



## **AMIS0133**

### ***Certified Reference Material***

### **Gold and Uranium Ore Witwatersrand Reference Material High Concentrate Grade**

### ***Certificate of Analysis***

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

Au Pb Collection	310	±	10.9	g/t
U XRF	3323	±	166	ppm
Specific Gravity	2.79	±	0.10	g/cc
Al <sub>2</sub> O <sub>3</sub>	4.59	±	0.16	%
Fe <sub>2</sub> O <sub>3</sub>	5.38	±	0.16	%
K <sub>2</sub> O	0.36	±	0.03	%
MnO	0.029	±	0.002	%
Na <sub>2</sub> O	0.33	±	0.04	%
P <sub>2</sub> O <sub>5</sub>	0.041	±	0.002	%
SiO <sub>2</sub>	85.41	±	1.18	%
TiO <sub>2</sub>	0.26	±	0.02	%

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  $U \times 1.1793 = U_3O_8$   
 $U_3O_8$  by XRF:  $3919 \pm 196$  ppm)

## Provisional Concentration and two “Between Laboratory” Standard Deviations

Cr<sub>2</sub>O<sub>3</sub> 0.11 ± 0.012 %  
LOI 2.47 ± 0.32 %

### Indicated Mean

CaO 0.032 %  
MgO 0.27 %

### Additional uncertified major element data

This data is displayed for informative purposes only. Insufficient data for certification was submitted by the laboratories to certify S.

	Mean	2SD	RSD%	n
S XRF %	1.7	0.03	0.941	15

**1. Intended use:** AMIS0133 was primarily produced to monitor the accuracy of a single analysis of very high grade gold ores hosted by siliceous rocks. It was prepared specifically for use as a QC material on samples taken from the basal contact of certain Witwatersrand reefs. It can also be used as a QC material to test gold concentrate sample analyses.

The additional geochemical data gathered however also enables its use as a uranium standard.

It can also be used by laboratories for method development and for the calibration of equipment.

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 was made from grade-sorted pulp rejects sourced from Anglo Gold Ashanti mine assay laboratories in South Africa. It represents sample material from the basal contacts of the Vaal Reef and the Carbon Leader Reef collected during routine underground sampling.

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

**4. Appearance:** The material is a very fine Blueish Grey coloured powder (Corstor 5B 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 require special labeling and placarding. AMIS0133 contains U (41.54 Bq/g) and Th (0.79 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 408, Table 1".

**7. Method of preparation:** The material was crushed, dry-milled and air-classified to 100% <54µm. Wet sieve particle size analysis of random samples confirmed the material was 100% <54µm. 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. ICP-OES, Pb collection.
2. SG ( gas pycnometer )
3. XRF fusion whole rock analysis, including U.

**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:** The high gold value of this material created a problem finding laboratories prepared to do determinations. Ultimately ten laboratories were each given eight samples for the Au determination. Nine laboratories returned results. Thirteen laboratories were each given eight randomly selected packages of sample for the U, SG and major elements. Results for all of the methods are set out below:

## Assay data

Lab Code	Au Pb Coll g/t	U XRF ppm	SG g/cc	Al2O3 XRF %	CaO XRF %	Cr2O3 XRF %	Fe2O3 XRF %	K2O XRF %	MgO XRF %	MnO XRF %	Na2O XRF %	P2O5 XRF %	S XRF %	SiO2 XRF %	TiO2 XRF %	LOI %
A	309	3257	2.72	4.45	0.04	0.11	5.47	0.37	0.25	0.027	0.32	0.04		84.56	0.27	2.64
A	308	3265	2.75	4.47	0.05	0.11	5.48	0.42	0.26	0.028	0.33	0.04		85.08	0.27	2.64
A	309	3223	2.72	4.40	0.05	0.11	5.43	0.40	0.24	0.026	0.34	0.04		85.08	0.28	2.59
A	307	3189	2.74	4.60	0.04	0.12	5.49	0.37	0.31	0.027	0.31	0.04		85.15	0.26	2.61
A	308	3249	2.72	4.54	0.05	0.12	5.56	0.45	0.29	0.029	0.34	0.04		85.27	0.27	2.58
A	306	3316	2.72	4.53	0.05	0.12	5.56	0.38	0.29	0.031	0.31	0.04		85.28	0.28	2.51
A	308	3164	2.69	4.61	0.04	0.12	5.52	0.38	0.30	0.028	0.34	0.04		84.85	0.26	2.53
A	307	3282	2.69	4.53	0.05	0.11	5.50	0.38	0.31	0.028	0.33	0.04		85.06	0.27	2.56
B	312	3202	2.76													
B	316	3195	2.77													
B	319	3235	2.75													
B	314	3233	2.78													
B	320	3227	2.77													
B	310	3250	2.77													
B	321	3194	2.79													
B	314	3216	2.76													
C	311	3200	2.82	4.69	0.02	0.11	5.34	0.37	0.34	0.030	0.34	0.04		85.21	0.26	2.65
C	310	3300	2.74	4.65	0.02	0.11	5.33	0.36	0.33	0.030	0.33	0.04		85.15	0.26	2.59
C	304	3200	2.81	4.70	0.02	0.11	5.35	0.37	0.34	0.030	0.33	0.04		85.35	0.26	2.56
C	309	3300	2.80	4.68	0.02	0.11	5.33	0.37	0.33	0.030	0.33	0.04		85.20	0.26	2.57
C	309	3300	2.74	4.68	0.02	0.11	5.33	0.37	0.34	0.030	0.33	0.04		85.25	0.26	2.55
C	311	3200	2.74	4.69	0.02	0.11	5.33	0.37	0.33	0.030	0.34	0.04		85.30	0.25	2.54
C	307	3300	2.77	4.67	0.02	0.11	5.31	0.37	0.34	0.030	0.32	0.04		85.20	0.26	2.53
C	307	3300	2.71	4.68	0.02	0.11	5.33	0.37	0.33	0.030	0.33	0.04		85.14	0.26	2.56
D	313	3400	2.79	4.58	0.03	0.11	5.42	0.34	0.34	0.030	0.31	0.04		87.20	0.25	2.55
D	319	3400	2.79	4.61	0.04	0.12	5.42	0.33	0.36	0.030	0.31	0.04		87.10	0.26	2.53
D	316	3300	2.76	4.60	0.03	0.11	5.40	0.35	0.37	0.040	0.31	0.05		87.10	0.26	2.51
D	319	3400	2.79	4.53	0.03	0.13	5.42	0.34	0.36	0.030	0.30	0.04		86.90	0.25	2.47
D	319	3300	2.80	4.53	0.04	0.12	5.42	0.33	0.37	0.030	0.32	0.04		86.90	0.26	2.53
D	317	3400	2.76	4.60	0.03	0.12	5.42	0.38	0.27	0.030	0.38	0.04		85.90	0.26	2.46
D	318	3300	2.79	4.52	0.03	0.12	5.40	0.36	0.27	0.030	0.39	0.05		84.90	0.26	2.43
D	316	3400	2.80	4.57	0.03	0.11	5.36	0.35	0.40	0.030	0.34	0.04		86.60	0.26	2.55
E	325	3080	2.58	4.29	0.02	0.10	5.32	0.32	0.15	0.030	0.32			82.60	0.25	2.26
E	316	3090	2.57	4.28	0.02	0.10	5.23	0.31	0.13	0.030	0.33			82.70	0.26	2.31
E	310	3090	2.54	4.27	0.02	0.10	5.24	0.31	0.14	0.029	0.32			82.60	0.26	2.33
E	313	3030	2.57	4.27	0.02	0.10	5.31	0.32	0.14	0.031	0.32			82.70	0.27	2.21
E	311	3030	2.58	4.28	0.02	0.10	5.35	0.32	0.14	0.032	0.32			82.60	0.27	2.30
E	302	3040	2.56	4.26	0.02	0.10	5.40	0.32	0.14	0.029	0.33			82.30	0.27	2.51
E	302	3020	2.54	4.30	0.02	0.10	5.26	0.31	0.13	0.030	0.31			82.80	0.28	2.20
E	307	3080	2.55	4.30	0.02	0.11	5.19	0.31	0.14	0.028	0.33			82.50	0.26	2.43
F		3420		4.57	0.04	0.11	5.42	0.36	0.28	0.030	0.33			84.70	0.26	2.21
F		3390		4.54	0.04	0.11	5.42	0.36	0.28	0.030	0.33			84.70	0.26	2.16
F		3410		4.56	0.04	0.11	5.43	0.36	0.28	0.030	0.34			84.70	0.26	2.19
F		3420		4.57	0.04	0.12	5.39	0.36	0.28	0.030	0.35			84.70	0.26	2.22
F		3410		4.57	0.05	0.11	5.42	0.36	0.28	0.030	0.35			84.60	0.25	2.25
F		3440		4.55	0.05	0.11	5.41	0.36	0.28	0.030	0.35			84.60	0.26	2.21
F		3430		4.55	0.04	0.11	5.44	0.36	0.28	0.030	0.33			84.60	0.26	2.25
F		3380		4.57	0.05	0.11	5.43	0.36	0.28	0.030	0.36			84.60	0.26	2.24
G	300	3300	2.84													
G	319	3320	2.83													
G	303	3310	2.83													
G	295	3300	2.83													
G	308	3320	2.83													
G	307	3300	2.82													
G	311	3290	2.82													
G	312	3290	2.83													
H	310	3437		4.65	0.03	0.09	5.02	0.33	0.19	0.030	0.29	0.04		84.40	0.25	2.66
H	306	3415		4.74	0.02	0.09	5.11	0.35	0.19	0.030	0.32	0.04		86.20	0.26	2.36
H	305	3449		4.51	0.02	0.09	5.28	0.34	0.20	0.030	0.35	0.04		86.20	0.25	2.64
H	308	3451		4.64	0.02	0.09	5.22	0.35	0.19	0.020	0.35	0.04		84.60	0.25	2.55
H	307	3447		4.56	0.02	0.08	5.24	0.33	0.19	0.020	0.30	0.04		84.80	0.25	2.63
H	310	3426		4.69	0.02	0.09	5.42	0.35	0.18	0.030	0.32	0.04		85.90	0.25	2.54
H	308	3447		4.47	0.03	0.09	5.45	0.35	0.21	0.020	0.31	0.04		85.40	0.26	2.69
H	309	3429		4.48	0.02	0.09	5.32	0.34	0.19	0.030	0.33	0.04		85.20	0.25	2.57
I	325	3290	2.75	4.51	0.08	0.14	5.14	0.32		0.028	0.39	0.02	1.68	85.56	0.26	
I	335	3247	2.76	4.47	0.07	0.14	5.17	0.32		0.029	0.42	0.02	1.66	86.17	0.27	
I	337	3245	2.75	4.53	0.12	0.14	5.17	0.32		0.030	0.40	0.02	1.67	86.40	0.26	
I	328	3250	2.78	4.47	0.08	0.14	5.16	0.32		0.028	0.38	0.02	1.68	86.05	0.27	
I	339	3226	2.75	4.48	0.09	0.15	5.15	0.32		0.028	0.40	0.02	1.67	85.71	0.27	
I	327	3265	2.75	4.48	0.08	0.14	5.18	0.32		0.029	0.40	0.02	1.65	85.89	0.26	
I	322	3274	2.76	4.43	0.07	0.14	5.17	0.33		0.028	0.39	0.02	1.64	85.28	0.26	
I	331	3242	2.77	4.44	0.07	0.14	5.15	0.33		0.029	0.38	0.02	1.66	85.89	0.26	

## Assay data (cont)

Lab Code	Au Pb Coll g/t	U XRF ppm	SG g/cc	Al2O3 XRF %	CaO XRF %	Cr2O3 XRF %	Fe2O3 XRF %	K2O XRF %	MgO XRF %	MnO XRF %	Na2O XRF %	P2O5 XRF %	S XRF %	SiO2 XRF %	TiO2 XRF %	LOI %
J	302	3234	2.89	4.59	0.03	0.11	5.33	0.36	0.23	0.028	0.37			85.39	0.25	2.52
J	303	3266	2.90	4.60	0.03	0.11	5.35	0.36	0.24	0.029	0.36			85.70	0.25	2.48
J	299	3384	2.87	4.54	0.03	0.11	5.29	0.36	0.22	0.025	0.35			84.29	0.25	2.52
J	302	3340	2.87	4.60	0.03	0.11	5.41	0.36	0.23	0.027	0.35			85.51	0.25	2.59
J	292	3301	2.84	4.59	0.03	0.11	5.32	0.36	0.23	0.027	0.37			85.24	0.26	2.56
J	296	3335	2.86	4.58	0.03	0.11	5.27	0.36	0.22	0.026	0.34			84.83	0.25	2.58
J	307	3258	2.89	4.56	0.03	0.11	5.26	0.36	0.23	0.027	0.34			84.92	0.25	2.65
J	304	3310	2.94	4.58	0.03	0.11	5.30	0.36	0.23	0.027	0.35			85.37	0.25	2.59
K		3340	2.78	4.68	0.03	0.12	5.44	0.36	0.26	0.029	0.34	0.04	1.70	86.40	0.27	2.62
K		3326	2.78	4.69	0.03	0.12	5.44	0.36	0.27	0.027	0.34	0.04	1.68	86.40	0.27	2.61
K		3319	2.78	4.67	0.03	0.12	5.41	0.36	0.26	0.027	0.34	0.04	1.70	86.40	0.27	2.67
K		3312	2.77	4.68	0.03	0.12	5.45	0.36	0.27	0.028	0.34	0.04	1.70	86.50	0.27	2.65
K		3329	2.79	4.71	0.03	0.12	5.44	0.36	0.27	0.028	0.32	0.04	1.69	86.40	0.27	2.65
K		3322	2.79	4.68	0.03	0.12	5.47	0.36	0.28	0.028	0.35	0.04	1.69	86.70	0.27	2.63
K		3287	2.79	4.68	0.03	0.12	5.35	0.35	0.27	0.028	0.32	0.04	1.68	85.80	0.26	2.60
K		3257	2.78	4.67	0.03	0.12	5.42	0.35	0.25	0.028	0.33	0.04	1.69	86.20	0.27	2.59
L		3460	2.86	4.67	0.04	0.12	5.45	0.36	0.29	0.030	0.35			85.81	0.26	2.26
L		3430	2.87	4.66	0.04	0.12	5.43	0.36	0.29	0.030	0.34			85.81	0.26	2.28
L		3430	2.88	4.69	0.04	0.13	5.44	0.37	0.29	0.030	0.35			85.87	0.26	2.20
L		3400	2.85	4.70	0.04	0.12	5.41	0.37	0.28	0.030	0.33			85.93	0.26	2.21
L		3470	2.89	4.65	0.04	0.13	5.45	0.36	0.29	0.030	0.34			85.86	0.26	2.25
L		3440	2.87	4.65	0.04	0.12	5.43	0.36	0.29	0.030	0.35			85.81	0.26	2.27
L		3450	2.89	4.68	0.04	0.12	5.44	0.36	0.28	0.030	0.35			85.82	0.26	2.25
L		3440	2.86	4.66	0.04	0.12	5.43	0.36	0.28	0.030	0.35			85.84	0.26	2.23
M		3124														
M		3130														
M		3115														
M		3208														
M		3170														
M		3138														
M		3129														
M		3127														

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. Total results from some laboratories that reported significant failures were also removed. 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. Activation Laboratories Pty Ltd (ActLabs, Canada)
2. Anglo Gold Ashanti - West Wits Laboratory, (South Africa).
3. Anglo Gold Ashanti - Navachab Gold Mine Laboratory, (Namibia).
4. Anglo Gold Ashanti - Vaal River Laboratory (South Africa)
5. ALS Chemex Laboratory Group (Brisbane Australia).
6. ALS Chemex Laboratory Group (Johannesburg, South Africa).
7. ALS Chemex Laboratory Group (Vancouver, Canada).
8. Genalysis Laboratory Services (Western Australia).
9. Labtium Inc (Finland)
10. MAED Laboratories (Knights, South Africa )
11. Performance Laboratories Ltd (Randfontein, South Africa).
12. Performance Laboratories ( Alanridge, South Africa )
13. Set Point Laboratories ( Pty ) Ltd (Isando, South Africa)
14. SGS Australia Pty Ltd (Newburn, Western Australia)

15. SGS Lakefield Research Africa ( Pty ) Ltd. (Johannesburg, South Africa)
16. SGS Mineral Services (Barberton, South Africa).
17. SGS Mineral Services Lakefield (Canada)
18. Ultra Trace (Pty) Ltd (Western Australia)

### 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:

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

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>	S <sub>w</sub> <sup>3</sup>	CSU <sup>4</sup>
Au	Pb Col	ppm	5.44	4.25	3.52	1.57
U	XRF	ppm	82.56	66.76	34.36	20.46
SG	pyc		0.05	0.05	0.02	0.02
Al <sub>2</sub> O <sub>3</sub>	XRF	%	0.08	0.06	0.04	0.02
Fe <sub>2</sub> O <sub>3</sub>	XRF	%	0.10	0.09	0.04	0.03
K <sub>2</sub> O	XRF	%	0.01	0.01	0.01	0.00
MnO	XRF	%	0.00	0.00	0.00	0.00
Na <sub>2</sub> O	XRF	%	0.02	0.01	0.01	0.00
P <sub>2</sub> O <sub>5</sub>	XRF	%	0.00	0.00	0.00	0.00
SiO <sub>2</sub>	XRF	%	0.59	0.51	0.35	0.18
TiO <sub>2</sub>	XRF	%	0.01	0.00	0.00	0.00

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. S<sub>w</sub> - 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 and p2 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:** AMIS0100 was originally certified/requested by a laboratory as a Reference material on 23 February 2009. 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](http://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.

**23 February 2009 (as a Reference Material)**

**26 October 2010 (as a Certified Reference Material)**

**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**