MATRIX REFERENCE MATERIALS
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AMIS0460

Certified Reference Material

Gold and Uranium Ore
Witwatersrand, South Africa

Certificate of Analysis

Recommended Concentrations and Limits[1. 2.]
(at two Standard Deviations)

Certified Concentration

Au Pb Collection	35.7	±	2.1	g/t
S 4A_MICP	2.5	±	0.2	%
S Comb/LECO	2.6	±	0.07	%
SG	2.76	±	0.07	Dimensionless
U 4A_MICP	1603	±	64	ppm
U XRF	1604	±	50	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 page 2 and uncertified trace element data presented as an appendix*

AMIS
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Major Oxides

Certified Concentrations (at two Standard Deviations)

Al_2O_3 XRF	3.8	±	0.05	%
CaO XRF	0.048	±	0.01	%
Cr_2O_3 XRF	0.071	±	0.003	%
Fe_2O_3 XRF	5.5	±	0.5	%
K_2O XRF	0.68	±	0.03	%
MgO XRF	0.44	±	0.02	%
MnO XRF	0.02	±	0.003	%
P_2O_5 XRF	0.04	±	0.001	%
TiO_2 XRF	0.26	±	0.014	%
U_3O_8 XRF	0.189	±	0.01	%

Informational Concentrations

Na_2O XRF	0.12	%
SiO_2 XRF	84.7	%
LOI	4.0	%

1. Intended Use: AMIS0460 can be used to check the analysis of gold and uranium ores, hosted by siliceous rocks, 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: 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.

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3. Approximate Mineral and Chemical Composition: The major gangue mineral is quartz with minor pyrite, uraninite and thucolite. It is more enriched in gold and quartz content although high uranium and carbon concentrations are also found. Uraninite grains are penetrated by the carbonaceous matter through cracks and further fragmented into smaller grain.

4. Appearance: The material is a very fine powder. It is colored Medium Dark Grey.

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 require special labeling and placarding. AMIS0460 contains U (20.05 Bq/g) and Th 0.01 Bq/g) and is classified as EXCEPTED 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 <54um. Wet sieve partic**l**e 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 scientifically selected for homogeneity testing and third party analysis. Statistical analysis of both homogeneity and the consensus test results were carried out by independent statisticians.

8. 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 U
3. U – XRF
4. Majors (Al_2O_3, CaO, Cr_2O_3, Fe_2O_3, K_2O, MgO, MnO, Na_2O, P_2O_5, SiO_2, TiO_2, U_3O_8, LOI) XRF fusion
5. S – Combustion analysis
6. 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: Eighteen laboratories were each given eight scientifically selected packages of sample. Twelve laboratories submitted 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 13), 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".

11. Participating Laboratories: The 12 out of 18 laboratories that provided results timeously were (not in same order as in the table of assays):

1. Argetest Ankara Turkey
2. Anglo Gold Ashanti - Vaal River Laboratory SA
3. Bureau Veritas Ultratrace Australia
4. Bureau Veritas Namibia
5. Chromatech Services SA
6. Genalysis Laboratory Services Perth
7. Quality Labs Tanzania
8. SGS Ankara
9. SGS Welkom
10. Set Point Laboratories (Isando) SA
11. Set Point Laboratories Husab Namibia
12. Shiva Analyticals India (Pty) Ltd

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12. Assay Data: Data as received from the laboratories for the important certified elements listed on p1 are set out below.

XRF Al_2O_3 %	XRF CaO %	XRF Cr_2O_3 %	XRF Fe_2O_3 %	XRF K_2O %	XRF MgO %	XRF MnO %	XRF Na_2O %	XRF P_2O_5 %	XRF SiO_2 %	XRF TiO_2 %
3.79	0.05	0.07	5.41	0.67	0.44	0.02	0.09	0.04	84.78	0.26
3.80	0.05	0.07	5.42	0.67	0.44	0.02	0.09	0.04	84.92	0.25
3.79	0.04	0.07	5.43	0.67	0.44	0.02	0.09	0.04	84.86	0.26
3.79	0.05	0.07	5.42	0.67	0.44	0.02	0.09	0.04	84.89	0.25
3.79	0.04	0.07	5.42	0.67	0.44	0.02	0.10	0.04	84.81	0.25
3.78	0.05	0.07	5.40	0.67	0.44	0.02	0.09	0.04	84.80	0.26
3.79	0.05	0.07	5.43	0.68	0.44	0.02	0.10	0.04	84.88	0.26
3.81	0.04	0.07	5.44	0.68	0.44	0.02	0.10	0.04	85.04	0.26
3.76	0.05	0.07	5.75	0.69	0.42	0.02	0.15	0.05	84.30	0.25
3.76	0.05	0.07	5.80	0.69	0.44	0.02	0.15	0.05	83.95	0.27
3.76	0.05	0.07	5.84	0.69	0.43	0.02	0.15	0.04	83.89	0.26
3.76	0.05	0.07	5.78	0.69	0.43	0.02	0.17	0.04	83.74	0.25
3.77	0.05	0.07	5.76	0.69	0.43	0.02	0.15	0.04	84.77	0.25
3.76	0.05	0.07	5.80	0.69	0.44	0.02	0.16	0.04	84.70	0.26
3.76	0.05	0.07	5.82	0.69	0.43	0.02	0.15	0.04	83.72	0.25
			5.81			0.02	0.16		84.53	
			5.41			0.02	0.11		84.49	
			5.39			0.02	0.11		84.38	
			5.41			0.02	0.10		84.52	
			5.42			0.02	0.11		84.48	
			5.43			0.02	0.11		84.53	
			5.39			0.02	0.11		84.36	
			5.41			0.02	0.10		84.37	

Pb Coll Au g/t	Pb Coll Au g/t	4A_MICP S %	Comb/LECO S %	SG SG Dimensionless	4A_MICP U ppm	XRF U ppm	XRF U_3O_8 ppm	LOI LOI %
34.70	34.1	2.55	2.57	2.74	1570	1620	0.19	3.85
36.10	33.8	2.56	2.58	2.71	1600	1630	0.19	3.83
35.40	33.9	2.54	2.61	2.73	1600	1620	0.19	3.84
35.30	34.3	2.54	2.57	2.73	1600	1630	0.19	3.83
35.80	33.6	2.55	2.61	2.72	1610	1640	0.19	3.84
34.70	34.1	2.55	2.57	2.74	1600	1630	0.19	3.84
34.70	34.3	2.58	2.58	2.76	1610	1610	0.19	3.82
36.00	34.1	2.56	2.58	2.75	1600	1610	0.19	3.83
35.40	35.5	2.34	2.53	2.75	1659	1610	0.19	4.32
35.49	35.8	2.35	2.54	2.76	1608	1614	0.19	4.30
35.40	35.8	2.36	2.54	2.75	1604	1612	0.19	4.29
34.88	35.9	2.28	2.52	2.75	1642	1615	0.19	4.39
35.61	35.9	2.36	2.60	2.75	1608	1601	0.19	4.35
35.63	35.8	2.36	2.52	2.77	1643	1609	0.19	4.32
35.08	35.7	2.40	2.55	2.75	1666	1598	0.19	4.40
35.25	35.7	2.37	2.57	2.75	1610	1609	0.19	4.41
35.75	34.9	2.58		2.80	1575	1626	0.19	3.84
35.90	34.3	2.49		2.80	1547	1599	0.19	3.86
35.55	35.6	2.50		2.79	1571	1631	0.19	3.83
35.60	36.1	2.54		2.80	1560	1609	0.19	3.84
35.30	35.4	2.56		2.78	1600	1623	0.19	3.82
35.30	35.8	2.54		2.79	1589	1626	0.19	3.89
35.50	36.4	2.53		2.77	1615	1639	0.19	3.85
35.30	34.2	2.50		2.82	1575	1632	0.19	3.87
37.59	37.234					1551	0.18	
36.92	37.069					1570	0.19	
37.29	37.094					1598	0.19	
37.40	36.551					1558	0.18	
37.68	36.629					1577	0.19	
37.17	37.054					1564	0.18	
37.28	36.864					1581	0.19	
38.07	36.964					1554	0.18	
35.50						1598	0.19	
35.10						1591	0.19	
35.60						1592	0.19	
35.80						1590	0.19	
35.40						1588	0.19	
34.80						1587	0.19	
36.00						1590	0.19	
35.90						1587	0.19	

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13. 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:

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]	σL [2]	SW [3]	CSU [4]
Au	Pb Collection	g/t	1.059	0.918	0.414	0.310
S	4A_MICP	%	0.114	0.180	0.027	0.104
S	Comb/LECO	%	0.034	0.051	0.023	0.036
SG	SG	Dimensionless	0.033	0.048	0.013	0.028
U	4A_MICP	ppm	32.221	40.332	20.694	23.666
U	XRF	ppm	24.780	24.841	9.992	11.227
Al_2O_3	XRF	%	0.024	0.042	0.007	0.030
CaO	XRF	%	0.004	0.004	0.004	0.003
Cr_2O_3	XRF	%	0.001	0.003	0.001	0.002
Fe_2O_3	XRF	%	0.233	0.354	0.021	0.204
K_2O	XRF	%	0.013	0.024	0.003	0.017
MgO	XRF	%	0.008	0.011	0.005	0.008
MnO	XRF	%	0.001	0.002	0.000	0.001
P_2O_5	XRF	%	0.001	<0.001	0.001	<0.001
TiO_2	XRF	%	0.007	0.005	0.007	0.004
U_3O_8	XRF	%	0.003	0.003	0.001	0.001

1 *S - Std Dev for use on control charts.*
2 *σL - Betw Lab Std Dev, for use to calculate a measure of accuracy.*
3 *SW - Within Lab Std 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 and p2 of this certificate fulfill the AMIS statistical criteria regarding agreement for certification and have been independently validated by Allan Fraser.

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: AMIS0460 is a new material.

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.

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19. 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.

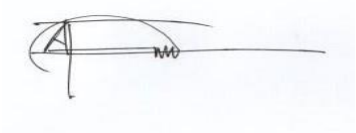
20. Recommended use: The data used to characterize this CRM has been scrutinized using outlier treatment techniques. This, together with the number of participating laboratories, should overcome any "inter-laboratory issues" and should lead to a very accurate measure for the given methods, notwithstanding 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, a part of Torre Industries, Thivhafuni Matodzi, and Allan Fraser; accept no liability for any decisions or actions taken following the use of the reference material.

25 January 2017

Certifying Officers:

African Mineral Standards: _____
Thivhafuni Matodzi



Geochemist:_____
Allan Fraser
M.Sc. (Geology), N.D. (Analytical Chem.), Pr.Sci.Nat.

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Appendix – uncertified element statistics

Element	Gen Method	N	Std Mean	SD	RSD_%	Unit
Ag	4A_MICP	24	4.075	0.553	13.562	ppm
Al	4A_MICP	32	19334.177	616.372	3.188	ppm
As	4A_MICP	24	607.375	28.970	4.770	ppm
Au	AR_GAAS	8	36.323	0.236	0.650	g/t
B	FUS	8	27.500	10.351	37.640	ppm
Ba	4A_MICP	30	124.516	3.456	2.775	ppm
BaO	XRF	7	0.020	0.000	0.000	%
Be	4A_MICP	32	0.943	0.131	13.851	ppm
Bi	4A_MICP	24	2.775	0.149	5.353	ppm
Ca	4A_MICP	32	344.834	40.394	11.714	ppm
CaO	FUS	8	0.050	0.000	0.000	%
Cd	4A_MICP	24	0.903	0.072	8.000	ppm
Ce	4A_MICP	16	103.553	1.849	1.786	ppm
Co	4A_MICP	38	214.982	10.210	4.749	ppm
Cr	4A_MICP	16	385.500	64.919	16.840	ppm
Cr	FUS	7	500.000	0.000	0.000	ppm
Cr2O3	FUS	7	0.070	0.000	0.000	%
Cs	4A_MICP	23	2.406	0.318	13.219	ppm
Cu	4A_MICP	31	643.135	7.162	1.114	ppm
Dy	4A_MICP	16	17.721	0.390	2.203	ppm
Er	4A_MICP	16	8.986	0.144	1.598	ppm
Eu	4A_MICP	16	2.067	0.108	5.246	ppm
Fe	4A_MICP	24	37884.375	1715.763	4.529	ppm
Fe	FUS	8	37837.500	232.609	0.615	ppm
Fe2O3	FUS	8	5.388	0.097	1.796	%
Ga	4A_MICP	24	5.035	0.322	6.404	ppm
Gd	4A_MICP	16	14.898	0.771	5.174	ppm
Ge	4A_MICP	8	0.725	0.046	6.385	ppm
Hf	4A_MICP	24	3.931	0.366	9.309	ppm
Ho	4A_MICP	16	3.471	0.154	4.448	ppm
In	4A_MICP	13	0.052	0.010	19.361	ppm
K	4A_MICP	30	5530.251	158.216	2.861	ppm
K2O	FUS	8	0.635	0.016	2.525	%
La	4A_MICP	23	57.397	1.835	3.197	ppm
Li	4A_MICP	31	14.480	0.399	2.752	ppm
Lu	4A_MICP	16	0.926	0.084	9.112	ppm
Mg	4A_MICP	24	2418.922	77.535	3.205	ppm

Element	Gen Method	N	Std Mean	SD	RSD_%	Unit
Mg	FUS	8	2525.000	46.291	1.833	ppm
MgO	FUS	8	0.425	0.009	2.178	%
Mn	4A_MICP	31	168.928	7.659	4.534	ppm
MnO	FUS	7	0.020	0.000	0.000	%
Mo	4A_MICP	32	2.488	0.325	13.057	ppm
Na	4A_MICP	32	702.402	109.959	15.655	ppm
Na2O	FUS	8	0.116	0.009	7.881	%
Nb	4A_MICP	24	10.019	0.582	5.805	ppm
Nd	4A_MICP	16	43.686	2.625	6.009	ppm
Ni	4A_MICP	32	177.144	7.759	4.380	ppm
P	4A_MICP	30	190.651	27.529	14.439	ppm
Pb	4A_MICP	32	582.618	32.528	5.583	ppm
Pr	4A_MICP	16	12.191	0.903	7.407	ppm
Rb	4A_MICP	21	25.768	0.666	2.585	ppm
Sb	4A_MICP	16	8.838	0.772	8.734	ppm
Sc	4A_MICP	32	4.303	0.367	8.529	ppm
Si	FUS	7	39.414	0.121	0.308	%
SiO2	FUS	8	78.450	0.288	0.367	%
Sm	4A_MICP	16	12.218	0.584	4.779	ppm
Sn	4A_MICP	16	1.844	0.186	10.092	ppm
SO3	XRF	7	6.470	0.177	2.734	%
Sr	4A_MICP	40	35.191	0.987	2.805	ppm
Ta	4A_MICP	16	4.266	0.258	6.037	ppm
Tb	4A_MICP	16	2.988	0.295	9.877	ppm
Te	4A_MICP	16	0.350	0.082	23.328	ppm
Th	4A_MICP	24	151.614	8.499	5.606	ppm
Ti	4A_MICP	24	0.103	0.010	9.575	%
Ti	FUS	7	0.150	0.000	0.000	%
TiO2	FUS	8	0.269	0.014	5.046	%
Tl	4A_MICP	24	0.381	0.073	19.258	ppm
Tm	4A_MICP	16	1.298	0.081	6.265	ppm
V	4A_MICP	28	37.746	1.990	5.271	ppm
W	4A_MICP	24	0.797	0.162	20.374	ppm
Y	4A_MICP	31	69.048	2.407	3.487	ppm
Yb	4A_MICP	15	7.376	0.115	1.556	ppm
Zn	4A_MICP	30	323.944	6.376	1.968	ppm
Zr	4A_MICP	38	125.521	10.863	8.654	ppm