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CERTIFICATE OF ANALYSIS FOR
CERTIFIED REFERENCE MATERIAL
OREAS 238b
Gold Ore (Fosterville Gold Mine, Victoria, Australia)

Table 1. Certified Values and Performance Gates for OREAS 238b.

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
Pb Fire Assay											
Au, ppm	3.08	0.085	2.91	3.25	2.83	3.34	2.75%	5.50%	8.25%	2.93	3.24
Aqua Regia Digestion (sample mass 10-50g)											
Au, ppm	3.00	0.088	2.82	3.17	2.73	3.26	2.94%	5.87%	8.81%	2.85	3.15
Cyanide Leach											
Au, ppm	2.74	0.168	2.41	3.08	2.24	3.25	6.11%	12.23%	18.34%	2.61	2.88
X-ray Photon Assay (recommended gross mass 400±15 g)											
Au, ppm	3.16	0.096	2.97	3.36	2.88	3.45	3.03%	6.06%	9.09%	3.01	3.32
4-Acid Digestion											
Ag, ppm	0.245	0.034	0.177	0.312	0.144	0.346	13.77%	27.54%	41.32%	0.232	0.257
Al, wt. %	7.47	0.138	7.20	7.75	7.06	7.89	1.84%	3.69%	5.53%	7.10	7.85
As, ppm	676	32	613	739	581	771	4.67%	9.33%	14.00%	642	710
Ba, ppm	685	21	643	728	621	750	3.12%	6.24%	9.36%	651	720
Be, ppm	2.47	0.228	2.01	2.92	1.78	3.15	9.23%	18.46%	27.68%	2.34	2.59
Bi, ppm	0.40	0.026	0.35	0.45	0.32	0.48	6.41%	12.81%	19.22%	0.38	0.42

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.



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Table 1 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											
Ca, wt. %	0.855	0.024	0.808	0.903	0.785	0.926	2.75%	5.51%	8.26%	0.813	0.898
Cd, ppm	0.097	0.028	0.041	0.154	0.012	0.182	29.11%	58.21%	87.32%	0.092	0.102
Ce, ppm	81	5.6	69	92	64	97	6.97%	13.94%	20.91%	77	85
Co, ppm	17.0	0.56	15.9	18.2	15.4	18.7	3.27%	6.55%	9.82%	16.2	17.9
Cr, ppm	124	13	98	150	85	163	10.56%	21.11%	31.67%	118	130
Cs, ppm	9.52	0.351	8.81	10.22	8.46	10.57	3.69%	7.37%	11.06%	9.04	9.99
Cu, ppm	30.8	1.74	27.3	34.3	25.6	36.0	5.65%	11.29%	16.94%	29.3	32.3
Dy, ppm	3.56	0.63	2.31	4.81	1.68	5.44	17.57%	35.15%	52.72%	3.38	3.74
Er, ppm	1.90	0.40	1.10	2.70	0.71	3.09	20.93%	41.87%	62.80%	1.80	1.99
Eu, ppm	1.26	0.119	1.02	1.50	0.90	1.61	9.47%	18.94%	28.41%	1.19	1.32
Fe, wt. %	4.10	0.101	3.90	4.30	3.80	4.40	2.45%	4.91%	7.36%	3.90	4.31
Ga, ppm	19.6	1.21	17.1	22.0	15.9	23.2	6.17%	12.35%	18.52%	18.6	20.5
Gd, ppm	5.14	0.375	4.39	5.89	4.02	6.26	7.29%	14.58%	21.87%	4.88	5.40
Hf, ppm	3.89	0.234	3.42	4.35	3.18	4.59	6.01%	12.02%	18.04%	3.69	4.08
Ho, ppm	0.66	0.13	0.39	0.92	0.26	1.06	20.36%	40.72%	61.08%	0.62	0.69
In, ppm	0.068	0.008	0.052	0.084	0.044	0.092	11.64%	23.28%	34.91%	0.065	0.072
K, wt. %	2.69	0.080	2.53	2.85	2.45	2.93	2.97%	5.93%	8.90%	2.56	2.83
La, ppm	38.8	2.96	32.9	44.7	30.0	47.7	7.61%	15.23%	22.84%	36.9	40.8
Li, ppm	48.8	3.55	41.7	55.9	38.1	59.4	7.28%	14.57%	21.85%	46.3	51.2
Lu, ppm	0.29	0.05	0.20	0.38	0.15	0.43	15.99%	31.98%	47.96%	0.28	0.31
Mg, wt. %	1.74	0.053	1.64	1.85	1.59	1.90	3.02%	6.03%	9.05%	1.66	1.83
Mn, wt. %	0.039	0.002	0.036	0.043	0.034	0.044	4.45%	8.90%	13.35%	0.037	0.041
Mo, ppm	0.90	0.056	0.79	1.01	0.73	1.07	6.16%	12.32%	18.49%	0.86	0.95
Na, wt. %	0.676	0.017	0.641	0.711	0.624	0.728	2.57%	5.13%	7.70%	0.642	0.710
Nb, ppm	14.3	1.04	12.2	16.4	11.2	17.4	7.26%	14.51%	21.77%	13.6	15.0
Nd, ppm	34.1	1.76	30.6	37.6	28.8	39.4	5.17%	10.35%	15.52%	32.4	35.8
Ni, ppm	65	3.1	59	71	56	74	4.74%	9.47%	14.21%	62	68
P, wt. %	0.065	0.003	0.060	0.071	0.057	0.073	4.12%	8.24%	12.37%	0.062	0.069
Pb, ppm	23.4	1.35	20.7	26.1	19.4	27.5	5.74%	11.49%	17.23%	22.3	24.6
Pr, ppm	9.31	0.503	8.30	10.31	7.80	10.81	5.40%	10.80%	16.21%	8.84	9.77
Rb, ppm	159	10	139	178	129	188	6.18%	12.35%	18.53%	151	167
Re, ppm	< 0.002	IND	IND	IND	IND	IND	IND	IND	IND	IND	IND
S, wt. %	0.175	0.007	0.160	0.190	0.153	0.197	4.22%	8.45%	12.67%	0.166	0.184
Sb, ppm	620	27	566	674	540	701	4.33%	8.66%	12.99%	589	651
Sc, ppm	14.3	1.03	12.2	16.3	11.2	17.4	7.22%	14.43%	21.65%	13.6	15.0
Sm, ppm	6.54	0.478	5.59	7.50	5.11	7.98	7.30%	14.60%	21.91%	6.22	6.87
Sn, ppm	3.69	0.265	3.16	4.22	2.89	4.48	7.18%	14.36%	21.55%	3.51	3.87
Sr, ppm	118	4	110	126	106	130	3.32%	6.63%	9.95%	112	124
Ta, ppm	1.07	0.085	0.90	1.24	0.82	1.32	7.92%	15.84%	23.75%	1.02	1.12

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; IND = indeterminate.

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.

IND = indeterminate (due to limited reading resolution of the methods employed).

Table 1 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											
Tb, ppm	0.67	0.033	0.61	0.74	0.58	0.77	4.85%	9.70%	14.54%	0.64	0.71
Th, ppm	14.5	0.69	13.1	15.9	12.4	16.6	4.76%	9.52%	14.28%	13.8	15.2
Ti, wt. %	0.461	0.018	0.425	0.497	0.407	0.515	3.89%	7.78%	11.67%	0.438	0.484
Tl, ppm	0.85	0.049	0.75	0.95	0.70	1.00	5.78%	11.57%	17.35%	0.81	0.89
Tm, ppm	0.27	0.06	0.15	0.39	0.09	0.44	22.23%	44.45%	66.68%	0.25	0.28
U, ppm	2.74	0.146	2.44	3.03	2.30	3.17	5.33%	10.65%	15.98%	2.60	2.87
V, ppm	108	3	102	114	99	117	2.78%	5.56%	8.34%	102	113
W, ppm	2.80	0.40	2.00	3.60	1.59	4.00	14.33%	28.66%	42.99%	2.66	2.94
Y, ppm	16.0	2.5	11.0	21.0	8.5	23.5	15.71%	31.42%	47.13%	15.2	16.8
Yb, ppm	1.82	0.39	1.04	2.60	0.65	2.99	21.48%	42.95%	64.43%	1.72	1.91
Zn, ppm	100	3.8	92	108	88	111	3.84%	7.68%	11.52%	95	105
Zr, ppm	132	10	112	152	102	162	7.56%	15.13%	22.69%	126	139
Aqua Regia Digestion											
Ag, ppm	0.240	0.013	0.214	0.266	0.200	0.279	5.47%	10.93%	16.40%	0.228	0.252
Al, wt. %	2.62	0.207	2.20	3.03	2.00	3.24	7.89%	15.78%	23.67%	2.49	2.75
As, ppm	674	25	623	725	597	750	3.78%	7.56%	11.34%	640	707
Ba, ppm	103	6	90	115	84	121	6.09%	12.18%	18.28%	97	108
Be, ppm	1.17	0.089	0.99	1.35	0.90	1.43	7.57%	15.15%	22.72%	1.11	1.23
Bi, ppm	0.38	0.032	0.31	0.44	0.28	0.47	8.39%	16.77%	25.16%	0.36	0.40
Ca, wt. %	0.309	0.020	0.269	0.349	0.249	0.369	6.45%	12.90%	19.35%	0.294	0.324
Cd, ppm	0.080	0.017	0.046	0.114	0.029	0.131	21.27%	42.54%	63.81%	0.076	0.084
Ce, ppm	55	3.1	49	61	46	64	5.59%	11.18%	16.77%	52	57
Co, ppm	15.2	0.87	13.5	17.0	12.6	17.8	5.69%	11.38%	17.07%	14.5	16.0
Cr, ppm	106	5	96	116	91	121	4.64%	9.28%	13.92%	101	111
Cs, ppm	6.85	0.253	6.34	7.35	6.09	7.61	3.69%	7.38%	11.08%	6.51	7.19
Cu, ppm	29.6	1.51	26.6	32.6	25.0	34.1	5.12%	10.23%	15.35%	28.1	31.1
Fe, wt. %	3.51	0.134	3.25	3.78	3.11	3.92	3.82%	7.65%	11.47%	3.34	3.69
Ga, ppm	7.93	0.571	6.78	9.07	6.21	9.64	7.21%	14.41%	21.62%	7.53	8.32
Ge, ppm	0.11	0.02	0.07	0.15	0.04	0.17	19.50%	39.00%	58.50%	0.10	0.11
Hf, ppm	0.54	0.08	0.38	0.70	0.30	0.78	14.71%	29.41%	44.12%	0.51	0.57
In, ppm	0.029	0.002	0.025	0.034	0.023	0.036	7.13%	14.27%	21.40%	0.028	0.031
K, wt. %	0.870	0.037	0.796	0.944	0.759	0.981	4.26%	8.53%	12.79%	0.827	0.914
La, ppm	27.1	2.42	22.2	31.9	19.8	34.3	8.94%	17.88%	26.82%	25.7	28.4
Li, ppm	38.9	2.51	33.9	44.0	31.4	46.5	6.46%	12.91%	19.37%	37.0	40.9
Lu, ppm	0.11	0.03	0.05	0.17	0.01	0.21	29.36%	58.73%	88.09%	0.10	0.11
Mg, wt. %	1.41	0.077	1.26	1.57	1.18	1.65	5.45%	10.89%	16.34%	1.34	1.49
Mn, wt. %	0.027	0.002	0.024	0.030	0.023	0.032	5.63%	11.27%	16.90%	0.026	0.029
Mo, ppm	0.81	0.045	0.72	0.90	0.68	0.95	5.57%	11.15%	16.72%	0.77	0.85
Na, wt. %	0.082	0.008	0.067	0.097	0.059	0.105	9.33%	18.66%	28.00%	0.078	0.086
Nb, ppm	0.39	0.11	0.17	0.61	0.06	0.72	27.84%	55.68%	83.52%	0.37	0.41

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.

Table 1 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
Aqua Regia Digestion continued											
Ni, ppm	61	3.8	53	68	49	72	6.25%	12.51%	18.76%	58	64
P, wt. %	0.058	0.002	0.054	0.062	0.052	0.064	3.36%	6.72%	10.08%	0.055	0.061
Pb, ppm	14.2	1.8	10.6	17.7	8.9	19.4	12.44%	24.87%	37.31%	13.5	14.9
Rb, ppm	83	2.8	78	89	75	92	3.40%	6.80%	10.20%	79	88
Re, ppm	< 0.001	IND	IND	IND	IND	IND	IND	IND	IND	IND	IND
S, wt. %	0.173	0.013	0.147	0.199	0.134	0.212	7.49%	14.97%	22.46%	0.164	0.181
Sb, ppm	469	83	302	635	219	719	17.78%	35.55%	53.33%	445	492
Sc, ppm	6.24	0.464	5.32	7.17	4.85	7.63	7.42%	14.85%	22.27%	5.93	6.56
Sn, ppm	1.45	0.094	1.26	1.63	1.17	1.73	6.47%	12.94%	19.41%	1.37	1.52
Sr, ppm	26.1	1.33	23.4	28.7	22.1	30.1	5.11%	10.22%	15.33%	24.8	27.4
Ta, ppm	< 0.01	IND	IND	IND	IND	IND	IND	IND	IND	IND	IND
Th, ppm	11.9	0.72	10.5	13.4	9.7	14.1	6.08%	12.16%	18.24%	11.3	12.5
Ti, wt. %	0.143	0.013	0.116	0.169	0.103	0.183	9.32%	18.63%	27.95%	0.136	0.150
Tl, ppm	0.52	0.05	0.41	0.63	0.36	0.68	10.30%	20.60%	30.91%	0.49	0.54
U, ppm	1.46	0.135	1.19	1.73	1.05	1.86	9.28%	18.57%	27.85%	1.38	1.53
V, ppm	69	3.2	62	75	59	78	4.63%	9.26%	13.89%	65	72
W, ppm	0.52	0.10	0.32	0.72	0.22	0.82	19.13%	38.27%	57.40%	0.49	0.55
Y, ppm	9.00	0.697	7.60	10.39	6.90	11.09	7.75%	15.50%	23.26%	8.55	9.44
Yb, ppm	0.87	0.14	0.58	1.15	0.44	1.30	16.47%	32.93%	49.40%	0.82	0.91
Zn, ppm	87	4.2	78	95	74	100	4.89%	9.79%	14.68%	82	91
Zr, ppm	21.3	2.6	16.0	26.5	13.4	29.1	12.27%	24.54%	36.81%	20.2	22.3

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.

IND = indeterminate (due to limited reading resolution of the methods employed).

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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 handling and correct use' should be read carefully.

Table 1 provides performance gate intervals for the certified values, Table 2 shows indicative values including major and trace element characterisation, Table 3 provides some indicative physical properties, Table 4 provides indicative mineralogy based on semi-quantitative XRD analysis and Table 5 presents the 95% expanded uncertainty and tolerance limits for all certified values. Gold homogeneity (via INAA) is shown in Table 6 and is also demonstrated by a nested ANOVA program using fire assay (see '**nested ANOVA**' section).

Tabulated results of all elements (including Au INAA analyses) together with uncorrected means, medians, standard deviations, relative standard deviations and percent deviation of lab means from the corrected mean of means (PDM³) are presented in the detailed certification data for this CRM (**OREAS 238b-DataPack.1.1.221110_162046.xlsx**).

Results are also presented in scatter plots for gold by fire assay, aqua regia digestion, cyanide leach and photon assay (Figures 1 to 4, respectively) together with $\pm 3SD$ (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.

SOURCE MATERIAL

OREAS 238b was prepared from a blend of high-grade, gold-bearing ore and barren metasediments. The ore was sourced from the Fosterville Mine, located 20km from the city of Bendigo in the state of Victoria, Australia. The deposit is hosted by a metamorphosed interbedded turbidite sequence of sandstones, siltstones and shales. Primary gold mineralization occurs as disseminated arsenopyrite and pyrite in a quartz–carbonate veinlet stockwork. Primary gold also occurs as visible gold where it variably overprints sulphide mineralization and is found as disseminated fine specks (>1 mm) of gold within host quartz veins. The visible gold is spatially associated with antimony mineralization, in the form of stibnite that occurs with quartz and varies from replacement and infill of earlier quartz–carbonate stockwork veins, to massive stibnite-only veins of up to 0.5m in width (Hitchman, Philips, & Greenberger, 2017).

Table 2. Indicative Values for OREAS 238b.

Constituent	Unit	Value	Constituent	Unit	Value	Constituent	Unit	Value
Pb Fire Assay								
Pd	ppb	0.887	Pt	ppb	0.581			
4-Acid Digestion								
Au	ppm	2.91	Ir	ppm	0.001	Ru	ppm	0.003
B	ppm	28.7	Pd	ppb	5.01	Se	ppm	0.80
Ge	ppm	0.20	Pt	ppb	1.09	Te	ppm	0.056
Hg	ppm	0.030	Rh	ppm	0.001			
Aqua Regia Digestion								
B	ppm	15.5	Ir	ppm	< 0.0015	Se	ppm	0.29
Dy	ppm	2.05	Nd	ppm	23.1	Si	wt. %	0.395
Er	ppm	0.90	Pd	ppb	30.1	Sm	ppm	4.28
Eu	ppm	0.65	Pr	ppm	6.29	Tb	ppm	0.46
Gd	ppm	4.03	Pt	ppb	2.37	Te	ppm	0.020
Hg	ppm	0.015	Rh	ppm	0.001	Tm	ppm	0.11
Ho	ppm	0.34	Ru	ppm	< 0.0009			
Borate Fusion XRF								
Al ₂ O ₃	wt. %	14.65	MgO	wt. %	2.93	SiO ₂	wt. %	67.39
CaO	wt. %	1.20	MnO	wt. %	0.050	SO ₃	wt. %	0.436
Fe ₂ O ₃	wt. %	5.88	Na ₂ O	wt. %	0.945	TiO ₂	wt. %	0.820
K ₂ O	wt. %	3.34	P ₂ O ₅	wt. %	0.151			
Thermogravimetry								
LOI ¹⁰⁰⁰	wt. %	2.50						
Infrared Combustion								
C	wt. %	0.105	S	wt. %	0.167			
Laser Ablation ICP-MS								
Ag	ppm	0.350	Hf	ppm	6.64	Sm	ppm	7.35
As	ppm	698	Ho	ppm	1.18	Sn	ppm	3.80
Ba	ppm	697	In	ppm	< 0.05	Sr	ppm	118
Be	ppm	3.00	La	ppm	41.2	Ta	ppm	1.22
Bi	ppm	0.51	Lu	ppm	0.47	Tb	ppm	0.97
Cd	ppm	0.20	Mn	wt. %	0.042	Te	ppm	< 0.2
Ce	ppm	80	Mo	ppm	1.00	Th	ppm	15.4
Co	ppm	18.0	Nb	ppm	16.0	Ti	wt. %	0.501
Cr	ppm	150	Nd	ppm	37.0	Tl	ppm	0.40
Cs	ppm	9.56	Ni	ppm	69	Tm	ppm	0.51
Cu	ppm	31.0	Pb	ppm	26.5	U	ppm	3.12
Dy	ppm	5.87	Pr	ppm	9.79	V	ppm	113
Er	ppm	3.37	Rb	ppm	162	W	ppm	4.00
Eu	ppm	1.36	Re	ppm	< 0.01	Y	ppm	31.0
Ga	ppm	19.8	Sb	ppm	664	Yb	ppm	3.22
Gd	ppm	6.22	Sc	ppm	14.8	Zn	ppm	100
Ge	ppm	1.55	Se	ppm	< 5	Zr	ppm	234

SI unit equivalents: ppm (parts per million; 1×10^{-6}) \equiv mg/kg; ppb (parts per billion; 1×10^{-9}) \equiv μ g/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.

PERFORMANCE GATES

Table 1 above 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 (adapted from Govett, 1983) [1].

COMMINUTION AND HOMOGENISATION PROCEDURES

The material constituting OREAS 238b was prepared in the following manner:

- Drying to constant mass at 105°C;
- Crushing and milling of the barren metasediments to 98% minus 75 microns;
- Crushing and milling of the ore material to 100% minus 30 microns;
- Combining the ore and barren metasediments in appropriate proportions to achieve the target Au grade;
- Homogenisation using OREAS' novel processing technologies;
- Packaging in 60g units sealed in laminated foil pouches and 1kg units in plastic jars.

PHYSICAL PROPERTIES

OREAS 238b was tested at ORE Research & Exploration Pty Ltd's onsite facility for various physical properties. Table 3 presents these findings that should be used for informational purposes only.

Table 3. Physical properties of OREAS 238b.

Bulk Density (g/L)	Moisture%	Munsell Notation [‡]	Munsell Color [‡]
796	0.16	N7	Light Gray

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

MINERALOGY

The semi-quantitative results shown in Table 4 below have been normalised to 100 % and represent the relative proportion of crystalline material. Totals greater or less than 100 % are due to rounding errors. Some amorphous material is likely present.

Table 4. Indicative mineralogy of OREAS 238b based on semi-quantitative XRD analysis.

Mineral / Mineral Group	% (mass ratio)
Chlorite	6
Kaolinite	3
Annite-biotite-phlogopite	25
Muscovite	16
Plagioclase	3
K-feldspar	1
Quartz	44
Cordierite	1
Anatase	1

ANALYTICAL PROGRAM

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

- Gold by fire assay (25-50g charge weight) with AAS (23 laboratories), ICP-OES (6 laboratories) finish and ICP-MS (1 laboratory) finish;
- Gold by aqua regia digestion (15-50g sample weight) with ICP-OES and/or ICP-MS (23 laboratories) finish;
- Gold by cyanide leach; a variety of cyanide leach methods were undertaken by the participating laboratories including the use of LeachWELL tablets, alkaline added sodium cyanide solution as well as sodium cyanide liquor with LeachWELL powder. The sample weights included: 15g (1 laboratory by ICP-OES finish), 20g (1 laboratory by AAS finish), 30g (6 laboratories by AAS finish), 50g (2 laboratories by ICP-MS finish and 1 laboratory by AAS finish) and 200g (4 laboratories by AAS and 1 laboratory by ICP-OES/AAS finish).
- Gold by X-ray PhotonAssay with recommended gross mass 400 ± 15 g (8 Chrysos PhotonAssay units at 4 installations with two rounds of data reported from each unit);
- Full ICP-OES and ICP-MS elemental suites by 4-acid (HNO_3 -HF- HClO_4 -HCl) digestion (up to 26 laboratories depending on the element);
- Full ICP-OES and ICP-MS elemental suites by aqua regia digestion (up to 24 laboratories depending on the element).
- Instrumental neutron activation analysis (INAA) for Au on 20 x 85mg subsamples to confirm homogeneity undertaken by the Australian Nuclear Science and Technology Organisation (ANSTO) located in Lucas Heights, NSW, Australia.

For the round robin program twenty 3kg test units were taken at predetermined intervals during the bagging stage, immediately following homogenisation and are considered representative of the entire prepared batch. Six pulp samples were submitted to each laboratory for analysis (the weight provided depended on whether the laboratory was

anticipated to undertake assays by gold cyanide leach). The samples received by each laboratory were obtained by taking two samples from each of three separate 3kg 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.

STATISTICAL ANALYSIS

Standard Deviation intervals (see Table 1) 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.***

Indicative (uncertified) values (Table 2) are present where the number of laboratories reporting a particular analyte is insufficient (< 5) to support certification or where inter-laboratory consensus is poor.

Certified Values and their uncertainty intervals (Table 5) 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 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 calculation of Tolerance Limits and homogeneity evaluation (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 in the ISO Guides [7,17]. All known or suspected sources of bias have been investigated or taken into account. ***The 95% Expanded Uncertainty should not be used as control limits for laboratory performance.***

Table 5. 95% Uncertainty & Tolerance Limits for OREAS 238b.

Constituent	Certified	95% Expanded Uncertainty		95% Tolerance Limits	
	Value	Low	High	Low	High
Pb Fire Assay					
Au, Gold (ppm)	3.08	3.05	3.11	3.07*	3.10*
Aqua Regia Digestion (sample mass 10-50g)					
Au, Gold (ppm)	3.00	2.96	3.04	2.98*	3.01*
Cyanide Leach					
Au, Gold (ppm)	2.74	2.65	2.83	2.73*	2.75*
X-ray Photon Assay (recommended gross mass 400±15 g)					
Au, Gold (ppm)	3.16	3.08	3.24	3.16*	3.17*
4-Acid Digestion					
Ag, Silver (ppm)	0.245	0.218	0.272	0.225	0.265
Al, Aluminium (wt.%)	7.47	7.34	7.61	7.34	7.60
As, Arsenic (ppm)	676	653	699	658	694
Ba, Barium (ppm)	685	669	702	674	697
Be, Beryllium (ppm)	2.47	2.31	2.63	2.35	2.58
Bi, Bismuth (ppm)	0.40	0.37	0.43	0.37	0.43
Ca, Calcium (wt.%)	0.855	0.836	0.875	0.839	0.872
Cd, Cadmium (ppm)	0.097	0.072	0.122	0.093	0.101
Ce, Cerium (ppm)	81	77	84	78	83
Co, Cobalt (ppm)	17.0	16.3	17.8	16.5	17.6
Cr, Chromium (ppm)	124	117	131	119	129
Cs, Caesium (ppm)	9.52	9.17	9.86	9.20	9.83
Cu, Copper (ppm)	30.8	29.2	32.4	29.9	31.7
Dy, Dysprosium (ppm)	3.56	3.09	4.03	3.41	3.71
Er, Erbium (ppm)	1.90	1.61	2.19	1.82	1.98
Eu, Europium (ppm)	1.26	1.12	1.39	1.19	1.32
Fe, Iron (wt.%)	4.10	4.00	4.20	4.05	4.15
Ga, Gallium (ppm)	19.6	18.7	20.4	19.1	20.0
Gd, Gadolinium (ppm)	5.14	4.79	5.49	4.97	5.31
Hf, Hafnium (ppm)	3.89	3.66	4.11	3.73	4.04
Ho, Holmium (ppm)	0.66	0.55	0.77	0.63	0.68
In, Indium (ppm)	0.068	0.063	0.074	0.063	0.074
K, Potassium (wt.%)	2.69	2.63	2.75	2.64	2.74
La, Lanthanum (ppm)	38.8	37.1	40.6	37.9	39.8
Li, Lithium (ppm)	48.8	46.7	50.9	47.5	50.0
Lu, Lutetium (ppm)	0.29	0.24	0.35	0.27	0.31
Mg, Magnesium (wt.%)	1.74	1.71	1.78	1.72	1.77
Mn, Manganese (wt.%)	0.039	0.038	0.040	0.039	0.040

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

*Gold Tolerance Limits for typical 30g fire assay, 25g aqua regia digestion, 30g cyanide leach and 400±15 g PhotonAssay methods are determined from 20 x 85mg INAA results and the Sampling Constant (Ingamells & Switzer, 1973).

Note: intervals may appear asymmetric due to rounding.

Table 5 continued.

Constituent	Certified	95% Expanded Uncertainty		95% Tolerance Limits	
	Value	Low	High	Low	High
4-Acid Digestion continued					
Mo, Molybdenum (ppm)	0.90	0.85	0.95	0.84	0.96
Na, Sodium (wt.%)	0.676	0.658	0.694	0.663	0.689
Nb, Niobium (ppm)	14.3	13.5	15.1	13.9	14.8
Nd, Neodymium (ppm)	34.1	32.6	35.6	32.7	35.5
Ni, Nickel (ppm)	65	63	67	63	67
P, Phosphorus (wt.%)	0.065	0.064	0.067	0.064	0.067
Pb, Lead (ppm)	23.4	22.2	24.7	22.4	24.5
Pr, Praseodymium (ppm)	9.31	8.85	9.77	8.92	9.70
Rb, Rubidium (ppm)	159	151	166	154	164
Re, Rhenium (ppm)	< 0.002	IND	IND	IND	IND
S, Sulphur (wt.%)	0.175	0.167	0.182	0.168	0.181
Sb, Antimony (ppm)	620	603	638	607	633
Sc, Scandium (ppm)	14.3	13.5	15.1	13.8	14.7
Sm, Samarium (ppm)	6.54	6.13	6.95	6.28	6.81
Sn, Tin (ppm)	3.69	3.52	3.86	3.52	3.86
Sr, Strontium (ppm)	118	114	122	116	120
Ta, Tantalum (ppm)	1.07	1.01	1.13	1.03	1.11
Tb, Terbium (ppm)	0.67	0.62	0.72	0.63	0.72
Th, Thorium (ppm)	14.5	14.0	15.0	14.0	15.0
Ti, Titanium (wt.%)	0.461	0.446	0.477	0.450	0.473
Tl, Thallium (ppm)	0.85	0.81	0.89	0.82	0.88
Tm, Thulium (ppm)	0.27	0.22	0.31	0.25	0.28
U, Uranium (ppm)	2.74	2.63	2.84	2.64	2.83
V, Vanadium (ppm)	108	105	110	106	110
W, Tungsten (ppm)	2.80	2.56	3.04	2.66	2.94
Y, Yttrium (ppm)	16.0	14.8	17.2	15.5	16.5
Yb, Ytterbium (ppm)	1.82	1.57	2.06	1.73	1.91
Zn, Zinc (ppm)	100	96	104	98	102
Zr, Zirconium (ppm)	132	126	139	129	136
Aqua Regia Digestion					
Ag, Silver (ppm)	0.240	0.222	0.257	0.222	0.257
Al, Aluminium (wt.%)	2.62	2.50	2.74	2.58	2.66
As, Arsenic (ppm)	674	655	693	662	685
Ba, Barium (ppm)	103	97	108	99	106
Be, Beryllium (ppm)	1.17	1.09	1.25	1.12	1.22
Bi, Bismuth (ppm)	0.38	0.35	0.41	0.33	0.42
Ca, Calcium (wt.%)	0.309	0.296	0.322	0.301	0.317

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 5 continued.

Constituent	Certified	95% Expanded Uncertainty		95% Tolerance Limits	
	Value	Low	High	Low	High
Aqua Regia Digestion continued					
Cd, Cadmium (ppm)	0.080	0.067	0.093	0.076	0.084
Ce, Cerium (ppm)	55	50	59	53	57
Co, Cobalt (ppm)	15.2	14.5	15.9	14.7	15.8
Cr, Chromium (ppm)	106	102	110	104	108
Cs, Caesium (ppm)	6.85	6.49	7.21	6.62	7.08
Cu, Copper (ppm)	29.6	28.3	30.8	28.9	30.3
Fe, Iron (wt.%)	3.51	3.42	3.61	3.47	3.56
Ga, Gallium (ppm)	7.93	7.53	8.32	7.66	8.19
Ge, Germanium (ppm)	0.11	0.08	0.14	IND	IND
Hf, Hafnium (ppm)	0.54	0.47	0.61	0.51	0.57
In, Indium (ppm)	0.029	0.027	0.031	0.027	0.032
K, Potassium (wt.%)	0.870	0.845	0.896	0.857	0.883
La, Lanthanum (ppm)	27.1	24.9	29.2	26.1	28.0
Li, Lithium (ppm)	38.9	37.0	40.9	38.1	39.8
Lu, Lutetium (ppm)	0.11	0.04	0.17	IND	IND
Mg, Magnesium (wt.%)	1.41	1.37	1.46	1.39	1.44
Mn, Manganese (wt.%)	0.027	0.026	0.028	0.027	0.028
Mo, Molybdenum (ppm)	0.81	0.76	0.87	0.76	0.86
Na, Sodium (wt.%)	0.082	0.075	0.089	0.079	0.086
Nb, Niobium (ppm)	0.39	0.30	0.49	0.36	0.43
Ni, Nickel (ppm)	61	58	63	59	62
P, Phosphorus (wt.%)	0.058	0.056	0.059	0.057	0.059
Pb, Lead (ppm)	14.2	13.0	15.3	13.3	15.0
Rb, Rubidium (ppm)	83	80	87	81	86
Re, Rhenium (ppm)	< 0.001	IND	IND	IND	IND
S, Sulphur (wt.%)	0.173	0.164	0.181	0.166	0.180
Sb, Antimony (ppm)	469	426	511	457	481
Sc, Scandium (ppm)	6.24	5.96	6.53	6.09	6.40
Sn, Tin (ppm)	1.45	1.34	1.55	1.39	1.50
Sr, Strontium (ppm)	26.1	24.9	27.3	25.5	26.7
Ta, Tantalum (ppm)	< 0.01	IND	IND	IND	IND
Th, Thorium (ppm)	11.9	11.3	12.6	11.6	12.3
Ti, Titanium (wt.%)	0.143	0.135	0.150	0.138	0.147
Tl, Thallium (ppm)	0.52	0.48	0.55	0.50	0.54
U, Uranium (ppm)	1.46	1.36	1.56	1.40	1.52
V, Vanadium (ppm)	69	66	71	67	70
W, Tungsten (ppm)	0.52	0.44	0.60	0.44	0.60

SI unit equivalents: ppm (parts per million; $1 \times 10^{-6} \equiv \text{mg/kg}$; 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 5 continued.

Constituent	Certified	95% Expanded Uncertainty		95% Tolerance Limits	
	Value	Low	High	Low	High
Aqua Regia Digestion continued					
Y, Yttrium (ppm)	9.00	8.43	9.56	8.75	9.24
Yb, Ytterbium (ppm)	0.87	0.70	1.04	0.78	0.95
Zn, Zinc (ppm)	87	84	90	85	88
Zr, Zirconium (ppm)	21.3	19.6	23.0	20.5	22.0

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.

Homogeneity Evaluation

For analytes other than gold, the tolerance limits (ISO 16269:2014) shown in Table 5 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 ($p=0.95$) will have concentrations lying between 29.9 and 31.7 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 6 below shows the gold INAA data determined on 20 x 85mg subsamples of OREAS 238b. An equivalent scaled version of the results is also provided to demonstrate the level of repeatability that would be achieved if 30g fire assay determinations were undertaken without the normal measurement error associated with this methodology. 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 (i.e., sampling error) and measurement error becomes negligible. In this instance a subsample weight of 85 milligrams was employed and the 1RSD of 0.14% was calculated for a 30g fire assay sample (2.63% at 85mg weights) and confirms the high level of gold homogeneity in OREAS 238b.

Table 6. Neutron Activation Analysis of Au (in ppm) on 20 x 85mg subsamples and showing the equivalent results scaled to a 30g sample mass typical of fire assay determination.

Replicate No	Au 85mg actual	Au 30g equivalent*
1	3.223	3.330
2	3.393	3.339
3	3.461	3.342
4	3.279	3.333
5	3.255	3.331
6	3.312	3.334
7	3.464	3.342
8	3.282	3.333
9	3.292	3.333
10	3.273	3.332
11	3.310	3.334
12	3.215	3.329
13	3.379	3.338
14	3.552	3.347
15	3.397	3.339
16	3.285	3.333
17	3.270	3.332
18	3.362	3.337
19	3.392	3.339
20	3.317	3.335
Mean	3.336	3.336
Median	3.311	3.334
Std Dev.	0.088	0.005
Rel.Std.Dev.	2.63%	0.14%

*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 OREAS 238b has also been evaluated in a **nested ANOVA** of the round robin program. Each of the forty-two 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 238b. The test was performed using the following parameters:

- Gold fire assay – 180 samples (30 laboratories each providing analyses on 3 pairs of samples);
- Gold aqua regia digestion – 138 samples (23 laboratories each providing analyses on 3 pairs of samples);
- Gold cyanide leach – 102 samples (17 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 the p -value. This process derived p -values of 1.000 for Au by fire assay, 1.000 for Au by aqua regia digestion and 0.119 for Au by cyanide leach. All p -values are insignificant and the Null Hypothesis is retained. Additionally, none of the other certified values showed significant p -values.

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 238b and whether the variance between two subsamples from the same unit is statistically distinguishable from the variance of two subsamples taken from any two separate 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.

Based on the statistical analysis of the results of the inter-laboratory certification program it can be concluded that OREAS 238b is fit-for-purpose as a certified reference material (see 'Intended Use' below).

PARTICIPATING LABORATORIES

1. Actlabs, Ancaster, Ontario, Canada
2. Alex Stewart International, Mendoza, Argentina
3. ALS, Lima, Peru
4. ALS, Loughrea, Galway, Ireland
5. ALS, Perth, WA, Australia
6. ALS, Vancouver, BC, Canada
7. American Assay Laboratories, Sparks, Nevada, USA
8. ANSTO, Lucas Heights, NSW, Australia
9. ARGETEST Mineral Processing, Ankara, Central Anatolia, Turkey
10. Bureau Veritas Commodities Canada Ltd, Vancouver, BC, Canada
11. Bureau Veritas Geoanalytical, Adelaide, SA, Australia
12. Bureau Veritas Geoanalytical, Perth, WA, Australia
13. Bureau Veritas Minerals, Hermosillo, Sonora, Mexico
14. Carsurin, Cikarang, West Java, Indonesia
15. Gekko Assay Labs, Ballarat, VIC, Australia
16. Inspectorate (BV), Lima, Peru
17. Inspectorate Griffith India, Gandhidham, Gujarat, India
18. Intertek Genalysis, Perth, WA, Australia
19. Intertek Tarkwa, Tarkwa, Ghana
20. Intertek Testing Services Philippines, Cupang, Muntinlupa, Philippines

21. MinAnalytical Services, Perth, WA, Australia
22. MSALABS, Vancouver, BC, Canada
23. On Site Laboratory Services, Bendigo, VIC, Australia
24. Ontario Geological Survey, Sudbury, Ontario, Canada
25. PT Geoservices Ltd, Cikarang, Jakarta Raya, Indonesia
26. PT Intertek Utama Services, Jakarta Timur, DKI Jakarta, Indonesia
27. Reminex Centre de Recherche, Marrakesh, Marrakesh-Safi, Morocco
28. Saskatchewan Research Council, Saskatoon, Saskatchewan, Canada
29. SGS Australia Mineral Services, Perth, WA, Australia
30. SGS Canada Inc., Vancouver, BC, Canada
31. SGS del Peru, Lima, Peru
32. SGS Tarkwa, Tarkwa, Western Region, Ghana
33. Shiva Analyticals Ltd, Bangalore North, Karnataka, India
34. Skyline Assayers & Laboratories, Tucson, Arizona, USA
35. Stewart Assay & Environmental Laboratories LLC, Kara-Balta, Chüy, Kyrgyzstan

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. Au by Pb Fire Assay in OREAS 238b

SPC.1630.RR1.OREAS 238b.2.Fire Assay.Au.Lab.220904.215858.SN

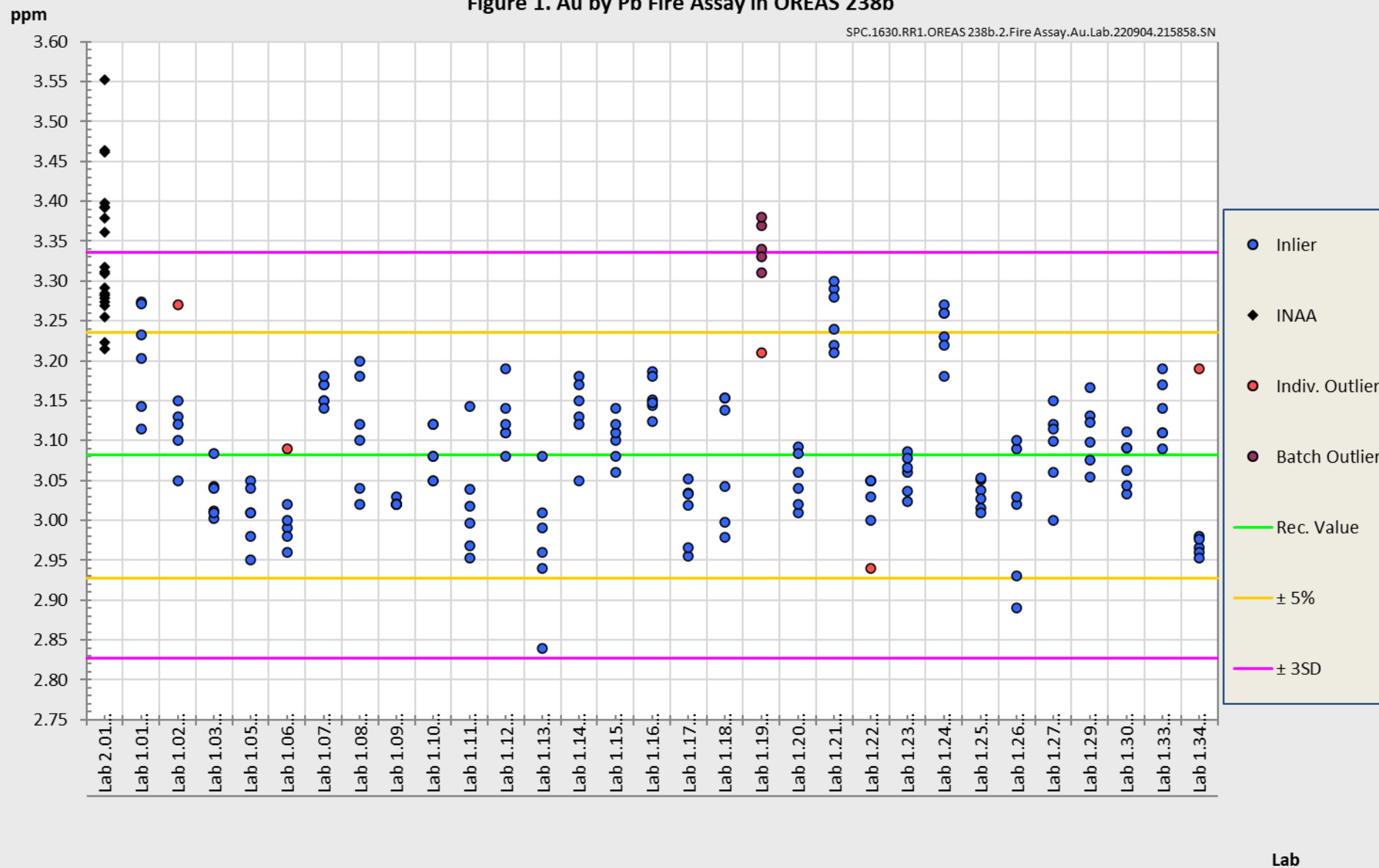
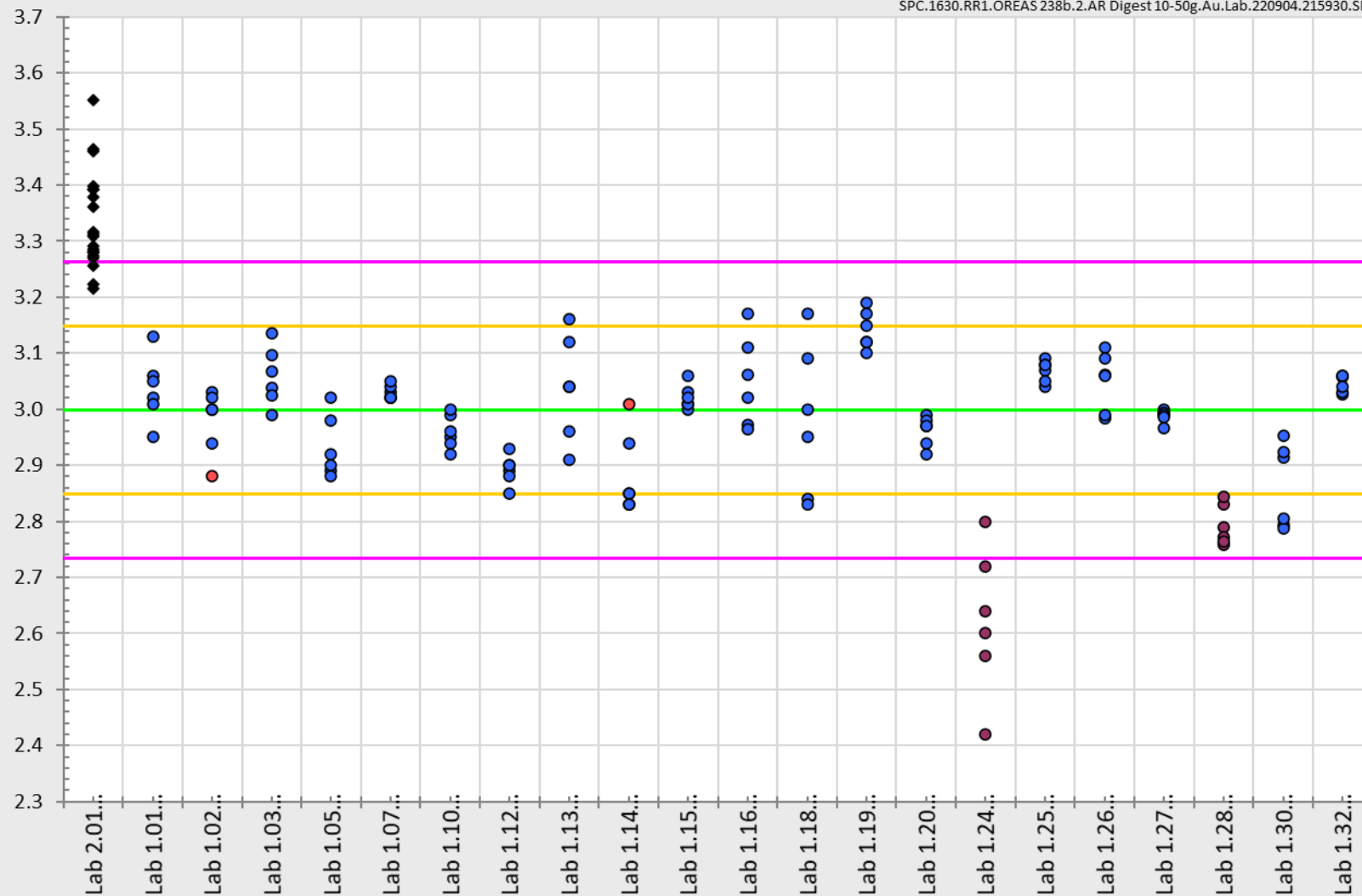


Figure 2. Au by Aqua Regia Digestion (sample weights 10-50g) in OREAS 238b

SPC.1630.RR1.OREAS 238b.2.AR Digest 10-50g.Au.Lab.220904.215930.SN

ppm



Lab

Figure 3. Au by Cyanide Leach in OREAS 238b

SPC.1630.RR1.OREAS 238b.2.CNL.Au.Lab.220904.215956.SN

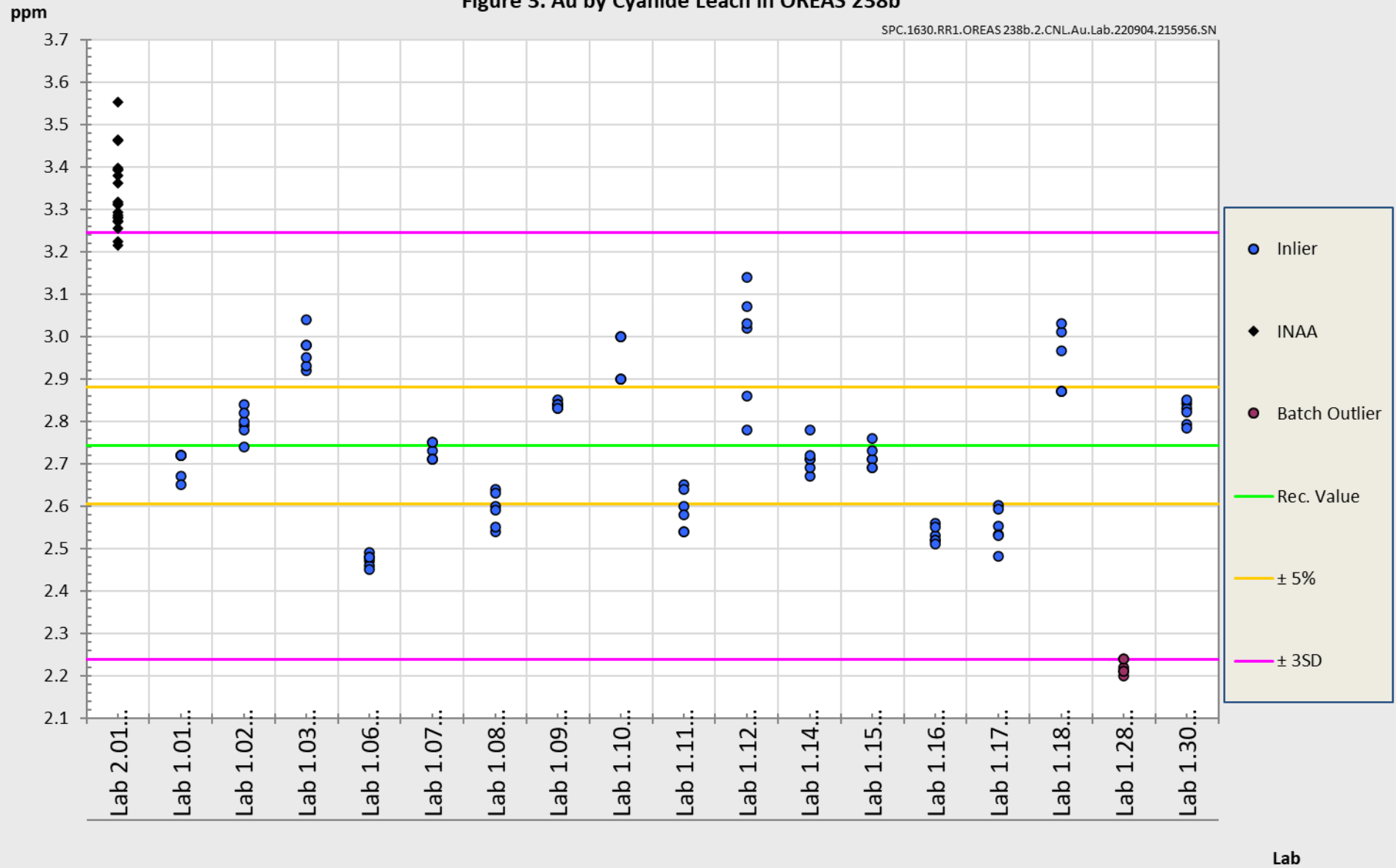
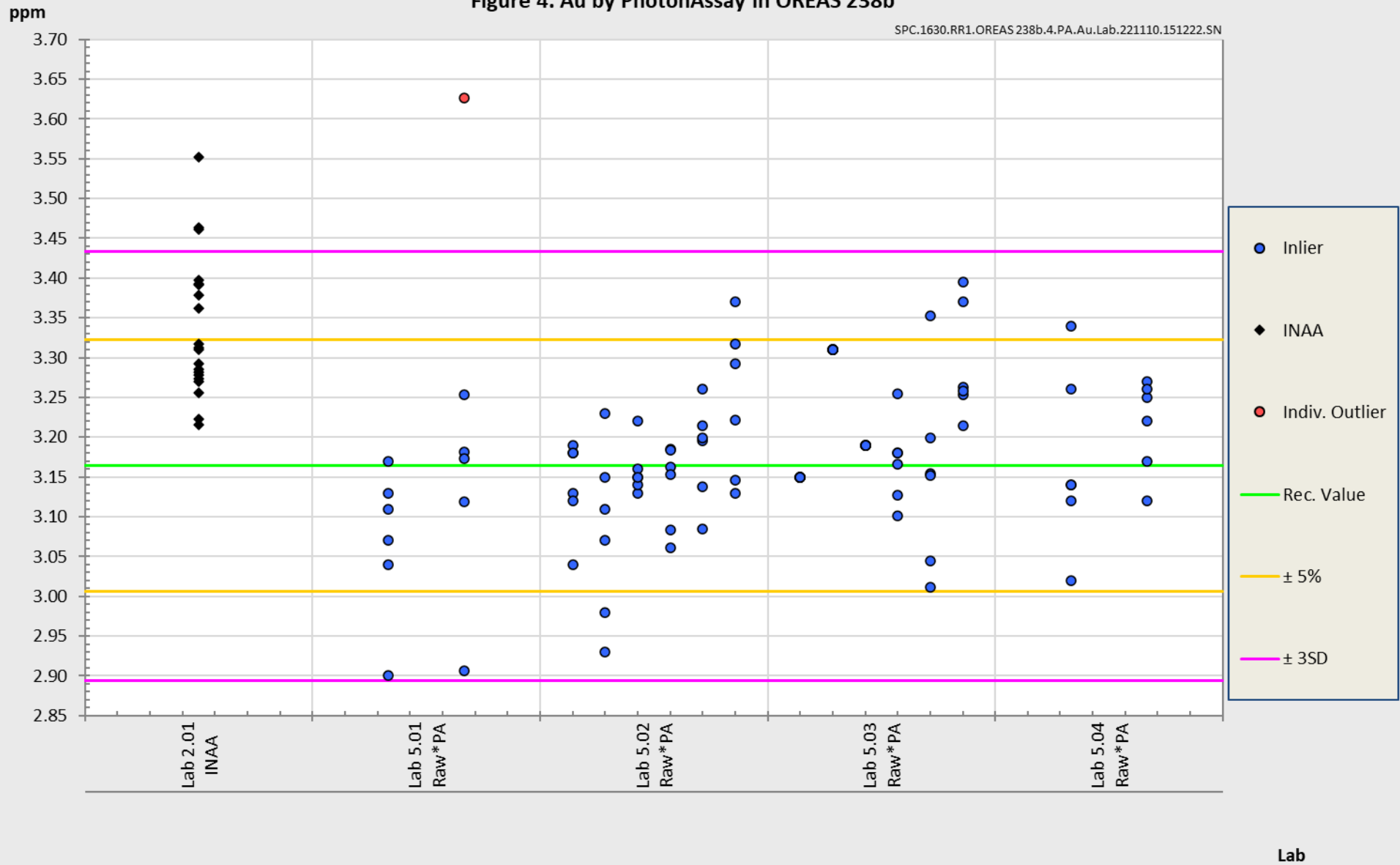


Figure 4. Au by PhotonAssay in OREAS 238b

SPC.1630.RR1.OREAS 238b.4.PA.Au.Lab.221110.151222.SN



PREPARER AND SUPPLIER

Certified reference material OREAS 238b was prepared, certified and supplied by:



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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 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 (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 238b 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 238b may be used to calibrate the entire procedure by producing a pure substance CRM transformed into a calibration solution. OREAS 238b 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.

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:

- Au by fire assay: $\geq 25\text{g}$;
- Au by aqua regia digestion: $\geq 15\text{g}$;
- Au by cyanide leach: $\geq 15\text{g}$;
- Au by PhotonAssay: recommended gross mass* $400 \pm 15\text{ g}$;
- 4-acid digestion with ICP-OES and/or MS finish: $\geq 0.25\text{g}$;
- Aqua regia digestion with ICP-OES and/or MS finish: $\geq 0.5\text{g}$.

**Gross mass refers to the mass of the entire jar assembly, including jar base, jar lid and contents. These value ranges were developed using a $\sim 40\text{g}$ empty jar mass but should be achievable for any jar-lid combination.*

PERIOD OF VALIDITY & STORAGE INSTRUCTIONS

The certification of OREAS 238b remains valid, within the specified measurement uncertainties, until September 2037, provided the CRM is handled and stored in accordance with the instructions given below. This certification is nullified if the CRM is any way changed or contaminated.

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

Long-term stability will be monitored at appropriate intervals and purchasers notified if any changes are observed. The period of validity may well be indefinite and will be reassessed prior to expiry with the aim of extending the validity if possible.

Single-use sachets

OREAS 238b is low in Sulphur (0.17 wt.% S) and is packaged in single-use laminated foil sachets. Following analysis, it is the manufacturer's expectation that any remaining material is discarded. It is the user's responsibility to prevent contamination and avoid prolonged exposure of the sample to the atmosphere prior to analysis.

Repeat-use packaging (e.g., 1kg plastic jars)

After taking a subsample, users should replace the lid of the jar promptly and securely to prevent accidental spills and airborne contamination. OREAS 238b contains a non-hygroscopic* matrix with an indicative value for moisture provided to enable users to check for changes to stored material by determining moisture in the user's laboratory and comparing the result to the value in Table 3 in this certificate.

The stability of the CRM in regard to oxidation from the breakdown of sulphide minerals to sulphates is negligible given its low sulphur concentration (0.17 wt.% S).

*A non-hygroscopic matrix means exposure to atmospheres significantly different, in terms of temperature and humidity, from the climate during manufacturing should have negligible impact on the precision of results. Hygroscopic moisture is the amount of adsorbed moisture (weakly held H₂O- molecules on the surface of exposed material) following exposure to the local atmosphere. Usually, equilibration of material to the local atmosphere will only occur if the material is spread into a thin (~2mm thick) layer and left exposed for a period of 2 hours.

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 [14].

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

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 1 are intended only to be used as an initial guide 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 then generally there is no cause for concern in regard to bias.

For use with the aqua regia digestion method

It is important to note that in the analytical industry there is no standardisation of the aqua regia digestion process. This method is a partial empirical digest and differences in recoveries for various analytes are commonplace. These are caused by variations in the digest conditions and 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.

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
2	17 th July, 2025	Updated the recommended gross mass for use in PhotonAssay analysis.
2	26 th June, 2025	Updated the recommended gross mass for use in PhotonAssay analysis.
1	10 th November, 2022	Added Au by PhotonAssay certification.
0	5 th September, 2022	First publication.

QMS ACCREDITATION

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

17th July, 2025

Craig Hamlyn (B.Sc. Hons - Geology), Technical Manager - ORE Pty Ltd

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