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## CERTIFICATE OF ANALYSIS FOR

### High Sulphidation Epithermal Ag-Cu-Au Ore (Mt Carlton, Queensland, Australia)

### CERTIFIED REFERENCE MATERIAL OREAS 600b

#### Summary Statistics for Key Analytes.

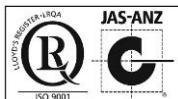
Constituent	Certified Value	1SD	95% Confidence Limits		95% Tolerance Limits	
			Low	High	Low	High
<b>Pb Fire Assay</b>						
Au, Gold (ppm)	0.204	0.007	0.201	0.207	0.203*	0.205*
<b>4-Acid Digestion</b>						
Ag, Silver (ppm)	25.1	1.00	24.7	25.6	24.6	25.7
Cu, Copper (ppm)	499	13	493	505	490	508

SI unit equivalents: ppm, parts per million  $\equiv$  mg/kg  $\equiv$   $\mu\text{g/g}$   $\equiv$  0.0001 wt.%  $\equiv$  1000 ppb, parts per billion.

\*Gold Tolerance Limits for typical 25-50g fire assay method is determined from 20 x 85mg INAA results and the Sampling Constant (Ingamells & Switzer, 1973).

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.



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**Table 1. Certified Values, SDs, 95% Confidence & Tolerance Limits for OREAS 600b.**

Constituent	Certified Value	SD	95% Confidence Limits		95% Tolerance Limits	
			Low	High	Low	High
<b>Pb Fire Assay</b>						
Au, Gold (ppm)	0.204	0.007	0.201	0.207	0.203*	0.205*
<b>Aqua Regia Digestion (sample weights 10-50g)</b>						
Au, Gold (ppm)	0.200	0.008	0.195	0.205	0.198*	0.201*
<b>Infrared Combustion</b>						
S, Sulphur (wt.%)	0.299	0.022	0.288	0.310	0.290	0.307
<b>4-Acid Digestion</b>						
Ag, Silver (ppm)	25.1	1.00	24.7	25.6	24.6	25.7
Al, Aluminium (wt.%)	7.58	0.296	7.45	7.71	7.48	7.69
As, Arsenic (ppm)	99	6.8	96	102	96	102
Ba, Barium (ppm)	3397	189	3304	3489	3324	3470
Be, Beryllium (ppm)	3.14	0.47	2.91	3.38	3.03	3.26
Bi, Bismuth (ppm)	5.42	0.378	5.22	5.62	5.25	5.60
Ca, Calcium (wt.%)	1.26	0.066	1.23	1.29	1.23	1.28
Cd, Cadmium (ppm)	2.08	0.098	2.04	2.13	1.99	2.18
Ce, Cerium (ppm)	93	8.0	88	98	90	96
Co, Cobalt (ppm)	2.77	0.236	2.66	2.89	2.63	2.92
Cr, Chromium (ppm)	22.3	3.0	21.0	23.5	20.4	24.1
Cs, Cesium (ppm)	6.91	0.317	6.75	7.07	6.78	7.03
Cu, Copper (ppm)	499	13	493	505	490	508
Dy, Dysprosium (ppm)	3.50	0.192	3.32	3.68	3.35	3.65
Er, Erbium (ppm)	1.01	0.086	0.93	1.09	IND	IND
Eu, Europium (ppm)	1.35	0.14	1.19	1.51	1.28	1.42
Fe, Iron (wt.%)	2.54	0.092	2.50	2.58	2.50	2.58
Ga, Gallium (ppm)	23.2	1.69	22.4	24.0	22.5	23.8
Gd, Gadolinium (ppm)	5.74	0.353	5.41	6.07	5.60	5.87
Ge, Germanium (ppm)	0.18	0.02	0.16	0.20	IND	IND
Hf, Hafnium (ppm)	6.89	0.443	6.66	7.12	6.62	7.16
Ho, Holmium (ppm)	0.49	0.047	0.44	0.54	0.46	0.52
In, Indium (ppm)	0.44	0.028	0.43	0.46	0.43	0.46
K, Potassium (wt.%)	3.03	0.075	3.00	3.06	2.98	3.08
La, Lanthanum (ppm)	44.1	5.1	41.6	46.7	42.6	45.6
Li, Lithium (ppm)	28.9	2.33	27.9	29.9	28.0	29.9
Lu, Lutetium (ppb)	67.4	10.2	54.5	80.3	IND	IND
Mg, Magnesium (ppm)	1229	69	1199	1259	1183	1275
Mn, Manganese (ppm)	293	12	288	299	287	299

SI unit equivalents: ppm, parts per million  $\equiv$  mg/kg  $\equiv$   $\mu\text{g/g} \equiv 0.0001$  wt.%  $\equiv 1000$  ppb, parts per billion.

\*Gold Tolerance Limits for typical 25-50g fire assay and 15-40g aqua regia digestion methods are determined from 20 x 85mg INAA results and the Sampling Constant (Ingamells & Switzer, 1973).

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 1 continued.**

Constituent	Certified Value	SD	95% Confidence Limits		95% Tolerance Limits	
			Low	High	Low	High
<b>4-Acid Digestion continued</b>						
Mo, Molybdenum (ppm)	5.43	0.396	5.28	5.59	5.15	5.71
Na, Sodium (wt.%)	2.76	0.095	2.72	2.80	2.71	2.80
Nb, Niobium (ppm)	18.6	1.37	18.0	19.3	18.2	19.1
Nd, Neodymium (ppm)	39.6	4.1	35.1	44.1	38.5	40.7
Ni, Nickel (ppm)	4.86	0.92	4.40	5.33	4.52	5.21
P, Phosphorus (ppm)	303	14	297	309	291	315
Pb, Lead (ppm)	119	4	118	121	116	122
Pr, Praseodymium (ppm)	10.7	0.89	9.6	11.7	10.2	11.2
Rb, Rubidium (ppm)	143	4	141	145	140	147
S, Sulphur (wt.%)	0.308	0.016	0.300	0.315	0.297	0.318
Sb, Antimony (ppm)	13.5	0.81	13.1	14.0	13.1	13.9
Sc, Scandium (ppm)	4.34	0.275	4.18	4.50	4.15	4.52
Se, Selenium (ppm)	3.33	0.36	3.00	3.66	2.98	3.67
Sm, Samarium (ppm)	7.92	0.547	7.30	8.54	7.57	8.28
Sn, Tin (ppm)	4.27	0.230	4.14	4.39	4.09	4.44
Sr, Strontium (ppm)	212	8	208	216	208	217
Ta, Tantalum (ppm)	1.48	0.097	1.43	1.53	1.43	1.53
Tb, Terbium (ppm)	0.77	0.10	0.67	0.86	0.75	0.79
Te, Tellurium (ppm)	2.05	0.179	1.97	2.14	1.92	2.18
Th, Thorium (ppm)	15.1	0.67	14.7	15.4	14.5	15.6
Ti, Titanium (wt.%)	0.120	0.005	0.117	0.122	0.118	0.122
Tl, Thallium (ppm)	1.02	0.065	0.99	1.06	0.99	1.06
U, Uranium (ppm)	5.97	0.361	5.77	6.17	5.81	6.14
V, Vanadium (ppm)	5.61	0.58	4.98	6.24	5.36	5.87
W, Tungsten (ppm)	4.63	0.49	4.43	4.82	4.32	4.93
Y, Yttrium (ppm)	15.0	0.78	14.6	15.3	14.5	15.4
Yb, Ytterbium (ppm)	0.56	0.06	0.49	0.64	0.54	0.59
Zn, Zinc (ppm)	404	14	399	410	397	412
Zr, Zirconium (ppm)	254	10	250	258	248	260
<b>Aqua Regia Digestion</b>						
Ag, Silver (ppm)	25.1	1.67	24.4	25.8	24.5	25.8
Al, Aluminium (wt.%)	0.590	0.043	0.569	0.612	0.574	0.607
As, Arsenic (ppm)	96	7.5	93	100	94	99
Ba, Barium (ppm)	668	34	650	687	654	683
Be, Beryllium (ppm)	0.64	0.052	0.61	0.67	0.61	0.68
Bi, Bismuth (ppm)	5.57	0.197	5.47	5.66	5.40	5.74

SI unit equivalents: ppm, parts per million  $\equiv$  mg/kg  $\equiv$   $\mu\text{g/g}$   $\equiv$  0.0001 wt.%  $\equiv$  1000 ppb, parts per billion.

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 1 continued.

Constituent	Certified Value	SD	95% Confidence Limits		95% Tolerance Limits	
			Low	High	Low	High
<b>Aqua Regia Digestion continued</b>						
Ca, Calcium (wt.%)	0.817	0.029	0.804	0.830	0.803	0.831
Cd, Cadmium (ppm)	2.08	0.131	2.01	2.16	2.00	2.17
Ce, Cerium (ppm)	57	4.0	55	59	55	59
Co, Cobalt (ppm)	2.16	0.084	2.15	2.18	2.02	2.31
Cr, Chromium (ppm)	26.6	2.13	25.7	27.5	25.5	27.7
Cs, Cesium (ppm)	1.48	0.143	1.39	1.57	1.43	1.53
Cu, Copper (ppm)	502	18	494	510	492	512
Fe, Iron (wt.%)	2.05	0.109	2.00	2.10	2.01	2.09
Ga, Gallium (ppm)	3.39	0.190	3.27	3.50	3.24	3.53
Ge, Germanium (ppm)	0.081	0.016	0.062	0.100	IND	IND
Hf, Hafnium (ppm)	1.40	0.25	1.25	1.55	1.35	1.45
Hg, Mercury (ppm)	0.088	0.012	0.082	0.095	0.060	0.117
In, Indium (ppm)	0.40	0.014	0.40	0.40	0.38	0.42
K, Potassium (wt.%)	0.273	0.018	0.263	0.282	0.261	0.284
La, Lanthanum (ppm)	29.1	1.59	28.3	29.8	28.3	29.8
Li, Lithium (ppm)	9.92	0.927	9.44	10.40	9.52	10.32
Mg, Magnesium (ppm)	481	74	450	513	466	496
Mn, Manganese (ppm)	252	10	248	256	246	258
Mo, Molybdenum (ppm)	5.01	0.183	4.94	5.09	4.78	5.25
Na, Sodium (wt.%)	0.085	0.010	0.080	0.090	0.081	0.088
Ni, Nickel (ppm)	4.41	0.276	4.29	4.53	4.12	4.69
P, Phosphorus (ppm)	234	10	229	239	223	244
Pb, Lead (ppm)	83	4.2	81	85	81	85
Rb, Rubidium (ppm)	15.7	0.91	15.1	16.3	15.2	16.2
S, Sulphur (wt.%)	0.251	0.018	0.243	0.259	0.242	0.260
Sb, Antimony (ppm)	10.2	0.97	9.7	10.8	9.8	10.6
Sc, Scandium (ppm)	1.17	0.15	1.09	1.25	1.09	1.25
Se, Selenium (ppm)	3.05	0.36	2.85	3.26	2.87	3.24
Sn, Tin (ppm)	1.42	0.116	1.36	1.48	1.35	1.49
Sr, Strontium (ppm)	26.7	1.70	25.9	27.5	26.0	27.5
Tb, Terbium (ppm)	0.40	0.10	0.28	0.52	0.38	0.42
Te, Tellurium (ppm)	1.99	0.186	1.90	2.09	1.89	2.10
Th, Thorium (ppm)	9.41	0.820	8.95	9.87	9.08	9.74
Ti, Titanium (ppm)	299	35	278	319	287	310
Tl, Thallium (ppm)	0.47	0.038	0.45	0.49	0.45	0.48
U, Uranium (ppm)	3.08	0.200	2.97	3.19	2.98	3.18

SI unit equivalents: ppm, parts per million  $\equiv$  mg/kg  $\equiv$   $\mu\text{g/g} \equiv 0.0001$  wt.%  $\equiv 1000$  ppb, parts per billion.

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 1 continued.**

Constituent	Certified Value	SD	95% Confidence Limits		95% Tolerance Limits	
			Low	High	Low	High
<b>Aqua Regia Digestion continued</b>						
V, Vanadium (ppm)	2.54	0.35	2.08	3.00	2.42	2.67
W, Tungsten (ppm)	2.44	0.30	2.32	2.56	2.08	2.80
Y, Yttrium (ppm)	7.51	0.591	7.21	7.81	7.30	7.72
Yb, Ytterbium (ppm)	0.23	0.03	0.19	0.27	0.21	0.25
Zn, Zinc (ppm)	329	9	325	332	321	337
Zr, Zirconium (ppm)	50	10	46	55	49	52

SI unit equivalents: ppm, parts per million  $\equiv$  mg/kg  $\equiv$   $\mu\text{g/g} \equiv 0.0001$  wt.%  $\equiv 1000$  ppb, parts per billion.

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 2. Indicative Values for OREAS 600b.**

Constituent	Unit	Value	Constituent	Unit	Value	Constituent	Unit	Value
<b>Pb Fire Assay</b>								
Ag	ppm	25.0	Pd	ppb	< 3	Pt	ppb	< 5
<b>Infrared Combustion</b>								
C	wt.%	0.229						
<b>4-Acid Digestion</b>								
Au	ppm	0.217	Pd	ppb	< 50	Rh	ppb	< 10
Hg	ppm	< 2	Pt	ppb	< 10	Ru	ppb	< 10
Ir	ppb	< 5	Re	ppb	< 2	Tm	ppb	85.7
<b>Aqua Regia Digestion</b>								
B	ppm	< 10	Lu	ppb	29.5	Rh	ppb	< 10
Dy	ppm	1.81	Nb	ppm	1.29	Ru	ppb	< 10
Er	ppm	0.45	Nd	ppm	23.5	Sm	ppm	4.32
Eu	ppm	0.68	Pd	ppb	< 10	Ta	ppm	0.013
Gd	ppm	3.47	Pr	ppm	6.56	Tm	ppb	45.0
Ho	ppm	0.24	Pt	ppb	< 5			
Ir	ppb	< 5	Re	ppb	< 1			
<b>Borate Fusion XRF</b>								
Al <sub>2</sub> O <sub>3</sub>	wt.%	14.83	MgO	wt.%	0.215	SiO <sub>2</sub>	wt.%	69.28
CaO	wt.%	1.73	MnO	wt.%	0.040	SO <sub>3</sub>	wt.%	0.751
Fe <sub>2</sub> O <sub>3</sub>	wt.%	3.73	Na <sub>2</sub> O	wt.%	3.73	TiO <sub>2</sub>	wt.%	0.190
K <sub>2</sub> O	wt.%	3.68	P <sub>2</sub> O <sub>5</sub>	wt.%	0.069			
<b>Thermogravimetry</b>								
H <sub>2</sub> O-	wt.%	0.280	LOI <sup>1000</sup>	wt.%	1.79			
<b>Laser Ablation ICP-MS</b>								
Ag	ppm	25.5	Hf	ppm	7.47	Sm	ppm	7.64
As	ppm	92	Ho	ppm	0.50	Sn	ppm	4.80
Ba	ppm	3450	In	ppm	0.43	Sr	ppm	204
Be	ppm	3.20	La	ppm	46.9	Ta	ppm	1.44
Bi	ppm	5.73	Lu	ppb	65.0	Tb	ppm	0.79

SI unit equivalents: ppm, parts per million  $\equiv$  mg/kg  $\equiv$   $\mu\text{g/g} \equiv 0.0001$  wt.%  $\equiv 1000$  ppb, parts per billion.

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 2 continued.**

Constituent	Unit	Value	Constituent	Unit	Value	Constituent	Unit	Value
<b>Laser Ablation ICP-MS continued</b>								
Cd	ppm	2.40	Mn	ppm	278	Te	ppm	2.10
Ce	ppm	91	Mo	ppm	5.60	Th	ppm	15.0
Co	ppm	2.80	Nb	ppm	19.1	Ti	wt.%	0.120
Cr	ppm	28.0	Nd	ppm	39.4	Tl	ppm	1.00
Cs	ppm	6.98	Ni	ppm	6.00	Tm	ppb	115
Cu	ppm	458	Pb	ppm	116	U	ppm	6.15
Dy	ppm	3.61	Pr	ppm	10.7	V	ppm	5.35
Er	ppm	0.96	Rb	ppm	139	W	ppm	5.00
Eu	ppm	1.25	Re	ppb	7.50	Y	ppm	15.5
Ga	ppm	22.2	Sb	ppm	14.1	Yb	ppm	0.48
Gd	ppm	5.66	Sc	ppm	6.40	Zn	ppm	365
Ge	ppm	1.50	Se	ppm	< 5	Zr	ppm	279

SI unit equivalents: ppm, parts per million  $\equiv$  mg/kg  $\equiv$   $\mu\text{g/g}$   $\equiv$  0.0001 wt.%  $\equiv$  1000 ppb, parts per billion.

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.

## 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.

## SOURCE MATERIAL

OREAS 600b was prepared from a blend of silver-copper-gold bearing ores from Evolution Mining's Mount Carlton Operation in Queensland, Australia and argillic rhyodacite waste rock sourced from a quarry east of Melbourne, Australia. A small amount of chalcocite-rich ore from the Sepon Mine in Laos was also added to help achieve the desired copper grade.

The mineralisation assemblage at Mount Carlton consists of pyrite, enargite/tennantite, tetrahedrite, digenite, covellite, sphalerite, galena, alunite, dickite, kaolinite and vuggy silica, hosted in advanced argillic altered rhyodacite containing sulphur-salts.

OREAS 600b is one of a suite of six CRMs developed from Mount Carlton ores ranging in grades from 25 -1015 ppm Ag, 0.2 -1.7 ppm Au and 0.05 - 5.0% Cu.

## COMMINTION AND HOMOGENISATION PROCEDURES

The material constituting OREAS 600b was prepared in the following manner:

- Drying of ore materials (sulphide-rich) to constant mass at 85°C;
- Drying of rhyodacite waste rock to constant mass at 105°C;
- Crushing and milling of the ore materials to 100% minus 30 microns;
- Crushing and milling of the rhyodacite waste rock to 98% minus 75 microns;
- Blending in appropriate proportions to achieve the desired grades;
- Packaging in 10g and 60g units in laminated foil pouches and 1kg units in plastic jars.

## PHYSICAL PROPERTIES

OREAS 600b was tested at ORE Research & Exploration Pty Ltd's onsite laboratory for various physical properties. Table 3 presents these findings that are to be used for informational purposes only.

**Table 3. Physical properties of OREAS 600b.**

CRM Name	Bulk Density (g/L)	Moisture%	Munsell Notation <sup>‡</sup>	Munsell Color <sup>‡</sup>
OREAS 600b	826	0.4	N8	Very Light Gray

<sup>‡</sup>The Munsell Rock Color Chart helps geologists and archeologists communicate with color more effectively by cross-referencing ISCC-NBS color names with unique Munsell alpha-numeric color notations for rock color samples.

## ANALYTICAL PROGRAM

Twenty five commercial analytical laboratories participated in the program to certify the elements reported in Table 1. The following methods were employed:

- Gold via 25-50g fire assay with AAS finish (14 laboratories) and ICP-OES (10 laboratories) finish;
- Gold via 10-40g aqua regia digestion with ICP-MS finish (10 laboratories) and AAS (2 laboratories) finish;
- Sulphur by infra-red combustion analysis (19 laboratories);
- 4-Acid digestion for full elemental suite ICP-OES/MS finish (up to 22 laboratories depending on the element).
- Aqua regia digestion for full elemental suite ICP-OES finish (up to 22 laboratories depending on the element) and AAS finish (1 laboratory);
- Gold by instrumental neutron activation analysis (INAA) on 20 x 85mg subsamples to confirm homogeneity (ANSTO, Lucas Heights).

It is important to note that in the analytical industry there is no standardisation of the aqua regia digestion process. Aqua regia is a partial empirical digest and differences in recoveries for various analytes are commonplace. These are caused by variations in the digest conditions which can include the ratio of nitric to hydrochloric acids, acid strength, temperatures, leach times and secondary digestions. Recoveries for sulphide-hosted base metal sulphides approach total values, however, other analytes, in particular the lithophile

elements, show greater sensitivity to method parameters. This can result in lack of consensus in an inter-laboratory certification program for these elements.

The approach applied here is to report certified values in those instances where reasonable agreement exists amongst a majority of participating laboratories. The results of specific laboratories may differ significantly from the certified values, but will, nonetheless, be valid and reproducible in the context of the specifics of the aqua regia method in use. Users of this reference material should, therefore, be mindful of this limitation when applying the certified values in a quality control program.

For the round robin program twenty 1kg test units were taken at predetermined intervals during the bagging stage, immediately following homogenisation and are considered representative of the entire prepared batch. Six 100g pulp samples were submitted to each laboratory for analysis received by each laboratory were obtained by taking two 100g samples from each of three separate 1kg test units. This format enabled nested ANOVA treatment of the results to evaluate homogeneity, i.e. to ascertain whether between-unit variance is greater than within-unit variance.

Table 1 presents the 109 certified values together with their associated 1SD's, 95% confidence and tolerance limits, Table 2 shows 96 indicative values for major and trace element composition. Gold homogeneity has been evaluated and confirmed by instrumental neutron activation analysis (INAA) on twenty ~85mg sample portions (see Table 4 below) and by a nested ANOVA program for both fire assay and aqua regia digestion (see '**nested ANOVA**' section).

Table 5 provides performance gate intervals for the certified values based on their pooled 1SD's. Tabulated results of all elements together with uncorrected means, medians, standard deviations, relative standard deviations and per cent deviation of lab means from the corrected mean of means (PDM<sup>3</sup>) are presented in the detailed certification data for this CRM (**OREAS 600b DataPack-1.0.190219\_133825.xlsx**).

Results are also presented in scatter plots for gold by fire assay, silver by 4-acid digestion and copper by 4-acid digestion (Figures 1 to 3, respectively) together with  $\pm 3\text{SD}$  (magenta) and  $\pm 5\%$  (yellow) control lines and certified value (green line). Accepted individual results are coloured blue and individual and dataset outliers are identified in red and violet, respectively.

## STATISTICAL ANALYSIS

**Certified Values, Confidence Limits, Standard Deviations and Tolerance Limits** (Table 1) 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. In certain instances statistician's prerogative has been employed in discriminating outliers.

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.

**Certified Values** are the means of accepted laboratory means after outlier filtering. The INAA data (see Table 4) is omitted from determination of the certified value for Au and is used solely for the calculation of Tolerance Limits and homogeneity evaluation of OREAS 600b.

**95% Confidence Limits** are inversely proportional to the number of participating laboratories and inter-laboratory agreement. It is a measure of the reliability of the certified value. A 95% confidence interval indicates a 95% probability that the true value of the analyte under consideration lies between the upper and lower limits. *95% Confidence Limits should not be used as control limits for laboratory performance.*

**Indicative (uncertified) values** (Table 2) are provided for the major and trace elements determined by borate fusion XRF ( $\text{Al}_2\text{O}_3$  to  $\text{TiO}_2$ ), laser ablation with ICP-MS (Ag to Zr), LOI at 1000°C and C by infrared combustion furnace and are the means of duplicate assays from Bureau Veritas, Perth. Additional indicative values by other analytical methods are present where the number of laboratories reporting a particular analyte is insufficient (< 5) to support certification or where inter-laboratory consensus is poor.

**Standard Deviation** values (1SDs) are reported in Table 1. They 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.

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.**

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 inter-lab 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.

## Homogeneity Evaluation

The tolerance limits (ISO 16269:2014) shown in Table 1 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 4-acid digestion, where 99% of the time ( $1-\alpha=0.99$ ) at least 95% of subsamples ( $\rho=0.95$ ) will have concentrations lying between 490 and 508 ppm. 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.**

Table 4 below shows the INAA data determined on 20 x 85mg subsamples of OREAS 600b. An equivalent scaled version of the results is also provided to demonstrate an appreciation of what this data means if 30g fire assay determinations were undertaken without the normal measurement error associated with this methodology.

**Table 4. Neutron Activation Analysis of Au (in ppm) on 20 x 85mg subsamples showing the equivalent results scaled to a 30g sample mass typical of fire assay determination.**

Replicate No	Au 85mg actual	Au 30g equivalent*
1	0.225	0.206
2	0.198	0.204
3	0.204	0.205
4	0.211	0.205
5	0.195	0.204
6	0.202	0.204
7	0.203	0.205
8	0.211	0.205
9	0.201	0.204
10	0.192	0.204
11	0.206	0.205
12	0.207	0.205
13	0.204	0.205
14	0.199	0.204
15	0.208	0.205
16	0.201	0.204
17	0.196	0.204
18	0.208	0.205
19	0.211	0.205
20	0.208	0.205
Mean	0.205	0.205
Median	0.204	0.205
Std Dev.	0.007	0.0004
<b>Rel.Std.Dev.</b>	<b>3.61%</b>	<b>0.192%</b>

\*Results calculated for a 30g equivalent sample mass using the formula:  $x^{30g\ Eq} = \frac{(x^{INAA} - \bar{X}) \times RSD@30g}{RSD@85mg} + \bar{X}$   
 where  $x^{30g\ Eq}$  = equivalent result calculated for a 30g sample mass  
 $(x^{INAA})$  = raw INAA result at 85mg  
 $\bar{X}$  = mean of 85mg INAA results

The homogeneity of gold has been determined by INAA using the reduced analytical subsample method which utilises the known relationship between standard deviation and analytical subsample weight (Ingamells and Switzer, 1973). 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. In this instance a subsample weight of 85 milligrams was employed and the 1RSD of 0.192% calculated for a 30g fire assay or aqua regia sample (3.61% at 85mg weights) confirms the high level of gold homogeneity in OREAS 600b.

The homogeneity of OREAS 600b has also been evaluated in a **nested ANOVA** of the round robin program. Each of the twenty-five round robin laboratories received six samples per CRM and these samples were made up of paired samples from three different, non-adjacent sampling intervals. The purpose of the ANOVA evaluation 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 of OREAS 600b. The test was performed using the following parameters:

- Gold fire assay – 144 samples (24 laboratories each providing analyses on 3 pairs of samples);
- Gold aqua regia digestion – 72 samples (12 laboratories each providing analyses on 3 pairs of samples);
- 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.

$P$ -values are a measure of probability where values less than 0.05 indicate a greater than 95% probability that the observed differences in within-unit and between-unit variances are real. The datasets were filtered for both individual and laboratory data set (batch) outliers prior to the calculation of  $p$ -values. This process derived  $p$ -values of 1.00 for Au by fire assay and 0.899 for Au by aqua regia digestion. Both  $p$ -values are insignificant and the Null Hypothesis is retained. Additionally, none of the other 109 certified values showed significant  $p$ -values. Please note that only results for constituents present in concentrations well above the detection levels (i.e. >20 x Lower Limit of Detection) for the various methods undertaken were considered for the objective of evaluating homogeneity.

It is important to note that ANOVA is not an absolute measure of homogeneity. Rather, it establishes whether or not the analytes are distributed in a similar manner throughout the packaging run of OREAS 600b and whether the variance between two subsamples from the same unit is statistically distinguishable to the variance from two subsamples taken from any two separate units. A reference material therefore, can possess poor absolute homogeneity yet still pass a relative homogeneity test if the within-unit heterogeneity is large and similar across all units.

Based on the statistical analysis of the results of the inter-laboratory certification program it can be concluded that OREAS 600b is fit-for-purpose as a certified reference material (see ‘Intended Use’ below).

## Performance Gates

Table 5 shows 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. 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  $\pm 10\% \pm 2DL$  (adapted from Govett, 1983)*

**Table 5. Performance Gates for OREAS 600b.**

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
<b>Pb Fire Assay</b>											
Au, ppm	0.204	0.007	0.190	0.218	0.183	0.226	3.51%	7.01%	10.52%	0.194	0.214
<b>Aqua Regia Digestion (sample weights 10-50g)</b>											
Au, ppm	0.200	0.008	0.183	0.216	0.175	0.225	4.17%	8.33%	12.50%	0.190	0.210
<b>Infrared Combustion</b>											
S, wt.%	0.299	0.022	0.254	0.343	0.232	0.365	7.41%	14.83%	22.24%	0.284	0.314
<b>4-Acid Digestion</b>											
Ag, ppm	25.1	1.00	23.2	27.1	22.2	28.1	3.97%	7.94%	11.91%	23.9	26.4
Al, wt.%	7.58	0.296	6.99	8.17	6.69	8.47	3.91%	7.82%	11.73%	7.20	7.96
As, ppm	99	6.8	85	112	78	119	6.90%	13.80%	20.69%	94	104
Ba, ppm	3397	189	3019	3774	2831	3963	5.55%	11.11%	16.66%	3227	3566
Be, ppm	3.14	0.47	2.21	4.08	1.75	4.54	14.81%	29.63%	44.44%	2.99	3.30
Bi, ppm	5.42	0.378	4.67	6.18	4.29	6.56	6.98%	13.95%	20.93%	5.15	5.69
Ca, wt.%	1.26	0.066	1.12	1.39	1.06	1.45	5.25%	10.49%	15.74%	1.19	1.32
Cd, ppm	2.08	0.098	1.89	2.28	1.79	2.37	4.70%	9.40%	14.10%	1.98	2.19
Ce, ppm	93	8.0	77	109	69	117	8.56%	17.12%	25.68%	88	98
Co, ppm	2.77	0.236	2.30	3.25	2.07	3.48	8.51%	17.01%	25.52%	2.63	2.91
Cr, ppm	22.3	3.0	16.3	28.2	13.4	31.2	13.34%	26.67%	40.01%	21.1	23.4
Cs, ppm	6.91	0.317	6.27	7.54	5.96	7.86	4.58%	9.17%	13.75%	6.56	7.25
Cu, ppm	499	13	473	525	460	538	2.59%	5.18%	7.77%	474	524
Dy, ppm	3.50	0.192	3.12	3.88	2.92	4.08	5.49%	10.97%	16.46%	3.33	3.68
Er, ppm	1.01	0.086	0.84	1.18	0.76	1.27	8.45%	16.90%	25.35%	0.96	1.06
Eu, ppm	1.35	0.14	1.07	1.63	0.93	1.77	10.34%	20.68%	31.02%	1.28	1.42
Fe, wt.%	2.54	0.092	2.36	2.73	2.27	2.82	3.63%	7.26%	10.89%	2.42	2.67

SI unit equivalents: ppm, parts per million  $\equiv$  mg/kg  $\equiv$   $\mu\text{g/g} \equiv 0.0001$  wt.%  $\equiv 1000$  ppb, parts per billion.

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
<b>4-Acid Digestion continued</b>											
Ga, ppm	23.2	1.69	19.8	26.5	18.1	28.2	7.29%	14.58%	21.87%	22.0	24.3
Gd, ppm	5.74	0.353	5.03	6.45	4.68	6.80	6.16%	12.32%	18.48%	5.45	6.03
Ge, ppm	0.18	0.02	0.14	0.22	0.11	0.24	12.01%	24.02%	36.03%	0.17	0.19
Hf, ppm	6.89	0.443	6.00	7.77	5.56	8.22	6.42%	12.85%	19.27%	6.54	7.23
Ho, ppm	0.49	0.047	0.40	0.59	0.35	0.63	9.67%	19.35%	29.02%	0.47	0.51
In, ppm	0.44	0.028	0.39	0.50	0.36	0.53	6.35%	12.70%	19.06%	0.42	0.47
K, wt.%	3.03	0.075	2.88	3.18	2.80	3.25	2.47%	4.95%	7.42%	2.88	3.18
La, ppm	44.1	5.1	33.9	54.3	28.8	59.5	11.59%	23.19%	34.78%	41.9	46.3
Li, ppm	28.9	2.33	24.2	33.6	21.9	35.9	8.07%	16.14%	24.20%	27.5	30.4
Lu, ppb	67.4	10.2	46.9	87.8	36.7	98.1	15.18%	30.36%	45.54%	64.0	70.7
Mg, ppm	1229	69	1091	1367	1022	1435	5.60%	11.20%	16.80%	1167	1290
Mn, ppm	293	12	270	317	258	329	4.07%	8.14%	12.22%	279	308
Mo, ppm	5.43	0.396	4.64	6.23	4.25	6.62	7.29%	14.58%	21.87%	5.16	5.71
Na, wt.%	2.76	0.095	2.57	2.95	2.47	3.04	3.45%	6.90%	10.34%	2.62	2.89
Nb, ppm	18.6	1.37	15.9	21.4	14.5	22.7	7.37%	14.75%	22.12%	17.7	19.6
Nd, ppm	39.6	4.1	31.3	47.8	27.2	51.9	10.42%	20.84%	31.26%	37.6	41.5
Ni, ppm	4.86	0.92	3.03	6.69	2.11	7.61	18.83%	37.66%	56.49%	4.62	5.10
P, ppm	303	14	276	330	262	344	4.49%	8.98%	13.47%	288	318
Pb, ppm	119	4	111	128	107	132	3.43%	6.86%	10.28%	113	125
Pr, ppm	10.7	0.89	8.9	12.5	8.0	13.3	8.29%	16.57%	24.86%	10.1	11.2
Rb, ppm	143	4	134	152	130	156	3.09%	6.19%	9.28%	136	150
S, wt.%	0.308	0.016	0.275	0.340	0.258	0.357	5.32%	10.65%	15.97%	0.292	0.323
Sb, ppm	13.5	0.81	11.9	15.1	11.1	15.9	5.96%	11.92%	17.87%	12.8	14.2
Sc, ppm	4.34	0.275	3.79	4.89	3.51	5.16	6.34%	12.67%	19.01%	4.12	4.55
Se, ppm	3.33	0.36	2.60	4.05	2.24	4.42	10.90%	21.80%	32.69%	3.16	3.49
Sm, ppm	7.92	0.547	6.83	9.02	6.28	9.56	6.91%	13.81%	20.72%	7.53	8.32
Sn, ppm	4.27	0.230	3.81	4.72	3.58	4.95	5.38%	10.76%	16.15%	4.05	4.48
Sr, ppm	212	8	196	228	188	236	3.79%	7.57%	11.36%	202	223
Ta, ppm	1.48	0.097	1.29	1.67	1.19	1.77	6.56%	13.12%	19.67%	1.41	1.55
Tb, ppm	0.77	0.10	0.56	0.98	0.45	1.08	13.58%	27.17%	40.75%	0.73	0.81
Te, ppm	2.05	0.179	1.69	2.41	1.52	2.59	8.73%	17.47%	26.20%	1.95	2.16
Th, ppm	15.1	0.67	13.7	16.4	13.1	17.1	4.44%	8.89%	13.33%	14.3	15.8
Ti, wt.%	0.120	0.005	0.110	0.130	0.105	0.134	4.12%	8.23%	12.35%	0.114	0.126
Tl, ppm	1.02	0.065	0.89	1.15	0.83	1.22	6.40%	12.80%	19.19%	0.97	1.07
U, ppm	5.97	0.361	5.25	6.69	4.89	7.06	6.04%	12.08%	18.11%	5.67	6.27
V, ppm	5.61	0.58	4.45	6.78	3.86	7.37	10.41%	20.82%	31.22%	5.33	5.89
W, ppm	4.63	0.49	3.64	5.62	3.15	6.11	10.67%	21.33%	32.00%	4.40	4.86
Y, ppm	15.0	0.78	13.4	16.5	12.6	17.3	5.23%	10.46%	15.69%	14.2	15.7
Yb, ppm	0.56	0.06	0.44	0.68	0.38	0.74	10.58%	21.15%	31.73%	0.54	0.59
Zn, ppm	404	14	376	432	362	447	3.49%	6.99%	10.48%	384	424
Zr, ppm	254	10	234	274	225	283	3.86%	7.71%	11.57%	241	267

SI unit equivalents: ppm, parts per million  $\equiv$  mg/kg  $\equiv$   $\mu\text{g/g} \equiv 0.0001$  wt.%  $\equiv 1000$  ppb, parts per billion.

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
<b>Aqua Regia Digestion</b>											
Ag, ppm	25.1	1.67	21.8	28.5	20.1	30.1	6.65%	13.29%	19.94%	23.9	26.4
Al, wt.%	0.590	0.043	0.504	0.677	0.461	0.720	7.30%	14.60%	21.90%	0.561	0.620
As, ppm	96	7.5	81	111	74	119	7.82%	15.64%	23.45%	92	101
Ba, ppm	668	34	601	735	568	769	5.01%	10.03%	15.04%	635	702
Be, ppm	0.64	0.052	0.54	0.75	0.49	0.80	8.08%	16.16%	24.23%	0.61	0.67
Bi, ppm	5.57	0.197	5.17	5.96	4.98	6.16	3.53%	7.06%	10.59%	5.29	5.84
Ca, wt.%	0.817	0.029	0.759	0.876	0.729	0.905	3.60%	7.19%	10.79%	0.776	0.858
Cd, ppm	2.08	0.131	1.82	2.35	1.69	2.48	6.30%	12.60%	18.91%	1.98	2.19
Ce, ppm	57	4.0	49	65	45	69	6.94%	13.88%	20.82%	54	60
Co, ppm	2.16	0.084	2.00	2.33	1.91	2.41	3.86%	7.73%	11.59%	2.06	2.27
Cr, ppm	26.6	2.13	22.4	30.9	20.2	33.0	8.00%	15.99%	23.99%	25.3	27.9
Cs, ppm	1.48	0.143	1.19	1.77	1.05	1.91	9.64%	19.27%	28.91%	1.41	1.55
Cu, ppm	502	18	465	539	447	558	3.68%	7.37%	11.05%	477	527
Fe, wt.%	2.05	0.109	1.83	2.27	1.72	2.38	5.29%	10.59%	15.88%	1.95	2.15
Ga, ppm	3.39	0.190	3.01	3.77	2.82	3.96	5.61%	11.21%	16.82%	3.22	3.56
Ge, ppm	0.081	0.016	0.049	0.114	0.032	0.130	20.04%	40.07%	60.11%	0.077	0.085
Hf, ppm	1.40	0.25	0.89	1.91	0.64	2.16	18.13%	36.26%	54.39%	1.33	1.47
Hg, ppm	0.088	0.012	0.064	0.112	0.052	0.124	13.62%	27.24%	40.86%	0.084	0.093
In, ppm	0.40	0.014	0.37	0.43	0.36	0.44	3.44%	6.87%	10.31%	0.38	0.42
K, wt.%	0.273	0.018	0.237	0.309	0.219	0.327	6.61%	13.21%	19.82%	0.259	0.286
La, ppm	29.1	1.59	25.9	32.3	24.3	33.9	5.48%	10.96%	16.45%	27.6	30.5
Li, ppm	9.92	0.927	8.07	11.77	7.14	12.70	9.34%	18.68%	28.03%	9.42	10.42
Mg, ppm	481	74	334	629	261	702	15.29%	30.58%	45.87%	457	505
Mn, ppm	252	10	232	271	222	281	3.88%	7.76%	11.64%	239	264
Mo, ppm	5.01	0.183	4.65	5.38	4.46	5.56	3.65%	7.30%	10.96%	4.76	5.26
Na, wt.%	0.085	0.010	0.065	0.105	0.055	0.115	11.77%	23.54%	35.31%	0.081	0.089
Ni, ppm	4.41	0.276	3.85	4.96	3.58	5.23	6.26%	12.51%	18.77%	4.19	4.63
P, ppm	234	10	213	255	202	265	4.46%	8.91%	13.37%	222	245
Pb, ppm	83	4.2	75	92	71	96	5.06%	10.12%	15.17%	79	87
Rb, ppm	15.7	0.91	13.9	17.5	13.0	18.4	5.77%	11.54%	17.31%	14.9	16.5
S, wt.%	0.251	0.018	0.215	0.288	0.196	0.306	7.26%	14.52%	21.79%	0.239	0.264
Sb, ppm	10.2	0.97	8.3	12.2	7.3	13.1	9.44%	18.89%	28.33%	9.7	10.7
Sc, ppm	1.17	0.15	0.87	1.47	0.72	1.61	12.73%	25.46%	38.19%	1.11	1.23
Se, ppm	3.05	0.36	2.33	3.78	1.97	4.14	11.87%	23.75%	35.62%	2.90	3.21
Sn, ppm	1.42	0.116	1.19	1.65	1.07	1.77	8.17%	16.34%	24.52%	1.35	1.49
Sr, ppm	26.7	1.70	23.3	30.1	21.6	31.8	6.34%	12.68%	19.03%	25.4	28.1
Tb, ppm	0.40	0.10	0.21	0.59	0.11	0.69	23.83%	47.66%	71.48%	0.38	0.42
Te, ppm	1.99	0.186	1.62	2.36	1.44	2.55	9.31%	18.62%	27.93%	1.89	2.09
Th, ppm	9.41	0.820	7.77	11.05	6.95	11.87	8.72%	17.43%	26.15%	8.94	9.88
Ti, ppm	299	35	229	368	195	402	11.59%	23.17%	34.76%	284	314
Tl, ppm	0.47	0.038	0.39	0.54	0.35	0.58	8.04%	16.07%	24.11%	0.44	0.49

SI unit equivalents: ppm, parts per million  $\equiv$  mg/kg  $\equiv$   $\mu\text{g/g} \equiv 0.0001$  wt.%  $\equiv 1000$  ppb, parts per billion.

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
<b>Aqua Regia Digestion continued</b>											
U, ppm	3.08	0.200	2.68	3.48	2.48	3.68	6.49%	12.97%	19.46%	2.93	3.23
V, ppm	2.54	0.35	1.85	3.24	1.50	3.58	13.63%	27.26%	40.89%	2.42	2.67
W, ppm	2.44	0.30	1.85	3.03	1.56	3.33	12.09%	24.18%	36.27%	2.32	2.56
Y, ppm	7.51	0.591	6.32	8.69	5.73	9.28	7.88%	15.75%	23.63%	7.13	7.88
Yb, ppm	0.23	0.03	0.16	0.30	0.13	0.33	14.94%	29.89%	44.83%	0.22	0.24
Zn, ppm	329	9	311	346	302	355	2.70%	5.40%	8.11%	312	345
Zr, ppm	50	10	30	70	20	80	19.77%	39.54%	59.31%	48	53

SI unit equivalents: ppm, parts per million  $\equiv$  mg/kg  $\equiv$   $\mu\text{g/g}$   $\equiv$  0.0001 wt.%  $\equiv$  1000 ppb, parts per billion.

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.

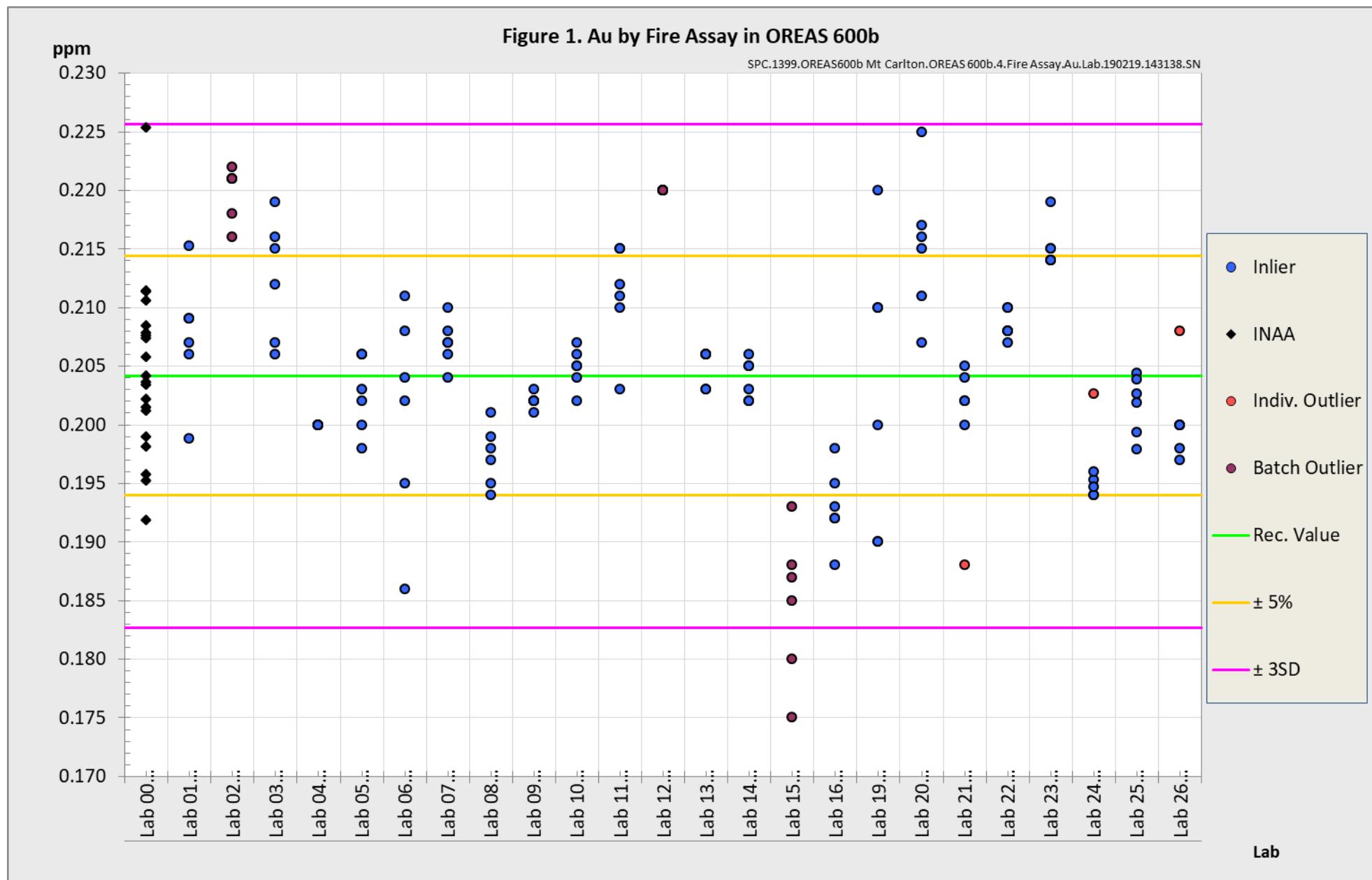
## PARTICIPATING LABORATORIES

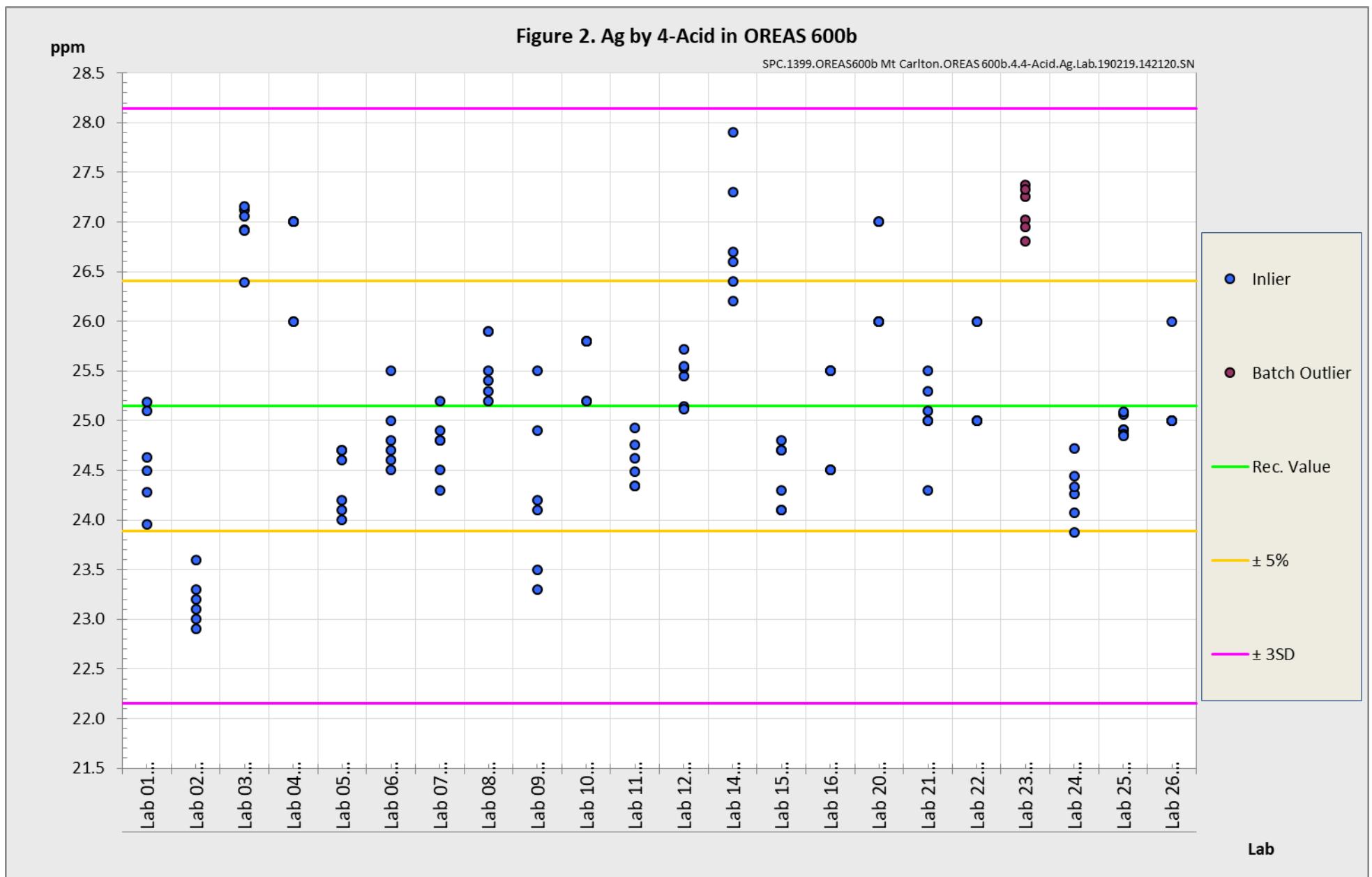
1. AGAT Laboratories, Mississauga, Ontario, Canada
2. Alex Stewart International, Mendoza, Argentina
3. ALS, Johannesburg, South Africa
4. ALS, Lima, Peru
5. ALS, Loughrea, Galway, Ireland
6. ALS, Perth, WA, Australia
7. ALS, Vancouver, BC, Canada
8. American Assay Laboratories, Sparks, Nevada, USA
9. ANSTO, Lucas Heights, NSW, Australia
10. ARGETEST Mineral Processing, Ankara, Central Anatolia, Turkey
11. Bureau Veritas Commodities Canada Ltd, Vancouver, BC, Canada
12. Bureau Veritas Geoanalytical, Perth, WA, Australia
13. Bureau Veritas Minerals, Hermosillo, Sonora, Mexico
14. Inspectorate (BV), Lima, Peru
15. Intertek Genalysis, Perth, WA, Australia
16. Intertek Testing Services, Townsville, QLD, Australia
17. Intertek Testing Services Philippines, Cupang, Muntinlupa, Philippines
18. PT Geoservices Ltd, Cikarang, Jakarta Raya, Indonesia
19. PT Intertek Utama Services, Jakarta Timur, DKI Jakarta, Indonesia
20. PT SGS Indo Assay Laboratories, Jakarta, Indonesia
21. SGS, Ankara, Anatolia, Turkey
22. SGS de Mexico SA de CV, Cd. Industrial, Durango, Mexico
23. SGS del Peru, Lima, Peru
24. SGS Lakefield Research Ltd, Lakefield, Ontario, Canada
25. Shiva Analyticals Ltd, Bangalore North, Karnataka, India

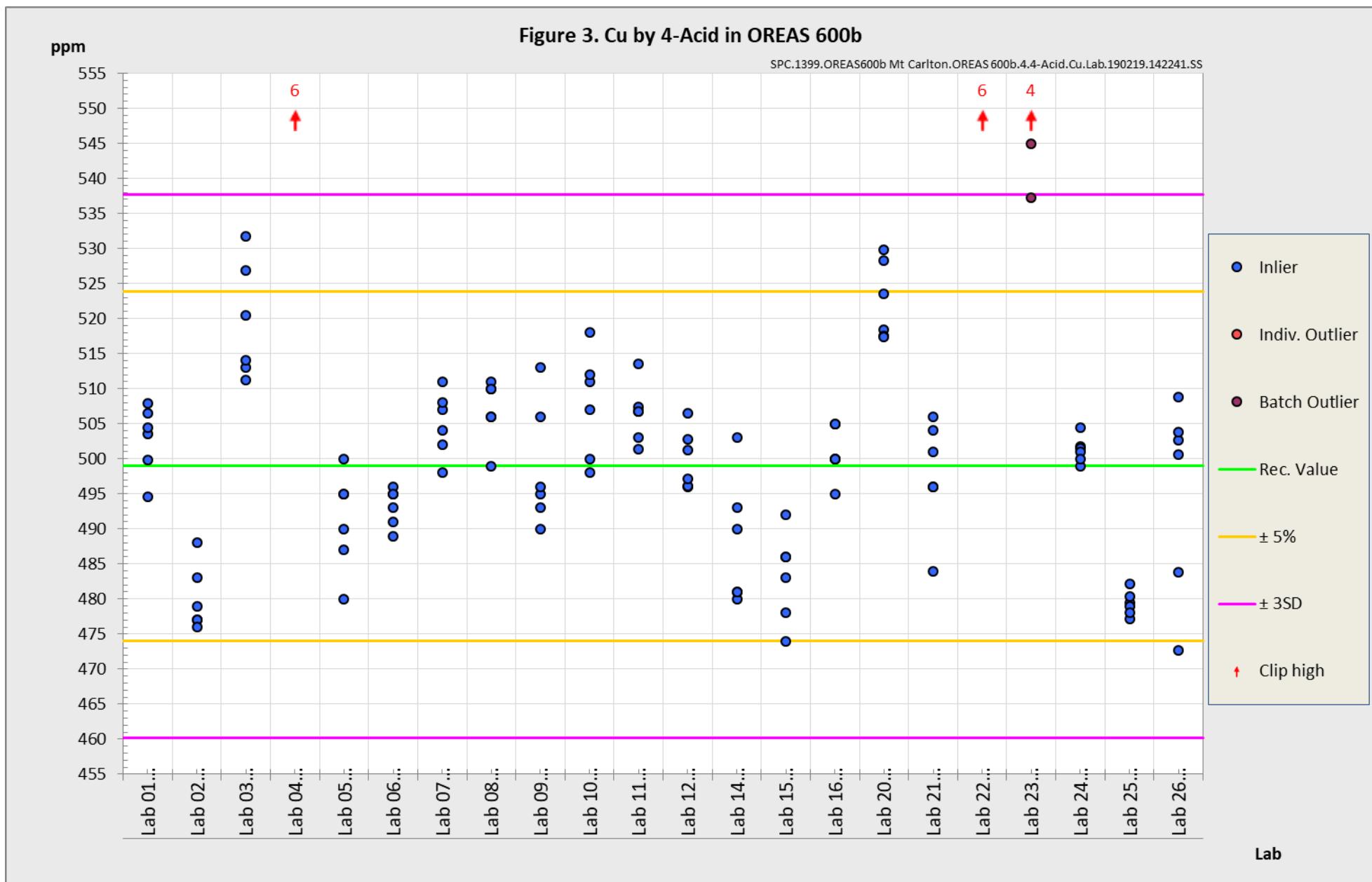
**Please note: Above numbered alphabetical list of participating laboratories does not reflect the Lab ID numbering on the scatter plots below.**

**Figure 1. Au by Fire Assay in OREAS 600b**

SPC.1399.OREAS600b Mt Carlton.OREAS 600b.4.Fire Assay.Au.Lab.190219.143138.SN







## PREPARER AND SUPPLIER

Certified reference material OREAS 600b was prepared, certified and supplied by:



ORE Research & Exploration Pty Ltd  
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AUSTRALIA

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Fax: +613-9729 8338  
Web: [www.ore.com.au](http://www.ore.com.au)  
Email: [info@ore.com.au](mailto:info@ore.com.au)

It is packaged in 10g and 60g units in laminated foil packets and in 1kg wide-mouth plastic jars.

## METROLOGICAL TRACEABILITY

The analytical samples were selected in a manner to represent the entire batch of prepared 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 that underlie the consensus values. Each analytical data set has been validated by its assayer through the inclusion of internal reference materials and QC checks during analysis.

The laboratories were chosen on the basis of their competence (from past performance in inter-laboratory programs undertaken by ORE Pty Ltd) for a particular analytical method, analyte or analyte suite, and sample matrix. Most of these laboratories have and maintain ISO 17025 accreditation. The certified values presented in this report are calculated from the means of accepted data following robust statistical treatment 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 method is possible. In this case, certification takes place on the basis of agreement among independent measurement results (see ISO Guide 35:2006, Clause 10).”*

## COMMUTABILITY

The measurements of the results that underlie the certified values contained in this report were undertaken by methods involving pre-treatment (digestion/fusion) 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 'field' 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 their field samples.

## INTENDED USE

OREAS 600b 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 600b may be used to calibrate the entire procedure by producing a pure substance CRM transformed into a calibration solution.

OREAS 600b is intended for the following uses:

- For the monitoring of laboratory performance in the analysis of analytes reported in Table 1 in geological samples;
- For the verification of analytical methods for analytes reported in Table 1;
- For the calibration of instruments used in the determination of the concentration of analytes reported in Table 1.

## STABILITY AND STORAGE INSTRUCTIONS

OREAS 600b has been prepared from sulphide bearing ores blended with rhyodacite. It contains a very low level of reactive sulphide (~0.3% S). In its unopened state and under normal conditions of storage the CRM has a shelf life beyond ten years. Its stability will be monitored at regular intervals and purchasers notified if any changes are observed.

## INSTRUCTIONS FOR CORRECT USE

The certified values for OREAS 600b refer to the concentration level in its packaged state. It should not be dried prior to weighing and analysis.

## HANDLING INSTRUCTIONS

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

## 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 releases and indemnifies Ore Research & Exploration Pty Ltd from and against all liability and costs arising from the use of this material and information.

## DOCUMENT HISTORY

Revision No.	Date	Changes applied
0	21 <sup>st</sup> February 2019	First publication.

## **QMS ACCREDITED**

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



## **CERTIFYING OFFICER**

21<sup>st</sup> February, 2019

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

## **REFERENCES**

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