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CERTIFICATE OF ANALYSIS FOR

Gold Oxide Ore (Cortez Mine, Nevada, USA)

CERTIFIED REFERENCE MATERIAL

OREAS 273

Table 1. Certified Values and Performance Gates for OREAS 273.

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	10.76	0.334	10.09	11.42	9.75	11.76	3.10%	6.21%	9.31%	10.22	11.29
X-ray Photon Assay											
Au, ppm	10.72	0.260	10.20	11.24	9.94	11.50	2.43%	4.85%	7.28%	10.18	11.25
4-Acid Digestion											
Ag, ppm	0.646	0.027	0.591	0.700	0.564	0.727	4.22%	8.43%	12.65%	0.613	0.678
Al, wt.%	1.65	0.097	1.46	1.85	1.36	1.95	5.86%	11.72%	17.58%	1.57	1.74
As, ppm	1211	69	1073	1349	1003	1418	5.71%	11.41%	17.12%	1150	1271
Ba, ppm	44.3	2.22	39.8	48.7	37.6	51.0	5.02%	10.04%	15.05%	42.1	46.5
Be, ppm	0.54	0.034	0.47	0.61	0.43	0.64	6.36%	12.73%	19.09%	0.51	0.56
Bi, ppm	0.64	0.033	0.57	0.71	0.54	0.74	5.15%	10.30%	15.45%	0.61	0.67
Ca, wt.%	19.43	1.221	16.99	21.88	15.77	23.10	6.28%	12.57%	18.85%	18.46	20.41
Cd, ppm	0.42	0.028	0.36	0.47	0.33	0.50	6.70%	13.40%	20.10%	0.40	0.44
Ce, ppm	22.8	1.54	19.7	25.9	18.2	27.4	6.74%	13.47%	20.21%	21.7	24.0
Co, ppm	2.21	0.139	1.93	2.48	1.79	2.62	6.30%	12.60%	18.90%	2.10	2.32

SI unit equivalents: ppm (parts per million) ≡ mg/kg ≡ µg/g ≡ 0.0001 wt.% ≡ 1000 ppb (parts per billion).

Note 1: intervals may appear asymmetric due to rounding.

Note 2: the number of decimal places quoted does not imply accuracy of the certified value to this level but are given to minimise rounding errors when calculating 2SD and 3SD windows.

Table 1 continued.

Constituent	Certified Value	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											
Cr, ppm	32.9	4.1	24.8	41.0	20.7	45.1	12.34%	24.69%	37.03%	31.3	34.5
Cs, ppm	3.05	0.117	2.82	3.28	2.70	3.40	3.84%	7.68%	11.52%	2.90	3.20
Cu, ppm	20.9	1.48	17.9	23.9	16.5	25.3	7.08%	14.16%	21.24%	19.9	22.0
Dy, ppm	2.95	0.150	2.65	3.25	2.50	3.40	5.10%	10.20%	15.30%	2.80	3.10
Er, ppm	1.83	0.097	1.64	2.03	1.54	2.12	5.29%	10.58%	15.87%	1.74	1.92
Eu, ppm	0.56	0.034	0.49	0.63	0.46	0.66	6.02%	12.03%	18.05%	0.53	0.59
Fe, wt.%	0.784	0.030	0.724	0.845	0.694	0.875	3.84%	7.68%	11.53%	0.745	0.824
Ga, ppm	4.45	0.350	3.75	5.15	3.40	5.50	7.85%	15.70%	23.55%	4.23	4.67
Gd, ppm	2.88	0.180	2.52	3.25	2.34	3.43	6.25%	12.50%	18.75%	2.74	3.03
Ge, ppm	0.14	0.03	0.09	0.19	0.06	0.21	18.44%	36.89%	55.33%	0.13	0.15
Hf, ppm	0.90	0.072	0.75	1.04	0.68	1.11	8.01%	16.01%	24.02%	0.85	0.94
Ho, ppm	0.63	0.044	0.54	0.71	0.49	0.76	7.07%	14.13%	21.20%	0.59	0.66
In, ppm	0.035	0.005	0.025	0.045	0.020	0.049	13.95%	27.90%	41.84%	0.033	0.037
K, wt.%	0.778	0.043	0.692	0.864	0.649	0.907	5.51%	11.02%	16.53%	0.739	0.817
La, ppm	18.7	1.23	16.3	21.2	15.0	22.4	6.57%	13.13%	19.70%	17.8	19.7
Li, ppm	11.8	0.64	10.5	13.1	9.8	13.7	5.47%	10.93%	16.40%	11.2	12.4
Lu, ppm	0.22	0.017	0.19	0.26	0.17	0.27	7.61%	15.22%	22.83%	0.21	0.23
Mg, wt.%	5.19	0.215	4.76	5.62	4.55	5.84	4.15%	8.29%	12.44%	4.93	5.45
Mn, wt.%	0.041	0.001	0.038	0.044	0.037	0.045	3.28%	6.55%	9.83%	0.039	0.043
Mo, ppm	7.42	0.279	6.86	7.97	6.58	8.25	3.76%	7.51%	11.27%	7.05	7.79
Na, wt.%	0.031	0.006	0.019	0.044	0.013	0.050	19.85%	39.69%	59.54%	0.030	0.033
Nb, ppm	3.82	0.297	3.22	4.41	2.92	4.71	7.79%	15.59%	23.38%	3.63	4.01
Nd, ppm	13.9	0.59	12.8	15.1	12.2	15.7	4.21%	8.43%	12.64%	13.2	14.6
Ni, ppm	31.2	1.91	27.4	35.0	25.4	36.9	6.13%	12.26%	18.39%	29.6	32.7
P, wt.%	0.103	0.005	0.094	0.113	0.089	0.118	4.69%	9.38%	14.08%	0.098	0.109
Pb, ppm	12.2	0.75	10.7	13.7	9.9	14.4	6.13%	12.26%	18.40%	11.6	12.8
Pr, ppm	3.57	0.164	3.24	3.90	3.08	4.07	4.60%	9.20%	13.81%	3.39	3.75
Rb, ppm	59	3.1	53	66	50	69	5.23%	10.47%	15.70%	56	62
Re, ppm	0.007	0.001	0.005	0.009	0.004	0.010	15.34%	30.67%	46.01%	0.007	0.007
S, wt.%	0.049	0.007	0.035	0.062	0.028	0.069	13.86%	27.72%	41.59%	0.046	0.051
Sb, ppm	26.7	1.02	24.7	28.8	23.7	29.8	3.82%	7.65%	11.47%	25.4	28.1
Sc, ppm	4.00	0.252	3.49	4.50	3.24	4.75	6.31%	12.63%	18.94%	3.80	4.20
Se, ppm	9.97	1.08	7.81	12.13	6.73	13.21	10.84%	21.68%	32.53%	9.47	10.47
Sm, ppm	2.65	0.081	2.49	2.82	2.41	2.90	3.05%	6.11%	9.16%	2.52	2.79
Sn, ppm	0.97	0.086	0.79	1.14	0.71	1.22	8.87%	17.74%	26.61%	0.92	1.01
Sr, ppm	321	19	283	359	263	378	5.97%	11.94%	17.92%	305	337
Ta, ppm	0.25	0.03	0.19	0.32	0.16	0.35	12.15%	24.31%	36.46%	0.24	0.27
Tb, ppm	0.45	0.033	0.38	0.51	0.35	0.55	7.24%	14.48%	21.72%	0.43	0.47
Te, ppm	0.21	0.03	0.16	0.26	0.14	0.29	11.96%	23.93%	35.89%	0.20	0.22
Th, ppm	2.94	0.116	2.71	3.17	2.59	3.29	3.95%	7.90%	11.85%	2.79	3.09

SI unit equivalents: ppm (parts per million) ≡ mg/kg ≡ µg/g ≡ 0.0001 wt.% ≡ 1000 ppb (parts per billion).

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											
Ti, wt.%	0.084	0.004	0.075	0.092	0.071	0.097	5.11%	10.23%	15.34%	0.080	0.088
Tl, ppm	9.47	0.363	8.75	10.20	8.38	10.56	3.83%	7.67%	11.50%	9.00	9.95
Tm, ppm	0.25	0.010	0.23	0.27	0.22	0.28	3.97%	7.94%	11.91%	0.23	0.26
U, ppm	6.22	0.302	5.62	6.83	5.32	7.13	4.85%	9.70%	14.55%	5.91	6.54
V, ppm	111	6	100	122	94	127	5.00%	9.99%	14.99%	105	116
W, ppm	10.5	0.49	9.6	11.5	9.1	12.0	4.65%	9.30%	13.95%	10.0	11.1
Y, ppm	24.9	1.19	22.5	27.2	21.3	28.4	4.77%	9.55%	14.32%	23.6	26.1
Yb, ppm	1.57	0.086	1.40	1.74	1.31	1.83	5.49%	10.98%	16.46%	1.49	1.65
Zn, ppm	46.4	3.62	39.2	53.6	35.5	57.3	7.80%	15.61%	23.41%	44.1	48.7
Zr, ppm	31.5	4.7	22.1	40.9	17.3	45.6	14.95%	29.91%	44.86%	29.9	33.0
Aqua Regia Digestion											
Ag, ppm	0.524	0.043	0.439	0.610	0.396	0.653	8.14%	16.28%	24.43%	0.498	0.551
Al, wt.%	0.549	0.056	0.438	0.661	0.382	0.717	10.17%	20.35%	30.52%	0.522	0.577
As, ppm	1215	61	1094	1337	1033	1398	5.00%	10.00%	15.00%	1154	1276
Ba, ppm	25.1	2.38	20.3	29.8	17.9	32.2	9.51%	19.02%	28.52%	23.8	26.3
Be, ppm	0.40	0.023	0.36	0.45	0.33	0.47	5.78%	11.56%	17.34%	0.38	0.42
Bi, ppm	0.61	0.024	0.56	0.66	0.54	0.69	3.96%	7.92%	11.89%	0.58	0.64
Ca, wt.%	18.56	1.328	15.91	21.22	14.58	22.55	7.16%	14.31%	21.47%	17.64	19.49
Cd, ppm	0.42	0.027	0.36	0.47	0.34	0.50	6.50%	13.00%	19.50%	0.40	0.44
Ce, ppm	16.2	1.15	13.9	18.5	12.7	19.6	7.12%	14.24%	21.36%	15.3	17.0
Co, ppm	2.24	0.30	1.65	2.83	1.36	3.13	13.16%	26.32%	39.48%	2.13	2.35
Cr, ppm	22.1	1.94	18.3	26.0	16.3	28.0	8.77%	17.53%	26.30%	21.0	23.3
Cs, ppm	1.42	0.20	1.03	1.82	0.83	2.01	13.83%	27.67%	41.50%	1.35	1.50
Cu, ppm	20.5	1.87	16.8	24.3	14.9	26.1	9.12%	18.23%	27.35%	19.5	21.6
Dy, ppm	2.89	0.241	2.40	3.37	2.16	3.61	8.34%	16.69%	25.03%	2.74	3.03
Er, ppm	1.72	0.117	1.49	1.96	1.37	2.08	6.80%	13.59%	20.39%	1.64	1.81
Eu, ppm	0.55	0.037	0.47	0.62	0.44	0.66	6.72%	13.43%	20.15%	0.52	0.57
Fe, wt.%	0.759	0.060	0.640	0.878	0.580	0.937	7.85%	15.69%	23.54%	0.721	0.797
Ga, ppm	1.75	0.22	1.30	2.19	1.08	2.41	12.68%	25.36%	38.04%	1.66	1.83
Gd, ppm	2.83	0.206	2.42	3.24	2.21	3.45	7.27%	14.55%	21.82%	2.69	2.97
Ge, ppm	< 0.1	IND	IND	IND	IND	IND	IND	IND	IND	IND	IND
Hf, ppm	0.22	0.03	0.16	0.27	0.13	0.30	12.63%	25.27%	37.90%	0.21	0.23
Hg, ppm	96	4.2	88	104	83	109	4.38%	8.77%	13.15%	91	101
Ho, ppm	0.60	0.052	0.49	0.70	0.44	0.75	8.80%	17.59%	26.39%	0.57	0.63
In, ppm	0.034	0.004	0.025	0.042	0.021	0.047	12.88%	25.77%	38.65%	0.032	0.035
K, wt.%	0.277	0.023	0.231	0.322	0.209	0.345	8.19%	16.39%	24.58%	0.263	0.291
La, ppm	12.9	0.74	11.4	14.4	10.7	15.1	5.74%	11.47%	17.21%	12.2	13.5
Li, ppm	4.37	0.427	3.52	5.23	3.09	5.65	9.77%	19.54%	29.30%	4.15	4.59
Lu, ppm	0.19	0.014	0.16	0.22	0.14	0.23	7.57%	15.15%	22.72%	0.18	0.20
Mg, wt.%	4.87	0.176	4.52	5.22	4.34	5.40	3.61%	7.21%	10.82%	4.63	5.11

SI unit equivalents: ppm (parts per million) ≡ mg/kg ≡ µg/g ≡ 0.0001 wt.% ≡ 1000 ppb (parts per billion).

Note 1: intervals may appear asymmetric due to rounding.

Note 2: the number of decimal places quoted does not imply accuracy of the certified value to this level but are given to minimise rounding errors when calculating 2SD and 3SD windows.

Table 1 continued.

Constituent	Certified Value	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											
Mn, wt.%	0.041	0.003	0.035	0.047	0.032	0.050	7.48%	14.96%	22.44%	0.039	0.043
Mo, ppm	7.36	0.617	6.12	8.59	5.51	9.21	8.39%	16.77%	25.16%	6.99	7.72
Nb, ppm	0.11	0.02	0.08	0.15	0.07	0.16	14.36%	28.73%	43.09%	0.11	0.12
Nd, ppm	11.4	0.92	9.5	13.2	8.6	14.1	8.09%	16.17%	24.26%	10.8	12.0
Ni, ppm	30.4	2.40	25.6	35.2	23.2	37.6	7.90%	15.79%	23.69%	28.9	31.9
P, wt.%	0.100	0.011	0.078	0.123	0.066	0.134	11.36%	22.71%	34.07%	0.095	0.105
Pb, ppm	12.1	1.18	9.7	14.4	8.5	15.6	9.78%	19.56%	29.34%	11.5	12.7
Pr, ppm	2.74	0.229	2.28	3.20	2.05	3.43	8.35%	16.69%	25.04%	2.60	2.88
Rb, ppm	20.4	2.1	16.2	24.6	14.1	26.6	10.22%	20.44%	30.65%	19.4	21.4
Re, ppm	0.007	0.001	0.004	0.009	0.003	0.010	19.37%	38.73%	58.10%	0.006	0.007
S, wt.%	0.045	0.009	0.027	0.063	0.018	0.072	20.22%	40.44%	60.67%	0.042	0.047
Sb, ppm	19.7	2.2	15.4	24.1	13.2	26.3	11.06%	22.11%	33.17%	18.7	20.7
Sc, ppm	3.87	0.40	3.06	4.67	2.65	5.08	10.45%	20.89%	31.34%	3.67	4.06
Se, ppm	8.97	0.747	7.48	10.46	6.73	11.21	8.33%	16.66%	24.99%	8.52	9.42
Sm, ppm	2.39	0.170	2.05	2.73	1.88	2.90	7.11%	14.21%	21.32%	2.27	2.51
Sn, ppm	0.60	0.08	0.43	0.76	0.35	0.85	13.91%	27.81%	41.72%	0.57	0.63
Sr, ppm	308	26	256	361	230	387	8.50%	17.00%	25.50%	293	324
Ta, ppm	< 0.01	IND	IND	IND	IND	IND	IND	IND	IND	IND	IND
Tb, ppm	0.44	0.033	0.37	0.51	0.34	0.54	7.55%	15.11%	22.66%	0.42	0.46
Te, ppm	0.20	0.04	0.12	0.28	0.09	0.32	19.33%	38.66%	57.99%	0.19	0.21
Th, ppm	2.43	0.128	2.17	2.68	2.04	2.81	5.29%	10.59%	15.88%	2.31	2.55
Ti, wt.%	0.008	0.002	0.004	0.011	0.002	0.013	23.07%	46.14%	69.21%	0.007	0.008
Tl, ppm	7.52	0.77	5.98	9.06	5.21	9.83	10.22%	20.45%	30.67%	7.14	7.90
Tm, ppm	0.23	0.008	0.21	0.25	0.21	0.25	3.38%	6.76%	10.14%	0.22	0.24
U, ppm	5.07	0.283	4.50	5.64	4.22	5.92	5.59%	11.18%	16.77%	4.82	5.32
V, ppm	60	6	48	73	42	79	10.20%	20.40%	30.60%	57	63
W, ppm	5.12	0.456	4.20	6.03	3.75	6.48	8.91%	17.82%	26.73%	4.86	5.37
Y, ppm	23.2	1.32	20.6	25.8	19.2	27.1	5.67%	11.35%	17.02%	22.0	24.4
Yb, ppm	1.41	0.130	1.15	1.67	1.02	1.80	9.18%	18.36%	27.54%	1.34	1.48
Zn, ppm	42.9	3.10	36.8	49.1	33.7	52.2	7.21%	14.42%	21.63%	40.8	45.1
Zr, ppm	7.93	0.652	6.62	9.23	5.97	9.88	8.22%	16.44%	24.66%	7.53	8.32

SI unit equivalents: ppm (parts per million) ≡ mg/kg ≡ µg/g ≡ 0.0001 wt.% ≡ 1000 ppb (parts per billion).

Note 1: intervals may appear asymmetric due to rounding.

Note 2: the number of decimal places quoted does not imply accuracy of the certified value to this level but are given to minimise rounding errors when calculating 2SD and 3SD windows.

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Table 2. Indicative Values for OREAS 273.

Constituent	Unit	Value	Constituent	Unit	Value	Constituent	Unit	Value
Pb Fire Assay								
Pd	ppb	< 5	Pt	ppb	< 5			
Aqua Regia Digestion (sample weights 10-50g)								
Au	ppm	0.357						
Cyanide Leach								
Au	ppm	6.41						
4-Acid Digestion								
B	ppm	39.3	Hg	ppm	26.5	Si	wt.%	0.065
Aqua Regia Digestion								
B	ppm	12.5	Pd	ppb	< 10	Si	wt.%	0.006
Na	wt.%	0.010	Pt	ppb	< 5			
Borate Fusion XRF								
Al_2O_3	wt.%	3.05	MgO	wt.%	8.92	SiO_2	wt.%	23.03
CaO	wt.%	28.53	MnO	wt.%	0.050	SO_3	wt.%	0.117
Fe_2O_3	wt.%	1.10	Na_2O	wt.%	0.015	TiO_2	wt.%	0.140
K_2O	wt.%	0.907	P_2O_5	wt.%	0.230			
Thermogravimetry								
LOI^{1000}	wt.%	33.51						
Infrared Combustion								
C	wt.%	10.85	S	wt.%	< 0.01			
Laser Ablation ICP-MS								
Ag	ppm	0.900	Hf	ppm	1.85	Sm	ppm	2.81
As	ppm	1350	Ho	ppm	0.68	Sn	ppm	1.20
Ba	ppm	49.8	In	ppm	< 0.05	Sr	ppm	319
Be	ppm	0.60	La	ppm	19.5	Ta	ppm	0.31
Bi	ppm	0.79	Lu	ppm	0.25	Tb	ppm	0.48
Cd	ppm	0.50	Mn	wt.%	0.045	Te	ppm	< 0.2
Ce	ppm	22.9	Mo	ppm	7.40	Th	ppm	3.10
Co	ppm	3.20	Nb	ppm	4.13	Ti	wt.%	0.087
Cr	ppm	38.5	Nd	ppm	14.7	Tl	ppm	5.80
Cs	ppm	3.26	Ni	ppm	37.0	Tm	ppm	0.27
Cu	ppm	28.0	Pb	ppm	16.0	U	ppm	6.53
Dy	ppm	2.99	Pr	ppm	3.78	V	ppm	121
Er	ppm	1.99	Rb	ppm	62	W	ppm	11.0
Eu	ppm	0.60	Re	ppm	0.013	Y	ppm	25.8
Ga	ppm	5.45	Sb	ppm	30.9	Yb	ppm	1.73
Gd	ppm	2.85	Sc	ppm	4.05	Zn	ppm	55
Ge	ppm	0.38	Se	ppm	< 5	Zr	ppm	65

SI unit equivalents: ppm (parts per million) ≡ mg/kg ≡ µg/g ≡ 0.0001 wt.% ≡ 1000 ppb (parts per billion).

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

INTRODUCTION

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

The refractory nature of the ore resulted in the gold analyses by aqua regia digestion and cyanide leach to be semi-quantitative and the data is presented in Table 2 for informational purposes only. 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 273-DataPack.1.0.210526_171005.xlsx**).

Results are also presented in scatter plots for gold by fire assay and PhotonAssay (Figures 1 and 2, 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 273 was prepared from high-grade oxidised gold ore from the Cortez Mine located in Lander and Eureka County, Nevada, USA. The mine is located on the Carlin Trend approximately 75 miles (120 km) southwest of Elko and is owned by Nevada Gold Mines (operated by Barrick).

Gold is surrounded by and intergrown with quartz and iron oxides that resulted from late-stage oxidation of hydrothermal sulphides. Many of the iron oxides contain significant amounts of As, with the gold commonly being concentrated in the zones of highest As (Radtke, et al., 1987, as cited in Portergeo, 2021).

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 273 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 273 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 273.

Bulk Density (g/L)	Moisture%	Munsell Notation‡	Munsell Color‡
662.2	0.99	N5	Medium 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 (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 on ~350g sample weights using 4 Chrysos PhotonAssay machines at 3 laboratories. Multiple rounds of data (comprising three or six replicates) were generated by different staff from 3 of the machines;
- 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).

The refractory nature of the ore resulted in the gold analyses by aqua regia digestion and cyanide leach to be semi-quantitative and the data is presented in Table 2 for informational purposes only. 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.

STATISTICAL ANALYSIS

Standard Deviation intervals (see Table 1) provide an indication of a level of performance that might reasonably be expected from a laboratory being monitored by this CRM in a QA/QC program. They take into account errors attributable to measurement uncertainty and CRM variability. For an effective CRM the contribution of the latter should be negligible in comparison to measurement errors. The Standard Deviation values include all sources of measurement uncertainty: between-lab variance, within-run variance (precision errors) and CRM variability.

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 'Instructions for correct 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.***

Certified Values, Standard Deviations, Confidence Limits and Tolerance Limits (Table 4) have been determined for each analyte following removal of individual, laboratory dataset (batch) and 3SD outliers (single iteration). For individual outliers within a laboratory batch the z-score test is used in combination with a second method that determines the per cent deviation of the individual value from the batch median. Outliers in general are selected on the basis of z-scores > 2.5 and with per cent deviations (i) > 3 and (ii) more than three times the average absolute per cent deviation for the batch. In certain instances, statistician's prerogative has been employed in discriminating outliers.

Each laboratory data set mean is tested for outlying status based on z-score discrimination and rejected if > 2.5. After individual and laboratory data set (batch) outliers have been eliminated a non-iterative 3 standard deviation filter is applied, with those values lying outside this window also relegated to outlying status.

Certified Values are the means of accepted laboratory means after outlier filtering. The INAA data (see Table 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 273 (see 'Homogeneity Evaluation' section below).

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

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

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 20.1 and 21.7 ppm. Put more precisely, this means that if the same number of subsamples were taken and analysed in the same manner repeatedly, 99% of the tolerance intervals so constructed would cover at least 95% of the total population, and 1% of the tolerance intervals would cover less than 95% of the total population (ISO Guide 35).

Please note that tolerance limits pertain to the homogeneity of the CRM only and should not be used as control limits for laboratory performance.

Table 4. 95% Confidence & Tolerance Limits for OREAS 273.

Constituent	Certified	95% Confidence Limits		95% Tolerance Limits	
	Value	Low	High	Value	Low
Pb Fire Assay					
Au, Gold (ppm)	10.76	10.64	10.87	10.72*	10.79*
X-ray Photon Assay					
Au, Gold (ppm)	10.72	10.21	11.23	10.71*	10.73*
4-Acid Digestion					
Ag, Silver (ppm)	0.646	0.635	0.657	0.612	0.680
Al, Aluminium (wt.%)	1.65	1.61	1.70	1.62	1.69
As, Arsenic (ppm)	1211	1180	1241	1187	1235
Ba, Barium (ppm)	44.3	43.3	45.3	43.0	45.5
Be, Beryllium (ppm)	0.54	0.52	0.55	0.51	0.57
Bi, Bismuth (ppm)	0.64	0.62	0.66	0.62	0.66
Ca, Calcium (wt.%)	19.43	18.88	19.98	19.06	19.81
Cd, Cadmium (ppm)	0.42	0.40	0.43	0.39	0.44
Ce, Cerium (ppm)	22.8	22.2	23.5	22.0	23.6
Co, Cobalt (ppm)	2.21	2.14	2.27	2.08	2.33
Cr, Chromium (ppm)	32.9	31.2	34.6	31.4	34.4
Cs, Caesium (ppm)	3.05	3.00	3.10	2.95	3.15
Cu, Copper (ppm)	20.9	20.3	21.5	20.1	21.7
Dy, Dysprosium (ppm)	2.95	2.86	3.04	2.86	3.04
Er, Erbium (ppm)	1.83	1.77	1.90	1.76	1.90
Eu, Europium (ppm)	0.56	0.54	0.59	0.53	0.59
Fe, Iron (wt.%)	0.784	0.772	0.797	0.768	0.801
Ga, Gallium (ppm)	4.45	4.29	4.62	4.31	4.59
Gd, Gadolinium (ppm)	2.88	2.78	2.99	2.79	2.98
Ge, Germanium (ppm)	0.14	0.12	0.16	IND	IND
Hf, Hafnium (ppm)	0.90	0.87	0.92	0.82	0.97
Ho, Holmium (ppm)	0.63	0.59	0.66	0.60	0.65
In, Indium (ppm)	0.035	0.033	0.037	0.030	0.040
K, Potassium (wt.%)	0.778	0.760	0.796	0.760	0.797
La, Lanthanum (ppm)	18.7	18.1	19.3	18.2	19.2
Li, Lithium (ppm)	11.8	11.5	12.0	11.3	12.3
Lu, Lutetium (ppm)	0.22	0.21	0.23	0.20	0.24
Mg, Magnesium (wt.%)	5.19	5.10	5.29	5.11	5.28
Mn, Manganese (wt.%)	0.041	0.041	0.042	0.040	0.042
Mo, Molybdenum (ppm)	7.42	7.31	7.52	7.21	7.62
Na, Sodium (wt.%)	0.031	0.029	0.034	0.029	0.034
Nb, Niobium (ppm)	3.82	3.68	3.95	3.65	3.98

SI unit equivalents: ppm (parts per million) ≡ mg/kg ≡ µg/g ≡ 0.0001 wt.% ≡ 1000 ppb (parts per billion).

*Gold Tolerance Limits for typical 30g fire assay and 350g x-ray photon assay methods are determined from 20 x 85mg INAA results and the Sampling Constant (Ingamells & Switzer, 1973).

Note: intervals may appear asymmetric due to rounding.

Table 4 continued.

Constituent	Certified	95% Confidence Limits		95% Tolerance Limits	
	Value	Low	High	Value	Low
4-Acid Digestion continued					
Nd, Neodymium (ppm)	13.9	13.6	14.3	13.5	14.4
Ni, Nickel (ppm)	31.2	30.3	32.0	30.1	32.2
P, Phosphorus (wt.%)	0.103	0.101	0.105	0.101	0.106
Pb, Lead (ppm)	12.2	11.8	12.6	11.8	12.6
Pr, Praseodymium (ppm)	3.57	3.48	3.67	3.47	3.68
Rb, Rubidium (ppm)	59	58	61	58	61
Re, Rhenium (ppm)	0.007	0.007	0.007	IND	IND
S, Sulphur (wt.%)	0.049	0.046	0.052	0.047	0.050
Sb, Antimony (ppm)	26.7	26.3	27.2	26.0	27.5
Sc, Scandium (ppm)	4.00	3.88	4.11	3.82	4.17
Se, Selenium (ppm)	9.97	9.28	10.66	9.24	10.70
Sm, Samarium (ppm)	2.65	2.62	2.69	2.54	2.77
Sn, Tin (ppm)	0.97	0.93	1.00	IND	IND
Sr, Strontium (ppm)	321	313	329	314	327
Ta, Tantalum (ppm)	0.25	0.23	0.27	0.24	0.27
Tb, Terbium (ppm)	0.45	0.43	0.47	0.43	0.47
Te, Tellurium (ppm)	0.21	0.20	0.22	0.16	0.26
Th, Thorium (ppm)	2.94	2.89	2.99	2.87	3.01
Ti, Titanium (wt.%)	0.084	0.082	0.086	0.082	0.086
Tl, Thallium (ppm)	9.47	9.31	9.64	9.25	9.70
Tm, Thulium (ppm)	0.25	0.24	0.25	0.23	0.26
U, Uranium (ppm)	6.22	6.10	6.35	6.11	6.34
V, Vanadium (ppm)	111	109	113	108	114
W, Tungsten (ppm)	10.5	10.3	10.8	10.3	10.8
Y, Yttrium (ppm)	24.9	24.4	25.3	24.4	25.3
Yb, Ytterbium (ppm)	1.57	1.52	1.62	1.48	1.66
Zn, Zinc (ppm)	46.4	44.9	47.9	44.9	47.9
Zr, Zirconium (ppm)	31.5	29.4	33.5	30.2	32.7
Aqua Regia Digestion					
Ag, Silver (ppm)	0.524	0.504	0.545	0.503	0.546
Al, Aluminium (wt.%)	0.549	0.524	0.575	0.531	0.568
As, Arsenic (ppm)	1215	1188	1243	1190	1241
Ba, Barium (ppm)	25.1	23.8	26.3	24.0	26.1
Be, Beryllium (ppm)	0.40	0.39	0.41	0.37	0.43
Bi, Bismuth (ppm)	0.61	0.60	0.62	0.59	0.63
Ca, Calcium (wt.%)	18.56	17.88	19.25	18.26	18.86
Cd, Cadmium (ppm)	0.42	0.41	0.43	0.39	0.45
Ce, Cerium (ppm)	16.2	15.6	16.7	15.7	16.6

SI unit equivalents: ppm (parts per million) ≡ mg/kg ≡ µg/g ≡ 0.0001 wt.% ≡ 1000 ppb (parts per billion).
Note: intervals may appear asymmetric due to rounding.

Table 4 continued.

Constituent	Certified	95% Confidence Limits		95% Tolerance Limits	
	Value	Low	High	Value	Low
Aqua Regia Digestion continued					
Co, Cobalt (ppm)	2.24	2.09	2.39	2.13	2.36
Cr, Chromium (ppm)	22.1	21.2	23.0	21.2	23.1
Cs, Caesium (ppm)	1.42	1.32	1.53	1.36	1.49
Cu, Copper (ppm)	20.5	19.7	21.3	19.8	21.2
Dy, Dysprosium (ppm)	2.89	2.69	3.08	2.77	3.01
Er, Erbium (ppm)	1.72	1.64	1.81	1.64	1.81
Eu, Europium (ppm)	0.55	0.50	0.59	0.48	0.61
Fe, Iron (wt.%)	0.759	0.732	0.785	0.740	0.777
Ga, Gallium (ppm)	1.75	1.63	1.87	1.65	1.85
Gd, Gadolinium (ppm)	2.83	2.66	3.00	2.76	2.91
Ge, Germanium (ppm)	< 0.1	IND	IND	IND	IND
Hf, Hafnium (ppm)	0.22	0.20	0.23	0.20	0.23
Hg, Mercury (ppm)	96	94	98	94	98
Ho, Holmium (ppm)	0.60	0.55	0.65	0.58	0.61
In, Indium (ppm)	0.034	0.032	0.035	0.029	0.038
K, Potassium (wt.%)	0.277	0.267	0.287	0.267	0.287
La, Lanthanum (ppm)	12.9	12.5	13.2	12.6	13.2
Li, Lithium (ppm)	4.37	4.13	4.61	4.18	4.56
Lu, Lutetium (ppm)	0.19	0.18	0.20	0.17	0.20
Mg, Magnesium (wt.%)	4.87	4.78	4.96	4.80	4.94
Mn, Manganese (wt.%)	0.041	0.039	0.042	0.040	0.041
Mo, Molybdenum (ppm)	7.36	7.08	7.63	7.16	7.55
Nb, Niobium (ppm)	0.11	0.10	0.12	IND	IND
Nd, Neodymium (ppm)	11.4	10.6	12.1	11.0	11.7
Ni, Nickel (ppm)	30.4	29.3	31.5	29.4	31.5
P, Phosphorus (wt.%)	0.100	0.095	0.105	0.098	0.103
Pb, Lead (ppm)	12.1	11.5	12.7	11.7	12.4
Pr, Praseodymium (ppm)	2.74	2.55	2.93	2.64	2.85
Rb, Rubidium (ppm)	20.4	19.3	21.5	19.7	21.1
Re, Rhenium (ppm)	0.007	0.006	0.007	IND	IND
S, Sulphur (wt.%)	0.045	0.040	0.049	0.042	0.048
Sb, Antimony (ppm)	19.7	18.7	20.7	19.0	20.4
Sc, Scandium (ppm)	3.87	3.68	4.06	3.67	4.06
Se, Selenium (ppm)	8.97	8.62	9.32	8.53	9.41
Sm, Samarium (ppm)	2.39	2.28	2.50	2.31	2.48
Sn, Tin (ppm)	0.60	0.55	0.64	0.58	0.62
Sr, Strontium (ppm)	308	297	320	302	314
Ta, Tantalum (ppm)	< 0.01	IND	IND	IND	IND

SI unit equivalents: ppm (parts per million) ≡ mg/kg ≡ µg/g ≡ 0.0001 wt.% ≡ 1000 ppb (parts per billion).
Note: intervals may appear asymmetric due to rounding.

Table 4 continued.

Constituent	Certified	95% Confidence Limits		95% Tolerance Limits	
	Value	Low	High	Value	Low
Aqua Regia Digestion continued					
Tb, Terbium (ppm)	0.44	0.42	0.47	0.42	0.46
Te, Tellurium (ppm)	0.20	0.19	0.22	0.17	0.24
Th, Thorium (ppm)	2.43	2.37	2.49	2.34	2.51
Ti, Titanium (wt.%)	0.008	0.007	0.008	0.007	0.008
Tl, Thallium (ppm)	7.52	7.14	7.90	7.33	7.71
Tm, Thulium (ppm)	0.23	0.22	0.24	0.22	0.24
U, Uranium (ppm)	5.07	4.94	5.20	4.95	5.19
V, Vanadium (ppm)	60	57	63	59	62
W, Tungsten (ppm)	5.12	4.89	5.34	4.96	5.27
Y, Yttrium (ppm)	23.2	22.6	23.8	22.6	23.8
Yb, Ytterbium (ppm)	1.41	1.32	1.50	1.36	1.46
Zn, Zinc (ppm)	42.9	41.6	44.3	41.7	44.2
Zr, Zirconium (ppm)	7.93	7.55	8.30	7.59	8.26

SI unit equivalents: ppm (parts per million) ≡ mg/kg ≡ µg/g ≡ 0.0001 wt.% ≡ 1000 ppb (parts per billion).
Note: intervals may appear asymmetric due to rounding.

Table 5 below shows the gold INAA data determined on 20 x 85mg subsamples of OREAS 273. 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 0.099% was calculated for a 30g fire assay sample (1.86% at 85mg weights) and confirms the high level of gold homogeneity in OREAS 273.

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	11.216	11.160
2	10.958	11.146
3	10.935	11.145
4	11.352	11.167
5	11.307	11.165
6	11.352	11.167
7	11.289	11.164
8	11.031	11.150
9	11.496	11.175
10	11.473	11.174
11	10.936	11.145
12	11.326	11.166
13	11.246	11.162
14	11.016	11.149
15	11.364	11.168
16	10.976	11.147
17	10.806	11.138
18	10.935	11.145
19	11.136	11.156
20	10.988	11.148
Mean	11.157	11.157
Median	11.176	11.158
Std Dev.	0.208	0.011
Rel.Std.Dev.	**1.86%**	**0.099%**

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

- Gold fire assay – 186 samples (31 laboratories each providing analyses on 3 pairs of samples);
- Null Hypothesis, H_0: Between-unit variance is no greater than within-unit variance (reject H_0 if *p*-value < 0.05);
- Alternative Hypothesis, H_1: Between-unit variance is greater than within-unit variance.

P-values are a measure of probability where values less than 0.05 indicate a greater than 95% probability that the observed differences in within-unit and between-unit variances are real. The datasets were filtered for both individual and laboratory data set (batch) outliers prior to the calculation of the *p*-value.

This process derived a *p*-value of 0.99 for Au by fire assay. This *p*-value is 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 273 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 273 is fit-for-purpose as a certified reference material (see 'Intended Use' below).

PARTICIPATING LABORATORIES

1. Actlabs, Ancaster, Ontario, Canada
2. AGAT Laboratories, Mississauga, Ontario, Canada
3. Alex Stewart International, Mendoza, Argentina
4. ALS, Lima, Peru
5. ALS, Loughrea, Galway, Ireland
6. ALS, Perth, WA, Australia
7. ALS, Reno, Nevada, USA
8. ALS, Vancouver, BC, Canada
9. ANSTO, Lucas Heights, NSW, Australia
10. Bureau Veritas Commodities and Trade, Inc., Sparks, Nevada, USA
11. Bureau Veritas Commodities Canada Ltd, Vancouver, BC, Canada
12. Bureau Veritas Geoanalytical, Adelaide, SA, Australia
13. Bureau Veritas Geoanalytical, Perth, WA, Australia
14. ESAN Istanbul, Istanbul, Turkey
15. Inspectorate (BV), Lima, Peru
16. Intertek Genalysis, Adelaide, SA, Australia
17. Intertek Genalysis, Perth, WA, Australia
18. Intertek Tarkwa, Tarkwa, Ghana
19. Intertek Testing Services Philippines, Cupang, Muntinlupa, Philippines
20. MinAnalytical Services, Kalgoorlie, WA, Australia
21. MinAnalytical Services, Perth, WA, Australia
22. MSALABS, Vancouver, BC, Canada
23. Nagrom, Perth, WA, Australia

24. On Site Laboratory Services, Bendigo, VIC, Australia
25. PT Geoservices Ltd, Cikarang, Jakarta Raya, Indonesia
26. PT Intertek Utama Services, Jakarta Timur, DKI Jakarta, Indonesia
27. Saskatchewan Research Council, Saskatoon, Saskatchewan, Canada
28. SGS, Randfontein, Gauteng, South Africa
29. SGS Australia Mineral Services, Kalgoorlie, WA, Australia
30. SGS Australia Mineral Services, Perth, WA, Australia
31. SGS Canada Inc., Vancouver, BC, Canada
32. SGS del Peru, Lima, Peru
33. SGS Tarkwa, Tarkwa, Western Region, Ghana
34. 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.

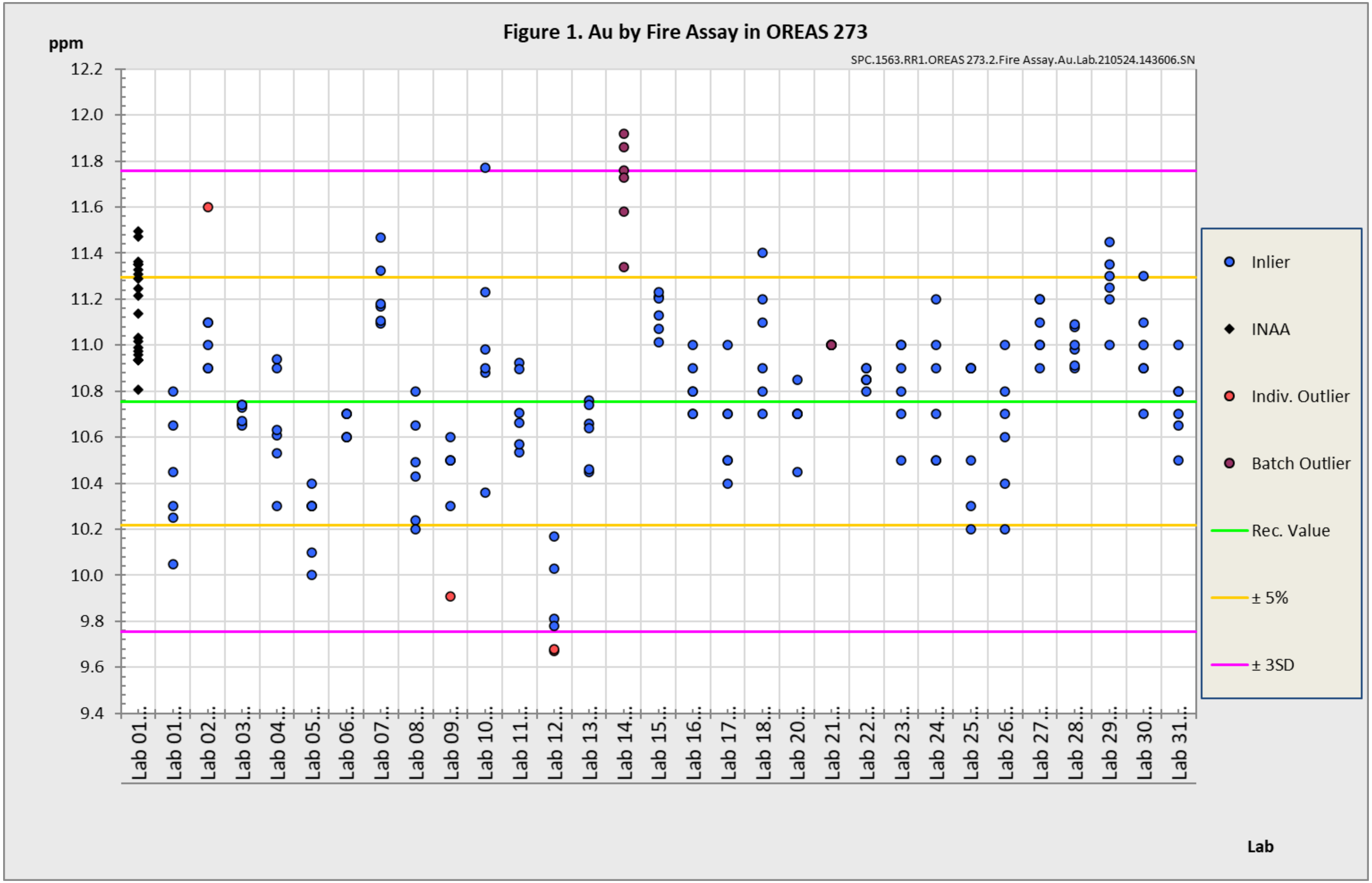
Figure 1. Au by Fire Assay in OREAS 273
ppm
SPC.1563.RR1.OREAS 273.2.Fire Assay.Au.Lab.210524.143606.SN
12.2
12.0
11.8
11.6
11.4
11.2
11.0
10.8
10.6
10.4
10.2
10.0
9.8
9.6
9.4
Lab 01...
Lab 01...
Lab 02...
Lab 03...
Lab 04...
Lab 05...
Lab 06...
Lab 07...
Lab 08...
Lab 09...
Lab 10...
Lab 11...
Lab 12...
Lab 13...
Lab 14...
Lab 15...
Lab 16...
Lab 17...
Lab 18...
Lab 20...
Lab 21...
Lab 22...
Lab 23...
Lab 24...
Lab 25...
Lab 26...
Lab 27...
Lab 28...
Lab 29...
Lab 30...
Lab 31...
Inlier
INAA
Indiv. Outlier
Batch Outlier
Rec. Value
± 5%
± 3SD
Lab

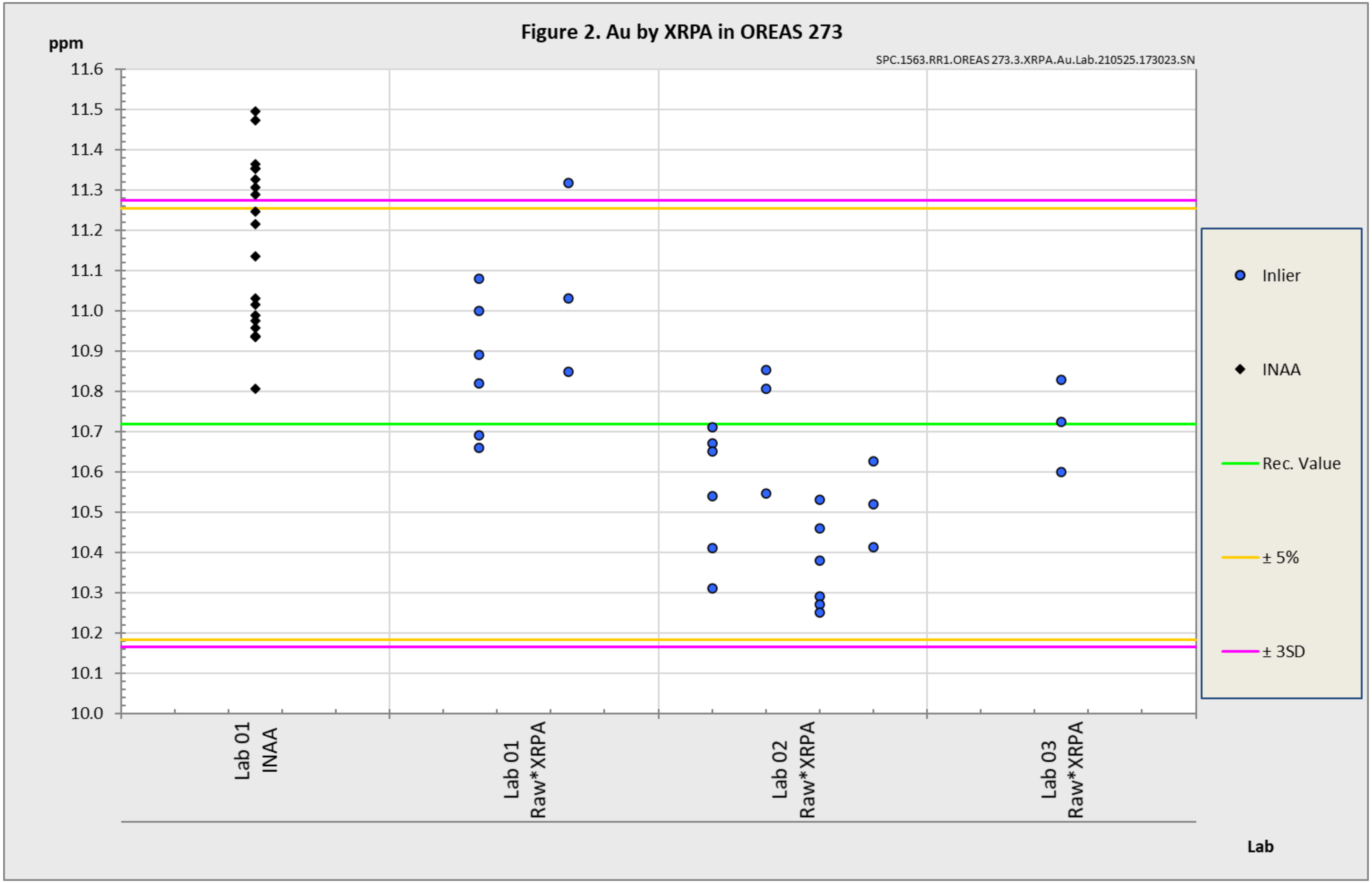
Figure 2. Au by XRPA in OREAS 273
ppm
SPC.1563.RR1.OREAS 273.3.XRPA.Au.Lab.210525.173023.SN
11.6
11.5
11.4
11.3
11.2
11.1
11.0
10.9
10.8
10.7
10.6
10.5
10.4
10.3
10.2
10.1
10.0
Lab 01 INAA
Lab 01 Raw*XRPA
Lab 02 Raw*XRPA
Lab 03 Raw*XRPA
Lab
Inlier
INAA
Rec. Value
± 5%
± 3SD

PREPARER AND SUPPLIER

Certified reference material OREAS 273 was prepared, certified and supplied by:

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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 method is possible. In this case, certification takes place on the basis of agreement among independent measurement results*** *(see ISO Guide 35:2006, Clause 10)."*

COMMUTABILITY

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

INTENDED USE

OREAS 273 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 273 may be used to calibrate the entire procedure by producing a pure substance CRM transformed into a calibration solution.

OREAS 273 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 273 is low in reactive sulphide (0.05 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 273 given its low sulphur concentration (0.05 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 273 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 273 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 PhotonAssay: ~350g;
- 4-acid digestion with ICP-OES and/or MS finish: ≥0.25g;
- Aqua regia digestion with ICP-OES and/or MS finish: ≥0.5g.

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 a first principle 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% confidence 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
0	25th May, 2020	First publication.

CERTIFYING OFFICER

25th May, 2021

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

QMS CERTIFICATION

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.

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