



African Mineral Standards

MATRIX REFERENCE MATERIALS

Tel: +27 (0) 11 923 0800 Fax: +27 (0) 11 392 4715 web: [www.amis.co.za](http://www.amis.co.za)  
11 Gewel Street (off Hulley Road), D1 Isando Business Park, Kempton Park, 1609  
P.O. Box 856, Isando, 1600, Gauteng, South Africa

## AMIS0298

### *Certified Reference Material*

**Cu Co Zn Au Ag concentrate, epithermal,  
Chelopech Mine, Bulgaria**

### *Certificate of Analysis*

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

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

Cu M/ICP	15.34	±	0.98	%
Cu Titration	15.65	±	0.39	%
Co Fus	604	±	54	ppm
Co M/ICP	584	±	69	ppm
Au Pb Collection	17.88	±	1.04	g/t
Ag M/ICP	346	±	39	ppm
As Fus	4.82	±	0.55	%
As M/ICP	4.83	±	0.32	%
Sb Fus	3724	±	256	ppm
Zn Fus	1.12	±	0.12	%
Zn M/ICP	1.09	±	0.11	%
Specific Gravity	4.13	±	0.18	

#### ***Provisional Concentrations***

Bi Fus	917	±	122	ppm
Bi M/ICP	866	±	176	ppm
Sb M/ICP	3571	±	562	ppm
Sn M/ICP	788	±	190	ppm

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>	1.58	±	0.14	%
Fe <sub>2</sub> O <sub>3</sub>	34.60	±	1.82	%
SiO <sub>2</sub>	7.92	±	0.28	%
S Comb/LECO	34.05	±	2.12	%

## ***Provisional Concentrations***

CaO	0.50	±	0.06	%
MnO	0.07	±	0.01	%
Na <sub>2</sub> O	0.22	±	0.06	%
LOI	28.35	±	6.04	%

## ***Indicated Means***

Cr <sub>2</sub> O <sub>3</sub>	0.03	%
K <sub>2</sub> O	0.18	%
MgO	0.33	%
TiO <sub>2</sub>	0.15	%

1. **Intended Use:** AMIS0298 can be used to check analysis of samples of epithermal arsenical copper cobalt silver gold concentrates 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:** The concentrate material for AMIS0298 was supplied by Namibia Custom Smelter (Dundee Precious Metals). The AMIS0298 concentrate is originally from Chelopech Mine located in central-western Bulgaria approximately 70 kilometres east of Sofia.

3. **Mineral and Chemical Composition:** Chelopech can be classified as a “gold-enargite high-sulphidation epithermal mineralizing system” similar to the deposits mined at Lepanto in the Philippines, El Indio in Chile, Freda River in Papua-New Guinea and Nansatsu in Japan. A cupriferous massive pyrite deposit is hosted in Upper Cretaceous andesitic to rhyodacitic pyroclastics and sub-volcanic intrusives. Massive pyrite predates the economic mineralization and is thought to be related to a phase of dacitic volcanism; whilst Cu, Cu-Au, Cu-Au-Pb-Zn and Pb-Zn mineralisation is later and related to a phase of injection of subvolcanic rhyodacites during the late Cretaceous. Mineralization shows a complex paragenesis with the main minerals comprising pyrite, quartz, chalcopyrite, tennantite and bornite whilst enargite, luzonite, tetrahedrite, gold, bournonite, chalcocite, sphalerite, galena, gypsum and barite are subordinate.

**4. Appearance:** The material is a very fine powder. It is colored Brownish Black (Corstor 5YR 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 <54um. Wet sieve particle size analysis of random samples confirmed the material was 98.5% <54um. 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. Au – Pb collection.
2. Co,Cu, Ag, As, Bi, Sb, Sn, Zn. Fusion AAS or ICP-OES.
3. Multi-acid digest multi-element scan - ICP-OES or ICP-MS.
4. Majors ( Co, Cu, As, Bi, Sb, Sn, Zn, 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.
5. S – combustion analysis.
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:** Seventeen laboratories were each given eight packages, comprising eight samples scientifically selected from throughout the batch. Fifteen 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 15 out of 17 laboratories that provided results timeously were (not in same order as in the table of assays):

1. Activation Laboratories Pty Ltd (ActLabs) CA
2. Ammtec Limited WA
3. Genalysis Laboratory Services (W Australia P)
4. OMAC Laboratories Limited (Ireland)
5. Rappa Research Laboratory
6. Set Point Laboratories (Isando) SA
7. SGS Australia Pty Ltd (Newburn) WA
8. SGS Chelopech (Bulgaria)
9. SGS Geosol Laboratories Ltda (Brazil)
10. SGS Mineral Services Callao (Peru)
11. SGS Mineral Services Lakefield (Canada)
12. SGS Philippines, Inc. (Philippines)
13. SGS South Africa (Pty) Ltd - Booyens JHB
14. SGS Townsville (Australia)
15. 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. **(Economic Elements)**

Lab Code	Cu M/ICP ppm	Cu Titration ppm	Co Fus ppm	Co M/ICP ppm	Au Pb Coll g/t	Ag M/ICP ppm	As Fus ppm	As M/ICP ppm	Bi Fus ppm	Bi M/ICP ppm	Sb Fus ppm	Sb M/ICP ppm	Sn M/ICP ppm	Zn Fus ppm	Zn M/ICP ppm
A		158800			18.3	348									
A		158400			18.1	352									
A		157600			18.4	361									
A		157900			18.8	364									
A		158100			18.5	364									
A		157800			18.0	359									
A		157300			18.0	357									
A		157400			18.6	358									
B	165022		684	585	18.1	378	48306	46354	1022	1046	3692	3705	910	11105	10927
B	162622		633	608	18.5	376	47896	46353	1004	1033	3709	3722	890	11065	10827
B	160542		649	574	17.9	378	48051	46298	1011	1011	3723	3695	893	11165	10626
B	160957		588	579	17.9	372	46928	45791	973	1012	3649	3648	888	11104	10739
B	159484		597	586	17.8	372	46979	45578	981	1013	3596	3661	887	10901	10620
B	162724		588	597	17.9	375	47216	46040	980	1014	3658	3734	913	11175	10771
B	163026		598	566	18.1	380	47401	46198	1001	1017	3663	3672	895	10943	10907
B	161662		602	605	18.2	376	47018	45577	996	1016	3704	3728	873	10858	10697
C		155000	610	623			47300	51000	690	708	3590		656	10300	
C		154000	620	635			47800	50000	705	804	3530		687	10300	
C		155000	640	647			47900		688	837	3630		675	10400	
C		154000	630	618			48800	50000	695	739	3810		635	10600	
C		154000	610	639			48500	50000	710	790	3780		653	10300	
C		155000	640	628			49000	51000	660	751	3610		626	10600	
C		154000	630	632			48900	50000	671	771	3590		677	10600	
C		154000	630	608			49200	50000	695	791	3790		671	10500	
D	153937		608	524	18.0		50095	48138	1000	917	3619	3340	802	11409	9647
D	151135		601	520	17.6		49908	46821	1000	897	3651	3351	814	11366	9562
D	156159		599	530	18.2		49613	47231	900	904	3695	3384	816	11229	9776
D	152640		590	519	17.4		48357	47331	900	900	3654	3367	808	11303	9404
D	153389		588	528	18.1		49131	47586	900	905	3604	3385	812	11146	9901
D	152288		589	526	18.2		48668	47231	900	903	3581	3356	801	11180	9498
D	154454		607	524	18.2		49143	47305	1000	912	3647	3400	800	11183	9703
D	155012		602		17.9		49282	47613	1000	913	3639	3424	802	11278	9808
E		156300	645		16.6	367	43083			625	3771			11943	
E		163300	620		16.6	347	44992			653	3814			11845	
E		162400	636		16.7	335	46993			628	3998			11643	
E		159400	650		16.7	341	42614			682	3616			12446	
E		159600	614		18.2	358	39448			909	3393			12547	
E		159500	589		18.0	336	42480			880	3583			12097	
E		159400	692		16.7	331	42456			895	3738			13313	
E		160600	616		16.6	371	43212			879	3751			12502	
F				480	17.6	298	48900			856	3900			11000	
F				510	17.3	291	50800			919	4090			11300	
F				540	17.3	321	49800			923	3990			11300	
F				545	17.4	322	49500			897	3960			11200	
F				530	18.3	316	49300			914	4030			10900	
F				535	17.3	328	49400			911	4100			10900	
F				535	17.6	317	49500			920	4070			11300	
F				555	17.6	330	48900			929	3970			11200	
G	136000			489	17.6	320	46400					3270	319		10500
G	145000			459	17.3	340	50400					2900	295		11000
G	148000			420	17.6	340	51300					2900	297		11100
G	145000			429	17.2	340	50900					2990	308		11100
G	146000			466	17.1	350	50800					2780	308		11000
G	145000			436	16.6	330	49000					2940	288		10900
G	149000			466	17.6	330	50700					3060	292		11500
G	150000			435	17.2	350	52000					2520	303		11600

### Assay data (Economic Elements-cont)

Lab Code	Cu M/ICP ppm	Cu Titration ppm	Co Fus ppm	Co M/ICP ppm	Au Pb Coll g/t	Ag M/ICP ppm	As Fus ppm	As M/ICP ppm	Bi Fus ppm	Bi M/ICP ppm	Sb Fus ppm	Sb M/ICP ppm	Sn M/ICP ppm	Zn Fus ppm	Zn M/ICP ppm
H	153000			600	17.0			48400		754		3700	800		11000
H	153800			600	17.1			48500		755		3800	800		11100
H	152800			600	17.4			48400		753		3700	800		11000
H	153800			600	17.6			48200		755		3800	800		11000
H	152500			600	17.4			48400		756		3800	800		11000
H	152000			600	17.4			48500		754		3700	800		11100
H	153200			600	17.5			48000		753		3800	800		11000
H	152000			600	17.7			48500		755		3700	800		11100
I	145700	148300	600	625		321	50300	41000	900	927	3800	3905	661	10800	11200
I	145200	148400	600	615		326	50600	40800	800	910	3800	3873	658	11200	11200
I	145300	148500	600	617		321	50400	41200	900	909	3800	3922	644	10800	11300
I	148000	148200	500	613		322	49700	41500	900	920	3800	3904	675	11100	11500
I	145500	148300	600	610		320	49900	41500	800	911	3800	3874	649	10800	11200
I	148600	148700	600	611		321	49900	41400	900	965	3700	3885	659	11200	11400
I	145500	148700	500	608		325	49300	40800	900	913	4000	3864	661	10900	11200
I	147200	148200	600	607		319	50800	40400	900	924	3800	3892	656	11100	11100
K	155000	153000		550											11075
K	152000	152000		560											11225
K	153000	155000		560											11150
K	154000	155000		560											11200
K	153000	154000		560											11200
K	152000	155000		560											11175
K	153000	154000		560											11225
K	151000	151000		550											11400
L		156500				355	43000							13000	
L		156200				350	45500							10500	
L		156500				355	42500							10500	
L		156200				350	44500							10500	
L		156200				345	45500							10500	
L		156500				350	46000							10500	
L		156200				350	43500							10500	
L		156500				350	43000							10500	
M	155000			580	20.1			49050		790		3700	900		10800
M	158000			620	20.8			52825		860		3500	950		10900
M	153000			580	20.1			51075		840		3500	900		10700
M	156000			580	19.7			51150		860		3500	950		10800
M	158000			600	17.4			49100		860		3600	1050		10900
M	160000			600	17.7			49050		850		3600	950		11000
M	159000			620	17.6			49075		850		3500	850		11000
M	158000			600	18.0			49000		910		3600	900		11000
N	155000			592	18.0	300	46600					101	790		11000
N	155000			596	18.1	300	46000					100	800		11600
N	158000			598	18.2	310	45800					102	810		11300
N	156000			613	18.4	320	46200					99	810		11500
N	155000			598	18.3	290	46200					102	790		11500
N	156000			576	18.1	310	46100					108	800		11200
N	155000			610	18.0	310	46300					102	800		11500
N	158000			590	18.3	310	46200					103	810		11400
O		157400			18.4										
O		157500			18.2										
O		157300			18.3										
O		157400			19.0										
O		157800			18.5										
O		157900			19.1										
O		157800			18.8										
O		158000			18.2										
P			590	471	17.5		52600		860	835	3700			12000	9770
P			620	461	18.4		52500		865	840	3600			12000	9240
P			610	463	17.8		51800		851	852	3500			12000	9850
P			550	467	18.7		51900		863	814	3700			12000	9340
P			540	444	17.4		52300		808	863	3600			14300	9430
P			550	472	17.5		52500		873	816	3700			12100	9950
P			550	450	18.6		52200		863	860	3700			12200	9360
P			550	461	18.4		52100		870	834	3700			12200	9700

### Assay data (Major Oxides -cont)

Lab Code	Al <sub>2</sub> O <sub>3</sub> XRF %	CaO XRF %	Cr <sub>2</sub> O <sub>3</sub> XRF %	Fe <sub>2</sub> O <sub>3</sub> XRF %	K <sub>2</sub> O XRF %	MgO XRF %	MnO XRF %	Na <sub>2</sub> O XRF %	SiO <sub>2</sub> XRF %	TiO <sub>2</sub> XRF %	LOI %	S Comb/LECO %	SG pyc
A												33.70	
A												34.20	
A												33.90	
A												33.70	
A												33.30	
A												33.40	
A												34.50	
A												33.40	
B	1.50	0.31	0.03	34.9	0.15	0.32	0.08	0.17		0.14		32.96	4.03
B	1.49	0.34	0.03	35.0	0.14	0.32	0.08	0.17		0.14		33.06	4.05
B	1.47	0.31	0.03	35.0	0.15	0.33	0.08	0.17		0.14		32.98	4.05
B	1.51	0.33	0.03	34.6	0.15	0.32	0.08	0.17		0.14		32.99	3.99
B	1.49	0.32	0.03	34.7	0.15	0.32	0.08	0.17		0.14		33.04	3.99
B	1.49	0.32	0.03	34.8	0.15	0.33	0.08	0.17		0.14		33.04	4.06
B	1.50	0.29	0.03	35.2	0.14	0.33	0.08	0.17		0.14		32.98	4.02
B	1.40	0.20	0.03	34.8	0.20	0.33	0.08			0.14		33.03	4.04

**Assay data (Major Oxides -cont)**

Lab Code	Al <sub>2</sub> O <sub>3</sub> XRF %	CaO XRF %	Cr <sub>2</sub> O <sub>3</sub> XRF %	Fe <sub>2</sub> O <sub>3</sub> XRF %	K <sub>2</sub> O XRF %	MgO XRF %	MnO XRF %	Na <sub>2</sub> O XRF %	SiO <sub>2</sub> XRF %	TiO <sub>2</sub> XRF %	LOI %	S Comb/LECO %	SG pyc
C	1.59	0.51	0.04	34.3	0.19	0.43	0.08	0.23	7.91	0.18	26.50	34.30	
C	1.55	0.51	0.04	34.2	0.18	0.40	0.08	0.23	7.78	0.17	28.70	33.80	
C	1.53	0.52	0.04	34.0	0.17	0.39	0.07	0.23	7.66	0.19	29.00	33.80	
C	1.55	0.50	0.04	34.2	0.18	0.42	0.08	0.23	7.75	0.17	28.70	34.30	
C	1.54	0.51	0.04	33.9	0.18	0.38	0.07	0.18	7.68	0.17	29.00	34.20	
C	1.55	0.50	0.03	34.0	0.18	0.40	0.08	0.22	7.70	0.17	28.90	34.00	
C	1.55	0.51	0.03	34.0	0.18	0.38	0.07	0.22	7.77	0.19	26.60	34.00	
C	1.56	0.52	0.04	34.0	0.18	0.37	0.08	0.20	7.74	0.16	27.10	34.00	
D		0.48	0.02	35.1	0.18	0.34	0.07	0.21		0.13			4.11
D		0.48	0.03	35.0	0.18	0.34	0.07	0.21		0.13			4.18
D		0.49	0.03	35.3	0.19	0.35	0.07	0.22		0.13			4.14
D		0.47	0.03	34.0	0.18	0.33	0.06	0.21		0.13			4.20
D		0.49	0.03	35.0	0.18	0.35	0.07	0.22		0.13			4.19
D		0.47	0.03	34.3	0.18	0.34	0.07	0.21		0.13			4.14
D		0.48	0.03	35.4	0.18	0.34	0.07	0.22		0.13			4.15
D		0.49	0.03	35.8	0.18	0.36	0.07	0.22		0.14			4.11
E	1.53	0.49	0.02		0.16	0.27	0.06	0.12		0.13		35.00	
E	1.55	0.50	0.02		0.17	0.27	0.08	0.13		0.15		34.90	
E	1.49	0.49	0.02		0.16	0.25	0.06	0.13		0.12		35.00	
E	1.45	0.45	0.02		0.18	0.28	0.06	0.22		0.10		35.00	
E	1.62	0.52	0.02		0.20	0.30	0.06	0.24		0.13		34.90	
E	1.57	0.48	0.02		0.19	0.28	0.06	0.23		0.13			
E	1.55	0.48	0.02		0.19	0.28	0.06	0.24		0.13		34.80	
E	1.59	0.49	0.02		0.20	0.28	0.06	0.24		0.13			
F	1.60	0.52	0.04	34.7	0.19	0.32	0.07	0.18	7.93	0.16	31.70		4.30
F	1.59	0.51	0.04	34.6	0.18	0.33	0.07	0.18	7.92	0.16	31.70		4.30
F	1.61	0.52	0.04	34.7	0.19	0.33	0.07	0.20	7.97	0.17	31.60		4.28
F	1.59	0.52	0.04	34.7	0.19	0.32	0.08	0.19	7.96	0.16	31.60		4.27
F	1.59	0.52	0.04	34.7	0.18	0.31	0.07	0.19	7.98	0.16	31.50		4.27
F	1.59	0.51	0.04	34.7	0.18	0.32	0.08	0.19	7.95	0.17	31.70		4.32
F	1.59	0.52	0.04	34.6	0.18	0.33	0.08	0.19	7.92	0.16	31.60		4.27
F	1.60	0.52	0.04	34.6	0.18	0.32	0.07	0.20	7.93	0.16	31.70		4.30
G	1.55	0.48	0.05	33.9	0.27	0.31	0.07	0.71		0.16		32.40	
G	1.42	0.49	0.05	30.5	0.25	0.28	0.07	0.68		0.14		31.70	
G	1.42	0.45	0.07	30.5	0.25	0.28	0.07	0.66		0.15		31.70	
G	1.45	0.46	0.05	31.2	0.25	0.29	0.07	0.69		0.16		32.50	
G	1.51	0.56	0.09	32.0	0.25	0.29	0.07	0.76		0.16		31.80	
G	1.42	0.44	0.05	30.9	0.24	0.28	0.06	0.66		0.15		32.50	
G	1.40	0.54	0.04	31.0	0.25	0.28	0.07	0.65		0.14		32.40	
G	1.85		0.05	32.9	0.27	0.30	0.07	1.04		0.20		32.50	
H	1.66	0.43	0.03	35.8	0.12	5.48	0.04	0.84	6.48	0.12	28.76	33.40	4.08
H	1.68	0.42	0.03	35.6	0.12	5.47	0.04	0.83	6.42	0.12	28.20	33.80	4.12
H	1.66	0.43	0.03	35.6	0.12	5.45	0.04	0.81	6.42	0.12	28.40	34.70	4.11
H	1.62	0.42	0.03	35.5	0.12	5.45	0.04	0.81	6.39	0.12	28.15	36.60	4.13
H	1.62	0.43	0.03	35.4	0.12	5.48	0.04	0.81	6.37	0.12	28.63	34.50	4.10
H	1.68	0.45	0.03	35.5	0.12	5.51	0.04	0.82	6.44	0.12	28.31	34.60	4.13
H	1.68	0.43	0.03	35.5	0.12	5.48	0.04	0.82	6.45	0.12	28.41	35.60	4.09
H	1.68	0.43	0.03	35.5	0.12	5.43	0.05	0.82	6.47	0.12	28.32	34.60	4.10
I	1.70	0.57	0.02	32.9	0.18	0.28	0.07	0.22		0.12		33.92	4.06
I	1.64	0.55	0.02	32.9	0.20	0.28	0.07	0.23		0.12		33.91	4.05
I	1.64	0.55	0.02	33.0	0.18	0.27	0.07	0.22		0.13		34.17	4.03
I	1.68	0.57	0.02	33.0	0.19	0.28	0.07	0.27		0.12		34.08	4.02
I	1.74	0.56	0.02	32.9	0.18	0.30	0.07	0.26		0.12		33.99	4.04
I	1.62	0.56	0.02	33.0	0.19	0.28	0.07	0.23		0.13		34.14	4.07
I	1.64	0.57	0.02	32.8	0.18	0.28	0.07	0.24		0.12		34.13	4.06
I	1.64	0.53	0.02	33.0	0.18	0.27	0.07	0.28		0.15		34.15	4.03
M	1.60	0.51	0.04	35.5	0.20	0.40	0.08	0.22	8.03	0.19	26.24		
M	1.60	0.53	0.04	35.7	0.20	0.39	0.08	0.20	8.08	0.19	26.03		
M	1.58	0.51	0.04	35.3	0.20	0.38	0.08	0.22	8.15	0.19	26.36		
M	1.60	0.51	0.04	35.4	0.19	0.38	0.08	0.22	8.02	0.19	26.66		
M	1.58	0.51	0.04	35.4	0.20	0.39	0.08	0.22	7.96	0.19	26.09		
M	1.56	0.50	0.05	34.1	0.17	0.39	0.08	0.22	7.81	0.18	26.10		
M	1.61	0.51	0.09	35.5	0.20	0.39	0.08	0.22	8.07	0.18	27.50		
M	1.60	0.51	0.05	35.6	0.19	0.38	0.08	0.22	8.01	0.18	25.71		
N	1.93	0.50	0.03	31.2	0.19	0.41	0.07	0.25	7.57	0.14	32.46	34.60	4.17
N	1.94	0.50	0.04	31.8	0.16	0.40	0.07	0.28	7.88	0.14	32.13	33.90	4.13
N	1.66	0.51	0.04	32.2	0.18	0.35	0.07	0.22	7.76	0.15	31.98	34.30	4.17
N	1.84	0.50	0.04	32.1	0.18	0.39	0.06	0.25	7.74	0.14	32.12	33.00	4.18
N	1.76	0.53	0.05	32.0	0.17	0.38	0.07	0.23	7.92	0.15	31.97	34.20	4.14
N	1.68	0.52	0.04	33.0	0.17	0.36	0.07	0.25	7.87	0.15	32.14	39.60	4.17
N	1.86	0.50	0.04	31.9	0.16	0.39	0.07	0.25	7.67	0.14	32.01	36.90	4.14
N	1.65	0.52	0.05	33.1	0.19	0.35	0.07	0.22	7.95	0.15	32.08	32.10	4.16
O												35.76	
O												35.49	
O												35.02	
O												35.91	
O												36.01	
O												35.66	
O												35.70	
O												35.65	
P	1.62	0.56	0.04	35.3	0.24	0.29	0.07	0.23	8.04	0.17	23.71	34.80	
P	1.57	0.53	0.03	35.0	0.22	0.28	0.08	0.20	8.05	0.17	23.60	34.10	
P	1.58	0.55	0.03	35.2	0.22	0.27	0.07	0.23	8.11	0.16	23.59	34.80	
P	1.58	0.52	0.04	35.3	0.25	0.30	0.07	0.20	8.06	0.17	23.58	34.40	
P	1.61	0.56	0.03	34.9	0.21	0.29	0.07	0.22	8.01	0.17	23.43	34.80	
P	1.57	0.58	0.03	35.1	0.22	0.27	0.07	0.22	8.03	0.20	23.48	35.00	
P	1.58	0.52	0.04	34.9	0.23	0.26	0.07	0.20	8.07	0.19	23.53	34.20	
P	1.62	0.50	0.03	35.2	0.23	0.29	0.08	0.22	8.01	0.20	23.46	34.30	

## 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:

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

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 <sup>1</sup>	$\sigma_L$ <sup>2</sup>	Sw <sup>3</sup>	CSU <sup>4</sup>
Cu	M/ICP	ppm	4898	4846	1560	1725
Cu	Titration	ppm	2265	2524	988	1040.4
Co	Fus	ppm	26.8	22.1	19.5	9.50
Co	M/ICP	ppm	34.4	32.0	10.8	10.7
Au	Pb Coll	g/t	0.52	0.35	0.35	0.12
Ag	M/ICP	ppm	19.4	19.9	7.90	7.60
As	Fus	ppm	2745	2391	969	764
As	M/ICP	ppm	1761	2206	735	993
Bi	Fus	ppm	61.2	69.7	35.4	31.7
Bi	M/ICP	ppm	88.1	84.2	33.9	30.1
Sb	Fus	ppm	128	107	83.5	42.1
Sb	M/ICP	ppm	281	335	66	137
Sn	M/ICP	ppm	95.0	106	17.2	40.1
Zn	Fus	ppm	601	596	172	212
Zn	M/ICP	ppm	560	513	148	172
Al <sub>2</sub> O <sub>3</sub>	XRF	%	0.07	0.06	0.03	0.021
CaO	XRF	%	0.04	0.030	0.019	0.010
Cr <sub>2</sub> O <sub>3</sub>	XRF	%	0.009	0.007	0.004	0.002
Fe <sub>2</sub> O <sub>3</sub>	XRF	%	0.91	0.82	0.31	0.28
K <sub>2</sub> O	XRF	%	0.033	0.027	0.011	0.008
MgO	XRF	%	0.047	0.042	0.013	0.013
MnO	XRF	%	0.006	0.004	0.003	0.001
Na <sub>2</sub> O	XRF	%	0.025	0.021	0.013	0.007
SiO <sub>2</sub>	XRF	%	0.135	0.155	0.075	0.070
TiO <sub>2</sub>	XRF	%	0.02	0.02	0.008	0.01
LOI		%	3.02	3.72	0.521	1.52
S	Comb/LECO	%	1.06	0.86	0.49	0.28
SG	pyc		0.087	0.103	0.023	0.042

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:** AMIS0298 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.

28 August 2013

*Correction on 07 August 2014 – pg 7 CSU table – Zn units were in % instead of ppm*

**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	341	44.8	6.6	62
Al	M/ICP	%	0.81	0.11	6.5	63
As	XRF	ppm	49270	1552	1.6	23
Ba	M/ICP	ppm	1100	2679	122	64
Be	M/ICP	ppm	0.17	0.09	24.9	18
Bi	XRF	ppm	899	150	8.3	24
Ca	M/ICP	%	0.36	0.12	16.3	70
Cd	M/ICP	ppm	70.9	114.0	80.4	64
Ce	M/ICP	ppm	9.5	10.6	55.6	38
Co	XRF	ppm	589	57.5	4.9	31
Cr	M/ICP	ppm	211.3	84.2	19.9	62
Cs	M/ICP	ppm	0.42	0.63	75.3	32
Cu	Fus	ppm	150844	4121	1.4	37
Cu	XRF	ppm	153968	4289	1.4	38
Dy	M/ICP	ppm	0.61	0.17	13.9	32
Er	M/ICP	ppm	0.36	0.08	11.3	32
Eu	M/ICP	ppm	0.19	0.02	6.2	28
Fe	M/ICP	%	24.0	2.0	4.2	60
Ga	M/ICP	ppm	12.1	4.9	20.1	32
Gd	M/ICP	ppm	0.74	0.17	11.2	32
Ge	M/ICP	ppm	41.4	32.3	39.0	24
Hf	M/ICP	ppm	0.54	0.14	13.3	32
Ho	M/ICP	ppm	0.11	0.03	13.3	32
In	M/ICP	ppm	8.1	2.3	14.3	32
K	M/ICP	%	0.16	0.05	15.2	66
La	M/ICP	ppm	3.3	3.7	55.3	49
Li	M/ICP	ppm	9.3	3.1	16.5	59
Lu	M/ICP	ppm	0.05	0.02	18.4	23
Mg	M/ICP	%	0.19	0.03	8.1	70
Mn	M/ICP	ppm	539	64.6	6.0	66
Mo	M/ICP	ppm	22.3	11.7	26.2	63
Na	M/ICP	%	0.16	0.06	17.5	63
Nb	M/ICP	ppm	1.6	0.60	19.1	32
Nd	M/ICP	ppm	4.0	1.6	20.0	32
Ni	M/ICP	ppm	2689	360	6.7	71
Pb	M/ICP	ppm	7076	1087	7.7	46
Pr	M/ICP	ppm	1.0	0.59	29.5	32
Rb	M/ICP	ppm	5.0	2.1	21.3	32
S	M/ICP	%	33.6	1.6	2.4	31
Sb	XRF	ppm	3800	561	7.4	16
Sc	M/ICP	ppm	2.3	0.70	15.3	39
Se	M/ICP	ppm	227	153	33.7	56
Si	M/ICP	%	3.7	0.15	2.0	8
Sm	M/ICP	ppm	0.84	0.23	13.8	32
Sn	Fus	ppm	831	70.4	4.2	38
Sn	XRF	ppm	905	166	9.2	32
Sr	M/ICP	ppm	150	112.0	37.4	71
Ta	M/ICP	ppm	0.07	0.06	43.2	17
Tb	M/ICP	ppm	0.10	0.02	11.8	31
Te	M/ICP	ppm	419.1	123.8	14.8	39
Th	M/ICP	ppm	1.0	0.63	31.4	32
Ti	M/ICP	%	0.08	0.02	9.4	54
Tl	M/ICP	ppm	22.1	19.6	44.3	38
Tm	M/ICP	ppm	0.06	0.0	0.0	15
U	M/ICP	ppm	3.1	0.84	13.6	32
V	M/ICP	ppm	165	54.1	16.3	70
W	M/ICP	ppm	37.1	36.0	48.5	38
Y	M/ICP	ppm	2.9	1.2	21.4	56
Yb	M/ICP	ppm	0.34	0.08	11.9	32
Zn	XRF	ppm	11203	349	1.6	38
Zr	M/ICP	ppm	17.9	6.8	19.0	56