African Mineral Standards
REFERENCE MATERIALS FOR AFRICAN ORES

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AMIS0161

Certified Reference Material

Copper cobalt oxide ore
Mukondo, DRC

Certificate of Analysis

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

Certified Concentrations[2.]

Co F	1.55	±	0.13	%
Co M/ICP	1.50	±	0.11	%
Co P	1.47	±	0.08	%
Co XRF	1.50	±	0.07	%
Cu F	4542	±	377	ppm
Cu M/ICP	4535	±	200	ppm
Cu P	4419	±	300	ppm
Cu XRF	4478	±	228	ppm
Specific Gravity	2.74	±	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_2O_3	11.91	±	0.24	%
CaO	0.37	±	0.02	%
Fe_2O_3	2.00	±	0.06	%
K_2O	2.44	±	0.04	%
MgO	5.67	±	0.20	%
MnO	0.08	±	0.01	%
P_2O_5	0.13	±	0.01	%
SiO_2	68.19	±	1.34	%
TiO_2	0.77	±	0.03	%

Provisional Concentrations

Cr_2O_3	0.04	±	0.01	%
LOI	5.78	±	1.06	%

Informational Mean

Na_2O	0.09	%

1. Intended Use: AMIS0161 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: AMIS0161 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 <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 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 (Al_2O_3, CaO, Cr_2O_3, Fe_2O_3, K_2O, MgO, MnO, Na_2O, SiO_2, 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 - Booysens
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	CaO	Cr2O3	Fe2O3	K2O	MgO	MnO	Na2O	P2O5	SiO2	TiO2	LOI	SG
	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%	%	%	%	%	%	%	%	%	%	%	%	
A		15300	14000			4560	4130		11.97	0.38	0.04	2.01	2.47	5.78	0.08	0.08	0.13	68.35	0.76	5.20	
A		15300	14300			4450	4100		11.93	0.38	0.06	2.01	2.45	5.76	0.08	0.07	0.13	68.20	0.76	5.20	
A		15200	14100			4470	4130		11.94	0.38	0.03	2.03	2.46	5.77	0.08	0.07	0.13	68.31	0.76	5.20	
A		15600	14400			4410	4130		11.89	0.37	0.03	1.99	2.45	5.72	0.07	0.07	0.13	67.98	0.75	5.20	
A		15400	14000			4550	4100		11.93	0.38		2.00	2.46	5.74	0.08	0.08	0.13	68.37	0.76	5.20	
A		15300	14400			4490	4100		11.89	0.37	0.01	1.98	2.45	5.72	0.07	0.07	0.13	68.00	0.75	5.20	
A		15600	14600			4510	4180		11.92	0.37		1.99	2.46	5.75	0.08	0.07	0.13	68.01	0.75	5.30	
A		15400	14500			4540	4110		11.92	0.38	0.03	2.01	2.46	5.76	0.08	0.08	0.13	68.19	0.77	5.20	
B	13474	14035	14846	15336	4004	4679	4646	4782	11.92	0.36	0.05	2.01	2.41	5.68	0.08	0.07	0.13	68.00	0.76	6.50	2.70
B	14973	14491	14681	15316	4159	4698	4856	4530	11.99	0.36	0.05	2.00	2.39	5.64	0.08	0.06	0.14	68.02	0.77	6.55	2.70
B	15707	14482	14772	15287	4452	4670	4399	4637	11.99	0.36	0.05	1.99	2.33	5.61	0.08	0.06	0.13	67.18	0.75	6.51	2.65
B	14141	14439	15136	14938	4048	4815	4516	4559	11.79	0.35	0.04	1.97	2.35	5.59	0.08	0.06	0.13	67.14	0.74	6.80	2.64
B	15651	14826	14844	15423	4388	4669	4641	4792	11.97	0.36	0.05	2.01	2.39	5.63	0.08	0.07	0.14	68.07	0.76	6.63	2.69
B	15609	14795	14768	15472	4346	4747	4495	4802	11.93	0.36	0.05	2.02	2.41	5.70	0.08	0.06	0.13	68.55	0.77	6.42	2.65
B	15355	14283	14946	15375	4294	4677	4683	4530	12.00	0.35	0.04	1.96	2.35	5.59	0.08	0.05	0.13	67.37	0.75	6.71	2.64
B	15100	14535	15023	15404	4200	4895	4573	4656	12.01	0.36	0.05	2.01	2.37	5.65	0.08	0.07	0.13	67.46	0.76	6.48	2.71
C	15300	14300			4510	4470			12.00	0.37	0.05	2.03	2.48	5.69	0.08	0.09		68.50	0.76	5.34	
C	15200	14800			4550	4460			11.90	0.38	0.05	2.05	2.47	5.68	0.08	0.09		68.50	0.76	5.39	
C	15400	15800			4510	4490			11.90	0.38	0.05	2.03	2.47	5.70	0.08	0.10		68.60	0.76	5.35	
C	14900	14000			4360	4260			11.90	0.38	0.05	2.02	2.45	5.68	0.08	0.09		68.60	0.76	5.30	
C	15600	14800			4610	4500			12.00	0.38	0.05	2.05	2.47	5.70	0.08	0.07		68.50	0.76	5.32	
C	15900	14900			4600	4480			12.00	0.38	0.05	2.02	2.47	5.69	0.08	0.09		68.60	0.75	5.34	
C	15400	13900			4500	4530			12.00	0.38	0.05	2.03	2.47	5.66	0.08	0.09		68.60	0.76	5.33	
C	14900	14500			4300	4500			12.00	0.38	0.05	2.04	2.47	5.66	0.08	0.08		68.60	0.76	5.34	
D				14900		4460	4570														
D				15000		4390	4570														
D				15000		4480	4450														
D				15000		4360	4790														
D				15200		4490	4550														
D				15000		4410	4520														
D				15000		4310	4550														
D				15000		4460	4620														
E				15400			4400	4600	11.70	0.36	0.04	1.97	2.43	5.58	0.08	0.05	0.12	67.30	0.75	6.27	
E				15200			4300	4500	11.70	0.36	0.05	1.96	2.44	5.56	0.08	0.05	0.13	67.30	0.76	6.30	
E				15000			4300	4400	11.70	0.37	0.04	1.98	2.43	5.54	0.07	0.06	0.12	67.40	0.77	6.30	
E				15000			4300	4400	11.80	0.37	0.04	2.00	2.43	5.61	0.06	0.06	0.12	67.70	0.76	6.34	
E				15000			4200	4400	11.70	0.37	0.04	1.99	2.44	5.57	0.07	0.07	0.13	67.80	0.76	6.38	
E				15200			4100	4500	11.70	0.37	0.05	1.98	2.45	5.59	0.07	0.06	0.13	67.50	0.76	6.25	
E				15000			4500	4400	11.70	0.37	0.03	2.00	2.43	5.59	0.07	0.06	0.13	67.10	0.76	6.22	
E				15000			4400	4400	11.80	0.36	0.04	1.97	2.44	5.55	0.07	0.08	0.12	67.50	0.76	6.30	
F		15847	15719			4509	4519														
F		15894	15647			4571	4421														
F		15945	15878			4531	4514														
F		16072	15938			4551	4483														
F		15716	15911			4524	4430														
F		16023	15943			4521	4497														
F		16094	15592			4526	4487														
F		16094	15991			4565	4455														
G		15700	15200	14800		4470	4430	4300	11.50	0.37	0.07	2.05	2.40	5.50	0.07	0.10	0.12	65.80	0.74	6.36	2.78
G		15700	15100	14800		4330	4400	4400	11.70	0.38	0.07	2.07	2.42	5.57	0.08	0.10	0.12	66.70	0.75	6.37	2.72
G		15300	15300	14200		4450	4420	4500	11.60	0.37	0.05	2.13	2.43	5.54	0.08	0.10	0.13	66.70	0.75	6.39	2.72
G		14600	15300	14500		4350	4500	4000	11.70	0.38	0.08	2.14	2.43	5.57	0.08	0.11	0.12	67.10	0.75	6.41	2.72
G		15400	15300	14600		4480	4480	4400	11.10	0.38	0.06	1.98	2.44	5.49	0.08	0.09	0.11	63.00	0.73	6.37	2.73
G		15300	15100	14400		4460	4580	4300	11.60	0.38	0.06	2.02	2.44	5.60	0.08	0.10	0.12	66.40	0.76	6.36	2.75
G		15000	15200	14700		4520	4410	4400	11.70	0.39	0.04	2.04	2.44	5.58	0.07	0.09	0.13	66.50	0.75	6.32	2.73
G		15300	15100	14700		4480	4480	4500	11.70	0.38	0.07	2.07	2.44	5.63	0.08	0.09	0.13	67.00	0.76	6.42	2.72

Assay data (cont)

Lab Code	Co F	Co M/ICP	Co P	Co XRF	Cu F	Cu M/ICP	Cu P	Cu XRF	Al2O3	CaO	Cr2O3	Fe2O3	K2O	MgO	MnO	Na2O	P2O5	SiO2	TiO2	LOI	SG
	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%	%	%	%	%	%	%	%	%	%	%	%	
H	16550	15400	14850		4830	4680	4710		12.05	0.46		2.07		5.86	0.08		0.13	73.10	0.79		2.81
H	16300	14950	15400		4770	4580	4560		11.95	0.46		2.03		5.80	0.08		0.10	72.70	0.78		2.80
H	16550	14600	14950		4820	4500	4460		12.05	0.45		2.01		5.85	0.08		0.12	73.10	0.79		2.78
H	16500	15050	15050		4830	4650	4450		12.10	0.46		2.01		5.88	0.08		0.11	73.30	0.79		2.76
H	16350	14650	15500		4830	4570	4590		12.05	0.44		2.00		5.86	0.08		0.12	73.00	0.78		2.79
H	16450	14950	15100		4770	4610	4500		11.90	0.47		1.97		5.80	0.08		0.12	72.30	0.78		2.76
H	16450	15000	14700		4810	4580	4330		12.05	0.45		1.98		5.83	0.08		0.14	71.90	0.79		2.74
H	16200	15000	15100		4770	4570	4470		11.95	0.44		1.95		5.80	0.08		0.10	71.60	0.78		2.78
I		14500	13700	15500		4600	4400	4600	11.90	0.37	0.04	2.00	2.45	5.58	0.08	0.08		68.50	0.75	5.45	
I		14900	14200	15500		4590	4510	4590	11.90	0.36	0.05	1.99	2.44	5.61	0.08	0.07		68.50	0.75	5.46	
I		14450	14300	15550		4570	4590	4600	11.95	0.37	0.05	2.01	2.45	5.62	0.08	0.08		68.40	0.75	5.44	
I		14700	13950	15500		4620	4450	4540	11.90	0.36	0.05	2.00	2.44	5.62	0.08	0.08		68.20	0.75	5.72	
I		14700	14250	15450		4600	4430	4580	11.85	0.37	0.06	2.00	2.44	5.61	0.08	0.08		68.30	0.75	5.62	
I		14650	13650	15400		4520	4440	4610	11.90	0.37	0.04	1.99	2.45	5.60	0.08	0.09		68.40	0.76	5.58	
I		14900	14300	15450		4630	4540	4590	11.85	0.37	0.05	2.01	2.44	5.60	0.08	0.09		68.30	0.77	5.60	
I		14000	14150	15500		4410	4510	4600	11.85	0.37	0.05	2.01	2.43	5.59	0.08	0.08		68.30	0.76	5.60	
J		14700	14600			4350	4450		11.90	0.37	0.04	1.99	2.44	5.78	0.08	0.12		68.20	0.76	5.36	
J		14350	14750			4340	4440		11.90	0.37	0.03	1.97	2.44	5.78	0.08	0.12		68.30	0.76	5.31	
J		14950	15250			4360	4510		11.90	0.37	0.04	1.96	2.43	5.77	0.07	0.12		68.30	0.75	5.33	
J		14750	14850			4380	4450		11.90	0.37	0.03	1.95	2.44	5.77	0.07	0.11		68.40	0.75	5.31	
J		14850	14700			4440	4420		11.90	0.37	0.04	1.97	2.45	5.78	0.08	0.11		68.30	0.76	5.32	
J		14750	15050			4410	4520		11.90	0.37	0.04	1.96	2.45	5.78	0.08	0.12		68.30	0.78	5.32	
J		14850	14600			4440	4380		11.95	0.37	0.03	1.94	2.45	5.79	0.07	0.11		68.40	0.74	5.30	
J		14750	14950			4360	4440		11.90	0.37	0.03	1.97	2.45	5.78	0.08	0.12		68.30	0.76	5.30	
K	14850	14350	15150		4490	4710	4430		11.45	0.34	0.04	1.95	2.23	5.29	0.07	0.07	0.10	69.90	0.75	6.21	2.84
K	15050	14450	14500		4520	4580	4350		11.65	0.35	0.04	2.00	2.28	5.40	0.08	0.08	0.11	69.10	0.77	6.49	2.75
K	14900	15000	14750		4470	4620	4510		12.00	0.35	0.05	2.02	2.34	5.48	0.08	0.09	0.12	70.60	0.78	6.45	2.72
K	14350	14800	14750		4330	4520	4490		11.75	0.34	0.04	1.98	2.29	5.41	0.08	0.09	0.12	68.90	0.77	6.50	2.85
K	14650	14800	14850		4450	4580	4490		12.05	0.35	0.05	2.04	2.35	5.55	0.08	0.09	0.12	71.00	0.79	6.19	2.72
K	14650	14450	14350		4420	4490	4360		11.75	0.34	0.04	1.98	2.32	5.41	0.08	0.09	0.12	69.70	0.77	6.79	2.73
K	14950	15100	14650		4430	4570	4510		11.85	0.35	0.04	2.01	2.31	5.46	0.08	0.09	0.12	69.70	0.77	6.42	2.74
K	14550	14100	14500		4410	4500	4320		11.80	0.36	0.04	2.14	2.32	5.46	0.09	0.09	0.12	69.90	0.77	6.40	2.75
L	14450	14600	14500	15050	4120	4460	4370	4630	11.95	0.37	0.04	1.96	2.41	5.79	0.08	0.13	0.13	69.10	0.79	5.26	
L	15250	14900	14550	14900	4440	4570	4520	4590	11.90	0.37	0.04	1.95	2.40	5.77	0.08	0.12	0.13	68.80	0.79	5.17	
L	15450	14650	14400	15000	4490	4480	4440	4580	11.95	0.37	0.04	1.98	2.40	5.77	0.08	0.13	0.12	68.80	0.78	5.27	
L	15400	14900	14850	14850	4450	4520	4370	4590	11.85	0.37	0.04	1.97	2.38	5.73	0.08	0.12	0.12	68.30	0.77	5.27	
L	15000	14850	14500	15100	4350	4510	4560	4450	12.00	0.38	0.05	1.97	2.42	5.80	0.08	0.13	0.13	69.20	0.78	5.25	
L	15500	14750	14600	14950	4480	4470	4580	4590	11.95	0.37	0.04	1.95	2.41	5.76	0.08	0.12	0.12	68.80	0.78	5.24	
L	15000	14500	14550	14900	4370	4420	4430	4580	11.95	0.37	0.04	1.94	2.40	5.77	0.08	0.13	0.12	68.70	0.78	5.27	
L	14900	14700	14950	15150	4350	4540	4430	4690	12.00	0.37	0.04	1.98	2.43	5.83	0.08	0.13	0.13	69.40	0.79	5.28	
M	15274	15442	14922		4504	4451	4301		11.93	0.36	0.04	2.02	2.48	5.65	0.07	0.07	0.13	68.47	0.77	5.40	2.84
M	14925	15496	14645		4378	4521	4169		11.80	0.37	0.04	2.02	2.45	5.62	0.08	0.08	0.13	68.33	0.76	5.39	2.75
M	15057	15394	14476		4333	4507	4135		12.05	0.37	0.04	2.02	2.45	5.70	0.07	0.08	0.13	68.48	0.77	5.39	2.72
M	15155	15374	14251		4453	4462	4096		11.89	0.36	0.04	2.01	2.46	5.67	0.08	0.07	0.14	68.24	0.77	5.40	2.73
M	15030	15221	14030		4296	4496	4018		11.84	0.36	0.04	2.03	2.46	5.66	0.08	0.06	0.13	68.51	0.77	5.41	2.84
M	14843	15457	14350		4618	4517	4151		11.92	0.36	0.04	2.02	2.46	5.62	0.07	0.07	0.13	68.33	0.78	5.40	2.70
M	14856	15416	14688		4333	4527	4213		11.91	0.36	0.04	2.02	2.46	5.65	0.07	0.07	0.12	68.15	0.77	5.41	2.76
M	14890	15492	14179		4603	4535	4061		11.88	0.36	0.04	2.03	2.46	5.67	0.08	0.06	0.13	68.70	0.77	5.40	2.75
O	15800	14400	12700	14300	4700	4700	4000	4500	12.13	0.34	0.04	2.01	2.45	5.16	0.08	0.13	0.13	67.95	0.78	6.22	2.73
O	15700	14700	12400	14400	4700	4700	4000	4500	12.11	0.34	0.04	2.01	2.45	5.14	0.08	0.13	0.14	67.96	0.78	6.23	2.75
O	15800	14500	12700	14400	4800	4700	4100	4300	12.04	0.33	0.04	2.01	2.45	5.16	0.08	0.13	0.13	68.09	0.78	6.23	2.72
O	15500	14500	12800	14500	4700	4700	3900	4400	12.08	0.33	0.04	2.01	2.43	5.16	0.08	0.12	0.13	68.00	0.78	6.23	2.74
O	15900	14500	12300	14200	4800	4700	4000	4400	12.12	0.34	0.04	2.01	2.45	5.15	0.08	0.13	0.13	67.95	0.78	6.25	2.75
O	15800	14700	12700	14500	4800	4700	3900	4400	12.03	0.34	0.04	2.01	2.45	5.15	0.08	0.13	0.14	68.03	0.78	6.26	2.73
O	15900	14500	13100	14500	4800	4700	4000	4400	12.08	0.34	0.04	2.01	2.45	5.18	0.08	0.13	0.13	67.95	0.78	6.22	2.73
O	15900	14500	12500	14400	4800	4700	4000	4300	12.07	0.34	0.04	2.00	2.46	5.19	0.08	0.14	0.14	67.99	0.78	6.22	2.76
Q	16400	16300		14900	4680	4630		4450	11.88	0.37	0.04	1.99	2.44	5.67	0.08	0.09		68.20	0.77	5.32	2.78
Q	16400	16300		15100	4640	4490		4490	11.90	0.37	0.04	1.98	2.44	5.66	0.08	0.09		68.12	0.76	5.36	2.79
Q	16200	16300		15000	4620	4510		4530	11.85	0.37	0.04	1.99	2.44	5.65	0.08	0.09		68.18	0.76	5.33	2.75
Q	16400	16100		15100	4680	4710		4490	11.90	0.37	0.04	1.98	2.44	5.66	0.08	0.08		68.18	0.76	5.33	2.75
Q	16200	16100		15200	4640	4590		4470	11.90	0.37	0.05	1.99	2.44	5.66	0.08	0.09		68.09	0.76	5.33	2.74
Q	16100	16300		15100	4600	4530		4480	11.93	0.37	0.04	2.00	2.45	5.67	0.08	0.08		68.17	0.77	5.40	2.79
Q	16400	16300		15600	4680	4690		4560	11.92	0.37	0.05	1.99	2.45	5.67	0.08	0.09		68.01	0.76	5.38	2.73
Q	16300	16100		15300	4660	4680		4560	11.92	0.37	0.04	1.98	2.44	5.66	0.08	0.08		68.25	0.77	5.32	2.74
R				19500				4500													2.77
R				20100				4200													2.76
R				19900				4400													2.75
R				19900				4200													2.76
R				19900				4400													2.76
R				20400				4300													2.76
R				20300				4400													2.76
R				20300				4300													2.76
S		18100				4100			8.94	0.25		1.77		8.01	0.07	0.07		71.53			
S		19800				4200			8.98	0.25		1.73		8.07	0.07	0.07		71.46			
S		17900				4100			9.15	0.25		1.80		8.39	0.07	0.07		71.02			
S		16500				4200			8.69	0.25		1.87		8.04	0.07	0.07		72.12			
S		16400				4200			8.66	0.25		1.74		8.12	0.07	0.07		72.65			
S		14900				4200			8.74	0.25		1.92		8.11	0.07	0.07		72.13			
S		17400				4100			8.79	0.25		1.80		7.97	0.07	0.07		71.40			
S		16900				4100			8.66	0.25		1.84		8.11	0.07	0.07		72.43			

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:

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]	σL [2]	Sw [3]	CSU [4]
Co	F	ppm	640	605	282	217
Co	M/ICP	ppm	412	291	245	92
Co	P	ppm	524	445	220	143
Co	XRF	ppm	365	355	146	127
Cu	F	ppm	188	174	87	63
Cu	M/ICP	ppm	104	68	57	19
Cu	P	ppm	158	115	78	34
Cu	XRF	ppm	114	92	71	34
Al2O3	XRF	%	0.151	0.099	0.090	0.029
CaO	XRF	%	0.017	0.013	0.005	0.004
Cr2O3	XRF	%	0.006	0.004	0.005	0.001
Fe2O3	XRF	%	0.028	0.017	0.019	0.005
K2O	XRF	%	0.028	0.022	0.013	0.007
MgO	XRF	%	0.113	0.092	0.034	0.027
MnO	XRF	%	0.004	0.002	0.003	0.001
Na2O	XRF	%	0.023	0.018	0.006	0.005
P2O5	XRF	%	0.007	0.004	0.005	0.002
SiO2	XRF	%	0.937	0.694	0.311	0.195
TiO2	XRF	%	0.013	0.009	0.007	0.002
LOI	XRF	%	0.530	0.445	0.076	0.129
SG			0.032	0.023	0.021	0.008

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: AMIS0161 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.

AMIS0161 Trace						
Analyte	Method	Unit	Mean	2SD	RSD%	n
Al	M/ICP	%	6.26	0.34	2.7	45
As	M/ICP	ppm	14	4.3	14.8	47
B	M/ICP	ppm	578			8
Ba	M/ICP	ppm	163	15	4.6	54
Be	M/ICP	ppm	4.05	0.51	6.3	40
Bi	M/ICP	ppm	3.58	0.79	11.0	17
Ca	M/ICP	%	0.27	0.02	3.2	53
Cd	M/ICP	ppm	0.20			7
Ce	M/ICP	ppm	77	7.5	4.9	24
Cr	M/ICP	ppm	224	108	24.2	56
Cs	M/ICP	ppm	2.42	0.04	0.9	14
Dy	M/ICP	ppm	4.90	0.36	3.6	16
Er	M/ICP	ppm	2.95	0.07	1.1	14
Eu	M/ICP	ppm	1.22	0.04	1.7	16
Fe	M/ICP	%	1.41	0.07	2.5	47
Ga	M/ICP	ppm	16	4.4	13.5	24
Gd	M/ICP	ppm	5.34	1.7	16.0	18
Hf	M/ICP	ppm	4.88	2.3	23.7	16
Ho	M/ICP	ppm	1.04	0.07	3.2	16
In	M/ICP	ppm	0.23	0.01	2.2	15
K	M/ICP	%	2.04	0.14	3.4	54
La	M/ICP	ppm	45	3.6	4.0	38
Li	M/ICP	ppm	219	22	5.0	46
Lu	M/ICP	ppm	0.41	0.02	1.9	14
Mg	M/ICP	%	3.56	0.17	2.4	46
Mn	M/ICP	ppm	602	60	4.9	54
Mo	M/ICP	ppm	2.50	0.80	16.1	38
Na	M/ICP	%	0.06	0.01	11.5	54
Nb	M/ICP	ppm	17	16	47.1	40
Nd	M/ICP	ppm	37	0.9	1.2	15
Ni	M/ICP	ppm	16	10	29.4	76
P	M/ICP	%	0.06	0.01	6.3	47
Pb	M/ICP	ppm	14	7.6	27.2	75
Pr	M/ICP	ppm	9.55	0.32	1.7	16
Rb	M/ICP	ppm	75	4.6	3.1	23
S	M/ICP	%	0.02	0.004	9.9	39
Sb	M/ICP	ppm	7.22	2.3	15.6	38
Sc	M/ICP	ppm	13	0.9	3.7	46
Si	M/ICP	%	32			7
Sm	M/ICP	ppm	7.28	0.21	1.5	15
Sn	M/ICP	ppm	2.60	0.72	13.8	16
Sr	M/ICP	ppm	20	2.2	5.7	53
Ta	M/ICP	ppm	2.46	3.9	80.3	24
Tb	M/ICP	ppm	0.80	0.04	2.4	16
Th	M/ICP	ppm	11	1.2	5.2	23
Ti	M/ICP	%	0.37	0.14	18.6	56
Tl	M/ICP	ppm	23	66	142.6	24
Tm	M/ICP	ppm	0.44	0.03	2.9	16
U	M/ICP	ppm	10	0.5	2.3	15
V	M/ICP	ppm	132	10	3.7	53
W	M/ICP	ppm	0.86	0.31	18.0	15
Y	M/ICP	ppm	29	1.7	2.9	30
Yb	M/ICP	ppm	2.82	0.09	1.5	15
Zn	M/ICP	ppm	103	17	8.1	93
Zr	M/ICP	ppm	147	17	5.7	44