Reference Material Certificate: Basalt and Sediment Hosted Gold
IMS-230

Table 1: IMS-230 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	2.19	0.050	0.036	2.16	2.21	0.058	2	0.12	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.

Material and Method of Preparation

IMS-230 is manufactured from a pulverised 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.

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 2.

Table 2: IMS-230 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	56
No. Determinations per sample	2
Number of technically invalid results	0
Mean concentration (Au g/t)	2.219
Material Standard Deviation (Au g/t)	0.032
Relative Standard Deviation	1.43%

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. 15 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 ± 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 15 participating laboratories which are listed in Table 3, 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 3: Participating Laboratories

Laboratory Name	Location	Mass (g)	Analysis method
Activation Laboratories Ltd	Ancaster, Ontario	25	25g Fire Assay ICP (FA25/OE04)
ALS Malaga	Malaga, Western Australia	30	30g Fire Assay ICP-AAS (1A2)
ALS North Vancouver	North Vancouver, British Columbia	30	30g Fire Assay ICP (Au-ICP21)
ALS OMAC Laboratories Ltd	Loughrea, Co. Galway	30	30g Fire Assay ICP (Au-ICP21)
ALS Reno	Reno, Nevada	50	50g Fire Assay ICP (Au-ICP22)
Bureau Veritas Adelaide	Wingfield, South Australia	40	40g Fire Assay AAS (FA001)
Bureau Veritas Canning Vale	Canningvale, Western Australia	50	50g Fire Assay ICP (Au-ICP22)
Bureau Veritas Vancouver	Vancouver, British Columbia	40	40g Fire Assay ICP(FA002)
Intertek Bohle	Townsville, Queensland	50	50g Fire Assay ICP (FA50/OE04)
Intertek Genalysis	Maddington, WA	50	50g Fire Assay ICP (FA50/OE04)
Intertek Utama Services Jakarta	Pasar Rebo, East Jakarta	30	30g Fire Assay AA (FA30/AA)
MSA Langley	Langley, British Columbia	50	50g Fire Assay ICP (FAS124)
SGS Burnaby	Burnaby, British Columbia	30	30g Fire Assay ICP (GE_FAI30V5)
SGS Lakefield	Lakefield, Ontario	50	50g Fire Assay ICP (GE_FAI50V5)
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-230, 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. 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

27/06/2022

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

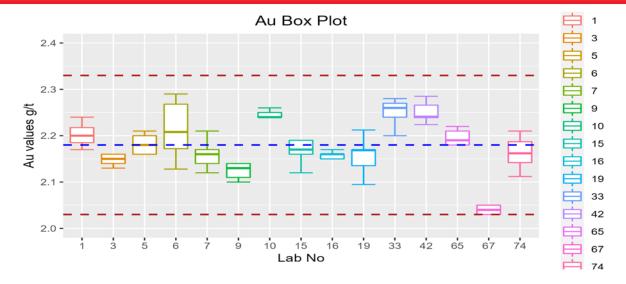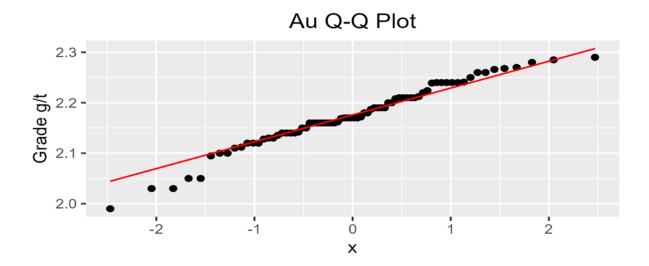| Batch #	Author	Document Version	Date	Modification
PBS230	H.Ooi	IMS230_Certificate_R0	30/6/2022	Original Version
PBS230	H.Ooi	IMS230_Certificate_R0.1	21/10/2022	Update Characterisation and Homogeneity boxplot
IMS230	H.Ooi	IMS230_Certificate_R1	17/03/2023	U_{CRM} value rounded to two significant figures

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	Lab 67	Lab 74	
1	2.19	2.16	2.16	2.13	2.17	2.13	2.25	2.24	2.16	2.21	2.28	2.24	2.1	2.05	2.11	
2	2.17	2.14	2.16	2.29	2.16	2.14	2.24	2.19	2.12	2.17	2.27	2.27	2.19	2.03	2.21	
3	2.24	2.16	2.18	2.21	2.21	2.1	2.19	2.12	2.16	2.14	2.26	2.24	2.18	2.05	2.14	
4	2.21	2.15	2.21	2.17	2.12	2.11	2.24	2.16	2.17	2.09	2.2	2.29	2.21	1.99	2.16	
5	-	2.13	2.2	2.27	2.14	2.14	2.26	2.17	2.15	2.17	2.24	2.22	2.22	2.03	2.19	
Count	4	5	5	5	5	5	5	5	5	5	5	5	5	0	5	69
Min	2.17	2.13	2.16	2.13	2.12	2.1	2.19	2.12	2.12	2.09	2.2	2.22	2.1	-	2.11	2.09
Max	2.24	2.16	2.21	2.29	2.21	2.14	2.26	2.24	2.17	2.21	2.28	2.29	2.22	-	2.21	2.29
Median	2.2	2.15	2.18	2.21	2.16	2.13	2.24	2.17	2.16	2.17	2.26	2.24	2.19	-	2.16	2.17
Mean	2.2	2.15	2.18	2.21	2.16	2.12	2.24	2.18	2.15	2.16	2.25	2.25	2.18	-	2.16	2.19
Std Dev	0.03	0.013	0.023	0.067	0.034	0.018	0.027	0.044	0.019	0.044	0.032	0.024	0.047	-	0.038	0.050
Coeff. Variation	1.36	0.61	1.05	3.02	1.57	0.86	1.21	2.02	0.89	2.04	1.41	1.08	2.18	-	1.76	2.31
Dev. From Cert Mean	0.79	-1.7	-0.15	1.28	-1.16	-2.8	2.32	-0.42	-1.52	-1.33	2.96	3.01	-0.24	-	-1.04	
95% Confidence Interval	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.023
SD Within Labs	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.036
SD Between Labs	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.089
M-Score	1.01	0.67	0.34	1.28	0.34	1.35	2.36	0	0.34	0.04	3.04	2.39	0.67	4.72	0.27	4

Au Box Plot

Au Q-Q Plot

Independent Mineral Standards Pty Ltd   16 Durham Rd. Bayswater WA 6053   Ph: +61 8 6155 7616
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Appendix 2

Tabulated and graphical presentation of homogeneity data.

	Samples														
Replicate No.	5676	5677	5678	5679	5680	5681	5682	5683	5684	5685	5686	5687	5688	5689	
1	2.244	2.172	2.208	2.226	2.228	2.2	2.268	2.223	2.181	2.204	2.275	2.229	2.245	2.205	
2	2.202	2.286	2.246	2.163	2.217	2.195	2.2	2.31	2.211	2.224	2.249	2.228	2.231	2.209	
Count	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
Mean	2.22	2.23	2.23	2.19	2.22	2.2	2.23	2.27	2.2	2.21	2.26	2.23	2.24	2.21	
Std Dev	0.03	0.081	0.027	0.045	0.008	0.004	0.048	0.062	0.021	0.014	0.018	0.001	0.01	0.003	
Replicate No.	5690	5691	5692	5693	5694	5695	5696	5697	5698	5699	5700	5701	5702	5703	**Overall**
1	2.167	2.202	2.33	2.128	2.206	2.29	2.211	2.263	2.303	2.232	2.251	2.227	2.098	2.246	
2	2.232	2.2	2.243	2.198	2.218	2.175	2.24	2.209	1.998	2.206	2.262	2.251	2.199	2.198	
Count	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
Mean	2.2	2.2	2.29	2.16	2.21	2.23	2.23	2.24	2.15	2.22	2.26	2.24	2.15	2.22	2.219
Std Dev	0.046	0.001	0.062	0.049	0.008	0.081	0.021	0.038	0.216	0.018	0.008	0.017	0.071	0.034	0.032

Independent Mineral Standards Pty Ltd   16 Durham Rd. Bayswater. WA 6053
enquiries@imstandards.com

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Au Box Plot

Pilbara Standards Pty Ltd   16 Durham Rd. Bayswater WA 6053Ph: +61 8 6155 7616 enquiries@imstandards.com

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