

**CERTIFICATE OF ANALYSIS FOR
 COPPER CONCENTRATE**

(Copper Sulphide Concentrate, Western Australia)

**CERTIFIED REFERENCE MATERIAL
 OREAS 995**

Table 1. Certified Values, Uncertainties & Tolerance Intervals for OREAS 995.

Constituent	Certified Value [†]	95% Expanded Uncertainty		95% Tolerance Limits	
		Low	High	Low	High
Umpire Labs (dry sample basis)					
Classical Wet Chemistry					
Cu, Copper (wt.%)	22.70	22.66	22.74	22.68	22.72
Geoanalytical Labs ('as received' sample basis)					
Pb Fire Assay					
Au, Gold (ppm)	4.52	4.45	4.59	4.50*	4.55*

SI unit equivalents: ppm (parts per million; 1×10^{-6}) \equiv mg/kg; wt.% (weight per cent) \equiv % (mass fraction).

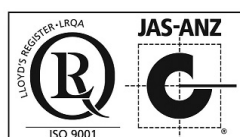
[†]This operationally defined measurand meets the requirements of ISO 17034 and all participating laboratories comply with the requirements of ISO 17025.

*Gold Tolerance Limits for typical 15g fire assay are determined from 20 x 85mg INAA results and the Sampling Constant (Ingamells & Switzer, 1973).

Note: intervals may appear asymmetric due to rounding.



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Table 1 continued.

Constituent	Certified Value [†]	95% Expanded Uncertainty		95% Tolerance Limits	
		Low	High	Low	High
4-Acid Digestion					
Ag, Silver (ppm)	37.3	35.4	39.1	36.3	38.2
Al, Aluminium (wt.%)	0.243	0.231	0.254	0.236	0.250
As, Arsenic (ppm)	1277	1214	1340	1246	1308
Ba, Barium (ppm)	9.25	8.05	10.44	8.45	10.04
Be, Beryllium (ppm)	< 0.05	IND	IND	IND	IND
Bi, Bismuth (ppm)	90	84	96	86	95
Ca, Calcium (wt.%)	0.351	0.338	0.364	0.342	0.360
Cd, Cadmium (ppm)	32.9	30.5	35.3	31.7	34.1
Ce, Cerium (ppm)	2.19	1.97	2.41	2.08	2.30
Co, Cobalt (ppm)	357	344	370	350	364
Cr, Chromium (ppm)	28.1	25.8	30.4	25.9	30.3
Cs, Caesium (ppm)	0.25	0.22	0.28	0.23	0.27
Cu, Copper (wt.%)	22.60	22.17	23.02	22.22	22.97
Fe, Iron (wt.%)	28.91	28.09	29.73	28.39	29.43
Ga, Gallium (ppm)	5.08	4.73	5.43	4.86	5.30
Hf, Hafnium (ppm)	0.22	0.19	0.25	IND	IND
In, Indium (ppm)	23.0	20.9	25.1	22.2	23.8
La, Lanthanum (ppm)	1.19	1.08	1.31	IND	IND
Li, Lithium (ppm)	0.91	0.75	1.07	IND	IND
Mg, Magnesium (wt.%)	0.731	0.699	0.764	0.717	0.745
Mn, Manganese (wt.%)	0.020	0.019	0.020	0.019	0.020
Mo, Molybdenum (ppm)	65	61	69	64	67
Na, Sodium (wt.%)	0.029	0.028	0.031	0.028	0.030
Nb, Niobium (ppm)	0.36	0.29	0.43	IND	IND
Ni, Nickel (ppm)	12.3	10.8	13.7	11.7	12.8
Pb, Lead (ppm)	2697	2540	2854	2644	2749
Rb, Rubidium (ppm)	1.81	1.62	1.99	1.61	2.00
Re, Rhenium (ppm)	0.16	0.15	0.18	0.15	0.18
S, Sulphur (wt.%)	29.02	27.54	30.50	28.41	29.63
Sb, Antimony (ppm)	34.9	32.2	37.5	33.5	36.2
Sc, Scandium (ppm)	0.81	0.65	0.97	IND	IND
Se, Selenium (ppm)	270	240	299	262	277
Sn, Tin (ppm)	17.5	15.5	19.6	16.1	18.9
Sr, Strontium (ppm)	6.36	5.89	6.84	6.14	6.59
Ta, Tantalum (ppm)	< 0.05	IND	IND	IND	IND
Te, Tellurium (ppm)	56	52	60	54	58

SI unit equivalents: ppm (parts per million; 1×10^{-6}) \equiv mg/kg; wt.% (weight per cent) \equiv % (mass fraction).

[†]This operationally defined measurand meets the requirements of ISO 17034 and all participating laboratories comply with the requirements of ISO 17025.

Note: intervals may appear asymmetric due to rounding; IND = indeterminate (due to limited reading resolution of the methods employed. For practical purposes the 95% Expanded Uncertainty can be set between zero and a two times multiple of the upper bound/non-detect limit value).

Table 1 continued.

Constituent	Certified Value [†]	95% Expanded Uncertainty		95% Tolerance Limits	
		Low	High	Low	High
4-Acid Digestion continued					
Th, Thorium (ppm)	0.30	0.26	0.34	0.28	0.31
Ti, Titanium (wt.%)	0.012	0.011	0.013	0.011	0.012
Tl, Thallium (ppm)	1.53	1.44	1.62	1.46	1.60
U, Uranium (ppm)	1.11	1.02	1.20	1.05	1.17
W, Tungsten (ppm)	2.44	2.18	2.71	2.26	2.63
Y, Yttrium (ppm)	1.65	1.50	1.80	IND	IND
Zn, Zinc (wt.%)	1.29	1.23	1.36	1.27	1.32
Zr, Zirconium (ppm)	9.09	7.99	10.19	8.59	9.59

SI unit equivalents: ppm (parts per million; 1×10^{-6}) \equiv mg/kg; wt.% (weight per cent) \equiv % (mass fraction).

[†]This operationally defined measurand meets the requirements of ISO 17034 and all participating laboratories comply with the requirements of ISO 17025.

Note: intervals may appear asymmetric due to rounding; IND = indeterminate (due to limited reading resolution of the methods employed).

Table 2. Certified Values, Uncertainties & Tolerance Intervals for other measurands in OREAS 995

Constituent	Certified Value	95% Expanded Uncertainty		95% Tolerance Limits	
		Low	High	Low	High
Geoanalytical Labs ('as received' sample basis)					
Peroxide Fusion ICP					
Al, Aluminium (wt.%)	0.243	0.221	0.265	0.227	0.259
As, Arsenic (ppm)	1356	1274	1437	1304	1408
Be, Beryllium (ppm)	< 1	IND	IND	IND	IND
Bi, Bismuth (ppm)	88	80	96	86	91
Ca, Calcium (wt.%)	0.389	0.344	0.434	0.362	0.415
Cd, Cadmium (ppm)	36.9	32.3	41.5	34.3	39.6
Ce, Cerium (ppm)	2.27	1.81	2.73	1.93	2.60
Co, Cobalt (ppm)	349	333	365	342	357
Cu, Copper (wt.%)	22.79	22.30	23.27	22.24	23.33
Fe, Iron (wt.%)	28.98	28.32	29.65	28.32	29.64
Ga, Gallium (ppm)	4.97	4.30	5.65	4.75	5.20
Gd, Gadolinium (ppm)	0.19	0.10	0.29	IND	IND
In, Indium (ppm)	24.4	23.1	25.8	23.7	25.2
La, Lanthanum (ppm)	1.23	1.10	1.37	IND	IND
Mg, Magnesium (wt.%)	0.793	0.766	0.821	0.770	0.816
Mn, Manganese (wt.%)	0.020	0.020	0.021	0.020	0.021
Mo, Molybdenum (ppm)	65	60	70	62	67
Pb, Lead (ppm)	2883	2736	3030	2786	2980
Pr, Praseodymium (ppm)	0.23	0.17	0.30	IND	IND

SI unit equivalents: ppm (parts per million; 1×10^{-6}) \equiv mg/kg; wt.% (weight per cent) \equiv % (mass fraction).

Note: intervals may appear asymmetric due to rounding; IND = indeterminate (due to limited reading resolution of the methods employed). For practical purposes the 95% Expanded Uncertainty can be set between zero and a two times multiple of the upper bound/non-detect limit value).

Table 2 continued.

Constituent	Certified Value	95% Expanded Uncertainty		95% Tolerance Limits	
		Low	High	Low	High
Peroxide Fusion ICP continued					
Rb, Rubidium (ppm)	2.18	1.70	2.66	1.95	2.42
Re, Rhenium (ppm)	0.19	0.12	0.26	IND	IND
S, Sulphur (wt.%)	31.18	30.29	32.07	30.63	31.74
Sb, Antimony (ppm)	38.2	34.4	41.9	35.6	40.7
Se, Selenium (ppm)	269	220	318	250	288
Si, Silicon (wt.%)	2.14	2.06	2.22	2.08	2.21
Sn, Tin (ppm)	48.9	44.5	53.3	46.4	51.3
Te, Tellurium (ppm)	55	49	62	51	60
Th, Thorium (ppm)	0.29	0.25	0.32	IND	IND
Ti, Titanium (wt.%)	0.011	0.010	0.013	IND	IND
Tl, Thallium (ppm)	1.53	1.43	1.64	1.44	1.63
U, Uranium (ppm)	1.24	1.00	1.48	IND	IND
W, Tungsten (ppm)	2.58	1.92	3.24	IND	IND
Y, Yttrium (ppm)	1.81	1.42	2.20	IND	IND
Zn, Zinc (wt.%)	1.34	1.28	1.39	1.30	1.37
Infrared Combustion					
S, Sulphur (wt.%)	31.53	30.91	32.15	31.15	31.91
Ion Selective Electrode					
F, Fluorine (ppm)	175	138	212	164	185

SI unit equivalents: ppm (parts per million; 1×10^{-6}) \equiv mg/kg; wt.% (weight per cent) \equiv % (mass fraction).

Note: intervals may appear asymmetric due to rounding; IND = indeterminate (due to limited reading resolution of the methods employed)

Table 3. Indicative Values for OREAS 995.

Constituent	Unit	Value	Constituent	Unit	Value	Constituent	Unit	Value
Umpire Labs (dry sample basis)								
Thermogravimetry								
H ₂ O-	wt.%	0.759						
Geoanalytical Labs ('as received' sample basis)								
Pb Fire Assay								
Ag	ppm	35.8						
4-Acid Digestion								
Dy	ppm	0.19	K	wt.%	0.033	Tb	ppm	< 0.1
Er	ppm	0.11	Lu	ppm	< 0.1	Tm	ppm	< 0.1
Eu	ppm	0.041	Nd	ppm	1.00	V	ppm	5.87
Gd	ppm	0.23	P	wt.%	0.005	Yb	ppm	0.10
Ge	ppm	0.94	Pr	ppm	0.25			
Ho	ppm	< 0.1	Sm	ppm	0.21			
Peroxide Fusion ICP								
Ag	ppm	38.3	Hf	ppm	< 10	Sc	ppm	< 10

SI unit equivalents: ppm (parts per million; 1×10^{-6}) \equiv mg/kg; wt.% (weight per cent) \equiv % (mass fraction).

Note: the number of significant figures reported is not a reflection of the level of certainty of stated values. They are instead an artefact of ORE's in-house CRM-specific LIMS.

Table 3 continued.

Constituent	Unit	Value	Constituent	Unit	Value	Constituent	Unit	Value
Peroxide Fusion ICP continued								
B	ppm	< 50	Ho	ppm	0.036	Sm	ppm	0.19
Ba	ppm	12.1	K	wt.%	0.078	Sr	ppm	9.79
Cr	ppm	46.2	Li	ppm	1.62	Ta	ppm	0.30
Cs	ppm	0.33	Lu	ppm	< 0.05	Tb	ppm	0.036
Dy	ppm	0.18	Nb	ppm	< 0.8	Tm	ppm	0.018
Er	ppm	0.11	Nd	ppm	0.89	V	ppm	5.92
Eu	ppm	0.059	Ni	ppm	< 10	Yb	ppm	0.10
Ge	ppm	1.97	P	wt.%	0.466			
Infrared Combustion								
C	wt.%	0.044						

SI unit equivalents: ppm (parts per million; 1×10^{-6}) \equiv mg/kg; wt.% (weight per cent) \equiv % (mass fraction).

Note: the number of significant figures reported is not a reflection of the level of certainty of stated values. They are instead an artefact of ORE's in-house CRM-specific LIMS.

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INTRODUCTION

OREAS reference materials are intended to provide a low-cost method of evaluating and improving the quality of analysis of geological samples. To the geologist they provide a means of implementing quality control in analytical data sets generated in exploration from the grass roots level through to prospect evaluation, and in grade control at mining operations. To the analyst they provide an effective means of calibrating analytical equipment, assessing new techniques and routinely monitoring in-house procedures. OREAS reference materials enable users to successfully achieve process control of these tasks because the observed variance from repeated analysis has its origin almost exclusively in the analytical process rather than the reference material itself. In evaluating laboratory performance with this CRM, the section headed 'Instructions for correct use' should be read carefully.

Tables 1 and 2 provide the certified values and their associated 95% expanded uncertainty and tolerance intervals, Table 3 shows indicative (non-certified) values, Table 4 provides some indicative physical properties and Table 5 presents the performance gate intervals for all certified values. Gold homogeneity (via INAA) is shown in Table 6 and has also undergone uniformity testing in a nested ANOVA program in both the fire assay and INAA data (see 'Homogeneity Evaluation' section).

Tabulated results of all analytes together with uncorrected means, medians, standard deviations, relative standard deviations and per cent deviation of lab means from the corrected mean of means (PDM³) are presented in the detailed certification data for this CRM (**OREAS 995-DataPack.1.0.230926_070758.xlsx**).

Results are also presented in scatter plots for Cu (wt.%) by classical wet chemistry and Au by fire assay in Figures 1 and 2 respectively, together with $\pm 3SD$ (magenta) and certified value (green line). Accepted individual results are coloured blue and individual and dataset outliers are identified in red and violet, respectively.

SOURCE MATERIAL

OREAS 995 was prepared from a blend of copper concentrate laboratory reject samples sourced from Australian mine site metallurgical plants. Copper, Iron and Sulphur by mass account for approx. 83.2% of the total chemical composition of OREAS 995.

COMMINUTION AND HOMOGENISATION PROCEDURES

The material constituting OREAS 995 was prepared in the following manner:

- Drying to constant mass at 85°C;
- Multi-stage milling to 100% minus 30 microns;
- Homogenisation using OREAS' novel processing technologies;
- Packaging into 10g and 50g units sealed under nitrogen in laminated foil pouches.

PHYSICAL PROPERTIES

OREAS 995 was tested at ORE Research & Exploration Pty Ltd's onsite facility for various physical properties. Table 4 presents these findings that should be used for informational purposes only.

Table 4. Physical properties of OREAS 231b.

Bulk Density (kg/m ³)	Moisture (wt.%)	Munsell Notation [‡]	Munsell Color [‡]
1026	1.2	5GY 2/1	Greenish Black

[‡]The Munsell Rock Color Chart helps geologists and archeologists communicate with colour more effectively by cross-referencing ISCC-NBS colour names with unique Munsell alpha-numeric colour notations for rock colour samples.

ANALYTICAL PROGRAM

For the interlaboratory 'round robin' certification program, a 700g sample was taken at each of 10 predetermined sampling intervals immediately following homogenisation and are considered representative of the entire prepared batch of OREAS 995.

Umpire Laboratories

Fourteen 'umpire' laboratories each received a single 60g sample and undertook copper and moisture analysis on the sample as received. The term 'umpire' here refers to the routine analysis by these laboratories using classical methodologies for precious and base metals.

Strict, pre-assay instructions were provided to ensure proper handling of moisture including:

- Equilibration of sample material to laboratory atmosphere for a minimum of 2 hours;
- Hygroscopic moisture analysis at 105°C determined on a separate subsample and weighed for analysis at the same time as the sample aliquots for Cu as per ISO 9599.

The laboratories were requested to report analyte concentrations on both a dry (using the moisture value to correct the sample to dry basis) and moisture-bearing basis and include all results for moisture determinations. **The 'Umpire Lab' certified values shown in Table 1 are on a dry sample basis (see 'Instructions for correct use' section).**

The following analytical methods were undertaken:

- Copper (3 trials on undried sample) by classical wet chemistry (short iodide titration).

Geoanalytical Laboratories

Fifteen geoanalytical laboratories also participated in the program where each laboratory received 6 x 70g samples by taking two samples from each of three separate 700g test units. This format enabled a nested ANOVA treatment of the results to evaluate homogeneity, i.e., to ascertain whether between-unit variance is greater than within-unit variance. The laboratories were instructed to undertake the following analyses:

- Gold by fire assay (10 laboratories used 5-15g charge weights and 4 laboratories used 20-50g charge weights) with AAS (11 laboratories) or ICP-OES (3 laboratories) finish;
- Full ICP-OES and MS elemental suites by 4-acid digestion (up to 14 laboratories depending on the element and with up to 5 laboratories using an AAS finish for Cu, Fe, S and Zn);

- Full ICP-OES and MS elemental suites by peroxide fusion (up to 12 laboratories depending on the element);
- Fluorine by ion selective electrode (8 laboratories);
- Total S by IR combustion furnace (11 laboratories).

Instrumental neutron activation analysis (INAA) for Au on 20 x 85mg subsamples was also undertaken at ANSTO, Lucas Heights to confirm homogeneity (see Table 6).

STATISTICAL ANALYSIS

Certified Values and their uncertainty intervals (Tables 1 and 2) have been determined for each analyte following removal of individual, laboratory dataset (batch) and 3SD outliers (single iteration).

For individual outliers within a laboratory batch the z-score test is used in combination with a second method that determines the per cent deviation of the individual value from the batch median. Outliers in general are selected on the basis of z-scores > 2.5 and with per cent deviations (i) > 3 and (ii) more than three times the average absolute per cent deviation for the batch. Each laboratory data set mean is tested for outlying status based on z-score discrimination and rejected if > 2.5 . After individual and laboratory data set (batch) outliers have been eliminated a non-iterative 3 standard deviation filter is applied, with those values lying outside this window also relegated to outlying status. However, while statistics are taken into account, the exercise of a statistician's prerogative plays a significant role in identifying outliers.

Certified Values are the means of accepted laboratory means after outlier filtering and are the present best estimate of the true value. The INAA data (see Table 6) is omitted from determination of the certified value for Au and is used solely for the evaluation of homogeneity and calculation of tolerance limits for gold (see 'Homogeneity Evaluation' section below).

95% Expanded Uncertainty provides a 95% probability that the true value of the analyte under consideration lies between the upper and lower limits and is calculated according to the method outlined in ISO 98-3 [6]. All known or suspected sources of bias have been investigated or taken into account.

Indicative (uncertified) values (Table 3) are present where the number of laboratories reporting a particular analyte is insufficient (< 5) to support certification or where interlaboratory consensus is poor.

Standard Deviation intervals (see Table 5) provide an indication of a level of performance that might reasonably be expected from a laboratory being monitored by this CRM in a QA/QC program. They take into account errors attributable to measurement uncertainty and CRM variability. For an effective CRM the contribution of the latter should be negligible in comparison to measurement errors. The Standard Deviation values include all sources of measurement uncertainty: between-lab variance, within-run variance (precision errors) and CRM variability.

In the application of SD's in monitoring performance it is important to note that not all laboratories function at the same level of proficiency and that different methods in use at a particular laboratory have differing levels of precision. Each laboratory has its own inherent SD (for a specific concentration level and analyte-method pair) based on the analytical

process and this SD is not directly related to the round robin program (see 'Intended Use' section for more detail).

The SD for each analyte's certified value is calculated from the same filtered data set used to determine the certified value, i.e., after removal of all individual, lab dataset (batch) and 3SD outliers (single iteration). These outliers can only be removed after the absolute homogeneity of the CRM has been independently established, i.e., the outliers must be confidently deemed to be analytical rather than arising from inhomogeneity of the CRM. **The standard deviation is then calculated for each analyte from the pooled accepted analyses generated from the certification program.**

PERFORMANCE GATES

Table 5 below shows intervals calculated for two and three standard deviations. As a guide these intervals may be regarded as warning or rejection for multiple 2SD outliers, or rejection for individual 3SD outliers in QC monitoring, although their precise application should be at the discretion of the QC manager concerned (also see 'Intended Use' section below). Westgard Rules extend the basics of single-rule QC monitoring using multi-rules (for more information visit www.westgard.com/mltirule.htm). A second method utilises a 5% window calculated directly from the certified value.

Standard deviation is also shown in relative percent for one, two and three relative standard deviations (1RSD, 2RSD and 3RSD) to facilitate an appreciation of the magnitude of these numbers and a comparison with the 5% window. Caution should be exercised when concentration levels approach lower limits of detection of the analytical methods employed as performance gates calculated from standard deviations tend to be excessively wide whereas those determined by the 5% method are too narrow. One approach used at commercial laboratories is to set the acceptance criteria at twice the detection level (DL) \pm 10%.

I.e., Certified Value \pm 10% \pm 2DL (Govett, 1983 [1]).

Table 5. Performance Gates for OREAS 995.

Constituent	Certified Value	Absolute Standard Deviations					Relative Standard Deviations			5% window	
		1SD	2SD Low	2SD High	3SD Low	3SD High	1RSD	2RSD	3RSD	Low	High
Umpire Labs (dry sample basis)											
Classical Wet Chemistry											
Cu, wt.%	22.70	0.074	22.55	22.85	22.48	22.92	0.33%	0.65%	0.98%	21.57	23.84
Pb Fire Assay (Grav)											
Au, ppm	4.52	0.118	4.29	4.76	4.17	4.87	2.61%	5.21%	7.82%	4.30	4.75
Geoanalytical Labs ('as received' sample basis)											
4-Acid Digestion											
Ag, ppm	37.3	2.13	33.0	41.5	30.9	43.6	5.71%	11.42%	17.14%	35.4	39.1
Al, wt.%	0.243	0.010	0.223	0.263	0.212	0.273	4.18%	8.36%	12.55%	0.231	0.255
As, ppm	1277	59	1159	1395	1100	1454	4.62%	9.24%	13.86%	1213	1341
Ba, ppm	9.25	0.838	7.57	10.92	6.73	11.76	9.07%	18.13%	27.20%	8.78	9.71
Be, ppm	< 0.05	IND	IND	IND	IND	IND	IND	IND	IND	IND	IND

SI unit equivalents: ppm (parts per million; $1 \times 10^6 \equiv$ mg/kg; wt.% (weight per cent) \equiv % (mass fraction). IND = indeterminate.

Note 1: intervals may appear asymmetric due to rounding.

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 windows.

Table 5 continued.

Constituent	Certified Value	Absolute Standard Deviations					Relative Standard Deviations			5% window	
		1SD	2SD Low	2SD High	3SD Low	3SD High	1RSD	2RSD	3RSD	Low	High
4-Acid Digestion continued											
Bi, ppm	90	5.3	80	101	74	106	5.86%	11.72%	17.58%	86	95
Ca, wt. %	0.351	0.014	0.324	0.378	0.310	0.392	3.86%	7.72%	11.59%	0.333	0.369
Cd, ppm	32.9	2.68	27.6	38.3	24.9	41.0	8.15%	16.30%	24.45%	31.3	34.6
Ce, ppm	2.19	0.202	1.79	2.59	1.58	2.80	9.24%	18.48%	27.72%	2.08	2.30
Co, ppm	357	18	322	393	304	411	4.98%	9.96%	14.93%	339	375
Cr, ppm	28.1	2.8	22.5	33.7	19.7	36.6	10.02%	20.05%	30.07%	26.7	29.5
Cs, ppm	0.25	0.021	0.21	0.29	0.19	0.31	8.25%	16.50%	24.75%	0.24	0.26
Cu, wt. %	22.60	0.403	21.79	23.40	21.39	23.80	1.78%	3.57%	5.35%	21.47	23.73
Fe, wt. %	28.91	0.671	27.57	30.25	26.90	30.93	2.32%	4.64%	6.96%	27.47	30.36
Ga, ppm	5.08	0.275	4.53	5.63	4.26	5.91	5.41%	10.83%	16.24%	4.83	5.34
Hf, ppm	0.22	0.03	0.16	0.28	0.13	0.30	13.11%	26.22%	39.33%	0.21	0.23
In, ppm	23.0	2.11	18.8	27.2	16.7	29.3	9.18%	18.36%	27.55%	21.8	24.1
La, ppm	1.19	0.116	0.96	1.43	0.85	1.54	9.67%	19.34%	29.01%	1.14	1.25
Li, ppm	0.91	0.15	0.62	1.20	0.47	1.35	16.10%	32.20%	48.30%	0.87	0.96
Mg, wt. %	0.731	0.045	0.642	0.820	0.597	0.865	6.10%	12.19%	18.29%	0.695	0.768
Mn, wt. %	0.020	0.001	0.018	0.022	0.017	0.023	5.09%	10.18%	15.27%	0.019	0.021
Mo, ppm	65	5.0	55	75	50	80	7.63%	15.26%	22.89%	62	68
Na, wt. %	0.029	0.001	0.027	0.032	0.025	0.034	4.72%	9.44%	14.16%	0.028	0.031
Nb, ppm	0.36	0.06	0.24	0.48	0.18	0.54	16.48%	32.96%	49.44%	0.34	0.38
Ni, ppm	12.3	1.6	9.1	15.5	7.5	17.0	12.91%	25.82%	38.73%	11.7	12.9
Pb, ppm	2697	193	2311	3083	2118	3275	7.15%	14.30%	21.45%	2562	2832
Rb, ppm	1.81	0.164	1.48	2.14	1.31	2.30	9.10%	18.19%	27.29%	1.72	1.90
Re, ppm	0.16	0.02	0.13	0.20	0.11	0.21	10.04%	20.08%	30.11%	0.16	0.17
S, wt. %	29.02	1.468	26.08	31.95	24.61	33.42	5.06%	10.12%	15.17%	27.57	30.47
Sb, ppm	34.9	2.74	29.4	40.3	26.6	43.1	7.86%	15.71%	23.57%	33.1	36.6
Sc, ppm	0.81	0.15	0.52	1.10	0.37	1.25	18.08%	36.15%	54.23%	0.77	0.85
Se, ppm	270	36	198	341	162	377	13.31%	26.61%	39.92%	256	283
Sn, ppm	17.5	2.5	12.4	22.6	9.9	25.2	14.54%	29.08%	43.61%	16.6	18.4
Sr, ppm	6.36	0.430	5.50	7.22	5.07	7.65	6.76%	13.52%	20.29%	6.04	6.68
Ta, ppm	< 0.05	IND	IND	IND	IND	IND	IND	IND	IND	IND	IND
Te, ppm	56	3.8	48	64	45	67	6.83%	13.66%	20.49%	53	59
Th, ppm	0.30	0.020	0.26	0.34	0.24	0.36	6.65%	13.30%	19.95%	0.28	0.31
Ti, wt. %	0.012	0.001	0.009	0.014	0.008	0.015	10.68%	21.35%	32.03%	0.011	0.012
Tl, ppm	1.53	0.070	1.39	1.67	1.32	1.74	4.57%	9.14%	13.70%	1.45	1.60
U, ppm	1.11	0.074	0.96	1.26	0.89	1.33	6.64%	13.27%	19.91%	1.06	1.17
W, ppm	2.44	0.186	2.07	2.82	1.89	3.00	7.62%	15.24%	22.85%	2.32	2.57
Y, ppm	1.65	0.112	1.42	1.87	1.31	1.98	6.80%	13.60%	20.40%	1.57	1.73
Zn, wt. %	1.29	0.099	1.09	1.49	0.99	1.59	7.67%	15.34%	23.01%	1.23	1.36
Zr, ppm	9.09	1.04	7.00	11.18	5.96	12.22	11.50%	22.99%	34.49%	8.64	9.54
Peroxide Fusion ICP											
Al, wt. %	0.243	0.016	0.211	0.275	0.195	0.291	6.65%	13.29%	19.94%	0.231	0.255
As, ppm	1356	90	1175	1536	1085	1626	6.65%	13.30%	19.96%	1288	1424
Be, ppm	< 1	IND	IND	IND	IND	IND	IND	IND	IND	IND	IND

SI unit equivalents: ppm (parts per million; 1×10^{-6}) \equiv mg/kg; wt. % (weight per cent) \equiv % (mass fraction). IND = indeterminate.

Note 1: intervals may appear asymmetric due to rounding.

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 windows.

Table 5 continued.

Constituent	Certified Value	Absolute Standard Deviations					Relative Standard Deviations			5% window	
		1SD	2SD Low	2SD High	3SD Low	3SD High	1RSD	2RSD	3RSD	Low	High
Peroxide Fusion ICP continued											
Bi, ppm	88	8.7	71	106	62	114	9.87%	19.74%	29.62%	84	93
Ca, wt. %	0.389	0.041	0.306	0.471	0.265	0.512	10.63%	21.26%	31.90%	0.369	0.408
Cd, ppm	36.9	4.4	28.2	45.7	23.8	50.1	11.89%	23.77%	35.66%	35.1	38.8
Ce, ppm	2.27	0.24	1.79	2.75	1.55	2.99	10.59%	21.18%	31.77%	2.15	2.38
Co, ppm	349	15	319	379	305	394	4.25%	8.50%	12.74%	332	367
Cu, wt. %	22.79	0.398	21.99	23.58	21.59	23.98	1.75%	3.49%	5.24%	21.65	23.93
Fe, wt. %	28.98	0.474	28.03	29.93	27.56	30.40	1.64%	3.27%	4.91%	27.53	30.43
Ga, ppm	4.97	0.330	4.31	5.63	3.98	5.96	6.63%	13.25%	19.88%	4.72	5.22
Gd, ppm	0.19	0.04	0.12	0.26	0.09	0.30	18.40%	36.79%	55.19%	0.18	0.20
In, ppm	24.4	1.39	21.7	27.2	20.3	28.6	5.70%	11.39%	17.09%	23.2	25.7
La, ppm	1.23	0.107	1.02	1.45	0.91	1.56	8.69%	17.38%	26.07%	1.17	1.30
Mg, wt. %	0.793	0.024	0.745	0.842	0.721	0.866	3.05%	6.10%	9.14%	0.754	0.833
Mn, wt. %	0.020	0.001	0.018	0.023	0.017	0.024	5.75%	11.50%	17.25%	0.019	0.022
Mo, ppm	65	4.8	55	74	50	79	7.44%	14.88%	22.32%	61	68
Pb, ppm	2883	199	2485	3281	2286	3480	6.90%	13.80%	20.70%	2739	3027
Pr, ppm	0.23	0.05	0.13	0.34	0.08	0.39	21.71%	43.43%	65.14%	0.22	0.25
Rb, ppm	2.18	0.42	1.33	3.03	0.91	3.46	19.43%	38.87%	58.30%	2.07	2.29
Re, ppm	0.19	0.03	0.13	0.25	0.10	0.28	15.70%	31.40%	47.10%	0.18	0.20
S, wt. %	31.18	0.755	29.67	32.69	28.92	33.45	2.42%	4.84%	7.26%	29.62	32.74
Sb, ppm	38.2	2.54	33.1	43.2	30.5	45.8	6.65%	13.29%	19.94%	36.2	40.1
Se, ppm	269	43	182	356	139	399	16.16%	32.32%	48.47%	255	282
Si, wt. %	2.14	0.046	2.05	2.24	2.00	2.28	2.16%	4.33%	6.49%	2.04	2.25
Sn, ppm	48.9	3.60	41.7	56.1	38.1	59.7	7.37%	14.74%	22.10%	46.4	51.3
Te, ppm	55	5.5	44	66	39	72	9.95%	19.90%	29.86%	52	58
Th, ppm	0.29	0.04	0.22	0.36	0.18	0.39	12.28%	24.56%	36.85%	0.27	0.30
Ti, wt. %	0.011	0.002	0.008	0.014	0.007	0.016	13.44%	26.89%	40.33%	0.011	0.012
Tl, ppm	1.53	0.114	1.31	1.76	1.19	1.88	7.44%	14.88%	22.32%	1.46	1.61
U, ppm	1.24	0.17	0.91	1.58	0.74	1.75	13.53%	27.06%	40.58%	1.18	1.30
W, ppm	2.58	0.40	1.78	3.39	1.37	3.80	15.64%	31.28%	46.92%	2.45	2.71
Y, ppm	1.81	0.31	1.18	2.44	0.87	2.75	17.30%	34.59%	51.89%	1.72	1.90
Infrared Combustion											
S, wt. %	31.53	0.734	30.06	33.00	29.33	33.73	2.33%	4.66%	6.98%	29.95	33.11
Ion Selective Electrode											
F, ppm	175	26	123	226	97	252	14.76%	29.52%	44.29%	166	183

SI unit equivalents: ppm (parts per million; 1×10^{-6}) \equiv mg/kg; wt. % (weight per cent) \equiv % (mass fraction).

Note 1: intervals may appear asymmetric due to rounding.

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 windows.

Homogeneity Evaluation

The tolerance limits (ISO 16269:2014) shown in Tables 1 and 2 were determined using an analysis of precision errors method and are considered a conservative estimate of true homogeneity. The meaning of tolerance limits may be illustrated for copper by classical wet chemistry, where 99% of the time ($1-\alpha=0.99$) at least 95% of subsamples ($\rho=0.95$) will have concentrations lying between 22.68 and 22.72 wt.%. Put more precisely, this means that if the same number of subsamples were taken and analysed in the same manner repeatedly, 99% of the tolerance intervals so constructed would cover at least 95% of the total

population, and 1% of the tolerance intervals would cover less than 95% of the total population (ISO Guide 35). **Please note that tolerance limits pertain to the homogeneity of the CRM only and should not be used as control limits for laboratory performance.**

The homogeneity of gold has been determined by INAA at ANSTO, Lucas Heights using the reduced analytical subsample method which utilises the known relationship between standard deviation and analytical subsample weight (Ingamells and Switzer, 1973 [2]). In this approach the sample aliquot is substantially reduced to a point where most of the variability in replicate assays should be due to inhomogeneity of the reference material and measurement error becomes negligible.

Table 6 below shows the gold INAA data determined on 20 x 85mg subsamples of OREAS 995. An equivalent scaled version of the results is also provided to demonstrate an appreciation of what this data means if 15g fire assays were undertaken without the normal measurement error associated with this methodology. In this instance, the 1RSD of 0.17% calculated for a 15g fire assay sample (2.21% at 85mg weights) confirms the high level of gold homogeneity in OREAS 995.

Table 6. Neutron Activation Analysis of Au (in ppm) on 20 x 85mg subsamples and showing the equivalent results scaled to a 15g sample mass typical of fire assay determination.

Replicate No	Au 85mg actual	Au 15g equivalent*
1	4.63	4.63
2	4.54	4.63
3	4.63	4.63
4	4.78	4.64
5	4.49	4.62
6	4.69	4.64
7	4.61	4.63
8	4.62	4.63
9	4.71	4.64
10	4.80	4.65
11	4.42	4.62
12	4.61	4.63
13	4.54	4.63
14	4.52	4.62
15	4.67	4.64
16	4.59	4.63
17	4.78	4.64
18	4.76	4.64
19	4.64	4.63
20	4.61	4.63
Mean	4.63	4.63
Median	4.62	4.63
Std Dev.	0.10	0.01
Rel.Std.Dev.	2.21%	0.17%

*Results calculated for a 15g equivalent sample mass using the formula: $x^{15g Eq} = \frac{(x^{INAA} - \bar{X}) \times RSD@15g}{RSD@85mg} + \bar{X}$

where $x^{15g Eq}$ = equivalent result calculated for a 15g sample mass

(x^{INAA}) = raw INAA result at 85mg

\bar{X} = mean of 85mg INAA results

Homogeneity has also been evaluated in an Analysis of Variance (**ANOVA**) of the INAA data. The 20 samples were comprised of paired samples from 10g samples taken from each of the ten 700g test units (representative of the entire prepared batch) and were randomised prior to assigning sample numbers. The duplicate samples enabled an ANOVA by comparison of within- and between-unit variances across the 10 pairs. The purpose of the ANOVA is to test that no statistically significant difference exists in the variance between units to that of the variance within units. This allows an assessment of homogeneity across the entire prepared batch. The test was performed using the following parameters:

- Gold by INAA – 20 results (1 laboratory providing duplicate analyses on 10 samples where each sample can be viewed as a ‘unit’);
- Null Hypothesis, H_0 : Between-unit variance is no greater than within-unit variance (reject H_0 if p -value < 0.05);
- Alternative Hypothesis, H_1 : Between-unit variance is greater than within-unit variance.

The data was not filtered for outliers prior to the calculation of the p -value. This process derived a p -value of 0.11, a statistically insignificant result so the Null Hypothesis is accepted. It is important to note that ANOVA is not an absolute measure of homogeneity. Rather, it establishes whether or not gold is uniformly distributed throughout the prepared batch of OREAS 151c and whether the variance between two subsamples from the same test unit is statistically indistinguishable from the variance of two subsamples taken from any two separate test units. A reference material therefore can possess poor absolute homogeneity yet still pass a relative homogeneity (ANOVA) test if the within-unit heterogeneity is large and similar across all units.

Each of the fifteen geoanalytical laboratories received six samples made up of paired samples from three different, non-adjacent sampling intervals permitting a nested ANOVA study. A test of these data was conducted for elements present in concentrations at least 20 times the lower limits of detection for the various methods involved. No significant p -values were found indicating that no evidence exists that between-unit variance is greater than within-unit variance.

Based on the statistical analysis of the results of the interlaboratory certification program it can be concluded that OREAS 995 is fit-for-purpose as a certified reference material (see ‘Intended Use’ below).

PREPARER AND SUPPLIER

Certified reference material OREAS 995 is prepared, certified and supplied by:



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10. ANSTO, Lucas Heights, NSW, Australia
11. ♦Bachelet, Angleur, Liege, Belgium
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20. *Intertek Testing Services Philippines, Cupang, Muntinlupa, Philippines
21. *PT Geoservices Ltd, Cikarang, Jakarta Raya, Indonesia
22. *PT Intertek Utama Services, Jakarta Timur, DKI Jakarta, Indonesia
23. ♦RCI Analytical Services BV, Oosterhout, Netherlands
24. *SGS de Mexico SA de CV, Cd. Industrial, Durango, Mexico
25. ♦SGS Lakefield Research Ltd, Lakefield, Ontario, Canada
26. *Shiva Analyticals Ltd, Bangalore North, Karnataka, India
27. ♦SRL, Perth, WA, Australia

♦ = Umpire laboratory (classical methods); * = Geoanalytical laboratory (instrumental methods).

Please note: To preserve anonymity, the above numbered alphabetical list of participating laboratories does not correspond with the Lab ID numbering on the scatter plots below.

Figure 1. Cu by Classical Wet Chemistry in OREAS 995

SPC.1650.RR1.OREAS995.2.Classical.Cu.Lab.230823.110007.SN

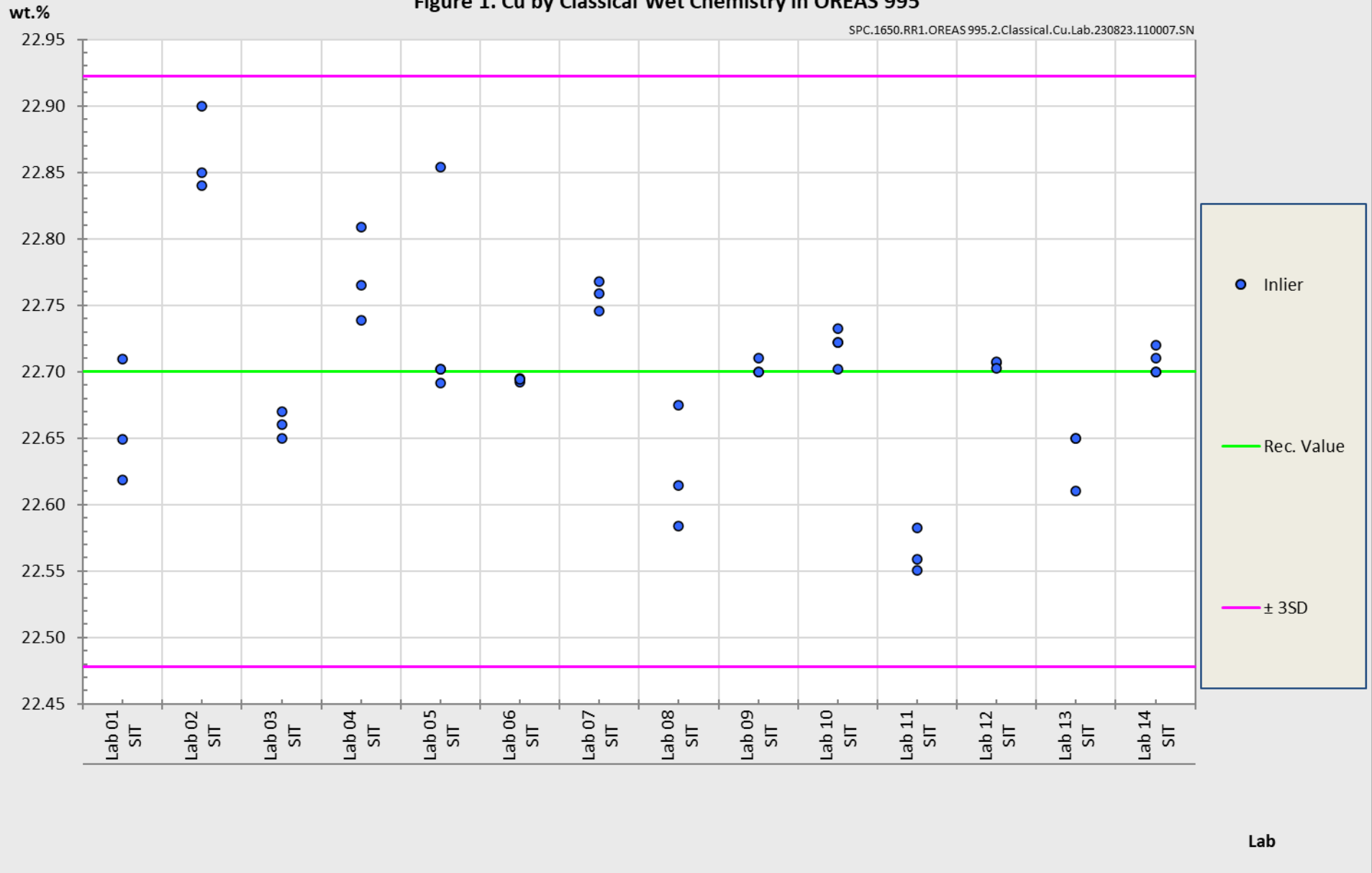
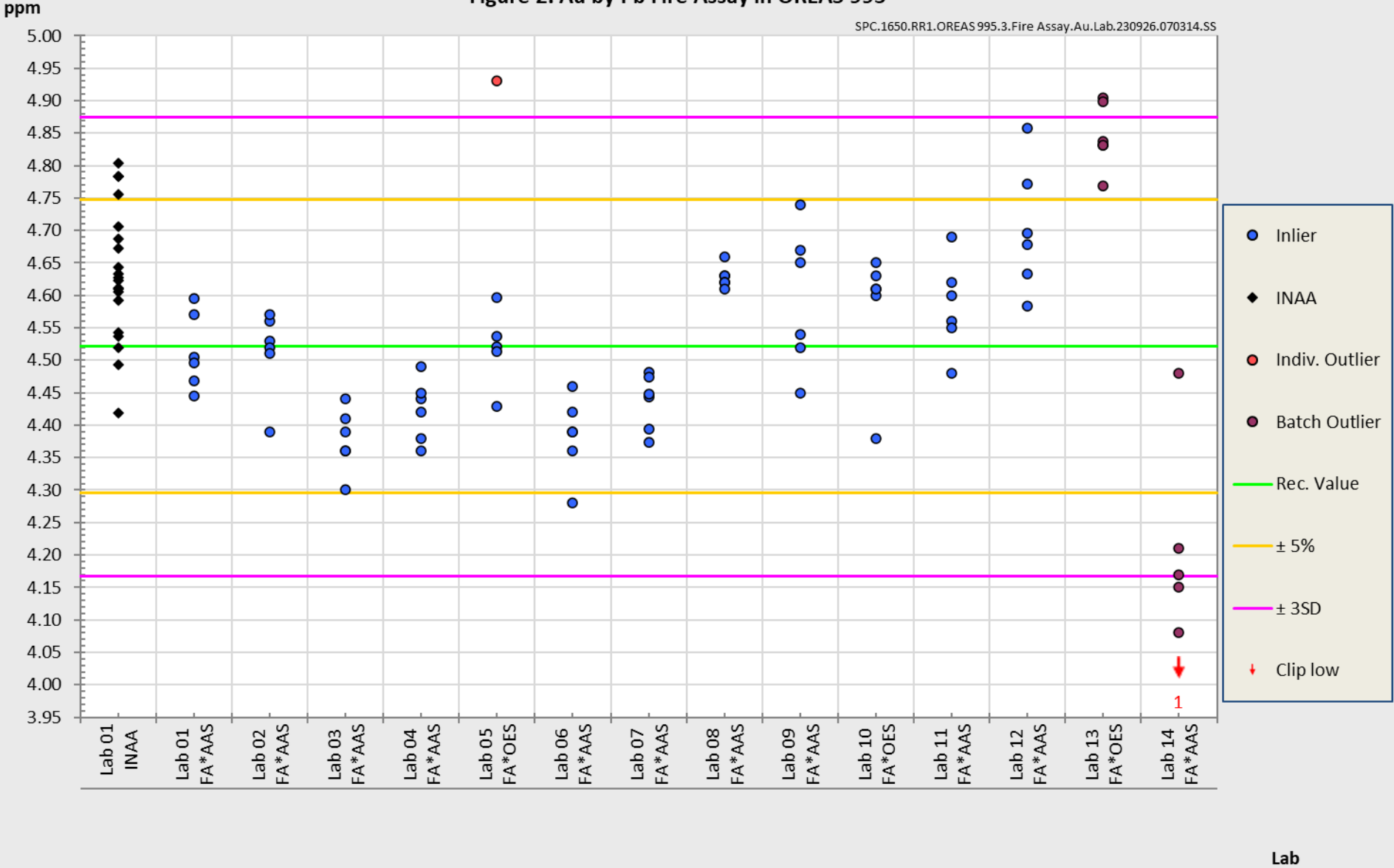


Figure 2. Au by Pb Fire Assay in OREAS 995

SPC.1650.RR1.OREAS995.3.Fire Assay.Au.Lab.230926.070314.SS



METROLOGICAL TRACEABILITY

The interlaboratory results that underpin the certified values are metrologically traceable to the international measurement scale (SI) of mass (either as a % mass fraction or as milligrams per kilogram (mg/kg)). In line with popular use, all data within tables in this certificate are expressed as the mass fraction in either weight percent (wt.%) or parts per million (ppm).

The analytical samples sent to participating laboratories were selected in a manner to be representative of the entire prepared batch of CRM. This 'representivity' was maintained in each submitted laboratory sample batch and ensures the user that the data is traceable from sample selection through to the analytical results. The systematic sampling method was chosen due to the low risk of overlooking repetitive effects or trends in the batch due to the way the CRM was processed. In line with ISO 17025 [9], each analytical data set received from the participating laboratories has been validated by its assayer through the inclusion of internal reference materials and QC checks during and post analysis.

The participating laboratories were chosen on the basis of their competence (from past performance in interlaboratory programs undertaken by ORE Pty Ltd) for a particular analytical method, analyte or analyte suite and sample matrix. These laboratories are accredited to ISO 17025 for Cu by classical wet chemistry methods, Au by fire assay and elements by 4-acid digestion. The other operationally defined measurands characterised in this certificate are derived from data procured mostly from ISO 17025 accredited laboratories. The certified values presented in this report are calculated from the means of accepted data following robust technical and statistical analysis as detailed in this report.

Guide ISO/TR 16476:2016, section 5.3.1 describes metrological traceability in reference materials as it pertains to the transformation of the measurand. In this section it states, *"Although the determination of the property value itself can be made traceable to appropriate units through, for example, calibration of the measurement equipment used, steps like the transformation of the sample from one physical (chemical) state to another cannot. Such transformations may only be compared with a reference (when available), or among themselves. For some transformations, reference methods have been defined and may be used in certification projects to evaluate the uncertainty associated with such a transformation. In other cases, only a comparison among different laboratories using the same procedure is possible. In this case, it is impossible to demonstrate absence of method bias; therefore, the result is an operationally defined measurand (ISO Guide 35:2017, 9.2.4c)."* Certification takes place on the basis of agreement among operationally defined, independent measurement results.

COMMUTABILITY

The measurements of the results that underlie the certified values contained in this report were undertaken by methods involving pre-treatment (fusion/digestion) of the sample. This served to reduce the sample to a simple and well understood form permitting calibration using simple solutions of the CRM. Due to these methods being well understood and highly effective, commutability is not an issue for this CRM. All OREAS CRMs are sourced from natural ore minerals meaning they will display similar behaviour as routine 'metallurgical concentrate' samples in the relevant measurement process. Care should be taken to ensure 'matrix matching' as close as practically achievable. The matrix and mineralisation style of

the CRM is described in the 'Source Material' section and users should select appropriate CRMs matching these attributes to the field samples being analysed.

INTENDED USE

OREAS 995 is intended to cover all activities needed to produce a measurement result. This includes extraction, possible separation steps and the actual measurement process (the signal producing step). OREAS 995 may be used to calibrate the entire procedure by producing a pure substance CRM transformed into a calibration solution.

OREAS 995 is intended for the following uses:

- For the monitoring of laboratory performance in the analysis of analytes reported in Tables 1 and 2 in geological samples;
- For the verification of analytical methods for analytes reported in Tables 1 and 2;
- For the calibration of instruments used in the determination of the concentration of analytes reported in Tables 1 and 2. When a value provided in this certificate is used to calibrate a measurement process, the uncertainty associated with that value should be appropriately propagated into the user's uncertainty calculation. Users can determine an approximation of the standard uncertainty by calculating one fourth of the width of the Expanded Uncertainty interval given in this certificate (Expanded Uncertainty intervals are provided in Tables 1 and 2).

MINIMUM SAMPLE SIZE

To relate analytical determinations to the values in this certificate, the minimum mass of sample used should match the typical mass that the laboratories used in the interlaboratory (round robin) certification program. This means that different minimum sample masses should be used depending on the operationally defined methodology as follows:

- Cu by classical wet chemistry: $\geq 0.5\text{g}$;
- Au by fire assay: $\geq 5\text{g}$;
- 4-acid digestion with ICP-OES and/or MS finish: $\geq 0.25\text{g}$;
- Peroxide fusion with ICP-OES and/or MS finish: $\geq 0.1\text{g}$;
- Total S by Infrared combustion furnace/CS analyser: $\geq 0.1\text{g}$;
- Fluorine by ion selective electrode: $\geq 0.2\text{g}$.

PERIOD OF VALIDITY & STORAGE INSTRUCTIONS

OREAS 995 is high in reactive sulphide content and has been packaged under a nitrogen environment in robust laminated foil pouches in single-use 10g and 50g units. In its unopened state in the sachets (sealed under nitrogen), OREAS 995 has a shelf life of at least ten years (until August 2033).

Store in a clean and cool dry place away from direct sunlight.

INSTRUCTIONS FOR HANDLING & CORRECT USE

Pre-homogenisation of the CRM prior to subsampling and analysis is not necessary as there is no particle segregation under transport [13].

Fine powders pose a risk to eyes and lungs and therefore standard precautions including the use of safety glasses and dust masks are advised.

Umpire laboratories using classical methods:

The umpire laboratory certified value for Cu refers to the concentration level on a dry sample basis. At each laboratory, analyses were performed on the sample as received (without drying) with the subsample for moisture analysis weighed simultaneously with the subsamples for the Cu assay. The Cu data was then corrected to dry basis using the moisture value obtained at each laboratory.

With the exception of one laboratory, moisture content varied amongst the laboratories from 0.15-1.55% with a best consensus value of 0.76%. The indicative value provided for moisture (H₂O-) should be viewed as informational only. Hygroscopic moisture is a dynamic property of pulp materials and will vary in response to the local laboratory atmosphere following equilibration.

Geoanalytical laboratories using instrumental methods:

All analyses were performed on the samples as received and reported as such in line with conventional instrumental method procedures.

QC monitoring using multiples of the Standard Deviation (SD)

In the application of SD's in monitoring performance it is important to note that not all laboratories function at the same level of proficiency and that different methods in use at a particular laboratory have differing levels of precision. Each laboratory has its own inherent SD (for a specific concentration level and analyte-method pair) based on the analytical process and this SD is not directly related to the round robin program.

The majority of data generated in the round robin program was produced by a selection of world class laboratories. The SD's thus generated are more constrained than those that would be produced across a randomly selected group of laboratories. To produce more generally achievable SD's the 'pooled' SD's provided in this report include interlaboratory bias. This 'one size fits all' approach may require revision at the discretion of the QC manager concerned following careful scrutiny of QC control charts.

The performance gates shown in Table 5 are intended only to be used as a preliminary guide as to what a laboratory may be able to achieve. Over a period of time monitoring your own laboratory's data for this CRM, SD's should be calculated directly from your own laboratory's process. This will enable you to establish more specific performance gates that are fit for purpose for your application as well as the ability to monitor bias. If your long-term trend analysis shows an average value that is within the 95% expanded uncertainty interval then generally there is no cause for concern in regard to bias.

LEGAL NOTICE

Ore Research & Exploration 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

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DOCUMENT HISTORY

Revision No.	Date	Changes applied
0	28 th September, 2023	First publication.

QMS CERTIFICATION

ORE Pty Ltd is accredited for compliance with ISO 17034.



ORE Pty Ltd is ISO 9001:2015 certified by Lloyd's Register Quality Assurance Ltd for its quality management system including development, manufacturing, certification and supply of CRMs.



CERTIFYING OFFICER

A handwritten signature in blue ink, appearing to read 'S. Hamlyn'.

28th September, 2023

Craig Hamlyn (B.Sc. Hons - Geology), Technical Manager - ORE P/L

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