African Mineral Standards
REFERENCE MATERIALS FOR AFRICAN ORES

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AMIS0096

Certified Reference Material

Unraniferous Karoo Sandstone
South Africa

Certificate of Analysis

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

Provisional Concentrations[2.]

U XRF	137	±	28	ppm
U M/ICP	132	±	23	ppm
Mo XRF	80	±	15	ppm
Mo M/ICP	79	±	15	ppm

Certified Concentrations

Specific Gravity	2.70	±	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

Cr2O3	0.15	±	0.02	%
Fe2O3	2.49	±	0.18	%
MgO	1.56	±	0.14	%
SiO2	86.55	±	2.14	%

Provisional Concentrations

Al2O3	4.16	±	0.64	%
CaO	1.48	±	0.24	%
K2O	0.59	±	0.09	%
MnO	0.092	±	0.014	%
Na2O	1.12	±	0.20	%
TiO2	0.19	±	0.03	%
S ICP	0.06	±	0.02	%
LOI	1.45	±	0.30	%

Informational means

P2O5	0.20	%

1. Intended Use: AMIS0096 can be used to check analysis of samples of uraniferous sandstone ores with a similar grade and matrix.

It is a matrix matched Certified Reference Material, fit for use as control samples in routine assay laboratory quality control when inserted within runs of samples and measured in parallel to the unknown. Its purpose is to monitor inter-laboratory or instrument bias and within lab precision. It can be used, indirectly, to establish the traceability of results to an SI system of units.

The recommended concentrations and limits for this material are property values based on a measurement campaign (round robin) and reflect consensus results from the laboratories that participated in the round robin.

Slight variations in analytical procedures between laboratories will reflect as slight biases to the recommended concentrations (see 19). Good laboratories will report results within the two standard deviation levels with a failure rate of <10 %.

The material can also be used for method development and for the calibration of equipment.

2. Origin of Material: AMIS0096 was made from Karoo sandstone material supplied by Uramin (Pty) Inc. from their Ryst Kuil project, situated about 60km south-east of Beaufort West, in the Western Cape Province, South Africa.

The Karoo Basin is a Permo-Triassic Gondwanaland basin. It is being explored for uranium, which occurs in basal sandy members of upward fining megacycles in the Adelaide Subgroup of the Beaufort Group. The host rock comprises a fine-grained greywacke to mud pebble conglomerate, containing ore grade, organic rich, pods.

The geology and associated mineralization is described in “Le Roux, J.P., and Toens, P.D.. (1986). A review of the uranium occurrences in the Karoo Sequence, South Africa. Anhauser,C.R., and Maske.S.(Eds)(1986). Mineral Deposits of Southern Africa. Vol II, 2119-2134.

3. Mineral and Chemical Composition: The host greywackes are composed of quartz, feldspar and rock fragments in equal proportions. The principle ore mineral is coffinite, with minor amounts of urano-organic compounds and rare uraninite, occurring with pyrite, arsenopyrite and molybdenum sulphide.

The uncertified major and trace element chemical composition are presented in the appendix to this certificate.

4. Appearance: The material is a very fine Pale Greenish Yellow coloured powder (Corstor 5Y 8/2).

5. Handling instructions: The material is packaged in Laboratory Packs and Explorer Packs that must be shaken or otherwise agitated before use. Normal safety precautions for handling fine particulate matter are suggested, such as the use of safety glasses, breathing protection, gloves and a laboratory coat.

6. Method of Preparation: The material was crushed, dry-milled and air-classified to <54um. Wet sieve parti**c**le size analysis of random samples confirmed the material was 98.5% <54um. It was then blended in a bi-conical mixer, systematically divided and then sealed into 1kg Laboratory Packs. Explorer Packs are subdivided from the Laboratory packs as required. Samples were randomly selected for homogeneity testing and third party analysis. Statistical analysis of both homogeneity and consensus test results were carried out by an independent statistician.

7. Methods of Analysis requested:

1. Multi-acid digest, including HF, ICP- OES or ICP-MS. Multi element scan (to include U).
2. Majors (Al2O3, CaO, Cr2O3, Fe2O3, K2O, MgO, MnO, Na2O, SiO2, TiO2. LOI.) ICP fusion.
3. U and Mo, XRF fusion.
4. SG (gas pycnometer).

8. Information requested:

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

9. Method of Certification: Twenty two laboratories were each given eight packages, comprising eight samples scientifically selected from throughout the batch. Fourteen of these laboratories reported results for the major elements.

Final limits were calculated after first determining if all data was compatible within a spread normally expected for similar analytical methods done by reputable laboratories. Data from any one laboratory was then removed from further calculations when the mean of all analyses from that laboratory failed a “t test” of the global means of the other laboratories. The means and standard deviations were then re-calculated using all remaining data. Any analysis that fell outside of the new two standard deviations was removed from the ensuing data base. The mean and standard deviations were again calculated using the remaining data.

The “between-laboratory” standard deviation is used in the calculation to eliminate technically and statistically invalid data. Upper and lower limits are based on the standard deviation of the remaining data, which reflect individual analyses and can be used to monitor accuracy in routine laboratory quality control. This is different to limits based on standard deviations derived from grouped set of analyses (see 12), which provide important measures for precision and trueness, but which are less useful for routine QC.

Standards with an RSD of near or less than 5 % are termed “Certified”, RSD’s of between near 5 % and 15 % are termed “Provisional”, and RSD’s over 15 % are termed “Informational”.

10. Participating Laboratories: (Not in same order as in the table of assays):

1. ACME Analytical Laboratories Ltd CA
2. Activation Laboratories Pty Ltd (ActLabs) CA
3. ALS Chemex Laboratory Group Johannesburg SA
4. ALS Chemex Laboratory Group Perth WA
5. ALS Chemex Laboratory Group Vancouver CA
6. Amdel Limited Adelaide (South Australia)
7. Anglo Gold Ashanti - Vaal River Laboratory SA
8. Anglo Research (Crown Campus)
9. Assayers Canada
10. Genalysis Laboratory Services WA
11. Geoscience Laboratories (GEO LABS) CA
12. Intertek Utama Services (Indonesia)
13. Labtium Inc Finland
14. Mintek (South Africa)
15. OMAC Laboratories Limited (Ireland)
16. Performance Laboratories SA
17. Set Point Laboratories (Isando) SA
18. SGS Australia Pty Ltd (Newburn) WA
19. SGS Lakefield Research Africa (Pty) Ltd (Booysens SA)
20. SGS Mineral Services Lakefield (Canada)
21. SRC Saskatchewan Research Council (Canada)
22. Ultra Trace (Pty) Ltd WA

11. Assay Data: Data as received from the laboratories for the important certified elements listed on p1 is set out below. A proficiency report has been sent to the managers of the participating laboratories. Additional digital data from this round robin is available on request.

Lab Code	U XRF ppm	U M/ICP ppm	Mo XRF ppm	Mo M/ICP ppm	SG
A	135.7	141.3	67.5		2.73
A	136.6	142.2	65.1		2.71
A	143.3	136.8	67.2		2.73
A	158.6	157.5	76.8		2.73
A	161.2	153.0	76.6		2.72
A	162.0	145.8	75.8		2.74
A	145.9	139.5	69.8		2.71
A	140.8	137.7	68.8		2.74
B	129.0	130.0	88.0	69.9	
B	152.0	144.0	97.0	86.9	
B	156.0	144.0	97.0	80.9	
B	124.0	122.0	82.0	73.3	
B	122.0	122.0	79.0	72.0	
B	132.0	133.0	89.0	78.7	
B	124.0	116.0	80.0	69.3	
B	125.0	124.0	80.0	68.4	
C	140.0	120.0		70.0	2.72
C	130.0	110.0		60.0	2.74
C	130.0	120.0		70.0	2.76
C	90.0	110.0		70.0	2.71
C	240.0	230.0		120.0	2.69
C	170.0	160.0		80.0	2.71
C	220.0	210.0		110.0	2.72
C	130.0	120.0		70.0	2.72
D		140.0	74.0		2.80
D	121.0	130.0	75.0		2.82
D	136.0	140.0	80.0		2.77
D	125.0	140.0	76.0		2.77
D	134.0	130.0	74.0		2.76
D	136.0	140.0	79.0		2.79
D	123.0	140.0	72.0		2.78
D	118.0	140.0	75.0		2.78
E					2.67
E					2.69
E					2.68
E					2.69
E					2.70
E					2.68
E					2.70
E					2.68
F					2.81
F					2.88
F					2.87
F					2.85
F					2.90
F					2.93
F					2.90
F					2.85

Lab Code	U XRF ppm	U M/ICP ppm	Mo XRF ppm	Mo M/ICP ppm	SG
G		112.4		69.1	
G		134.9		80.6	
G		147.1		86.5	
G		140.0		82.7	
G		148.1		85.9	
G		122.3		73.7	
G		133.0		79.9	
G		121.0		72.7	
H	159.5		81.9		
H	157.8		81.7		
H	158.6		81.3		
H	157.8		81.6		
H	156.9		81.5		
H	159.5		82.0		
H	153.5		80.3		
H	155.6		80.2		
I		234.0		124.0	2.66
I		142.0		82.0	2.65
I		214.0		129.0	2.66
I		227.0		130.0	2.70
I		228.0		131.0	2.69
I		140.0		84.0	2.71
I		137.0		82.0	2.68
I		121.0		74.0	2.69
J	136.0	145.0	88.0	68.9	2.65
J	138.0	130.0	74.0	69.9	2.63
J	138.0	122.0	88.0	78.3	2.68
J	142.0	133.0	75.0	75.2	2.63
J	135.0	122.0	88.0	82.5	2.64
J	131.0	129.0	70.0	84.3	2.60
J	140.0	141.0	89.0	83.9	2.65
J	137.0	129.0	72.0	73.7	2.69
K	143.0	140.5	91.0	86.9	2.67
K	141.0	134.5	91.0	84.0	2.72
K	144.0	140.0	91.0	87.0	2.71
K	141.0	140.5	92.0	88.5	2.71
K	142.0	135.0	91.0	87.2	2.79
K	141.0	143.0	90.0	91.0	2.70
K	143.0	140.0	90.0	89.2	2.77
K	144.0	131.0	91.0	83.4	2.75
L				86.9	
L				83.0	
L				82.7	
L				83.9	
L				82.6	
L				81.1	
L				81.9	
L				82.3	

Lab Code	U XRF ppm	U M/ICP ppm	Mo XRF ppm	Mo M/ICP ppm	SG
M	130.0	130.0	79.0	80.0	2.58
M	122.0	120.0	74.0	75.0	2.61
M	160.0	160.0	94.0	94.0	2.55
M	122.0	120.0	75.0	85.4	2.57
M	122.0	130.0	73.0	76.0	2.53
M	122.0	130.0	77.0	75.0	2.57
M	157.0	150.0	95.0	83.8	2.55
M	121.0	134.5	73.0	74.0	2.52
N				80.0	
N				73.0	
N				128.0	
N				82.0	
N				71.0	
N				72.0	
N				77.0	
N				76.0	
O	129.0	131.6		67.1	2.65
O	125.1	129.2		66.9	2.67
O	140.8	140.8		76.4	2.65
O	141.7	140.0		76.4	2.66
O	145.4	145.4		78.0	2.67
O	143.0	143.0		77.7	2.65
O	119.9	125.0		67.8	2.69
O	121.2	125.6		67.2	2.64
P	124.0	118.1	94.0	86.9	
P	160.0	156.5	90.0	88.9	
P	124.0	118.5	72.0	86.9	
P	123.0	117.7	78.0	85.8	
P	125.0	116.7	76.0	72.4	
P	160.0	155.6	89.0	88.8	
P	123.0	121.1	72.0	86.3	
P	121.0	122.6	75.0	88.0	
Q	157.0	143.5		83.4	
Q	157.0	146.0		79.7	
Q	137.0	127.5		85.3	
Q	121.0	113.5		79.2	
Q	128.0	121.0		81.6	
Q	155.0	150.5		78.7	
Q	121.0	116.0		79.5	
Q	123.0	119.5		78.7	
R	115.3				
R	127.2				
R	156.9				
R	156.9				
R	118.7				
R	120.4				
R	118.7				
R	119.6				

Assay data (cont)

Lab Code	U XRF ppm	U M/ICP ppm	Mo XRF ppm	Mo M/ICP ppm	SG
S		118.3			
S		161.6			
S		204.0			
S		136.9			
S		147.7			
S		202.9			
S		166.7			
S		150.2			
T	107.0	110.0	68.0	67.1	
T	127.0	120.0	81.0	72.3	
T	125.0	121.0	79.0	70.7	
T	132.0	120.0	77.0	69.5	
T	128.0	119.0	79.0	68.8	
T	151.0	144.0	88.0	82.7	
T	120.0	112.0	76.0	65.3	
T	113.0	111.0	74.0	65.1	

Lab Code	U XRF ppm	U M/ICP ppm	Mo XRF ppm	Mo M/ICP ppm	SG
U	137.2				
U	137.9				
U	138.8				
U	139.0				
U	140.0				
U	138.3				
U	138.7				
U	137.8				
V		108.0		80.0	
V		147.0		106.0	
V		115.0		84.0	
V		116.0		86.0	
V		135.0		96.0	
V		102.0		77.0	
V		149.0		73.0	
V		178.0		100.0	

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

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

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

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

Analyte	Method	Unit	S [1]	σ_L [2]	Sw [3]	CSU [4]
U	XRF	ppm	13.71	5.76	11.70	1.97
U	M/ICP	ppm	11.70	4.39	10.60	1.74
Mo	XRF	ppm	7.65	4.69	5.97	1.72
Mo	M/ICP	ppm	7.67	4.10	5.68	1.27
SG	pyc		0.04	0.04	0.02	0.01
Al2O3	XRF	%	0.32	0.13	0.28	0.05
CaO	XRF	%	0.12	0.04	0.11	0.02
Cr2O3	XRF	%	0.009	0.005	0.006	0.002
Fe2O3	XRF	%	0.095	0.049	0.072	0.015
K2O	XRF	%	0.04	0.02	0.04	0.01
MgO	XRF	%	0.07	0.05	0.02	0.02
MnO	XRF	%	0.007	0.005	0.005	0.002
Na2O	XRF	%	0.104	0.039	0.094	0.016
P2O5	XRF	%	0.031	0.017	0.025	0.006
SiO2	XRF	%	1.07	0.58	0.78	0.18
TiO2	XRF	%	0.016	0.006	0.014	0.002
S	ICP	%	0.009	0.007	0.005	0.003
LOI		%	0.151	0.081	0.115	0.026

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. *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. Uncertified 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: AMIS0096 is a new material.

16. Period of validity: The certified values are valid for this product, while still sealed in its original packaging, until notification to the contrary. The stability of the material will be subject to continuous testing for the duration of the inventory. Should product stability become an issue, all customers will be notified and notification to that effect will be placed on the www.amis.co.za website.

17. Minimum sample size: The majority of laboratories reporting used a 0.5g sample size for the ICP and 10g for the XRF. This is the recommended minimum sample size for the use of this material.

18. Radioactivity: Shipments of this material do not require special marking, labeling or placarding. AMIS0096 does contain U (1.7 Bq/g) and Th (0.02 Bq/g), but due to 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".

19. 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.

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 40 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.

9 October 2009

Certifying Officers:

African Mineral Standards:_____

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

Geochemist:_____

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

Appendix 1. – Uncertified trace element statistics.

Analyte	Method	Unit	Mean	2SD	RSD%	n
Ag	M/ICP	ppm	0.17	0.38	110.3	25
Al	M/ICP	%	2.23	0.60	13.4	101
As	M/ICP	ppm	69.7	17.4	12.5	108
Ba	M/ICP	ppm	169	50	14.9	116
Be	M/ICP	ppm	0.89	0.31	17.1	97
Bi	M/ICP	ppm	0.10	0.04	20.9	57
Ca	M/ICP	%	1.06	0.29	13.9	99
Cd	M/ICP	ppm	0.60	0.35	29.0	89
Ce	M/ICP	ppm	27.4	5.6	10.2	84
Co	M/ICP	ppm	14.5	2.8	9.6	124
Cr	M/ICP	ppm	760	175	11.5	93
Cs	M/ICP	ppm	1.03	0.20	9.6	68
Cu	M/ICP	ppm	34.0	6.0	8.8	110
Dy	M/ICP	ppm	1.49	0.38	12.8	63
Er	M/ICP	ppm	0.88	0.18	10.2	55
Eu	M/ICP	ppm	0.43	0.13	14.9	55
Fe	M/ICP	%	1.76	0.19	5.4	98
Ga	M/ICP	ppm	5.63	1.36	12.1	83
Gd	M/ICP	ppm	1.77	0.35	9.9	54
Ge	M/ICP	ppm	0.44	0.83	95.4	32
Hf	M/ICP	ppm	1.18	0.94	39.8	82
Ho	M/ICP	ppm	0.30	0.06	9.3	54
In	M/ICP	ppm	0.02	0.005	13.1	33
K	M/ICP	%	0.51	0.12	12.2	109
La	M/ICP	ppm	13.8	3.1	11.1	92
Li	M/ICP	ppm	11.8	2.9	12.4	106
Lu	M/ICP	ppm	0.14	0.05	19.0	53
Mg	M/ICP	%	0.94	0.10	5.3	77
Mn	M/ICP	ppm	721	138	9.6	98
Na	M/ICP	%	0.79	0.20	12.6	104
Nb	M/ICP	ppm	2.91	1.45	24.9	89
Nd	M/ICP	ppm	11.7	2.5	10.7	63
Ni	M/ICP	ppm	91.0	13.8	7.6	115
P	M/ICP	ppm	903	381	21.1	76
Pb	M/ICP	ppm	18.1	4.2	11.7	84
Pr	M/ICP	ppm	3.24	0.74	11.5	48
Rb	M/ICP	ppm	23.4	6.5	13.8	93
Re	M/ICP	ppm	0.07	0.01	9.7	44
Sb	M/ICP	ppm	6.02	1.35	11.2	104
Sc	M/ICP	ppm	4.65	1.01	10.9	76
Se	M/ICP	ppm	1.91	4.28	112.1	20
Si	M/ICP	%	40.0	1.2	1.4	8
Sm	M/ICP	ppm	2.12	0.43	10.2	54
Sn	M/ICP	ppm	1.75	0.39	11.0	72
Sr	M/ICP	ppm	77.1	22.8	14.8	114
Ta	M/ICP	ppm	0.31	0.15	23.7	59
Tb	M/ICP	ppm	0.28	0.10	18.1	55
Te	M/ICP	ppm	0.28	0.45	80.5	13
Th	M/ICP	ppm	4.93	1.00	10.2	84
Ti	M/ICP	%	0.11	0.02	11.1	90
Tl	M/ICP	ppm	0.68	0.20	14.5	94
Tm	M/ICP	ppm	0.13	0.04	14.8	54
V	M/ICP	ppm	38.7	8.6	11.1	101
W	M/ICP	ppm	1.24	0.41	16.6	69
Y	M/ICP	ppm	8.14	2.16	13.2	105
Yb	M/ICP	ppm	0.94	0.25	13.4	55
Zn	M/ICP	ppm	379	64	8.4	93
Zr	M/ICP	ppm	40.4	11.4	14.1	78