



## AMIS0348

### *Certified Reference Material*

**Copper cobalt mixed oxide/sulphide ore  
Kakanda, DRC**

### *Certificate of Analysis*

#### **Recommended Concentrations and Limits<sup>1</sup> (at two Standard Deviations)**

##### ***Certified Concentrations<sup>2</sup>***

Co F	1436	±	139	ppm
Co M/ICP	1399	±	121	ppm
Co P	1395	±	112	ppm
Cu F	1.943	±	0.114	%
Cu M/ICP	1.915	±	0.094	%
Cu P	1.932	±	0.114	%
Specific Gravity	2.82	±	0.10	

##### ***Provisional Concentration***

Cu Soluble ppm	0.970	±	0.138	%
----------------	-------	---	-------	---

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 <sub>2</sub> O <sub>3</sub>	4.56	±	0.12	%
CaO	11.69	±	0.24	%
Fe <sub>2</sub> O <sub>3</sub>	2.51	±	0.06	%
K <sub>2</sub> O	1.15	±	0.04	%
MgO	11.58	±	0.16	%
MnO	0.07	±	0.002	%
SiO <sub>2</sub>	44.22	±	0.48	%
TiO <sub>2</sub>	0.30	±	0.02	%
LOI	19.75	±	1.40	%

## **Provisional Concentration**

Cr <sub>2</sub> O <sub>3</sub>	0.03	±	0.01	%
--------------------------------	------	---	------	---

## **Indicated Mean**

Na <sub>2</sub> O	0.06	%
-------------------	------	---

**1. Intended Use:** AMIS0348 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 (CRM) 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:** AMIS0348 was made using Copper-Cobalt sulphide and mixed oxide and sulphide ore from the Kakanda Nord and Kakanda Sud projects, 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 Kakanda project is in the Katanga Province, 50km north west of Likasi, 160km northwest of the regional capital Lubumbashi and 95km east of Kolwezi, in the DRC. The Kakanda deposit is hosted by sedimentary rocks of the Neoproterozoic Katangan sequence developed within the Lufilian Arc in the Central African Copperbelt. Mineralisation is generally hosted within the dolomitic shales and argillites of the Mines Series

**3. Mineral and Chemical Composition:** The main economic mineralogy comprises chalcocite, and malachite with subordinate carrollite, chalcopyrite, bornite and heterogenite.

**4. Appearance:** The material is a very fine Dark Blueish Grey powder (Corstor colour chart – 10B 2.5/1).

**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 homogenized in a double cone blender, systematically divided and 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. Acid Soluble AAS.
2. Co, Cu. Fusion AAS or ICP-OES (F).
3. Multi-acid digest multi-element scan - ( to include Co, Cu ). ICP-OES or ICP-MS (M/ICP).
4. Aqua regia digest – Co, Cu. ICP-OES or ICP-MS (P).
5. Pressed pellet multi-element scan - (to include Co, Cu ) (XRF).
6. Majors (Al<sub>2</sub>O<sub>3</sub>, CaO, Cr<sub>2</sub>O<sub>3</sub>, Fe<sub>2</sub>O<sub>3</sub>, K<sub>2</sub>O, MgO, MnO, Na<sub>2</sub>O, SiO<sub>2</sub>, TiO<sub>2</sub>. LOI) XRF fusion.
7. 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:** Twenty five laboratories were each given eight packages, comprising eight samples scientifically selected from throughout the batch. Twenty three laboratories reported 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 23 out of 25 laboratories that provided results timeously were (not in same order as in the table of assays):

1. Acme Analytical Laboratories Chile
2. ACME Analytical Laboratories Ltd CA
3. Activation Laboratories Pty Ltd (ActLabs) CA
4. Activation Laboratorios Ltda (Chile)
5. ALS Chemex Laboratory Group Brisbane Australia
6. ALS Chemex Laboratory Group Johannesburg SA
7. ALS Chemex Laboratory Group Perth WA
8. ALS Chemex Laboratory Group Vancouver CA
9. ALS Chemex Laboratory Zambia
10. ALS OMAC (Ireland)
11. Genalysis Laboratory Services (W Australia P)
12. Intertek Utama Services (Indonesia)
13. Set Point Laboratories (Isando) SA
14. Set Point Laboratories Botswana
15. SGS Australia Pty Ltd (Newburn) WA
16. SGS Geosol Laboratories Ltda (Brazil)
17. SGS Mineral Services Callao (Peru)
18. SGS Mineral Services Lakefield (Canada)
19. SGS South Africa (Pty) Ltd - Booyens JHB
20. SGS Toronto (Canada)
21. SGS Townsville (Australia)
22. Skyline Assayers and Labs (USA)
23. 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 Soluble 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					18861		9263													
A					18807		7276													
A					18751		5395													
A					18707		6088													
A					16456		5552													
A					18479		9051													
A					18370		6607													
A					18537		8071													
B	1400.0	1390	1400	19000	19400	19200	9360	4.61	11.76	0.03	2.51	1.14	11.58	0.07	0.05	44.23	0.31	19.08	2.89	
B	1420.0	1410	1410	19100	19200	19100	10000	4.62	11.73	0.03	2.49	1.14	11.58	0.07	0.07	44.21	0.30	19.09	2.91	
B	1440.0	1440	1420	19200	19200	18900	9760	4.64	11.76	0.03	2.52	1.15	11.64	0.07	0.07	44.37	0.31	19.06	2.91	
B	1440.0	1440	1390	19400	19400	19000	9670	4.62	11.74	0.03	2.50	1.15	11.59	0.07	0.05	44.30	0.31	19.10	2.89	
B	1440.0	1390	1410	19300	19500	19300	9950	4.64	11.77	0.03	2.51	1.15	11.60	0.07	0.05	44.31	0.30	19.09	2.90	
B	1440.0	1430	1380	19500	19700	19000	10300	4.62	11.77	0.03	2.50	1.14	11.61	0.07	0.07	44.37	0.31	19.12	2.91	
B	1420.0	1390	1400	19300	19400	19100	10000	4.64	11.78	0.03	2.51	1.14	11.63	0.07	0.05	44.36	0.31	19.12	2.91	
B	1440.0	1410	1410	19300	19600	19300	9960	4.63	11.75	0.03	2.52	1.14	11.58	0.07	0.05	44.20	0.30	19.11	2.92	
C	1340.0	1450	1230	19900	19400	19600													2.88	
C	1400.0	1350	1250	20300	19300	19400													2.87	
C	1410.0	1410	1270	20500	19400	20100													2.89	
C	1420.0	1440	1270	20600	18700	21000													2.88	
C	1390.0	1430	1230	20500	18100	21100													2.89	
C	1400.0	1390	1270	20000	19000	19300													2.89	
C	1410.0	1420	1270	20300	20200	20100													2.89	
C	1440.0	1420	1270	20700	19500	19600													2.91	

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 Soluble 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		1380	1450		19200	19950		4.62	11.75	0.03	2.50	1.16	11.55	0.07	0.05	44.60	0.29	19.10	2.82
D		1380	1400		19000	19250		4.57	11.70	0.03	2.49	1.16	11.45	0.07	0.05	44.30	0.29	19.10	2.83
D		1360	1420		19050	19700		4.55	11.60	0.03	2.47	1.14	11.40	0.07	0.05	43.90	0.28	19.09	2.76
D		1360	1430		18800	19750		4.60	11.75	0.03	2.48	1.16	11.50	0.07	0.05	44.50	0.29	19.08	2.80
D		1350	1390		18850	19100		4.61	11.80	0.03	2.49	1.16	11.50	0.07	0.06	44.40	0.28	19.29	2.78
D		1320	1380		18450	19050		4.60	11.70	0.03	2.50	1.15	11.60	0.07	0.05	44.40	0.29	19.09	2.77
D		1370	1410		19000	19550		4.63	11.80	0.03	2.47	1.16	11.45	0.07	0.05	44.20	0.28	19.08	2.78
D		1350	1430		18800	19850		4.59	11.70	0.03	2.47	1.16	11.45	0.07	0.05	44.10	0.29	19.17	2.79
E	1610.0		1610	20000		19600		4.56	11.70	0.03	2.54	1.16	11.60	0.07	0.06	44.50	0.31	19.10	
E	1580.0		1500	19800		19600		4.55	11.90	0.03	2.57	1.16	11.70	0.07	0.07	44.40	0.31	19.10	
E	1520.0		1510	19500		20300		4.56	11.90	0.03	2.57	1.17	11.60	0.07	0.08	44.40	0.31	19.10	
E	1660.0		1400	20200		20000		4.58	11.80	0.05	2.55	1.15	11.70	0.07	0.07	44.50	0.31	19.10	
E	1570.0		1500	19900		19900		4.55	11.80	0.03	2.56	1.17	11.70	0.07	0.07	44.50	0.32	19.10	
E	1570.0		1460	19800		19600		4.53	11.90	0.03	2.57	1.15	11.70	0.07	0.07	44.50	0.31	19.10	
E	1580.0		1650	19900		19800		4.59	11.70	0.04	2.53	1.15	11.70	0.07	0.08	44.50	0.31	19.10	
E	1620.0		1500	20200		20400		4.60	11.90	0.04	2.58	1.16	11.70	0.07	0.06	44.40	0.31	19.10	
F		1390	1420		19350	20100		4.55	11.70	0.03	2.51	1.17	11.55	0.07		44.80	0.30	19.06	2.73
F		1350	1410		18900	20100		4.45	11.45	0.03	2.60	1.14	11.35	0.06		43.90	0.28	19.08	2.76
F		1370	1410		19200	20000		4.49	11.60	0.03	2.47	1.16	11.45	0.06		44.40	0.29	19.07	2.76
F		1380	1470		19050	20600		4.57	11.70	0.03	2.53	1.18	11.55	0.07		44.90	0.30	19.08	2.77
F		1390	1480		19250	21000		4.48	11.50	0.02	2.45	1.15	11.35	0.06		44.00	0.28	19.09	2.79
F		1390	1500		19450	21000		4.43	11.40	0.03	2.47	1.14	11.25	0.06		43.80	0.28	19.07	2.81
F		1380	1450		19300	20700		4.53	11.70	0.03	2.52	1.16	11.55	0.07		44.80	0.30	19.12	2.74
F		1410	1440		19450	20700		4.49	11.55	0.03	2.50	1.15	11.45	0.06		44.20	0.29	19.10	2.74
H	1430.0	1410		19300				4.52	11.50	0.03	2.48	1.14	12.65	0.07	0.05		0.29	21.00	2.82
H	1460.0	1380		19600				4.63	11.75	0.03	2.57	1.15	12.35	0.07	0.05		0.29	20.90	2.87
H	1480.0	1400		19900				4.57	11.50	0.03	2.50	1.15	12.70	0.07	0.05		0.29	20.80	2.83
H	1430.0	1390		19750				4.47	11.70	0.03	2.51	1.15	12.75	0.07	0.05		0.29	20.90	2.80
H	1420.0	1390		19150				4.71	11.95	0.03	2.60	1.12	12.50	0.07	0.05		0.30	20.70	2.80
H	1480.0	1410		19700				4.58	11.25	0.03	2.49	1.29	12.55	0.07	0.05		0.28	20.50	2.82
H	1450.0	1370		19700				4.68	12.00	0.03	2.56	1.14	12.35	0.07	0.05		0.29	20.80	2.79
H	1420.0	1420		19250				4.52	11.50	0.03	2.51	1.15	12.55	0.07	0.05		0.29	20.80	2.81
I	1440.0	1390		19700	18400		12500	4.45	11.74	0.05	2.56	0.99	11.60	0.07		43.61	0.29	21.01	2.80
I	1440.0	1400		19400	18200		12400	4.35	11.84	0.06	2.63	0.96	11.58	0.07		43.69	0.30	21.03	2.83
I	1440.0	1390		19900	18200		12200	4.28	11.76	0.06	2.58	0.99	11.68	0.07		43.73	0.30	21.01	2.82
I	1450.0	1420		20100	18600		11700	4.60	11.66	0.05	2.54	0.98	11.60	0.07		43.90	0.30	21.05	2.81
I	1450.0	1410		19600	18500		11500	4.53	11.61	0.04	2.53	0.95	11.62	0.07		43.63	0.30	21.10	2.79
I	1440.0	1400		19300	18700		11900	4.63	11.66	0.04	2.54	0.94	11.63	0.07		43.92	0.30	21.08	2.81
I	1440.0	1390		19100	18100		12100	4.53	11.69	0.04	2.53	0.96	11.52	0.07		43.72	0.30	21.06	2.83
I	1430.0	1400		19400	18400		12600	4.45	11.76	0.04	2.54	1.01	11.62	0.07		44.26	0.31	21.07	2.83
J	1800.0	1361	1219	25800				4.62	11.75	0.03	2.53	1.16	11.55	0.06	0.07	44.34	0.31	19.75	
J	1700.0	1318	1355	23400				4.51	11.76	0.03	2.52	1.16	11.57	0.06	0.05	44.28	0.31	20.06	
J	1600.0	1294	1214	23900				4.53	11.73	0.03	2.50	1.17	11.51	0.06	0.05	44.32	0.32	20.06	
J	1400.0	1333	1240	16500				4.79	11.76	0.03	2.55	1.17	11.59	0.06	0.07	44.36	0.32	20.16	
J	1700.0	1346	1241	24700				4.57	11.81	0.03	2.53	1.17	11.61	0.07	0.05	44.66	0.30	20.24	
J	1700.0	1324	1206	24400				4.61	11.85	0.03	2.56	1.15	11.68	0.07	0.05	44.48	0.30	19.65	
J	1700.0	1337	1237	23800				4.55	11.78	0.03	2.51	1.18	11.48	0.06	0.05	44.60	0.32	19.85	
J	1400.0	1321	1189	18400				4.62	11.87	0.03	2.53	1.16	11.70	0.06	0.05	44.54	0.32	19.95	
K	1520.0	1329	1326	19040	19220	19070	10180	4.55	11.61	0.03	2.52	0.95	11.67	0.07	0.11	44.10	0.28	20.18	2.71
K	1540.0	1299	1317	19660	17840	18810	10160	4.58	11.59	0.03	2.52	1.02	11.61	0.07	0.07	44.10	0.28	20.37	2.71
K	1490.0	1302	1325	18310	17820	18990	10140	4.55	11.57	0.04	2.51	1.00	11.62	0.07	0.08	44.10	0.29	20.45	2.72
K	1530.0	1343	1351	19120	17800	18770	10170	4.57	11.56	0.04	2.52	1.08	11.65	0.07	0.06	44.10	0.28	20.64	2.75
K	1440.0	1308	1367	17780	19930	18980	10060	4.55	11.62	0.03	2.52	0.98	11.68	0.07	0.10	44.10	0.28	20.64	2.76
K	1450.0	1319	1358	17870	18520	18600	10170	4.61	11.65	0.03	2.52	0.92	11.74	0.07	0.13	44.30	0.29	20.68	2.77
K	1540.0	1351	1298	19080	18070	18780	10070	4.54	11.55	0.04	2.50	1.04	11.63	0.07	0.07	44.10	0.28	20.61	2.75
K	1550.0	1279	1372	19290	17010	18710	10100	4.55	11.54	0.04	2.52	0.99	11.65	0.07	0.07	43.90	0.28	20.45	2.76
L		1360	1420		18800	18900	9050								0.05				2.87
L		1320	1430		19300	18900	8790								0.05				2.86
L		1400	1450		19150	19150	8370								0.05				2.82
L		1380	1440		19200	19000	8560								0.05				2.83
L		1365	1410		19250	18750	8680								0.05				2.83
L		1355	1400		19200	18650	8950								0.05				2.82
L		1350	1400		18950	18650	8800								0.05				2.83
L		1340	1430		18750	19000	8580								0.05				2.81
M	1464.0	1526	1429	19269	19547	18887	11021												2.78
M	1486.0	1458	1432	19107	18996	18657	10630												2.88
M	1472.0	1518	1428	19345	18811	18839	10568												2.87
M	1468.0	1498	1432	19280	19080	18820	10753												2.86
M	1465.0	1486	1473	19535	19599	19403	10696												2.88
M	1467.0	1508	1443	19578	19770	18994	10913												2.78
M	1487.0	1521	1474	19509	19866	19625	10818												2.81
M	1462.0	1448	1426	19525	18578	18789	11036												2.88
N		1494	1380		19222	18980	9280												
N		1507	1370		19483	18440	9140												
N		1500	1290		19428	16580	9480												
N		1499	1370		19002	18930	9290												

## 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 Soluble 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		1420			19500		10500	4.57	11.72	0.03	2.50	1.16	11.64	0.07	0.10	44.29	0.31	19.40	
Q		1420			19300		10500	4.58	11.72	0.05	2.52	1.16	11.63	0.07	0.09	44.29	0.31	19.20	
Q		1420			19300		10300	4.57	11.71	0.04	2.52	1.16	11.61	0.07	0.09	44.18	0.32	19.70	
Q		1410			19400		10600	4.70	11.67	0.04	2.53	1.16	11.61	0.07	0.07	44.28	0.30	19.40	
Q		1420			19500		10600	4.57	11.71	0.04	2.52	1.16	11.63	0.07	0.08	44.26	0.31	19.30	
Q		1420			19400		10400	4.56	11.67	0.03	2.51	1.15	11.62	0.07	0.10	44.12	0.31	19.20	
Q		1450			19700		10200	4.56	11.68	0.01	2.48	1.16	11.60	0.07	0.07	44.28	0.30	19.80	
Q		1410			19600		10500	4.56	11.69	0.02	2.51	1.16	11.63	0.07	0.08	44.32	0.30	19.50	
R					18630		9380												
R					18840		9380												
R					18410		9380												
R					18110		9380												
R					18700		9380												
R					19260		9380												
R					18450		9380												
R					18860		9380												
S		1400			18400		8900												
S		1500			18600		9000												
S		1500			18600		8800												
S		1500			18600		8700												
S		1400			18500		8900												
S		1400			18400		8800												
S		1500			18700		8900												
S		1500			18700		8800												
T		1300	1300		21300	19600									0.05				
T		1300	1310		19400	20200									0.05				
T		1280	1300		18800	20700									0.05				
T		1300	1310		18800	20000									0.05				
T		1290	1310		19300	19200									0.05				
T		1300	1330		19100	19800									0.05				
T		1300	1310		19200	20400									0.05				
T		1310	1300		19300	20600									0.05				
U		1430	1420		19550	19350	9620	4.59	11.70	0.03	2.47	1.14	11.50	0.07	0.05	45.60	0.30	19.80	2.94
U		1470	1410		20000	19200	9910	4.72	11.65	0.03	2.57	1.16	11.65	0.07	0.06	45.30	0.30	19.75	2.86
U		1480	1420		19800	19200	9700	4.49	11.30	0.03	2.42	1.12	11.20	0.07	0.04	44.50	0.29	19.80	2.88
U		1460	1390		19850	19050	9870	4.67	11.85	0.03	2.51	1.16	11.70	0.07	0.05	46.70	0.30	19.80	2.98
U		1460	1370		19650	18750	9940	4.44	11.25	0.03	2.39	1.10	11.15	0.07	0.04	44.00	0.29	19.80	2.84
U		1480	1420		20200	19250	9630	4.44	11.25	0.03	2.39	1.11	11.15	0.07	0.04	44.20	0.29	19.65	2.85
U		1460	1400		20000	19000	10100	4.62	11.70	0.03	2.48	1.15	11.55	0.07	0.04	46.00	0.30	19.70	2.76
U		1480	1420		19900	19400	9520	4.50	11.50	0.03	2.44	1.11	11.30	0.07	0.04	44.70	0.29	19.75	2.85
V		1463	1413		19543	19350													2.78
V		1414	1417		19627	19650													2.77
V		1444	1396		19569	19250													2.76
V		1461	1415		19668	19200													2.78
V		1424	1419		19881	19600													2.77
V		1471	1416		19650	19500													2.76
V		1429	1414		19723	19650													2.76
V		1439	1409		19650	19350													2.75
W	1300.0	1400	1200	19700	19500	18900	7812	4.53	11.52	0.03	3.37	1.16	11.56	0.07		43.78	0.29	20.10	2.82
W	1300.0	1400	1200	19700	19300	18800	7900	4.54	11.51	0.03	3.46	1.17	11.53	0.07		43.81	0.29	19.92	2.82
W	1300.0	1400	1200	19349	19300	18900	7900	4.61	11.56	0.04	3.30	1.17	11.64	0.07		44.14	0.30	19.88	2.82
W	1300.0	1400	1200	19700	19200	18900	7839	4.55	11.60	0.02	3.31	1.18	11.68	0.07		44.16	0.30	20.10	2.81
W	1300.0	1400	1200	19398	19100	18900	7854	4.54	11.62	0.03	3.17	1.15	11.60	0.07		44.02	0.30	19.99	2.82
W	1300.0	1400	1200	19112	19400	18900	7970	4.55	11.50	0.02	3.15	1.16	11.50	0.07		43.93	0.29	19.87	2.83
W	1300.0	1400	1100	19100	19300	18800	7756	4.52	11.56	0.02	3.15	1.16	11.60	0.07		43.96	0.30	19.91	2.82
W	1300.0	1400	1200	19600	19100	18900	7800	4.56	11.67	0.02	3.14	1.16	11.65	0.07		44.52	0.30	19.98	2.81
Y	1440.0				18400														
Y	1400.0				18100														
Y	1410.0				18200														
Y	1400.0				18000														
Y	1410.0				18300														
Y	1400.0				18200														
Y	1400.0				18300														
Y	1410.0				18300														

## 12 Measurement of Uncertainty : (ref Dr Hugh Bartlett, Hugh Bartlett Consulting CC.)

The samples used in this certification process have been selected in such a way as to represent the entire batch of material and were taken from the final packaged units; therefore all possible sources of uncertainty (sample uncertainty and measurement uncertainty) are included in the final combined standard uncertainty determination.

The uncertainty measurement takes into consideration the between lab and the within lab variances and is calculated from the square roots of the variances of these components using the formula:

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

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

Analyte	Method	Unit	S <sup>1</sup>	$\sigma_L$ <sup>2</sup>	SW <sup>3</sup>	CSU <sup>4</sup>
Co	F	ppm	69.36	63.88	22.13	21.46
Co	M/ICP	ppm	60.62	38.08	22.97	9.18
Co	P	ppm	55.87	40.21	22.84	11.39
Cu	F	ppm	569.3	487.0	263.3	165.4
Cu	M/ICP	ppm	472.2	274.2	276.2	72.89
Cu	P	ppm	568.2	389.4	285.3	111.8
Cu	Soluble	ppm	568.2	389.4	285.3	111.8
Al <sub>2</sub> O <sub>3</sub>	XRF	%	0.059	0.028	0.048	0.000
CaO	XRF	%	0.116	0.069	0.084	0.023
Cr <sub>2</sub> O <sub>3</sub>	XRF	%	0.004	0.002	0.003	0.001
Fe <sub>2</sub> O <sub>3</sub>	XRF	%	0.035	0.022	0.023	0.007
K <sub>2</sub> O	XRF	%	0.020	0.014	0.012	0.005
LOI		%	0.696	0.580	0.128	0.168
MgO	XRF	%	0.085	0.061	0.052	0.020
MnO	XRF	%	0.001	0.000	0.001	0.000
Na <sub>2</sub> O	XRF	%	0.011	0.009	0.006	0.003
SiO <sub>2</sub>	XRF	%	0.238	0.167	0.162	0.059
TiO <sub>2</sub>	XRF	%	0.011	0.007	0.006	0.002
SG	pyc		0.050	0.035	0.024	0.010

1. S - Std Dev for use on control charts.
2.  $\sigma_L$  - 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:** AMIS0348 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](http://www.amis.co.za) website.

**17. Minimum sample size:** The majority of laboratories reporting used a 0.5g sample size for the ICP. This is the recommended minimum sample size for the use of this material.

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

**19. Recommended use:** The data used to characterize this CRM has been scrutinized using outlier treatment techniques. This, together with the number of participating laboratories, should overcome any "inter-laboratory issues" and should lead to a very accurate measure for the given methods, notwithstanding the underlying assumption that what the good inter-laboratory labs

reported was accurate. However an amount of bad data might have had an effect, resulting in limits which in some situations might be too broad for the effective monitoring of a single analytical method, laboratory or production process. Users should set their own limits based on their own data quality objectives and control measurements, after determining the performance characteristics of their own particular method, using a minimum of 20 analyses using this CRM. User set limits should normally be within the limits recommended on p1 and 2 of this certificate.

**20. Legal Notice:** This certificate and the reference material described in it have been prepared with due care and attention. However AMIS, Set Point Technology (Pty) Ltd, Mike McWha, Dr Barry Smee and Smee and Associates Ltd; accept no liability for any decisions or actions taken following the use of the reference material.

14 November 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 - Uncertified trace element statistics

Analyte	Method	Unit	Mean	2SD	RSD%	n
Ag	M/ICP	ppm	1.8	0.90	24.6	98
Al	M/ICP	%	2.4	0.31	6.3	136
As	M/ICP	ppm	8.9	4.1	23.2	95
Ba	M/ICP	ppm	204	27.3	6.7	96
Be	M/ICP	ppm	1.6	0.37	11.6	86
Bi	M/ICP	ppm	4.9	3.3	34.5	52
Ca	M/ICP	%	8.1	0.54	3.4	140
Cd	M/ICP	ppm	0.11	0.10	41.9	14
Ce	M/ICP	ppm	55.9	5.0	4.5	36
Cr	M/ICP	ppm	139	62.4	22.5	151
Cs	M/ICP	ppm	1.1	0.09	4.3	32
Dy	M/ICP	ppm	2.5	0.43	8.6	23
Er	M/ICP	ppm	1.3	0.23	8.8	24
Eu	M/ICP	ppm	0.88	0.16	9.2	24
Fe	M/ICP	%	1.7	0.15	4.3	140
Ga	M/ICP	ppm	8.3	3.2	19.5	56
Gd	M/ICP	ppm	2.8	2.8	49.5	32
Hf	M/ICP	ppm	1.7	0.24	7.1	37
Ho	M/ICP	ppm	0.47	0.06	5.9	24
In	M/ICP	ppm	0.62	0.06	4.9	37
K	M/ICP	%	0.95	0.13	6.9	136
La	M/ICP	ppm	25.5	5.8	11.4	88
Li	M/ICP	ppm	73.4	17.4	11.9	89
Lu	M/ICP	ppm	0.18	0.03	8.7	24
Mg	M/ICP	%	6.8	0.60	4.4	149
Mn	M/ICP	ppm	517	55.2	5.3	151
Mo	M/ICP	ppm	2.7	0.7	13.2	81
Na	M/ICP	%	2.5	11.3	229	104
Nb	M/ICP	ppm	7.5	13.9	92.5	72
Nd	M/ICP	ppm	24.3	1.1	2.2	21
Ni	M/ICP	ppm	128	16.6	6.5	130
P	M/ICP	ppm	943	148	7.9	104
Pb	M/ICP	ppm	8.3	9.3	55.6	102
Pr	M/ICP	ppm	6.6	0.82	6.2	24
Rb	M/ICP	ppm	34.9	3.0	4.3	45
Re	M/ICP	ppm	0.02	0.03	73.7	24
S	M/ICP	%	0.7	0.12	8.7	121
Sb	M/ICP	ppm	2.4	6.5	137	49
Sc	M/ICP	ppm	5.7	1.0	9.1	100
Se	M/ICP	ppm	0.64	1.7	135	37
Si	M/ICP	%	20.6	0.40	1.0	8
Sm	M/ICP	ppm	4.3	0.31	3.7	24
Sn	M/ICP	ppm	1.3	1.3	50.8	48
Sr	M/ICP	ppm	128	13.7	5.4	119
Ta	M/ICP	ppm	0.37	0.38	50.4	48
Tb	M/ICP	ppm	0.48	0.06	6.2	23
Te	M/ICP	ppm	1.5	3.5	116	17
Th	M/ICP	ppm	5.4	0.46	4.2	38
Ti	M/ICP	%	0.11	0.07	32.1	104
Tl	M/ICP	ppm	1.1	4.5	213	39
Tm	M/ICP	ppm	0.19	0.02	5.5	24
U	M/ICP	ppm	3.9	0.63	8.0	40
V	M/ICP	ppm	62.9	13.6	10.8	96
W	M/ICP	ppm	1.6	6.2	190	35
Y	M/ICP	ppm	11.0	2.7	12.2	81
Yb	M/ICP	ppm	1.0	0.35	16.9	24
Zn	M/ICP	ppm	37.7	8.6	11.5	117
Zr	M/ICP	ppm	61.9	17.6	14.2	90