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CERTIFICATE OF ANALYSIS FOR

CERTIFIED REFERENCE MATERIAL

OREAS 236

Gold Ore (Frogs Leg Gold Mine, Western Australia)

Table 1. Certified Values and Performance Gates for OREAS 236.

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	1.85	0.059	1.73	1.97	1.67	2.03	3.19%	6.39%	9.58%	1.76	1.94
Aqua Regia Digestion (sample mass 10-50g)											
Au, ppm	1.75	0.087	1.58	1.93	1.49	2.01	4.99%	9.98%	14.96%	1.66	1.84
Cyanide Leach											
Au, ppm	1.79	0.048	1.70	1.89	1.65	1.94	2.66%	5.33%	7.99%	1.70	1.88
PhotonAssay (recommended gross mass 490±20 g)											
Au, ppm	1.85	0.053	1.74	1.95	1.69	2.01	2.89%	5.78%	8.68%	1.76	1.94
4-Acid Digestion											
Ag, ppm	0.478	0.058	0.363	0.594	0.305	0.651	12.06%	24.13%	36.19%	0.454	0.502
Al, wt.%	6.59	0.152	6.29	6.90	6.14	7.05	2.30%	4.60%	6.90%	6.26	6.92
As, ppm	68	4.0	60	76	56	80	5.88%	11.77%	17.65%	64	71
Ba, ppm	246	9	228	264	219	273	3.65%	7.30%	10.96%	233	258
Be, ppm	0.46	0.029	0.40	0.52	0.37	0.55	6.39%	12.78%	19.16%	0.44	0.48
Bi, ppm	0.061	0.007	0.048	0.075	0.042	0.081	10.70%	21.39%	32.09%	0.058	0.064

SI unit equivalents: ppm (parts per million; 1 x 10^{-6}) ≡ mg/kg; wt.% (weight per cent) ≡ % (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
4-Acid Digestion continued											
Ca, wt.%	5.93	0.246	5.44	6.43	5.20	6.67	4.14%	8.29%	12.43%	5.64	6.23
Cd, ppm	0.62	0.044	0.53	0.71	0.49	0.76	7.12%	14.25%	21.37%	0.59	0.65
Ce, ppm	14.0	1.36	11.2	16.7	9.9	18.0	9.74%	19.48%	29.22%	13.3	14.7
Co, ppm	41.5	2.36	36.8	46.2	34.4	48.6	5.69%	11.39%	17.08%	39.4	43.6
Cr, ppm	86	4.3	78	95	74	99	4.92%	9.85%	14.77%	82	91
Cs, ppm	1.01	0.072	0.86	1.15	0.79	1.23	7.18%	14.37%	21.55%	0.96	1.06
Cu, ppm	170	6	158	182	152	188	3.51%	7.02%	10.53%	161	178
Dy, ppm	3.94	0.264	3.41	4.47	3.15	4.73	6.70%	13.39%	20.09%	3.74	4.13
Er, ppm	2.43	0.154	2.12	2.74	1.97	2.89	6.32%	12.64%	18.96%	2.31	2.55
Eu, ppm	0.96	0.030	0.90	1.02	0.87	1.05	3.07%	6.14%	9.21%	0.92	1.01
Fe, wt.%	8.00	0.273	7.46	8.55	7.18	8.82	3.41%	6.83%	10.24%	7.60	8.40
Ga, ppm	16.1	1.6	12.8	19.4	11.2	21.1	10.21%	20.42%	30.63%	15.3	16.9
Gd, ppm	3.47	0.230	3.01	3.93	2.78	4.16	6.62%	13.24%	19.86%	3.30	3.65
Hf, ppm	1.80	0.081	1.64	1.96	1.56	2.04	4.50%	9.01%	13.51%	1.71	1.89
Ho, ppm	0.86	0.032	0.80	0.92	0.76	0.96	3.73%	7.45%	11.18%	0.82	0.90
In, ppm	0.080	0.008	0.063	0.096	0.055	0.104	10.18%	20.37%	30.55%	0.076	0.084
K, wt.%	0.559	0.019	0.521	0.597	0.502	0.616	3.41%	6.83%	10.24%	0.531	0.587
La, ppm	5.99	0.462	5.06	6.91	4.60	7.38	7.72%	15.44%	23.16%	5.69	6.29
Li, ppm	10.5	0.61	9.3	11.7	8.7	12.4	5.84%	11.69%	17.53%	10.0	11.0
Lu, ppm	0.37	0.028	0.32	0.43	0.29	0.46	7.55%	15.09%	22.64%	0.35	0.39
Mg, wt.%	3.40	0.104	3.19	3.60	3.08	3.71	3.06%	6.11%	9.17%	3.23	3.57
Mn, wt.%	0.133	0.007	0.120	0.147	0.113	0.154	5.07%	10.15%	15.22%	0.127	0.140
Mo, ppm	1.56	0.19	1.18	1.94	0.99	2.13	12.20%	24.39%	36.59%	1.48	1.64
Na, wt.%	2.15	0.056	2.04	2.27	1.99	2.32	2.60%	5.20%	7.79%	2.05	2.26
Nb, ppm	3.63	0.282	3.06	4.19	2.78	4.47	7.76%	15.53%	23.29%	3.45	3.81
Nd, ppm	9.01	0.462	8.09	9.94	7.63	10.40	5.13%	10.25%	15.38%	8.56	9.46
Ni, ppm	68	4.3	60	77	56	81	6.26%	12.52%	18.78%	65	72
P, wt.%	0.045	0.003	0.040	0.050	0.038	0.053	5.69%	11.38%	17.07%	0.043	0.048
Pb, ppm	30.5	1.99	26.5	34.5	24.5	36.5	6.53%	13.06%	19.59%	29.0	32.0
Pr, ppm	1.94	0.101	1.74	2.14	1.64	2.24	5.22%	10.44%	15.65%	1.84	2.04
Rb, ppm	14.1	0.83	12.4	15.7	11.6	16.6	5.91%	11.82%	17.73%	13.4	14.8
Re, ppm	0.003	0.001	0.001	0.004	0.000	0.005	32.25%	64.50%	96.76%	0.003	0.003
S, wt.%	0.444	0.017	0.411	0.477	0.394	0.494	3.75%	7.49%	11.24%	0.422	0.466
Sb, ppm	1.76	0.147	1.47	2.06	1.32	2.20	8.36%	16.72%	25.08%	1.67	1.85
Sc, ppm	38.5	1.91	34.7	42.3	32.8	44.2	4.96%	9.92%	14.88%	36.6	40.4
Se, ppm	< 5	IND	IND	IND	IND	IND	IND	IND	IND	IND	IND
Sm, ppm	2.71	0.171	2.37	3.05	2.19	3.22	6.32%	12.64%	18.96%	2.57	2.84
Sn, ppm	1.08	0.13	0.82	1.35	0.68	1.48	12.33%	24.66%	36.99%	1.03	1.14
Sr, ppm	95	4.9	85	105	81	110	5.10%	10.20%	15.30%	90	100
Ta, ppm	0.25	0.03	0.19	0.31	0.16	0.33	11.52%	23.04%	34.55%	0.24	0.26

SI unit equivalents: ppm (parts per million; 1 x 10^{-6}) ≡ mg/kg; wt.% (weight per cent) ≡ % (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.

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	0.62	0.036	0.54	0.69	0.51	0.72	5.78%	11.57%	17.35%	0.59	0.65
Te, ppm	0.11	0.02	0.08	0.15	0.06	0.17	15.54%	31.08%	46.63%	0.11	0.12
Th, ppm	1.10	0.11	0.87	1.33	0.76	1.44	10.34%	20.68%	31.02%	1.05	1.16
Ti, wt.%	0.639	0.026	0.586	0.692	0.559	0.718	4.15%	8.30%	12.44%	0.607	0.671
Tl, ppm	0.24	0.018	0.21	0.28	0.19	0.30	7.34%	14.69%	22.03%	0.23	0.25
Tm, ppm	0.36	0.022	0.31	0.40	0.29	0.42	6.03%	12.06%	18.09%	0.34	0.38
U, ppm	0.35	0.04	0.26	0.43	0.22	0.48	12.54%	25.09%	37.63%	0.33	0.36
V, ppm	279	15	248	310	233	325	5.50%	10.99%	16.49%	265	293
W, ppm	30.5	1.43	27.6	33.4	26.2	34.8	4.70%	9.41%	14.11%	29.0	32.0
Y, ppm	21.7	0.85	20.0	23.4	19.1	24.2	3.92%	7.84%	11.76%	20.6	22.7
Yb, ppm	2.32	0.152	2.02	2.63	1.87	2.78	6.54%	13.07%	19.61%	2.21	2.44
Zn, ppm	144	6	131	157	124	163	4.52%	9.04%	13.55%	136	151
Zr, ppm	55	3.9	47	63	43	67	7.16%	14.33%	21.49%	52	58
Aqua Regia Digestion											
Ag, ppm	0.488	0.029	0.430	0.546	0.400	0.575	5.96%	11.91%	17.87%	0.463	0.512
Al, wt.%	3.16	0.167	2.82	3.49	2.65	3.66	5.28%	10.57%	15.85%	3.00	3.31
As, ppm	67	3.4	60	73	56	77	5.10%	10.21%	15.31%	63	70
B, ppm	90	6.9	76	104	70	111	7.64%	15.28%	22.92%	86	95
Ba, ppm	35.7	2.94	29.8	41.6	26.9	44.5	8.24%	16.49%	24.73%	33.9	37.5
Be, ppm	0.26	0.020	0.22	0.30	0.20	0.32	7.73%	15.46%	23.20%	0.25	0.28
Bi, ppm	0.062	0.006	0.050	0.074	0.044	0.079	9.50%	19.00%	28.50%	0.059	0.065
Ca, wt.%	2.64	0.209	2.22	3.06	2.01	3.26	7.93%	15.86%	23.79%	2.51	2.77
Cd, ppm	0.61	0.031	0.55	0.68	0.52	0.71	5.03%	10.06%	15.10%	0.58	0.65
Ce, ppm	10.6	0.39	9.8	11.4	9.4	11.8	3.71%	7.42%	11.13%	10.1	11.2
Co, ppm	30.8	2.21	26.4	35.2	24.2	37.4	7.18%	14.37%	21.55%	29.3	32.3
Cr, ppm	32.8	1.81	29.2	36.4	27.4	38.3	5.52%	11.04%	16.57%	31.2	34.5
Cs, ppm	0.73	0.023	0.68	0.77	0.66	0.80	3.21%	6.43%	9.64%	0.69	0.76
Cu, ppm	169	6	157	182	151	188	3.66%	7.32%	10.98%	161	178
Dy, ppm	2.58	0.204	2.18	2.99	1.97	3.19	7.90%	15.79%	23.69%	2.45	2.71
Er, ppm	1.52	0.16	1.20	1.85	1.03	2.02	10.74%	21.48%	32.21%	1.45	1.60
Eu, ppm	0.58	0.08	0.42	0.74	0.34	0.82	13.79%	27.59%	41.38%	0.55	0.61
Fe, wt.%	5.95	0.217	5.52	6.38	5.30	6.60	3.64%	7.28%	10.92%	5.65	6.25
Ga, ppm	11.6	0.69	10.3	13.0	9.6	13.7	5.91%	11.82%	17.73%	11.0	12.2
Gd, ppm	2.24	0.142	1.96	2.53	1.81	2.67	6.35%	12.70%	19.06%	2.13	2.35
Ge, ppm	0.15	0.02	0.11	0.18	0.09	0.20	12.24%	24.47%	36.71%	0.14	0.15
Hf, ppm	0.54	0.045	0.45	0.63	0.41	0.68	8.38%	16.76%	25.13%	0.51	0.57
Hg, ppm	0.046	0.012	0.022	0.071	0.009	0.084	26.63%	53.25%	79.88%	0.044	0.049
Ho, ppm	0.53	0.06	0.40	0.65	0.34	0.71	11.58%	23.17%	34.75%	0.50	0.55
In, ppm	0.039	0.003	0.032	0.045	0.029	0.048	8.47%	16.95%	25.42%	0.037	0.040
K, wt.%	0.134	0.008	0.117	0.151	0.109	0.160	6.31%	12.63%	18.94%	0.128	0.141

SI unit equivalents: ppm (parts per million; 1 x 10^{-6}) ≡ mg/kg; wt.% (weight per cent) ≡ % (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											
La, ppm	4.72	0.262	4.20	5.25	3.94	5.51	5.55%	11.10%	16.65%	4.49	4.96
Li, ppm	9.28	0.440	8.40	10.16	7.96	10.60	4.74%	9.48%	14.22%	8.82	9.74
Lu, ppm	0.18	0.017	0.15	0.22	0.13	0.23	9.30%	18.59%	27.89%	0.17	0.19
Mg, wt.%	1.72	0.049	1.63	1.82	1.58	1.87	2.83%	5.66%	8.49%	1.64	1.81
Mn, wt.%	0.071	0.004	0.063	0.079	0.059	0.083	5.62%	11.23%	16.85%	0.068	0.075
Mo, ppm	1.49	0.071	1.35	1.63	1.27	1.70	4.80%	9.59%	14.39%	1.41	1.56
Na, wt.%	0.265	0.017	0.231	0.299	0.214	0.316	6.37%	12.74%	19.11%	0.252	0.278
Nb, ppm	0.16	0.05	0.07	0.25	0.02	0.30	29.25%	58.50%	87.75%	0.15	0.17
Nd, ppm	6.89	0.326	6.23	7.54	5.91	7.87	4.74%	9.48%	14.22%	6.54	7.23
Ni, ppm	48.8	3.29	42.3	55.4	39.0	58.7	6.73%	13.45%	20.18%	46.4	51.3
P, wt.%	0.045	0.001	0.042	0.048	0.040	0.049	3.26%	6.53%	9.79%	0.043	0.047
Pb, ppm	30.5	2.06	26.3	34.6	24.3	36.6	6.77%	13.54%	20.31%	28.9	32.0
Pr, ppm	1.43	0.130	1.17	1.69	1.04	1.82	9.08%	18.16%	27.24%	1.36	1.50
Rb, ppm	5.87	0.428	5.02	6.73	4.59	7.16	7.28%	14.57%	21.85%	5.58	6.17
Re, ppm	0.002	0.000	0.001	0.003	0.001	0.003	18.47%	36.94%	55.42%	0.002	0.002
S, wt.%	0.445	0.025	0.395	0.496	0.369	0.521	5.67%	11.34%	17.01%	0.423	0.467
Sb, ppm	0.90	0.31	0.28	1.52	0.00	1.83	34.64%	69.28%	103.92%	0.85	0.94
Sc, ppm	6.47	0.66	5.15	7.80	4.48	8.46	10.24%	20.49%	30.73%	6.15	6.80
Se, ppm	< 1	IND	IND	IND	IND	IND	IND	IND	IND	IND	IND
Sm, ppm	1.89	0.184	1.52	2.26	1.34	2.44	9.74%	19.49%	29.23%	1.79	1.98
Sn, ppm	0.68	0.049	0.59	0.78	0.54	0.83	7.21%	14.42%	21.64%	0.65	0.72
Sr, ppm	29.7	2.67	24.4	35.1	21.7	37.8	8.98%	17.96%	26.94%	28.3	31.2
Ta, ppm	< 0.01	IND	IND	IND	IND	IND	IND	IND	IND	IND	IND
Tb, ppm	0.39	0.021	0.35	0.43	0.32	0.45	5.38%	10.77%	16.15%	0.37	0.41
Te, ppm	0.11	0.01	0.08	0.13	0.07	0.15	12.64%	25.29%	37.93%	0.10	0.11
Th, ppm	0.88	0.057	0.76	0.99	0.71	1.05	6.50%	13.00%	19.51%	0.83	0.92
Ti, wt.%	0.387	0.061	0.265	0.509	0.204	0.570	15.76%	31.51%	47.27%	0.368	0.406
Tl, ppm	0.13	0.009	0.11	0.14	0.10	0.15	7.18%	14.37%	21.55%	0.12	0.13
Tm, ppm	0.20	0.02	0.15	0.24	0.13	0.26	10.75%	21.49%	32.24%	0.19	0.21
U, ppm	0.24	0.014	0.21	0.27	0.20	0.29	5.83%	11.66%	17.50%	0.23	0.25
V, ppm	158	10	137	179	127	190	6.63%	13.27%	19.90%	150	166
W, ppm	22.6	2.9	16.7	28.5	13.8	31.5	13.05%	26.10%	39.15%	21.5	23.7
Y, ppm	12.9	0.84	11.2	14.6	10.4	15.4	6.54%	13.08%	19.61%	12.3	13.6
Yb, ppm	1.29	0.13	1.03	1.55	0.90	1.68	10.17%	20.35%	30.52%	1.23	1.35
Zn, ppm	133	7	118	148	111	155	5.53%	11.05%	16.58%	126	139
Zr, ppm	17.8	2.1	13.7	22.0	11.6	24.1	11.73%	23.46%	35.19%	16.9	18.7

SI unit equivalents: ppm (parts per million; 1 x 10^{-6}) ≡ mg/kg; wt.% (weight per cent) ≡ % (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.

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Table 2. Indicative Values for OREAS 236.

Constituent	Unit	Value	Constituent	Unit	Value	Constituent	Unit	Value
4-Acid Digestion								
Ge	ppm	*0.12*	Hg	ppm	*< 2*			
Aqua Regia Digestion								
Pd	ppb	*< 10*	Pt	ppb	*9.80*			
Borate Fusion XRF								
Al_2O_3	wt.%	*12.67*	Fe_2O_3	wt.%	*11.81*	S	wt.%	*0.442*
As	ppm	*70*	K_2O	wt.%	*0.669*	SiO_2	wt.%	*52.79*
BaO	ppm	*285*	MgO	wt.%	*5.85*	Sn	ppm	*7.50*
CaO	wt.%	*8.56*	MnO	wt.%	*0.177*	Sr	ppm	*127*
Cl	ppm	*2705*	Na_2O	wt.%	*2.90*	TiO_2	wt.%	*1.10*
Co	ppm	*50*	Ni	ppm	*75*	V_2O_5	ppm	*570*
Cr_2O_3	ppm	*145*	P_2O_5	wt.%	*0.110*	Zn	ppm	*155*
Cu	ppm	*185*	Pb	ppm	*35.0*	Zr	ppm	*78*
Thermogravimetry								
LOI^{1000}	wt.%	*3.27*						
Infrared Combustion								
C	wt.%	*0.195*	S	wt.%	*0.380*			
Laser Ablation ICP-MS								
Ag	ppm	*0.500*	Hf	ppm	*2.11*	Sm	ppm	*2.79*
As	ppm	*67*	Ho	ppm	*0.92*	Sn	ppm	*1.10*
Ba	ppm	*258*	In	ppm	*0.075*	Sr	ppm	*95*
Be	ppm	*0.35*	La	ppm	*6.12*	Ta	ppm	*0.27*
Bi	ppm	*0.060*	Lu	ppm	*0.37*	Tb	ppm	*0.63*
Cd	ppm	*0.70*	Mn	wt.%	*0.140*	Te	ppm	*< 0.2*
Ce	ppm	*13.7*	Mo	ppm	*1.60*	Th	ppm	*1.12*
Co	ppm	*44.4*	Nb	ppm	*3.80*	Ti	wt.%	*0.659*
Cr	ppm	*103*	Nd	ppm	*9.54*	Tl	ppm	*< 0.2*
Cs	ppm	*1.00*	Ni	ppm	*75*	Tm	ppm	*0.38*
Cu	ppm	*172*	Pb	ppm	*33.0*	U	ppm	*0.38*
Dy	ppm	*4.08*	Pr	ppm	*2.07*	V	ppm	*300*
Er	ppm	*2.60*	Rb	ppm	*14.1*	W	ppm	*32.8*
Eu	ppm	*0.99*	Re	ppm	*< 0.01*	Y	ppm	*23.0*
Ga	ppm	*15.8*	Sb	ppm	*1.85*	Yb	ppm	*2.53*
Gd	ppm	*3.52*	Sc	ppm	*39.5*	Zn	ppm	*153*
Ge	ppm	*1.43*	Se	ppm	*< 5*	Zr	ppm	*72*

SI unit equivalents: ppb (parts per billion; 1 x 10^{-9}) ≡ µg/kg; ppm (parts per million; 1 x 10^{-6}) ≡ mg/kg; wt.% (weight per cent) ≡ % (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.

INTRODUCTION

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

Table 1 provides performance gate intervals for the certified values based on their pooled 1SD’s. Table 2 shows indicative values including major and trace element characterisation by Bureau Veritas in Perth, Western Australia which includes:

- Major oxides by lithium borate fusion with X-ray fluorescence;
- LOI at 1000°C by thermogravimetric analyser;
- Total Carbon and Sulphur by infrared combustion furnace;
- Trace elements by laser ablation (on the fused bead) with ICP-MS finish.

Table 3 provides some indicative physical properties and Table 4 presents the 95% confidence and tolerance limits for all certified values. Gold homogeneity (via INAA) is shown in Table 5 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 (PDM[3]) are presented in the detailed certification data for this CRM (**OREAS 236-DataPack.1.2.230609_102808.xlsx**).

Results are also presented in scatter plots for gold by fire assay, aqua regia digestion, cyanide leach and PhotonAssay (Figures 1 to 4, respectively) together with ±3SD (magenta) and ±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 236 was prepared from a blend of gold ore and barren greenstone. The ore was sourced from the Frogs Leg Gold Mine located 19km west of Kalgoorlie in Western Australia. The Cambrian greenstone was sourced from a quarry 145km north of Melbourne, Australia.

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) ± 10%.

i.e., Certified Value ± 10% ± 2DL (adapted from Govett, 1983).

COMMINUTION AND HOMOGENISATION PROCEDURES

The material constituting OREAS 236 was prepared in the following manner:

- Drying the gold ore and greenstone to constant mass at 105°C;
- Crushing and multi stage milling of gold ore to 100% minus 30 microns;
- Crushing and multi stage milling of greenstone to >98% minus 75 microns;
- Final homogenisation;
- Packaging in 1kg units in plastic jars.

PHYSICAL PROPERTIES

OREAS 236 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 236.

Bulk Density (g/L)	Moisture%	Munsell Notation‡	Munsell Color‡
824	0.70	5GY 6/1	Greenish Gray

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

ANALYTICAL PROGRAM

Thirty-one 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 (21 laboratories) and ICP-OES (5 laboratories) finish;
- Gold by aqua regia digestion (15-50g sample weight) with ICP-OES and/or ICP-MS (22 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: 20g (1 laboratory by AAS finish), 30g (4 laboratories by AAS finish), 50g (3 laboratories by ICP-MS finish and 1 laboratory by AAS finish),

60g (1 laboratory by ICP-MS finish) and 200g (5 laboratories by AAS and 1 laboratory by ICP-MS finish).

- Gold by x-ray PhotonAssay with recommended gross mass 490±20 g (12 Chrysos PhotonAssay units at 7 laboratories 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 23 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).

To confirm homogeneity, gold by instrumental neutron activation analysis (INAA) was undertaken on 20 x 85mg subsamples by the Australian Nuclear Science and Technology Organisation (ANSTO) located in Lucas Heights, NSW, Australia (see Table 5 in the 'Homogeneity Evaluation' section below).

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.

For the Au by PhotonAssay (PA) characterisation program, a 1kg sample was provided for analysis to each PA equipped laboratory. Each 1kg sample underwent the following preparation and analysis:

1. Send 1kg of each candidate reference material to each PA equipped laboratory.
2. From the 1kg sample provided, Chrysos staff prepare two PA jars (~350g each), conduct weight/fill measurements and run both samples through PA machine three times to get a total of 6 measurements.
3. Material is returned to 1kg tub.
4. Steps 2-3 are repeated for each machine operating at that laboratory (3 machines for Intertek Perth, 2 machines at ALS Perth, 3 machines at ALS Kalgoorlie; 1 machine for the other laboratories).
5. 1kg tub of material is then handed over to the internal staff to repeat steps 2-4.

For certification purposes, the steps above generate a total of 144 results from seven participating PA equipped laboratories.

STATISTICAL ANALYSIS

Certified Values and their uncertainty intervals (Table 4 below) have been determined for each analyte following removal of individual, laboratory dataset (batch) and 3SD outliers (single iteration).

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

Certified Values are the means of accepted laboratory means after outlier filtering and are the present best estimate of the true value. The INAA data (Table 5) 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 236 (see ‘Homogeneity Evaluation’ section below).

The 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 ISO Guides [6,16]. All known or suspected sources of bias have been investigated or taken into account.

Indicative (uncertified) values (Table 2) are present where the number of laboratories reporting a particular analyte is insufficient (< 5) to support certification. These major and trace element characterisation values are presented for informational purposes only.

Standard Deviation intervals (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.

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

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

The standard deviation is then calculated for each analyte from the pooled accepted analyses generated from the certification program.

Homogeneity Evaluation

For analytes other than gold, the tolerance limits (ISO 16269:2014) shown in Table 4 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 166 and 173 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. Certified Values, Uncertainty & Tolerance Intervals for OREAS 236.

Constituent	Certified	95% Expanded Uncertainty		95% Tolerance Limits	
	Value	Low	High	Value	Low
Pb Fire Assay					
Au, Gold (ppm)	1.85	1.83	1.87	1.84*	1.86*
Aqua Regia Digestion (sample mass 10-50g)					
Au, Gold (ppm)	1.75	1.71	1.79	1.74*	1.76*
Cyanide Leach					
Au, Gold (ppm)	1.79	1.77	1.82	1.79*	1.80*
PhotonAssay (recommended gross mass 490±20 g)					
Au, Gold (ppm)	1.85	1.83	1.87	1.84*	1.85*
4-Acid Digestion					
Ag, Silver (ppm)	0.478	0.433	0.524	0.452	0.504
Al, Aluminium (wt.%)	6.59	6.45	6.74	6.49	6.69
As, Arsenic (ppm)	68	65	71	66	69
Ba, Barium (ppm)	246	239	253	242	250
Be, Beryllium (ppm)	0.46	0.43	0.49	0.42	0.50
Bi, Bismuth (ppm)	0.061	0.053	0.070	IND	IND
Ca, Calcium (wt.%)	5.93	5.78	6.09	5.84	6.03
Cd, Cadmium (ppm)	0.62	0.58	0.67	0.59	0.65
Ce, Cerium (ppm)	14.0	13.1	14.8	13.5	14.4
Co, Cobalt (ppm)	41.5	40.2	42.8	40.6	42.4
Cr, Chromium (ppm)	86	83	90	84	89
Cs, Caesium (ppm)	1.01	0.93	1.09	0.96	1.05
Cu, Copper (ppm)	170	165	174	166	173
Dy, Dysprosium (ppm)	3.94	3.70	4.18	3.78	4.09
Er, Erbium (ppm)	2.43	2.29	2.57	2.35	2.51
Eu, Europium (ppm)	0.96	0.91	1.01	0.93	1.00
Fe, Iron (wt.%)	8.00	7.79	8.22	7.87	8.14
Ga, Gallium (ppm)	16.1	15.2	17.1	15.7	16.5
Gd, Gadolinium (ppm)	3.47	3.23	3.72	3.33	3.62
Hf, Hafnium (ppm)	1.80	1.68	1.92	1.70	1.90
Ho, Holmium (ppm)	0.86	0.81	0.91	0.83	0.88
In, Indium (ppm)	0.080	0.071	0.088	0.073	0.086
K, Potassium (wt.%)	0.559	0.540	0.578	0.550	0.568
La, Lanthanum (ppm)	5.99	5.67	6.30	5.81	6.16
Li, Lithium (ppm)	10.5	10.1	10.9	10.2	10.8
Lu, Lutetium (ppm)	0.37	0.34	0.40	0.35	0.39
Mg, Magnesium (wt.%)	3.40	3.32	3.48	3.35	3.44
Mn, Manganese (wt.%)	0.133	0.129	0.138	0.131	0.135

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

*Gold Tolerance Limits for typical 30g fire assay, 25g aqua regia digestion, 200g cyanide leach and 490±20g PhotonAssay methods are determined from 20 x 85mg INAA results and the Sampling Constant (Ingamells & Switzer, 1973).
IND: indeterminate (due to limited reading resolution of the methods employed).
Note: intervals may appear asymmetric due to rounding.

Table 4 continued.

Constituent	Certified	95% Expanded Uncertainty		95% Tolerance Limits	
	Value	Low	High	Value	Low
4-Acid Digestion continued					
Mo, Molybdenum (ppm)	1.56	1.43	1.69	1.48	1.64
Na, Sodium (wt.%)	2.15	2.09	2.22	2.12	2.19
Nb, Niobium (ppm)	3.63	3.40	3.86	3.48	3.77
Nd, Neodymium (ppm)	9.01	8.56	9.47	8.82	9.20
Ni, Nickel (ppm)	68	66	71	67	70
P, Phosphorus (wt.%)	0.045	0.044	0.047	0.044	0.046
Pb, Lead (ppm)	30.5	29.1	31.8	29.6	31.4
Pr, Praseodymium (ppm)	1.94	1.79	2.09	1.88	2.00
Rb, Rubidium (ppm)	14.1	13.4	14.7	13.7	14.4
Re, Rhenium (ppm)	0.003	0.001	0.004	IND	IND
S, Sulphur (wt.%)	0.444	0.430	0.458	0.434	0.454
Sb, Antimony (ppm)	1.76	1.65	1.88	1.67	1.85
Sc, Scandium (ppm)	38.5	37.2	39.8	37.3	39.7
Se, Selenium (ppm)	< 5	IND	IND	IND	IND
Sm, Samarium (ppm)	2.71	2.47	2.94	2.62	2.80
Sn, Tin (ppm)	1.08	0.95	1.22	IND	IND
Sr, Strontium (ppm)	95	92	98	93	97
Ta, Tantalum (ppm)	0.25	0.22	0.27	0.23	0.27
Tb, Terbium (ppm)	0.62	0.57	0.66	0.59	0.64
Te, Tellurium (ppm)	0.11	0.09	0.14	IND	IND
Th, Thorium (ppm)	1.10	1.02	1.18	1.05	1.15
Ti, Titanium (wt.%)	0.639	0.619	0.658	0.623	0.654
Tl, Thallium (ppm)	0.24	0.23	0.26	0.23	0.25
Tm, Thulium (ppm)	0.36	0.33	0.39	0.34	0.37
U, Uranium (ppm)	0.35	0.31	0.38	0.32	0.37
V, Vanadium (ppm)	279	269	290	271	288
W, Tungsten (ppm)	30.5	29.4	31.7	29.5	31.6
Y, Yttrium (ppm)	21.7	21.0	22.4	21.3	22.0
Yb, Ytterbium (ppm)	2.32	2.18	2.47	2.28	2.37
Zn, Zinc (ppm)	144	139	148	141	146
Zr, Zirconium (ppm)	55	52	57	53	57
Aqua Regia Digestion					
Ag, Silver (ppm)	0.488	0.460	0.515	0.467	0.508
Al, Aluminium (wt.%)	3.16	3.04	3.27	3.09	3.22
As, Arsenic (ppm)	67	64	69	65	68
B, Boron (ppm)	90	84	97	88	92

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

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

Table 4 continued.

Constituent	Certified	95% Expanded Uncertainty		95% Tolerance Limits	
	Value	Low	High	Value	Low
Aqua Regia Digestion continued					
Ba, Barium (ppm)	35.7	33.8	37.5	34.7	36.7
Be, Beryllium (ppm)	0.26	0.24	0.29	0.23	0.29
Bi, Bismuth (ppm)	0.062	0.055	0.069	IND	IND
Ca, Calcium (wt.%)	2.64	2.52	2.75	2.57	2.70
Cd, Cadmium (ppm)	0.61	0.58	0.65	0.58	0.65
Ce, Cerium (ppm)	10.6	10.3	11.0	10.4	10.9
Co, Cobalt (ppm)	30.8	29.5	32.1	29.9	31.7
Cr, Chromium (ppm)	32.8	31.5	34.1	32.0	33.6
Cs, Caesium (ppm)	0.73	0.70	0.75	0.71	0.74
Cu, Copper (ppm)	169	165	174	166	173
Dy, Dysprosium (ppm)	2.58	2.30	2.86	2.45	2.72
Er, Erbium (ppm)	1.52	1.29	1.76	1.31	1.74
Eu, Europium (ppm)	0.58	0.47	0.69	0.54	0.62
Fe, Iron (wt.%)	5.95	5.80	6.10	5.86	6.04
Ga, Gallium (ppm)	11.6	11.1	12.1	11.2	12.0
Gd, Gadolinium (ppm)	2.24	2.02	2.47	2.12	2.36
Ge, Germanium (ppm)	0.15	0.12	0.17	IND	IND
Hf, Hafnium (ppm)	0.54	0.50	0.58	0.52	0.56
Hg, Mercury (ppm)	0.046	0.034	0.059	0.027	0.066
Ho, Holmium (ppm)	0.53	0.44	0.61	IND	IND
In, Indium (ppm)	0.039	0.032	0.045	0.034	0.043
K, Potassium (wt.%)	0.134	0.128	0.141	0.130	0.139
La, Lanthanum (ppm)	4.72	4.53	4.92	4.59	4.85
Li, Lithium (ppm)	9.28	8.93	9.63	9.03	9.53
Lu, Lutetium (ppm)	0.18	0.16	0.20	IND	IND
Mg, Magnesium (wt.%)	1.72	1.69	1.76	1.70	1.75
Mn, Manganese (wt.%)	0.071	0.069	0.074	0.070	0.072
Mo, Molybdenum (ppm)	1.49	1.42	1.56	1.43	1.54
Na, Sodium (wt.%)	0.265	0.255	0.275	0.257	0.273
Nb, Niobium (ppm)	0.16	0.12	0.20	IND	IND
Nd, Neodymium (ppm)	6.89	6.40	7.37	6.68	7.10
Ni, Nickel (ppm)	48.8	46.9	50.8	47.8	49.9
P, Phosphorus (wt.%)	0.045	0.043	0.046	0.044	0.046
Pb, Lead (ppm)	30.5	29.2	31.7	29.3	31.6
Pr, Praseodymium (ppm)	1.43	1.24	1.61	1.32	1.54
Rb, Rubidium (ppm)	5.87	5.55	6.19	5.65	6.09

SI unit equivalents: ppm (parts per million; 1 x 10^{-6}) ≡ mg/kg; wt.% (weight per cent) ≡ % (mass fraction).
IND: indeterminate (due to limited reading resolution of the methods employed).
Note: intervals may appear asymmetric due to rounding.

Table 4 continued.

Constituent	Certified	95% Expanded Uncertainty		95% Tolerance Limits	
	Value	Low	High	Value	Low
Aqua Regia Digestion continued					
Re, Rhenium (ppm)	0.002	0.001	0.003	IND	IND
S, Sulphur (wt.%)	0.445	0.429	0.462	0.434	0.456
Sb, Antimony (ppm)	0.90	0.74	1.06	0.82	0.98
Sc, Scandium (ppm)	6.47	6.03	6.92	6.22	6.73
Se, Selenium (ppm)	< 1	IND	IND	IND	IND
Sm, Samarium (ppm)	1.89	1.65	2.12	1.76	2.01
Sn, Tin (ppm)	0.68	0.62	0.75	IND	IND
Sr, Strontium (ppm)	29.7	28.2	31.3	28.9	30.6
Ta, Tantalum (ppm)	< 0.01	IND	IND	IND	IND
Tb, Terbium (ppm)	0.39	0.36	0.41	0.37	0.41
Te, Tellurium (ppm)	0.11	0.09	0.12	IND	IND
Th, Thorium (ppm)	0.88	0.81	0.95	0.83	0.92
Ti, Titanium (wt.%)	0.387	0.356	0.418	0.375	0.399
Tl, Thallium (ppm)	0.13	0.12	0.14	IND	IND
Tm, Thulium (ppm)	0.20	0.17	0.22	IND	IND
U, Uranium (ppm)	0.24	0.23	0.25	0.23	0.25
V, Vanadium (ppm)	158	152	165	154	162
W, Tungsten (ppm)	22.6	20.6	24.6	21.8	23.4
Y, Yttrium (ppm)	12.9	12.4	13.5	12.5	13.3
Yb, Ytterbium (ppm)	1.29	1.13	1.45	1.17	1.41
Zn, Zinc (ppm)	133	129	137	130	136
Zr, Zirconium (ppm)	17.8	16.5	19.2	17.0	18.6

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

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

Note: intervals may appear asymmetric due to rounding.

Table 5. 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	1.853	1.901
2	1.904	1.904
3	1.943	1.906
4	1.951	1.906
5	1.822	1.899
6	1.782	1.897
7	1.937	1.906
8	1.859	1.901
9	1.998	1.909
10	1.953	1.906
11	1.905	1.904
12	1.930	1.905
13	1.894	1.903
14	1.987	1.908
15	1.906	1.904
16	1.884	1.903
17	1.969	1.907
18	1.858	1.901
19	1.852	1.901
20	1.887	1.903
Mean	1.904	1.904
Median	1.905	1.904
Std Dev.	0.056	0.003
Rel.Std.Dev.	**2.95%**	**0.158%**

*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

Table 5 below shows the gold INAA data determined on 20 x 85mg subsamples of OREAS 230. 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 0.158% was calculated for a 30g fire assay sample (2.95% at 85mg weights) and confirms the high level of gold homogeneity in OREAS 236.

The homogeneity of OREAS 236 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 236. The test was performed using the following parameters:

- Gold fire assay – 156 samples (26 laboratories each providing analyses on 3 pairs of samples);
- Gold aqua regia digestion – 132 samples (22 laboratories each providing analyses on 3 pairs of samples);
- Gold cyanide leach – 108 samples (18 laboratories each providing analyses on 3 pairs of samples);
- Gold PhotonAssay – 48 samples (Chrysos and internal staff both conduct triplicate analysis of 2 PA jars across 12 PA machines [installed across 7 laboratories]);
- 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 0.981 for Au by fire assay, 0.995 for Au by aqua regia digestion, 0.526 for Au by cyanide leach and 0.183 for Au by PhotonAssay.. 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 236 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 236 is fit-for-purpose as a certified reference material (see 'Intended Use' below).

PREPARER AND SUPPLIER

Certified reference material OREAS 236 was prepared, certified and supplied by:

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4. ALS, Kalgoorlie, WA, Australia
5. ALS, Lima, Peru
6. ALS, Loughrea, Galway, Ireland
7. ALS, Perth, WA, Australia
8. ALS, Vancouver, BC, Canada
9. ANSTO, Lucas Heights, NSW, Australia
10. Bureau Veritas Commodities Canada Ltd, Vancouver, BC, Canada
11. Bureau Veritas Geoanalytical, Perth, WA, Australia
12. CRS Laboratories Oy, Kempele, Northern Ostrobothnia, Finland
13. ESAN Istanbul, Istanbul, Turkey
14. Inspectorate (BV), Lima, Peru
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22. On Site Laboratory Services, Bendigo, VIC, Australia
23. Ostrea Mineral Laboratories, Inc., Laguna, Philippines
24. PT Geoservices Ltd, Cikarang, Jakarta Raya, Indonesia
25. PT Intertek Utama Services, Jakarta Timur, DKI Jakarta, Indonesia
26. Ravenswood Gold, Ravenswood, QLD, Australia
27. Reminex Centre de Recherche, Marrakesh, Marrakesh-Safi, Morocco
28. SGS, Randfontein, Gauteng, South Africa
29. SGS Canada Inc., Vancouver, BC, Canada
30. SGS del Peru, Lima, Peru
31. SGS Tarkwa, Tarkwa, Western Region, Ghana
32. Shiva Analyticals Ltd, Bangalore North, Karnataka, India
33. Skyline Assayers & Laboratories, Tucson, Arizona, USA

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

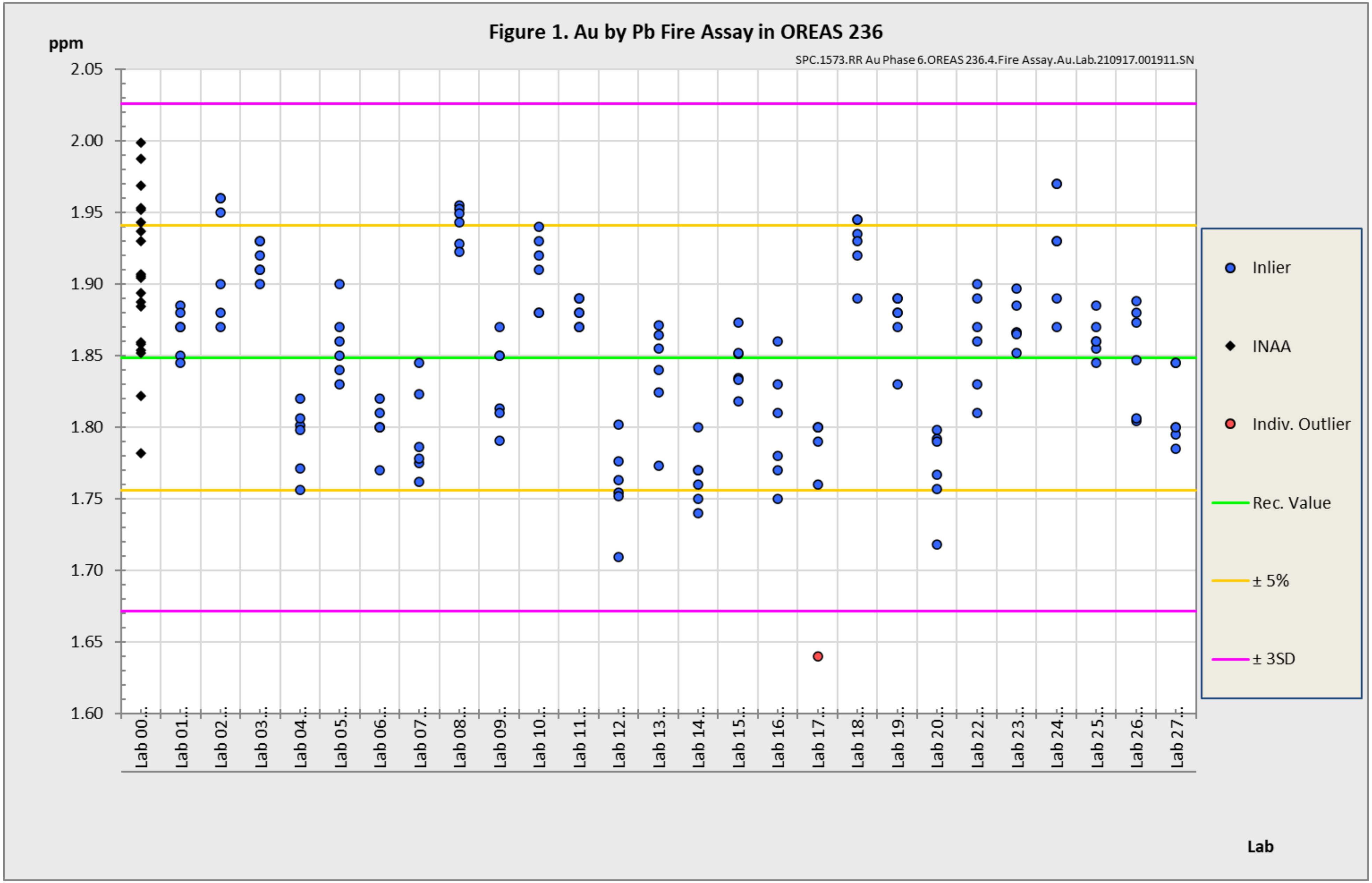
Figure 1. Au by Pb Fire Assay in OREAS 236
SPC.1573.RR Au Phase 6.OREAS 236.4.Fire Assay.Au.Lab.210917.001911.SN
ppm
2.05
2.00
1.95
1.90
1.85
1.80
1.75
1.70
1.65
1.60
Lab 00...
Lab 01...
Lab 02...
Lab 03...
Lab 04...
Lab 05...
Lab 06...
Lab 07...
Lab 08...
Lab 09...
Lab 10...
Lab 11...
Lab 12...
Lab 13...
Lab 14...
Lab 15...
Lab 16...
Lab 17...
Lab 18...
Lab 19...
Lab 20...
Lab 22...
Lab 23...
Lab 24...
Lab 25...
Lab 26...
Lab 27...
Lab
Inlier
INAA
Indiv. Outlier
Rec. Value
± 5%
± 3SD

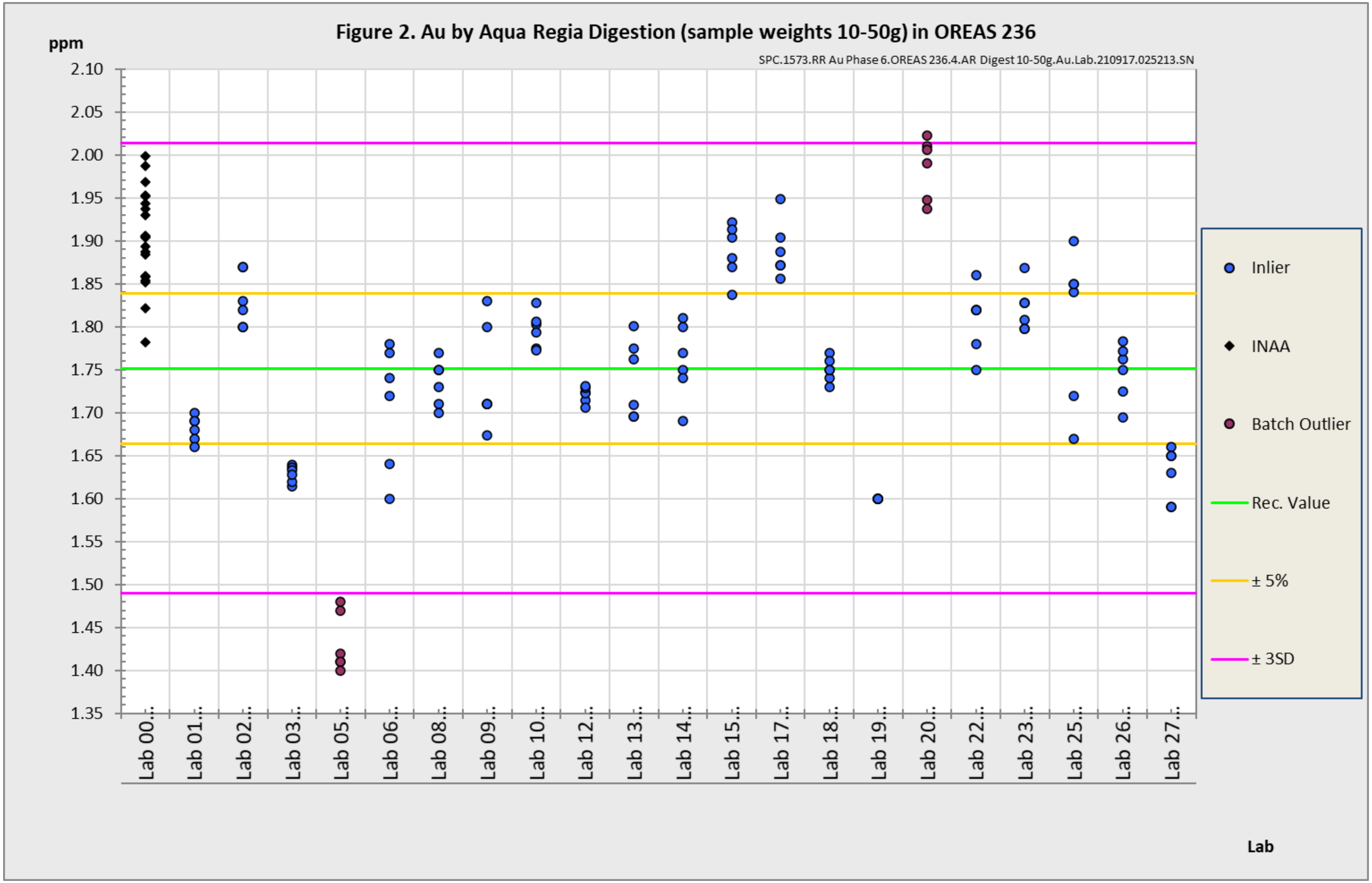
Figure 2. Au by Aqua Regia Digestion (sample weights 10-50g) in OREAS 236
SPC.1573.RR Au Phase 6.OREAS 236.4.AR Digest 10-50g.Au.Lab.210917.025213.SN
ppm
2.10
2.05
2.00
1.95
1.90
1.85
1.80
1.75
1.70
1.65
1.60
1.55
1.50
1.45
1.40
1.35
Lab 00...
Lab 01...
Lab 02...
Lab 03...
Lab 05...
Lab 06...
Lab 08...
Lab 09...
Lab 10...
Lab 12...
Lab 13...
Lab 14...
Lab 15...
Lab 17...
Lab 18...
Lab 19...
Lab 20...
Lab 22...
Lab 23...
Lab 25...
Lab 26...
Lab 27...
Inlier
INAA
Batch Outlier
Rec. Value
± 5%
± 3SD
Lab

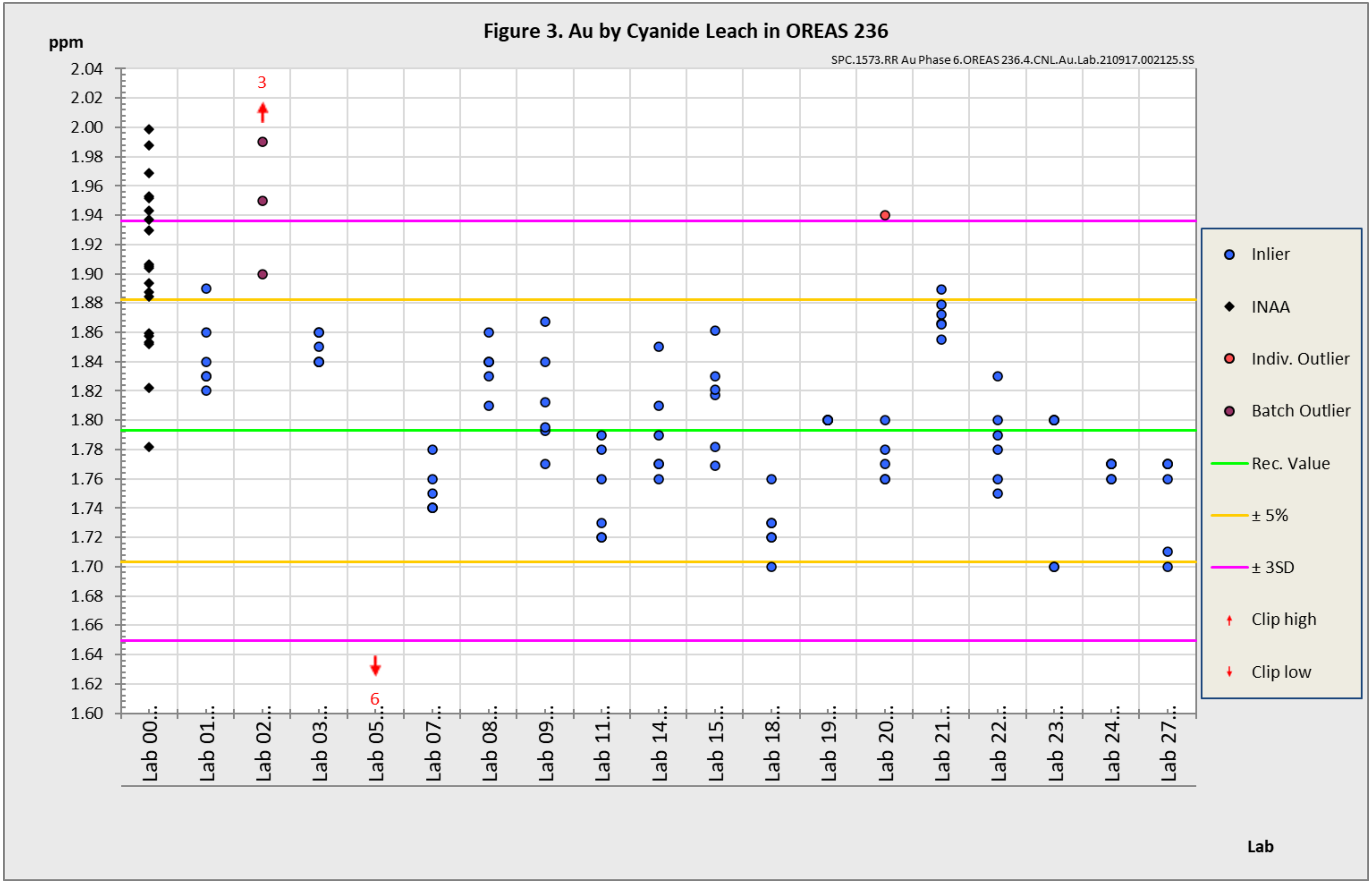

Figure 3. Au by Cyanide Leach in OREAS 236

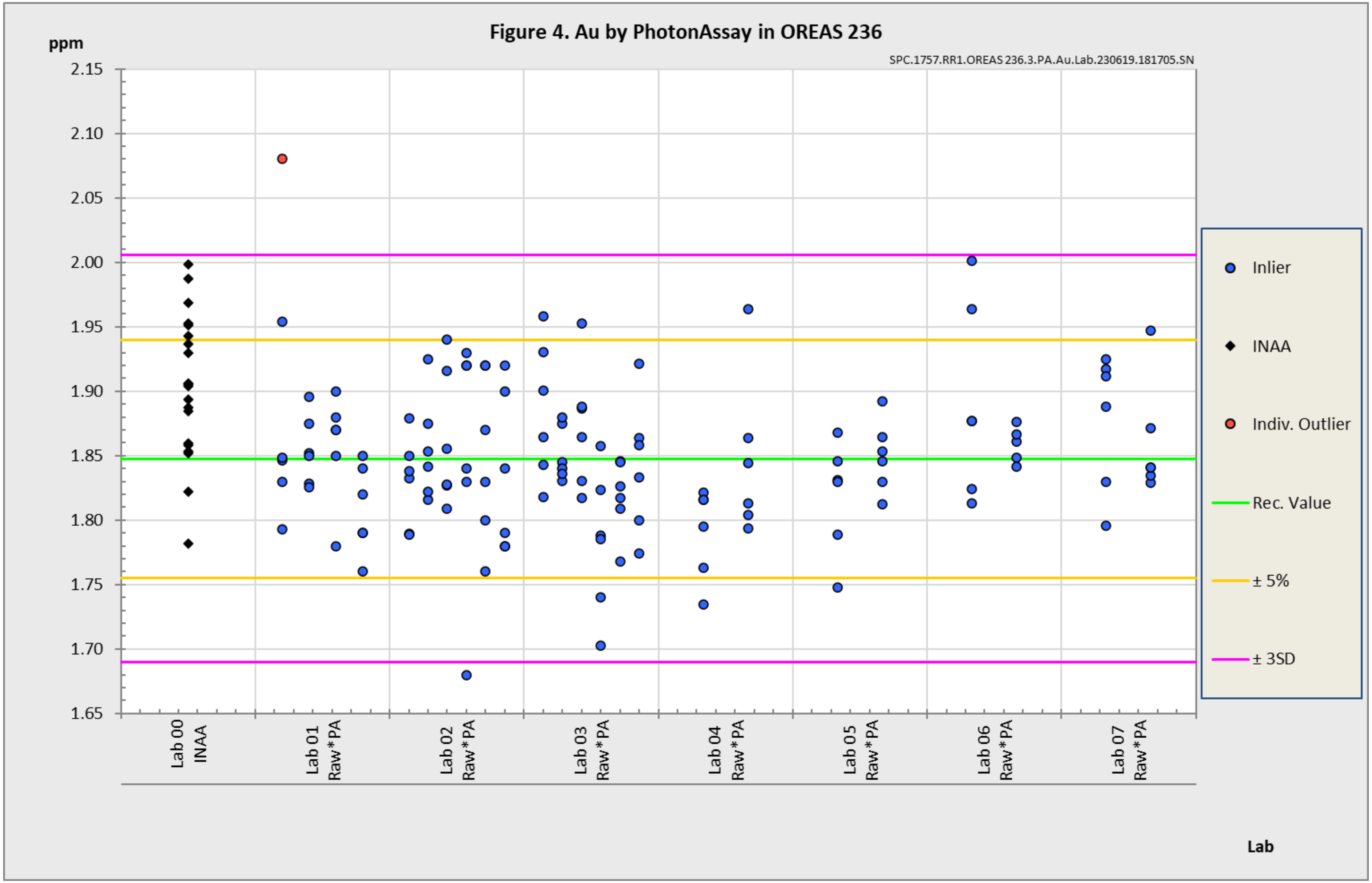
Figure 4. Au by PhotonAssay in OREAS 236
ppm
SPC.1757.RR1.OREAS 236.3.PA.Au.Lab.230619.181705.SN
2.15
2.10
2.05
2.00
1.95
1.90
1.85
1.80
1.75
1.70
1.65
Lab 00
INAA
Lab 01
Raw*PA
Lab 02
Raw*PA
Lab 03
Raw*PA
Lab 04
Raw*PA
Lab 05
Raw*PA
Lab 06
Raw*PA
Lab 07
Raw*PA
Inlier
INAA
Indiv. Outlier
Rec. Value
± 5%
± 3SD
Lab

METROLOGICAL TRACEABILITY

The analytical samples were selected in a manner representative of the entire batch of the 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 236 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 236 may be used to calibrate the entire procedure by producing a pure substance CRM transformed into a calibration solution.

OREAS 236 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 236 is low in reactive sulphide (0.38 wt.% S) and in its unopened state and under normal conditions of storage has a shelf life beyond ten years. Its stability will be monitored at regular intervals and purchasers notified if any changes are observed.

Single-use sachets

Following analysis of the CRM subsample it is the manufacturers' expectation that any remaining material is discarded. The stability of the material after opening the sachet is not within the scope of proper use. However, if opened sachets are resealed after opening, then under ordinary* storage conditions the CRM will have a shelf-life beyond ten years.

**ordinary storage conditions: means storage not in direct sunlight in a dry, clean, well ventilated area at temperatures between -5° and 50°C.*

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

The stability of the CRM after opening the lid of the plastic jar is only affected by local atmospheric conditions with regard to oxidation and hygroscopic change. There is no segregation affect (please see our Technical Note on Particle Segregation).

The primary cause of change through oxidation is in relation to the breakdown of sulphide minerals to sulphates and is negligible for OREAS 236 given its low sulphur concentration (0.38 wt.% S).

Hygroscopic change is the amount of absorbed moisture (weakly held H_2O- 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. OREAS 236 contains a non-hygroscopic matrix and therefore, exposure to a local atmosphere that is significantly different (in terms of temperature and humidity) from the climate during manufacturing will have negligible impact on the precision of results. The 'Physical Properties' section indicates the approximate moisture concentration.

INSTRUCTIONS FOR CORRECT USE

The certified values for OREAS 236 refer to the concentration level in its packaged state. It should not be dried prior to weighing and analysis. 1kg jars permit repeated sampling as long as the lid is promptly re-secured to prevent airborne contamination.

Minimum sample size

As a practical guide, 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 sample masses should be used depending on the operationally defined methodology.

- Au by fire assay: ≥25g;
- Au by aqua regia digestion: ≥15g;
- Au by cyanide leach: ≥20g;
- Au by PhotonAssay: recommended gross mass* 490±20 g;
- 4-acid digestion with ICP-OES and/or MS finish: ≥0.25g;
- Aqua regia digestion with ICP-OES and/or MS finish: ≥0.5g.

**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 ~40g empty jar mass but should be achievable for any jar-lid combination.*

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

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.

HANDLING INSTRUCTIONS

Fine powders pose a risk to eyes and lungs and therefore standard precautions including 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**
4	27th November, 2025	Updated the recommended gross mass for use in PhotonAssay analysis.
3	4th Jun, 2025	Updated the recommended gross mass for use in PhotonAssay analysis.
2	29th Jun, 2023	Revised the Au by PhotonAssay Certified Value and its associated uncertainty (following the commissioning of more instruments available for round robin since the initial publication).
1	29th Oct, 2021	Corrected list of ‘Participating Laboratories’.
0	22nd Sep, 2021	First publication.

QMS CERTIFICATION

ORE Pty Ltd is accredited for compliance with ISO 17034.

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

CERTIFYING OFFICER

27th November, 2025

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

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