African Mineral Standards
REFERENCE MATERIALS FOR AFRICAN ORES

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AMIS0077

Certified Reference Material

Gold and Uranium Ore
Witwatersrand Reference Material
Ore Grade

Certificate of Analysis

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

Certified Concentrations[2.]

Au (Pb Collection)	12.09	±	0.64	g/t
U (XRF)*	477	±	38	ppm
U (M/ICP)*	455	±	50.7	ppm
Specific Gravity	2.79	±	0.16	g/cc

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.*
3. *Or, by applying a chemical conversion factor of U x 1.1793 = U_3O_8*
   U_3O_8 by multi acid digestion: 537 ± 60 ppm
   U_3O_8 by XRF: 563 ± 45 ppm

1. **Intended use:** AMIS0077 is suitable for monitoring the accuracy of a single analysis of gold ores hosted by siliceous rocks. The material can be used for routine quality control by inserting within a batch of samples.

   The recommended mean and "Between Lab" standard deviations for this standard reflect the average 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 and this is acceptable. Good laboratories however will report results within the two standard deviation levels with a failure of <10 %.

2. **Origin of material:** This standard is a blend of Ventersdorp Contact Reef, Carbon Leader Reef and Vaal Reef material provided by Anglo Gold Ashanti in South Africa. It was made from a mixture of pulp reject sample material, collected during routine underground sampling, sourced from mine assay laboratories and blended down to a required grade with silica.

3. **Mineral and chemical composition:** The major gangue mineral is quartz with minor pyrite, uraninite and thucolite. Gold occurs primarily as discrete grains.

   The major element chemistry has been calculated, from predominantly XRF data submitted by sixteen of the laboratories, from the eight samples sent each lab. Uncertified statistics from this data are:

	mean	2SD	RSD%	n	unit
Al_2O_3	10.70	0.21	1.0	76	%
CaO	5.44	0.11	1.0	94	%
Cr_2O_3	0.07	0.01	8.7	94	%
Fe_2O_3	5.15	0.09	0.9	91	%
K_2O	0.41	0.02	2.0	91	%
LOI	1.58	0.34	10.6	82	%
MgO	3.58	0.21	3.0	102	%
MnO	0.08	0.00	1.9	75	%
Na_2O	1.18	0.11	4.7	102	%
P_2O_5	0.05	0.01	9.6	63	%
S	0.85	0.05	2.8	54	%
SiO_2	71.15	1.43	1.0	93	%
TiO_2	0.18	0.01	2.4	89	%

   Uncertified trace element statistics are also appended to this certificate.

4. **Appearance:** The material is a very fine powder coloured 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. **Radioactivity:** Shipments of this material do not require special marking, labeling or placarding. AMIS0077 does contain U (5.9 Bq/g) and Th (0.19 Bq/g) but due to the low activity concentrations it is classified as EXEMPT MATERIAL in terms of “Safety Standards Series No. TS-R-1: Regulations for the Safe Transport of Radioactive Material, International Atomic Energy Agency, 2005, para 403, Table 1”.

7. **Method of preparation:** The material was crushed, dry-milled and air-classified to 100% <54um. Wet sieve particle size analysis of random samples confirmed the material was 100% <54um. It was then blended in a bi-conical mixer, systematically divided and then sealed into 1kg Laboratory Packs. Samples were randomly selected for homogeneity testing and third party analysis. Statistical analysis for the consensus test results were carried out by an independent statistician. Explorer Packs are subdivided from the Laboratory packs as required.

8. **Methods of Analysis requested:**

   1. Au – Pb collection ICP-OES or ICP-MS.
   2. Multi-acid digest U ICP- OES or ICP-MS.
   3. U XRF.
   4. Majors (Al_2O_3, CaO, Cr_2O_3, Fe_2O_3, K_2O, MgO, MnO, Na_2O, SiO_2, TiO_2, LOI.) XRF fusion.
   5. SG (gas pycnometer)

9. **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.

10. **Method of certification:** Twenty two laboratories were each given eight randomly selected packages of sample.

    The mean and standard deviation for all data was calculated. Outliers were defined as samples beyond the mean $\pm$ 2 Standard Deviations from all data. These outliers were removed from the data and a new mean and standard deviation was determined.

    Standards with an RSD of near or less than 5 % are then certified, RSD's of between near 5 % and 15 % are given Provisional Concentrations and limits, those with RSD's over 15 % are given Indicated Concentrations.

    This method is different from that used to calculate the Confidence Interval shown on many Government-produced standards in that the actual "between-laboratory" standard deviation is used in the calculations. This produces upper and lower limits that reflect actual individual analyses rather than a grouped set of analyses. The limits can therefore be used to monitor accuracy from individual analyses, unlike the Certified Limits published on other standards which quote a Confidence Interval.

11. **Participating laboratories:** (Not in same order as in the table of assays)

    1. ACME Analytical Laboratories Ltd., (Canada).
    2. Activation Laboratories Ltd., (ActLabs, Ancaster, ON, Canada).
    3. AGA - Vaal River Laboratory (South Africa).
    4. AGA - West Wits Laboratory, (South Africa).
    5. ALS Chemex, (Perth, Australia).
    6. ALS Chemex, (Vancouver, Canada).
    7. ALS Chemex South Africa (Pty) Ltd.
    8. Anglo Research (Crown Campus, South Africa).
    9. Assayers Canada, (Vancouver).
    10. Genalysis Laboratory Services (Pty) Ltd., (Australia).
    11. Pt Intertek Utama Services (Intertek, Indonesia)
    12. Labtium Inc. (Finland).
    13. MAED Laboratories - Knights (South Africa).
    14. AGA - Navachab Gold Mine Laboratory, (Namibia).
    15. OMAC Laboratories (Ireland).
    16. Performance Laboratories, (South Africa).

17. Set Point Laboratories (Pty) Ltd (South Africa).
18. SGS Welshpool (Australia).
19. SGS Mineral Services - Barberton, (South Africa).
20. SGS Lakefield Research (Canada).
21. SGS Lakefield Research Africa (Pty) Ltd. (Joburg, South Africa)
22. Ultra Trace (Pty) Ltd. (Australia).

12. Assay Data: Data as received from the laboratories is set out below. A proficiency report has been sent to the managers of the participating laboratories.

Laboratory Code	Au (Pb coll) g/t	U (M/ICP) ppm	U (XRF) ppm	Specific Gravity g/cc
A	12.09	498		2.77
A	12.63	474		2.76
A	12.35	499		2.73
A	12.84	491		2.75
A	12.62	518		2.76
A	12.98	478		2.76
A	12.62	495		2.76
A	12.68	506		2.75
B	11.90	454	490	2.72
B	11.60	416	430	2.73
B	11.50	396	500	2.72
B	11.60	429	440	2.73
B	11.60	385	490	2.70
B	11.70	394	460	2.71
B	11.70	410	460	2.72
B	11.70	472	420	2.61
C	12.08		505	2.75
C			499	2.75
C	11.10		513	2.72
C	11.39		499	2.87
C	11.46		504	2.72
C	11.47		502	2.92
C	11.75		502	2.87
C	11.38		503	2.92
D	11.50			
D	12.10			
D	12.23			
D	11.95			
D	12.02			
D	12.02			
D	12.10			
D	12.10			
E		412	460	2.68
E		424	460	2.63
E		460	460	2.65
E		404	470	2.67
E		411	460	2.64
E		433	450	2.65
E		403	460	2.67
E		431	460	2.64
F	12.05	440	400	2.77
F	12.05	438	400	2.76
F	11.70	439	500	2.80
F	12.05	445	400	2.72
F	12.05	440	500	2.74
F	12.20	439	400	2.81
F	11.95	440	500	2.83
F	11.95	440	400	2.77
G	12.30	449		2.70
G	12.30	460		2.74
G	12.10	440		2.72
G	11.95	440		2.69
G	11.70	460		2.75
G	12.00	460		2.59
G	11.85	460		2.74
G	11.95	440		2.68
H	12.20		457	2.91
H	12.20			2.90
H	12.10		460	2.91
H	12.30		458	2.95
H	12.10		455	2.90
H	12.30		456	2.90
H	12.30		460	2.93
H	12.30		457	2.93

Laboratory Code	Au (Pb coll) g/t	U (M/ICP) ppm	U (XRF) ppm	Specific Gravity g/cc
I	11.20	402		
I	11.40	375		
I	10.30	375		
I	12.20	371		
I	12.60	390		
I	11.20	392		
I	10.50	395		
I	10.90	391		
J	12.12	490	457	2.85
J	12.17	478	461	2.81
J	12.06	480	464	2.84
J	12.09	478	460	2.84
J	12.25	474	463	2.83
J	11.97	494	460	2.87
J	12.14	480	462	2.84
J	11.99	481	460	2.86
K	11.50			2.58
K	11.90			2.59
K	11.80			2.57
K	11.80			2.55
K	11.90			2.60
K	11.80			2.58
K	11.70			2.59
K	11.80			2.55
L	11.90	444		
L	12.40	427		
L	12.50	415		
L	12.60	432		
L	12.60	416		
L	12.40	437		
L	12.60	432		
L	11.60	424		
M	12.20			
M	12.24			
M	12.24			
M	12.20			
M	12.26			
M	12.22			
M	12.20			
M	12.06			
N	12.80			
N	12.79			
N	11.99			
N	12.50			
N	12.75			
N	12.75			
N	12.28			
N	11.98			
O	12.34	444		2.75
O	12.38	456		2.62
O	12.18	453		2.61
O	12.26	464		2.75
O	12.09	452		2.69
O	11.88	442		2.66
O	12.09	450		2.73
O	11.98	450		2.66
P	12.10		481	
P	12.10		461	
P	12.10		459	
P	12.20		441	
P	12.10		461	
P	12.20		477	
P	12.40		451	
P	12.20		472	

Laboratory Code	Au (Pb coll) g/t	U (M/ICP) ppm	U (XRF) ppm	Specific Gravity g/cc
Q	11.91	461	478	2.83
Q	12.01	470	479	2.83
Q	12.40	468	478	2.84
Q	11.88	464	479	2.83
Q	12.43	490	479	2.84
Q	12.21	471	475	2.82
Q	12.46	471	475	2.83
Q	12.14	458	477	2.83
R	11.90	480	472	
R	12.00	503	478	
R	12.50	521	475	
R	11.80	526	477	
R	12.20	493	480	
R	11.60	524	470	
R	12.30	503	481	
R	11.30	523	488	
S	12.08			
S	12.08			
S	12.32			
S	11.92			
S	12.16			
S	12.20			
S	11.32			
S	11.68			
T	11.20	520	520	2.79
T	11.20	510	520	2.83
T	10.90	520	530	2.83
T	11.40	520	520	2.84
T	11.60	520	520	2.85
T	11.00	520	530	2.86
T	11.60	510	520	2.81
T	11.00	500	520	2.84
U			490	2.80
U			493	2.80
U			495	2.80
U			499	2.81
U			495	2.80
U			498	2.80
U			491	2.81
U			491	2.81
V	12.10	476	510	2.86
V	12.30	469	520	2.90
V	12.20	481	510	2.90
V	11.80	478	520	2.89
V	12.40	476	510	2.87
V	12.30	495	500	2.88
V	12.30	478	500	2.89
V	11.80	475	510	2.88

13. 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:

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]	σ_L [2]	S_w [3]	CSU [4]
Au	Pb Col	ppm	0.32	0.15	0.22	0.04
U	M/ICP	ppm	26.20	21.35	12.12	6.89
U	XRF	ppm	18.99	15.35	8.61	4.96
SG	pyc		0.08	0.06	0.04	0.02

1. *S - Std Dev for use on control charts.*
2. *σ_L - Betw Lab Std Dev, for use to calculate a measure of accuracy.*
3. *S_W - 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.*

14. 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.

15. 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.

16. Certification: AMIS0077 was originally certified/requested by a laboratory as a Reference material on 14 April 2008. This recertification was for the purpose of calculating the Combined Standard Uncertainties (CSU).

17. 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.

18. 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.

19. Availability: This product is available in Laboratory Packs containing 1kg of material or in Explorer Packs containing client specified weights of material from 50g up to 250g. Laboratory Packs are sealed bottles delivered in sealed foil pouches. Explorer Packs contain material in standard geochem envelopes placed into foil pouches that are nitrogen flushed and vacuum sealed.

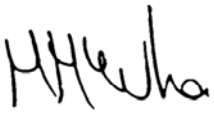
20. Recommended use: The data used to characterize this CRM has been scrutinized using outlier treatment techniques. This, together with the number of participating laboratories, should overcome any "inter-laboratory issues" and should lead to a very accurate measure for the given methods, notwithstanding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

21. 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 April 2008 (as a Reference Material)

26 October 2010 (as a Certified Reference Material)

Certifying officers:



African Mineral Standards: _____

Mike McWha
BSc (Hons), FGSSA, MSAIMM, Pr.Sci.Nat

Geochemist: _____

Barry W. Smee
BSc, PhD, P.Geo, (B.C.)

APPENDIX

Uncertified Trace Elements.

	mean	2SD	RSD%	n	unit
Ag M/ICP	1.40	0.97	34.5	37	ppm
Al M/ICP	5.69	0.49	4.3	46	%
As M/ICP	191.9	15.2	3.9	62	ppm
Ba M/ICP	100.6	10.9	5.4	54	ppm
Be M/ICP	0.472	0.074	7.8	24	ppm
Bi M/ICP	0.726	0.086	6.0	38	ppm
Ca M/ICP	3.85	0.45	5.8	45	%
Cd M/ICP	0.264	0.071	13.5	38	ppm
Ce M/ICP	33.6	2.8	4.1	38	ppm
Co M/ICP	50.5	5.5	5.5	54	ppm
Cr M/ICP	383.2	75.0	9.8	40	ppm
Cs M/ICP	1.02	0.34	16.6	38	ppm
Cu M/ICP	41.6	4.2	5.1	54	ppm
Fe M/ICP	3.46	0.18	2.6	31	%
Ga M/ICP	9.51	1.09	5.7	54	ppm
Hf M/ICP	1.98	0.41	10.4	38	ppm
K M/ICP	0.331	0.012	1.8	43	%
La M/ICP	16.8	1.8	5.4	55	ppm
Li M/ICP	7.89	0.93	5.9	47	ppm
Mg M/ICP	2.05	0.24	5.8	48	%
Mn M/ICP	595.7	48.9	4.1	39	ppm
Mo M/ICP	8.83	2.15	12.2	55	ppm
Na M/ICP	0.830	0.097	5.8	46	%
Nb M/ICP	4.12	0.90	11.0	45	ppm
Ni (M/ICP	138.1	11.2	4.0	54	ppm
Pb M/ICP	186.3	25.6	6.9	55	ppm
Rb M/ICP	14.2	1.3	4.7	54	ppm
Sb M/ICP	7.57	1.83	12.1	51	ppm
Sc M/ICP	10.0	0.5	2.3	44	ppm
Sn M/ICP	1.33	0.49	18.3	30	ppm
Sr M/ICP	128.4	11.6	4.5	72	ppm
Ta M/ICP	1.69	0.30	9.0	40	ppm
Te M/ICP	0.132	0.033	12.5	30	ppm
Th M/ICP	46.4	4.2	4.6	55	ppm
Tl M/ICP	0.159	0.060	18.7	39	ppm
V M/ICP	55.2	5.7	5.1	56	ppm
W M/ICP	0.642	0.328	25.6	39	ppm
Y M/ICP	24.1	1.5	3.2	53	ppm
Zn M/ICP	189.6	7.8	2.1	45	ppm
Zr M/ICP	62.8	12.5	10.0	55	ppm