



CERTIFIED REFERENCE MATERIAL RRM Au012

PRODUCT: GOLD ORE CERTIFICATE OF ANALYSIS

Certificate Number: RRM CRM Au012 REV:000

Date: 22 February 2017

Table 1 Au012 – Summary of Results

Analyte (Unit)	Assigned value	Standard Deviation		95% Confidence Limits	
		Within Laboratory	Between Laboratory	Lower	Upper
Au ppm	1.37	0.05	0.06	1.35	1.39

Prepared and Supplied:

Certified Reference Material Au012 has been prepared, certified and is supplied by;

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Certified Reference Materials (CRMs) are used by laboratories to prove the value of their service offerings and for clients of laboratories to evaluate and monitor laboratory performance. CRMs must comply with high metrological requirements and ensuring traceability of measurement results.

Since most techniques employing analytical instrumentation are comparative, these techniques require a sample of known composition (CRM) for accurate calibration. Grade and Matrix matched CRM's are thus vital to the core of the analytical chemistry industry.

Origin of Material:

RRM Au012 was prepared from a range of siliceous gold bearing samples combined to provide the desired gold grade achieved and within a Silicate; low Carbon, low Iron, low Sulphur matrix.

Country of Origin: South Africa.

Preparation of Material:

The material constituting RRM Au012 has been prepared according to ISO 17034:2016, and includes the following:

- Drying to constant mass
- Crushing and dry milling to nominal 53µm particle size
- Homogenization
- Systematic rotary division of the entire lot
- Packaging
 - 200-1000g sealed tubs
 - 30g-150g geochem pouches, vacuum sealed in barrier foil

Homogeneity Testing:

The Homogeneity of the RRM Au012 was conducted at a reputable laboratory, with ISO 17025:2005 accreditation for the analysis of gold at the levels present in this material.

In the preparation of all CRMs at RRM, after initial sample preparation (i.e. drying, crushing, splitting and sizing to 95% passing 53µm), the material is passed through multiple division phases, in well-designed rotary sample dividers (custom designed for powder sampling), from the initial batch weight down to the final product/aliquot size. To prove the homogeneity of the material between divisions, two primary cuts (i.e. 20% of the batch) are randomly selected. Each cut is representatively divided down through RSD's to laboratory packages. 10 x aliquots are randomly collected, separated into two test portions and submitted to a single laboratory for analysis. The laboratory analysed each test portion 4 times with a total of 80 analyses reported.

Homogeneity results of the batch are presented as the standard deviation between two primary cuts and within unit homogeneity/repeatability standard deviation.

Table 2 Au012 – Homogeneity Testing Results

Within batch SD	0.005	ppm
Within unit SD	0.04	ppm

ANOVA (one-way analysis of variance) was used to assess the homogeneity. No significant variation was observed for both 'batch' and 'within unit' exercises.

Methods of Analysis:

The analysis of the test samples has been conducted according to routine analytical procedures at each of the participating laboratories. The 'industry standard' Fire assay procedure was employed by the participating laboratories, as well as one laboratory reporting results using high energy dispersive XRF.

Statistical Evaluation:

Results received from the inter-laboratory study have been subjected to statistical evaluation. Statistically invalid outliers were excluded from the final evaluation. Gold by Fire Assay and ED-XRF achieved in this particular inter-laboratory study is regarded as acceptable; this is a certified value.

Table 3 Au012 – Statistical Evaluation

Parameter	Au
Assigned value (ppm)	1.37
Number of Laboratories	20
Number of Analyses	128
Between Laboratory Standard Deviation	0.06
Within Laboratory Standard Deviation	0.05
Between Laboratory Relative Standard Deviation	4.07%
Within Laboratory Relative Standard Deviation	3.42%
Standard Uncertainty	0.009
Lower confidence limit	1.35
Upper confidence limit	1.39
Lower limit of tolerance	1.26
Upper limit of tolerance	1.48

Informational Values:

Gold by Aqua Regia digestion Instrumental Finish was conducted at 6 laboratories in order to provide informational values for this material for this particular method.

Table 4 Au012 – Statistics (Au by Aqua Regia Digest)

Parameter	Au (Aqua Regia)
Assigned value (ppm)	1.23
Number of Laboratories	6
Number of Analyses	14
Between Laboratory Standard Deviation	0.13
Within Laboratory Standard Deviation	0.03
Between Laboratory Relative Standard Deviation	10.8%
Within Laboratory Relative Standard Deviation	2.16%
Standard Uncertainty	0.054
Lower confidence limit	1.12
Upper confidence limit	1.34
Lower limit of tolerance	0.97
Upper limit of tolerance	1.50

Informational values are provided as a rough guide to the elemental composition of this material. A sample was analysed at one laboratory; Four Acid Digestion ICP-OES and ICP-MS 60 element package. The four acid digestion is a mixture of hydrofluoric, nitric, perchloric and hydrochloric acids. This digest is suitable for dissolving silica based samples and approaches total dissolution for most minerals. However, some highly resistant refractory minerals may not be totally digested.

Table 5 Au012 – Multi-Element (Informational Values)

Al ₂ O ₃ %	CaO %	Fe ₂ O ₃ %	K ₂ O %	MgO	Na ₂ O %	TiO ₂ %	S %	
11.6	5.39	11.0	0.88	7.47	2.39	0.67	0.51	
Ag ppm	As ppm	Ba ppm	Be ppm	Bi ppm	Cd ppm	Ce ppm	Co ppm	Cs ppm
0.16	50	182	0.60	0.12	0.27	19	44	3.2
Cr ppm	Cu ppm	Dy ppm	Er ppm	Eu ppm	Ga ppm	Gd ppm	Ge ppm	Hf ppm
256	225	2.9	1.8	0.78	18	2.8	0.10	2.0
Ho ppm	In ppm	La ppm	Li ppm	Lu ppm	Mn ppm	Mo ppm	Nb ppm	Nd ppm
0.63	0.08	8.6	20	0.26	1207	3.7	3.0	9.6
Ni ppm	P ppm	Pb ppm	Pr ppm	Rb ppm	Re ppm	Sb ppm	Sc ppm	Se ppm
256	384	7.2	2.3	25	0.01	1.0	28	0.90
Sm ppm	Sn ppm	Sr ppm	Ta ppm	Tb ppm	Te ppm	Th ppm	Tl ppm	Tm ppm
2.5	1.0	116	0.02	0.45	0.22	2.0	0.23	0.24
U ppm	V ppm	W ppm	Y ppm	Yb ppm	Zn ppm	Zr ppm		
0.63	190	6.1	15	1.8	122	60		

Intended Use:

The Certified Reference Material RRM Au012 is intended to be used in analytical laboratories that analyse samples of similar grades (as presented in this certificate of analysis) and matrix (silicate; low carbon, low iron, low sulphur).

- Monitoring of routine laboratory performance (both internal and external)
- Method development and method validation
- Instrument calibration

Instructions before Use:

Safety precautions (in-line with safe laboratory practices) for handling fine particulate matter are advised; such as the use of safety glasses, dust masks, gloves and a laboratory coats.

Minimum Sample Size:

Based on the results of the homogeneity assessment and evaluation of results submitted by the laboratories contributing certification data, the minimum size of a test portion is recommended to be 25g.

Analysis Validity:

The property value for RRM Au012 Certified Reference Material remains valid provided that good laboratory practice is observed during handling and storage.

The material is in fine powder form and may be hygroscopic in nature. The material may be required to be dried at 105°C until constant mass is achieved.

Traceability:

The characterization of this material has been achieved by inter-laboratory study, each laboratory using an appropriate analytical method. These methods are calibrated against traceable standard solutions and analysed against appropriate Certified Reference Materials.

Participating Laboratories:

A list of the 20 participating laboratories (not in the same order as the results on the data tables) is presented in the table below:

Table 6 Au012 – Participating Laboratories

ALS Geochemistry (Brisbane), Australia
ALS Geochemistry (Lima), Peru
ALS Geochemistry (Loughrea), Ireland
ALS Geochemistry (Perth), Australia
ALS Geochemistry (Vancouver), Canada
AngloGold Ashanti - Vaal River Laboratory, South Africa
Aurum Laboratories, Australia
Bureau Veritas (Perth), Australia
Bureau Veritas (Swakopmund), Namibia
Chromatech Services, South Africa
Intertek Minerals (Maddington), Australia
Intertek Minerals (Tarkwa), Ghana
MAED Laboratory Services, South Africa
MinAnalytical, Australia
Nagrom, Australia
Newcrest Mining - Orange Laboratory, Australia
Ready Lead Assay Laboratory, South Africa
SGS (Perth), Australia
SibanyeGold - Beatrix Operations, South Africa
SibanyeGold - Driefontein Operations, South Africa

Revisions:

This certificate is version 0.00 for the material RRM-Au012; and is intended to be a 'live document' intended to reflect progress in analytical chemistry. In that, any significant new data and information could be added at any time to ensure the currency and relevance of the certification. Any revisions to this Certificate of Analysis will be made available via the company website (www.resourcereferencematerials.com).

Acknowledgements:

We would like to gratefully acknowledge the participating laboratories and the staff at RRM for their contributions to this certification exercise.

Legal Notice:

This material has been meticulously prepared and a comprehensive statistical evaluation conducted to assign the property value. The Purchaser, by receipt of this material and certificate, indemnifies and releases Resource Reference Materials (Pty) Ltd from and against any and all liability and costs arising from the use of this material and certificate and any actions taken thereupon.

Approval:

This Certificate of Analysis was approved on behalf of Resource Reference Materials (Pty) Ltd:

Name		
Position	C.S. van der Linde	
	Managing Director	

22nd February 2017

References:

ISO 17034:2016 General requirements for the competence of reference material producers
 DRAFT ISO GUIDE 35:2016 Reference materials — Guidance for the characterization and the assessment of the homogeneity and stability of the material
 ISO 5725-2:1994 Accuracy (trueness and precision) of measurement methods and results - Part 2: Basic method for the determination of repeatability and reproducibility of a standard measurement method
 ISO 13528:2015 Statistical methods for use in proficiency testing by interlaboratory comparison
 ISO 17025:2005 General requirements for the competence of testing and calibration laboratories