Reference Material Certificate: Basalt and Sediment Hosted Gold

IMS-261

Table 1: IMS-261 Certified Values

Analyte	unit	Certified Value (*y*)	Standard Deviation (s)		95% Confidence Interval (*CI*)		u_{CRM}^	*k*#	U_{CRM}~	No. of Labs (ISO/IEC 17025)	No. Samples
			1 SD	1 SD Within Lab	lower	upper					
Au	g/t	7.03	0.219	0.132	6.92	7.15	0.083	2	0.17	14	69

Note 1. SI units equivalent: 1 ppm, parts per million ≡ grams per ton ≡ mg/kg ≡ ug/g ≡ 0.0001 wt.% ≡ 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.
^ Standard uncertainty.
# Coverage Factor.
~ Expanded Uncertainty.

Table 2: IMS-261 Informational Values

Analyte	XRF Value (wt.%)
Al_2O_3	14.21
Ba	0.018
CaO	7.7
Cr	0.021
Fe	10.69
K_2O	0.54
MgO	4.48

Analyte	XRF Value (wt.%)
Mn	0.163
Na_2O	2.37
P	0.079
S	0.088
SiO_2	51.67
TiO_2	1.7
LOI-1000	1.16

Material and Method of Preparation

IMS-261 is manufactured from a pulverised (95%< 105µm) basalt rock blended with pulverised weathered sediments 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 both lithium-borate fusion with x-ray fluorescence spectrometry (XRF) determination. The multi-elemental analysis results presented in Table 2 are for informational 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-261 Homogeneity Study Results

Analytical Method	Pb collection Fire Assay, AAS or ICP finish
Number of Samples Submitted	28
Number of Samples tested	28
Total Samples in Analysis	28
No. Determinations per sample	2
Number of technically invalid	0
Mean concentration (Au g/t)	7.05
Material Standard Deviation (Au g/t)	0.048
Relative Standard Deviation	0.68%

Material Characterisation and Certification Methodology

A total of 70 x 100g samples were selected for inter-laboratory round-robin analysis, 5 samples were provided to 14 laboratories. Laboratories analysed samples via lead collection fire-assay digestion followed by either AAS or ICP. All 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 laboratory averages for analytes with no outlier laboratory results, or median of laboratory medians 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 ± *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 in accordance with ISO Guide 35. 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.

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 for Certified Values in Table 1. This is achieved through the use of accredited ISO17025 assay laboratories during homogeneity, characterisation and stability studies.

An insufficient number of samples and or independent laboratories have been used to establish metrological traceability of the informational values and any uncertainties listed in Table 2. The values are presented to inform users of nature of the material matrix.

Participating laboratories

Samples were sent to 14 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	30g Fire Assay ICP-AAS (1A2)
ALS Malaga	Malaga, Western Australia	50	50g Fire Assay ICP (Au-ICP22)
ALS North Vancouver	North Vancouver, British Columbia	30	30g Fire Assay ICP (Au-ICP21)
ALS OMAC Laboratories Ltd	Loughrea, Co. Galway	50	50g Fire Assay ICP (Au-ICP22)
ALS Reno	Reno, Nevada	30	30g Fire Assay ICP (Au-ICP21)
Bureau Veritas Adelaide	Wingfield, South Australia	40	40g Fire Assay ICP(FA002)
Bureau Veritas Canning Vale	Canningvale, Western Australia	40	40g Fire Assay AAS (FA001)
Bureau Veritas Hermosillo	Sonora, Mexico	50	50g Fire Assay AAS (FA450)
Bureau Veritas Vancouver	Vancouver, British Columbia	50	50g Fire Assay ICP(FA350-Au)
Intertek Bohle	Townsville, Queensland	50	50g Fire Assay ICP (FA50/OE04)
Intertek Genalysis	Maddington, WA	25	25g Fire Assay ICP (FA25/OE04)
Intertek Utama Services Jakarta	Jakarta, Indonesia	30	30g Fire Assay AA (FA30/AA)
MSA Langley	Langley, British Columbia	50	50g Fire Assay ICP (FAS124)
SGS Perth Airport	Perth Airport, Western Australia	50	50g Fire Assay AAS (FAA505

Preparer and Supplier of Certified Reference Material

This certified reference material, IMS-261, 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, with unique labels showing the batch number.

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.

The estimate of material and measurement uncertainties reported in this certificate are the product of the participating laboratories, not any individual laboratory. Commercial laboratories typically have different measurement uncertainties to site-based laboratories. Application of the grouped uncertainties reported in this certificate to a specific laboratory for ongoing QC may lead to many false reports of out-of-control processes, or alternatively non reporting of out-of-control processes.

It is recommended that the centre line and control limits of a Shewhart chart used for ongoing monitoring of a particular laboratory are derived from averaged values and variation from replicate analysis of this CRM after removal of outliers.

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.

Minimum Sample Mass

This reference material has been certified using 25g to 50g aliquots for fire assay. Uncertainty and homogeneity statements relating to this are only applicable if a minimum of 25g sample mass is used.

Period of Validity

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

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. 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.

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

Certification Date

18th October 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.

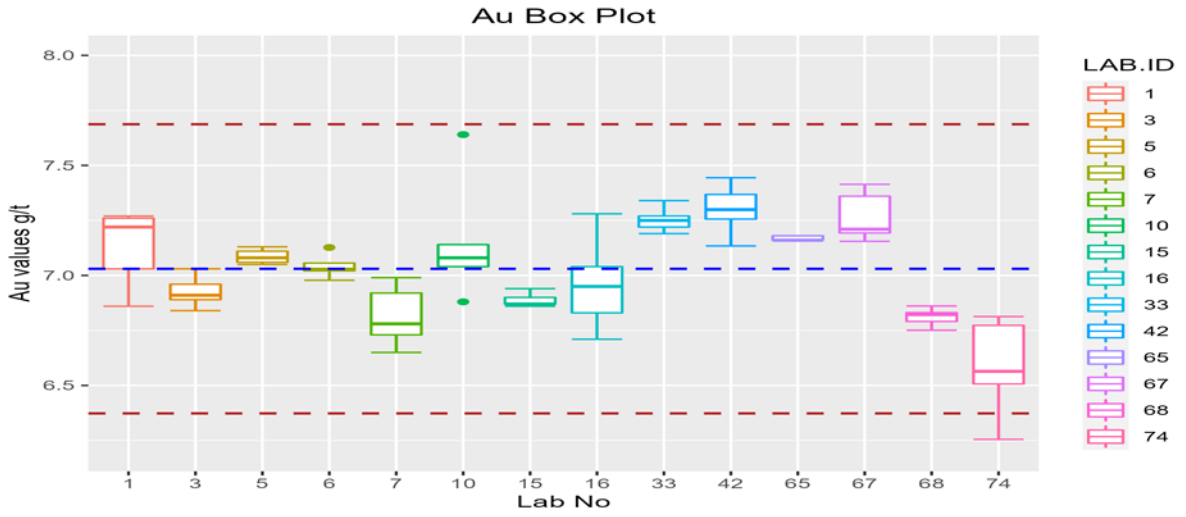
Version History

Batch #	Document Version	Date	Modification
IMS-261	R0	13/10/2022	Initial Document
IMS-261	R0.1	21/10/2022	Update Characterisation and Homogeneity boxplot
IMS-261	R2	20/3/2023	U_{crm} rounded to two significant figures

Appendix 1

Tabulated and graphical presentation of certification data.

	Laboratory Number														
Determination No.	1	3	5	6	7	10	15	16	33	42	65	67	68	74	Overall
1	7.27	6.96	7.11	7.028	6.65	7.04	6.87	6.83	7.27	7.368	7.16	7.193	6.791	6.507	
2	6.86	6.91	7.05	7.021	6.92	7.08	6.87	6.71	7.34	7.444	7.16	7.36	6.822	6.255	
3	7.03	7.03	7.08	7.056	6.73	6.88	6.94	7.28	7.22	7.256	7.18	7.155	6.831	6.564	
4	7.22	6.89	7.06	7.127	6.99	7.14	6.86	7.04	7.19	7.299	7.16	7.414	6.751	6.773	
5	7.26	6.84	7.13	6.978	6.78	7.64	6.9	6.95	7.25	7.134	7.18	7.21	6.861	6.813	
Count	5	5	5	5	5	5	5	5	5	5	5	5	5	4	69
Min	6.86	6.84	7.05	6.98	6.65	6.88	6.86	6.71	7.19	7.13	7.16	7.16	6.75	6.51	6.51
Max	7.27	7.03	7.13	7.13	6.99	7.64	6.94	7.28	7.34	7.44	7.18	7.41	6.86	6.81	7.64
Median	7.22	6.91	7.08	7.03	6.78	7.08	6.87	6.95	7.25	7.3	7.16	7.21	6.82	6.67	7.06
Mean	7.13	6.93	7.09	7.04	6.81	7.16	6.89	6.96	7.25	7.3	7.17	7.27	6.81	6.66	7.03
Std Dev	0.179	0.072	0.034	0.055	0.139	0.287	0.033	0.217	0.057	0.117	0.011	0.113	0.042	0.151	0.219
Coeff. Variation	2.5	1.04	0.47	0.78	2.04	4.01	0.47	3.12	0.78	1.6	0.15	1.56	0.62	2.27	3.12
Dev. From Cert Mean	1.35	-1.53	0.75	0.12	-3.12	1.74	-2.07	-1.01	3.14	3.79	1.92	3.31	-3.16	-5.25	
95% Confidence Interval	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.113
SD Within Labs	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.132
SD Between Labs	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.422
M-Score	0.7	0.6	0.11	0.11	1.15	0.11	0.77	0.44	0.82	1.03	0.44	0.65	0.97	2.05	4


Au Box Plot
Au values g/t
8.0
7.5
7.0
6.5
1
3
5
6
7
10
15
16
33
42
65
67
68
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Lab No
LAB.ID
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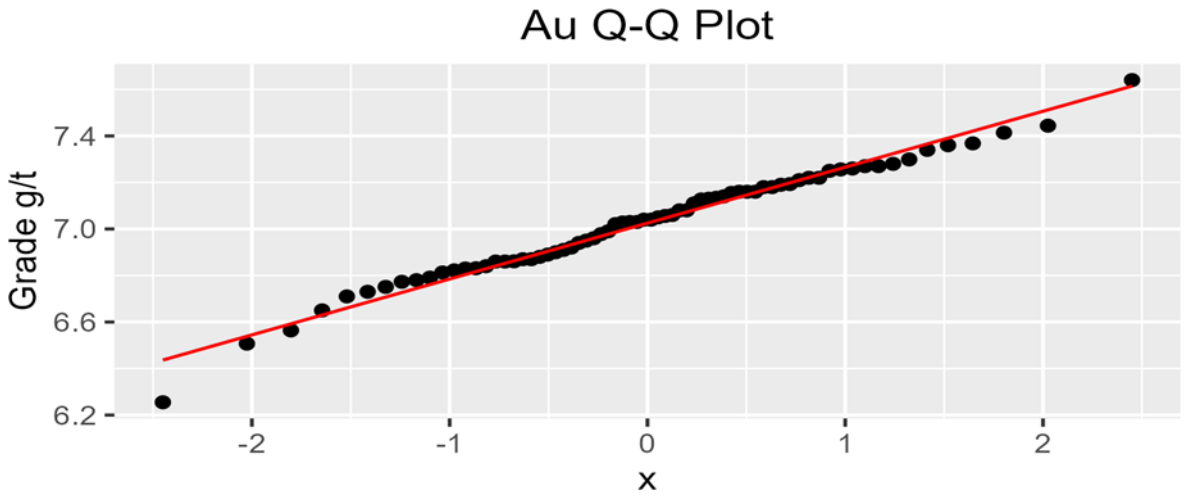
33
42
65
67
68
74

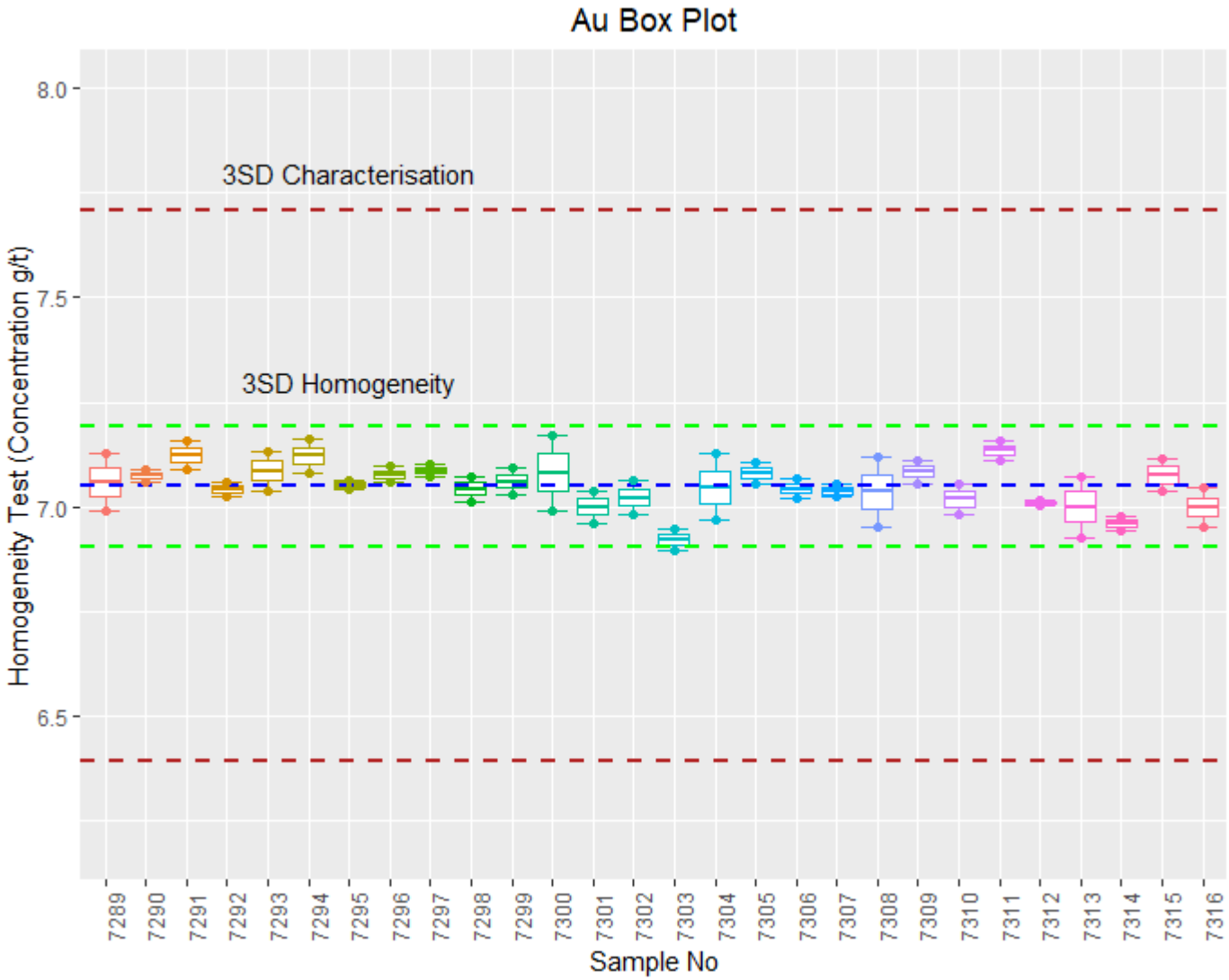

Au Q-Q Plot
Grade g/t
7.4
7.0
6.6
6.2
-2
-1
0
1
2
x

Appendix 2

Tabulated and graphical presentation of homogeneity data.

	Samples														
Replicate No.	7289	7290	7291	7292	7293	7294	7295	7296	7297	7298	7299	7300	7301	7302	Overall
1	7.127	7.09	7.091	7.058	7.133	7.082	7.042	7.058	7.073	7.013	7.028	7.172	6.961	6.983	
2	6.989	7.059	7.157	7.023	7.039	7.163	7.063	7.096	7.101	7.073	7.094	6.992	7.038	7.062	
Count	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
Mean	7.06	7.07	7.12	7.04	7.09	7.12	7.05	7.08	7.09	7.04	7.06	7.08	7	7.02	
Std Dev	0.098	0.022	0.047	0.025	0.066	0.057	0.015	0.027	0.02	0.042	0.047	0.127	0.054	0.056	

	Samples														
Replicate No.	7303	7304	7305	7306	7307	7308	7309	7310	7311	7312	7313	7314	7315	7316	Overall
1	6.894	7.126	7.106	7.021	7.055	6.952	7.056	7.057	7.158	7.015	7.072	6.978	7.036	6.954	
2	6.947	6.969	7.056	7.067	7.023	7.12	7.113	6.981	7.112	7.003	6.928	6.943	7.116	7.045	
Count	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
Mean	6.92	7.05	7.08	7.04	7.04	7.04	7.08	7.02	7.14	7.01	7	6.96	7.08	7	7.05
Std Dev	0.037	0.111	0.035	0.033	0.023	0.119	0.04	0.054	0.033	0.008	0.102	0.025	0.057	0.064	0.048


Au Box Plot
3SD Characterisation
3SD Homogeneity
Homogeneity Test (Concentration g/t)
8.0
7.5
7.0
6.5
7289
7290
7291
7292
7293
7294
7295
7296
7297
7298
7299
7300
7301
7302
7303
7304
7305
7306
7307
7308
7309
7310
7311
7312
7313
7314
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Sample No