

Certified Reference Material Certificate: Basalt hosted Gold IMS-191

Table 1: IMS-191 Certified Values

Analyte	unit	Certified Value (y)	Standard Deviation (s)		95% Confidence Interval (CI)		U_{CRM}^{\wedge}	$K^{\#}$	U_{CRM}^{\sim}	No. of Labs (ISO/IEC 17025)	No. Samples
			1 SD	1 SD Within Lab	lower	upper					
Au	g/t	0.98	0.027	0.014	0.97	1.00	0.043	2	0.086	13	64

Note 1. SI units equivalent: 1 ppm, parts per million \equiv grams per ton \equiv mg/kg \equiv ug/g \equiv 0.0001 wt.% \equiv 1000ppb, parts per billion

Note 2. The number of decimal places quoted does not imply accuracy of the certified value to this level but are given to minimise rounding errors when calculating 2SD and 3SD.

\wedge Standard uncertainty.

$\#$ Coverage Factor.

\sim Expanded Uncertainty.

Table 2: IMS-191 Indicative Values

Analyte	XRF Value (wt.%)	Analyte	XRF Value (wt.%)
Al ₂ O ₃	14.2	Ni	0.004
As	0.06	P	0.091
Ba	0.01	Pb	0.02
CaO	9.1	S	1.53
Cl	0.04	SiO ₂	50.9
Co	0.005	Sn	0.003
Cr	0.02	Sr	0.026
Cu	0.007	TiO ₂	1.99
Fe	9.8	V	0.03
K ₂ O	0.39	Zn	0.03
MgO	5.49	Zr	0.01
Mn	0.15	LOI1000	1.0
Na ₂ O	2.97		

Material and Method of Preparation

IMS-191 is manufactured from a pulverised basalt rock blended with minor quantities of pulverised pyrite and spiked with gold (Au). The blended materials underwent a multi-stage homogenisation process and were discharged into storage drums. During the discharge the material was sub-sampled at regular intervals from which homogeneity and characterisation samples were drawn.

The samples taken were randomised before being submitted to independent ISO/IEC 17025 accredited laboratories for homogeneity and inter-laboratory round-robin testing.

Multi-element results provide valuable analytical information to assist laboratories in selecting the optimal procedure when performing a digest and analysis of the reference material. A single sample was analysed by lithium-borate fusion with x-ray fluorescence spectrometry (XRF) determination. The multi-elemental analysis results presented in Table 2 are for indicative purpose only.

Homogeneity Analysis

A homogeneity study was undertaken in accordance with ISO Guide 35:2017 and ISO17034:2016 using systematically selected samples to be representative of the entire batch. The sample identifiers were randomised to ensure different production order and laboratory analytical order. These samples were submitted to a single laboratory for multiple analysis in a single batch under repeatable conditions. The homogeneity study results were reviewed, and the material was deemed suitable for progressing to the inter-laboratory round-robin stage. A summary of the study results is presented in Table 3.

Table 3: IMS-191 Homogeneity Study Results

Analytical Method	Pb collection Fire Assay, AAS or ICP finish
Number of Samples Submitted	30
Number of Samples tested	30
Total Samples in Analysis	60
No. Determinations per sample	2
Number of technically invalid results	0
Mean concentration (Au g/t)	1.017
Standard Deviation (Au g/t)	0.041
Relative Standard Deviation	4.03%

Material Characterisation and Certification Methodology

A total of 75 x 100g samples were selected for inter-laboratory round-robin analysis, 5 samples were provided to 15 laboratories. Laboratories analysed samples via lead collection fire-assay digestion followed by either AAS or ICP. 13 laboratories returned results in this round.

The process of characterisation was undertaken in accordance with ISO Guide 35:2017 and ISO17034:2016 following examination of grouped laboratory results for potential technical failures by way of comparison with the established CRM submitted for analysis with the candidate material. Where required, further investigation of outliers was conducted. Laboratory results deemed technical outliers were removed from the analysis pool prior to the determination of statistical parameters. The certifying officer, in some cases, may use their judgment in identifying or eliminating outliers outside of these statistical parameters.

- Certified value was determined by average of lab averages for analytes with no outlier laboratory results, or median of median for those with outlier laboratory results
- Standard deviation (s) is the measure of spread of analyte determinations and includes inter-laboratory bias, method uncertainty, and material homogeneity uncertainty. Approximately 95% of determinations using the same analytical method are expected to be between two standard deviations either side of the certified value. The standard deviation is calculated from the validated laboratory group data less outlier laboratory and individual determinations.
- Confidence Interval (CI) is an estimate of the true (unknowable) analyte concentration in the material at the 95% confidence interval. For example, a 95% CI could be interpreted as there is a 0.95 probability that the true value is between certified value $\pm CI$. The narrower the interval, the more precise the certified value. The 95% CI should not be used for determination of quality control gates.
- Standard Uncertainty (u_{CRM}) is the sum of variance from characterisation, homogeneity and stability studies. The uncertainty of characterisation is derived from the standard deviation of average of laboratory averages divided by the square root of the number of laboratories. Uncertainty of material homogeneity (u_{hom}) is the sum of ANOVA within and between sample uncertainty derived from the homogeneity study. An allowance for stability has been included in accordance with ISO Guide 35.
- Coverage Factor (K) is the students t-distribution value for two tailed test at 95%.
- Expanded Uncertainty (U_{CRM}) is the product of coverage factor and standard uncertainty, and represents the 95% confidence interval of the true unknowable analyte concentration of the batch combined with the bias from individual samples.

Participating laboratories

Samples were sent to 13 participating laboratories which are listed in Table 4, along with nominal sample mass and analysis method. The laboratories are presented in alphabetical order, and are not related to the laboratory number identified in Appendix 1.

Table 4: Participating Laboratories

Laboratory Name	Location	Mass (g)	Analysis method
Activation Laboratories Ltd	Ancaster, Ontario	30	FA-AA
ALS Malaga	Malaga, Western Australia	50	Au-ICP22
ALS Reno	Reno, Nevada	30	Au-ICP21
ALS Vancouver	North Vancouver, British Columbia	30	Au-AA23
ALS OMAC Laboratories Ltd	Loughrea, Co. Galway	30	Au-ICP21
Bureau Veritas Canning Vale	Canning Vale, Western Australia	40	FA40AAS
Bureau Veritas Adelaide	Wingfield, South Australia	40	FA002
Intertek Genalysis	Maddington, Western Australia	50	FA50/OE
Intertek Utama Services Jakarta	Rebo, East Jakarta	50	FA50/AA
Intertek Townsville	Townsville, Queensland	50	FA50/OE
SGS Lakefield	Lakefield, Ontario	30	FAA30V5
SGS Perth	Perth Airport, Western Australia	50	FAA505
SGS Vancouver	Burnaby, British Columbia	50	FAI50V5

Preparer and Supplier of Certified Reference Material

This certified reference material, IMS-191, was prepared and certified by:

Independent Mineral Standards Pty Ltd

16 Durham Rd
Bayswater, WA 6053
Australia
Ph: +61 8 6155 7616
imstandards.com.au

The material is available in sealed 1 kg PET jars or 6kg boxes, with unique labels showing the batch number.

Minimum Sample Mass

This reference material has been certified using 30g to 50g aliquots for fire assay. Uncertainty and homogeneity statements relating to this are only applicable if a minimum of 30g sample mass is used.

Intended Use

The pulverised reference material is intended for monitoring and testing the accuracy and precision of Pb collection fire-assay analysis of gold ores. This intended use may include a quality control program within a minerals or mine site laboratory.

Period of Validity

This Certificate is valid 5 years from the date of original issue.

Commutability

This pulverised reference material is not commutable to any other analytical methods than as stated by its intended use.

Metrological Traceability

Metrological traceability of the assigned values and their uncertainties has been established through an unbroken chain to the SI unit kilogram. This is achieved through the use of accredited ISO17025 assay laboratories during homogeneity, characterisation and stability studies.

Stability and Storage Instructions

Jars should be stored in a cool dry location, and mixed by shaking the sealed container before opening for first use. This product contains a low level of sulphide material. Once opened it is recommended to re-seal opened jars when not in use. All jars have been labelled with a recommended use by date. The long-term storage of this product is monitored, and purchasers will be notified if changes are observed during the period of validity of the product.

Instructions for Correct Use

The certified values derived from fire-assay digestion and analysis is based on the concentration level in the packaged state, and no further drying is required before weighing and analysis.

Legal Notice

Independent Mineral Standards Pty Ltd has prepared and statistically evaluated the property values of this reference material to the best of its ability. The purchaser by receipt hereof releases and indemnifies Independent Mineral Standards Pty Ltd from and against all liability and costs from the use of this material and information.

Certifying Officer

Bruce Armstrong, Operations Manager

Certification Date

27/04/2022

References

ISO Guide 35:2017, Reference materials – General and statistical principles for certification.
ISO17034:2016, General Requirements for the competence of reference material producers.

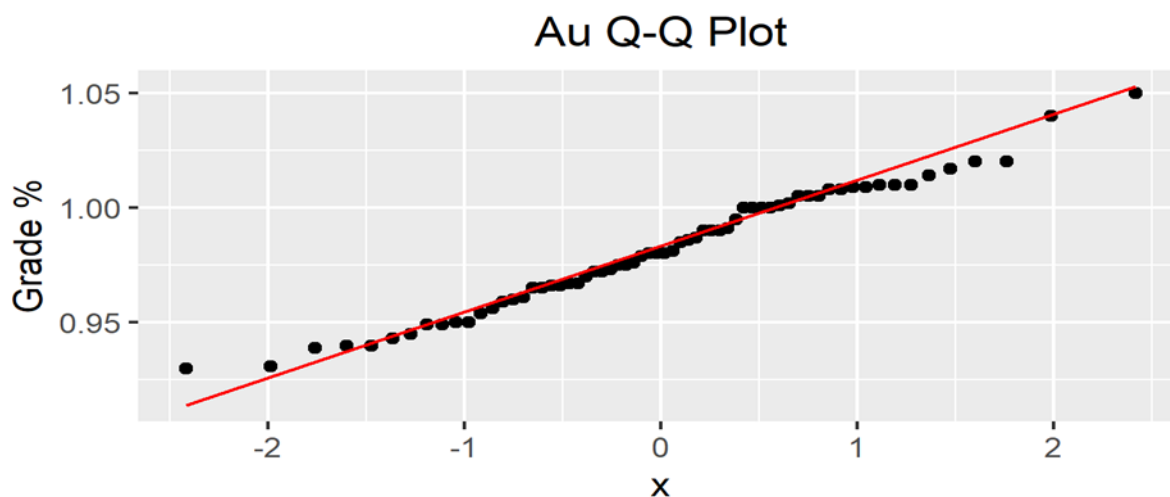
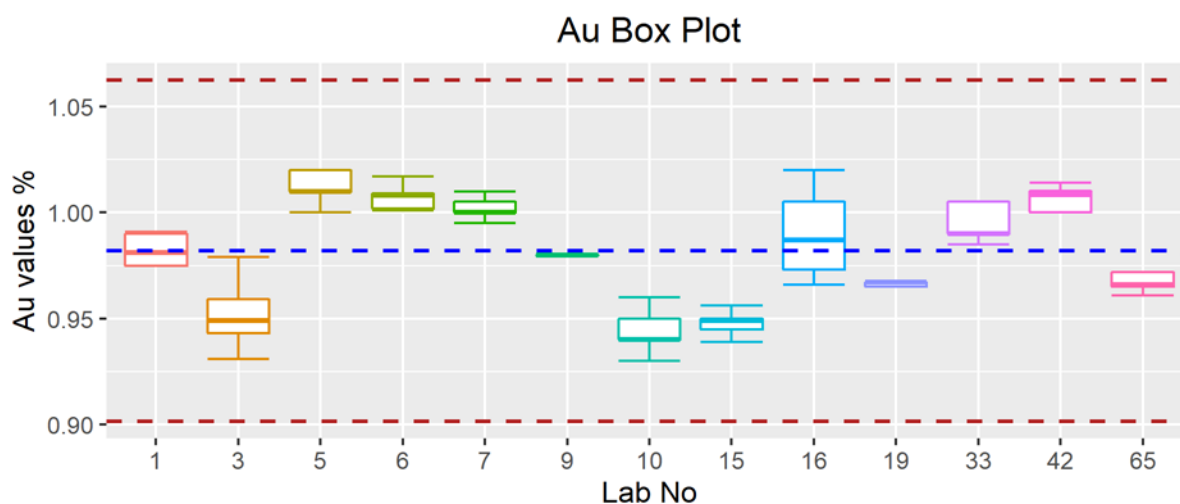
Version History

Batch #	Author	Document Version	Date	Modification
IMS-191	J. Carter	IMS191_Certificate_R5	27/04/2022	Addition of ISO17034 Accreditation. Edit U_{CRM} value
IMS-191	J.Carter	IMS191_Certificate_R6	21/06/2022	Minor text corrections
IMS-191	H.Ooi	IMS191_Certificate_R7	25/01/2023	Correction of Table 1 95% CI header text

Appendix 1

Tabulated and graphical presentation of certification data.

Determination No.	Laboratory Number													Overall
	Lab 1	Lab 3	Lab 5	Lab 6	Lab 7	Lab 9	Lab 10	Lab 15	Lab 16	Lab 19	Lab 33	Lab 42	Lab 65	
1	0.991	0.931	1.01	1.017	1	0.98	0.95	0.949	0.987	0.954	0.99	1.009	0.986	
2	0.975	0.979	1	1.001	0.995	0.97	0.94	0.939	1.02	0.967	0.99	1.014	0.965	
3	0.981	0.959	1.01	1.002	1.005	0.98	0.94	0.95	1.005	0.972	1.005	1.008	0.966	
4	0.99	0.943	1.02	1.009	1	1	0.93	0.956	0.966	0.967	1.04	0.976	0.961	
5	0.975	0.949	1.05	1.008	1.01	0.98	0.96	0.945	0.973	0.965	0.985	-	0.972	
Count	5	5	5	5	5	5	5	5	5	5	5	4	5	64
Min	0.975	0.931	1	1.001	0.995	0.97	0.93	0.939	0.966	0.954	0.985	0.976	0.961	0.93
Max	0.991	0.979	1.05	1.017	1.01	1	0.96	0.956	1.02	0.972	1.04	1.014	0.986	1.05
Median	0.981	0.949	1.01	1.008	1	0.98	0.94	0.949	0.987	0.967	0.99	1.008	0.966	0.981
Mean	0.982	0.952	1.018	1.007	1.002	0.982	0.944	0.948	0.99	0.965	1.002	1.002	0.97	0.982
Std Dev	0.0078	0.0181	0.0192	0.0064	0.0057	0.011	0.0114	0.0063	0.0224	0.0067	0.0225	0.0174	0.0098	0.0268
Coeff. Variation	0.79	1.9	1.89	0.64	0.57	1.12	1.21	0.66	2.26	0.69	2.25	1.73	1.01	2.73
Dev. From Cert Mean	-0.09	-3.16	3.53	2.45	1.9	-0.13	-4	-3.61	0.7	-1.72	1.9	1.88	-1.35	
95% Confidence Interval														0.0147
SD Within Labs														0.0141
SD Between Labs														0.0542
M-Score	0	1.14	1.03	0.96	0.67	0.04	1.46	1.14	0.21	0.54	0.32	-	0.53	4



Appendix 2

Tabulated and graphical presentation of homogeneity data.

	Samples															
Replicate No.	S4195	S4188	S4181	S4166	S4190	S4168	S4185	S4184	S4173	S4179	S4187	S4169	S4167	S4178	S4172	
1	1.023	1.007	1.015	1.032	1.015	1.036	1.018	1.045	1.027	1.02	1.012	1.01	1.018	0.993	0.955	
2	1.019	0.982	1.131	0.974	0.971	1.011	0.965	0.982	1.037	0.977	1.047	1.046	1.011	1.013	1.008	
Count	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
Mean	1.02	0.99	1.07	1	0.99	1.02	0.99	1.01	1.03	1	1.03	1.03	1.01	1	0.98	
Std Dev	0.003	0.018	0.082	0.041	0.031	0.018	0.037	0.045	0.007	0.03	0.025	0.025	0.005	0.014	0.037	
Replicate No.	S4171	S4186	S4180	S4170	S4175	S4183	S4182	S4191	S4177	S4174	S4194	S4192	S4176	S4193	S4189	Overall
1	1.007	1.014	1.045	1.019	1.025	1.018	1.268	1.004	1.024	1.019	0.997	1.019	1.001	1.008	1.001	
2	1.017	1.01	1.017	1.019	1.014	1.037	1.021	1.009	1.012	1.007	1.016	0.989	0.987	0.988	0.996	
Count	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
Mean	1.01	1.01	1.03	1.02	1.02	1.03	1.14	1.01	1.02	1.01	1.01	1	0.99	1	1	1.017
Std Dev	0.007	0.003	0.02	0	0.008	0.013	0.175	0.004	0.008	0.008	0.013	0.021	0.01	0.014	0.004	0.041

Au Box Plot

