



African Mineral Standards

MATRIX REFERENCE MATERIALS

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## AMIS0228

### *Certified Reference Material*

### **Gold ore, Birimian Ahafo Gold Mine, Ghana**

### *Certificate of Analysis*

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

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

Au Pb Collection	5.03	±	0.26	g/t
Specific Gravity	2.80	±	0.08	

1. *Manufacturers recommended limits for use of the material as control samples, based on two standard deviations, calculated using "Between Laboratory" statistics for treatment of the data for trivial, non-trivial and technically invalid results. See sections 1, 9 and 12.*
2. *There is additional certified major element data presented on p2 and uncertified trace element data presented as an appendix.*

# Major Element Recommended Concentrations and Limits (at two Standard Deviations)

## *Certified Concentrations*

Al <sub>2</sub> O <sub>3</sub>	13.56	±	0.18	%
CaO	4.02	±	0.06	%
Fe <sub>2</sub> O <sub>3</sub>	5.90	±	0.12	%
K <sub>2</sub> O	1.40	±	0.04	%
MgO	2.33	±	0.05	%
MnO	0.08	±	0.01	%
Na <sub>2</sub> O	5.26	±	0.34	%
SiO <sub>2</sub>	59.55	±	1.02	%
TiO <sub>2</sub>	0.55	±	0.02	%
LOI	6.54	±	0.70	%

## *Provisional Concentrations*

Cr <sub>2</sub> O <sub>3</sub>	0.04	±	0.01	%
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**1. Intended Use:** AMIS0228 can be used to check analysis of samples of gold ore 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 Section 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:** AMIS0228 is a commissioned CRM made from material supplied by SGS Minerals Services from the Ahafo Gold Mine, owned and operated by Newmont Mining Corporation.

The Ahafo mine is located in the Brong Ahafo region of west-central Ghana, about 30 km south of Sunyani and 290 km northwest of the capital city of Accra. Newmont Ghana currently operates four open pits at Ahafo with reserves contained in 13 pits, over a strike length of 40 km.

The Ahafo license is located in the Yamfo Sefwi gold belt, a well-defined zone of many gold occurrences that trends 20-30° east of north and stretches northwards from the Ghanaian border with Cote d'Ivoire for a distance of about 200 km. Intruded along this trend are a series of hornblende granodiorites which preferentially exploit a major regional break separating Lower Birimian sediments from Upper Birimian volcanics. Newmont's property covers three segments of the granodiorite - metasediment contact.

Gold mineralisation is generally associated with a brecciated and hydrothermally altered shear-zone of granodiorite lying in thrust/wrench contact with underlying graphitic phyllites of the Birimian Supergroup. The phyllites also contain scattered pods of gold mineralisation, but these appear to

be limited to a zone lying no more than 20 m from the granodiorite. The thrust contact always dips east at angles varying from 30° to 65°. Gold mineralisation is also associated with a shear zone about 1.2 km east of the granodiorite - metasediment contact that was expressed by a low-level soil geochemical target. The granodiorite hosted shear zone is subparallel to the main trend and dipping from 60° east to sub-vertical.

**3. Mineral and Chemical Composition:** The gold occurs with very fine disseminated pyrite. Arsenopyrite is absent; the ore is non-refractory above and below oxidation

**4. Appearance:** The material is a very fine powder. It is colored a Light Grey (Corstor 5Y 7/1).

**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 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 the consensus test results were carried out by independent statisticians.

**7. Methods of Analysis requested:**

1. Au – Pb collection ICP-OES or ICP-MS.
2. Multi-acid digest, including HF, ICP- OES or ICP-MS. Multi element scan to include Ag.
3. 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.
4. S – Total Combustion.
5. SG ( gas pycnometer )

**8. Information requested:**

1. State aliquots used for all determinations.
2. Report all results for gold and uranium in ppm.
3. All results for major elements to be reported as oxides in percentages.
4. All results for multi-element scans to be reported in ppm.
5. Report all QC data, to include replicates, blanks and certified reference materials used.
6. State and provide brief description of analytical techniques used.

**9. Method of Certification:** Twenty eight laboratories were each given eight randomly selected packages of sample. Twenty two of the laboratories submitted results.

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 22 out of 28 laboratories that provided results timeously were (not in same order as in the table of assays):

1. ALS Chemex Laboratory Group Vancouver CA
2. ALS Chemex Laboratory Group Johannesburg SA
3. ALS Chemex Laboratory Group Perth WA
4. Anglo Gold Ashanti - Navachab Gold Mine Laboratory Namibia
5. Anglo Gold Ashanti - Vaal River Laboratory SA
6. Genalysis Laboratory Services (South Africa) Pty
7. Genalysis Laboratory Services W Australia
8. Intertek Utama Services (Indonesia)
9. Performance Laboratories FS (Allanridge)
10. Set Point Laboratories (Isando) SA
11. SGS Geosol Laboratories Ltda (Brazil)
12. SGS Kalgoorlie WA
13. SGS Mineral Services Callao (Peru)
14. SGS Mineral Services Lakefield (Canada)
15. SGS Mwanza
16. SGS South Africa (Pty) Ltd - Booyens JHB
17. SGS Tarkwa (Ghana)
18. SGS Toronto (Canada)
19. SGS Townsville (Australia)
20. Super Laboratory Services (Barberton SA)
21. Super Laboratory Services (Springs SA)
22. Ultra Trace (Pty) Ltd WA

**11. Assay Data:** Data as received from the laboratories for the important certified elements listed on p1 and 2 are 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	Au Pb Coll ppm	Al2O3 XRF %	CaO XRF %	Cr2O3 XRF %	Fe2O3 XRF %	K2O XRF %	LOI %	MgO XRF %	MnO XRF %	Na2O XRF %	SiO2 XRF %	TiO2 XRF %	S Comb %	SG pycnometer
B	5.11	14.30	3.57	0.04	5.10	1.99	6.13	2.12	0.07	5.00	61.20	0.47	1.41	
B	5.01	14.30	3.56	0.04	5.09	1.97	6.10	2.14	0.07	5.02	61.30	0.48	1.42	
B	5.10	14.20	3.58	0.04	5.10	1.98	6.05	2.12	0.08	5.02	61.20	0.48	1.42	
B	5.21	14.30	3.60	0.04	5.11	1.98	6.10	2.12	0.07	5.03	61.20	0.48	1.46	
B	5.08	14.10	3.57	0.03	5.07	1.98	6.14	2.12	0.07	5.02	61.00	0.48	1.42	
B	5.00	14.20	3.58	0.04	5.12	1.99	6.07	2.11	0.07	4.99	61.00	0.48	1.43	
B	5.10	14.20	3.55	0.04	5.07	1.97	6.08	2.11	0.08	4.98	60.90	0.48	1.42	
B	5.09	14.40	3.61	0.04	5.14	2.00	6.18	2.14	0.08	5.07	61.60	0.49	1.41	
C	5.04												1.37	2.78
C	5.00												1.36	2.74
C	4.88												1.37	2.77
C	5.02												1.38	2.74
C	4.85												1.37	2.76
C	5.04												1.37	2.74
C	5.05												1.39	2.73
C	4.96												1.37	2.71
D	5.05	13.80	4.14	0.06	6.04	1.48	6.61	2.06	0.09	5.06	60.50	0.57	1.40	2.77
D	5.00	13.50	4.05	0.04	5.89	1.43	6.57	2.03	0.08	5.00	59.10	0.55	1.44	2.78
D	5.02	13.40	4.08	0.04	5.90	1.44	6.61	2.05	0.09	5.04	58.70	0.55	1.41	2.76
D	5.01	13.40	4.03	0.04	5.86	1.40	6.49	2.02	0.08	4.96	58.80	0.55	1.42	2.77
D	5.04	13.60	4.06	0.03	5.88	1.37	6.51	2.05	0.08	4.95	59.30	0.54	1.42	2.78
D	4.96	13.90	4.33	0.04	5.85	1.43	6.49	2.05	0.09	5.00	60.60	0.54	1.43	2.77
D	4.87	13.50	4.08	0.06	5.91	1.36	6.52	2.04	0.09	4.94	58.60	0.55	1.34	2.78
D	4.95	13.40	4.08	0.09	5.91	1.43	6.98	2.03	0.09	5.01	58.80	0.55	1.40	2.77
G	4.42	13.60	3.96	0.04	5.82	1.42	7.06	2.28	0.08	5.44	59.30	0.56		
G	4.29	13.50	4.00	0.04	5.88	1.39	7.03	2.30	0.08	5.35	59.60	0.56		
G	4.57	13.60	4.00	0.05	5.94	1.40	7.02	2.30	0.08	5.33	59.60	0.56		
G	4.17	13.50	3.96	0.04	5.86	1.41	7.02	2.30	0.08	5.33	59.90	0.56		
G	4.39	13.40	3.97	0.04	5.86	1.39	7.08	2.25	0.08	5.25	59.30	0.56		
G	4.08	13.60	4.00	0.04	5.86	1.40	7.02	2.29	0.08	5.27	59.80	0.57		
G	4.46	13.60	4.00	0.04	5.88	1.40	7.00	2.29	0.08	5.41	59.80	0.57		
G	4.34	13.40	4.02	0.04	5.87	1.38	7.03	2.28	0.08	5.24	59.40	0.57		
H	4.83													
H	4.29													
H	4.34													
H	4.75													
H	4.60													
H	4.35													
H	4.29													
H	4.37													
I	5.24													
I	5.14													
I	5.28													
I	5.03													
I	4.98													
I	4.97													
I	5.21													
I	5.04													

### Assay data (cont)

Lab Code	Au Pb Coll ppm	Al2O3 XRF %	CaO XRF %	Cr2O3 XRF %	Fe2O3 XRF %	K2O XRF %	LOI %	MgO XRF %	MnO XRF %	Na2O XRF %	SiO2 XRF %	TiO2 XRF %	S Comb %	SG pycnometer
K	4.86													
K	3.59													
K	4.38													
K	5.79													
K	5.92													
K	5.01													
K	4.56													
K	5.67													
L	5.05													
L	4.84													
L	5.06													
L	5.06													
L	5.04													
L	5.18													
L	4.98													
L	4.83													
M	4.92												1.32	2.89
M	4.88												1.23	2.87
M	4.84												1.35	2.88
M	4.92												1.35	2.87
M	4.44												1.28	2.87
M	5.00												1.32	2.90
M	4.60												1.23	2.86
M	4.58												1.35	2.87
O	5.31	13.64	4.04	0.04	5.87	1.42	6.69	2.34	0.08	5.27	59.70	0.56		2.88
O	5.01	13.61	4.04	0.04	5.86	1.42	6.68	2.34	0.08	5.27	59.67	0.55		2.88
O	5.14	13.62	4.05	0.04	5.89	1.42	6.69	2.34	0.08	5.26	59.69	0.56		2.83
O	4.86	13.64	4.05	0.04	5.89	1.42	6.66	2.34	0.08	5.27	59.65	0.56		2.82
O	5.06	13.67	4.06	0.04	5.90	1.42	6.69	2.35	0.08	5.27	59.75	0.55		2.84
O	5.14	13.66	4.05	0.04	5.89	1.42	6.69	2.35	0.08	5.27	59.72	0.56		2.89
O	4.93	13.63	4.05	0.04	5.87	1.42	6.70	2.34	0.08	5.26	59.65	0.56		2.85
O	5.10	13.64	4.06	0.04	5.89	1.42	6.72	2.35	0.08	5.27	59.72	0.56		2.88
P	4.70													
P	4.53													
P	4.55													
P	4.66													
P	4.68													
P	4.74													
P	4.77													
P	4.71													
Q	4.87													
Q	4.87													
Q	5.10													
Q	4.70													
Q	4.83													
Q	5.05													
Q	4.09													
Q	5.10													
R	4.53	13.55	3.86	0.03	5.55	1.37	6.44	2.32	0.08	5.22	57.70	0.56		
R	5.32	13.55	3.86	0.04	5.55	1.36	6.32	2.32	0.08	5.23	57.70	0.54		
R	4.42	13.50	3.84	0.03	5.54	1.36	6.51	2.33	0.08	5.23	57.60	0.54		
R	4.52	13.50	3.85	0.04	5.54	1.36	6.38	2.32	0.08	5.24	57.70	0.53		
R	4.53	13.55	3.86	0.03	5.54	1.36	6.32	2.32	0.08	5.22	57.70	0.53		
R	4.58	13.55	3.86	0.04	5.53	1.36	6.44	2.33	0.08	5.22	57.70	0.54		
R	4.26	13.55	3.86	0.03	5.52	1.36	6.45	2.32	0.08	5.24	57.80	0.54		
R	4.58	13.50	3.85	0.04	5.53	1.36	6.58	2.33	0.08	5.24	57.50	0.53		
S	5.03	13.65	4.02	0.03	5.84	1.38	6.97	2.31	0.08	5.24	59.38	0.54		2.83
S	5.04	13.62	4.01	0.03	5.85	1.37	6.96	2.31	0.08	5.23	59.31	0.54		2.84
S	5.07	13.57	4.04	0.03	5.83	1.37	6.87	2.31	0.08	5.21	59.11	0.54		2.78
S	5.07	13.67	4.03	0.03	5.83	1.38	6.90	2.32	0.08	5.24	59.31	0.54		2.79
S	5.06	13.69	4.04	0.03	5.86	1.39	6.85	2.34	0.08	5.25	59.42	0.54		2.90
S	5.03	13.68	4.04	0.03	5.84	1.39	6.89	2.31	0.08	5.22	59.19	0.53		2.75
S	5.03	13.61	4.01	0.03	5.83	1.39	7.13	2.32	0.08	5.24	59.35	0.54		2.83
S	4.99	13.72	4.04	0.03	5.84	1.40	7.02	2.33	0.08	5.26	59.46	0.54		2.68
T	5.27													2.79
T	5.18													2.79
T	5.25													2.78
T	5.29													2.82
T	5.18													2.80
T	5.23													2.81
T	5.18													2.79
T	5.22													2.81
U	4.95													
U	4.99													
U	5.12													
U	5.02													
U	5.06													
U	5.00													
U	5.01													
U	5.08													
V	5.03	13.54	4.01	0.04	5.97	1.42	6.47	2.34	0.08	5.43	59.83	0.55	1.31	2.84
V	5.14	13.51	4.01	0.04	6.00	1.42	6.38	2.34	0.08	5.41	59.89	0.55	1.33	2.84
V	5.11	13.52	4.00	0.04	5.98	1.42	6.39	2.33	0.08	5.42	59.93	0.55	1.32	2.79
V	5.02	13.45	4.00	0.04	5.95	1.42	6.37	2.34	0.08	5.38	59.73	0.55	1.37	2.78
V	5.05	13.53	4.00	0.04	5.99	1.43	6.47	2.33	0.08	5.40	59.84	0.55	1.38	2.76
V	5.01	13.51	3.99	0.04	5.98	1.41	6.48	2.34	0.08	5.42	59.88	0.55	1.35	2.81
V	5.09	13.51	4.00	0.04	5.96	1.41	6.49	2.35	0.08	5.42	59.94	0.55	1.39	2.78
V	5.08	13.50	3.98	0.04	5.99	1.42	6.54	2.33	0.08	5.38	59.89	0.55	1.38	2.77

### Assay data (cont)

Lab Code	Au Pb Coll ppm	Al2O3 XRF %	CaO XRF %	Cr2O3 XRF %	Fe2O3 XRF %	K2O XRF %	LOI %	MgO XRF %	MnO XRF %	Na2O XRF %	SiO2 XRF %	TiO2 XRF %	S Comb %	SG pycnometer
W	4.89													2.76
W	4.93													2.78
W	4.86													2.80
W	4.83													2.77
W	5.08													2.76
W	4.94													2.78
W	4.93													2.76
W	5.02													2.77
X	5.04	13.50	4.04	0.04	5.86	1.41		2.38	0.09	5.30	59.47	0.55	1.25	
X	5.04	13.49	4.03	0.05	5.88	1.42		2.35	0.09	5.27	59.48	0.55	1.28	
X	5.01	13.45	4.04	0.04	5.83	1.41		2.36	0.09	5.27	59.40	0.55	1.26	
X	5.07	13.49	4.05	0.04	5.83	1.41		2.37	0.08	5.29	59.35	0.56	1.29	
X	5.08	13.48	4.02	0.04	5.87	1.41		2.36	0.09	5.24	59.41	0.55	1.30	
X	5.06	13.53	4.06	0.04	5.88	1.42		2.38	0.09	5.30	59.58	0.55	1.28	
X	5.10	13.49	4.05	0.04	5.86	1.41		2.37	0.09	5.27	59.35	0.55	1.25	
X	5.04	13.47	4.04	0.04	5.85	1.41		2.37	0.09	5.28	59.34	0.55	1.27	
Z	4.94													
Z	5.19													
Z	5.21													
Z	5.06													
Z	4.76													
Z	5.09													
Z	5.10													
Z	5.17													
ZA	5.09	13.70	4.00	0.04	5.98	1.43	6.02	2.30	0.10	5.56	59.10	0.73		2.79
ZA	5.06	13.60	4.01	0.04	6.00	1.43	6.04	2.30	0.10	5.57	59.10	0.73		2.77
ZA	5.06	13.70	4.02	0.04	5.96	1.43	5.92	2.40	0.10	5.57	59.20	0.73		2.78
ZA	5.06	13.60	4.00	0.04	6.00	1.42	6.15	2.40	0.10	5.59	59.10	0.72		2.78
ZA	5.06	13.60	4.01	0.04	5.96	1.43	5.92	2.30	0.10	5.59	59.00	0.73		2.79
ZA	5.01	13.70	4.01	0.04	5.99	1.42	6.15	2.40	0.10	5.60	59.10	0.73		2.78
ZA	5.01	13.60	4.01	0.04	5.96	1.42	6.04	2.40	0.10	5.55	59.10	0.72		2.78
ZA	5.09	13.70	4.01	0.04	6.00	1.43	6.04	2.30	0.10	5.55	59.10	0.72		2.79
ZB	5.16													
ZB	5.18													
ZB	4.98													
ZB	5.18													
ZB	5.10													
ZB	4.97													
ZB	5.16													
ZB	5.15													

**12. Measurement of Uncertainty:** 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>	σ <sub>L</sub> <sup>2</sup>	Sw <sup>3</sup>	CSU <sup>4</sup>
Au	Pb Coll	ppm	0.125	0.066	0.090	0.018
Al2O3	XRF	%	0.086	0.074	0.051	0.029
CaO	XRF	%	0.029	0.032	0.015	0.013
Cr2O3	XRF	%	0.005	0.004	0.003	0.002
Fe2O3	XRF	%	0.057	0.057	0.021	0.024
K2O	XRF	%	0.024	0.023	0.013	0.009
LOI		%	0.347	0.350	0.084	0.133
MgO	XRF	%	0.025	0.029	0.008	0.012
MnO	XRF	%	0.004	0.003	0.002	0.001
Na2O	XRF	%	0.172	0.149	0.034	0.053
SiO2	XRF	%	0.609	0.588	0.332	0.226
TiO2	XRF	%	0.010	0.009	0.006	0.004
SG	pycnometer		0.043	0.042	0.022	0.015

S - Std Dev for use on control charts.

1. σ<sub>L</sub> - Betw Lab Std Dev, for use to calculate a measure of accuracy.
2. Sw - Within Lab Stc Dev, for use to calculate a measure of precision.
3. CSU - Combined Standard Uncertainty, a component for use to calculate
4. the total uncertainty in method validation.

**13. Certified values:** The Certified, Provisional and Indicated values listed on p1 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 and who have maintained measurement traceability during the analytical process.

**15. Certification:** AMIS0228 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 and a 30g sample size for the fire assay. These are the recommended minimum sample sizes 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 50 to 250g) of material. The Laboratory Packs are sealed bottles delivered in sealed foil pouches. The Explorer Packs contain material in standard geochem envelopes, nitrogen flushed and 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.

27 October 2011

**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	0.40	0.07	8.85	53
Al	M/ICP	%	7.09	0.37	2.60	69
As	M/ICP	ppm	76.85	6.57	4.27	76
Ba	M/ICP	ppm	446	39.30	4.41	71
Be	M/ICP	ppm	1.78	0.18	4.99	70
Bi	M/ICP	ppm	0.38	0.07	9.82	70
Ca	M/ICP	%	2.82	0.14	2.55	90
Cd	M/ICP	ppm	0.31	0.06	8.94	53
Ce	M/ICP	ppm	45.74	5.84	6.39	85
Co	M/ICP	ppm	18.70	2.47	6.60	93
Cr	M/ICP	ppm	225	36.70	8.15	71
Cs	M/ICP	ppm	2.39	0.31	6.58	45
Cu	M/ICP	ppm	60.53	7.23	5.97	101
Dy	M/ICP	ppm	1.85	0.30	8.17	30
Er	M/ICP	ppm	1.02	0.16	7.99	31
Eu	M/ICP	ppm	1.02	0.15	7.49	31
Fe	M/ICP	%	4.06	0.21	2.53	98
Ga	M/ICP	ppm	19.47	2.17	5.56	85
Gd	M/ICP	ppm	2.76	0.30	5.43	30
Ge	M/ICP	ppm	0.15	0.04	14.65	24
Hf	M/ICP	ppm	2.64	0.48	9.11	72
Ho	M/ICP	ppm	0.35	0.08	11.99	31
In	M/ICP	ppm	0.04	0.01	12.10	64
K	M/ICP	%	1.17	0.10	4.34	103
La	M/ICP	ppm	21.70	2.77	6.38	94
Li	M/ICP	ppm	10.93	1.41	6.47	87
Lu	M/ICP	ppm	0.16	0.04	11.63	53
Mg	M/ICP	%	1.36	0.16	5.73	111
Mn	M/ICP	ppm	650	71.77	5.52	88
Mo	M/ICP	ppm	10.45	1.06	5.09	87
Na	M/ICP	%	3.86	0.29	3.76	79
Nb	M/ICP	ppm	3.68	1.05	14.22	48
Nd	M/ICP	ppm	20.22	1.17	2.89	30
Ni	M/ICP	ppm	44.09	4.84	5.49	103
P	M/ICP	ppm	304	27.88	4.59	68
Pb	M/ICP	ppm	23.18	2.94	6.35	94
Pd	M/ICP	ppm	0.01	0.01	37.64	8
Pr	M/ICP	ppm	5.31	0.59	5.55	30
Pt	M/ICP	ppm	0.01	0.01	34.18	8
Rb	M/ICP	ppm	31.97	3.04	4.76	85
Re	M/ICP	ppm	0.00	0.00	10.34	22
S	M/ICP	%	1.41	0.13	4.60	77
Sb	M/ICP	ppm	8.31	1.27	7.62	62
Sc	M/ICP	ppm	12.29	1.32	5.38	87
Se	M/ICP	ppm	1.71	0.93	27.18	24
Si	M/ICP	%	28.09	0.47	0.84	8
Sm	M/ICP	ppm	3.75	0.48	6.41	31
Sn	M/ICP	ppm	0.91	0.12	6.89	44
Sr	M/ICP	ppm	662	66.37	5.01	85
Ta	M/ICP	ppm	0.26	0.09	16.99	45
Tb	M/ICP	ppm	0.36	0.08	10.94	56
Te	M/ICP	ppm	0.66	0.11	8.39	77
Th	M/ICP	ppm	3.66	0.39	5.36	77
Ti	M/ICP	%	0.24	0.05	10.04	71
Tl	M/ICP	ppm	0.20	0.02	4.95	51
Tm	M/ICP	ppm	0.15	0.03	11.40	32
U	M/ICP	ppm	1.64	0.18	5.53	84
V	M/ICP	ppm	56.69	6.49	5.72	82
W	M/ICP	ppm	46.25	16.86	18.23	64
Y	M/ICP	ppm	9.74	1.03	5.28	85
Yb	M/ICP	ppm	1.11	0.12	5.31	52
Zn	M/ICP	ppm	84.48	8.28	4.90	102
Zr	M/ICP	ppm	93.52	13.54	7.24	62