Reference Material Certificate
Basalt Hosted Gold - Copper Sulphide
IMS-333

Table 1a: IMS-333 Certified Values

Analyte	unit	Certified Value (y)	Standard Deviation (s)		95% Confidence Interval (CI)		uCRM^	k#	UCRM~	No. of Labs (ISO/IEC 17025)	No. Samples
			1 SD	1 SD Within Lab	lower	upper					
Fire Assay											
Au	g/t	2.99	0.062	0.048	2.96	3.01	0.026	2	0.052	13	65
Mixed Acid Digest											
Cu	ppm	1018	27.8	14.7	1002	1034	14	2	27	12	60

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.

Additional certified elements are listed in Table 1b on next page.

Version History

Batch #	Document Version	Date	Modification
IMS-333	R0	25/06/2024	Initial Document

Table 2b: IMS-333 Certified Values

Analyte	unit	Certified Value (y)	Standard Deviation (s)		95% Confidence Interval (CI)		uCRM^	k#	UCRM~	No. of Labs (ISO/IEC 17025)	No. Samples
			1 SD	1 SD Within Lab	lower	upper					
Ag	ppm	1.1	0.29	0.16	0.9	1.4	0.33	2	0.66	10	49
Al	%	7.48	0.127	0.077	7.39	7.56	0.079	2	0.16	11	55
As	ppm	62.0	4.85	2.75	59.5	64.5	3.8	2	7.5	11	55
Ba	ppm	161	5.4	3.0	155	167	4.0	2	8.0	11	55
Be	ppm	0.8	0.18	0.06	0.6	0.9	0.51	2.45	1.2	6	30
Bi	ppm	6.0	2.33	1.03	2.6	9.4	3.1	2.36	7.4	7	30
Ca	%	6.02	0.191	0.065	5.78	6.26	0.12	2	0.24	11	55
Cd	ppm	0.8	0.14	0.08	0.6	1.0	0.32	2.36	0.76	7	35
Co	ppm	35.5	1.67	0.57	33.7	37.3	1.5	2	2.9	12	60
Cr	ppm	111	6.9	5.9	109	114	8.7	2	17	11	55
Fe	%	10.4	0.38	0.13	10.2	10.7	0.16	2	0.32	11	55
K	%	0.34	0.012	0.005	0.33	0.35	0.005	2	0.009	11	55
La	ppm	9.6	0.49	0.02	8.7	10.4	0.61	2.45	1.5	6	30
Li	ppm	9.0	0.77	0.52	7.4	10.6	1.3	2.31	3.0	8	40
Mg	%	2.66	0.069	0.033	2.62	2.70	0.030	2	0.060	11	55
Mn	ppm	1201	45.7	16.0	1169	1232	18	2	36	11	55
Mo	ppm	1.6	0.48	0.44	1.4	1.9	1.1	2.45	2.7	6	27
Na	%	2.10	0.078	0.034	2.05	2.15	0.030	2	0.059	11	55
Ni	ppm	33.2	2.62	1.10	31.6	34.8	1.3	2	2.6	12	60
P	ppm	833	33.9	14.8	812	854	16	2	32	11	55
Pb	ppm	105	6.4	3.1	100	109	3.9	2	7.7	12	60
S	%	3.25	0.123	0.043	3.17	3.34	0.048	2	0.096	11	55
Sc	ppm	26.8	0.97	0.44	26.2	27.5	0.64	2	1.3	11	55
Sr	ppm	242	8.6	3.2	237	248	3.4	2	6.8	11	55
Ti	%	1.04	0.027	0.014	1.02	1.06	0.012	2	0.025	11	55
V	ppm	220	7.3	3.1	215	225	5.5	2	11	11	55
Zn	ppm	449	25.2	7.5	434	465	11	2	22	12	60
Zr	ppm	115	1.3	1.2	110	120	2.2	2.57	5.7	5	25

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 3: IMS-333 Informational Values

Analyte	unit	Certified Value (y)	Standard Deviation (s)		95% Confidence Interval (CI)		uCRM^	k#	UCRM~	No. of Labs	No. Samples
			1 SD	1 SD Within Lab	lower	upper					
Mixed Acid Digest											
Ce	ppm	22.1	1.29	1.39	21.6	22.7	10	3.18	32	3	14
Ga	ppm	20.0	1.43	1.01	18.0	21.9	1.5	2.78	4.3	4	20
Nb	ppm	5.8	0.45	-	-	-		12.71	-	1	5
Sb	ppm	7.7	1.48	1.03	4.4	10.9	2.4	3.18	7.5	3	12
Sn	ppm	16.1	13.26	-	-	-	13	4.3	54	2	10
Te	ppm	6.6	2.30	-	-	-	-	12.71	-	1	5
Th	ppm	2.8	0.50	-	-	-	-	12.71	-	1	4
U	ppm	10.0	0.00	-	-	-	-	12.71	-	1	5
Y	ppm	29.4	1.42	0.38	27.5	31.3	0.92	2.57	2.4	5	25

Material and Method of Preparation

IMS-333 is manufactured from a pulverised (95%< 105µm) basalt rock spiked with gold (Au) and blended with a copper sulphide concentrate sourced from an Australian mine site. 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 ISO17025 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 two separate laboratories for multiple analysis in a single batch under repeatable conditions.

Firstly, analysis was performed using instrument neutron activation analysis (INAA) for single element Au, with an aliquot mass (1g) significantly below common practice for gold analysis. The reduced aliquot mass method is used to test material homogeneity by amplifying the volume-variance effect of small masses, whilst using an analytical method with suitable measurement uncertainty. The reduced aliquot INAA results have been scaled to equivalent 25g variance by using the method of Ingamells and Switzer (1973).

Secondly, analysis was performed using a four-acid digest with an ICP-OES finish for multiple elements with an aliquot mass of 0.2g.

The homogeneity study results for both methods were reviewed, and the material was deemed suitable for progressing to the inter-laboratory round-robin stage. A summary of the study results for Au and Cu are presented in Appendix 2 and Table 4.

Table 4: IMS-333 Homogeneity Study Results

Analytical Method	INAA (Au, g/t)	FA equivalent (Au, g/t)	4A-OES (Cu, ppm)
Aliquot mass (g)	1	25	0.2g
Number of Samples Submitted	20	-	20
Number of Samples tested	20	-	20
Total Samples in Analysis	20	-	20
No. Determinations per sample	2	-	2
Number of technically invalid	0	-	0
Mean concentration	2.82	2.82	1008
Material Standard Deviation equivalent	0.084	0.017	9.0
Relative Standard Deviation	3.0%	0.6%	0.9%

Material Characterisation and Certification Methodology

A total of 65 x 100g samples were selected for inter-laboratory round-robin analysis, 5 samples were provided to 13 laboratories. Laboratories analysed samples via lead collection fire-assay digestion followed by either AAS or ICP, and also by four-acid digest with ICP finish for a standard suite of elements. 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.
- Within laboratory standard deviation (s_w) is the average spread of determination values across the reporting laboratories, less outlier laboratory and individual determinations. This is calculated by single factor ANOVA of the participating laboratory groups.
- 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.

The certified value of any elemental concentration may not be negative even though in some cases the uncertainty error bounds define a range less than 0%. These cases are due to low concentrations of some analytes relative to the analytical detection limits and increments of precision.

Analytes have been categorised as Certified or Informational based on:

- Confirmation of sufficient between-unit variance demonstrating material homogeneity.
- Sufficient agreement between all laboratories.
- A comparison of results between ISO17025 and non-ISO17025 accredited laboratories.

Participating laboratories

The participating laboratories are listed in Table 5. The laboratories are presented in alphabetical order, and are not related to the laboratory number identified in Appendix 1.

Table 5: Participating Laboratories

Laboratory Name	Location	Analysis methods
Activation Labs	Ancaster, Canada	30g Fire Assay ICP-AAS (1A2), 4 Acid Digest ICP-OES package (1F2)
ALS	Malaga, Australia	50g Fire Assay ICP (Au-ICP22), 4-Acid Digest ICP-OES package (ME-ICP61)
ALS	North Vancouver, Canada	30g Fire Assay ICP (Au-ICP21), 4-Acid Digest ICP-OES package (ME-ICP61)
ALS	Loughrea, Ireland	50g Fire Assay ICP (Au-ICP22), 4-Acid Digest ICP-OES package (ME-ICP61)
Bureau Veritas	Canning Vale, Australia	40g Fire Assay AAS (FA001)
Bureau Veritas	Wingfield, Australia	40g Fire Assay AAS(FA001), 4-Acid Digest ICP-OES package (MA101)
Bureau Veritas	Vancouver, Canada	50g Fire Assay ICP(FA350-Au), 4-Acid Digest ICP-OES package (MA300)
Intertek	Maddington, Australia	25g Fire Assay ICP (FA25/OE04), 4 Acid Digest ICP-OES package (4A/OE33)
Intertek	Jakarta, Indonesia	30g Fire Assay AA (FA30/AA), 4 Acid Digest ICP-OES package (4A/OE33)
Intertek	Townsville, Australia	50g Fire Assay ICP (FA50/OE04), 4-Acid Digest ICP-OES package (4A/OE33)
MSALabs	Langley, Canada	50g Fire Assay ICP (FAS124), 4-Acid Digest ICP-OES package (ICP-230)
SGS	Burnaby, Canada	50g Fire Assay ICP (GE_FAI50V5), 4-Acid Digest ICP-OES package (GE_ICP40Q12)
SGS	Perth, Australia	50g Fire Assay AAS (GE_FAA50V5), 4-Acid Digest ICP-OES package (GE_ICP40Q12)

Preparer and Supplier of Certified Reference Material

This certified reference material, IMS-333, 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 boxes, with unique labels showing the batch number.

Minimum Sample Mass

This reference material has been certified for the analysis of Au by fire assay using aliquots ranging from 25g to 50g. This reference material has also been certified for Cu and other available elements using four-acid digest using 0.2g aliquots. Uncertainty and homogeneity statements relating to each applicable analysis are only applicable for the corresponding minimum aliquot sample mass.

Intended Use

The pulverised reference material is intended for monitoring and testing the accuracy and precision of Pb collection fire-assay analysis, and multi-element ICP analysis of gold-copper 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.

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 for Certified Values in Table 1. This is achieved by selecting and comparing results from sufficient assay laboratories accredited to ISO17025. Where there was insufficient data to establish metrological traceability the results are listed as informational values in Table 2.

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 sulphide material. Once opened it is recommended to re-seal opened jars when not in use. 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 are 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 - ISO17034:2016 authorised signatory

Certification Date

25 June 2024

References

ISO Guide 35:2017, Reference materials – General and statistical principles for certification.

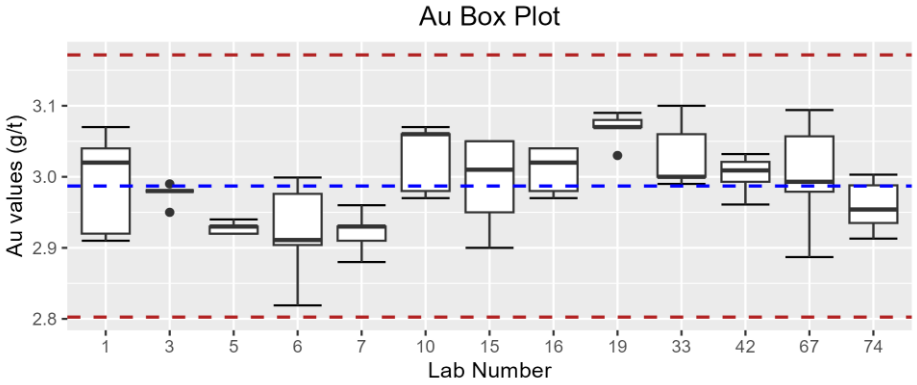
ISO17034:2016, General Requirements for the competence of reference material producers.

Appendix 1

Tabulated and graphical presentation of certification data.

	Laboratory Number													
Au Determination (g/t)	Lab 1	Lab 3	Lab 5	Lab 6	Lab 7	Lab 10	Lab 15	Lab 16	Lab 19	Lab 33	Lab 42	Lab 67	Lab 74	Overall
Detection Limit	0.005	0.001	0.01	0.005	0.01	0.01	0.001	0.001	0.01	0.01	0.005	0.002	0.002	
1	3.04	2.95	2.93	2.819	2.88	2.97	3.05	3.02	3.07	3.10	2.961	3.057	3.003	
2	2.91	2.99	2.92	2.904	2.93	2.98	3.05	3.04	3.08	3.00	3.009	3.094	2.988	
3	3.07	2.98	2.92	2.976	2.93	3.07	2.90	2.98	3.03	2.99	3.032	2.887	2.954	
4	3.02	2.98	2.93	2.999	2.96	3.06	2.95	3.04	3.07	3.06	2.993	2.993	2.935	
5	2.92	2.98	2.94	2.911	2.91	3.06	3.01	2.97	3.09	3.00	3.021	2.979	2.913	65
Count	5	5	5	5	5	5	5	5	5	5	5	5	5	2.82
Min	2.91	2.95	2.92	2.82	2.88	2.97	2.9	2.97	3.03	2.99	2.96	2.89	2.91	3.10
Max	3.07	2.99	2.94	3	2.96	3.07	3.05	3.04	3.09	3.1	3.03	3.09	3	3.00
Median	3.02	2.98	2.93	2.91	2.93	3.06	3.01	3.02	3.07	3	3.01	2.99	2.95	2.99
Mean	2.99	2.98	2.93	2.92	2.92	3.03	2.99	3.01	3.07	3.03	3	3	2.96	0.062
Std Dev	0.073	0.015	0.008	0.071	0.029	0.049	0.066	0.033	0.023	0.048	0.028	0.08	0.037	2.06
Coeff. Variation	2.43	0.51	0.29	2.41	1.01	1.61	2.2	1.1	0.74	1.58	0.92	2.65	1.25	
Dev. From Cert Mean	0.17	-0.37	-1.98	-2.18	-2.18	1.37	0.17	0.77	2.71	1.44	0.54	0.5	-0.95	0.027
95% Confidence Interval	-	-	-	-	-	-	-	-	-	-	-	-	-	0.048
SD Within Labs	-	-	-	-	-	-	-	-	-	-	-	-	-	0.100
SD Between Labs	-	-	-	-	-	-	-	-	-	-	-	-	-	4
M-Score	0.67	0.67	2.36	3	2.36	2.02	0.34	0.67	2.36	0	0.3	0.24	1.55	3
Z-Score	0.04	0.1	0.53	0.59	0.59	0.37	0.04	0.21	0.73	0.39	0.15	0.13	0.26	65

	Laboratory Number													
Cu Determination (ppm)	Lab 1	Lab 3	Lab 5	Lab 6	Lab 7	Lab 10	Lab 15	Lab 16	Lab 19	Lab 33	Lab 42	Lab 67	Lab 74	Overall
Detection Limit	1	1	1	1	1	5	1	1	0.5	-	1	2	1	
1	998	996	995	1016	981	1050	1050	1065	1016	-*	1045	982	1025	
2	1020	989	1040	1004	989	1024	1035	1060	1033	-*	1009	985	1018	
3	1000	997	1010	1008	962	1028	1055	1060	1024	-*	1035	990	1010	
4	1000	1020	1040	986	985	1067	1045	1055	1012	-*	1026	988	986	
5	1010	1010	1060	1005	944	1036	1045	1065	1010	-*	1059	1007	1028	
Count	5	5	5	5	5	5	5	5	5	0	5	5	5	60
Min	998	989	995	986	944	1024	1035	1055	1010	-	1009	982	986	944.0
Max	1020	1020	1060	1016	989	1067	1055	1065	1033	-	1059	1007	1028	1067.0
Median	1000	997	1040	1005	981	1036	1045	1060	1016	-	1035	988	1018	1017.0
Mean	1005.6	1002.4	1029	1003.8	972.2	1041	1046	1061	1019	-	1034.8	990.4	1013.4	1018.2
Std Dev	9.32	12.42	26.08	11.01	18.86	17.61	7.42	4.18	9.49	-	18.93	9.76	16.82	27.82
Coeff. Variation	0.93	1.24	2.53	1.1	1.94	1.69	0.71	0.39	0.93	-	1.83	0.99	1.66	2.73
Dev. From Cert Mean	-1.24	-1.55	1.06	-1.42	-4.52	2.24	2.73	4.2	0.08	-	1.63	-2.73	-0.47	
95% Confidence Interval	-	-	-	-	-	-	-	-	-	-	-	-	-	15.29
SD Within Labs	-	-	-	-	-	-	-	-	-	-	-	-	-	14.74
SD Between Labs	-	-	-	-	-	-	-	-	-	-	-	-	-	56.59
M-Score	0.59	0.69	0.8	0.42	1.25	0.66	0.97	1.49	0.03	-	0.62	1	0.03	4
Z-Score	-	-	-	-	-	-	-	-	-	-	-	-	-	3


Au Box Plot
Au values (g/t)
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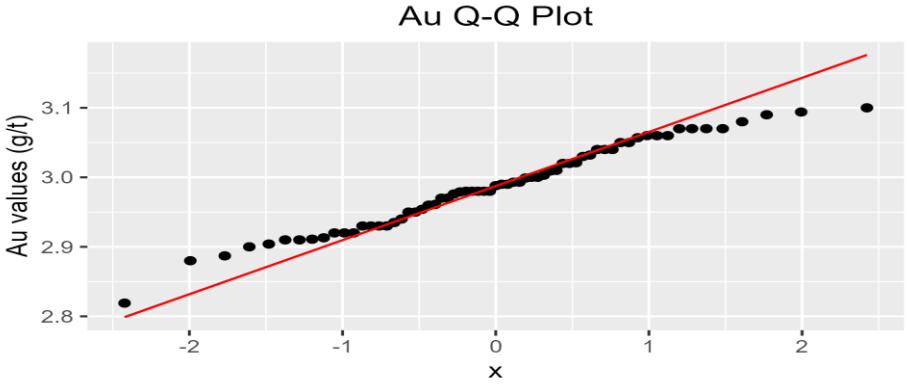
3.0
2.9
2.8
1
3
5
6
7
10
15
16
19
33
42
67
74
Lab Number


Au Q-Q Plot
Au values (g/t)
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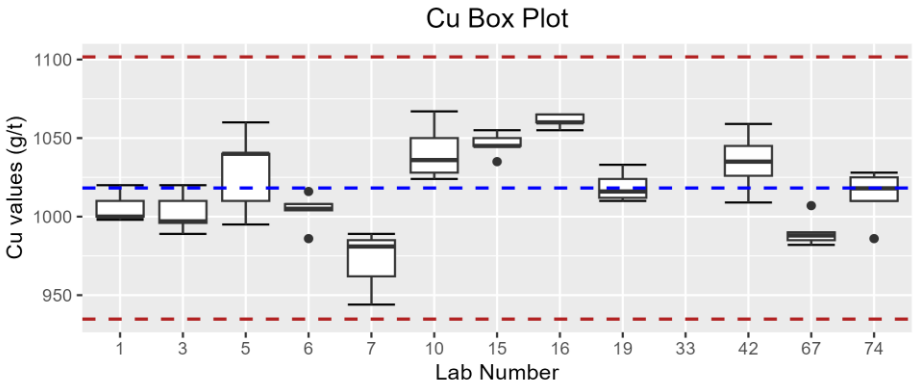
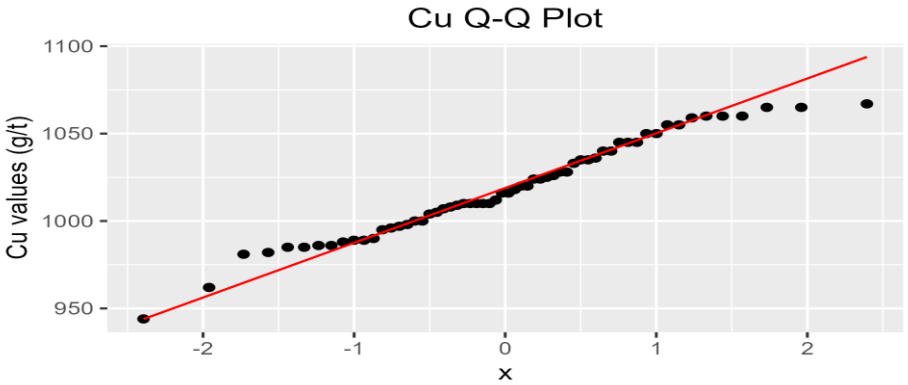
3.0
2.9
2.8
-2
-1
0
1
2
x

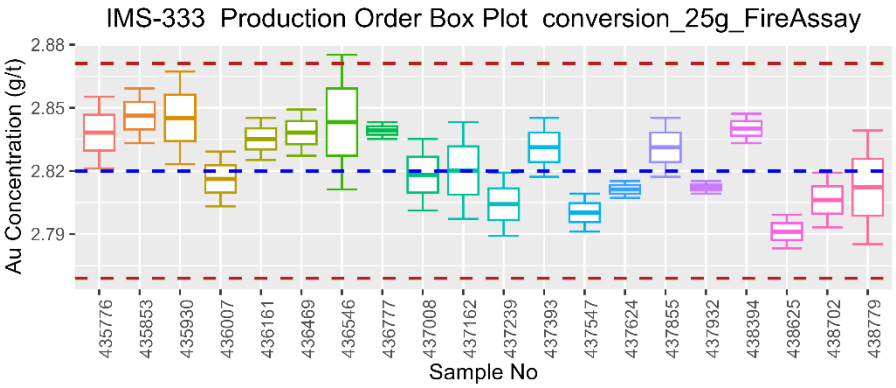

Cu Box Plot
Cu values (g/t)
1100
1050
1000
950
1
3
5
6
7
10
15
16
19
33
42
67
74
Lab Number

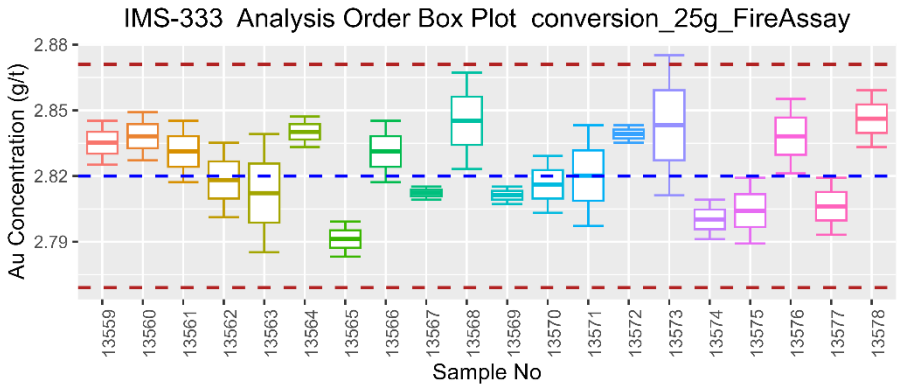

Cu Q-Q Plot
Cu values (g/t)
1100
1050
1000
950
-2
-1
0
1
2
x

Appendix 2

Tabulated and graphical presentation of homogeneity data.

Au		13559	13560	13561	13562	13563	13564	13565	13566	13567		
	1	2.85	2.85	2.82	2.80	2.84	2.85	2.80	2.85	2.81		
	2	2.83	2.83	2.85	2.84	2.79	2.83	2.78	2.82	2.82		
		13568	13569	13570	13571	13572	13573	13574	13575	13576	13577	13578
	1	2.82	2.81	2.83	2.80	2.84	2.81	2.81	2.82	2.86	2.79	2.86
	2	2.87	2.82	2.80	2.84	2.84	2.88	2.79	2.79	2.82	2.82	2.83





Cu		13579	13580	13581	13582	13583	13584	13585	13586	13587		
	1	1,016	1,004	1,008	986	1,005	1,004	1,001	1,018	996		
	2	1,014	1,007	1,014	996	991	1,000	995	1,013	1,006		
		13588	**13589**	**13590**	**13591**	**13592**	**13593**	**13594**	**13595**	**13596**	**13597**	**13598**
	1	1,027	1,019	1,006	1,017	1,017	1,027	1,012	1,003	1,020	1,005	1,025
	2	1,009	1,026	1,010	995	989	1,022	978	1,013	1,010	1,007	998