049			20793	20463														
E		31369	31187			20590	20607														
E		31237	31236			20897	20575														
E		31820	31130			20976	20510														
E		31940	31076			20842	20705														
E		31482	31280			20805	20532														
E		31561	31553			20889	20742														
F		31678	31702	32000		20006	20337	18400	9.70	0.42	0.08	2.72	1.93	5.21	0.17	0.12	0.47	64.10	0.79	6.96	2.84
F		31524	31214	31000		20170	20088	17800	9.65	0.42	0.10	2.68	1.89	5.23	0.17	0.13	0.47	63.80	0.78	6.84	2.78
F		31338	31113	31900		20030	20192	18400	9.75	0.42	0.09	2.75	1.92	5.27	0.17	0.13	0.48	64.30	0.77	6.89	2.81
F		31557	30478	31900		20024	19816	18200	9.65	0.42	0.05	2.89	1.93	5.24	0.18	0.13	0.48	63.80	0.78	6.86	2.81
F		31635	31314	31600		20253	20032	18100	9.57	0.42	0.11	2.80	1.93	5.20	0.18	0.13	0.46	63.80	0.77	6.89	2.82
F		31422	31246	31700		20037	20250	18100	9.65	0.44	0.12	2.76	1.92	5.20	0.17	0.12	0.49	64.10	0.78	6.85	2.78
F		31412	31328	31600		20362	20245	18000	9.65	0.42	0.09	2.72	1.91	5.23	0.17	0.12	0.47	63.90	0.78	6.87	2.81
F		31380	31366	31700		20334	20376	18300	9.78	0.43	0.06	2.68	1.91	5.31	0.18	0.12	0.48	64.60	0.78	6.93	2.82

Assay data (cont)

Lab Code	Co F	Co M/ICP	Co P	Co XRF	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 XRF	SG	
	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%	%	%	%	%	%	%	%	%	%	%	%		
G								19400													2.83	
G								19100														2.84
G								18600														2.82
G								18800														2.83
G								19600														2.82
G								19600														2.83
G								19500														2.82
G								18600														2.82
H	33745	30798	31372		21533	20036	19452		9.66	0.40	0.05	2.49	1.92	5.33	0.17	0.07	0.49	65.48	0.79	5.94	2.84	
H	31380	30737	30555		20111	20070	18847		9.82	0.41	0.05	2.50	1.91	5.33	0.17	0.06	0.50	65.70	0.80	5.93	2.85	
H	31354	30895	31394		20172	20212	19205		9.80	0.40	0.05	2.49	1.91	5.33	0.17	0.07	0.48	65.42	0.80	5.93	2.85	
H	32047	31362	31797		20471	20298	19705		9.78	0.41	0.05	2.48	1.91	5.33	0.17	0.06	0.50	65.38	0.79	5.91	2.87	
H	32051	31652	30280		20484	20510	18642		9.80	0.41	0.05	2.50	1.91	5.30	0.17	0.07	0.48	65.44	0.80	5.91	2.83	
H	32102	31003	30394		20733	20246	18915		9.81	0.44	0.05	2.49	1.90	5.37	0.17	0.07	0.49	65.65	0.81	5.92	2.84	
H	32596	30668	31209		20798	20118	19322		9.82	0.41	0.05	2.49	1.90	5.37	0.17	0.07	0.49	65.46	0.80	5.92	2.88	
H	31379	30941	30911		20184	20350	19203		9.76	0.41	0.05	2.49	1.91	5.29	0.17	0.07	0.49	65.32	0.81	5.85	2.85	
J		31300	30300			20200	20200		9.87	0.41	0.02	2.44	1.90	5.42	0.17	0.10	0.49	65.28	0.78	5.70		
J		31900	31000			20400	20800		9.87	0.42	0.02	2.45	1.91	5.44	0.17	0.11	0.50	65.40	0.79	5.60		
J		31600	30900			20500	20800		9.87	0.41	0.02	2.45	1.91	5.43	0.17	0.10	0.50	65.14	0.78	5.80		
J		31700	31000			20300	20700		9.90	0.41	0.03	2.47	1.91	5.45	0.17	0.10	0.50	65.34	0.78	5.80		
J		31600	30800			20700	20800		9.88	0.41	0.02	2.45	1.91	5.42	0.17	0.11	0.50	65.25	0.78	5.70		
J		31900	30800			20500	20600		9.88	0.41	0.02	2.45	1.91	5.43	0.17	0.11	0.50	65.17	0.78	5.80		
J		31700	30700			20400	20700		9.92	0.42	0.02	2.47	1.92	5.46	0.17	0.10	0.50	65.31	0.78	5.80		
J		31400	30200			20100	20300		9.88	0.41	0.02	2.46	1.91	5.44	0.17	0.11	0.50	65.28	0.78	5.80		
K	32074	29314	30770	31443	19712	20964	20362	21233	10.01	0.39	0.05	2.50	1.88	5.40	0.19	0.08	0.49	65.60	0.80	7.07	2.71	
K	28453	30022	30079	31787	18775	21065	19735	21476	9.95	0.41	0.05	2.49	1.90	5.38	0.19	0.06	0.51	65.69	0.81	7.04	2.78	
K	29821	29767	30306	31884	18322	20651	20158	21699	9.82	0.41	0.05	2.50	1.89	5.40	0.19	0.08	0.50	66.20	0.80	7.07	2.72	
K	28608	29669	30562	32039	18111	20727	20350	21515	9.93	0.40	0.06	2.47	1.89	5.36	0.19	0.08	0.50	65.74	0.80	7.10	2.71	
K	30033	30636	29851	32078	18850	21346	20307	21321	9.98	0.41	0.05	2.50	1.88	5.35	0.19	0.08	0.50	65.74	0.80	7.20	2.77	
K	27417	29983	29761	31683	18358	20836	20806	21306	9.95	0.40	0.05	2.48	1.89	5.37	0.19	0.08	0.51	65.52	0.79	7.18	2.75	
K	28369	29437	30172	31738	18182	20950	20876	21389	9.87	0.40	0.05	2.45	1.88	5.32	0.19	0.07	0.52	65.09	0.80	7.22	2.72	
K	30701	29048	30868	32194	18976	20232	20277	21767	9.89	0.41	0.05	2.50	1.89	5.39	0.19	0.08	0.52	65.65	0.79	7.02	2.71	
L		34800				20100			7.94	0.52		2.59		4.12	0.16	0.08		68.53				
L		35900				19800			7.99	0.53		2.57		4.11	0.17	0.08		69.11				
L		33800				20100			7.86	0.50		2.56		4.16	0.17	0.07		68.86				
L		34700				20200			8.11	0.53		2.60		4.18	0.16	0.07		69.10				
L		33200				19900			7.99	0.55		2.56		4.16	0.17	0.08		69.00				
L		34800				20600			8.12	0.55		2.62		4.11	0.17	0.08		68.83				
L		36000				20300			7.94	0.55		2.59		4.16	0.17	0.08		68.50				
L		35400				20000			7.88	0.52		2.67		4.13	0.17	0.08		68.77				
M		28000	29200	32100		19800	20400		9.84	0.40	0.04	2.45	1.90	5.29	0.17	0.07		65.70	0.79	5.88		
M		29900	29700	32000		20600	20900		9.85	0.40	0.04	2.45	1.89	5.28	0.17	0.08		65.60	0.79	5.99		
M		29600	26700	32000		20800	18400		9.85	0.40	0.05	2.45	1.90	5.28	0.17	0.08		65.70	0.79	5.94		
M		30500	29000	32000		21000	20300		9.83	0.40	0.04	2.44	1.90	5.30	0.17	0.08		65.60	0.79	5.97		
M		29000	29200	32000		20200	20500		9.84	0.40	0.05	2.45	1.89	5.29	0.17	0.08		65.70	0.78	5.93		
M		28900	29400	32100		20300	20300		9.84	0.40	0.04	2.46	1.90	5.30	0.17	0.08		65.60	0.78	5.96		
M		30100	29700	32100		20700	20600		9.83	0.40	0.04	2.46	1.90	5.32	0.17	0.08		65.60	0.80	5.95		
M		29600	28900	32100		20800	20200		9.83	0.41	0.05	2.46	1.90	5.34	0.18	0.09		65.50	0.81	5.94		
N		30500	30600			19950	20300		9.88	0.41	0.04	2.39	1.90	5.44	0.17	0.15		65.40	0.78	5.88		
N		30700	31100			19750	20200		9.87	0.41	0.04	2.38	1.90	5.45	0.17	0.16		65.50	0.78	5.88		
N		31200	29300			20100	19750		9.86	0.41	0.04	2.42	1.90	5.44	0.18	0.15		65.30	0.77	5.87		
N		31000	31100			19750	20000		9.84	0.41	0.04	2.42	1.90	5.44	0.17	0.14		65.40	0.78	5.86		
N		29000	30100			19550	19850		9.83	0.41	0.04	2.44	1.90	5.43	0.18	0.15		65.20	0.78	5.93		
N		30800	30000			19550	20300		9.87	0.41	0.04	2.41	1.90	5.45	0.17	0.15		65.30	0.77	5.90		
N		29700	31200			19750	20300		9.84	0.41	0.04	2.43	1.89	5.44	0.17	0.16		65.30	0.80	5.88		
N		30100	30000			19650	19800		9.86	0.41	0.04	2.44	1.90	5.44	0.18	0.15		65.30	0.79	5.88		
O	30300	30600	30400		20300	21000	20100		10.02	0.39	0.05	2.41	1.85	5.41	0.17	0.09		65.00	0.84	6.71	2.86	
O	29900	29600	30000		19750	20800	20100		10.05	0.40	0.05	2.40	1.86	5.40	0.17	0.08		65.25	0.83	6.71	2.77	
O	29600	30600	30600		19650	21000	20300		10.04	0.39	0.05	2.40	1.87	5.43	0.17	0.09		65.20	0.83	6.70	2.88	
O	29400	30600	31700		19700	21500	20400		10.10	0.40	0.05	2.42	1.87	5.41	0.18	0.08		65.19	0.83	6.69	2.81	
O	29700	31200	30700		19800	21200	20600		10.05	0.39	0.05	2.42	1.86	5.40	0.18	0.09		65.23	0.83	6.70	2.81	
O	30300	30100	27400		20000	19200	20100		10.10	0.40	0.05	2.41	1.87	5.43	0.18	0.09		65.05	0.83	6.74	2.86	
O	29700	30600	27900		19750	19250	20500		10.06	0.39	0.05	2.41	1.85	5.39	0.18	0.09		65.00	0.83	6.73	2.88	
O	30100	30600	27300		19700	18900	20300		10.07	0.40	0.05	2.42	1.87	5.42	0.18	0.09		65.24	0.82	6.70	2.87	
P	30800	29100	29900	31200	20000	20100	20800	21200	9.93	0.41	0.05	2.43	1.88	5.47	0.17	0.16	0.48	66.30	0.82	5.87		
P	30800	30500	28600	31100	20000	20700	19600	21300	9.91	0.42	0.05	2.41	1.88	5.46	0.17	0.16	0.48	66.00	0.81	5.85		
P	29800	30400	29500	31500	19550	20500	20300	21500	10.00	0.42	0.05	2.44	1.90	5.51	0.17	0.17	0.49	66.60	0.82	5.79		
P	30900	28800	30300	31200	20300	19750	21100	21300	9.93	0.41	0.05	2.43	1.88	5.47	0.17	0.16	0.49	66.10	0.81	5.83		
P	30600	29700	28800	31300	20200	19950																

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	1572	1465	730	526
Co	M/ICP	ppm	901	605	492	175
Co	P	ppm	1028	719	617	227
Co	XRF	ppm	871	834	347	298
Cu	F	ppm	1170	1133	457	405
Cu	M/ICP	ppm	415	274	234	79
Cu	P	ppm	379	149	343	61
Cu	XRF	ppm	782	849	247	322
Al ₂ O ₃	XRF	%	0.110	0.084	0.047	0.025
CaO	XRF	%	0.016	0.012	0.006	0.004
Cr ₂ O ₃	XRF	%	0.005	0.004	0.003	0.001
Fe ₂ O ₃	XRF	%	0.072	0.054	0.032	0.016
K ₂ O	XRF	%	0.018	0.015	0.007	0.005
MgO	XRF	%	0.079	0.066	0.027	0.020
MnO	XRF	%	0.007	0.005	0.003	0.001
Na ₂ O	XRF	%	0.030	0.026	0.006	0.008
P ₂ O ₅	XRF	%	0.012	0.011	0.006	0.004
SiO ₂	XRF	%	0.792	0.637	0.179	0.185
TiO ₂	XRF	%	0.017	0.013	0.007	0.004
LOI	XRF	%	0.482	0.425	0.038	0.128
SG			0.031	0.023	0.022	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: AMIS0160 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.

19 May 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. This data has been compiled and iterated; some of the elements could be certified (if requested). It is presented below for informational use.

AMIS0160 Trace

Element	Unit	Mean	2SD	RSD%	n
Al	%	5.1	0.2	2.1	47
As	ppm	25	5	9.7	45
B	ppm	610	37	3.0	8
Ba	ppm	133	20	7.4	56
Be	ppm	5.6	0.5	4.3	31
Bi	ppm	3.8	0.1	1.9	16
Ca	%	0.3	0.02	3.2	54
Cd	ppm	0.2	0.0	0.0	7
Ce	ppm	131	9	3.5	24
Cr	ppm	270	52	9.6	40
Cs	ppm	1.9	0.1	3.8	16
Dy	ppm	5.2	0.1	1.4	15
Er	ppm	3.1	0.1	1.6	16
Eu	ppm	1.7	0.0	1.4	14
Fe	%	1.7	0.1	2.4	48
Ga	ppm	14	0	1.3	15
Gd	ppm	6.7	0.2	1.3	14
Hf	ppm	4.8	2.2	23.4	16
Ho	ppm	1.1	0.1	2.4	16
In	ppm	0.3	0.02	2.8	16
K	%	1.6	0.1	3.2	54
La	ppm	76	6	4.2	31
Li	ppm	205	19	4.5	55
Lu	ppm	0.4	0.02	2.4	16
Mg	%	3.3	0.4	5.5	55
Mn	ppm	1363	89	3.3	55
Mo	ppm	6.1	1.2	9.9	40
Na	%	0.1	0.01	11.2	55
Nb	ppm	13	9	35.0	32
Nd	ppm	59	1	0.9	15
Ni	ppm	29	13	21.4	94
P	%	0.2	0.02	4.8	48
Pb	ppm	15	10	34.2	76
Pr	ppm	16	1	3.3	16
Rb	ppm	61	5	3.8	23
S	%	0.1	0.01	7.4	72
Sb	ppm	7.8	4.5	28.7	40
Sc	ppm	13	1	5.4	48
Si	%	31	0.2	0.3	8
Sm	ppm	10	0	2.2	16
Sn	ppm	2.2	0.4	9.1	14
Sr	ppm	23	4	7.7	55
Ta	ppm	4.4	10.1	115.1	24
Tb	ppm	0.9	0.03	1.5	15
Te	ppm	0.1	0.1	39.1	5
Th	ppm	12	4	16.6	24
Ti	%	0.4	0.2	23.8	48
Tl	ppm	47	134	143.2	24
Tm	ppm	0.4	0.02	2.5	16
U	ppm	17	1	2.0	15
V	ppm	149	13	4.3	56
W	ppm	1.0	0.7	35.5	16
Y	ppm	29	6	9.5	36
Yb	ppm	2.8	0.2	4.4	16
Zn	ppm	109	22	10.3	95
Zr	ppm	150	52	17.5	47