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CERTIFICATE OF ANALYSIS FOR

Heap Leach Oxide (Goldstrike Mine, Nevada, USA)

CERTIFIED REFERENCE MATERIAL

OREAS 264

Table 1. Certified Values and Performance Gates for OREAS 264.

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	0.307	0.011	0.286	0.329	0.276	0.339	3.44%	6.88%	10.31%	0.292	0.323
Aqua Regia Digestion (sample mass 10-50g)											
Au, ppm	0.295	0.015	0.264	0.326	0.249	0.341	5.23%	10.46%	15.68%	0.280	0.310
Cyanide Leach											
Au, ppm	0.273	0.021	0.231	0.316	0.210	0.337	7.74%	15.48%	23.22%	0.260	0.287
PhotonAssay (recommended gross mass 410±15 g)											
Au, ppm	0.309	0.032	0.246	0.373	0.214	0.404	10.23%	20.45%	30.68%	0.294	0.325
4-Acid Digestion											
Ag, ppm	1.29	0.063	1.16	1.41	1.10	1.47	4.86%	9.73%	14.59%	1.22	1.35
Al, wt.%	4.31	0.103	4.11	4.52	4.01	4.62	2.38%	4.76%	7.14%	4.10	4.53
As, ppm	305	14	277	333	263	346	4.54%	9.09%	13.63%	290	320
Ba, ppm	841	21	800	883	779	904	2.46%	4.93%	7.39%	799	883
Be, ppm	1.49	0.104	1.28	1.70	1.18	1.80	6.96%	13.93%	20.89%	1.41	1.56
Bi, ppm	0.17	0.013	0.15	0.20	0.13	0.21	7.69%	15.38%	23.07%	0.16	0.18

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.%	0.405	0.019	0.367	0.443	0.347	0.463	4.74%	9.49%	14.23%	0.385	0.425
Cd, ppm	2.21	0.200	1.81	2.61	1.61	2.81	9.06%	18.12%	27.18%	2.10	2.32
Ce, ppm	42.3	2.06	38.2	46.4	36.1	48.5	4.88%	9.75%	14.63%	40.2	44.4
Co, ppm	9.71	0.410	8.89	10.53	8.48	10.94	4.23%	8.45%	12.68%	9.22	10.19
Cr, ppm	72	11	49	94	38	105	15.71%	31.43%	47.14%	68	75
Cs, ppm	5.87	0.306	5.25	6.48	4.95	6.78	5.23%	10.45%	15.68%	5.57	6.16
Cu, ppm	94	4.2	85	102	81	106	4.49%	8.98%	13.47%	89	98
Dy, ppm	3.64	0.173	3.29	3.98	3.12	4.16	4.75%	9.49%	14.24%	3.46	3.82
Er, ppm	2.07	0.174	1.73	2.42	1.55	2.59	8.39%	16.77%	25.16%	1.97	2.18
Eu, ppm	0.93	0.069	0.80	1.07	0.73	1.14	7.41%	14.82%	22.24%	0.89	0.98
Fe, wt.%	2.24	0.072	2.10	2.38	2.03	2.46	3.21%	6.42%	9.63%	2.13	2.35
Ga, ppm	12.7	0.46	11.8	13.6	11.3	14.1	3.65%	7.31%	10.96%	12.1	13.3
Gd, ppm	3.97	0.382	3.20	4.73	2.82	5.11	9.63%	19.25%	28.88%	3.77	4.17
Hf, ppm	1.87	0.21	1.45	2.29	1.24	2.50	11.22%	22.43%	33.65%	1.78	1.97
Ho, ppm	0.70	0.08	0.54	0.85	0.47	0.93	10.92%	21.85%	32.77%	0.66	0.73
In, ppm	0.039	0.002	0.035	0.044	0.032	0.047	6.23%	12.46%	18.70%	0.038	0.041
K, wt.%	1.84	0.050	1.74	1.94	1.69	1.99	2.74%	5.48%	8.21%	1.74	1.93
La, ppm	22.8	1.77	19.3	26.3	17.5	28.1	7.76%	15.52%	23.29%	21.7	23.9
Li, ppm	19.8	1.00	17.8	21.8	16.9	22.8	5.02%	10.04%	15.07%	18.8	20.8
Lu, ppm	0.31	0.028	0.25	0.36	0.22	0.39	9.05%	18.09%	27.14%	0.29	0.32
Mg, wt.%	0.315	0.011	0.293	0.337	0.282	0.348	3.47%	6.94%	10.41%	0.299	0.331
Mn, wt.%	0.045	0.001	0.043	0.047	0.042	0.048	2.13%	4.26%	6.39%	0.043	0.047
Mo, ppm	9.69	0.461	8.77	10.62	8.31	11.08	4.76%	9.51%	14.27%	9.21	10.18
Na, wt.%	0.036	0.010	0.017	0.055	0.007	0.065	26.56%	53.12%	79.68%	0.034	0.038
Nb, ppm	7.79	0.533	6.73	8.86	6.19	9.39	6.84%	13.69%	20.53%	7.40	8.18
Nd, ppm	21.1	1.15	18.8	23.4	17.7	24.6	5.45%	10.90%	16.36%	20.1	22.2
Ni, ppm	61	2.3	56	65	54	68	3.87%	7.74%	11.61%	58	64
P, wt.%	0.217	0.008	0.200	0.234	0.192	0.243	3.88%	7.76%	11.64%	0.206	0.228
Pb, ppm	9.88	0.587	8.71	11.05	8.12	11.64	5.94%	11.87%	17.81%	9.39	10.38
Pr, ppm	5.49	0.351	4.79	6.20	4.44	6.55	6.39%	12.79%	19.18%	5.22	5.77
Rb, ppm	76	3.7	69	84	65	87	4.87%	9.74%	14.62%	72	80
Re, ppm	< 0.002	IND	IND	IND	IND	IND	IND	IND	IND	IND	IND
S, wt.%	0.129	0.004	0.122	0.137	0.118	0.141	3.02%	6.05%	9.07%	0.123	0.136
Sb, ppm	26.3	2.43	21.5	31.2	19.1	33.6	9.22%	18.44%	27.66%	25.0	27.7
Sc, ppm	8.38	0.310	7.76	9.00	7.45	9.31	3.70%	7.39%	11.09%	7.96	8.80
Se, ppm	6.76	0.89	4.97	8.55	4.08	9.44	13.24%	26.48%	39.72%	6.42	7.10
Sm, ppm	4.24	0.263	3.71	4.77	3.45	5.03	6.21%	12.43%	18.64%	4.03	4.45
Sn, ppm	1.42	0.134	1.15	1.69	1.02	1.82	9.45%	18.90%	28.35%	1.35	1.49
Sr, ppm	100	3.3	93	107	90	110	3.34%	6.69%	10.03%	95	105
Ta, ppm	0.53	0.034	0.46	0.59	0.43	0.63	6.38%	12.75%	19.13%	0.50	0.55

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	0.58	0.058	0.46	0.69	0.41	0.75	9.95%	19.91%	29.86%	0.55	0.61
Te, ppm	0.11	0.02	0.07	0.14	0.06	0.16	15.41%	30.81%	46.22%	0.10	0.11
Th, ppm	6.99	0.431	6.13	7.85	5.70	8.29	6.16%	12.32%	18.48%	6.64	7.34
Ti, wt.%	0.223	0.009	0.204	0.242	0.195	0.252	4.23%	8.46%	12.69%	0.212	0.234
Tl, ppm	1.45	0.050	1.35	1.55	1.30	1.60	3.44%	6.88%	10.32%	1.37	1.52
Tm, ppm	0.29	0.04	0.22	0.37	0.18	0.41	12.91%	25.82%	38.72%	0.28	0.31
U, ppm	5.72	0.307	5.10	6.33	4.80	6.64	5.37%	10.75%	16.12%	5.43	6.00
V, ppm	301	10	280	321	270	332	3.41%	6.82%	10.23%	286	316
W, ppm	5.28	0.298	4.69	5.88	4.39	6.18	5.65%	11.29%	16.94%	5.02	5.55
Y, ppm	20.8	1.07	18.7	22.9	17.6	24.0	5.14%	10.28%	15.42%	19.8	21.8
Yb, ppm	2.10	0.21	1.68	2.53	1.46	2.75	10.17%	20.33%	30.50%	2.00	2.21
Zn, ppm	224	7	210	239	202	247	3.29%	6.58%	9.87%	213	236
Zr, ppm	70	7	55	85	48	92	10.55%	21.09%	31.64%	67	74
Aqua Regia Digestion											
Ag, ppm	0.573	0.032	0.508	0.638	0.475	0.670	5.67%	11.33%	17.00%	0.544	0.601
Al, wt.%	1.21	0.14	0.93	1.49	0.79	1.64	11.71%	23.43%	35.14%	1.15	1.27
As, ppm	300	13	275	326	262	339	4.23%	8.45%	12.68%	285	315
Ba, ppm	482	22	437	527	415	550	4.65%	9.30%	13.96%	458	506
Be, ppm	1.01	0.075	0.86	1.16	0.79	1.24	7.41%	14.81%	22.22%	0.96	1.07
Bi, ppm	0.16	0.013	0.14	0.19	0.12	0.20	7.98%	15.97%	23.95%	0.15	0.17
Ca, wt.%	0.389	0.021	0.348	0.431	0.328	0.451	5.28%	10.55%	15.83%	0.370	0.409
Cd, ppm	2.26	0.178	1.91	2.62	1.73	2.80	7.84%	15.69%	23.53%	2.15	2.38
Ce, ppm	10.4	0.89	8.6	12.2	7.8	13.1	8.50%	17.01%	25.51%	9.9	10.9
Co, ppm	9.66	0.494	8.67	10.65	8.18	11.14	5.11%	10.23%	15.34%	9.18	10.14
Cr, ppm	37.9	4.1	29.7	46.0	25.6	50.1	10.81%	21.61%	32.42%	36.0	39.7
Cs, ppm	2.76	0.51	1.73	3.79	1.22	4.30	18.61%	37.22%	55.83%	2.62	2.90
Cu, ppm	92	2.9	87	98	84	101	3.11%	6.21%	9.32%	88	97
Dy, ppm	2.61	0.220	2.17	3.05	1.95	3.27	8.42%	16.85%	25.27%	2.48	2.74
Er, ppm	1.24	0.090	1.06	1.42	0.97	1.51	7.25%	14.50%	21.75%	1.18	1.30
Eu, ppm	0.65	0.035	0.58	0.72	0.55	0.76	5.36%	10.72%	16.08%	0.62	0.69
Fe, wt.%	2.09	0.075	1.94	2.24	1.87	2.32	3.59%	7.19%	10.78%	1.99	2.20
Ga, ppm	4.05	0.363	3.32	4.77	2.96	5.14	8.98%	17.96%	26.94%	3.84	4.25
Gd, ppm	3.08	0.31	2.46	3.70	2.15	4.01	10.07%	20.14%	30.21%	2.92	3.23
Ge, ppm	< 0.1	IND	IND	IND	IND	IND	IND	IND	IND	IND	IND
Hf, ppm	0.20	0.03	0.13	0.27	0.09	0.30	17.77%	35.55%	53.32%	0.19	0.21
Hg, ppm	1.96	0.159	1.64	2.27	1.48	2.43	8.14%	16.27%	24.41%	1.86	2.05
Ho, ppm	0.48	0.026	0.42	0.53	0.40	0.55	5.49%	10.98%	16.47%	0.45	0.50
In, ppm	0.030	0.001	0.027	0.032	0.026	0.034	4.45%	8.90%	13.35%	0.028	0.031
K, wt.%	0.529	0.068	0.393	0.665	0.325	0.733	12.83%	25.65%	38.48%	0.503	0.555
La, ppm	5.02	0.363	4.29	5.74	3.92	6.11	7.25%	14.49%	21.74%	4.76	5.27

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
Aqua Regia Digestion continued											
Li, ppm	3.63	0.233	3.16	4.09	2.93	4.33	6.43%	12.86%	19.29%	3.45	3.81
Lu, ppm	0.13	0.008	0.12	0.15	0.11	0.16	6.36%	12.73%	19.09%	0.13	0.14
Mg, wt.%	0.099	0.011	0.077	0.120	0.066	0.131	10.92%	21.84%	32.77%	0.094	0.104
Mn, wt.%	0.046	0.002	0.041	0.050	0.039	0.052	4.57%	9.14%	13.72%	0.043	0.048
Mo, ppm	9.15	0.668	7.82	10.49	7.15	11.16	7.30%	14.59%	21.89%	8.70	9.61
Nb, ppm	0.063	0.012	0.038	0.087	0.025	0.100	19.77%	39.54%	59.31%	0.059	0.066
Nd, ppm	7.55	1.09	5.38	9.73	4.29	10.82	14.40%	28.80%	43.20%	7.18	7.93
Ni, ppm	59	2.9	53	65	50	68	4.86%	9.72%	14.59%	56	62
P, wt.%	0.204	0.011	0.183	0.225	0.173	0.236	5.14%	10.28%	15.42%	0.194	0.215
Pb, ppm	9.30	0.520	8.26	10.34	7.74	10.86	5.59%	11.19%	16.78%	8.83	9.76
Pr, ppm	1.66	0.27	1.12	2.20	0.85	2.47	16.34%	32.68%	49.02%	1.58	1.74
Rb, ppm	21.5	3.5	14.6	28.5	11.1	32.0	16.19%	32.38%	48.56%	20.4	22.6
S, wt.%	0.104	0.011	0.081	0.127	0.069	0.138	11.07%	22.13%	33.20%	0.099	0.109
Sb, ppm	13.9	2.5	9.0	18.9	6.5	21.3	17.72%	35.45%	53.17%	13.2	14.6
Sc, ppm	4.89	0.277	4.34	5.45	4.06	5.72	5.67%	11.34%	17.00%	4.65	5.14
Se, ppm	6.09	0.87	4.35	7.82	3.49	8.69	14.24%	28.48%	42.72%	5.78	6.39
Sm, ppm	2.34	0.186	1.97	2.71	1.78	2.90	7.96%	15.92%	23.88%	2.22	2.46
Sn, ppm	0.58	0.08	0.43	0.74	0.35	0.82	13.42%	26.83%	40.25%	0.55	0.61
Sr, ppm	79	5.1	69	89	64	94	6.44%	12.87%	19.31%	75	83
Ta, ppm	< 0.01	IND	IND	IND	IND	IND	IND	IND	IND	IND	IND
Tb, ppm	0.45	0.026	0.40	0.50	0.37	0.53	5.73%	11.47%	17.20%	0.43	0.47
Te, ppm	0.10	0.01	0.08	0.13	0.06	0.14	12.92%	25.84%	38.76%	0.10	0.11
Th, ppm	2.60	0.26	2.07	3.13	1.81	3.39	10.12%	20.24%	30.36%	2.47	2.73
Tl, ppm	0.93	0.052	0.83	1.04	0.78	1.09	5.55%	11.10%	16.65%	0.89	0.98
Tm, ppm	0.15	0.007	0.14	0.17	0.13	0.18	4.82%	9.64%	14.46%	0.15	0.16
U, ppm	3.33	0.147	3.03	3.62	2.88	3.77	4.42%	8.83%	13.25%	3.16	3.49
V, ppm	146	16	115	177	100	193	10.64%	21.28%	31.92%	139	154
W, ppm	1.32	0.23	0.86	1.79	0.63	2.02	17.48%	34.95%	52.43%	1.26	1.39
Y, ppm	13.5	0.83	11.8	15.1	11.0	16.0	6.17%	12.35%	18.52%	12.8	14.1
Yb, ppm	0.95	0.052	0.85	1.06	0.80	1.11	5.41%	10.81%	16.22%	0.91	1.00
Zn, ppm	221	9	203	239	194	248	4.04%	8.07%	12.11%	210	232
Zr, ppm	7.79	1.16	5.48	10.11	4.32	11.26	14.85%	29.70%	44.54%	7.40	8.18

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 264.

Constituent	Unit	Value	Constituent	Unit	Value	Constituent	Unit	Value
Pb Fire Assay								
Pd	ppb	3.50	Pt	ppb	< 5			
4-Acid Digestion								
B	ppm	372	Ge	ppm	0.18	Hg	ppm	< 2
Aqua Regia Digestion								
B	ppm	19.9	Pt	ppb	4.83	Ti	wt.%	0.005
Na	wt.%	0.011	Re	ppm	0.001			
Pd	ppb	< 10	Si	wt.%	0.019			
Borate Fusion XRF								
Al_2O_3	wt.%	8.35	MgO	wt.%	0.545	SiO_2	wt.%	80.76
CaO	wt.%	0.570	MnO	wt.%	0.055	SO_3	wt.%	0.312
Fe_2O_3	wt.%	3.21	Na_2O	wt.%	0.035	TiO_2	wt.%	0.390
K_2O	wt.%	2.24	P_2O_5	wt.%	0.502			
Thermogravimetry								
LOI^{1000}	wt.%	2.58						
Infrared Combustion								
C	wt.%	< 0.01	S	wt.%	0.065			
Laser Ablation ICP-MS								
Ag	ppm	1.75	Hf	ppm	3.59	Sm	ppm	4.65
As	ppm	374	Ho	ppm	0.88	Sn	ppm	1.70
Ba	ppm	867	In	ppm	< 0.05	Sr	ppm	103
Be	ppm	1.70	La	ppm	24.7	Ta	ppm	0.60
Bi	ppm	0.23	Lu	ppm	0.39	Tb	ppm	0.70
Cd	ppm	2.80	Mn	wt.%	0.047	Te	ppm	< 0.2
Ce	ppm	43.5	Mo	ppm	9.90	Th	ppm	7.66
Co	ppm	11.3	Nb	ppm	8.93	Ti	wt.%	0.237
Cr	ppm	92	Nd	ppm	22.8	Tl	ppm	2.60
Cs	ppm	6.67	Ni	ppm	71	Tm	ppm	0.39
Cu	ppm	113	Pb	ppm	13.0	U	ppm	6.18
Dy	ppm	4.13	Pr	ppm	5.96	V	ppm	326
Er	ppm	2.57	Rb	ppm	82	W	ppm	6.00
Eu	ppm	0.98	Re	ppm	< 0.01	Y	ppm	24.9
Ga	ppm	14.9	Sb	ppm	34.9	Yb	ppm	2.63
Gd	ppm	4.35	Sc	ppm	8.85	Zn	ppm	240
Ge	ppm	2.58	Se	ppm	< 5	Zr	ppm	128

SI unit equivalents: ppb (parts per billion; 1×10^{-9}) ≡ µg/kg; ppm (parts per million; 1×10^{-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 element characterisation by laser ablation 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 264-DataPack.1.3.230609_164234.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

Certified Reference Material (CRM) OREAS 264 was prepared from oxide heap leach material sourced from the Goldstrike operation in Eureka County in north-eastern Nevada. The mining operation is located on the Carlin Trend and owned by Nevada Gold Mines (operated by Barrick).

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 264 was prepared in the following manner:

- Drying the gold ore to constant mass at 105°C;
- Crushing and multi stage milling of gold ore to 100% minus 30 microns;
- Final homogenisation;
- Packaging in 60g units sealed in laminated foil pouches and 500g units in plastic jars.

PHYSICAL PROPERTIES

OREAS 264 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 264.

Bulk Density (g/L)	Moisture%	Munsell Notation‡	Munsell Color‡
556	0.88	10YR 7/4	Grayish Orange

‡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 (15-40g charge weight) with AAS (19 laboratories), ICP-OES (11 laboratories) or ICP-MS finish (1 laboratory);
- Gold by aqua regia digestion (15-50g sample weight) with ICP-MS (14 laboratories), AAS (7 laboratories) or ICP-OES finish (1 laboratory);
- 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 (7 laboratories by AAS finish), 50g (3 laboratories by ICP finish and 1 laboratory by AAS finish), 60g (1 laboratory by ICP finish) and 200g (6 laboratories by AAS and 1 laboratory by ICP finish).

- Gold by x-ray photon assay with recommended gross mass 410±15 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 aqua regia digestion (up to 25 laboratories depending on the element);
- Full ICP-OES and ICP-MS elemental suites by 4-acid (HNO_3-HF-$HClO_4$-HCl) digestion (up to 25 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 characterisation 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. For all analytical methods except for Au by PhotonAssay, 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 264 (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-α=0.99) at least 95% of subsamples (ρ=0.95) will have concentrations lying between 92 and 96 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 264.

Constituent	Certified	95% Expanded Uncertainty		95% Tolerance Limits	
	Value	Low	High	Value	Low
Pb Fire Assay					
Au, Gold (ppm)	0.307	0.304	0.311	0.305*	0.310*
Aqua Regia Digestion (sample mass 10-50g)					
Au, Gold (ppm)	0.295	0.289	0.301	0.293*	0.297*
Cyanide Leach					
Au, Gold (ppm)	0.273	0.264	0.282	0.273*	0.274*
PhotonAssay (recommended gross mass 410±15 g)					
Au, Gold (ppm)	0.309	0.301	0.318	0.309*	0.310*
4-Acid Digestion					
Ag, Silver (ppm)	1.29	1.22	1.35	1.23	1.34
Al, Aluminium (wt.%)	4.31	4.22	4.41	4.25	4.38
As, Arsenic (ppm)	305	295	314	298	311
Ba, Barium (ppm)	841	824	859	827	856
Be, Beryllium (ppm)	1.49	1.37	1.61	1.40	1.57
Bi, Bismuth (ppm)	0.17	0.16	0.19	IND	IND
Ca, Calcium (wt.%)	0.405	0.390	0.420	0.393	0.417
Cd, Cadmium (ppm)	2.21	2.10	2.32	2.15	2.28
Ce, Cerium (ppm)	42.3	40.6	44.0	41.2	43.4
Co, Cobalt (ppm)	9.71	9.39	10.02	9.45	9.96
Cr, Chromium (ppm)	72	65	78	68	75
Cs, Caesium (ppm)	5.87	5.67	6.06	5.71	6.02
Cu, Copper (ppm)	94	91	96	92	96
Dy, Dysprosium (ppm)	3.64	3.43	3.84	3.50	3.78
Er, Erbium (ppm)	2.07	1.94	2.21	1.98	2.17
Eu, Europium (ppm)	0.93	0.86	1.00	0.89	0.98
Fe, Iron (wt.%)	2.24	2.19	2.29	2.21	2.28
Ga, Gallium (ppm)	12.7	12.2	13.2	12.4	13.1
Gd, Gadolinium (ppm)	3.97	3.67	4.27	3.80	4.14
Hf, Hafnium (ppm)	1.87	1.71	2.03	1.77	1.98
Ho, Holmium (ppm)	0.70	0.63	0.77	0.66	0.73
In, Indium (ppm)	0.039	0.037	0.042	0.035	0.044

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 350g 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					
K, Potassium (wt.%)	1.84	1.78	1.89	1.81	1.86
La, Lanthanum (ppm)	22.8	21.4	24.2	22.1	23.5
Li, Lithium (ppm)	19.8	18.9	20.7	19.2	20.5
Lu, Lutetium (ppm)	0.31	0.27	0.35	0.29	0.33
Mg, Magnesium (wt.%)	0.315	0.306	0.324	0.308	0.322
Mn, Manganese (wt.%)	0.045	0.044	0.046	0.044	0.046
Mo, Molybdenum (ppm)	9.69	9.30	10.09	9.41	9.98
Na, Sodium (wt.%)	0.036	0.032	0.041	0.035	0.038
Nb, Niobium (ppm)	7.79	7.31	8.27	7.54	8.05
Nd, Neodymium (ppm)	21.1	20.2	22.0	20.6	21.6
Ni, Nickel (ppm)	61	59	62	59	62
P, Phosphorus (wt.%)	0.217	0.209	0.225	0.213	0.222
Pb, Lead (ppm)	9.88	9.43	10.33	9.46	10.30
Pr, Praseodymium (ppm)	5.49	5.23	5.76	5.30	5.69
Rb, Rubidium (ppm)	76	73	79	74	78
Re, Rhenium (ppm)	< 0.002	IND	IND	IND	IND
S, Sulphur (wt.%)	0.129	0.124	0.135	0.125	0.134
Sb, Antimony (ppm)	26.3	24.7	28.0	25.6	27.1
Sc, Scandium (ppm)	8.38	7.94	8.82	8.09	8.68
Se, Selenium (ppm)	6.76	5.97	7.55	6.32	7.20
Sm, Samarium (ppm)	4.24	4.01	4.47	4.02	4.46
Sn, Tin (ppm)	1.42	1.31	1.53	IND	IND
Sr, Strontium (ppm)	100	97	102	98	102
Ta, Tantalum (ppm)	0.53	0.50	0.56	0.49	0.56
Tb, Terbium (ppm)	0.58	0.53	0.63	0.55	0.60
Te, Tellurium (ppm)	0.11	0.08	0.14	IND	IND
Th, Thorium (ppm)	6.99	6.70	7.29	6.79	7.20
Ti, Titanium (wt.%)	0.223	0.215	0.231	0.219	0.228
Tl, Thallium (ppm)	1.45	1.39	1.50	1.40	1.49
Tm, Thulium (ppm)	0.29	0.26	0.33	0.27	0.32
U, Uranium (ppm)	5.72	5.53	5.91	5.57	5.86
V, Vanadium (ppm)	301	293	309	294	307
W, Tungsten (ppm)	5.28	5.05	5.52	5.09	5.48
Y, Yttrium (ppm)	20.8	19.9	21.7	20.3	21.3
Yb, Ytterbium (ppm)	2.10	1.93	2.28	2.01	2.20
Zn, Zinc (ppm)	224	219	230	220	228

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					
Ag, Silver (ppm)	0.573	0.544	0.602	0.548	0.598
Al, Aluminium (wt.%)	1.21	1.13	1.29	1.18	1.24
As, Arsenic (ppm)	300	293	308	295	306
Ba, Barium (ppm)	482	467	498	468	496
Be, Beryllium (ppm)	1.01	0.93	1.10	0.97	1.06
Bi, Bismuth (ppm)	0.16	0.15	0.17	IND	IND
Ca, Calcium (wt.%)	0.389	0.377	0.402	0.378	0.400
Cd, Cadmium (ppm)	2.26	2.15	2.38	2.20	2.33
Ce, Cerium (ppm)	10.4	9.7	11.1	10.1	10.8
Co, Cobalt (ppm)	9.66	9.23	10.09	9.38	9.94
Cr, Chromium (ppm)	37.9	35.5	40.2	36.6	39.1
Cs, Caesium (ppm)	2.76	2.48	3.03	2.65	2.87
Cu, Copper (ppm)	92	90	95	91	94
Dy, Dysprosium (ppm)	2.61	2.33	2.89	2.50	2.71
Er, Erbium (ppm)	1.24	1.10	1.38	1.17	1.30
Eu, Europium (ppm)	0.65	0.58	0.72	0.63	0.67
Fe, Iron (wt.%)	2.09	2.04	2.15	2.05	2.13
Ga, Gallium (ppm)	4.05	3.72	4.37	3.83	4.27
Gd, Gadolinium (ppm)	3.08	2.71	3.45	2.93	3.23
Ge, Germanium (ppm)	< 0.1	IND	IND	IND	IND
Hf, Hafnium (ppm)	0.20	0.17	0.23	0.18	0.21
Hg, Mercury (ppm)	1.96	1.86	2.05	1.90	2.01
Ho, Holmium (ppm)	0.48	0.43	0.52	0.45	0.50
In, Indium (ppm)	0.030	0.029	0.031	0.028	0.032
K, Potassium (wt.%)	0.529	0.492	0.566	0.517	0.541
La, Lanthanum (ppm)	5.02	4.77	5.26	4.84	5.19
Li, Lithium (ppm)	3.63	3.43	3.83	3.43	3.82
Lu, Lutetium (ppm)	0.13	0.12	0.15	0.12	0.14
Mg, Magnesium (wt.%)	0.099	0.093	0.104	0.095	0.102
Mn, Manganese (wt.%)	0.046	0.044	0.047	0.045	0.046
Mo, Molybdenum (ppm)	9.15	8.76	9.55	8.92	9.39
Nb, Niobium (ppm)	0.063	0.048	0.078	IND	IND
Nd, Neodymium (ppm)	7.55	6.40	8.71	7.34	7.76
Ni, Nickel (ppm)	59	57	61	58	60
P, Phosphorus (wt.%)	0.204	0.197	0.212	0.201	0.208
Pb, Lead (ppm)	9.30	8.95	9.65	9.01	9.58

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					
Pr, Praseodymium (ppm)	1.66	1.39	1.93	1.58	1.74
Rb, Rubidium (ppm)	21.5	19.4	23.7	20.9	22.2
S, Sulphur (wt.%)	0.104	0.095	0.112	0.097	0.111
Sb, Antimony (ppm)	13.9	12.7	15.2	13.4	14.5
Sc, Scandium (ppm)	4.89	4.67	5.11	4.73	5.06
Se, Selenium (ppm)	6.09	5.35	6.82	5.70	6.47
Sm, Samarium (ppm)	2.34	2.11	2.57	2.24	2.44
Sn, Tin (ppm)	0.58	0.53	0.63	0.56	0.61
Sr, Strontium (ppm)	79	76	82	77	81
Ta, Tantalum (ppm)	< 0.01	IND	IND	IND	IND
Tb, Terbium (ppm)	0.45	0.41	0.49	0.44	0.47
Te, Tellurium (ppm)	0.10	0.08	0.12	IND	IND
Th, Thorium (ppm)	2.60	2.43	2.77	2.49	2.71
Tl, Thallium (ppm)	0.93	0.89	0.98	0.90	0.96
Tm, Thulium (ppm)	0.15	0.14	0.17	0.14	0.17
U, Uranium (ppm)	3.33	3.20	3.46	3.23	3.42
V, Vanadium (ppm)	146	138	155	143	150
W, Tungsten (ppm)	1.32	1.17	1.48	1.26	1.39
Y, Yttrium (ppm)	13.5	12.9	14.1	13.1	13.8
Yb, Ytterbium (ppm)	0.95	0.88	1.02	0.93	0.98
Zn, Zinc (ppm)	221	216	227	217	226
Zr, Zirconium (ppm)	7.79	7.05	8.54	7.46	8.13

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 below shows the gold INAA data determined on 20 x 85mg subsamples of OREAS 264. 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 0.215% was calculated for a 30g fire assay sample (4.05% at 85mg weights) and confirms the high level of gold homogeneity in OREAS 264.

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	0.325	0.326
2	0.302	0.325
3	0.290	0.324
4	0.337	0.326
5	0.323	0.326
6	0.316	0.325
7	0.346	0.327
8	0.334	0.326
9	0.333	0.326
10	0.326	0.326
11	0.320	0.326
12	0.337	0.326
13	0.314	0.325
14	0.332	0.326
15	0.333	0.326
16	0.339	0.327
17	0.319	0.326
18	0.335	0.326
19	0.329	0.326
20	0.325	0.326
Mean	0.326	0.326
Median	0.328	0.326
Std Dev.	0.013	0.001
Rel.Std.Dev.	**4.05%**	**0.215%**

*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 264 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 264. The test was performed using the following parameters:

- Gold fire assay – 186 samples (31 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 – 120 samples (20 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.

A p-value of less than 0.05 indicates the probability of the test statistic being at least as extreme as the one observed given that the null hypothesis is true. A p-value indicates how incompatible the data are with the Null Hypothesis. The smaller the p-value, the greater statistical incompatibility of the data with the null hypothesis. 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 0.89 for Au by fire assay, 0.91 for Au by aqua regia digestion, 0.98 for Au by cyanide leach and 0.99 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 except for Lu by 4-acid digestion (p-value = 0.002).

Any statistically significant result must be checked to determine whether it is also technically significant. A study of the ANOVA components shows that the variation between units is sufficiently constrained (RSD = 9.0%) given the low concentration of Lu at 0.3ppm. The magnitude of the effect of between-unit variation is similar to typical measurement error at this low concentration of Lu (0.3ppm) by 4-acid digestion. This isolated case is most likely a false positive (a significant difference is detected where, in reality, none exists). There is no other supporting evidence to suspect greater between-unit variance compared with within-unit variance. The null hypothesis is therefore retained.

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 264 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 264 is fit-for-purpose as a certified reference material (see 'Intended Use' below).

PREPARER AND SUPPLIER

Certified reference material OREAS 264 was prepared, certified and supplied by:

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PARTICIPATING LABORATORIES

1. Actlabs, Ancaster, Ontario, Canada
2. AGAT Laboratories, Mississauga, Ontario, Canada
3. Alex Stewart International, Mendoza, Argentina
4. ALS (formerly MinAnalytical Services), Canning Vale, WA, Australia
5. ALS, Kalgoorlie, WA, Australia
6. ALS, Lima, Peru
7. ALS, Loughrea, Galway, Ireland
8. ALS, Perth, WA, Australia
9. ALS, Reno, Nevada, USA
10. ALS, Vancouver, BC, Canada
11. ANSTO, Lucas Heights, NSW, Australia
12. ANSTO, Lucas Heights, NSW, Australia
13. Bureau Veritas Commodities and Trade, Inc., Sparks, Nevada, USA
14. Bureau Veritas Commodities Canada Ltd, Vancouver, BC, Canada
15. Bureau Veritas Geoanalytical, Adelaide, SA, Australia
16. Bureau Veritas Geoanalytical, Perth, WA, Australia
17. ESAN Istanbul, Istanbul, Turkey
18. Inspectorate (BV), Lima, Peru
19. Intertek Genalysis, Adelaide, SA, Australia
20. Intertek Genalysis, Perth, WA, Australia
21. Intertek Tarkwa, Tarkwa, Ghana
22. Intertek Testing Services Philippines, Cupang, Muntinlupa, Philippines
23. MSA ENVAL Laboratories, Yamoussoukro, Côte d'Ivoire
24. MSALABS, Val-d'Or, Quebec, Canada
25. MSALABS, Vancouver, BC, Canada
26. Nagrom, Perth, WA, Australia
27. On Site Laboratory Services, Bendigo, VIC, Australia
28. PT Geoservices Ltd, Cikarang, Jakarta Raya, Indonesia
29. PT Intertek Utama Services, Jakarta Timur, DKI Jakarta, Indonesia
30. Ravenswood Gold, Ravenswood, QLD, Australia
31. Saskatchewan Research Council, Saskatoon, Saskatchewan, Canada
32. SGS, Randfontein, Gauteng, South Africa
33. SGS Australia Mineral Services, Kalgoorlie, WA, Australia
34. SGS Australia Mineral Services, Perth, WA, Australia
35. SGS Canada Inc., Vancouver, BC, Canada
36. SGS del Peru, Lima, Peru
37. SGS Tarkwa, Tarkwa, Western Region, Ghana
38. 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.

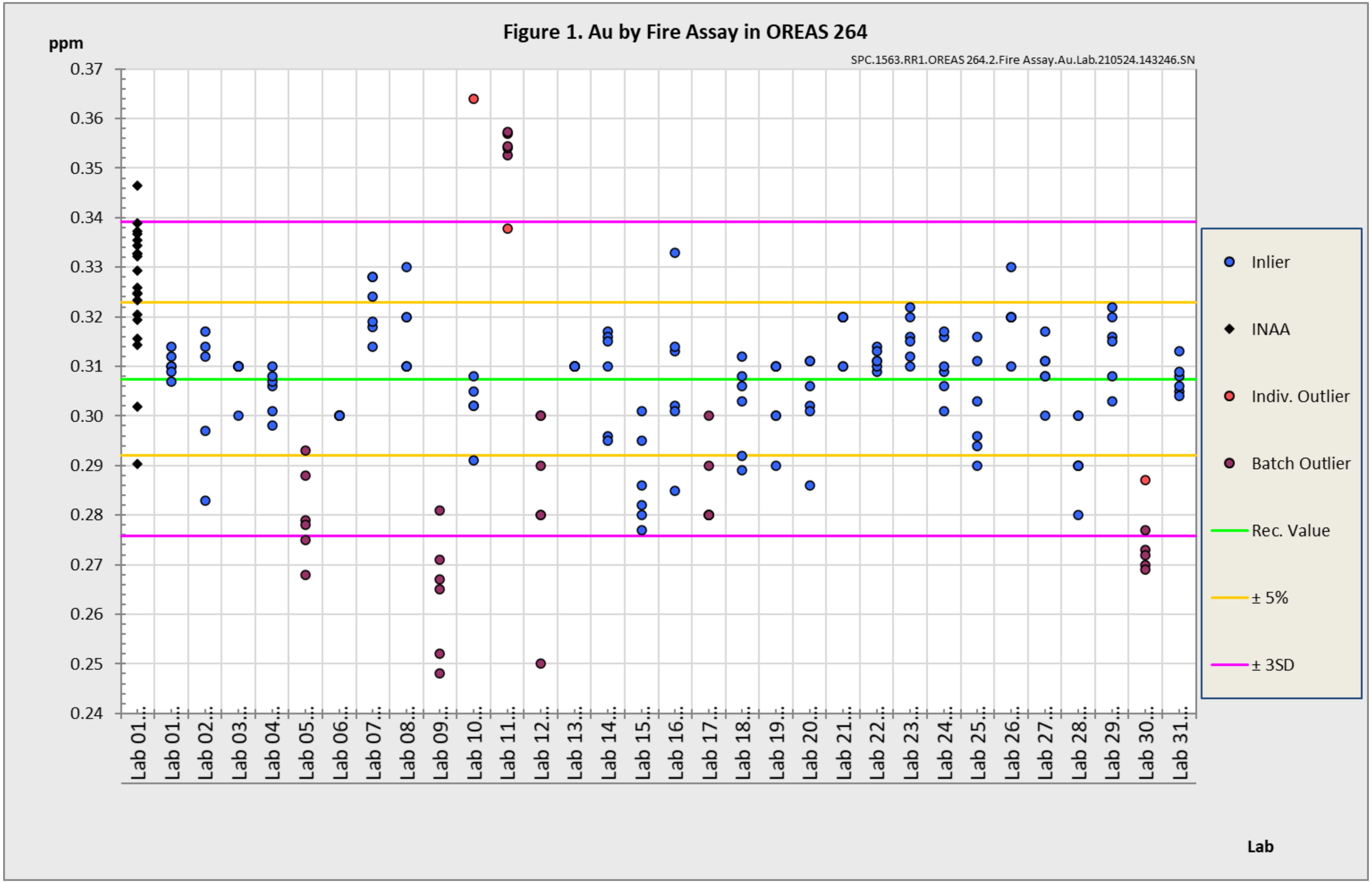
Figure 1. Au by Fire Assay in OREAS 264

SPC.1563.RR1.OREAS 264.2.Fire Assay.Au.Lab.210524.143246.SN

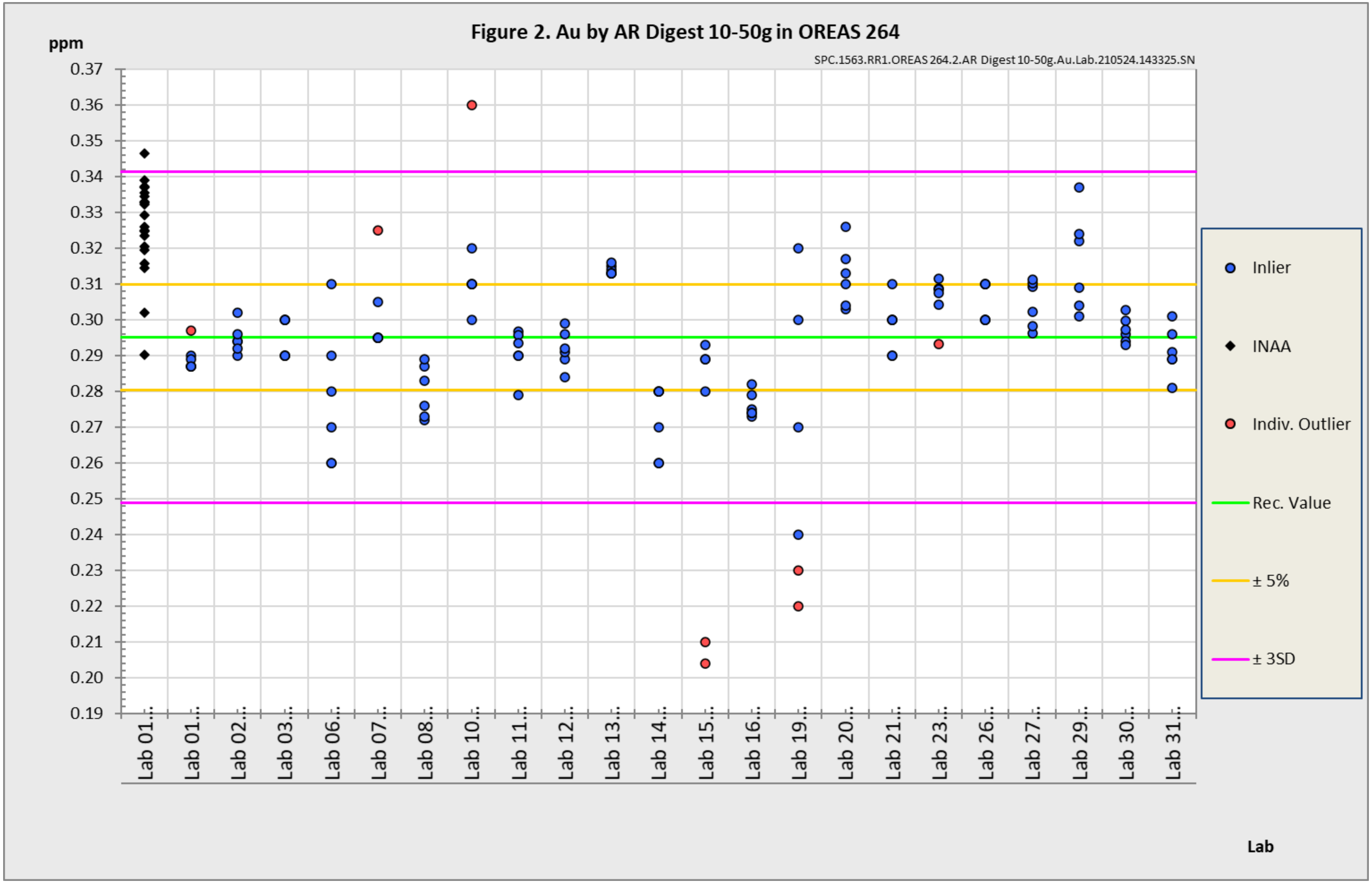
Figure 2. Au by AR Digest 10-50g in OREAS 264
SPC.1563.RR1.OREAS 264.2.AR Digest 10-50g.Au.Lab.210524.143325.SN
ppm
0.37
0.36
0.35
0.34
0.33
0.32
0.31
0.30
0.29
0.28
0.27
0.26
0.25
0.24
0.23
0.22
0.21
0.20
0.19
Lab 01...
Lab 01...
Lab 02...
Lab 03...
Lab 06...
Lab 07...
Lab 08...
Lab 10...
Lab 11...
Lab 12...
Lab 13...
Lab 14...
Lab 15...
Lab 16...
Lab 19...
Lab 20...
Lab 21...
Lab 23...
Lab 26...
Lab 27...
Lab 29...
Lab 30...
Lab 31...
Inlier
INAA
Indiv. Outlier
Rec. Value
± 5%
± 3SD
Lab

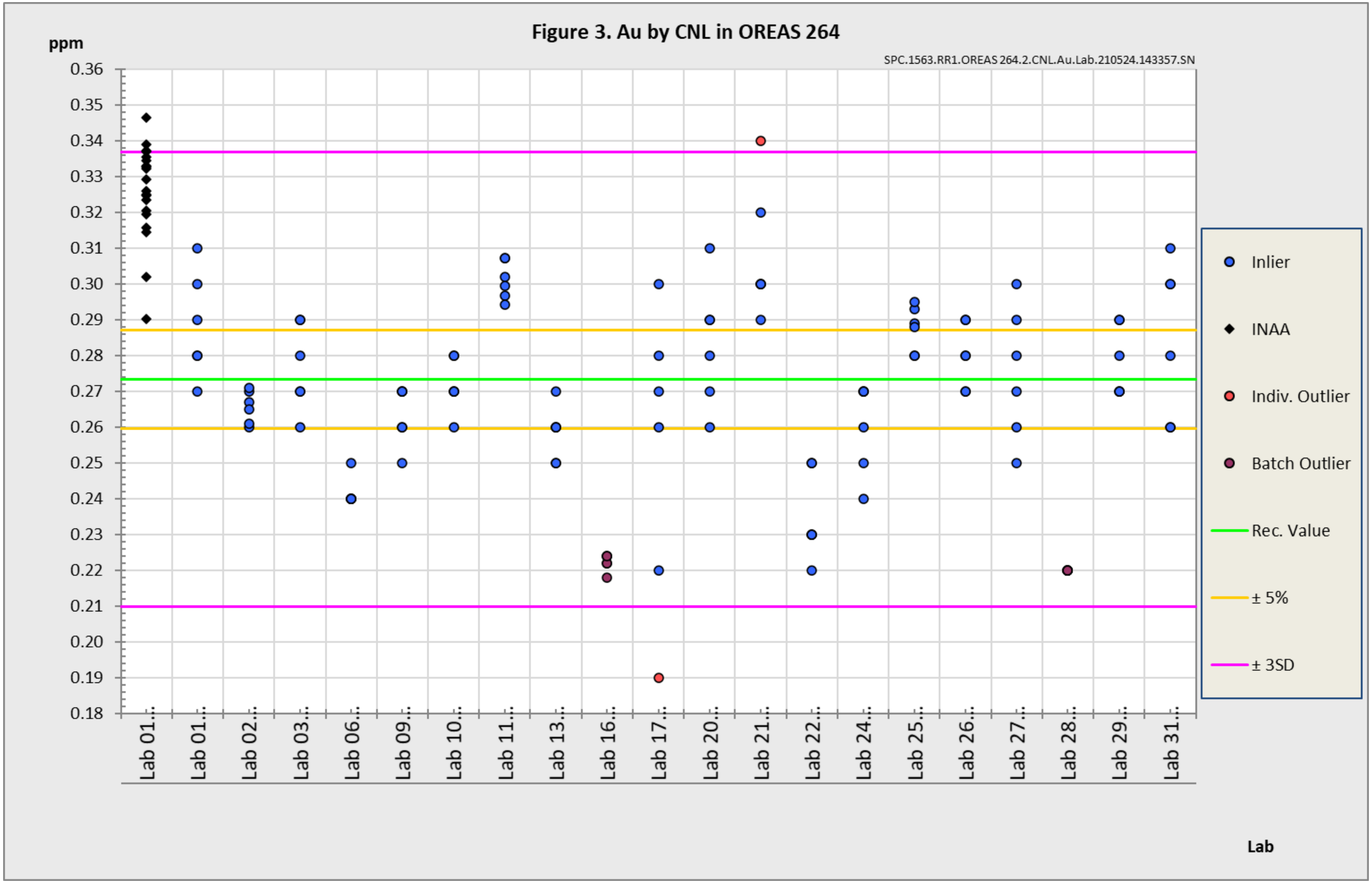
Figure 3. Au by CNL in OREAS 264
SPC.1563.RR1.OREAS 264.2.CNL.Au.Lab.210524.143357.SN
ppm
0.36
0.35
0.34
0.33
0.32
0.31
0.30
0.29
0.28
0.27
0.26
0.25
0.24
0.23
0.22
0.21
0.20
0.19
0.18
Lab 01...
Lab 01...
Lab 02...
Lab 03...
Lab 06...
Lab 09...
Lab 10...
Lab 11...
Lab 13...
Lab 16...
Lab 17...
Lab 20...
Lab 21...
Lab 22...
Lab 24...
Lab 25...
Lab 26...
Lab 27...
Lab 28...
Lab 29...
Lab 31...
Lab
Inlier
INAA
Indiv. Outlier
Batch Outlier
Rec. Value
± 5%
± 3SD

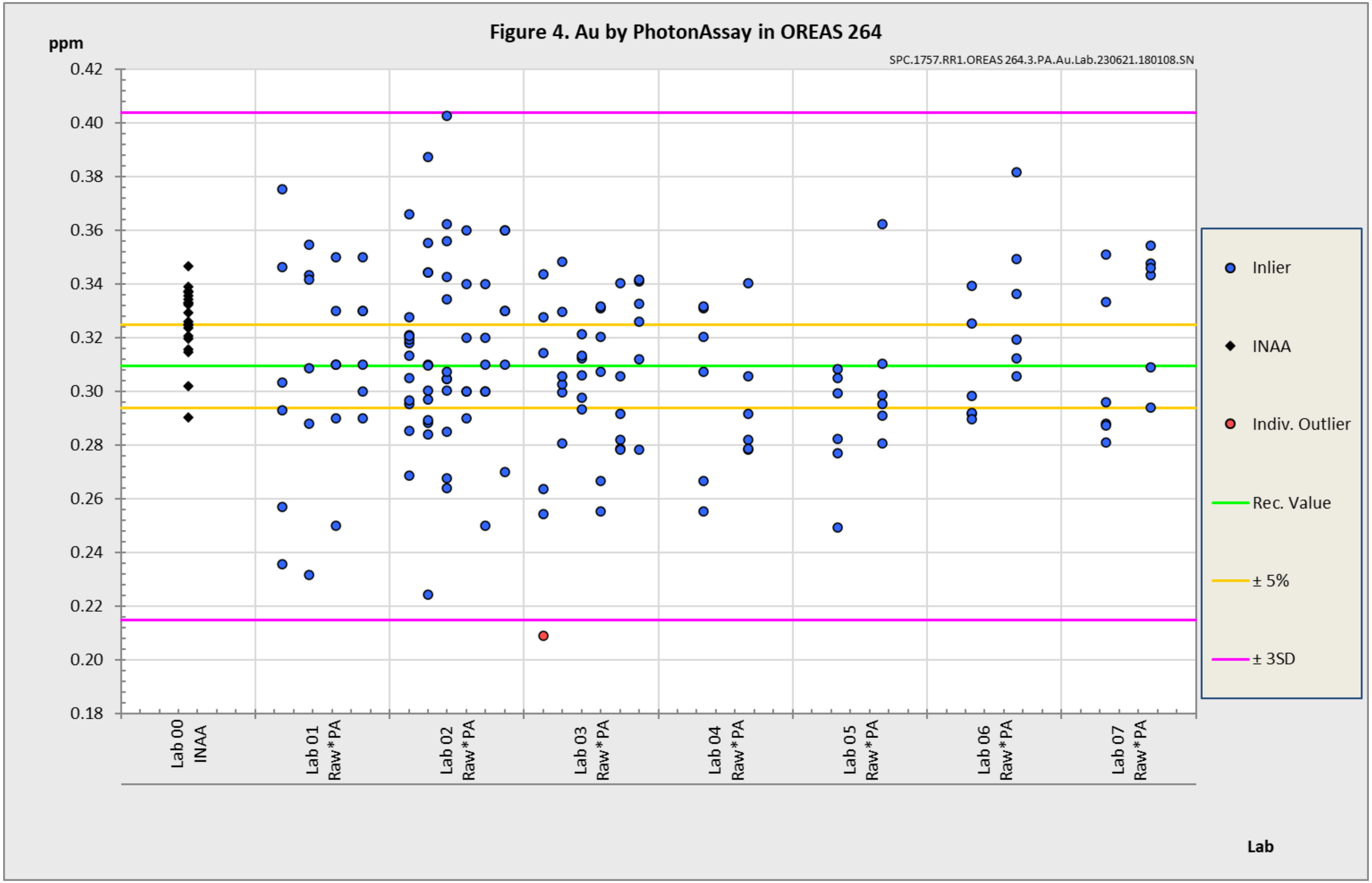
Figure 4. Au by PhotonAssay in OREAS 264
SPC.1757.RR1.OREAS 264.3.PA.Au.Lab.230621.180108.SN
ppm
0.42
0.40
0.38
0.36
0.34
0.32
0.30
0.28
0.26
0.24
0.22
0.20
0.18
Lab 00 INAA
Lab 01 Raw*PA
Lab 02 Raw*PA
Lab 03 Raw*PA
Lab 04 Raw*PA
Lab 05 Raw*PA
Lab 06 Raw*PA
Lab 07 Raw*PA
Lab
Inlier
INAA
Indiv. Outlier
Rec. Value
± 5%
± 3SD

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 264 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 264 may be used to calibrate the entire procedure by producing a pure substance CRM transformed into a calibration solution.

OREAS 264 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 264 is low in reactive sulphide (0.19 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 264 given its low sulphur concentration (0.13 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 264 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 264 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: ≥30g;
- Au by aqua regia digestion: ≥25g;
- Au by cyanide leach: ≥20g;
- Au by PhotonAssay: recommended gross mass* 410±15 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
2	11th June, 2025	Updated the recommended gross mass for use in PhotonAssay analysis.
1	29th June, 2023	Revised the Au by PhotonAssay Certified Value and it's associated uncertainty (following the commissioning of more instruments available for round robin since the initial publication).
0	25th May, 2020	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

11th June, 2025

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

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[4] ISO Guide 31:2015. Reference materials – Contents of certificates and labels.

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[12] OREAS-BUP-70-09-11: Statistical Analysis - OREAS Evaluation Method.

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